European Commission

# FOSTERING IMPROVED TRAINING TOOLS FOR RESPONSIBLE RESEARCH AND INNOVATION

Grant Agreement n. 741477
**Project Acronym: FIT4RRI**

# Summary Report

## Deliverable 1.3

Due date of deliverable: June 30, 2018
Actual submission date: July 03, 2018

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**Status**: Public

| Function | Staff | Delivery date |
|---|---|---|
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| Internal review | Alfonso Alfonsi (K&I) | June 17, 2018 |
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| Reviewed by | Adrian Solomon, Nikos Zaharis (SEERC) | June 27, 2018 |
| Final version | Luciano d'Andrea (K&I) | June 28, 2018 |
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**Project full title**: Fostering Improved Training Tools for Responsible Research and Innovation
**Start date of the project**: May 1, 2017
**Duration of the project**: 36 months
**Project funding scheme:** Horizon 2020, SwafS-04-2016 - Opening Research Organisations in the European Research Area
**Project co-ordinator**: Università degli Studi di Roma La Sapienza
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This project has received funding from the European Union’s Horizon 2020 Programme for research and innovation under Grant Agreement no. 741477

# Contents

# Introduction

This report summarises the results of WP1 (Mapping and Benchmarking) of the project "Fostering Improved Training Tools for Responsible Research and Innovation" (FIT4RRI), funded by the EU DG Research and Innovation under Horizon 2020 (SwafS-04-2016 - Opening Research Organisations in the European Research Area). The project is implemented by a consortium of 13 partners, led by the Sapienza University of Rome.

The overall aim of the project is to contribute to the diffusion and consolidation of Responsible Research and Innovation (RRI) and Open Science (OS) in European Research Funding and Performing Organisations (RFPOs). This involves enhancing RRI competences and skills through improvements in currently available RRI training (in terms of training tools, actions and strategies), as well as promoting the diffusion of more advanced governance settings to foster the institutional embedment of RRI and OS in research organisations.

In this context, WP1 - Mapping and Benchmarking, coordinated by Conoscenza e Innovazione (K&I), was specifically aimed at mapping the **drivers** for and **barriers** to the diffusion and embedment of RRI practices and approaches in RFPOs and benchmarking **RRI experiences** that have succeeded in mainstreaming RRI practices in individual RFPOs, groups of RFPOs or specific research fields. WP1 is also expected to provide inputs for the RRI-oriented experiments to be carried out under WP3 (Experiments). This component of the project, focused on governance settings, is also expected to interact with the other FIT4RRI component (WP4), focused on RRI and OS training.

WP1 started on May 1, 2017 and ended on June 30, 2018, for a total duration of 14 months.

The Report (D1.3) includes four Chapters.

**Chapter One** describes the institutional framework, the aims and structure of WP1 and the activities carried out. **Chapter Two** focuses on the Literature review (Task 1) and the Context Tailoring Meetings (Task 2), while **Chapter Three** on the Inventory of RRI-oriented experiences (Task 3) and the Benchmarking exercise (Task 4). **Chapter Four** will dwell upon the main points emerging from the WP and some inputs of the experiments to be conducted under WP3.

Two documents are attached to this Report, i.e., the Report on the Literature Review (D1.1) and the Benchmarking Report (D2.1).

The text has been drafted by a team made up of Luciano d'Andrea, Maresa Berliri, and Federico Luigi Marta (K&I).

Chapter One

# Aims, structure and activities of WP1

## 1. Aims

WP1 - Mapping and Benchmarking has been focused on the **analysis of diffusion and embedment of RRI and OS in research organisations**. In accordance with an overall theoretical choice adopted under WP1 and, more in general, in the FIT4RRI Project, the concept of RRI will be used hereinafter as including the notion of Open Science[1].

Two specific objectives have been pursued through the WP1:

- **Building a map of the critical issues** pertaining to RRI for RFPOs by identifying interests, values, trends, drivers for and barriers to the diffusion and embedment of RRI practices and approaches in RFPOs, and
- **Benchmarking experiences**, which succeeded in mainstreaming RRI practices in individual research organisations, groups of them or specific research fields.

WP1 was developed in coordination with WP2 (Sectoral Diagnosis) and was expected to provide inputs to WP3 (Experiments). WP2 is focused on the variability of RRI-related dynamics in different research and disciplinary sectors as well as national contexts while WP3. It includes a literature review (Task 2.1), 5 Sectoral workshops (Task 2.2) and a WP Summary Report (Task 2.5). WP3 is focused on developing 4 co-creation experiments involving different RFPOs (tasks 3.1, 3.2, 3.3, and 3.4), a mutual learning exercise among the actors involved in the experiments (Task 3.5) and a WP Summary Report (Task 3.6).

## 2. Structure

To attain these objectives, **four tasks** have been carried out.

- **Task 1.1 - Literature Review**. This task was aimed at conducting a comprehensive literature review on RRI centred on the governance settings, analysing interests, values, trends, drivers for and barriers to RRI. The task was led by K&I, and conducted in cooperation with the University of Helsinki.

- **Task 1.2 - Context Tailoring Meetings**. This task was aimed at contextualising the outputs of the literature review and refining them through the organisation of a consultation process in Finland, Greece, Italy, and the Netherlands. The task was led by Sapienza University of Rome and conducted in cooperation with K&I, the Maastricht University, the University of Helsinki and SEERC.

- **Task 1.3 - Inventory of RRI advanced experiences**. This task was aimed at developing a typology of advanced governance settings and a methodology for the Benchmarking exercise, to be conducted under Task 1.4. The task was implemented by K&I.

[1] An analysis of the reasons why it was decided to consider Open Science as part of RRI is given in the Report on the Literature Review (see Deliverable D1.1).

– **Task 1.4 - Benchmarking exercise**. This task was aimed at identifying meters (benchmarks) for developing effective RRI governance settings, external conditions facilitating their implementations (enablers) and factors favouring their transferability. The task was led by K&I.

The WP Summary Report is not the subject of any specific task, but is an activity directly in charge of the WP leader (K&I).

As it is easy to observe, Task 1.2 (Context Tailoring Meetings) represents a completion and refinement of Task 1.1 (Literature Review), while Task 1.3 (Inventory of RRI advanced experiences), although provided with its own specific aims, also served as preparatory phase for implementing Task 1.4 (Benchmarking exercise).

Therefore, the structure of WP1 can be understood as organised in two "steams" of action, of which one including Task 1.1 and Task 1.2, and the other including Task 1.3 and Task 1.4, as showed in the following figure.

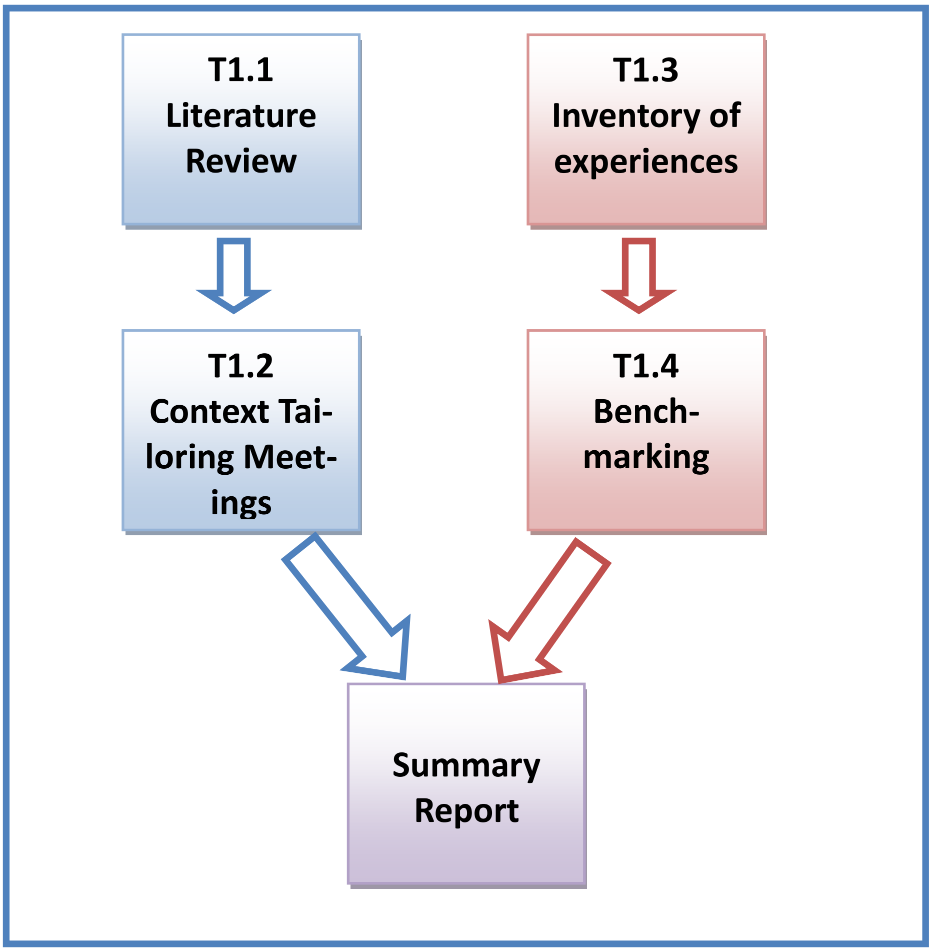


**Figure 1. Structure of WP1**

As specified in the introduction, Chapter Two will be focused on the first two tasks (Tasks 1.1 and 1.2) and Chapter Three to the other two tasks (Tasks 1.3 and 1.4).

# 3. Activities

In this sub-section, a brief description of the activities carried out under WP1 during the WP implementation period (from May 1, 2017 to June 30, 2018) will be provided.

## *3.1. Activities conducted under Task 1.1*

With regard to Task 1.1 "Literature review", the following activities were carried out in the period June-December 2017.

- Drafting of a "Theoretical and strategic note", i.e., an internal note aimed at providing a theoretical background for WP1 and at defining the structure of the literature review (May 2017).
- Presentation of the contents of the note and, in particular, of the structure of the literature review at the Kick-off Meeting of the project (June 2017).
- First round of analysis of the literature (May to September 2017).
- Drafting of the first part "Structure and methodology" and the second part "Science and Innovation" of the Report on the Literature Review (September 2017).
- Second round of analysis of the literature (October to November 2017).
- Cooperation with the University of Helsinki for the development of Sections 2.1. and 2.2. (devoted to barriers to and drivers of RRI) of the third part "Responsible Research and Innovation" of the Report (November 2017).
- Drafting of the third part and the fourth part "Framing RRI in a changing science" of the Report (November 2017).
- Review of the text at K&I (completed on November 2017).
- Review of the text by Ciência Viva (Carlos Catalão Alves and Gonçalo Praça) as partner in charge of it the final reviewing process (completed on December 2017).
- Development of the final version of the Report on the Literature Review and its submission (January 2, 2018).

The Literature Review was drafted by Luciano d'Andrea and Federico Marta, (K&I), and, for Part Three, sub-section 2.2., by Nina Kahma and Susanna Vase (University of Helsinki - UH).

## *3.2. Activities conducted under Task 1.2*

With regards to Task 1.2 "Context Tailoring Meetings - CTMs", the following activities were carried out in the period October 2017-May 2018.

- Definition of contents and structure of the CTMs (October to November 2017).
- Drafting of the documents necessary to the organisation of the CTMs (October to November 2017), i.e.:
    - The "Note for the implementation of the Context Tailoring Meeting", delivered to the partners in charge of organising the CTM in their own country
    - The "Background document in preparation of the Context Tailoring Meeting", delivered to the participants one week before the event
    - The "Guidelines for the moderator of the Context Tailoring Meeting", delivered to the partners in charge of organising the CTM in their own country

- The "Note on the reporting of the Context Tailoring Meeting", delivered to the partners in charge of organising the CTM in their own country
- The "Informed consent form", delivered to the participants prior to the event.

– Preparation by the consultation process by each involved partner, including the translation, when necessary, of the Background document in the local language, the contacts with potential participants, the sending of the Background document, the organisation of the meetings and interviews (October 2017 to May 2018).
– Implementation of the consultation process[2] in Italy (November 2017), the Netherlands (November 2017 to March 2018), Finland (January 2018), and Greece (April to May 2018).
– Drafting of the fourth national reports (January to May 2018).

### *3.3. Activities conducted under Task 1.3*

With regards to Task 1.3 "Inventory of RRI advanced experiences", the following activities were carried out in the period July 2017-February 2018.

– Definition of the criteria for identifying RRI experiences (July 2017).
– Identification of a large number of experiences focused on RRI, on the basis of different sources (July to December 2017).
– Development of a database (INV1) containing 302 records of RRI experiences (October to December 2017).
– Definition of the criteria for selecting the "Advanced Experiences - AEs" (November 2017).
– Selection and analysis of "AEs" (December 2018).
– Development of a database (INV2) containing 48 records of AEs (January to February 2018
– Selection of AEs to be submitted to the benchmarking process, leading to the development of a third database (INV3) (February 2018).
– Revision and editing of INV1 and INV2 (February 2018).

### *3.4. Activities conducted under Task 1.4*

With regards to Task 1.4 "Benchmarking exercise", the following activities were carried out in the period December 2017-June 2018.

– Review of the scientific literature on benchmarking (December 2017).
– Definition of the benchmarking procedures (December 2017).
– Application of the benchmarking procedures to the AEs included in INV3, collection of additional documentation and development of a dossier for each of them (February to March).
– Drafting of the Benchmarking Report (March to April 2018).
– Internal review of the text at K&I (April 2018).
– Review of the text by the University of Minho (Pedro Principe) as partner in charge of the final reviewing process (April 2018).
– Development of the final version of the Benchmarking Report and its delivery (April 2018).

[2] As is explained in Chapter Two, for organisational reasons, in the Netherlands and Greece the consultation process included more than one meeting and a set of interviews.

Chapter Two

# Literature Reviews and Context Tailoring Meetings

# 1. Introduction

This Chapter is devoted to Task 1.1 "Literature Review" and Task 1.2 "Context Tailoring Meetings". Both tasks were aimed at identifying and mapping trends, drivers and barriers related to the diffusion and embedment of RRI in European research organisations and at developing an analysis of how RRI is perceived and interpreted by both scholars and stakeholders.

The Literature Review allowed to get a wealth of information which has been then the subject of a dialogue with different stakeholders through the organisation of the Context Tailoring Meetings (CTMs) in four European countries conducted. This is the reason why, as already highlighted in the previous Chapter, these two tasks are presented in the same Chapter.

The Chapter is divided into the following graphs, in addition to this introduction:

- **Sub-section 2** describes the features of the Literature Review (aims, structure and methodology)
- **Sub-section 3** is devoted to the description of the CTMs (aims, structure and methodology)
- **Sub-section 4** presents the results emerging from both the Literature Review and the CTMs.

# 2. Literature Review

## *2.1. Aims of the Literature Review*

The Literature Review (attached to this report) was aimed at analysing the **gap between the potential role and the actual impact of RRI** on European research organisations and research systems. To this aim, the Literature Review also considered trends, drivers and barriers entailed with the institutional embedment of RRI in research organisations.

Moreover, the Literature Review was conceived for generating useful inputs about possible strategies, practices and tools to be applied in the four co-creation experiments to be conducted under the WP3.

The Literature Review has been entirely produced by K&I, with the exception of a paragraph (Para. 2.2., Part Three), developed by the University of Helsinki.

## *2.2. Structure of the Literature Review*

The Literature Review includes **four parts**.

**Part One** is devoted to the **aims, structure and methodology** of the Literature Review.

**Part Two** is focused on the **changes affecting science**, both internally and in its relations with society, so as to provide an overall picture about the context in which RRI is to be placed. It includes two sections, strongly intertwined with each other.

- **Theoretical approaches**. This Section includes an analysis of the shift from modern to post-modern society and the theoretical models (Mode 1 - Mode 2, Post-academic science, etc.) developed to account for the many changes affecting science and innovation in the last decades.
- **Change processes.** This Section includes a reasoned inventory of change processes occurring in science and innovation. In particular, the focus is on the problematic aspects related to these changes, especially as concerns the professional and living conditions of scientists and the organisational functioning of research institutions.

**Part Three** is focused on **Responsible Research and Innovation** (RRI), as concerns both the theoretical approaches to RRI and experiences and facts connected to it. It includes two sections.

- **Theoretical approaches**. This Section includes a comparative summary of theories and concepts of RRI, so as to identify its main features and structures.
- **RRI in action**. This Section includes an analysis about the feasibility conditions, drivers and barriers related to RRI, conducted on the basis of a literature review of academic journals and the literature produced in the framework of EC-funded projects focused on RRI.

**Part Four** aims to interpret the **outputs emerging from the previous parts**, in view also of the next steps of FIT4RRI, in order to understand how RRI can actually be used to help scientists and research organisations to meet the challenges related to changes affecting science. It includes three sections.

- **Summary of the main issues**. This Section summarises the contents of the two previous parts.
- **Open questions**. This Section is focused on a reflection about the reasons behind the still limited and uneven penetration of RRI in European research systems.
- **A provisional framework for the experimentations**. This Section provides some orientations for approaching RRI in a way which can be as fruitful as possible in the context of the experiments to be carried out under WP3.

## *2.3. Methodology of the Literature Review*

The Literature Review is the combination of **different components** based on different types of sources and specific approaches.

The **first two components**, respectively focused on the shift from modern to post-modern society and the theoretical models developed to account for the many changes affecting science and innovation, largely leverage upon a consolidated corpus of knowledge and theoretical approaches. In methodological terms, they are based on a typical "theoretical review" (review of theories).

The **third component**, focused on the main changes affecting science, can be methodologically defined as a "scoping review", i.e., a literature review aiming to map the key concepts underpinning a research area through a "snowballing method" allowing to put together issues rarely dealt with comprehensively.

The **fourth component**, devoted to the theoretical approaches to RRI, can be defined as a "conceptual review", primarily based on a second-tier analysis of existing literature reviews on RRI concepts and approaches.

The **fifth and the sixth components**, both devoted to how RRI is or can be implemented, are based on an analysis of specialised sources, i.e., in one case, the deliverables produced under projects carried out in FP7 and Horizon 2020 Framework Programme, and, in the other, scientific articles on drivers and barriers related to RRI.

Overall, 200 texts (published or unpublished) have been consulted.

## 3. Context Tailoring Meetings (CTMs)

### *3.1. Aims of the Context Tailoring Meetings*

As stated in the introduction of this Chapter, on the basis of the results of the Literature Review, a set of focus groups, called "Context Tailoring Meetings - CTMs", and interviews have been organised respectively in Finland, Greece, Italy, and the Netherlands.

The process pursued the objective of **contextualizing the contents and conclusions** of the Literature Review about the transformations taking place in science and the factors hindering the diffusion of RRI among research organisations. This necessarily entailed the collection of information about orientations, representations and opinions of different stakeholders and, especially, of researchers, about the transformations affecting science and about RRI.

The name "Context Tailoring Meetings" has been chosen precisely to express such an objective: to "contextualise" the outputs of the Literature Review, "tailoring" them on the real conditions of the main research actors, leveraging upon information and opinion given by the participants or co-produced during the meetings themselves.

### *3.2. Structure of the Context Tailoring Meetings*

Taking into consideration the outputs of the Literature Review, the CTMs and the interviews have been structured in four parts.

The **first part** concerned the **processes of transformation** which are affecting research and innovation. The main issues considered were: how and to what extent participants[3] perceived these changes; which are, among them, the most problematic, and risky and which the most promising and potentially beneficial; which are the dominant attitudes participants perceive in their organisation towards such changes.

The **second part** concerned the **diffusion of RRI** in research organisations as well as participants' **perception and attitudes toward RRI**. The main issues considered were: to what extent RRI has conceptually and terminologically permeated the participants' organisations and, if

[3] We will use the term "participants" also to refer to "interviewees".

that be the case, how; which are the participants' prevailing attitudes towards RRI; which are the attitudes towards RRI in the participants' organisation.

The **third part** concerned the **feasibility conditions of RRI**. The main issues considered were: under which conditions RRI is actually implementable; to what extent RRI is relevant to the major changes affecting science and innovation; to what extent it is effective; to what extent it is sustainable.

The **fourth part** concerned the **barriers to RRI.** Leveraging upon the results of the Literature Review, different kinds of barriers have been discussed, including political barriers, institutional and organisational barriers and social and cultural barriers.

### *3.3. Methodology of the Context Tailoring Meeting*

Given the objectives of the CTMs, a methodology was adopted based on **dialogue** (through focus groups) and **consultation** (through interviews).

All the participants have been contacted and, once they have accepted to participate, a "Background document in preparation of the Context Tailoring Meetings" has been sent them, prior to the consultation. The document was organised in four parts: an introduction; a Section devoted to the presentation of the RRI; a Section focused on the contents of the CTM; a final Section explaining how the information and opinions would be managed in order to protect the participants' privacy.

Moreover, another methodological document, titled "Note on the implementation of the Context Tailoring Meetings" was developed in order to provide the concerned partners (Sapienza University of Rome, K&I, University of Helsinki, University of Maastricht, and SEERC) with directions about how to organise the CTM.

Finally, a third document, titled "Guidelines for the moderator of the Context Tailoring Meetings" was drafted and sent to the moderators of the CTM in order to help them manage the event or, in case, the interviews.

Each partner has been also provided with a "template" for the reporting process and an informed consent form to be signed by the participants.

All these documents were prepared by K&I and reviewed by Sapienza University of Rome.

As mentioned above, due to organisational reasons, also linked to the difficulties met in the Netherlands and in Greece to involve the participants in a unique event, it was decided to organised more than one CTM, with a smaller number of participants each, and individual interviews. Overall, 59 people were involved, of which 23 in the Netherlands, 15 in Italy, 11 in Greece and 10 in Finland.

A typology of participants, by country, is given below.

| | Finland | Greece | Italy | Netherlands | Total |
|---|---|---|---|---|---|
| Professors and Senior researchers | 6 | 4 | 5 | 10 | **25** |
| Post-docs and PhD students | 1 | 0 | 3 | 4 | **8** |
| University administrative staff | 1 | 0 | 5 | 1 | **7** |
| Representatives of civil society organisations | 0 | 1 | 1 | 2 | **4** |
| Representatives of governments and public administrations | 2 | 2 | 0 | 4 | **8** |
| Representatives of industry and private sector | 0 | 4 | 1 | 2 | **7** |
| **Total** | **10** | **11** | **15** | **23** | **59** |

As it can be easily observed, the category of Senior researchers/Professors largely outnumbers the other categories. Moreover, also considering the groups of Post-doc/PhD students and University administrative staff members, participants working in research organisations were 30 out of 59 participants. This was due to the choice of focusing on those who work in the research domain, being they the main stakeholders involved to whom RRI is addressed.

In Italy, the CTM also viewed the participation of a delegation of the Conference of General Directors of University Administrations (CODAU), which represented a category – the University administrators – usually overlooked or even ignored when RRI-related issues are discussed.

The CTMs lasted around two hours and half and the interviews around 45 minutes. The partners in charge of the organisation of CTMs have been also asked to adapt the structure of CTMs or the interviews to the national context and local needs.

In **Finland**, the CTM was coordinated by Mikko Rask (University of Helsinki), supported by Nina Kahma and Susanna Vase, of the same University.

In **Greece** the CTM consultations were carried out by the SEERC research team and coordinated by its director, Nikos Zaharis.

In **Italy**, the CTM was led by Andrea Riccio (Sapienza University of Rome), coordinator of the FIT4RRI Project, supported by Luciano d'Andrea and Maresa Berliri, both from K&I.

In the **Netherlands**, the activities were coordinated by Harro van Lente (University of Maastricht), supported by Ragna Zeiss and Zahar Koretsky, of the same university.

For each country, a national report has been drafted and delivered to K&I.

## 4. Main results from the Literature Review and the CTMs

In this graph, the main results of both the Literature Review and the CTMs will be presented. Since the Literature Review already led to the drafting of a specific report (attached to this document, including all the references used), only a short summary of the main outputs of it will be proposed, while more room will be devoted to the CTMs and interviews.

Five issues will be in particular considered:

- The transition process affecting science
- The main trends characterising such transition
- Knowledge and awareness of RRI
- Barriers to the implementation of RRI
- Orientations for the implementation of RRI.

### *4.1. Changes affecting science*

**Literature Review**

Part of the Literature Review is devoted to the changes affecting science and innovation from the 1980s onward.

The Literature Review led to some considerations about size and nature of such a transition. The main emerging points are summarised below.

i. **Science and innovation are undergoing a long transitional phase**, variably interpreted through different (half-descriptive and half-prescriptive) theoretical models (Mode 1 - Mode 2, Post-academic science, Post-normal science, Triple/Quadruple Helix approach, Academic Capitalism). The concept of "transition" is used to signify that changes affecting science and innovation (also accelerated by the development of digital technologies) are marking the passage from a configuration of social, cultural, technological and economic conditions to another one, remarkably different. This concept refers both to changes that, like in a drift, are brought about by an accumulation of factors, independently of the agency and intention of the actors involved, and to the kind of guidance that the concerned actors try to provide to these on-going processes. Differently from other transitional processes (e.g., demographic transition or urban transition) the trajectory, the features and the future outcomes of the transition in science are still largely unclear.

ii. **This transitional phase is part of a broader shift from modern to post-modern society**, which affects in similar ways all social institutions (politics, religion, family, state administration, etc.). In modern society, social institutions, science included, were solid, highly structured, authoritative, standardised, and self-contained, while in the post-modern context they appear to be weak, characterised by blurring boundaries, uncertain internal procedures, and de-standardised solutions. While, in the modern context, social institutions were legitimated by the power of the State and rarely questioned, in the post-modern context their legitimacy, credibility and reputation are continuously challenged.

iii. **This critical turn makes science socially weaker**. Science, a social institution, is now characterised by diminishing authority, uncertainty about internal mechanisms and standards, a declining and increasingly difficult access to resources, while public distrust and disaffection toward it increase. What is at stake is not only the management of the growingly complex relations between science and society but also the very functioning of the internal mechanisms of science, pertaining to the way in which scientific knowledge is produced, assessed, and used.

The main outputs of the CTMs largely confirm what emerged from the Literature Review about the transition process, also providing some additional information, which can be summarised in the following points.

a. **An undefined transition**. Participants largely appear to be aware of the transition affecting science and innovation, even though they are not well aware of its nature, features, and future trajectories. This produces in many of them a sense of disorientation and uncertainty. Some of the expressions used by participants can be meaningful for grasping this overall feeling. They speak, for example, of: the "lack of vision and confusion"; frustration due to the fact of "being exposed to the occurring changes"; new procedures and mechanisms to be identified and adopted; the stress and worries of "having to take care of so many things"; "being all worried about working pressure"; the change as inevitable and risky; the change "requires an adaptation by organizations".

b. **A global process**. The transition process is perceived by many as produced by changes which come from afar and which develop in a global dimension. Some participants speak of "open science" and "open innovation" to refer to a science and innovation process open to society and markets in a global perspective. European research and innovation systems are challenged by new competitors (for example, China and India), and have to work in a "new globalised context", characterised by "rapid changes" and the production of a huge amount of data "which nobody knows how to use for the benefit of society".

c. **The decreasing social status of science**. In general, participants highlight a decreasing status of science within society. Some of them, for example, notice how the transition process is connected to a loss of charisma and legitimacy of science in society. According to others, people still keep of thinking to researchers as "someone locked in their ivory tower", although this is no longer true at all. Moreover, citizens do not perceive the different actors involved with science and innovation. For example, PhD students and Post-docs are not perceived at all as "research actors" while they play a pivotal role in the research systems. Other participants observe that transition in science and innovation is rapidly changing science-society relations, producing negative effects on the social image of science.

d. **Increasing tensions**. The transition process in science and innovation is also producing different tensions which impact on the daily life of researchers. Participants highlighted different factors producing tensions such as the difficulty of reconciling research activities with teaching activities, problems met in promoting the so-called "Third mission" of the universities, difficulties in combining research and the market, and the strong pressure on all researchers (especially post-docs and PhDs) due to the growing demand for greater transparency and accountability in research. Another source of tensions is the lack of time researchers experience in their daily life, due to the increasing obligations and tasks they are asked to take on. Dutch participants devoted particular attention to impact assessment (mandatory in that country) which creates quite a few paradoxes. One of them is that, in the Netherlands, the Standard Evaluation Protocol (SEP) provides the assessment of the societal and economic impacts of research programmes while the evaluation of the productivity of researchers is based on scientific excellence, mainly measured on the basis of the quality and number of publications and the quality of the journals in which they are published. There is also a serious gap between academia and industry in the use of research results, which is viewed as another problematic factor.

e. **Risks for the quality of research**. All that notwithstanding, the majority of participants maintain that the quality of research products is still high. However, some participants are anyhow worried that some trends (such as the increasing competition, the shrinking of research funds and the malfunctioning of research evaluation systems; see next graph) could affect the quality of research in the middle and long run.

f. **Transition: a problem or an opportunity?** Obviously, participants also express diversified views of the transition. Many of them see the transition process as offering new and unexpected opportunities for both individual researchers and European research systems. In this perspective, what is needed is that researchers and research organisations adapt their pace to that of change processes. Other participants, on the contrary, see transition especially as a risk and claim for actions to mitigate its negative consequences.

g. **Desire to get involved**. Regardless their view of the transition, an interest and even a desire to get involved in managing the process of change have been expressed by the great majority of participants, especially by researchers. Participants claim that much more opportunities could be given to exchange ideas and opinions on these issues, since they have been rare so far.

### *4.2. The main trends characterising the transition*

**Literature Review**

A Section of the Literature Review (Section 2, Part Two) is devoted to the changes affecting science and innovation. The analysis led to a "**reasoned inventory**" of change processes, focusing attention on those which have a direct impact on the professional and personal condition of scientists and on the daily activities of research organisations.

Such inventory, including 11 main "trends of change", is summarised in the table below.

| TRENDS | DESCRIPTION |
|---|---|
| **1. Hyper-competition** | Science as a hyper-competitive environment entailing an acceleration and modification of the usual research process. |
| **2. Acceleration of the research process** | Working faster seen as a requirement for high quality research; changes in the organisation of academic life and in the researchers' lifestyle; researchers under condition of stress and pressure. |
| **3. Shrinking of research funds** | Increasing difficulties in acquiring funds and publishing; decline in the success rate for grant applicants, with an increasing waste of time. |
| **4. Task diversification** | Market-oriented organisation of the research process, in which research is required to engage with a wider range of different types of activities (participation in extended research networks, direct involvement in innovation and technology transfer, activities related to accountability, transparency and public scrutiny, administrative work, etc.). This is leading to a decrease in the time devoted to scientific work. |

| TRENDS | DESCRIPTION |
|---|---|
| **5. Increasing staffing** | Increased numbers of contingent staff (PhD students and Postdocs), due to the need for cost containment; increased use of soft money to pay the contingent staff: fewer opportunities for young researchers to access permanent positions; increased pressure on young researchers to make more in less time, creating hardships especially for women scientists. |
| **6. Increased segmentation** | Segmentation of staff based on age and contractual status, producing impacts such as:<br>• Decrease in productivity among young researchers<br>• Increased control over academic tasks<br>• Overtraining (tendency to retain PhD students and Postdocs longer than necessary)<br>• Decrease in teaching quality (increasingly done by ever cheaper teaching staff)<br>• Changes in internal labour relationships (research organisations no longer as a "community of peers" but merely as employers)<br>• Individualisation (researchers increasingly acting as individual professionals and not as part of a staff)<br>• Attitude of self-promotion among scientists<br>• Stratification and polarisation of academic staff (academic staff split between those who benefit from change and those who are damaged by it). |
| **7. Increasing mobility** | Mobility as a factor promoting an increase in scientific performance but having possible critical impacts on the lives of researchers, such as: delays in accessing permanent positions; difficulties in returning to one's home country; problems in managing family life, especially for women scientists; loss of social ties. |
| **8. Increasing pressure on research assessment systems** | Traditional research assessment procedures are no longer able to manage the hyperproduction of scientific knowledge; systematic problems and errors in peer review, lessening its reliability; problematic tendency to use quantitative indicators to assess researchers, research institutions and scientific journals, with distorting effects on science quality. |
| **9. Governance shift** | Tendency to adopt entrepreneurial models for managing research organisations, requiring a balance of different steering mechanisms; high variability in types of research organisations; differentiation in terms of national contexts; strong resistance to change; need for highly participatory approaches. |
| **10. Increasing openness to external actors** | Growing need for research organisations and researchers to interact with external actors (political authorities, civil society, industry, etc.) for different reasons (innovation, providing expertise, public engagement, policy issues, societal engagement, science communication, etc.); need to find the right openness level; institutional undervaluation of openness-related initiatives; conceptual ambiguities and interpretive mismatches about openness; resistance and barriers to openness; decreasing trust in science. |
| **11. Critical dynamics affecting the quality of research products** | Impact of changes on the quality of research, such as:<br>• Tendency of researchers to adopt safe and low-risk research strategies (favouring conservative and short-term thinking and penalising more creative and unor- |

| TRENDS | DESCRIPTION |
|---|---|
| | thodox approaches)<br>• Tendency to produce irrelevant science (producing publications for career advancement rather than producing advances in science)<br>• Tendency to produce redundant papers (publishing the same data or papers more than once)<br>• Tendency to work on research project that ensure short-term achievements and profitable results<br>• Increasing malpractice<br>• Decreasing reproducibility of scientific data<br>• Undesirable impacts of commercial interests on research quality. |

The inventory shows that the transition phase which science and innovation are deeply involved with is not only affecting science-society relations or the way in which research organisations interact with industry, but also the **most "intimate" mechanisms of science**, including the reproducibility of scientific data, peer-reviewing, research quality assessment and the organisation of the research process.

**Context Tailoring Meetings**

The inventory developed in the Literature Review has been used as basis for discussing on the trends affecting science and innovation in the CTMs and in the interviews.

In general, while in the Literature Review, a predominantly negative or critical interpretation of the trends is emerged, participants in CTMs and interviewees express diverging opinions. Many of them highlight risks while others assess these trends, or at least some of them, as opening up to new opportunities to harness.

However, the dominant perception is that of **uncertainty**, coupled with a **demand for more effective tools and strategies** for managing the transition. In particular, the lack of a comprehensive view of the transition has been highlighted. This fact limits the possibility to take adequate measures and to identify possible synergies among the trends.

In all the CTMs and interviews, **hyper-competitiveness** among researchers and the **shrinking of research funds** emerge as the trends perceived by most of the discussants as the most problematic, intense and interconnected.

Some specific observations about the 11 trends are reported below.

a. **Hyper-competition**. As we just observed, this trend is perceived by practically all the actors (in particular by researchers) and is considered as one of the most stressful and risky, especially for young researchers. It is mainly viewed as the context or the cause of other trends, with special reference to the shrinking of research funds and the increasing pressure on the research assessment systems.

b. **Acceleration of the research process**. This trend is largely perceived by researchers, also for its impact of their own professional life (for example, in terms of time pressure). It has been observed that this trend makes it more difficult for researchers to understand how to use (also for social and economic purposes) the results of research activities.

c. **Shrinking of research funds**. This trend was considered in all the CTMs and interviews as a general and negative trend. In particular, participants are worried for the decreasing investments on fundamental research (which is considered essential also for fostering innovation) and for the decreasing quality of the research due to inadequate resources. Researchers and research institutions are more and more forced to invest time and energy to apply for research funds (especially European and international calls) with a declining success rates. According to some participants, there is also the risk that this process could favour, not the best projects, but the research groups more able to develop winning research proposals and "to sell them" to the funding agencies.

d. **Task diversification and staff segmentation**. These two trends have been prevalently discussed together. Participants mainly highlighted that they could have negative impacts on the continuity of the researchers' career. Moreover, together with the shrinking of funds, these trends may also lead to a proliferation of research projects with large teams of researchers, in which "we try to do a lot with few resources". This process also penalises part-time and youth researchers and women scientists. Task diversification, in particular, may also have contradictory effects. On the one hand, it can contribute in creating the institutional space allowing researchers to get more engaged in activities addressing science-society relations. On the other hand, when badly managed, it could lead to reduce the time devoted by researchers to research activities and may require new skills and abilities researchers are usually lacking. Specific trainings and economic incentives are therefore needed.

e. **Increasing staffing**. With reference to this trend, participants mainly focused on the risk for young researchers not to find appropriate permanent positions in the research systems. Hence the need for developing support mechanisms and specific policies helping researchers (especially women) in their career path.

f. **Increasing researchers' mobility**. This trend was not considered as risky or negative. On the contrary, in some cases, increasing mobility has been interpreted by participants as an opportunity for researchers to learn and to improve their research skills. It is worth observing how the problematic nature of this trend for promoting women's careers in science and innovation did not emerge.

g. **Governance shift**. This trend has not been discussed much by participants. Some considerations in this regard emerged while discussing other trends (hyper-competitiveness, shrinking of research funds, increasing openness to external actors). In general, it is not clearly perceived by participants.

h. **Increasing pressure on research assessment systems**. This trend has been extensively discussed by participants, even though with significant differences across countries. All participants highlight the tendency towards an increasingly wider use of impact factor as a measure for evaluating both researchers and research institutions. This tendency is largely considered inadequate and misleading, for different reasons.

- It does not allow to take into account the diversification of the tasks and activities carried out, especially in relation to the so-called "third mission" of the universities or to

RRI. Also teaching and management are in this way overlooked and viewed as "time-wasting" activities in terms of career advancement.

- It leads to consider speed in producing results as the main assessment criterion rather than the quality of the research product.
- It entails paradoxes and conflicts related to the relationship, e.g., between the assessment of researchers and the assessment of the impact of their research or between the assessment of curiosity-driven research and the assessment of applied research oriented to innovation and societal issues.
- Finally, it may produce distortions on peer review mechanisms due to the large amount of papers to be reviewed, which leads to controversial practices, selective processes based on power dynamics and patron-client relations, improper use of self-citations and other practices which may jeopardise the quality of the scientific product.

i. **Increasing openness to external actors**. Opening science and innovation to external stakeholders is generally seen as positive by participants, especially for favouring a responsible use of research results and making research more oriented to societal needs. According to some participants, there are widespread resistances to this process, due to the diverging interests between researchers, the public sector and the business sector. This situation is also worsened by the weak links between research and industry as regards both the use of research results and the mobility of researchers between research institutions and private companies. In this general context, CTMs and interviews mainly dwelled upon open access of scientific publications. Some specific issues related to open access deserve to be mentioned.

- Some participants observed that research institutions are not prepared to manage the "big data revolution". In fact, this latter requires important research infrastructures and specific skills which are absent in many research organisations.
- Many participants observed that researchers are not interested to produce open access publications because of the low impact factor of the majority of open access journals.
- Other participants recalled that an important part of research funds comes from the private sector. This makes it difficult for researchers to produce open access publications since research data are generated for industrial purposes.
- According to some participants, sustaining the development of open access publications requires some systemic changes which are difficult to be triggered, such as, e.g., the establishment of ad hoc national and university funds for open access publications, the development of high quality peer review procedures (the example of MIT publications was given) for open access publications, the full involvement of scientific journals to promote open access policies (for example, the creation of open access sections in scientific journals adopting the same quality requirements applied in the print-on-paper journals) as well as the development of actions aimed at raising the awareness of researchers about this issue.

j. **Critical dynamics affecting the quality of research products**. As regards this trend, the great majority of participants did not report a decrease in the research quality, even though other trends (especially the shrinking of research funds) may affect it in the long term. Some participants recalled that the number of frauds and other kinds of abuse or violations in research practices remains stable over time.

## *4.3. Knowledge and awareness of RRI*

**Literature Review**

A specific section of the Literature Review analyses how the concept of RRI has been theoretically developed and which are the models proposed implementing its principles. This provides some indirect information on how much knowledge and awareness of RRI are actually widespread among research organisations, researchers and other stakeholders.

On the basis of this analysis, the Literature Review comes to some conclusions, although of a provisional nature, about the main features of RRI which may favour or hinder its actual acceptance by research and innovation actors. These conclusions are summarised in the following points.

i. **A powerful concept**. RRI is a "buzzword" or an "umbrella word", flexible and open enough to allow different interpretations and applications. For this reason, RRI is or can be a mobilising concept that can spark the interest of different actors and eventually orient research policies at national or institution level. In this sense, RRI is a powerful concept, precisely because it is a "boundary object" that can reflect, combine and coordinate different sets of meanings shared by many groups of people but intuitively comprehensible, albeit in different ways, to anyone.

ii. **A concept with a story behind it**. RRI did not come out of the blue, but is the latest product of discussions and movements developed in the past, each producing different "cognate concepts". Its wide semantic domain allows it to subsume these concepts and issues and to express social values, needs and expectations related to practically any science-in-society issue such as science communication, transparency and accountability of public services, ethical demands, boost to innovation, equal opportunities, people participation, or good governance.

iii. **A hidden assumption**. RRI is based on a hidden critical assumption, according to which science and innovation are (or have been so far) under-responsible, i.e., lacking control over the risks they produce, the social desirability of their impacts and the ethical correctness of their methods or outcomes, or even irresponsible, i.e., actively pursuing objectives or adopting practices which are, e.g., ethically doubtful or socially questionable.

iv. **The normative nature of RRI**. Probably because of this hidden assumption, RRI is almost always seen as a normative and prescriptive approach, aimed at modifying research and innovation processes through different tools and strategies (norms, directions, codes of actions, etc.), even regardless of the actual feasibility conditions. For the same reason, RRI does not have, in principle, limitations in encompassing any possible desirable feature of science and technology, including effectiveness, sustainability, inclusiveness, anticipatory orientation, responsiveness, reflexivity, transparency, care, proactivity, deliberation, accountability, equity and efficiency, with the risk that RRI becomes a sort of a "wish list" about science and technology.

v. **The difficult pathway toward RRI**. The normative and prescriptive nature of RRI seems to make it difficult to be practically applied. The analysis of the RRI application models says something useful in this regard. In many cases, application models are ambitious and unrealistic. In other cases, they do not provide real orientations but simply some principles or methods to guide research organisations into the complexity of RRI. In both cases, a linear pathway towards RRI is privileged. On the contrary, RRI implementation process appears to be highly context-dependent and complex, as concerns contents and dimensions, feasibility conditions and application strategies.

vi. **The low relevance of RRI to the transitional changes affecting science**. Finally, RRI seems to be almost exclusively interpreted as something pertaining to science-society relations. Only incidentally do the interpretations and models examined consider the possible relations between RRI and the main change processes the "inner mechanisms" of scientific production (see sub-section 4.1. above).

There is therefore a sort of a paradox: RRI is a mobilising and powerful concept which is however difficult to apply in the real world and which is little related to the problems researchers and research organisations are dealing with and worried of.

**Context Tailoring Meetings**

As for the CTMs and the interviews, the following issues can be identified with respect to knowledge and awareness of RRI.

a. **A limited knowledge of RRI**. The first point to be highlighted is that most participants had only a vague and limited knowledge of RRI. Only few of them had a specific knowledge in this regard, some participants had heard of it generically, while the majority did not know it at all. According to participants from universities, in their working environment researchers usually do not know RRI and are little aware of the processes RRI mainly refers to. Administrative staff members are more aware than researchers. Other concepts similar or related to RRI seem to be more known, such as "open science", "university third mission" and "corporate social responsibility", "knowledge co-creation" and "impacts of science". National policies have a role in that. For example, in Greece, the notion of RRI and similar concepts are not shared too much also because RRI is not considered a priority in the national research policies; in Italy, the concept of "third mission" is prevalently adopted; in the Netherlands, RRI is not considered in the research policies, while the concept of "impact of research" is included in the national research evaluation system. The knowledge of RRI in the industrial environment seems to be even more limited.

b. **The diffusion of RRI-related principles**. Although the concept of RRI is not widespread, according to many participants, various RRI-related principles and RRI keys are already practised, such as the principles of dialogue with stakeholders, the respect of diversity, research ethics, public engagement and gender equality. In this perspective, some participants posed the question of the added value of the concept of RRI in comparison to more comprehensible and shared concepts. In general, a better definition of RRI, able to take into account national traditions in research and innovation, is needed.

c. **The difficult implementation of RRI**. Shifting from the conceptual to the practical level, other problems emerged. Many participants noticed that the concept is too vague and ambiguous for being concretely adopted by research institutions. Researchers and university leaders met serious problems in understanding, e.g., how RRI can be implemented, who can be responsible for it within an organisation, how to combine RRI-oriented policies with the already existing policies (e.g., pertaining to gender equality or open access) and how to adapt RRI to the organisational context. Other problems are related to costs. Some participants noticed that implementing RRI requires significant short-term investments on the part of the concerned organisations while its economic benefits are uncertain and anyhow produced only in a long-term perspective. Further problems emerge when the application of RRI in the private sector and in industry is concerned, due to the lack of best practices allowing to show if, how, to what extent and under which conditions RRI may generate a competitive advantage for the companies.

d. **The risk of bureaucratisation**. Beyond the difficulties mentioned above, many participants dwelled upon the risk of bureaucratisation of RRI, highlighting, e.g., the risk of making RRI a simple "tick box operation" that does not affect the usual research practices and evaluation mechanisms, an additional "superstructure" imposed on researchers and research staff entailing a set of new obligations to be fulfilled or a simple "label" to put on already existing practices. Moreover, a bureaucratisation process would make RRI impossible to be applied in the small and medium-sized enterprises and, more in general, in the private sector.

### *4.4. Barriers to the implementation of RRI*

**Literature Review**

The Literature Review provides a quite comprehensive analysis of the major **barriers hindering or even impeding the implementation of RRI** or part of it in research organisations. The analysis is based on two different sources:

- Documents of EC-funded projects focused on RRI
- Scientific journals.

From the documents produced under **EC-funded projects**, the barriers which have been identified are presented in the table below, organised in four main categories, i.e., barriers related to the awareness of RRI, barriers related to the relevance of RRI, barriers related to the effectiveness of RRI and barriers related to the sustainability of RRI.

| Group of barriers | Sub-set | Barriers |
|---|---|---|
| **Barriers related to awareness**<br>barriers hindering or impeding the main actors from becoming interested in or aware of RRI and RRI-related issues | Barriers related to overall cultural attitudes of the players involved | - Resistance to change<br>- Risk aversion<br>- Protection of academic freedom<br>- Self-referentiality of RRI actors<br>- Short-term time frame<br>- Researcher specialisation<br>- Value systems of RRI actors<br>- University training approaches |
| | Barriers to the interaction between the actors concerned | - Stereotypes<br>- Lack of collaborative culture<br>- Diverging visions of societal benefits<br>- Conflicts between local, national and international cultures |
| **Barriers related to relevance**<br>barriers which make RRI not relevant (or perceived | Barriers related to existing priority schemes | - Excellence vs. RRI<br>- Pressure to publish<br>- Creating growth and making a profit<br>- Open Access vs. IP/ patenting |

| Group of barriers | Sub-set | Barriers |
|---|---|---|
| as such) to the problems, interests and worries of research actors, stake-holders and the public in general | | - Distrust in scientific institutions and in RRI |
| | Barriers related to the dynamics of RRI incen-tives | - Lack of material incentives<br>- Lack of scientific recognition<br>- RRI as a disincentive for scientific recognition<br>- Lack of incentives for non-R&I actors<br>- Unclear benefits of RRI |
| **Barriers related to effec-tiveness**<br>barriers which make RRI ineffective or not suffi-ciently effective (or create this perception) | Barriers related to uncer-tainty about RRI and RRI implementation | - Uncertainty about the concept<br>- Uncertainty about the promoters<br>- Uncertainty about the process<br>- Uncertainty about the impacts |
| | Barriers related to re-quirements and condi-tions for RRI implemen-tation | - Lack of resources<br>- Lack of skills and training opportunities<br>- Lack of communication channels |
| | Barriers related to spe-cific technical issues in-trinsically connected to RRI implementation | - Management of public participation<br>- Turning RRI outputs into policies |
| **Barriers related to sus-tainability**<br>all the factors make it dif-ficult for RRI to be or be perceived as sustainable, so it can become part of the identity of the actors concerned | | - Bureaucratisation<br>- Lack of investments<br>- Resistance and institutional barriers<br>- Inadequate legal and regulatory framework<br>- Inadequate policy framework<br>- Difficulties in defining objectives<br>- Difficulties in defining responsibilities and implementation procedures<br>- Lack of evidence and data about RRI |

From the scientific journals, the barriers which have been identified are summarised in the points below.

i. **Conceptual ambiguity**. RRI is an ambiguous concept due to different factors (unclear definition of the term, lack of contextualisation to other academic discourses, dogmatic stance in proposing the concept). This represents a barrier in that it leads to a lack of clarity about how RRI approach works or may work in real life.

ii. **Lack of ownership related to top-down governance**. RRI's rhetoric is grounded on a bottom-up approach although it is organized through a top-down approach by the European Commission. This also led to consider RRI more as a frame conducted by policy makers and policy scholars and not by the scientists themselves. Various actors also see RRI as a threat to the autonomy of researchers and academic freedom.

iii. **Lack of guidelines for implementation of RRI**. There is a lack of concrete RRI guidelines, both in general and for specific research fields or disciplines. RRI can be seen as distant and inoperative from the viewpoint of rapidly developing disciplines. Moreover, the overall uncertainty both in the political and economic realm in Europe has, in recent years, posed challenges for implementing RRI.

iv. **Inadequate institutional structures**. The lack of adequate institutional structures is observed, at different levels: governmental institutions, funding bodies, ethical boards, academic institutions, industry and corporations. This situation makes it difficult, e.g., the interdisciplinary work, the cooperation among the actors within research institutions and that among stakeholders, and the definition of a common RRI framework.

v. **Lack of proof of the benefits of RRI**. The most important obstacles for engagement in RRI can be found in the stakeholders not being able to see its benefits. RRI is often seen as an external element, a constraint or an additional norm imposed from the outside to science and innovation. At the core of not seeing the benefits of applying RRI there are also financial issues, such as budget constraints and unpredictable costs.

**Context Tailoring Meetings**

In the CTMs and interviews, issues related to the feasibility conditions of RRI and the barriers to its implementation were addressed. For the sake of simplicity, barriers have been classified in three categories: political barriers; institutional and organizational barriers; social and cultural barriers.

a. **Political barriers**. In this domain, the lack of interest in RRI at the country level was highlighted, which results in the absence of specific legislation and national policies and frameworks also due to the low priority attached to RRI or to the research sector as a whole. In the Netherlands this element did not emerge probably because of the strong engagement of the national governments, if not on RRI, certainly on advanced forms of research and innovation.

b. **Institutional and organisational barriers**. Many participants identified the major barriers to RRI in the current organisation of universities that does not allow researchers, administrative staff and other stakeholders to work adopting RRI-oriented approaches. The same organisational boundaries both between institutions and within single institutions (for example, departments and divisions) make the adoption of RRI quite difficult. Another issue is the lack of support by and limited engagement of the leaders of research organisations. All that has some consequences: RRI is prevalently conducted by few researchers on a voluntary basis; when this is not the case, it is not clear who is responsible for its implementation; guidelines or guidance on how to implement RRI are lacking; there are no incentives, infrastructures, and resources for pushing researchers and research organisations to implement RRI; research organisations adopt different regulations and approaches which limit inter-organisational cooperation; there are few training opportunities on RRI; many bureaucratic procedures impede or hinder the implementation of RRI; lack of monitoring procedures; European networks involving researchers and research institutions in support of RRI are lacking.

c. **Social and cultural barriers**. These barriers largely vary across the research areas and disciplines. Moreover, differences can be observed between the public sector and the private sector. It has been also noticed that the concept of RRI is too abstract and vague to be considered as relevant for the life of researchers and research organisations. In general, the main barriers emerged from CTMs and interviews are: low level of awareness on the usefulness and interest of RRI for the researchers; resistance to see RRI a priority with respect to other issues, such as teaching, quality of research, or research evaluation, with the effect to simply consider RRI-related activities a waste of time; resistance to adopt new concepts by researchers, also depending upon the different disciplinary cultures; difficulties by researchers and major stakeholders to clearly identify the added value of RRI in general and also with respect to existing policies pertaining to, e.g., ethical issues, gender equality or open access; lack of trust between the various stakeholders involved in the implementation of RRI; lack of a "vocabulary" of RRI in the different national languages.

### *4.5. Orientations for the implementation of RRI*

**Literature Review**

In the last part of the Literature Review, some orientations were given for favouring the implementation of RRI. They can be summarised in three main points.

i. **Considering RRI as a set of opportunities**. It might be useful to weaken the normative view of RRI. Rather than a set of principles and orientations to be applied to research practices, RRI should be more usefully viewed as a set of opportunities available to researchers, research institutions and other stakeholders to address the major problems they have to deal with in their daily business.

ii. **Connecting RRI to the changes affecting science**. RRI should be viewed as relevant to all transitional changes affecting science (and not only to those related to science-in-society issues). Moreover, RRI could be viewed as a strategy helping research institutions, researchers and other relevant actors to manage such changes effectively. Thus, there is the need to adopt RRI, not only because it is right, but especially because it is useful for appropriately dealing with the transition affecting science and innovation.

iii. **Recognising the context-sensitive nature of RRI**. It is finally important to recognise the context-sensitive nature of RRI. Any attempt to implement RRI principles and tools should be necessarily tailored to the organisation involved in it. This means that there is not a unique RRI but many RRIs, according to the organisation in which RRI is applied. Such an approach would be also important in order to avoid adhering to a fully prescriptive and normative view of RRI.

**Context Tailoring Meetings**

Some orientations about possible strategies aimed at implementing RRI also emerged from CTMs and interviews. They are summarised in the following points.

a. **Managing the conceptual vagueness of RRI**. Clarifying the concept of RRI is considered by many participants a requirement for putting it into practice. RRI still means many different things depending on who uses it and why. Creating a common basket of meanings revolving around RRI is thus needed. It is also necessary to connect the concept of RRI with other similar concepts such as "open access" and "open science".

b. **Contextualising RRI**. Participants stressed the need for contextualising RRI, both conceptually and practically, adapting it to the features of the organisation, the national research traditions and policies, the disciplinary areas and sectors or the type or research (basic research, applied research, etc.). This also means not to start from scratch but leveraging on the existing practices (pertaining to, e.g., gender equality, open access, ethical issues, public engagement and education).

c. **Creating a favourable institutional and organisational environment**. A pivotal issue is that of creating an institutional and organisational environment which could be favourable for embedding RRI in research organisations. This may entail, e.g.: establishing RRI-devoted institutional roles and leaders; creating a climate of mutual cooperation and confidence among the concerned stakeholders; establishing a clear regulatory and policy framework at national level; providing funds for supporting RRI-oriented initiatives and research; widely promoting RRI-oriented awareness raising and training activities.

d. **Modifying the current research evaluation practices**. Another condition which is considered necessary in order to promote RRI in research systems is the modification of the current research evaluation practices. In practical terms, according to many participants, researchers and research organisations should no longer be exclusively assessed on the basis of the publications produced, but also according to other criteria related to RRI, so as to provide researchers and research organisations with solid motivations and incentives for getting engaged with RRI.

e. **Promoting an integrated leadership**. For being implemented, RRI requires a distributed and integrated leadership at all organisational levels, also including administrative staff. This process cannot be conducted by merely adopting a normative and top-down approach, but favouring a close interaction among all the components of the organisations, thus activating widespread cultural changes.

Chapter Three

# Inventory and Benchmarking exercise

## 1. Introduction

In the framework of the WP1 activities, a Benchmarking exercise (Task 1.4) was undertaken based on the results of the inventory of RRI Advanced Experiences (AEs), conducted under Task 1.3. This Chapter, on the basis of the Benchmarking Report (herewith attached) describes aims, methodology, structure and main results of both the tasks.

The Chapter is divided into the following sub-sections, in addition to this introduction:

- **Sub-section 2** describes the features of the Inventory (aims, structure and methodology)
- **Sub-section 3** describes the features of the Benchmarking exercise (aims and methodology)
- **Sub-section 4** presents the results emerging from both the inventory and the Benchmarking exercise.

## 2. Inventory

### *2.1. Aims of the Inventory*

The Inventory of RRI advanced experiences was aimed at:

- Developing a typology of RRI-oriented governance settings
- Defining a methodology for the Benchmarking exercise.

The Inventory includes a description of experiences with a specific focus on the governance settings adopted in order to institutionally embed RRI (in terms of practices, tools, arrangements, and culture) in research organisations, taking into account the critical issues emerged from the Literature Review.

### *2.2. Structure of the Inventory*

The structure of the inventory has been based on the **typology of RRI-oriented governance settings** developed during the process. In this sub-section, therefore, this typology is described, starting from the same concept of "RRI-oriented governance setting".

On the basis of the current literature[4], this concept has been understood as a process through which a given governance structure (e.g., norms, practices, internal relation, culture, etc.) is modified in a way that permanently incorporates RRI. In other words, we considered RRI-oriented governance setting **any attempt aimed at institutionally embedding in research organisations new arrangements related to RRI**. A broad notion of RRI has been adopted, including any reference to the RRI keys (open access, gender equality, etc.), RRI dimensions (respon-

[4] See, in particular: Van Hoof, L. & Kraus, G. (2017). Is there a need for a new governance model for regionalised Fisheries Management? Implications for science and advice. *Marine Policy*, *84*, 152-155; Pierre, J. (Ed.), (2000). *Debating governance: Authority, steering, and democracy*. OUP Oxford.

siveness, anticipation, inclusiveness, reflexivity, etc.) as well as a general consideration of societal challenges in research and innovation.

Following this reasoning, we considered **RRI Advanced Experiences** (AEs) any kind of initiative (project, programme, measure, policy, etc.) in which an RRI-oriented governance setting is recognisable. This definition had two implications.

- The first implication was that, in this way, it was possible to compare AEs which were extremely different in substantive terms (for example, AEs focused on open access and AEs focused on gender equality), but similar for the governance setting they adopted.
- The second implication was that the benchmarking process did not concern the AEs as such, but only the governance setting they applied (see the Section 3 below). Consequently, all the aspects of the AEs which did not pertain to the governance setting were not considered.

On the basis of an analysis of an extended number of RRI-oriented experiences (INV1, see subsection 2.3.), a **typology of RRI-oriented governance settings** has been developed.

Such a typology identifies **nine models of governance settings**, each adopting a specific approach to the question: "how to get individuals or a group to implement RRI" (see, in this regards, the table presented in the next page).

The typology has been constructed on the basis of **two variables**.

The **first variable** concerns where the **triggering point of change** is placed, i.e., which actors are asked to start and manage the process of change in the target RFPO. Again, three cases can be identified.

- **Internally-initiated governance settings**. Governance settings which tend to induce institutional changes on the basis of a model which is shaped by and relies upon actors acting from inside the RFPO.
- **Externally-initiated governance settings**. Governance settings which tend to induce institutional changes on the basis of a model which is shaped by and relies upon actors acting from outside the RFPO. In this case, therefore, the AE will be attributed to the actors which brought the governance setting model from outside rather than the institution in which such a model is actually applied.
- **Network-initiated governance settings.** Governance settings which tend to induce institutional changes through cooperation relationships linking the target RFPO with other organisations.

The **second variable** can be referred to as **focus** of change, i.e., the factors in the life of an organisation which the governance setting primarily addresses and leverages upon to trigger the change process. Three main cases can be identified.

- **Social governance settings**. Governance settings which tend to induce institutional changes directly by modifying the social patterns (cognitive, emotional, relational, behavioural, etc.) which are taken for granted and shared by the majority of people inside the organisation[5].

[5] This reflects a sociological view of institution; see, for example, Berger, P.L. & Luckmann, T. (1966). *The Social Construction of Reality: A Treatise in the Sociology of Knowledge*, Garden City, NY, Anchor Books;

– **Normative governance settings**. Governance settings which tend to induce institutional changes directly by modifying the existing norms (procedures, guidelines, protocols, rules or organisational charts, etc.), i.e. the "rules of the game" on which the life of the organisation is based[6].
– **Knowledge-oriented governance settings**. Governance settings which tend to induce institutional changes indirectly by primarily engaging the RFPO in producing knowledge on and through RRI, i.e., producing knowledge on RRI and/or adopting RRI principles and tools to produce knowledge.

This typology can be represented in the form of a matrix, combining these two variables to generate nine models of governance settings.

| FOCUS / TRIGGERING POINT | Social patterns first | Rules first | Knowledge first |
|---|---|---|---|
| Changes from inside | A Internally-initiated social model | B Internally-initiated normative model | C Internally-initiated knowledge-oriented model |
| Changes from outside | D Externally-initiated social model | E Externally-initiated normative model | F Externally -initiated knowledge-oriented model |
| Changes through network | G Network-initiated social model | H Network-initiated normative model | I Network-initiated knowledge-oriented model |

Some additional observations may help clarify this typology.

The typology presented above is of a **theoretical nature**, even though based on the analysis of many empirical cases. Moreover, in real life, boundaries between different governance setting models are much more blurred. For example, an AE can adopt two governance setting models at the same time, by addressing both social patterns and norms or by triggering the process both from inside the concerned research organisation and by relying on external organisations (this is the case, for example, of many EC-funded institutional change projects). Therefore, AEs have been attributed to the different governance setting models by identifying the prevailing model shaping them.

As for the **triggering point** of governance settings, this concept refers, as mentioned above, exclusively to those who start and guide the process, thus shaping the governance setting, and not to those who pay for it or decide to start it. For example, a governance setting may be ei-

North, D.C. (1990). *Institutions, Institutional Change and Economic Performance*, Cambridge University Press, Cambridge.

[6] This reflects an organisational view of institution; see, for example, Coriat B., Weinstein, O. (2002). Organizations, firms and institutions in the generation of innovation Research Policy 31273–290; North D.C. (1990). *Institutions, Institutional Change and Economic Performance*, Cambridge University Press, Cambridge.

ther started by creating an internal unit to take charge of it (internally-initiated process) or by hiring external experts in charge of implementing it within the institution (externally-initiated process). In both cases, the decision to start the process was taken by the leadership of the concerned institution.

As for the **focus of governance settings**, while social and normative models reflect a direct approach to institutional change (i.e., changing the institution by modifying the social patterns or the norms), the knowledge-oriented models reflect an indirect approach to institutional change, based on the (conscious or unconscious) assumption that the inclusion of RRI in research contents also has an impact on the life of the organisation, producing or fostering change.

### *2.3. Methodology of Inventory*

The methodology used in the Inventory and Benchmarking process included four main steps overall, the first three pertaining to Task 1.3 and the last to Task 1.4, here described.

The **first step** was the identification of a large number of experiences focused on RRI, on the basis of different sources (including: EC-funded projects; national projects; scientific literature; grey literature; websites), leading to a first overall inventory (INV1).

Three approaches were used to identify the experiences.

- The first approach involved identifying those experiences which were explicitly oriented to RRI or RRI keys, i.e., on the basis of the promoters' intents.
- The second approach involved identifying those experiences which were regarded as oriented towards RRI or RRI keys by people not directly concerned with the experience (for example, researchers, governmental officers, etc.) found in literature.
- The third approach involved identifying those experiences regarded as pertaining to RRI or RRI keys by the FIT4RRI Project partners.

This process led to the compilation of the **first Inventory** (INV1) made up of 302 items, each referring to an RRI-oriented experience (see Annex 1 of the Benchmarking Report herewith attached). For each experience, only information about its identification, i.e., title, promoter organisation, and reference to information source used to identify it, was included.

The **second step** concerned the selection of the identified RRI-oriented experiences on the basis of a first analysis and screening process, leading to a specific **inventory of "Advanced Experiences"** (INV2), i.e. RRI-oriented experiences matching some meters of capacity and transferability making them "advanced". This second inventory included 43 records, referring to experiences which, on the basis of the analysis done, were considered to be "advanced", i.e., endowed with a capacity to generate and implement a governance setting. INV2 was structured according to the typology of RRI-oriented governance settings (see sub-section 2.2. above)

The **third step** was an **in-depth analysis and screening process** of the Advanced experiences identified, leading to the compilation of a **third inventory** (INV3) containing the most innovative AEs in terms of governance settings. The third step involved identifying a select group of 18 AEs to be submitted to the Benchmarking exercise, selected on the basis of the following procedure:

- The AEs included in each of the nine classes of the typology of governance settings were ranked on the basis of the meters of capacity and transferability potentials (see sub-section 3.1.), including the quality and wealth of available information on the experience. The results of this process were discussed within the team and approved in their final form.
- For each class, a number of AEs, corresponding as far as possible to the relative size of each group, was selected, thus identifying a group of 18 AEs, which has been subjected to the Benchmarking exercise.

## 3. Benchmarking exercise

### *3.1. Aims of the Benchmarking exercise*

In the overall logic of the FIT4RRI Project, the Benchmarking exercise was aimed at getting three main types of information, i.e.:

- The **practices** making the RRI governance settings applied in the AEs actually innovative and effective (benchmarks)
- The **guiding factors** that bring about results (enablers), and
- The **transferability potentials** of the governance settings, i.e., to what extent and under which conditions the identified governance settings can actually be transferred to other contexts.

More in general, the Benchmarking exercise offered precious information about how to develop initiatives aimed at RRI which are capable to induce long-term significant institutional transformations in research organisations.

### *3.2. Methodology of the Benchmarking exercise*

Because of the great diversification both in the governance setting models and the ways in which they can actually be implemented, it has been impossible to conduct a reliable in-depth analysis on each AE (especially in the cases of initiatives which are large in scope, such as national funding schemes or national research programmes).

For this reason, a **qualitative approach to benchmarking** has been adopted. This approach is often used both for companies and for regions, for which a quantitative approach is difficult to apply since many data are not available or not consistent.

Differently from quantitative benchmarking, qualitative benchmarking is not aimed at identifying quantitative standards to be attained, but at singling out the **key factors** which determine successful developments (be it of a company, a region, or a project) and often applies a scoring model which is based on group discussions among stakeholders.

In order to develop this approach, three sets of meters have been applied:

- **Entry thresholds** – meters to select the AEs which were actually relevant to the Benchmarking exercise (Consistency, Impactivity, Visibility, and RRI orientation)
- **Capacity** – meters to get information about the capacity of the governance setting to actually modify the governance structure of the target RFPO(s) (Innovativeness, Relevance, Effectiveness, and Sustainability)
- **Transferability** – meters to single out the most transferable solutions emerging from the AE making it possible to replicate the governance setting model elsewhere (Transferability orientation, Transferability potential).

The Benchmarking Report explains in detail the content of each meter. The following table shows the list of the meters used.

| SET OF METERS | meters |
|---|---|
| ENTRY THRESHOLDS | Consistency |
| | Impact |
| | Visibility |
| | RRI orientation |
| CAPACITY | Innovativeness |
| | Relevance |
| | Effectiveness |
| | Sustainability |
| TRASFERABILITY | Transferability orientation |
| | Transferability potentials |

The methodology of benchmarking exercise has been implemented through a five-step procedure applied to INV3:

- For each of the 18 AEs a file with all the relevant available information was compiled
- Each file was analysed in-depth by one of the team members using a specific grid of analysis
- The results of the analysis were discussed within the team, with the aim of identifying, for each AE, the most innovative and potentially transferable practices, to be regarded as benchmarks in the realm of RRI-oriented governance settings
- The final version of the grids was drawn up, providing the basis for the drafting the Benchmarking Report.

After the delivery of the Benchmarking Report, contacts were established with the promoters of the AEs in order to get additional information, when needed.

## 4. Main results from the Inventory and the Benchmarking exercise

In this sub-section, the main results of both the Inventory and the Benchmarking exercise will be presented.

### *4.1. The results of the Inventory*

The main results of Task 1.3 have been the development of the **three inventories** mentioned above[7].

As already said, INV1, including 302 RRI-oriented experiences, provided the empirical bases for developing the typology of governance settings. INV1 is included in the Benchmarking Report attached to this WP1 Summary Report.

INV2 allowed to test and refine the typology of governance setting. The 43 RRI Advanced Experiences included in INV2 have been distributed among the nine classes forming the typology of RRI governance settings. Such a distribution is given in the table below[8].

| FOCUS / TRIGGERING POINT | Social patterns first | Rules first | Knowledge first |
|---|---|---|---|
| **Changes from inside** | MODEL A<br>13 | MODEL B<br>0 | MODEL C<br>4 |
| **Changes from outside** | MODEL D<br>3 | MODEL E<br>8 | MODEL F<br>1 |
| **Changes through network** | MODEL G<br>4 | MODEL H<br>2 | MODEL I<br>8 |

As for INV3, as we said, it contains 18 Advanced Experiences drawn from INV2. The breakdown of the 18 AEs among the nine classes of the typology of RRI governance setting is reported in the table below.

| TRIGGERING POINT | FOCUS | | |
|---|---|---|---|
| | **Social patterns first** | **Rules first** | **Knowledge first** |
| **Changes from inside** | MODEL A<br>– JERRI Project at TNO<br>– LIBRA Project at CeMM<br>– TRIGGER Project at UPD<br>– RRI policies at UAB | MODEL B<br>None | MODEL C<br>– Synbiochem<br>– Midstream Modulation at TU Delft |

[7] The inventories are included in the Benchmarking Report, attached to this report.
[8] As said above, although based on an empirical analysis, the typology was of a theoretical nature. For such a reason, it should not be considered an anomaly that there are no AEs to represent one of the governance setting models identified (Model B).

| TRIGGERING POINT | FOCUS | | |
|---|---|---|---|
| | Social patterns first | Rules first | Knowledge first |
| Changes from outside | MODEL D<br>– CeRRI, Fraunhofer IAO | MODEL E<br>– MVI, NWO<br>– Biotek 2021, RCN<br>– CDI, VINNOVA<br>– EuroPriSe, ITA | MODEL F<br>– SoScience |
| Changes through network | MODEL G<br>– University Network Education by Responsibility | MODEL H<br>– Athena SWAN Charter | MODEL I<br>– CSymBi<br>– Mistra Urban Futures<br>– Applied Nanoparticles<br>– Ethics and Society, HBP |

A short description of each AEs included in INV3 are provided below (for each AE, the identification number used in INV1 is reported in brackets).

**Internally-initiated social model (Model A)**

**The JERRI Project at TNO (INV1 #105)**. The Joining Efforts for Responsible Research and Innovation (JERRI) Project is a project funded by the European Commission under Horizon 2020. Having started in 2016 and expected to be completed in 2019, the project is aimed at developing action plans in two research institutes (Fraunhofer Gesellschaft and the Netherlands Organization for Applied Scientific Research – TNO), focusing on the main RRI keys (Ethics, Societal Engagement, Gender Equality and Gender in Research and Innovation Content, Science Education, and Open Access). In the Benchmarking Report, the focus was only on activities conducted at the Netherlands Organisation for Applied Scientific Research (TNO).

**The LIBRA Project at CeMM (INV1 #188)**. The Leading Innovative measures to reach gender Balance in Research Activities (LIBRA) Project is an EC funded project which brings together ten research institutes in life sciences in ten European countries with the aim of promoting gender equality in the institutions concerned and fostering the inclusion of gender and sex dimension in research contents. This AE, therefore, does not concern RRI as a whole but one of its keys (gender equality). The project includes an initial assessment of the participating organisation, a mutual learning process, and the design and development of 10 institute-tailored Gender Equality Plans, based, also, on a set of cross-cutting activities. In the Benchmarking Report, the focus was only on activities conducted at the Research Center for Molecular Medicine (CeMM), one of the ten involved institutes. The Project started in 2015 and is expected to be completed in 2019.

**The TRIGGER Project at Université Paris Diderot (INV1 #189)**. The TRansforming Institutions by Gendering contents and Gaining Equality in Research (TRIGGER) Project was funded by the EC and the Italian government with the aim of promoting gender-oriented institutional changes in five European research institutions and fostering the use of gender and sex as meaningful variables in research processes. The Project also included a mutual learning process involving not only the project partners but also representatives of other EC-funded projects promoting gender-oriented action plans in research institutions. In the Benchmarking Report, the focus was only on activities conducted at the Université Paris Diderot (UPD), one of the five involved research institutes. The Project started in 2014 and ended in 2017.

**RRI policies at Universitat Autonoma de Barcelona (INV1 #237)**. The Universitat Autonoma de Barcelona (UAB) has long been engaged in promoting and implementing RRI-oriented actions and strategies, regarding different RRI keys (public engagement, gender equality, ethical issues, education, open access), benefiting also from the participation of UAB in several RRI-focused EC-funded projects. Among the RRI-oriented activities, the following can be mentioned: the establishment of an Observatory for Equality; the creation of an Ethics Committee; the development of different initiatives aimed at public engagement and education (including the creation of an Institute for Science Education and an observatory for the spread of science); the creation of the Intellectual Property and Open Access website for open-access publication (Open Access Institutional Repository) and providing support to the staff about these issues.

**Internally-initiated normative model (Model B)**

As said above, no AEs has been considered falling into this Model.

**Internally-initiated knowledge-oriented model (Model C)**

**Synbiochem (INV1 #19)**. The University of Manchester Synthetic Biology Research Centre for Synthetic Biology of Fine and Speciality Chemicals (Synbiochem) is a research institute aimed at developing cutting-edge research in the field of synthetic biology, leading to new products and methods for drug development. Synbiochem adopts an interdisciplinary approach and works in partnership with all four faculties of the University of Manchester. The institute includes an RRI platform for developing major programmes on the ethical and regulatory aspects of research, also including real-time assessment and anticipation of research and innovation trajectories, deliberation and reflection, and collaborative development.

**Midstream Modulation at TU Delft (INV1 #12)**. At the Technical University of Delft, in the Netherlands, the Midstream Modulation approach was tested in 2008. The core of this approach consists of the inclusion of humanists and social researchers in laboratory work to orient decisions and reflection. The test was developed by adopting a specific protocol, allowing the team in charge of the project to discuss ethically relevant topics with laboratory staff, as well as normative issues and the ways in which decisions are taken. Midstream Modulation has been also applied in other organisational and national contexts.

**Externally-initiated social model (Model D)**

**Fraunhofer Center for Responsible Research and Innovation - CeRRI (INV1 #121)**. The Fraunhofer Center for Responsible Research and Innovation (CeRRI) is a research unit based at the Fraunhofer Institute for Industrial Engineering (IAO), which provides services to other institutions and private companies related to Responsible Research and Innovation. In particular, CeRRI developed new approaches and methods that allow research agendas and technology development processes to be need-oriented from the very start, thus increasing the efficient use of research funds and the societal acceptance of future solutions. The staff included members with knowledge and skills from different fields, such as the natural sciences, economics, design, communication, social sciences, and computer science.

**Externally-initiated normative model (Model E)**

**Responsible Innovation Programme - MVI (INV1 #4)**. In 2009, the Dutch Research Council (NWO), which is the major research funding agency in the Netherlands, launched the Responsible Innovation Programme (MVI), characterised by RRI-oriented features and selection criteria, and especially the consideration of the ethical and societal aspects of the proposed innovation projects at an early stage. Moreover, applicants are requested to actively involve stakeholders in project implementation and in the management of its results. An interdisciplinary approach, mixing humanities, natural sciences and social sciences, is also included in the criteria to be adopted.

**BIOTEK 2021 (INV1 #7)**. In 2012, the Norwegian Research Council (NRC) established the Biotechnology for Innovation – BIOTEK 2021 Programme as part of the implementation of the 2011-2020 National Strategy for Biotechnology and as the continuation of the previous programme on functional genomics (FUGE). BIOTEK 2021 covers four substantive fields (marine sector, medical sector, industrial biotechnology sector, and agricultural sector) and four cross-cutting focus areas, one of which concerns the relations between biotechnology and society.

**Challenge-Driven Innovation - CDI (INV1 #91)**. The Challenge-Driven Innovation (CDI) Programme is a research programme established by the Swedish research funding agency VINNOVA in 2011. The programme promotes the development of new, sustainable solutions with international eminence that can meet crucial societal challenges. Projects under this funding scheme are expected to be "visionary"; challenging existing mental models, in order to contribute to the development of a more sustainable society and solving societal challenges.

**EuroPriSe (INV1 #290)**. EuroPriSe (European Privacy Seal) is a privacy certification system for IT products, IT-based services and websites that are compliant with the EU data protection system. The certification system, established in 2008, is managed by the Institute of Technology Assessment (ITA) of the Austrian Academy of Science. The origin of EuroPriSe is to be found in two EC-funded projects carried out by ITA and other partners, which led to the definition of a set of guidelines and criteria for data protection compliant and privacy enhancing security technologies.

**Externally-initiated knowledge-oriented model (Model F)**

**SoScience (INV1 #76)**. SoScience is a small private enterprise based in Paris providing advice and consultancy services to companies and organisations in the development of new research and innovation programmes shaped around RRI. SoScience was established in 2013.

**Network-initiated social model (Model G)**

**University Network Education by Responsibility (INV1 #213)**. The University Network Education by Responsibility (Hochschulnetzwerk Bildung durch Verantwortung) is an association of universities (37 at present) that aims to strengthen the civic engagement of students, teachers and other university members. Formally established as an association in 2015, the University Network provides associate members with expertise, resources, learning and knowledge exchange opportunities, advocacy and lobbying, and joint research programmes. This is mainly done through "Service Learning", a teaching approach which combines lecture hall or classroom and civic involvement, engaging students and teachers in working with communities while learning and teaching.

**Network-initiated normative model (Model H)**

**Athena SWAN Charter (INV1 #120)**. Athena SWAN Charter was established in 2005 to encourage and recognise commitment to advancing the careers of women in STEM employment in higher education and research. It was established by the Athena Project, promoted by a group of women academics, with the support of the Scientific Women's Academic Network (SWAN). Athena SWAN promotes a network connecting research institutions who applied for an Athena SWAN Award (bronze, silver and gold). The Charter is managed by the Equality Challenge Unit, a registered charity funded by the Scottish Funding Council, the Higher Education Funding Council for Wales and Universities UK, and through direct subscription from higher education institutions in England and Northern Ireland. Around 590 university departments and 140 research institutions have received awards so far.

**Network-initiated knowledge-oriented model (Model I)**

**CSynBI (INV1 #47)**. CSynBI is a synthetic biology research centre established in 2009 through an EPSRC Science and Innovation award designed to stimulate new activity in areas of synthetic biology of national strategic importance. CSynBI includes scientific researchers at Imperial College London and societal and ethical researchers from the Department of Social Science, Health and Medicine at King's College London, who explore the social, political, economic and ethical dimensions of synthetic biology.

**Mistra (INV1 #51)**. Mistra Urban Futures is an international centre for sustainable urban development based in Sweden and established in 2010. It is financed by the foundations Mistra and Sida, together with a consortium comprising: Chalmers University of Technology, the University of Gothenburg, the City of Gothenburg, the Gothenburg Region Association of Local Authorities (GR), IVL Swedish Environmental Research Institute, the County Administrative Board of Västra Götaland, and the Region of Västra Götaland.

**Applied Nanoparticles (INV1 #124)**. Applied Nanoparticles s.l. (AppNps) is a spin-off of the Catalan Institute of Nanotechnology (ICN2), the University Autonoma of Barcelona (UAB) and the Institut Català de Recerca i Estudis Avançats (ICREA), established in 2013, for the development and production of Biogas+, a biogas ready to use additives based on safe and sustainable engineered iron based nanoparticles directed towards the optimisation of anaerobic digestion processes which increase the production of biogas from organic waste. Among the co-founders, there are scientists from these institutions, international RRI experts (Responsible Research and Innovation), and experts in e-communication, business development and technology transfer. The AppNps offices are in Barcelona and the laboratory is in the UAB campus. AppNps business is based on the principles of Responsible Innovation, focusing on the design processes of nanoparticles and low energy consumption, low toxicity, waste minimisation and reduction of emissions.

**Ethics and Society in the Human Brain Project (INV1 #241)**. Ethics and Society is one of the sub-projects of the Human Brain Project (HBP), a H2020 Flagship Project focused on neuroscience, computing and brain-related medicine. The 10-year Project began in 2013 and directly employs some 500 scientists at more than 100 universities, teaching hospitals and research centres across Europe. The project includes 12 sub-projects that span the development of six ICT-based platforms, as well as data gathering, cognitive and theoretical neuroscience, ethics, and administrative services. The Ethics and Society sub-project aims to study the ethical and societal implications of HBP's work and includes different kind of activities.

### *4.2. Results of the Benchmarking exercise*

Two main results from the Benchmarking exercise can be identified:

- The identification of the benchmarks
- Their relations with the institutional change process.

**Benchmarks**

The main result of the Benchmarking exercise has been that of having identified and allowed an analysis, for each selected AE, of the most effective and transferable practices. Such practices can be therefore considered as "**benchmarks**" from the perspective of establishing effective RRI-oriented governance settings.

Overall, **36 benchmarks** have been singled out. The analysis of the benchmarks identified is contained in the Benchmarking Report, which is attached to this deliverable.

The table below provide the list of the AEs and of the benchmarked practices.

| MODEL | Description | AE | Benchmark |
|---|---|---|---|
| A | Internally-initiated social model | JERRI Project at TNO | – Goal setting process<br>– RRI institutionalisation level analysis<br>– Transition roadmap to RRI |
| | | LIBRA Project at CeMM | – Highly representative enlarged team<br>– RRI-oriented procedures setting process<br>– Initial diagnostic analysis |
| | | TRIGGER Project at UPD | – Internal organisational coordination<br>– Links with external stakeholders<br>– Sustainability plan |
| | | RRI policies at UAB | – Multiple focal points for RRI actions<br>– Light integration of RRI keys |
| B | Internally-initiated normative model | None | |
| C | Internally-initiated knowledge-oriented model | Symbiochem | – RRI integration in the productive process<br>– Establishment of an RRI Unit |
| | | Midstream Modulation at TU Delft | – Protocol for interdisciplinary integration |

| MODEL | Description | AE | Benchmark |
|---|---|---|---|
| D | Externally-initiated social model | CeRRI | – Mainstreaming approach to RRI<br>– Tailored managerial support |
| E | Externally-initiated normative model | MVI, NWO | – RRI-related criteria for research funding<br>– RRI-oriented platform and networking |
| | | Biotek 2021, RCN | – RRI embedment in funding scheme as a core issue<br>– RRI framework for applicants |
| | | CDI, VINNOVA | – Three-stage procedure to research funding |
| | | EuroPriSe, ITA | – Certification process |
| F | Externally-initiated knowledge-oriented model | SoScience | – Business-oriented approach to RRI<br>– Partnership-like approach in consultancy services |
| G | Network-based social model | University Network Education by Responsibility | – RRI-oriented comprehensive training |
| H | Network-based normative model | Athena SWAN Charter | – Three-level award system<br>– Self-assessment and peer-reviewing process<br>– Local networks |
| I | Network-based knowledge-oriented model | CSymBi | – STEM and social sciences institutional partnerships |
| | | Mistra Urban Futures | – Local co-creation platforms<br>– Joint knowledge production process |
| | | Applied Nanoparticles | – RRI-sensitive production process<br>– RRI-oriented code of conduct |
| | | Ethics and Society, HBP | – Multiple approach to RRI embedment in research programmes<br>– Ethical concerns registration system<br>– Ethics Management Team and Ethics Rapporteurs |

**The relation between benchmarks and institutional change**

Another significant result which deserves to be mentioned in this report is the relation between benchmarks and institutional change.

In fact, the interest of WP1 was focused on the **process of institutional embedment of RRI in research organisations** through the application of specific governance settings. Hence the need to understand in which way the 36 benchmarked practices contributes in activating and driving the institutional change.

To this end, a **model of institutional change process** has been adopted including four components[9].

- **Transformational agent**. The first component is the existence of a group of people (a team) that can progressively activate and sustain the institutional change over time, becoming a transformational agent within the organisation, i.e., increasingly capable of managing the complexity inherent in RRI-oriented institutional change.
- **Mobilisation**. The second component refers to the need to mobilise and involve key actors and individuals, achieving the consent, energy and support necessary to trigger a process of change.
- **Impact making**. The third component refers to the capacity to actually alter existing the institutional arrangements, activating a process of change, modifying social patterns, normative structures or the way in which knowledge is designed, implemented and used.
- **Sustainability**. The last component concerns the capacity to activate mechanisms that allow RRI-oriented arrangements to last and evolve over time, thus becoming part of the current practices and culture of the organisation.

The table below shows which component the different benchmarked practices primarily focus on, at least in the interpretation given to them in the Benchmarking Report.

| MODEL | AE | Benchmark | Dominant component |
|---|---|---|---|
| A | JERRI Project at TNO | – Goal setting process | MOBILISATION |
| | | – RRI institutionalisation level analysis | IMPACT MAKING |
| | | – Transition roadmap to RRI | SUSTAINABILITY |
| | LIBRA Project at CeMM | – Highly representative enlarged team | TRANSFORMATIONAL AGENT |
| | | – RRI-oriented procedures setting process | MOBILISATION |
| | | – Initial diagnostic analysis | IMPACT MAKING |
| | TRIGGER Project at UPD | – Internal organisational co-ordination | TRANSFORMATIONAL AGENT |
| | | – Links with external stake-holders | MOBILISATION |
| | | – Sustainability plan | SUSTAINABILITY |
| | RRI policies at UAB | – Multiple focal points for RRI actions | TRANSFORMATIONAL AGENT |
| | | – Light integration of RRI keys | SUSTAINABILITY |
| C | Symbiochem | – RRI integration in the productive process | IMPACT MAKING |
| | | – Establishment of an RRI Unit | TRANSFORMATIONAL AGENT |

[9] The model has been developed under two EC-funded projects focused on gender equality in science, i.e., the STAGES (Structural Transformation to Achieve Gender Equality in Science) project and the TRIGGER (Transforming Institutions by Gendering contents and Gaining Equality in Research) Project.

| MODEL | AE | Benchmark | Dominant component |
| --- | --- | --- | --- |
| | Midstream Modulation at TU Delft | – Protocol for interdisciplinary integration | IMPACT MAKING |
| D | CeRRI | – Mainstreaming approach to RRI | IMPACT MAKING |
| | | – Tailored managerial support | MOBILISATION |
| E | MVI, NWO | – RRI-related criteria for research funding | IMPACT MAKING |
| | | – RRI-oriented platform and networking | MOBILISATION |
| | Biotek 2021, RCN | – RRI embedment in funding scheme as a core issue | IMPACT MAKING |
| | | – RRI framework for applicants | MOBILISATION |
| | CDI, VINNOVA | – Three-stage procedure to research funding | IMPACT MAKING |
| | EuroPriSe, ITA | – Certification process | IMPACT MAKING |
| F | SoScience | – Business-oriented approach to RRI | IMPACT MAKING |
| | | – Partnership-like approach in consultancy services | MOBILISATION |
| G | University Network Education by Responsibility | – RRI-oriented comprehensive training | MOBILISATION |
| H | Athena SWAN Charter | – Three-level award system | SUSTAINABILITY |
| | | – Self-assessment and peer-reviewing process | IMPACT MAKING |
| | | – Local networks | MOBILISATION |
| I | CSymBi | – STEM and social sciences institutional partnerships | TRANSFORMATIONAL AGENT |
| | Mistra Urban Futures | – Local co-creation platforms | MOBILISATION |
| | | – Joint knowledge production process | MOBILISATION |
| | Applied Nanoparticles | – RRI-sensitive production process | IMPACT MAKING |
| | | – RRI-oriented code of conduct | IMPACT MAKING |
| | Ethics and Society, HBP | – Multiple approach to RRI embedment in research programmes | IMPACT MAKING |
| | | – Ethical concerns registration system | MOBILISATION |
| | | – Ethics Management Team and Ethics Rapporteurs | TRANSFORMATIONAL AGENT |

Overall:

- 14 practices are focused on the impact making component
- 12 practices are focused on the mobilisation component
- 6 practices are focused on the transformational agent component
- 4 practices are focused on the sustainability component.

The distribution of the practices per governance setting models is given below.

| TRIGGERING POINT | FOCUS | | | |
|---|---|---|---|---|
| | **Social patterns first** | **Rules first** | **Knowledge first** | **TOTAL** |
| **Changes from inside** | MODEL A<br>Tran. Agent 3<br>Mobilisation 3<br>Imp. making 2<br>Sustainability 3 | MODEL B<br>Tran. Agent 0<br>Mobilisation 0<br>Imp. Making 0<br>Sustainability 0 | MODEL C<br>Tran. Agent 1<br>Mobilisation 0<br>Imp. making 2<br>Sustainability 0 | INTERNALLY-INITIATED MODELS<br>Tran. Agent 4<br>Mobilisation 3<br>Imp. making 4<br>Sustainability 3 |
| **Changes from out-side** | MODEL D<br>Tran. Agent 0<br>Mobilisation 1<br>Imp. making 1<br>Sustainability 0 | MODEL E<br>Tran. Agent 0<br>Mobilisation 2<br>Imp. Making 4<br>Sustainability 0 | MODEL F<br>Tran. Agent 0<br>Mobilisation 1<br>Imp. making 1<br>Sustainability 0 | EXTERNALLY-INITIATED MODELS<br>Tran. Agent 0<br>Mobilisation 4<br>Imp. making 6<br>Sustainability 0 |
| **Changes through network** | MODEL G<br>Tran. Agent 0<br>Mobilisation 1<br>Imp. making 0<br>Sustainability 0 | MODEL H<br>Tran. Agent 0<br>Mobilisation 1<br>Imp. making 1<br>Sustainability 1 | MODEL I<br>Tran. Agent 2<br>Mobilisation 3<br>Imp. making 3<br>Sustainability 0 | NETWORK-BASED MODELS<br>Tran. Agent 2<br>Mobilisation 5<br>Imp. making 4<br>Sustainability 1 |
| **TOTAL** | SOCIAL MODELS<br>Tran. Agent 3<br>Mobilisation 5<br>Imp. making 3<br>Sustainability 3 | NORMATIVE MODELS<br>Tran. Agent 0<br>Mobilisation 3<br>Imp. making 5<br>Sustainability 1 | KNOWLEDGE-ORIENTED MODELS<br>Tran. Agent 3<br>Mobilisation 4<br>Imp. making 6<br>Sustainability 0 | ALL MODELS<br>Tran. Agent 6<br>Mobilisation 12<br>Imp. making 14<br>Sustainability 4 |

This distribution is evidently based on few qualitative data and cannot be at all meaningful in statistical terms. Moreover, the practices benchmarked have been selected according to qualitative criteria and each practice has been attributed to a governance setting component according to the criterion of prevalence (in some cases, the practice may involve more than one component).

However, some observations can be made in regard to this distribution.

a. The number of practices pertaining to the **transformational agent** is six. These practices only fall within three governance setting models, namely, Model A, Model C, and Model I. The issue is evidently important in the case of Model A (internally-initiated social model), since the AEs belonging to this group adopt an integrated approach to RRI (typically, a comprehensive action plan) and, therefore, they need to identify a specific group as the one responsible for activating the change. In the cases of Model C (Internally-initiated knowledge-oriented model) and Model I (network-based knowledge-oriented model), the transformational agent is represented by a unit or other forms of institutional structure allowing experts on RRI-related issues to contribute to the production of scientific knowledge in a visible and recognised way. No benchmarked practice has been identified in the case of normative models. This suggests that the need to establish an "agent" appears to be less relevant when a set of norms, standards or established procedures are to be introduced in the organisation.

b. **Mobilisation** is a component which recurs twelve times overall. It is present in any kind of governance setting model. It is worth noting that the mobilisation component is also represented in the case of normative-oriented models. For example, RRI-oriented funding schemes usually combine a normative approach (expressed in, e.g., criteria applied for selecting applications, templates specifying how to include RRI in Project proposals, RRI-oriented requirements, etc.) with initiatives aimed at "mobilising" the potential or actual applicants (for example, providing them with information on RRI, training services and tailored support services). This makes us think that RRI cannot be transferred to research organisations simply on the basis of a set of norms and formal procedures, following a mere top-down approach.

c. The **impact-making** component, recurring fourteen times, is also widespread in all governance setting models. This fact is not surprisingly at all, since this component includes all the practices concerning the capacity to actually alter existing institutional arrangements, activating a process of change. However, the nature of the solutions adopted varies widely. For example, in some cases (practices 2, 6 and 27), the focus is on diagnosing the situation of the organisation concerned from the point of view of RRI or specific aspects of it. In other cases (practices 12, 14, 15, 19, 23 and 34), the problem on the table is how to integrate RRI in the research and innovation process so as to avoid RRI becoming only a marginal component of it. Finally, there are practices (17, 21, 22, 32 and 33) which appear to be more focused on how to make an RRI-oriented approach practically feasible, modifying or enriching current practices.

d. The component of **sustainability** is the least represented among the benchmarked practices (four times). In particular, this component is represented three times out of four in the case of Model A governance setting (internally-initiated social model). This can be partially explained by taking into consideration that the AEs belonging to this model mainly use the "action plan" approach, i.e., an integrated multi-year plan involving many (if not all) internal units of the institution, as well as internal and often external stakeholders. In this framework, sustainability – i.e., permanently institutionalising the solutions developed under the action plans – becomes a pivotal issue for preventing long-term failures. The remaining case refers to Athena SWAN, falling within Model H (Network-based normative model). This case is interesting since the normative mechanism (the award) is conceived and organised in a way that encourages the institutions concerned to enhance their engagement continuously and to embed it permanently into institutional arrangements. However, other practices which have been connected to other components also play a function in making RRI sustainable over time, such as the local co-creation platforms developed under the Mistra Urban Futures (practice 30), or RRI integration in the productive process (practice 12), as found in the case of Symbiochem.

Chapter Four

# Emerging points and inputs for the experiments

# 1. Emerging points

As discussed in Chapter One, WP1 had two main objectives, i.e. building a map of the critical issues pertaining to RRI and identifying experiences in which RRI has been successfully embedded in individual research organisations.

In addition to that, WP1 also allowed to better understand the complex dynamics related to the present transformations of science and innovation and consequently also to draw a quite detailed view of RRI as a part of this picture.

In this Section, we will therefore attempt to single out some emerging points in this regard.

## *1.1. The transition occurring in science*

Both the Literature Review and the CTMs show how science is experiencing a **process of transition**.

We refer to the concept of transition since it fits well with the results emerging from WP1.

This term is used, not to refer to specific changes or set of interconnected changes, but to "processes of structural change in societal (sub-) systems" which "come about when the dominant structures in society (regimes) are put under pressure by external changes in society, as well as endogenous innovation"[10] or, adopting another definition, "as a gradual, continuous process of change where the structural character of a society (or a complex sub-system of society) is transformed"[11]. It is to be noticed that, in both definitions, transition is connected to a **structural change**, i.e. a modification of the "structures" of society or of a large part of it.

Examples of transitional processes can be, for example the demographic transition (the transition from high birth and death rates to lower birth and death rates), the urban transition (the growth of urban population and the decrease of the rural one), the energy transition (the transition towards sustainable energy), the digital transition (the increase weight of digital technologies in social life and in the management of information), or what we should refer to as the gender equality transition (the shift towards a society based on an equal distribution of power among genders).

As the Literature Review highlights, the changes occurring in science are precisely of a "structural nature" and affect an important sub-system of society, i.e., science. This process is profoundly and irreversibly transforming it, altering its social status and its relations with the other sectors of society as well as modifying its most basic and intimate mechanisms, related to the very production of "scientific knowledge".

All the scholars who tried to interpret this process (such as Henry Etzkowitz, Silvio Funtowicz, Michael Gibbons, Loet Leydesdorff, Helga Nowotny, Jerry Ravetz, Peter Scott, and John Ziman)

[10] Loorbach, D. (2010). Transition management for sustainable development: a prescriptive, complexity-based governance framework. *Governance*, *23*(1), 161-183.
[11] Rotmans, J., Kemp, R. & Van Asselt, M. (2001). More evolution than revolution: transition management in public policy. *Foresight*, *3*(1), 15-31.

recognise the systemic and structural nature of these changes and connect them, although to different extent, to the overall shift from modern to the so-called "post-modern" society.

However, differently from other similar transitional process, the one involving science (and, indirectly, innovation) seems to be still in **its incipient phases**.

As both the Literature Review and the CTMs shows, the overall trajectory of the transition of science is far from being clear. Researchers and stakeholders perceive that the usual mechanisms of governance of science no longer work and the usual practices related to scientific production are no longer so certain and shared, as they were in the recent past. At the same time, **they are not actually aware of what will occur next**. Research institutions start to change their practices and internal organisations in order to adapt the occurring changes, but this process is happening with variable pace, in fragmented and uncoordinated ways and with little awareness about the expected results. This probably occurs because the transition of science does not have the characteristics of a mature transition and therefore it is not yet characterised by, e.g., univocal symbols and meanings, a common ground of values and ideas and the co-ordination patterns among the actors which are necessary to drive the process.

All in all, transition is still perceived more as the **crisis of the modern social institution of science** rather than as the **emergence of a new (post-modern) one**.

### *1.2. Reactions to the transition of science*

In the context depicted above, it is not surprising that the reactions of stakeholders and research actors are widely different from each other.

CTMs suggest that the dominant feeling is that of **uncertainty** and **disorientation**. Forms of **resistance**, **rejection** and **under-evaluation** of the occurring transitional processes have been also observed.

However, in the vast majority of participants in the CTMs appear to be **clearly aware** of the **global size** of the transition and **what is at stake** with it. Moreover, if they perceive the tensions it is producing on their own life and their own organisations and are worried of some specific trends (for example, the increasing competitiveness among researchers and research institutions or the shrinking of research funds), they also recognise the **new opportunities** it can open up (for example, a stronger and more intense dialogue with citizens, the possibility to aim research towards societal challenges, the development of a real interdisciplinary research, etc.).

What deserves to be highlighted here is the tendency and will of almost all the actors to **get involved** in the transition process and not to be mere spectators of the changes taking place; and many of them are doing it, in different ways and predominantly at the individual level, on a voluntary basis and in a still unfavourable institutional context.

Therefore, if the transition of science does not seem to be consolidated yet, it is already activating what, in the sociological domain, is usually referred to as "**mobilisation of agency**", i.e., the people’s attitude and capacity to creatively think and act relatively more autonomously from the existing social structures (in this case, that of the modern social institution of science) in order to favour the establishment of new ones.

### *1.3. The role of RRI*

**RRI** can be interpreted as one of the **organised and policy-oriented reactions to the transition of science** and to the **uncertainty** this latter generates in the research systems and in the society as a whole. In theoretical terms, it can be also understood as including any effort for overcoming the fragmentation characterising science as social institution and for coordinating all the actions aimed at governing the transitional processes affecting science.

As highlighted in the Report on the Literature Review, RRI is thought and developed precisely for facing and managing the critical turn of science and innovation from modernity to post-modernity, in order to reposition them in a changed society. Hence the claim for an alignment of science and innovation to values, ethical standards and expectations of society by making them more reflexive, anticipatory, responsive and inclusive.

The analysis done and the results of CTMs reveal some **serious limits** in adopting RRI as a policy framework.

- First of all, although RRI is a powerful concept, especially thanks to its interpretive flexibility allowing to potentially attract the interest of many different kinds and stakeholders, as a matter of fact **its success is extremely limited**: RRI is little known outside the circles of RRI experts and practitioners; it is still not widespread among research organisations; it is overlapped by other more consolidated (and sometimes more appreciated) notions like "open science", "university third mission" or "corporate social responsibility", thus creating confusion and tensions; its added value is often questioned since it incorporates already existing and well-established principles and policies (such as those related to gender equality, ethical issues or open access); many explicit or implicit resistances to RRI among researchers and research are reported.

- Second, a **mismatch between RRI concept and practice** is largely perceived. Conceptually, RRI is prevalently expressed in normative terms, as a set of principles to be implemented. However, participants in the CTMs – also confirming what has emerged from the literature review – clearly expressed the difficulty of identifying the new norms to be introduced and the means to implement them. The same factor which makes RRI attractive – being an "umbrella concept" able to raise the interest of different kinds of people and stakeholders and susceptible of different interpretations – makes it also difficult to put it into practice: RRI is a notion too broad in scope, ambiguous and vague in its contents to be applied. Also because of its vagueness, RRI is difficult to combine with the existing policies. Moreover, especially in the private sector, implementing RRI is viewed as costly while its long-term economic benefits are uncertain. Finally, many respondents also perceive a risk to make RRI a bureaucratic affair, a "tick box operation" or a "superstructure" which does not modify research organisations at all.

- Third, there is an evident **lack of policies, investments, resources and institutional spaces** for implementing RRI. Leaders of research institutions are little mobilised and anyhow uncertain about how to introduce RRI in their own organisation; governments usually are little sensitive towards RRI and do not offer incentives, resources, guidelines and support to researchers and research organisations; finally, participants in the CTMs also highlighted the lack of opportunities to discuss, also informally, about RRI-related issues within research organisations.

- Finally, the **relation between RRI and changes affecting science is quite occasional and limited**. In particular, RRI is mainly focused on science-society relations, at different levels and at different stages of the research process (upstream, midstream and downstream), while tends to overlook or even ignore other critical mechanisms of science such as the increasing competition among researchers and research organisations, the shrinking of research funds, the uncertain future of many young researchers or the decreasing reliability of peer reviewing procedures or the increasing difficulties met in scientific data reproducibility.

Overall, the **picture emerging from the analysis** about the role RRI is playing and could play for managing the transitional processes affecting science **is highly problematic**. RRI encapsulates principles and values which are supposedly highly shared by researchers, stakeholders and the society at large. However, it has not been capable, at least so far, to intercept the "**mobilization of agency**" freed from the transition of science.

In this sense, RRI is still a **feeble policy framework**, because of its prescriptive nature, its vagueness, its limited practicability and its tendency to "colonise" other more consolidated spheres of action (gender equality, open access, etc.) in which many actors have been involved for a long time, thus generating tensions and confusion.

### *1.4. Materialising RRI*

All that notwithstanding, the **Benchmarking exercise** says us that materialising RRI is possible.

In fact, the advanced experiences which have been selected and analysed in depth provide, as a whole, a quite realistic picture of the key recurrent elements characterising the attempts aimed at materialising RRI.

Four main issues deserve to be deepened in this regard:

- **Contextualisation**. The first issue is the diversity characterising the RRI advanced experiences. Through the Benchmarking exercise, nine different governance settings models, i.e., nine different general strategies for embedding RRI or part of it in research organisations, have been identified. Within each model, many different approaches and versions can be also identified; and that, not to speak of the myriad of tools and practices developed to implement these approaches. This wide diversity is due to the need of contextualising RRI in a given space and in a given time, i.e., in a given national context and research organisation, for facing specific needs, expectations, and challenges. In this sense, RRI does not exist in itself. Rather, it starts existing only when a contextualisation process occurs allowing RRI to materialise into an RRI self-tailored and fully contextualised profile, able to cope with the problems researchers and research organisations are primarily worried about. Also, in the framework of the Context Tailoring Meetings, a strong demand for contextualising RRI has been expressed by many stakeholders, in order to connect its general principles to the actual needs of researchers and research organisations.

- **Transformational agent**. In each RRI advanced experience, the contextualisation process is always started by what can be referred to as a "transformational agent", i.e., a group of people – internal, external or connected to the organisation – which starts trying to capture the free-floating agency made available by the transition of science and to orient it towards impact-making actions so as to modify the existing structures (practices, views, languages, culture, perceptions, objectives, etc.). Transformational agents are highly motivated and are usually well aware of the need of mobilising other stakeholders and individuals. Moreover, they tend to progressively construct a quite clear idea of the objectives to pursue, the barriers to face and the processes to activate. To some extent, they anticipate the future by critically approaching the present.
- **RRI as a set of resources**. Transformational agents do not necessarily refer to RRI when activating the process of change. In many cases, the promoters of the advanced experiences explicitly refer to RRI, but, in many others, only an aspect of it is considered (for example, gender equality or ethical issues) while, in some cases, the concept of RRI is intentionally kept hidden. Regardless of how explicit the reference to RRI is, all the advanced experiences are anyhow strongly connected with the constellation of meanings on which RRI is based, such as those related to, e.g., anticipation, inclusiveness, reflexivity, risk prevention, equality, societal challenges, openness or ethics. We could say that, in practical terms, RRI, in itself, is unusable, but, at the same time, it perfectly serves as a source of inspiration, a cultural background, a stock of knowledge, or, broadly speaking, as a set of resources usable to permanently modify the existing structures of science.

- **The lack of a favourable institutional and social framework**. The work of the transformational agents is however slowed down by the lack of a favourable cultural and political framework. Because of, e.g., the lack of support and resources, the absence of effective policy actions, the limited availability of incentives and the shortage of appropriate skills and capacities, the representatives of the advanced experiences sometimes feel a sense of isolation. Not by chance, in the national contexts where RRI-oriented policies are more developed (e.g., in the Netherlands or the Scandinavian area), they are more aware of the potentials of their own action and tend to recognise their action as a part of a broader transformation of the governance of science. In these contexts, also the public actors are more active. The role of a favourable framework is also shown by the fact that an important portion of advanced experiences are directly or indirectly connected to RRI-oriented EC policies. The lack of an enabling environment for RRI makes every step more difficult to take, any solution more difficult to institutionalise, any impact more difficult to harness and any practice more difficult to transfer.

Summing up, the Benchmarking exercise tells us that materialising RRI is possible. It is possible, in other words, to turn RRI from being a vague normative, prescriptive and quite abstract concept, practically unusable in itself, into a contextualised and self-tailored "RRI profile", allowing researchers, research institutions and the society at large to better manage the impacts of the occurring transition of science. However, to root RRI "into the earth", a transformational agent is needed, i.e., a group of people – inside, outside or connected to the research organisation – motivated and able to mobilise and orient the people's agency freed out by the transitional processes by using RRI as a set of resources from which to draw inspiration and opportunities. This process could be extremely facilitated by the presence of a favourable non-prescriptive, but highly supportive, institutional and social framework, at national or at organisation level, allowing stakeholders to define their own RRI profile; framework which, in most of the cases, is presently lacking.

## 2. Input for the experiments

The considerations made above are also helpful for providing some input for the design and implementation of the four RRI-oriented experiments to be conducted under WP3. This issue was already addressed in the last part of the Report on the Literature Review.

Some points can be singled out, connected with each other so as to shape an "ideal" pathway towards RRI. These points, individually and collectively, can be understood, not as a step-by-step procedure, but as a part of a broader and more complex process of change, the dynamics of which cannot be pre-defined.

### *2.1. Interpreting the context*

The first step is **interpreting the context** which RRI should be embedded in.

This means **identifying the critical issues** the concerned RFPO is facing, should face or is interested in facing in the near future. This may include both the general trends affecting R&I in general (competitiveness, relations with stakeholders, gender issues, ethical issues, etc.) or local problems (for example, access to internal resources, interactions with other groups or departments, lack of skills, lack of time, etc.).

This also means **critically reviewing the major features of the RFPO**, at different levels, such as:

- At the level of its **culture** (research mission and objectives, disciplinary cultures of the members, governance styles, attitudes towards innovation, etc.)
- At the level of its **agency**, i.e. its orientation to act and invest on specific actions or sectors with respect to, e.g. the use of the research results, the relations with the public, the relations with the governments (national/local), the relations with industry, the development of their own department or research group
- At the level of its **action** (what the RFPO actually does, how it is done, and what effects are produced, etc.)
- At the level of its **identity**, i.e., the way in which the RFPO controls its own internal and external environment (internal organisation, relations with external stakeholders, quality control mechanisms, etc.).

### *2.2. Understanding RRI*

The second input to give to the staff engaged with the experimentations is that of **correctly understanding RRI**.

As we highlighted above, RRI cannot be viewed as something applicable in itself, adopting a normative and prescriptive approach. Rather, RRI is to be interpreted as a set of resources to select and use according to the needs and features of the concerned institution.

The main guiding criterion to apply in this selection process is therefore **usefulness**. RRI should be applied, not only on the basis of some ethical reason, but when and to the extent that it is considered useful for allowing the concerned RFPO (research group, research department, private company, research organisation, etc.) to better manage the impacts of the transitional processes affecting science.

This also requires a knowledge and an interpretation of RRI, which could be built up in many ways, e.g., using the many resources available on the Web and on the literature, resorting to experts in RRI, establishing cooperation agreements with other entities, and the like.

### *2.3. Establishing the transformational agent*

As the RRI advanced experiences suggest, RRI cannot be applied without a transformational agent who triggers the process.

It is difficult to say how this step can be taken. Advanced experiences are triggered in many ways: an executive board of a research organisation deciding to entrust a unit or a group of officers to develop an action plan; a government deciding to develop RRI-oriented funding schemes and to support the applicants with networking and counselling; a private consulting firm specialised in RRI supporting a university or a private company; two research organisations deciding to work together in order to apply RRI in their activities; a network of researchers deciding to do something in their own institution for implementing RRI; a research institution deciding to take a certification requiring the adoption of RRI-oriented practices.

These examples show that there is not a standard procedure for activating RRI.

However, whatever the path followed, it should necessarily end with the **establishment of a transformational agent** as it was defined above, i.e. a group of people able to mobilise the others on RRI-oriented actions and programmes. This group, to actually work, needs some resources, skills and social recognition to start, which can be different according to the context.

### *2.4. Developing a self-tailoring profile of RRI*

The fourth step of this "ideal" pathway toward RRI is that of **developing a self-tailored profile of RRI**, i.e., an idea or vision of RRI which can be applicable to the nature and features of the RFPO and which can help solve the problems the RFPO is facing or is interested to face.

The key here is to understand the added value of RRI for the actor both to address present or future problems and to open up new opportunities. At this stage, the option of not engaging the organisation in RRI-oriented actions is also seriously to be considered.

### *2.5. Defining an RRI implementation strategy*

The last step is more technical in nature, i.e., defining the **strategy for implementing the RRI profile** within the RFPO.

The Benchmarking exercise highlights that many strategies can be devised in order to embed RRI in a given organisation (in fact nine governance setting models have been identified). However, the "right strategy" can only come from internal reflection based on the results of the previous phases.

# Annex 1

# Report on the Literature Review

**FOSTERING IMPROVED TRAINING TOOLS FOR RESPONSIBLE RESEARCH AND INNOVATION**

Grant Agreement n. 741477

**Project Acronym: FIT4RRI**

# Report on the Literature Review

## Deliverable 1.1

**Due by**: December 31st, 2017
**Deliverable responsible**: Luciano d'Andrea (K&I)
**Status**: Public

| Function | Staff | Delivery date |
|---|---|---|
| Prepared by | Luciano d'Andrea and Federico Luigi Marta (K&I), Nina Khama and Susanna Vase (UH) | November 17, 2017 |
| Internal review | Alfonso Alfonsi (K&I) | November 24, 2017 |
| 1st draft delivered by | Luciano d'Andrea (K&I) | December 12, 2017 |
| Reviewed by | Carlos Catalão Alves & Gonçalo Praça (Ciência Viva) | December 22, 2017 |
| Final version | Luciano d'Andrea (K&I) | December 27, 2017 |
| Submitted to EU by | Andrea Riccio | December 29, 2017 |

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**Project full title**: Fostering Improved Training Tools for Responsible Research and Innovation
**Project funding scheme:** Horizon 2020, SwafS-04-2016 - Opening Research Organisations in the European Research Area
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This project has received funding from the European Union's Horizon 2020 Programme for research and innovation under Grant Agreement no. 741477

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# Introduction

This report includes the results of the Literature Review conducted under WP1 (Mapping and benchmarking) of the project “Fostering Improved Training Tools for Responsible Research and Innovation” (FIT4RRI), co-funded by the EU DG Research and Innovation under Horizon 2020.

Overall, the project aims at contributing to the diffusion and consolidation of Responsible Research and Innovation (RRI) and Open Science (OS) in the European research funding and performing organisations (RFPOs) by, on the one hand, e**nhancing competences** and **skills** related to RRI and OS through an improvement of the RRI and OS **training offer** (in terms of training tools, actions and strategies) currently available and, on the other hand, promoting the diffusion of more advanced **governance settings** favouring the institutional embedment of RRI and OS in research organisations.

In this context, the WP1, coordinated by Conoscenza e Innovazione (K&I), is specifically aimed at mapping the **drivers** for and **barriers** to the diffusion and embedment of RRI and OS practices and approaches in RFPOs and Benchmarking **RRI** and **OS experiences,** which succeeded in mainstreaming RRI practices in individual RFPOs, groups of them or specific research fields. WP1 is also expected to provide inputs for the RRI-oriented experiments to be carried out under WP3 (Experiments). This component of the project, focused on governance settings, is also expected to interact with the other component of FIT4RRI (WP4), focused on RRI and OS training offer.

This literature review is the output of the Task 1.1. of WP1, the objective of which is **building a map of the critical issues** pertaining to RRI (and OS) for RFPOs, identifying trends, barriers, drivers, interests and values connected to RRI and Open Science.

The document is in four parts.

- **Part One** is devoted to the structure and the methodology of the literature review.
- **Part Two** includes the results of the literature review concerning the changes affecting science in general, so as to provide an overall picture about the context in which RRI/OS is to be placed.
- **Part Three** includes the results of the literature review concerning RRI/OS, as concerns both the theoretical approaches to RRI/OS and experiences and facts connected to it.
- **Part Four** is aimed at connecting the outcomes of parts Two and Three, in order to understand how RRI can actually be used to help scientists and research organisations to meet the challenges related to changes affecting R&I.

The text has been written by Luciano d’Andrea and Federico Luigi Marta (K&I), with the exception of the paragraph “RRI in academic journals: drivers and barriers” (Part Three, Para. 2.2.), drafted by Nina Kahma and Susanna Vase (University of Helsinki), and reviewed by Alfonso Alfonsi (K&I) and Mikko Rask (University of Helsinki).

# Part One

# Structure and methodology

## 1. Structure

### *1.1. Assumptions*

The structure of the literature review has been developed on the basis on some assumptions, connected with the same approach adopted by FIT4RRI.

The starting point of the project proposal is provided by the **critical stance** adopted by the **Call**. The Call highlights the presence of gaps in the "the dissemination of RRI practices", which vary "from one discipline to another and from one country to another". In order to match these gaps, the Call indicates, as a key solution, the further development of "specific trainings for researchers and academics (in particular young scientists during under- and post-graduate training)" even though "also policy-makers and staff working in funding bodies, need to be supported".

In the **proposal**, such a critical stance is interpreted in a broader perspective, i.e., as a "serious **gap** between the **potential role** that Responsible Research and Innovation (RRI) and Open Science (OS) could play in helping Research Funding and Performing Organisations (RFPOs) to manage the rapid transformation processes affecting science (especially science-in-society aspects) and the **actual impact** RRI and OS currently have on RFPOs, research sectors and national research systems".

The literature review should therefore start to address the factors which are at the basis of such a gap, starting with the **main assumption of the project proposal**, i.e., that RRI should play a role in managing the rapid changes affecting science and innovation.

### *1.2. Aims and structure of the literature review*

As we said above, the project proposal defines a logical pathway in which the literature review plays an important role, i.e., that of enabling an analysis of RRI trends, barriers and drivers, as well as the interests and values involved in it. Its outputs should be a "map of critical RRI issues for RFPOs".

However, following the assumption that RRI has or should have a role in the management of the main changes affecting science and innovation, it was decided to include in the literature review trends, barriers, drivers, interests and values connected to S&I in general, so as to start analysing the interactions between RRI and changes occurring in science and innovation.

This approach explains the **structure** given to this literature review.

Apart from this one, it includes the following **three parts**.

**Part Two** is focused on the **changes affecting science**, both internally and in its relations with society. It includes two sections.

- **Theoretical approaches**. This section includes a comparative summary of the main theoretical approaches used to interpret the transformation processes occurring in science and innovation (Mode 1 - Mode 2, Post-academic science, etc.).
- **Change processes**. This section includes a reasoned inventory of change processes occurring in science and innovation. In particular, the focus is on the problematic aspects related to these changes, especially as concerns the professional and living conditions of scientists and the organisational functioning of research institutions.

Obviously, these two sections are strongly intertwined, since the theoretical approaches are based on an analysis of change processes, even though many of them escape the theoretical lens adopted in these approaches.

**Part Three** is focused on **Responsible Research and Innovation** (RRI). It includes two sections.

- **Theoretical approaches**. This section includes a comparative summary of theories and concepts of RRI, so as to identify its main features and structures.
- **RRI in action**. This section includes an analysis of drivers and barriers to RRI. This section, in particular, contains:
- A literature review of academic journals which can be considered an autonomous product, even though fully embedded in this report
- A literature review based on the practical and empirical literature produced in the framework of EC-funded projects focused on RRI.

**Part Four** aims to connect the **outputs emerging from the previous parts**, in view also of the next steps of FIT4RRI. It includes three sections.

- **Summary of the main issues**. This section is aimed at briefly summarising the main findings of the literature review.
- **Open questions**. This section is focused on a reflection about the reasons behind the still limited and uneven penetration of RRI in European research systems.
- **A provisional framework for the experimentations**. This section provides some orientations for approaching RRI in a way which can be as fruitful as possible in the context of the experiments to be carried out under WP3.

For its aims and structure, the literature review can be understood as both **comprehensive** and **interpretive**.

It is **comprehensive** since its scope is necessarily wide, including different components developed through different approaches (see Para. 2). It is **interpretive**, since its main output is defining interpretive frameworks about RRI to be usefully applied in the next steps of the project. In order not to confuse the analytical and the interpretive, each section of the report includes a paragraph (titled "Discussion") where the interpretive dimension is developed.

In the DoA, the Literature Review was described as dealing with "RRI and open science centred on governance settings". However, it is *de facto* focused on RRI rather than on Open Science, for three main reasons.

1. In its traditional meaning, the concept of "Open Science" largely **overlaps with the concept of "Open Access"** (OECD, 2015b), which is fully embedded in the concept of "Responsible Research and Innovation".
2. In the meaning recently adopted by the European Commission (2016c), Open Science acquired a broader meaning, coupling the idea of "Open Access" with that of increasingly intense cooperation among all stakeholders and players (scientists, citizens, publishers, research institutions, research funding organisations, education professionals, etc.) through interaction models made possible by digital technologies. Also in this second sense, however, **Open Science seems to be largely overlapped with the concept of RRI**, although its focus is mainly on the many opportunities made available by information technologies and on university-industry relations.
3. Finally**,** at least in the European context, **RRI has so far been used as a "cultural label"** in scientific or policy literature about the openness of science and innovation to society. For this reason, such a concept can be used to readily access literature. This is not the case for the concept of "Open Access" which is still little used in literature, at least in the meaning proposed by the European Commission.

These considerations, however, cannot solve the **tensions which likely exists between the concept of RRI and that of Open Science**. Broadly speaking, RRI sees the "openness of science" as strongly related to the alignment of science to values, ethical standards and expectations of society by making it more reflexive, anticipatory, responsive and inclusive, while Open Science focuses much more on the transformative role played by ICT tools, networks and media, understood as able to radically modify the way in which science is carried out, disseminated and deployed, thus making it more open, global, collaborative, creative and closer to society. Therefore, if the objectives are similar, the overall approach and the view of science and science-society relations of RRI and Open Science are only partially overlapped with each other.

## 2. Methodology

This literature review **includes six components**, each one partially or totally autonomous from each other.

The **first component** concerns the **shift from modern to post-modern society** (Part Two, Para. 1.1. and Para. 1.2.) which revolves around a set of classics of the contemporary sociological theory, including, e.g., Margareth Archer, Zygmunt Bauman, Ulrich Beck, Daniel Bell, Peter Berger, Manuel Castells, Norbert Elias, Anthony Giddens, and Thomas Luckmann. This component is also enriched with contributions from many other authors providing insights into how this shift is occurring in different spheres of social life.

The **second component** focuses on the **theoretical models developed to account for the many changes affecting science and innovation** in the last decades (Part Two, Para. 1.3. and 1.4.). This component is mainly based on a set of scholars in Science and Technology Studies, including e.g., Henry Etzkowitz, Silvio Funtowicz, Michael Gibbons, Loet Leydesdorff, Helga Nowotny, Jerry Ravetz, Peter Scott, and John Ziman.

These two components largely leverage upon a consolidated corpus of knowledge and theoretical approaches. Their added value is mainly produced by the connections established among the different issues presented so as to shape an overall background for the next parts and sections of the report.

The **third component** focuses on the **main change processes affecting science** (Part Two, Section 2). In this case, a "scoping review" has been conducted, i.e., a literature review aiming “to map the key concepts underpinning a research area and the main sources and types of evidence available” (Mays, Roberts & Popay, 2001), through a “snowballing method” allowing to put together issues rarely dealt with comprehensively.

The **fourth component** pertains to the **theoretical approaches to RRI** (Part Three, Section 1). The component is a **conceptual review** primarily based on a second-tier analysis of existing literature reviews on RRI concepts and approaches.

Finally, two other components are included in this literature review, both **dealing with RRI in action**.

The **fifth component** is based on an analysis of the deliverables produced under EC-funded projects dealing with RRI (Part Three, Para. 2.1.). This analysis entailed a scanning of all deliverables produced under projects carried out in FP7 and Horizon 2020 Framework Programme and the selection of the most relevant among them.

The **sixth component** is a literature review of scientific articles on drivers and barriers related to RRI (Part Three, Para. 2.2.). The methodology applied is presented in the introduction of the text.

# Part Two

# Science and innovation

This part explores the social transformations affecting science and innovation, adopting two different approaches detailed in two different sections.

The first section analyses the different theoretical approaches developed in the last few decades to account for the major changes which have occurred in the way in which scientific knowledge is produced and used. In this paragraph, specific attention is focused on the proper framing of these changes within the broader transition from modernity to post-modernity.

The second section will provide a reasoned **inventory of change processes** occurring in science, assuming a "**grass-roots perspective**", i.e., one expressing, as far as possible, the point of view of the "average Principal Investigator" working in an "average" research institution or university.

A number of conclusive reflections will follow.

## 1. Theoretical approaches

### *1.1. The shift from modernity to post-modernity*

In this section the changes occurring in science and innovation are framed within the broader changes which, as of the 1960s, have profoundly modified contemporary society as a whole.

As a whole, these changes have been described as a shift from modern society to another kind of society, variably termed as "post-industrial society" (Bell, 1976), "late modernity" (Giddens, 1991), "risk society" (Beck, 1992), "liquid society" (Bauman, 2000), "network society" (Castells, 2000) or "high-speed society" (Rosa, 2013).

For the sake of simplicity, we will refer to this "new society" as a "**post-modern society**", even though this concept is highly controversial (Beck, 1992).

While the modernity/post-modernity debate lasted for more than two decades (and, to a certain extent, is still continuing), a relatively broad convergence about the key trends characterising this shift can be observed. The following seem to be particularly relevant here, i.e.:

- Globalisation
- Weakening of social structures
- Individualisation
- Risk and uncertainty
- Diversification and fragmentation
- Blurred cognitive and social boundaries.

**Globalisation**. Post-modern times are characterised by the emergence of a single interconnected world (made possible by the huge development of ICTs) producing complex and extended social configurations of mutual interdependences (De Swaan, 1988) of different natures (economic, social, cultural, but also cognitive and emotional). One of the main well-known effects of globalisation has been the rapid growth of economic competition at global level, affecting both national economies and individual companies. Globalisation has led to a systematic dis-embedding of social relations (Giddens, 1990), i.e., lifted out from their local embeddedness, based on specific space-time relations.

**Weakening of social structures**. Globalisation has produced a rapid weakening of social structures, i.e., the dominant patterns of action and social relationships (Berger & Luckmann, 1996; North, 1990; Nadel, 1951), legitimated by cognitive structures, such as socially supported views, representations, beliefs and stereotypes. In fact, any social structure, until then, was necessarily based on specific space-time frames and fully incorporated into the local dimension. Dis-embedding processes led to an overall weakening of culture (i.e., traditional worldviews and social norms) and its capacity to produce patterns and cognitive schemes orienting individual behaviours and led to an increased role of "self-reflexive" behaviours in personal and institutional life (Archer, 2007; Giddens, 1991; Beck, Giddens & Lash, 1994).

**Individualisation**. Connected to the weakening of social structures, a parallel acceleration of the process of individualisation (Elias, 1991) can be observed, deriving from and driving an increase in people's subjectivity (Quaranta, 1986; d'Andrea, Declich & Feudo, 2014), i.e. their capacity and power to think and act more freely, as well as to "build up" their own lives, projects, and identities (Berger, Berger & Kellner, 1974; Giddens, 1991; Beck & Beck-Gernsheim, 2002). Individualisation produced a set of general trends, including:

- The tendency of individuals to **bypass intermediated entities** (associations, trade unions, political parties, etc.)
- The tendency of individuals towards **self-disclosure** (in terms of opinions, ideas, personal attitudes, private feelings, intimate aspects of life, body, etc.) in public or semi-public environments (both physical and virtual)
- The radical change in the usual **mechanisms of social control** (for example, the tendency of people towards self-steering, rejecting established values and beliefs and instead becoming sensitive to the opinions of their friends).

**Risk and uncertainty.** Risk profiles have changed too. Because of the weakening of social structures and of the institutions of modern society (see below), people have become more directly exposed to risks of different kinds (Beck, 1992; Giddens, 2001; Renn, 2008; Zinn, 2008), such as environmental risks, unemployment, lack of access to social protection and pension schemes, or health risks. Moreover, individuals are increasingly asked to manage their own lives by themselves, with no institutions or dominant social patterns to guide them. Finally, also technology, while used to control risks, produces in turn new risks (Beck, 1999; Giddens, 1990). Therefore, the sense of uncertainty appears to be a dominant characteristic both in social life and in the biographical dimension.

**Diversification and fragmentation**. The modified balance between individuals and social structures has produced great social and cultural diversification within society. It is more and more difficult to identify homogeneous social groups and classes or dominant behavioural patterns. Even the identity of individuals is more unstable, fragmented and inconsistent (Giddens, 2001; Bauman, 2005; Barglow, 1994). At the same time, diversification feeds a multitude of ideas, initiatives, behaviours and forms of knowledge, accelerating social changes (Rosa, 2013).

**Blurred cognitive and social boundaries**. Another consequence of the mix of weakening of social structure and individualisation is the blurring, if not the collapse, of social boundaries on which modernity was built (Beck, Bonss & Lau, 2003), including the most fundamental distinctions (nature/culture or past/present/future) (d'Andrea, Declich & Feudo, 2014), as well as distinctions among life domains and social spheres (for example, private/public or professional life/leisure). Even personal identity does not have stable boundaries. The effect is that new boundaries have to be constantly negotiated among actors so that common problems or public issues can be addressed.

### *1.2. The critical turn of the social institutions of modernity*

One of the major outcomes of this set of intertwined processes is that the social institutions on which modernity was grounded (such as family, politics, institutionalised religions, economics, state and, obviously, science) are facing deep critical transformations, the long-term outcomes of which are uncertain.

It is quite difficult to define common trajectories for these transformations. Although, four main cross-cutting critical issues can be identified among those most relevant to this literature review, i.e.:

- Diminishing authority
- Distrust and disaffection
- De-standardization
- Declining capacity to provide services and to ensure social equality.
-

**Diminishing authority**. All the institutions of modernity are to different extents exposed to an erosion of authority and prestige, so that they are less and less able to provide orientation and guidance, while compliance with the rules set by them decreases. This process may include the authority of politicians and political parties (see, for example, Dalton, 2004), of parents (see, for example, Galiani, Staiger & Torrens, 2017) or of religious leaders (Bruce, 2006), even though it does not imply a decline in religion itself (see, for example, Kaufman, 2008). This process reduces the power of institutions, which means they increasingly need to negotiate more with internal and external actors.

**Distrust and disaffection**. A decline in people's trust and an increase in their disaffection towards the institutions of modernity can usually also be observed. This is particularly evident in the case of politics, where the spread of anti-political attitudes (i.e., negative feelings towards politicians, parties, parliaments, and governments) is increasingly being reported (see, for example, Blokker, 2013; Mair, 2013; Clarke, 2015). However, a decreasing level of trust is also observed towards financial institutions (see Springford, 2011) and medical institutions (see, for example, Zheng, 2015).

**De-standardization**. Another factor characterising the social institutions of modernity is de-standardization, i.e., the lack of dominant standards and behavioural patterns regulating social institutions, leading to the desynchronization of social life (Rosa, 2003). Well known examples include the de-standardization of family (see, for example, Vono de Vilhena & Oláh, 2017), transitions to adulthood (Furlong, 2013), life course (Beck, 1992; Heinz, 2001), or employment (Koch & Frits, 2013). De-standardization can be observed also in the increasing cognitive and ethical relativism characterising society (Schantz & Seidel, 2011). More in general, de-standardization is also a manifestation of the weakening of established boundaries between social spheres, social identities or social conditions. For example, boundaries between youth and adulthood are uncertain and youth cultures are increasingly shared by both children and adults (Buckingham, Bragg & Kehily, 2014).

**Declining public resources.** The factors described above have led to a shrinking availability of public resources to meet an often increasing demand for services. This is not an even process and the situation largely varies according to national contexts and sectors. However, the weakening of States and the globalisation of financial markets are pushing governments and public authorities to impose greater controls over available resources and to reduce public expenditures. This does not mean that the welfare state is disappearing (Fahey, 2010), but that it is becoming much more difficult than in the past to combine competitiveness with social cohesion, as testified, in Europe, by the uncertain development of the European Social Model (Hermann & Mahnkopf, 2010; Hacker, 2013; Vaughan-Whitehead, 2015).

### *1.3. The critical turn of science: interpretive models*

Different interpretive models have been developed in the last few decades to account for the many changes affecting science and innovation. Undoubtedly, the most well-known are the Mode 1 - Mode 2 model (Gibbons et al., 1994, Nowotny, Scott & Gibbons, 2001, 2003), Post-academic Science (Ziman, 2000), the Triple (or Quadruple) Helix Approach (Etzkowitz & Leydesdorff, 1998, 2000; Carayannis, Barth & Campbell, 2012) and Post-Normal Science (Funtowicz & Ravetz, 1993).

#### A. The Mode 1 - Mode 2 Model

The most influential and comprehensive interpretive scheme is undoubtedly the Mode 1 - Mode 2 model, which can be viewed as half-descriptive and half-prescriptive, so that Mode 2 can be understood as both "the way science is going and the way it should go" (Stilgoe, 2016). Moreover, the Mode 1 - Mode 2 model is probably the one that recognizes most the relationships between new modes of scientific knowledge production and the overall shift from modernity to post-modernity, even though the latter is referred to as "knowledge society" (Nowotny, Scott & Gibbons, 2001).

The main attributes distinguishing Mode 2 from Mode 1 have been summarised by the authors themselves (Nowotny, Scott & Gibbons, 2003) and can be schematised as follows.

| Mode 1 | Mode 2 |
|---|---|
| Academic context | Context of application |
| Disciplinarity | Transdisciplinarity |
| Homogeneity | Heterogeneity |
| Autonomy | Reflexivity/Social accountability |
| Traditional quality control (peer review) | Novel quality control |

(From: Hassels & Van Lente, 2008)

These main trends can be summarised as follows.

**Research context**. Under Mode 2, knowledge is generated within a context of application, which influences all research steps (definition of the problems to address, methodologies to apply, outcomes to disseminate and results to be used). Under Mode 1, all these elements are generated in the academic context and transferred, if need be, to the context of application.

**Disciplinary dynamics**. Under Mode 2, research is used to solve problems and, therefore, it needs different theoretical perspectives and methodologies not necessarily derived from pre-existing disciplines (hence the concept of transdisciplinarity). Under Mode 1, research is generated under the internal impulse of specific disciplinary research dynamics.

**Research community**. Under Mode 2, research is conducted by communities (mainly virtual communities) which are different in nature and connected to each other in open ways, thanks to the huge development of ICTs. Thus, research is also carried out by new kinds of knowledge organisations, including think-thanks, NGOs, management consultants or activist groups, with the effect that science is becoming a heterogeneous practice. Under Mode 1, research is done almost exclusively by academic research institutions.

**Actors involved**. Under Mode 2, the research process becomes much more reflexive, i.e., it includes dialogue or "conversations" among many different actors so as to incorporate different views. In this way, "problem- solving environments influence topic-choice and research-design as well as end-users" (Nowotny, Scott & Gibbons, 2003). Under Mode 1, the topics, research design and end-users are autonomously identified in the academic realm.

**Quality control**. Under Mode 2 conditions, new criteria come into play (not necessarily consistent with each other) of different kinds of quality (economic, social, political, etc.), strongly influencing prioritization processes. Under Mode 1, peer review, the use of disciplinary-based quality criteria was practically the only approach for quality assessment of scientific products.

## B. Post-Academic Science

Post-academic science is an expression coined by John Ziman (1994, 2000) to describe the emerging transformations of the ways in which scientific knowledge is produced. According to Ziman, the shift from academic to post-academic science is marked by a set of general trends (Kellogg, 2006; Hassels & Van Lente, 2008). In contrast to the Mode 1 - Mode 2 model, the approach developed by Ziman is not intended to be at all prescriptive or normative, since the author himself finds fault with many of the trends underlying post-academic science, but a purely descriptive and interpretive model. The main attributes distinguishing post-academic from academic science can be summarised as follows.

| Academic science | Post-academic science |
|---|---|
| Academic sites | Multiple-site networks |
| Internal scrutiny | Public scrutiny |
| Scientific value of knowledge | Utility of scientific knowledge |
| Separation between scientific research and industrial research | Industrialisation of scientific research |
| Disciplinarity | Transdisciplinarity and specialisation |
| Autonomy, separation between research work and administrative work, institutional access to research funds | Political steering, bureaucratisation of the research work and competitive access to research funds |

**Multiplication of knowledge production sites**. In post-academic science, research is a collective enterprise, involving large trans-disciplinary networks of scientific actors collaborating in multiple sites. Different kinds of institutions are involved and relations between them can be short-term and superficial. This "virtual lab" is made up of permanent employees and an increasing number of scientists working under fixed-term contracts. In academic science, research was carried out in single labs while the scope of cooperation with other institutions was smaller and based on long-term relations.

**Openness to public scrutiny**. This "virtual lab" is mainly web-based and research results are increasingly accessible to anyone on the web, even though there is still tension between the tendency to allow Open Access to scientific publications and data and the tendency to privatize this access. In any case, science, in post-academic conditions, is much more open (both potentially and concretely) to public scrutiny than it was in the academic era, where the same access to publications and data was extremely limited if not technically impossible for laypeople or non-scientific institutions.

**Utility of scientific knowledge**. Another trend is that science is increasingly under pressure to produce "useful knowledge", i.e., knowledge which could have an economic value, could be used by governments or could be applied to address social needs. One of the effects of this tendency is the decreasing role of fundamental curiosity-driven research in the scientific landscape and the increasing support given to applied research.

**Industrialisation of scientific research**. The stress placed on the utility of research products has fostered increased adoption of industrial standards and organisational procedures in the scientific process. Paradoxically, while scientific publications and data are increasingly accessible to anyone, data and knowledge susceptible to economic exploitation are more and more privatised. In academic science, industrial research and scientific research are clearly separated.

**Transdisciplinarity and specialisation**. In the context of post-academic science, transdisciplinarity and specialisation are both expanding. This is not a paradox (Kellogg, 2006). In fact, the increasing complexity of research activities is leading to a fragmentation of research tasks and, consequently, to increased specialisation. Thus, while a few have a truly interdisciplinary frame of inquiry, most researchers perform small and repetitive tasks without contacts with other researchers.

**Political steering, bureaucratisation and competitive access to research funds**. According to Ziman (1996), «*science is becoming a too large and expensive enterprise. Governments are putting strict financial ceilings on their patronage and are trying to get better value for their money*». Consequently, governments are taking a political steering stance over science, devising policies favouring the development of marketable technologies, leveraging also upon an increasingly competitive access to research funds. This also entails a progressive bureaucratisation of research activities and an increasing impact of administrative work on research processes. Academic science is characterised by greater autonomy for researchers and scientific institutions, separation of research work and administrative work, and by the delivery of institutional funds to research institutions.

### C. Triple Helix Approach

Another renowned model describing the changes occurring in the ways in which scientific knowledge is produced is the Triple Helix Approach (Etzkowitz & Leydesdorff, 2000), which, more recently, has also been proposed as the Quadruple Helix Approach (Carayannis, Barth & Campbell, 2012). As in the case of the Mode 1 - Mode 2 model, this approach is also partly descriptive and partly prescriptive, in the sense that it considers it necessary, for the sake of science and society as a whole, to sustain the trends depicted in the model.

Rather than just knowledge production, the model focuses on innovation. In particular, the model observes the prominent role acquired by universities in the innovation process, which has transformed the previously dyadic industry/government relations into closer triadic interactions and coordination involving State, Academia and Industry (hence the image of the "Triple Helix").

For the sake of simplicity, we shall focus only on some of the main trends identified under the Triple Helix model.

The main attributes distinguishing Triple Helix from dyadic industry/government relations are as follows.

| Dyadic industry-government relations | Triple Helix |
|---|---|
| Academia not involved in innovation | Academia involved in innovation |
| Separation of institutional spheres | Co-evolution and hybridisation of institutional spheres |
| Two university missions: teaching and research | Third mission and entrepreneurial research |
| Disciplinarity | Transdisciplinarity |

**Involvement of Academia with innovation**. In the Triple Helix approach, academia is increasingly involved in innovation dynamics, leading to ever closer cooperation and coordination with Industry and State.

**Relations among institutional spheres**. The involvement of academic institutions in innovation is happening in a context of increasing levels of interdependency among the three institutional spheres, creating the premises for co-evolution. Interdependency and co-evolution are producing, at the interface between State, Academia and Industry, the spread and differentiation of an increasing number of "hybrid" organisations (spin-off firms, tri-lateral initiatives, strategic alliances, etc.), facilitating higher cooperation levels. This is also supported through internal differentiation at the institution level (for example, the creation of the liaison offices in universities).

**University missions**. At the level of academia, the triple helix approach emphasises the changes directly affecting universities, which are assuming new characteristics linked to their new role of proactive promoters of innovation**,** epitomised in the concept of "entrepreneurial university[1]. The key concept that universities are being asked to pursue is a "third mission", i.e., promoting socio-economic development, together with the traditional missions of teaching and research (Etzkowitz, Ranga, Benner, Guaranys, Maculan, & Kneller, 2008). Obviously, the

[1] The Entrepreneurial university can be also legitimately considered as a model distinguished from the Triple Helix approach. See, in this regard, Kwiek, 2015.

definition of a third mission has structurally modified the ways in which the other two missions are pursued. For example, students should also be trained and encouraged to become entrepreneurs or to create new companies so they can contribute directly to the economic development of society.

**Disciplinary dynamics**. Finally, the Triple Helix approach emphasizes the increasing relevance of trans-disciplinary research, especially considering that the most advanced research sectors, such as nanotechnology, are to a great extent based on contributions, methodologies and interests emanating from different disciplinary fields.

### D. POST-NORMAL SCIENCE

Post-normal science is another model for interpreting changes affecting scientific knowledge production. This model is more limited in scope compared to those presented above. In fact, developed by Silvio Funtowicz and Jerome Ravetz (1993), rather than describing a general turn in scientific production, it highlights the increasing need to investigate issues where «*facts are uncertain, values in dispute, stakes high and decisions urgent*". Thus, the concept of "post-normal science» refers to the kind of research which goes beyond the boundaries of usual applied research, since it entails higher decision stakes and a higher level of uncertainty of the facts under investigation.

Post-normal science necessarily requires new institutional arrangements, including:

- The use of an extended peer community, involving all those who, for different reasons, are affected by the issues under investigation
- The use of a language which is more comprehensible to all actors in the public arena
- The development of new channels and ways to communicate science to facilitate political debate
- Greater involvement of policy actors in all phases of the research process
- The coexistence of competing interpretive proposals, from which competing solutions may derive.

### E. OTHER MODELS

In a review of the literature on new knowledge production, Hessels & Van Lente (2008) identify other interpretive models of changes affecting science and innovation.

**Academic capitalism**. The model (Slaughter & Leslie, 1997; Slaughter & Rohades, 2000) is mainly oriented towards accounting for the increasing weight of market dynamics in the life of university institutions under the pressure of globalisation processes. The model emphasizes the increasing importance of university market activities and growing competition in the academic environment (access to funds, patenting, activating university-industry partnerships, etc.).

**Strategic research**. The term "strategic research" was coined by Irvine & Martin (1984) to refer to basic research which, from the beginning, is conducted with the expectation that usable knowledge will be produced to address practical needs. Later, Arie Rip (2004) used the same concept to refer to a broader regime aiming to combine the economic and societal relevance of research and excellence. The European Commission also uses the concept of "strategic research" in the Europe 2020 strategy to refer to research focused on the big challenges for Europe, such as energy security, transport, climate change and ageing.

**Innovation systems**. Another approach is that of innovation systems. The concept was introduced by Lundvall (1985, 1992) and developed by the same author (Lundvall, 2016) and many others (for example, Pavell & Pavitt, 1994; Metcalfe, 1995) including international agencies (such as OECD, 1997). The model sees innovation as a nonlinear process based on interaction among many actors of different types (including research institutions), where knowledge-related dynamics play a prominent role in terms of not only developing new ideas and solutions but also activating learning processes involving the organisations concerned.

**Finalisation theory**. Hessels & Van Lente (2008) also mention, among the many approaches to scientific knowledge production, the finalisation theory, mainly developed by Bohme, van den Daele and Krohn (1976). On the basis of empirical research, they distinguish between different cognitive phases of the development of research fields, including the first ones (pre-paradigmatic and paradigmatic phases) where scientific research is not influenced by factors external to science, while in the last case (the finalisation phase), these external factors play a role. In this phase, according to the finalization theory, scientists need external demand in order to identify and select from among alternative research paths, equivalent from a scientific perspective but different in terms of potential economic and societal impacts.

### *1.4. Key trends in science and innovation*

The eight different models, although differing from each other in terms of focus and interpretive scheme, revolve around a single set of trends affecting science and innovation. An attempt to cluster these trends is provided in the following table.

| Cluster of trends | Models |
|---|---|
| **Multi-actor process** | Mode1-Mode2, Post-academic Science, Triple Helix, Post-normal science, Academic Capitalism, Strategic Research, Innovation Systems, Finalisation Theory |
| **Utility of scientific knowledge** | Mode1-Mode2, Post-academic Science, Triple Helix, Post-normal science, Academic Capitalism, Strategic Research, Innovation Systems, Finalisation Theory |
| **Macro-transdisciplinarity and micro-specialisation** | Mode1-Mode2, Post-academic Science, Triple Helix, Post-normal science |
| **Accountability and public scrutiny** | Mode1-Mode2, Post-academic Science, Post-normal science |
| **Political steering** | Mode1-Mode2, Post-academic Science, Post-normal science, Strategic Research |

#### A. Multi-Actor Process

All models converge on the idea that scientific knowledge is now produced through **widening networks** of researchers and research institutions, with the direct involvement, also, of **many**

**other kinds of actors**, including governmental entities, local authorities, industrial partners, civil society organisations or the public at large.

The models focusing on innovation (e.g., Triple Helix, Academic Capitalism, Innovation Systems) emphasize the interactions of universities and research institutions with industrial partners and governments, while other models (e.g., Mode 1 - Mode 2 or Post-Academic Science) also clarify the relations with societal actors. All in all, science and innovation are becoming a truly "**social enterprise**" (d'Andrea & Montefalcone, 2009), involving multiple actors with different roles, the boundaries of which are blurred and variable. The development of so-called "citizen science" is an expression of this.

Some of the interpretive models emphasize how the increasing interactions among scientific, industrial, governmental and societal actors are activating forms of hybridization, i.e., the spread of institutions which cannot be fully identified as belonging to the industrial sector, the scientific sector, or the civic sector (e.g., new institutions, like science parks or spin-off firms, sharing features from the industrial sector and the research sector or NGOs, developing research scientific capacities).

### B. UTILITY OF SCIENTIFIC KNOWLEDGE

Unlike in the past, **science has to justify itself** and **scientists have to justify their research** by producing knowledge which has or is likely to have an economic and a societal value. This tendency is emphasized in all the approaches considered above and produces a shift in the context in which scientific knowledge is produced, from the internal dynamics of science to the context of application.

This tendency has different consequences, including:

- The decreasing role of "pure" curiosity-driven research (Ziman, 2000) accompanied with increasing difficulties in discriminating between basic research, applied research and product development (Gibbons, 1999)
- The adoption of research policies directly connecting research to societal challenges and economic growth (Jacob et al., 2013)
- The adoption of new criteria (of an economic, social or political nature) for the allocation of research funds and resources (see, for example, European Commission, 2013)
- The development of new languages more comprehensible to all actors in the public arena to deal with scientific issues (Faulkner, 2011)
- The development of new communication channels and social configurations around the production of scientific knowledge (Bultitude, 2011)

Thus, there is "a shift from the search for knowledge to the search for relevance" (Davenport, Leitch & Arie Rip, 2003) as also the criteria related to the "**relevance**" of scientific research are changing (Hessels, Van Lente & Smits, 2009) so as to encompass societal needs and economic advantages, with multiplying effects on all the single components of the research process. Examples of this include the adoption of industry-inspired working models and criteria (the "entrepreneurial university" model epitomizes such a trend) and increasing competition among researchers and research institutions on a global scale to produce usable discoveries.

### C. Transdisciplinarity

The progressive dominance of problem-solving research is fostering an ever greater tendency towards **transdisciplinarity**. It should also be noted that transdisciplinarity is coupled with an increasing segmentation of the research process into extremely specialised sectors, with their own culture, communication circuits and publications. Thus, transdisciplinarity goes hand in hand with **hyper-specialisation**.

Transdisciplinarity may have various consequences, including:

- Radical changes in the institutional organisation of research and higher education institutions
- The creation of new scientific communities and networks, with their own culture, language, symbols, interests and approaches
- The reshaping of the structure of scientific publishing
- Tensions between disciplinary communities
- The modification of research methodologies
- The increasing role of knowledge brokerage.

### D. Accountability, Transparency and Public Scrutiny

Another evident change in science as a social institution is an **increasing demand for accountability and transparency** of science and scientists and the enlarged **openness of scientific knowledge to public scrutiny**.

All this may have different implications, including:

- The increased weight of ethical issues related to both scientific processes and outputs
- Modifications in the organisational charts and procedures adopted by research organisations (for example, establishment of public engagement offices, the adoption of ethical protocols, the establishment of ethical committees, etc.)
- Multiplication of monitoring and evaluation mechanisms on research and research outputs based on the involvement of citizens and stakeholders (see, for example, Jackson Barbagallo & Haste, 2005; Center for Advancement of Informal Science Education, 2009; Canadian Institute of Health Research, 2010).

Demands for accountability, transparency and public scrutiny are directly connected to the public's changing attitude towards science. According to Innerarity (2013), statistical data show that more trust is placed in science than other social institutions, but confidence in the objectivity of scientific experts is declining drastically. Thus, "in a knowledge society, the significance of knowledge increases, but the relevance of science decreases".

E. POLITICAL STEERING

One of the main features of science in a post-modern era is undoubtedly the strengthening role played directly by governments and governmental agencies in the research process. The autonomy of science and scientists is relatively limited, while governments are more engaged in defining priorities and criteria for accessing research funds, evaluating research results and orienting innovation processes.

Political steering, however, also implies profound changes in governmental structure, in terms of capacities, skills, and strategic orientations. Political steering carried out through inadequate personnel and leaderships may be an obstacle for research. Moreover, as stressed by Ziman (2000), political steering is also connected to the bureaucratisation of research activities, with an increasing burden of administrative work falling on scientists and research personnel.

### *1.5. Connecting science to the shift from modern to post-modern society*

The aim of this summary of the main approaches developed for interpreting the changes affecting science and innovation was to provide a clearer framing of Responsible Research and Innovation within a broader picture.

Simplifying somewhat, **five clusters of trends** have been isolated, more or less summarising the many trends highlighted by the approaches examined above, i.e.:

- Multi-actor process
- Utility of scientific knowledge
- Transdisciplinarity
- Accountability, transparency and public scrutiny
- Political steering.

It could be useful now to link these science and innovation trend clusters to the overall change processes marking the shift from modernity to post-modernity, as they were detailed above, i.e.:

- Globalisation
- Weakening of social structures
- Individualisation
- Risk and uncertainty
- Diversification and fragmentation
- Blurring cognitive and social boundaries.

The results of this exercise are summarised in the following table.

| Clusters of trends in science | Overall trends in post-modern age | Description |
|---|---|---|
| **Science as a multi-actor process** | Globalisation | Dis-embedding of traditional social relations underpinning scientific knowledge production, which is no longer carried out in specific local space-time frameworks, but through open and extended social configurations involving both expert and lay actors (OECD, 2016). |
| | Weakening of social structures | Science increasingly unable to manage the multiplying levels of relations connecting it with the other social spheres or keep control over internal processes (Ziman, 2000) |
| | Blurring cognitive and social boundaries | Decreasing solidity of traditional categorisations cognitively and socially underpinning modernity. In the case of science, weakening of the demarcation criteria distinguishing science and non-science (see, for example, Gieryn, 1983, 1995), scientists and laypeople (see, for example, Wynne, 1996; Collins, 2014; Grundmann, 2017) or science and technology (Gibbons, Limoges, Nowotny, Schwartzman, Scott, & Trow, 1994). Hence the increasing need for boundary work supporting science (Gieryn, 1983; Hellström & Merle; 2003; Evans, 2005; Koskinen, 2016) |
| **Utility of scientific knowledge** | Globalisation | Science as part of the global competition (OECD, 2016), albeit with limited development of the institutions of the knowledge economy (Pagano & Rossi, 2009). Science increasingly involved in national and international policies to address global challenges strategies (see, in this regard, Schwachula, Vila Seoane & Hornidge, 2014; OECD, 2015a) |
| | Weakening of social structures | Because of their diminishing authority and credibility, science and scientists are increasingly questioned and asked to demonstrate their usefulness (Gibbons, Limoges, Nowotny, Schwartzman, Scott, & Trow, 1994; Ziman, 2000; Chilvers & Macnaghten, 2014). |
| | Individualisation | Growing capacity and power of ordinary (lay) people to develop their own, autonomous, view of science and science-related issues (including anti-science orientations) and to sustain them in the public arena (Bultitude, 2011; Engdahl & Lidskog, 2014) |
| **Transdisciplinarity** | Blurred cognitive and social boundaries | Decreasing weight of the categories that organise the world into stable separate sectors (disciplines in science, ministries in the government sector, professional spheres in the job market, etc.) despite strong resistance towards this process (for resistance and problems related to the weakening of disciplinary boundaries, see Bourdieu, 1984; Jahn, Bergmann & Keil, 2012) |
| | Risk and uncertainty | Increasing sensitiveness towards global risks, calling for science to be reorganised according to |

| Clusters of trends in science | Overall trends in post-modern age | Description |
|---|---|---|
| | | problems rather than to disciplinary fields, requiring an inclusive approach encompassing both disciplinary and cross-disciplinary research (European Commission, 2010) |
| **Accountability, transparency and public scrutiny** | Weakening of social structures | Decreasing authority of social institutions leading them to "justify" the money spent for the activities carried out in terms of efficiency and impacts (see Guthrie, Wamae, Diepeveen, Steven & Grant, 2013; OECD, 2016) |
| | Individualisation | Extreme individualisation in contemporary society, increasing the capacity of ordinary people as individuals to have a say in public affairs (Beck & Beck-Gernsheim, 2002). In science, this is leading to an increasing demand for individualised views of science. |
| | Risk and uncertainty | People's increasing sensitiveness to risk, including those produced by science, feeding the demand for scientific institutions to be transparent and fully accountable (Pardo & Calvo, 2002; European Commission, 2009) |
| | Diversification and fragmentation | Social institutions and service providers reacting to an increasingly diversified demand by multiplying and reinforcing evaluation mechanisms in order to be more accountable and open to public scrutiny |
| **Political steering** | Globalisation | Governments increasingly assuming a leadership role in supporting national economics in global markets, thus including science in this effort (Porter, 1990; Dinnie, 2008) |
| | Risk and uncertainty | Governments increasingly expected to gain control of the sources of risks, including those related to science and innovation, through regulatory policies (Irwin, Rothstein, Yearley & McCarthy, 1997; Jasanoff, 2012; Demortain, 2017) |

There are moreover also recurrent schemes shaping policy reactions to the critical shift from modernity to post-modernity, including the following:

- Increasing effort to **reduce costs**, to deliver more with less (Institute of Leadership & Management, 2010) or to deliver less with less (Rivera, Roman & Simmonds, 2012; Hyman, 2015)
- Increasing efforts to **improve efficiency** and to demonstrate their own social usefulness (European Commission, 2013)
- Establishing **accountability regimes** (Bovens, 2006)
- Introducing **collaborative mechanisms** (Boyle & Harris, 2009; Ae Chun, Luna-Reyes & Sandoval-Almazan, 2012) and fostering the **participation of citizens and stakeholders** (Peters & Pierre, 1995; Jordan, Wurzel & Zito, 2005)

- Introducing **deliberative approaches in decision making** (Bohman & Rehg, 1997; Dryzek & List, 2003; Goodin, 2008)
- Establishing **regulatory framework** for risk prevention (see, in this regard, the debate on the regulatory state: Majone, 1994, 2010; Bartle & Vass, 2008; Lodge, 2008)
- Developing **ethical procedures**, in terms of the so-called "applied ethics" (Frey, 2004; Cohen & Wellman, 2014; Koven, 2016), driving the spread of specialised ethical codes for the pragmatic regulation of specific sectors, preventing risks and ensuring integrity.

As may easily be observed, most, if not all, of these orientations are included – sometimes in descriptive, sometimes in prescriptive terms – in the models of scientific knowledge production (post-academic science, Mode 1 - Mode 2 model, etc.) examined above and – as we shall see in Part Three – they are also largely incorporated in the concept and tools of RRI.

### *1.6. Discussion*

In this Section, a short analysis has been conducted with the final aim of framing RRI within the overall changes affecting science. With this aim in mind, an attempt was made to frame the latter within the main trends of change affecting societies in their shift from the modern to the so-called post-modern age. Therefore, this first section detailed three main operations:

- A summative analysis of the main trends affecting societies and social institutions
- A comparative analysis of the main interpretive approaches developed to account for the main changes affecting science and innovation
- An attempt to find connections between the latter and the former.

Three short considerations about the outputs of this process can be made.

#### A. CHANGING SOCIETY AND CHANGING SCIENCE

Needless to say, changes affecting science and innovation reflect the major transformations occurring in society as a whole. In modern society, social institutions, science included, were solid, highly structured, authoritative, standardised and self-contained, while in the post-modern context they appear to be weak, with uncertain boundaries and internal procedures, and de-standardised.

While they were legitimated by the power of the state, now their legitimacy, credibility and reputation are continuously questioned, activating negotiation processes at different levels (symbolic, institutional, interpretive, etc.).

#### B. SCIENCE AS A SOCIALLY WEAK INSTITUTION

Since science is experiencing the same critical turn affecting all the institutions of modernity, we should then recognise it as an institution which is socially at risk, even though, quite paradoxically, it is now technically stronger than it was in the past (in terms of both scientific advancements and technological impacts). It is quite strange that we are usually reluctant to consider science as an institution socially at risk, given the crisis of other institutions (such as politics, trade unions, marriage or family), where factors and trends are very similar.

This crisis could be defined in terms of **under-socialisation of science**, i.e. as an inadequate or even decreasing capacity of science and innovation systems to adapt to a changing society and to manage and steer the transformations affecting them (d'Andrea & Montefalcone, 2009).

What is at stake with science socialisation is not only the management of the growingly complex relations between science and society but also the functioning of the internal mechanisms of science, pertaining to the way in which scientific knowledge is produced, assessed, and used and ultimately the way in which the scientific method is actually applied and protected.

### C. Science from Models to Facts

So far, our reasoning has been based on general models. However, the distance between models and facts can be extremely wide. In fact, different situations and hybrids can co-exist and recurrent patterns of change may assume multiple forms, depending on the institutional, national, or social context, producing, also, variable impacts. Thus, the question we wish to examine now is the extent to which these trends actually manifest themselves in the lives of researchers and research institutions.

This is the issue which we will address in the next section.

## 2. Change processes

This section focuses on creating a **reasoned inventory of change processes** occurring in science (with a special focus on STEMs[2]), going also beyond or, rather, beneath the general models briefly presented above. Some preliminary remarks are to be made.

- The **inventory is necessarily selective**, focusing on the changes which may be of most relevance to science-in-society issues and RRI. In particular, an effort will be made to assume the point of view, so to speak, of an "average Principal Investigator" working in an average research institution or university, so as to understand as far as possible how s(he) may "decode" the concepts and messages connected to RRI. In fact – as we highlighted above – the assumption of FIT4RRI is that the acceptance and spread of RRI depends on its relevance and capacity to address the problems scientists and research institutions have to manage, deriving mostly from changes affecting science and innovation.

- The **inventory deliberately does not consider the many variables** which come into the picture. Changes in science and innovation are obviously different according, e.g., to national research systems and policies, disciplinary fields, kinds of research, kinds of involved institutions, economic environment and social context.

[2] STEMs refers to Science, Technology, Engineering and Mathematics.

## *2.1. Hypercompetition*

There could be many possible starting points for an analysis of changes affecting science. However, adopting a grass-roots perspective, so to speak, the factor producing the most impact on the lives or research institution and researcher is probably the skyrocketing increase in the competition to access funds and resources. This competition is so tough, especially in high-growth sectors such as biosciences, that some authors refer to it as "**hypercompetition**" (Alberts, Kirschner, Tilghman & Varmus, 2014; Schatz, 2014; Fochler, Felt & Müller, 2016).

The concept of "hypercompetition" is taken from economics and business management (D'Aveni, 1994) to refer to a competitive environment characterised by new traits which drastically distinguish it from "traditional" competitive environments. In the hypercompetitive environment, **time has collapsed the traditional process cycle** (launch of new product, exploitation and counter attack) and **equilibrium is impossible to sustain**. Therefore, competitive advantages can only be temporary and changes are continuous, since the only advantage is to keep replacing an advantage, including your own advantage.

## *2.2. Acceleration of the research process*

One major effect of a hypercompetitive environment is undoubtedly the **acceleration of the research process** (Pels, 2003; Garforth & Cervinková, 2009; Müller, 2014; Vostal, 2016). In general, fast work is considered a requirement for high quality research and the rapid exploitation of scientific knowledge. This process is not necessarily bad or good (Vostal, 2016; Felt, 2017), even though a movement promoting "slow science" is also emerging (slow science.org, 2013).

Acceleration means an «*increase of countable academic output per predefined unit of time*», e.g. per year, such as data produced, articles written, volumes edited, grant proposals submitted, lectures given, students passed, etc. (Müller, 2014). This necessarily requires a **reorganisation of the academic life** and **changes in the researcher's lifestyle** as well. If this does not happen, accelerating the research process may be problematic for the proper management of the reduction of the time needed for conducting experiments, verifying data, interacting with other researchers, writing papers, peer-reviewing, publishing, etc.

More in general, as Müller (2014) emphasizes, «*many of the problematic trends in current academia become tangible on the experiential level as questions of pace*», producing, e.g., tensions between different duties and tasks, a feeling of constant time pressures or problems in organising research work. For these reasons, in many research sectors, researchers experience **a condition of stress and pressure** which may greatly affect their professional and even personal lives (Bianchetti & Quartiero, 2010).

## *2.3. Shrinking of public research funds*

Another factor feeding competition is the **shrinking of public research funds**, also affecting high-growth research fields, such as biosciences (Alberts, Kirschner, Tilghman & Varmus, 2014).

In 2014, for the first time since 1981 (when data were first collected), OECD recorded a decrease in overall government spending on research and development (R&D) and higher education (OECD, 2016).

In the **European Research Area**, the government budget allocation on research and development (GBARD) **has declined in relative terms from 2008** to reach 0.67% of the Gross Domestic Product (GDP) in 2016, with a -0.5% compounded average growth rate (CAGR). A great variability across the countries is however to be noted. For example, increases are reported in countries like Austria, Czech Republic, Denmark, Finland, Germany, Poland, and Switzerland and decreases in countries like France, Hungary, Italy, Latvia, Spain, and United Kingdom (European Commission, 2016d).

This process is mainly interpreted as **structural**, in the sense that it is not due to contingent economic and financial crises but to the increasing costs of research (Ziman, 1996; Alberts, Kirschner, Tilghman & Varmus, 2014), including those for equipment, researchers' time, laboratory animals (Stephan, 2012) and access to scientific publications (Rose-Wiles, 2011), producing a growing impact on research organisations (Ehrenberg, Rizzo & Jakubson, 2003). This is making access to research funds much more selective and competition to access private funds much tougher.

This process also involves **an impact on time**. Indeed, the shrinking of funds is producing a decline in the success rate of grant applicants, with scientists having less time to devote to their research work (Alberts, Kirschner, Tilghman & Varmus, 2014).

### *2.4. Diversification of tasks*

Managing competition and the acceleration of scientific work in a context of diminishing resources means that a **market-oriented organisation** of the research process is becoming increasingly necessary.

One of the main consequence of such a process is a broad **diversification of tasks** (Kogan, Moses & El Khawas, 1994; Musselin, 2007), i.e., researchers are engaged in a **wider range of activities requiring, a wider range of skills and capacities**. For example:

- **Participation in extended research networks** obliges researches to spend time and resources to develop and maintain interactions with other research institutions, researchers and other stakeholders, in a context of diminishing time availability and resources (Bakken, Lantigua, Busacca & Bigger, 2009)
- The tendency to stress the **utility of scientific knowledge** pushes them to write research proposals to access research funds, to be engaged with technology transfer, to adapt their activities to performance-based and efficiency-oriented new management orientations (Fredman & Doughney, 2012) or to deal with the many economic aspects related to the research process, so as to address the decreasing availability of research funds
- The emphasis on **accountability, transparency and public scrutiny** obliges researchers to deal with many aspects related to science communication, ethical issues, administrative work and management of research funds.

Diversification of tasks both derives from and feeds an increase in the **bureaucratization of research work** (Schneider, 2013; Bozeman, 2015) which has a wide range of consequences on the lives of researchers and research institutions (see the box below).

## THE ADMINISTRATIVE BURDEN OF RESEARCHERS

The Federation of American Societies for Experimental Biology (FASEB) carried out in 2013 a survey on the administrative burden of researchers, involving 1,324 biological and biomedical researchers. The following items summarised the administrative burden deriving from grant preparation, submission, management, and funding.

**Grant Preparation**

• Extremely time consuming, taking anywhere from 25 to 100 percent of a PI's time for several months each year. • Each agency has unique formatting and informational requirements, even for basic information such as CVs and conflict of interest reporting. • Requirement for institutional regulatory body review and/or pre-approval prior to grant submission. • Lack of financial support for a PI's or Postdoc's salary during the grant proposal drafting and submission process. • Grant proposals require many details that are difficult to accurately predict, such as calculation and justification detailed research budgets.

**Effort Reporting**

• Difficult to accurately determine how much time was spent each week on overlapping projects by technical personnel supported by multiple grants. • Data from effort reporting may be flawed due to rigid reporting and formatting requirements (i.e., approximations are not allowed and the assumption of a 40-hour workweek is not always applicable to research), creating misinformation that is used to develop policies. • Lack of Institutional Administrative Support, Pre- and Post-Award • Lack of administrative support made grant submission and management the highest burden for many responders. • Concerns regarding indirect costs and the extent to which they are used to provide pre- and post-award management support. • Lack of scientific expertise among support staff results in researchers performing most of the administrative work themselves.

**Personnel Management**

• Delays and inefficiencies in the creation of new positions funded by a grant and in transfer of employees from one position to another as grants or research projects change. (It is unclear to what extent this is the result of agency policies versus institution policies, or whether this is primarily due to federal, state, or local labor laws.) • Having to lay-off trained research assistants and then re-hire and train new research assistants due to short gaps between one grant ending and the next being awarded. • Lack of sufficient flexibility for PIs to create desired personnel positions due to funding mechanism-specific rules.

**Time-to-Award**

• The time between submission of a grant proposal and receipt of an award makes short- and intermediate-term planning for research projects very difficult. • Delays in funding decisions cause PIs to continue submitting more and more "backup" grants.

**Financial Tracking and Reporting**

• Issues related to error-prone, overly complex, and difficult-to-navigate billing and financial tracking systems. • Lack of institutional expertise with smaller grants or less common funding mechanisms leads to conflicting institutional management and reporting. • Difficulty in assigning expenses to individual grants in multi-grant funded laboratories and similar issues with managing segregated funding. • Use of different financial categories by Institutions and agencies.

**Grant Funding Regulations**
• Inability to charge computers or required hardware and software updates to relevant grants. • Expansion of funding mechanism-specific rules for how awards can be spent, creating confusion.

**Subcontracts, Multi-Institution, and Multi-Agency Funding**
• Communication issues among researchers and administration across different study sites. • Difficulty with project management and oversight creates disincentives to participate in future large-scale collaborations. • Monthly invoicing and reimbursements for subcontracts do not always occur in a timely manner. • Lengthy finalization process for subcontracts due to institutional and agency requirements as well as state and federal laws.

**Electronic Submission and Tracking Systems**
• Institutional and agency systems "opaque" and "confusing." • Deploying software prior to full testing and validation is burdensome. • Utilization of user-unfriendly electronic forms by both agencies and institutions.

Source: FASEB, 2013

### *2.5. Increased staffing*

Task diversification is producing labour diversification, due to **increased staffing of research personnel** so as to ensure that all the necessary tasks involved in the research process are done properly and in due time.

However, the diminishing availability of research funds and resources is making it more difficult to enlarge research staff through the usual hiring and promotion schemes science institutions used in the past.

This has brought an **increase in contingent staff**, i.e., doctoral students and Postdocs, involved in research processes. This increase grew significantly in the last decades, to the extent that research systems in general, and especially in some specific sectors such as the bio-sciences, can be referred to as a "**PhD factory**" (Dijstelbloem, Huisman, Miedema & Mijnhardt, 2013).

This tendency is primarily due to **costs**. For example, in the USA, in 2010, a Postdoc salary was about $15.00 an hour, a graduate student about $20.00 (excluding fringe benefits and indirect payments), and a staff scientist about $32.00 per hour (Stephan, 2012). Moreover, in contrast to tenure-track researchers, contingent staff are increasingly paid with **soft-money**, i.e., money from research grants (Alberts, Kirschner, Tilghman & Varmus, 2014), thus working on the basis of a specific project. Reducing costs and increasing the labour force allow research organisations to be more competitive in the global research and innovation market.

This system is **disadvantageous for PhD students and Postdocs**, since «*they enjoy the thrill and challenge of scientific research*» and are engaged in a "rat race" (Alberts, Kirschner, Tilghman & Varmus, 2014) to access permanent positions while opportunities to get a permanent contract are drastically diminishing and the time needed to reach a permanent position are becoming longer (Stephan, 2012). Ravetz (2016), in turn, highlights the presence of a question of right involved in such mechanisms, since the science system is increasingly training people «*with the prospect of a lifetime sequence of short-terms jobs on contracts, lacking any rights of security and whose renewal depends on the four of the principal investigators*». In this way, many researchers, mostly after more than 10 years of temporary contracts, are forced to look for a career outside research, even though their experience of work is one-sided and they are not fit (or feel unfit) for other kinds of work.

This system is also a **frail system**, since it functions as a sort of **pyramid scheme or Ponzi system**, which works only if demand for faculty positions keeps on growing (Stephan, 2005). It is based on an "**implicit contract**", according to which PhD students and Postdocs provide a "surplus" of work, getting some benefits from their supervisors (for example, support in looking for new positions, co-signature of a publication, etc.) (Stephan & Levin, 1997). Again, the problem is that supervisors find it increasingly difficult to fulfil their promises due to the increasing competition.

**Lack of information** is another factor feeding this process. When deciding on their future career, students and PhD students seldom receive appropriate information about career options, opportunities and especially risks (Stephan, 2013). For this reason they see their **careers as highly linear** (Garforth & Cervinková, 2009), including a period devoted to doctoral studies, one or two Postdoctoral periods and then an attempt to become junior group leader somewhere. All breaks and periods working for non-academic tasks are seen as deviations from the career path. There is a sort of a **gap** between the linear perception of one's own career and the increasingly uncertain and non-linear career perspectives actually offered to young scientists.

A secondary impact of this process is the generation of a **new category of researchers**, i.e., those selling their labour temporarily by joining a research institution only for the time needed to work on a specific project (Ylijoki, 2014a), no longer aspiring to reach a permanent position.

It should also be considered that PhD students and Postdocs are the ones who **suffer most from the acceleration of the research process** (Vostal, 2014), being more vulnerable to the "imperatives" of producing, for example, rapid results, publishing one paper at least per year or demonstrating their skills and capacities in view of developing their career. Their aim is not simply to acquire academic capital, but to **acquire academic capital in a short time** (Müller, 2014) so as to gain advantage over competitors.

This also partially explains the presence of **gender inequality dynamics in science** as regards career advancement and access to leadership positions (European Commission, 2012a, 2016a). In fact, increased staffing and acceleration of the research process further heighten competition, disadvantaging those – typically women – who have more difficulty to fully concentrate on work because of the amount of caring activities they perform in family life (Goulden, Frasch & Mason, 2009; Archie, Kogan & Laursen, 2015) as well as for psychological dynamics (Shapiro & Sax, 2011; Dayton, 2013). It is to say that gender inequality is undoubtedly related to many persistent and deep rooted social processes going far beyond the domain of science (Valian, 1998). However, in the case of science, it is also fostered by specific forms of social stereotyping (Shapiro & Williams, 2012) and a masculine image of science (Keller & Kirkup, 1992) which structurally permeates research institutions (European Commission, 2012a).

## *2.6. Segmentation*

Task diversification and acceleration have also led to an increase in the **segmentation** (Musselin, 2007) of academic and research work. Segmentation is mainly based on age and contractual status.

- As regards **age**, tasks are shared out according to career position, so that experiments are prevalently done by PhD students and Postdocs, while seniors researchers are more involved with other tasks of an administrative and organisational nature.
- As for **contractual status**, contingent staff now performs a widening range of tasks previously performed by tenure-track personnel.

Thus, and quite paradoxically, permanent research staff is less in contact with actual scientific work and increasingly tend to transfer research and teaching responsibilities to temporary personnel.

This segmentation process may have many consequences.

- **Decreasing productivity of young researchers**. The segmentation process pushes contingent staff to work for long periods as staff scientists under temporary contracts. The lack of certain job prospects has negative effects on their autonomy and motivations, reducing their productivity (Stephan, 2005).
- **Increased control over academic tasks**. The segmentation of research work is favouring increased control over academic tasks. Control over single-task workers is easier than that over multiple-task workers (Musselin, 2007).
- **Overtraining**. The system tends to retain PhD students and Postdocs longer than necessary, with the double effect of damaging their career opportunities and diverting them from research tasks by increasingly getting them to do non-research (and often low-skilled) tasks (Stephan, 2005).
- **Decreasing quality of teaching**. Segmentation is leading to a decrease in the quality of teaching. This task is increasingly performed by ever cheaper teaching staff (especially temporary staff), while student numbers are rising (Dijstelbloem, Huisman, Miedema & Mijnhardt, 2013).
- **Changes in internal labour relationships**. Segmentation is also leading to a "late industrialisation" of the internal organisation of academic work, thus also modifying labour relationships. In the past, research organisations were perceived as a welcoming environment for researchers and a sort of community of peers. Now they are increasingly functioning as employers who use incentives and other mechanisms to activate internal competition, while researchers increasingly perform the role of labourers. Affiliation to an institution is thus turning into an ordinary labour relationship (Musselin, 2005, 2007).
- **Individualisation**. Researchers (especially Postdocs) are more and more inclined to act as individual professionals, since success is linked to their capacity to get through their research work as fast as possible, devising their own strategies and activating personal relationships. Single projects and collaborations are seen as useful only as long as they allow them to produce high impact publications, and are merely treated as launching points for the next step in a career that is to be advanced elsewhere (Müller, 2014).
- **Self-promotion attitudes**. Individualisation is also fostering self-promotion attitudes among scientists, especially in terms of publicising themselves and their own research activities via the Web (leveraging on the increasing use of blogging, micro-blogging and nanopublications) and public conferences (Dijstelbloem, Huisman, Miedema & Mijnhardt, 2013).
- **Stratification and polarisation in academic staff**. Finally, these changes are also producing stratification and polarisation in academic staff (Slaughter & Leslie, 1997; Slaughter &

Rhoades, 2000; Ylijoki, 2014b), which, in turn, is profoundly modifying and splitting the academic identities of research staff (Ylijoki & Ursin, 2015). In fact, those who benefit from changes (for example, those who exploit the cheap labour provided by contingent staff) and those who are damaged by them (for example, researchers who accept lower-grade positions of a technical or administrative nature in order to access permanent positions) do not share the same identity as scientists, since their interests and perceptions no longer overlap or clearly diverge.

### *2.7. Increasing mobility*

Another key feature of scientific careers is increasing **geographical mobility**. In general, many studies that measure academic performance mainly through publication data highlight that mobility is a **factor favouring an increase in scientists' performance** (see for example: Dubois, Rochet & Schlenker, 2014; Franzoni, Scellato & Stephan, 2014; Halevi, Moed & Bar-Ilan, 2016), allowing scientists to enlarge their personal networks (Franzoni, Scellato, & Stephan, 2014; Weert, 2013), facilitating their career progression (see, for example, Watson et al., 2010) and their access to new skills and capacities (Franzoni, Scellato & Stephan, 2014).

In any case, for scientists, the extent and importance of benefits deriving from mobility largely vary, depending on different factors, including career stage, length of stay, personal choices and specific circumstances (Guthrie, Lichten, Corbett & Wooding, 2017)

In **organisational terms**, and as regards **personal and professional living conditions**, extreme mobility may have important impacts on scientists.

First of all, extreme mobility involving many countries may have **negative impacts on access to permanent positions** (Marinelli, Pérez & Fernández-Zubieta, 2013). A **permanent position is also more difficult to find** for scientists returning home from abroad than "domestic scientists" (Fernández-Zubieta, Marinelli & Peréz, 2013).

Moreover, mobility may have a **strong impact on family life**. There is a **gender component** which comes into play in that, since having care responsibilities (children, partner, etc.) is a barrier to mobility (Cox, 2008; Børing, Flanagan, Gagliardi, Kaloudis & Karakasidou, 2015). Therefore, women are at a disadvantage compared to men (Weert, 2013) and, in fact, they are less likely to be internationally mobile than men (Guthrie, Lichten, Corbett & Wooding, 2017).

There are also problems related to the **loss of social ties** (Heining, Jerger & Lingens, 2007) and those deriving from the **time required for adjustment and familiarization** with the new working and cultural environment, which can even lead to a delay in the publication of new studies (Halevi, Moed & Bar-Ilan, 2016). **Other factors problematising stays abroad** may also include quality of life issues, unsatisfactory arrangements and practices concerning social security, immigration rules, health care insurances, and costs of living (European Commission, 2008)

### 2.8. Increasing pressure on research assessment systems

Research quality assessment criteria and tools are also affected by rapid changes. This issue is too complex to be deepened here. We will limit ourselves to only a few aspects which overall suggest an **increasing pressure** on research assessment systems.

The core of the problem is that the rapid increase in the number of researchers (Guthrie, Lichten, Corbett & Wooding, 2017), producing an increasing number of papers (European Commission, 2016b), is creating a **hyperproduction of scientific knowledge** (Dijstelbloem, Huisman, Miedema & Mijnhardt, 2013) to the extent that usual research quality assessment procedures (mainly based on peer reviewing and bibliometrics) seem no longer to be able to cope.

Many authors (for example, Young, Ioannidis & Al-Ubaydli, 2008; Osterloh & Frey, 2015; Hicks & Wouters, 2015) emphasize the **expanding and even distorting use of scientific publications**, which, once intended to communicate scientific results and validate them, are now serving different objectives, related to personal careers, resource allocation, visibility, reputation and completion among scientists and among research organisations.

The huge number of scientific products is **making it more difficult to ensure good quality peer review**. For example, the pressure of time, which increasingly characterises the lives of researchers, is a factor which affects peer review quality. Principal investigators have no time to review manuscripts and often leave this task to less experienced colleagues. The increasing number of manuscripts proposed for publication often obliges the editorial boards of journals to enlarge the pool of peer reviewers to include less experienced scholars. Time constraints also affect the peer review of applications for research grants, due also to the increasing number of applications submitted for funding (Alberts, Kirschner, Tilghman & Varmus, 2014).

Moreover, for these and other reasons, **peer reviews are not reliable enough**: they tend to produce diverging and unreliable results (Rothwell & Martyn, 2000; Starbuck 2005), are too influenced by the beliefs of reviewers (Lawrence, 2003) and are too conservative, rarely contradicting mainstream thinking (Campanario, 1998). Social and power dynamics may also influence the outputs of peer reviews (Newton, 2010). According to research on peer reviews in the medical sector (Schroter, Black, Evans, Godlee, Osorio & Smith, 2008), only a few of the errors present in papers were reported on average (one major error out of three on average).

The perceived reduced reliability of qualitative peer reviews is leading to an **increased use of quantitative indicators** (citation indexes, impact factors, etc.) based on bibliometrics. This approach has started to dominate science governance with the production of rankings (of departments, publications, etc.) which may greatly influence scholarly careers and the future of research institutions (Osterloh & Frey, 2015; Hudson & Laband, 2013).

However, according to other scholars (for example: MSCS Editorial Board, 2009; Ernst, 2010; Gunsteren, 2015), the use of quantitative indicators **cannot measure quality effectively** and may produce **distorting effects on science**. For example, citation indexes (Kermarrec, Faou, Merlet, Robert & Segoun, 2007):

- Are often exposed to manipulation
- Do not correlate with the originality of a scientific publication (being citations, for example, often linked to momentarily emerging trends)

- Produce fluctuating classifications of journals
- Do not include sources of scientific information (for example, conference proceedings are usually not covered) other than journals.

As for **research rankings**, they are not consistent over time (Lawrence, 2003) and tend to have a low prognostic quality, i.e., capacity to identify the future influence of a publication (Starbuck, 2006; Hudson & Laband 2013). A set of recurrent problems have also been observed in the use of citation indexes for evaluating scientific journals (see the box below)

PROBLEMS IN THE USE OF THE IMPACT FACTOR

**Technical ISI (Institute for Scientific Information) database problems**
• Biased towards the English language. • Biased sample of journals included in the database, • Database coverage different for research fields. • Books, conference proceedings, letters not included as source items. • Delayed registration of citation. • Frequent misprints (up to 25%). • Synonymy (several variants of the same article). • Homonymy (several authors with the same name). • Publishing time penalises disciplines with longer turnover times.

**Research field effects**
• Field size. • Field dynamics (expansion or contraction). • Research theme. • Inter-field relations (e.g., clinical medicine draws heavily on basic science, but not vice versa). • Bias towards research fields with literature that rapidly becomes obsolete.

**Reference selection and citer motivation**
• Primary criterion for reference selection is not quality but utility in research. • Incomplete referencing due to journal space limitations. • Reference copying. • Flattery (citation of editors, potential referees). • Self-citation. • In-house citation (friends and close colleagues). • Review articles heavily cited. • Utility in research rather than pure scientific quality is the primary criterion for reference selection.

**Problems associated with using the journal impact factor**
• Journal Impact Factors (JIFs) are determined by technicalities unrelated to the scientific quality of their articles. • JIFs are not statistically representative of individual journal articles. • Distribution of citations in articles within same journal is not uniform. • JIFs correlate poorly with actual citation rates of individual articles. • No mechanisms to correct self-citations. • Selective journal self-citation: articles tend to preferentially cite other articles in the same journal. • JIFs are a function of the number of references per article in research field. • Short publication times result in high JIFs. • National bias in reference selection favours American journals. • Review articles are cited in particular, resulting high JIFs.

Source: Ha, Tan & Soo, 2006

The **falsity of published research findings** is also concerned with this process. According to Ioannidis (2005), it is possible to identify a number of correlations between the falsity of published research findings and other variables. For example, the greater the financial and other interests in a scientific field, or the more fashionable a scientific field is (with more scientific teams involved and higher competition), the less likely the research findings are true.

In addition to this, scientific knowledge is also increasingly measured according to **criteria** which regard aspects (potential economic exploitation, utility from a problem-solving perspective, etc.) **different from intrinsic scientific quality**, involving “hybrid fora”, i.e., mixed committees of researchers and public users in charge of evaluating research proposals and research products (Dijstelbloem, Huisman, Miedema & Mijnhardt, 2013). This choice reflects changes in the definition of the social relevance of science and technology (Hessels, Van Lente & Smits, 2009) as well as deep changes in the way in which research institutions work. It is also true to say that the introduction of selection criteria related to the social or political significance of a research proposal remains highly controversial (Lamont, 2009).

All these critical issues do not necessarily lead to a search for radical alternatives to the existing assessment procedures. Rather, the main tendency is to improve, adapt or integrate existing assessment approaches or to change the ways in which they are used (for a discussion of this issue see, for example, Birukou et al., 2011; House of Commons, Science and Technology Committee, 2011; Mulligan, Hall & Raphael, 2013).

### *2.9. Governance shift*

Another problematic issue which is connected to the major trends of change affecting science is the modification of **university and research institute governance models**. The overall tendency is to **shift from the Humboldtian or traditional** model of university to the so-called **Entrepreneurial model**.

As maintained by some authors (De Boer, Enders & Schimank, 2005; Fried, 2006), this shift cannot be understood in black-or-white terms, since many different mechanisms of coordination and collective control are involved. De Boer, Enders and Schimank (2005), in particular, identify five main mechanisms concerned with this process:

- **State regulation** (i.e., state rules under which universities are allowed to operate)
- **Stakeholders guidance** (i.e., the guidance provided by state authorities or other delegated entities to other actors/stakeholder representatives, such as university board members)
- **Academic self-governance** (i.e., the processes and procedures of consensus building within and among academic components)
- **Managerial self-governance** (i.e., the governance exerted by the senior leadership and management of an institution)
- **Competition** (as the underlying rationale for the coordination of priorities and decision making).

According to the authors, what is changing is the balance among these mechanisms. In the traditional model, state regulation and academic self-governance are the strongest components, while in the entrepreneurial model, the strongest components are stakeholder guidance, managerial self-governance and competition. However, new forms of equilibrium among the involved mechanisms are not always simple to attain.

This shift does not occur in a uniform manner, owing also to the different types of academic institution. For example, McNay (1995) distinguishes four ideal types of university on the basis of two variables: the level of policy definition (i.e., the level of control by external factors, such as state intervention); the level of control over implementation.

| | | CONTROL OF IMPLEMENTATION | |
|---|---|---|---|
| | | Loose | Tight |
| POLICY DEFINITION | Loose | A. COLLEGIAL | B. BUREAUCRATIC |
| | Tight | C. ENTREPRENEURIAL | D. CORPORATE |

Thus, the **collegial type** tends to be the most traditional type of university, being scarcely influenced by external control and policy constraints, while the **corporate type** is strongly driven by political decision-making processes and tight control systems. The **entrepreneurial type** of university institution is strongly oriented to the outside world but the management style is based on a devolved leadership, where small project teams are the dominant unit. Finally, the **bureaucratic type** is mainly based on rules and regulation, formal control mechanisms and the strong power of senior management, while political definition is loose.

The general shift from traditional to entrepreneurial model is also greatly influenced by the **national context** (regulations, legal frameworks, cultural traditions), which heavily affect, for example, the structure of higher education governance, funding mechanisms, the role of private institutions or the culture and structure of academic staff (see, for example, Eurydice, 2008). The dynamics of science (in terms of pressure for productivity and practical application of research outputs) varies greatly according to disciplinary field (Hessels, van Lente, Grin & Smits, 2011)

All in all, scientific literature shows that the general shift from traditional to entrepreneurial model of university ends up generating a **wide range of situations** which are difficult to compare with each other and even more difficult to include in predefined categories and typologies. This is to say that research institutions are increasingly characterised by the typical de-standardisation processes of the post-modern age.

Moreover, the process of change is **far from being linear and smooth**.

On the one hand, the many actors involved (governments, governing bodies, rectors, academic staffs, central administrations, students, external stakeholders) adopt **widely different behaviours, orientations and strategies** to manage the change or interpret their roles in the changing context (Fried, 2005).

On the other hand, there is a lot of **resistance to the process of change**, with highly differentiated effects on how the change actually occurs. There are many voices against the adoption of a managerialist perspective (see, for example: Manne, 1999; Marginson & Considine, 2000; Fuller, 2001). More importantly, many stakeholders more or less actively tend to oppose change (Meek, Goedegebuure, Santiago & Carvalho, 2010; Mainardes, Alves & Raposo, 2011), producing different kinds of impact (Mainardes, Alves & Raposo, 2011; Lumijärvi, Arminen, Lähde & Koschke, 2012), including: the adoption of defensive routines so as to make it more difficult to implement change; development of poorly drafted plans often never implemented; lack of senior management commitment; tendency to maintain familiar communication chains thus reducing the introduction of new communicative configurations; conflictive attitudes towards new reforms; lack of compliance toward deadlines.

It should also be highlighted that, in a highly fragmented structure like academic institutions (Fried, 2005), resistance also emerges because of **mistakes and inadequate strategies in promoting change**. For example, reforms activated suddenly, started from outside, without any previous internal discussion aimed at explaining the reasons behind the process, planned in small circles or reserving too short a time for implementing the reform are most likely to exacerbate resistance (Lumijärvi, Arminen, Lähde & Koschke, 2012). More in general, both purely "top-down" and "bottom-up" approaches are limited as a way of fostering change, whereas an approach based on "**distributive leadership**" (Keppel, O'Dwyer, Lyon & Childs, 2010), in which change is jointly managed by different stakeholders, or a hybrid approach (Bolden, 2011) is more likely to succeed (Brown, 2013).

## *2.10. Increasing openness to external actors*

No less important for research organisations is the capacity to manage their **openness to society**, where the term "openness" refers to a lack of restriction or boundaries in participation (including innovation-oriented collaborations), transparency and accountability in decision-making and receptiveness to change in processes (McCarthy, Fitzgerald, O'Raghallaigh & Adam, 2017).

The relevance of this issue is evident, considering how universities and research organisations as well as single researchers increasingly interact with actors other than scientists for different reasons, such as: contributing to the development of national or local policies by serving as experts; fostering research-based innovation programmes; cooperating with the private sector; participating in public debates on science-related issues; participating in or supporting the local cultural and social life (community engagement); encouraging public participation in research programmes (citizens science); cooperating in science communication and education initiatives.

This issue will be further analysed in Part Three, since openness clearly is at the core of RRI. However, some issues can be highlighted.

- **Increased complexity**. Openness entails increased complexity in the management of research institutions. Openness-based strategies cannot be adopted by considering openness as a new organisational function to be added to the existing one while at the same time continuing "business as usual". Rather, a general reconfiguration of management and cultural approach is needed (Boogaard et al., 2013).
- **Openness level**. A problematic aspect is finding the "right" level of openness for a project or an institution towards external actors. For example, a study on the impact of openness on information system development projects shows that «*while openness contributes to higher levels of project success, a tipping point also exists, beyond which openness actually begins to contribute to diminishing returns*» (McCarthy, Fitzgerald, O'Raghallaigh & Adam, 2017).
- **Institutional undervaluing**. Openness, in its many forms, is usually overlooked in its relevance and potential role by research institutions, as shown by different studies on the level of importance attached practically to Public Engagement (for example: Neresini & Bucchi, 2011; Bauer & Jensen, 2011). This leads to openness-related practices being left as optional and not structurally embedded in research organisations (Burchell, 2015; Watermeyer, 2015), with the result that scientists involved in openness-oriented activities are

not rewarded for their activities (Burchell, 2015) nor get any reputational benefits , and may be even be considered «*'not good enough' for an academic career*» (The Royal Society, 2006).

- **Conceptual ambiguities and interpretive mismatches**. Many conceptual frameworks have been developed to deal with the many forms of openness, including, e.g., Public Engagement with Science and Technology, Triple and Quadruple Helix, Citizens Science, Universities' Third Mission, Universities' Civic Engagement, Science communication, Innovation Ecosystem, Innovation Networks, or Innovation Districts (see the analysis by Lassnigg, Hartl, Unger & Schwarzenbacher, 2017). However, the presence of these different frameworks (which usually correspond to different communication circuits and communities of experts) produces ambiguities and new boundaries. For example, the approach focused on Public Engagement tends to exclude industry and to focus on citizens and stakeholders; the Third Mission approach is focused on industry and tends to exclude citizens. Moreover, the same framework may be interpreted in different ways. For example, it is not rare for scientists to include among the components of public engagement purely communicative activities (such as relations with media), student recruitment, knowledge transfer, or working with policy makers (Research Councils UK et al., 2010).

- **Resistance and barriers**. The process of opening up research institutions to society often comes up against different types of resistances and barriers. For example, obstacles to university-industry collaborations can be found, for example, in the different institutional norms governing public and private knowledge, the different culture of public and private researchers, conflicts over patenting issues, the lack of clear views by scientists about the benefits of working with industry (Bruneel, D'Este & Stalter, 2010). Other examples of resistance and barriers to openness among researchers and research institutions can be of a managerial nature (e.g., time constraints; lack of funding and other resources, etc.), a cultural nature (e.g., passivity of decision makers, limited relevance accorded to laypeople, etc.), related to the lack of capacity and skills (for example, communication skills, managerial skills, etc.) or to political issues (e.g., resistance to changes in existing power relationships, lack of political frame and will to invest in openness, etc.) (Rask et. al, 2016).

- **Distrust in science**. As regards openness in science, another emerging issue is the decreasing trust people have in science and scientists, recorded also statistically (for example, Eurobarometer, 2010 and 2013; Scientific America, 2010). Scientific judgments on matters of practical concern are not infrequently suspected of being incompetent and biased (Carrier, 2017). Distrust also tends to increase in sectors or on questions where science is perceived to be in close connection with industry (Chilvers & Macnaghten, 2011) or political interests (Bolsen, Druckman & Cook, 2013). Distrust is also fed by bias, manipulation and misinterpretations which may occur at any step of the research process, up to the communication of research results to the public (Ferrante, 2016). This means that participation of citizens, NGOs or stakeholders in science and innovation cannot be taken for granted.

- **Impacts on open data on science**. Another trend, strongly connected to the progressive openness of science, is the increasing impacts of ICT and, especially, open data on the way in which science is produced, disseminated, deployed, used and managed (OECD, 2015b; European Commission, 2016b). Hence, the idea of an open science (i.e., a science that fully use the opportunities provided by ICTs) which goes far beyond the concept of open access. In fact, ICTs not only make it possible a different way to access publications, but provide a wide range of opportunities related to the «*interoperability of scientific infrastructure, open and shared research methodologies (such as open applications and infor-*

*matics code), and machine-friendly tools allowing, for example, text and data mining*» (OECD, 2015b), which, overall, make science necessarily more transparent and more embedded in societal ethos and dynamics. Nevertheless, technological opportunities cannot be turned into real changes without concurrent social, cultural and policy transformations involving the many actors involved in the production and use of scientific knowledge (OECD, 2015b). It is also important to note that, as RRI, also the concept of Open Science can be considered as an "umbrella concept", encompassing different assumptions and views of science (Fecher & Friesike, 2014)

### *2.11. Critical dynamics affecting the quality of research products*

There is much debate about the extent to which the new organisation of research work influences research quality. Views are polarised in this regard.

On the one hand, many authors maintain that **changes are already occurring** and scientific **institutions cannot but rapidly adapt their internal organisation to them**.

Different models have been developed for orienting research and university organisations in managing this adaptation process, including the Entrepreneurial University Model (Etzkowitz, 1983 and 2004; Jacob, Lundqvist & Hellsmark, 2003; European Commission-OECD, 2012), the application of New Public Management in science policies (De Boer, Enders & Leisyte, 2007; Elzinga, 2010; Enders, De Boer & Westerheijden, 2011) or the so called Emerging Global model (Mohrman, Ma & Baker, 2008). Moreover, interpretative models like the Mode 1 - Mode 2 model or the Triple Helix model, as well as many others focusing on innovation (Innovation Systems, Strategic research, etc.) undoubtedly have been intended, at least partially, as prescriptive models (Hessels & Van Lente, 2008).

From this perspective, problems related to research quality are prevalently viewed as the effect of delays, mistakes and lack of political will in promoting serious reforms of research systems or single research institutions.

On the other hand, other authors maintain that it is **precisely the adoption of these models that bring about problems** in research quality. Some aspects can be considered here.

- **Safe research strategies**. The tendency towards the "projectification" of science (Vermeulen, 2010; Ylijoki, 2014a), i.e., organising research work as a set of manageable processes based on projects, roadmaps and precise timing, is pushing scientists to favour safe research projects (Stephan, 2012) with limited risks of failure. In many cases, projects are viewed by researchers not for their potential in terms of knowledge production, but for their capacity to facilitate their own access to funds needed, e.g., to retain PhD students or Postdocs, to get external support to keep lab going, to get support for one's own salary, or to match productivity standards adopted by one's own research organisation. Moreover, past research results play an important role in accessing new research funds. Thus, having research projects with limited results in terms of discoveries and publications in one's own curriculum may be highly problematic for career advancement. All this is conducive to conservative, short-term thinking in applicants, reviewers and funders, and penalises more creative and unorthodox approaches (Alberts, Kirschner, Tilghman & Varmus, 2014).

- **Irrelevant science**. The increasing need for scientists and especially for PhD students and Postdocs to publish papers in order to "remain in the research market" may have the distorting effect of pushing them to produce meagre and sometimes bad publications «*which do not serve science, but which scientists need to advance their careers*» (Dijstelbloem, Huisman, Miedema & Mijnhardt, 2013).
- **Redundant papers**. Another phenomenon linked to increased competition in science is that of redundant papers, i.e., the tendency to publish the same data or even the same paper in different journals, with the aim of increasing the impact factor of one's own publications (Brochard, 2004; Noè & Batten, 2006; Amado Senaris, 2008).
- **Short-term orientation and instrumentalisation**. The tendency to "commodify" science may lead to a narrow focus on short-term achievement and results and on research able to produce patentable and profitable results, penalising long-term projects (Radder, 2010; Irzik, 2013).
- **Increasing malpractice**. Hypercompetition and the adoption of new forms of research organisation is sometimes also viewed as one of the main factors fostering scientific malpractice (plagiarisms, data fabrication or manipulation, etc.), thus producing a decrease in the integrity of science and its quality (Kaiser, 2014).
- **Decreasing reproducibility of scientific data**. For different reasons (pressure to publish, selective reporting, insufficient replication in the lab, poor oversight, low statistical power and scientific malpractice), often connected to the accelerated pace of the research process, around 50% of all research data (European Commission, 2016b) and probably more (Baker, 2016) are considered not reproducible. Lack of reproducibility is also connected to increased competition in accessing high-impact-factor journals, which encourage behaviours – such as exaggeration of claims, selective reporting of data, cutting corners, exaggerating the values of findings, and overstating the significance of publications – which undermine the integrity of published work and adversely affect the conduct of science (Alberts, Kirschner, Tilghman & Varmus, 2014; Patterson, 2016).
- **Negative impacts of commodification of scientific research.** Commercial interests may also have undesirable impacts on research methods and their results and may lead to a higher level of secrecy that could slow down the overall advance of science, raising a variety of legal, moral, and philosophical questions about the patentability of the results of academic research. Commodification will be detrimental to those areas of academic inquiry that are seen to be useless from the perspective of economic instrumentalisation and may entail the problem of potential abuse of public funds for private purposes (Radder, 2010).

### *2.12. Discussion*

The key idea at the basis of this literature review is that the difficulties met by RRI to diffuse and be adopted (especially in STEMs) are connected to the change processes which are affecting science as a social institution. In particular, it is supposed here that RRI is or is perceived by scientists to be irrelevant or not useful enough to manage such change processes.

In this framework, an effort has been made in this section to develop a "**reasoned inventory**" of change processes occurring in science, focusing attention on the "**grass-root problems**" facing scientists and research organisations, i.e., the critical issues which have a direct impact on the professional and personal condition of scientists or on the daily activities of an organisation.

The main issues emerging from the analysis are summarised below.

| TRENDS | DESCRIPTION |
|---|---|
| **1. Hypercompetition** | Science as a hypercompetitive environment where the traditional process cycle has collapsed due to time constraints and equilibrium is impossible to sustain |
| **2. Acceleration of the research process** | Working faster seen as a requirement for high quality research; changes in the organisation of academic life and in the researchers' lifestyle; researchers under condition of stress and pressure |
| **3. Shrinking of research funds** | Scientists and research organisation working in an increasingly competitive environment, especially in accessing to funds and publishing; decline in the success rate for grant applicants, with an increasing waste of time |
| **4. Task diversification** | Market-oriented organisation of the research process, in which research is required to engage with a wider range of different types of activities (participation in extended research networks, direct involvement in innovation and technology transfer, activities related to accountability, transparency and public scrutiny, administrative work, etc.). This is leading to a decrease in the time devoted to scientific work. |
| **5. Increased staffing** | Increased numbers of contingent staff (PhD students and Postdocs), due to the need for cost containment; increased use of soft money to pay the contingent staff: fewer opportunities for young researchers to access permanent positions; increased pressure on young researchers to make more in less time, creating hardships especially for women scientists. |
| **6. Increased segmentation** | Segmentation of staff based on age and contractual status, producing impacts such as:<br>- Decrease in productivity among young researchers<br>- Increased control over academic tasks<br>- Overtraining (tendency to retain PhD students and Postdocs longer than necessary)<br>- Decrease in teaching quality (increasingly done by ever cheaper teaching staff)<br>- Changes in internal labour relationships (research organisations no longer as a "community of peers" but merely as employers)<br>- Individualisation (researchers increasingly acting as individual professionals and not as part of a staff)<br>- Attitude of self-promotion among scientists<br>- Stratification and polarisation of academic staff (academic staff split between those benefit from change and those who are damaged by it) |
| **7. Increasing mobility** | Mobility as a factor promoting an increase in scientific performance but having possible critical impacts on the lives of researchers, such as: delays in accessing permanent positions; difficulties in returning to one's home country; problems in managing family life, especially for women scientists; |

| TRENDS | DESCRIPTION |
|---|---|
| | loss of social ties |
| **8. increasing pressure on research assessment systems** | Traditional research assessment procedures are no longer able to manage the hyperproduction of scientific knowledge; systematic problems and errors in peer review, lessening its reliability; problematic tendency to use quantitative indicators to assess researchers, research institutions and scientific journals, with distorting effects on science quality |
| **9. Governance shift** | Tendency to adopt entrepreneurial models for managing research organisations, requiring a balance of different steering mechanisms; high variability in types of research organisations; differentiation in terms of national contexts; strong resistance to change; need for highly participatory approaches. |
| **10. Increasing openness to external actors** | Rising complexity in managing research organisations due to growing need to interact with external actors (political authorities, civil society, industry, etc.) for different reasons (innovation, providing expertise, public engagement, policy issues, societal engagement, science communication, etc.); need to find the right openness level; institutional undervaluation of openness-related initiatives; conceptual ambiguities and interpretive mismatches about openness; resistance and barriers to openness; decreasing trust in science |
| **11. Critical dynamics affecting the quality of research products** | Impact of changes on the quality of research, such as:<br>- Tendency of researchers to adopt safe and low-risk research strategies (favouring conservative and short-term thinking and penalising more creative and unorthodox approaches)<br>- Tendency to produce irrelevant science (producing publications for career advancement rather than producing advances in science)<br>- Tendency to produce redundant papers (publishing the same data or papers more than once)<br>- Tendency to work on research project that ensure short-term achievements and profitable results<br>- Increasing malpractice<br>- Decreasing reproducibility of scientific data<br>- Undesirable impacts of commercial interests on research quality |

It is interesting to notice the convergence between the main outputs of this analysis on the main changes affecting science and the results of an opinion poll (Belluz, Plumer & Resnick, 2016) carried out in 2016 involving 270 scientists about the biggest problems facing science (see the box below).

THE 7 PROBLEMS FACING SCIENCE

The results of an opinion poll about the problems facing science was published in the information website *Vox* on September 7, 2016, on the basis of interviews involving 270 scientists (including graduate students, senior professors, and laboratory heads) from different disciplines and research fields.

Ranking based on the seriousness of the problems is as follows.

**1. Academia has a big money problem**

Funds, in many fields, are shrinking and the way money is handed out puts pressure on labs to publish a lot of papers, breeds conflicts of interest, and encourages scientist to overhype their work.

**2. Too many studies are poorly designed. Blame bad incentives**

Scientists are ultimately judged by the research they publish. And the pressure to publish means that scientists often design their studies poorly, to game them so they turn out to be a little more "revolutionary" through specific research decisions and cutting corners in how they analyse their data.

**3. Replicating results is crucial. But scientists rarely do it**

Scientists tend not to replicate scientific results as they should and, when they attempt to replicate a study, they often find they cannot do so.

**4. Peer review is broken**

Numerous studies and systematic reviews have shown that peer review does not reliably prevent poor-quality science from being published and frequently fails to detect fraud and other problems.

**5. Too much science is locked behind paywall**

Many scientific works are not easily accessible, being locked away in paywalled journals, difficult and costly to access.

**6. Science is poorly communicated to the public**

Lack of appropriate communication approaches leads many laypeople to hold on to completely unscientific ideas or have a crude view of how science works.

**7. Life as a young academic is incredibly stressful**

Many tenured scientists and research labs depend on small armies of graduate students and Postdoctoral researchers to perform their experiments and conduct data analysis. However, young researchers are poorly paid, work very hard, encounter family problems, and have limited career prospects. This situation tends to disproportionately affect women.

Source: Belluz, Plumer and Resnick, 2016

On the basis of these trends, some considerations can be made.

## A. Transitional Process

The first consideration concerns the **desirability and acceptance of the transformations**, as well as the fact that the way these transformations are actually managed is still controversial.

Some authors (for example, Benessia et al., 2016) maintain that **science is in crisis**, which manifests itself in different ways (many of them already discussed above), affecting the different components of the science process:

- **Science quality** (e.g., decreasing reproducibility of scientific data, increasing malpractices)

- **Assessment procedures** (e.g., problems of peer-review, abuse of metrics)
- **Reward systems** (the usual systems now producing perverse incentives)
- **Organisation of labour** (increasingly based on a division of labour on an industrial scale)
- **Recruitment mechanisms** (increasingly training people who will never access to permanent positions)
- **Public image of science** (increasingly affected by the science quality crisis)
- **Self-perception of scientists** (from being part of a peer community to being part of an industrialised sector).

It should also be said that the idea of a crisis in science is not at all new (see, for example, Mohr, 1977). However, the present-day crisis does not only concern science as a cultural force (and thus its cultural influence in society), but also science as knowledge-producing institutions (and thus its internal production, regulation and control mechanisms). In other words, science is becoming a **weak institution**, not only in **social and cultural terms**, but also, so to speak, in **technical terms**, i.e., in terms of the functioning of its own technical procedures.

Using a problematic term like "crisis" could be excessive or uselessly pessimistic. However, a **transitional process** is surely taking place, and a growing demand to move towards a new and more advanced equilibrium is also emerging. The EC-promoted consultation on *Science 2.0* (European Commission, 2015) or the programme *Science in Transition*, developed in the Netherlands (Dijstelbloem, Huisman, Miedema & Mijnhardt, 2013), are good examples. Overall, scholars seem to be prevalently worried about this changing picture, although recognising the potential benefits that some changes may have in the future.

### B. The Contradictory Impacts of the Proposed Solutions

A second consideration concerns the **different solutions** proposed to manage changes.

As we already observed, various models have been developed in the last two decades (such as Mode 1 - Mode 2, Triple Helix or Academic Capitalism; see Part Two, Para. 1.3.) as drivers for change in research systems. More or less, the proposed solutions tend to overlap on some key orientations for research institutions and researchers, such as:

- Adoption of forms of anticipatory and dynamic governance
- Increased and smoother relations with external actors and the public at large
- Increased engagement with innovation and stronger cooperation with industry
- Higher level of transparency, accountability and self-reflexivity
- Higher capacity to manage the ever-increasing amount of scientific information produced by adopting more advanced ICT technologies
- Boosting trans-disciplinary work and a problem-solving approach.

As shown in the literature review, the adoption of these models or the principle behind them often leads to **unintended consequences** and **side effects** (difficult to prevent and appropriately manage) which affect, to different extents, the activities of research organisations and especially the lives of researchers.

For example:

- The increasing orientation towards the **utility of scientific knowledge** is also, for example, leading to an acceleration in the research process, unsettling the lives of researchers, an extreme segmentation of the research work (with the exploitation of contingent staff, like PhD students and Postdocs) or a decrease in the quality of scientific products
- Making science a **multi-actor process** also entails or may entail a weakening and distortion of research quality assessment practices, a complexification of the management of research organisations or an increase in internal resistance to the openness of research institutions towards societal actors
- Greater **political steering** of science may be accompanied by task diversification and increased competition over accessing funds
- The orientation toward **accountability, transparency and public scrutiny** may lead to an increasing segmentation of research work, greater diversification of the tasks to be performed and an increased complexity in implementing reforms in the organisational and governance structure of research institutions.

In this framework, the introduction of new models or principles may be experienced subjectively by scientists and university managers mainly in terms of the short-term **problematic effects** they bring about (on research organisations, quality of research products, or the lives and professional conditions of researchers), and not their benefits in the long run. This may raise resistance (both active and passive) or open opposition within research organisations.

Therefore, in this picture, it is important to understand the **actual and potential role RRI** can play. In the next part, devoted to RRI, we will try to examine this issue in greater depth.

# Part Three

# Responsible Research and Innovation

In this section, the focus moves from research and innovation processes to Responsible Research and Innovation. We will try to explore this issue first by analysing RRI from a theoretical perspective (section 1) and then looking in depth at "RRI in action", dealing with methods and especially critical issues connected to its practical application (section 2).

## 1. Theoretical approaches

### *1.1. Conceptual RRI models*

It is inevitable that an analysis of Responsible Research and Innovation (RRI) will start by noticing the extent to which this notion is becoming popular among policy makers and research communities focused on science and innovation.

Its success is certainly also due to the strong support given by EC to the adoption and spread of this notion. Many of the projects intended to develop theoretically and apply practically RRI policy framework and tools (including FIT4RRI) are directly propelled by EC funds (Kuhlmann, 2016).

However, it could be simplistic and reductive to consider the success of RRI as a mere effect of a political will. Rather, RRI has emerged as a **mobilising concept** (Ribeiro, Smith & Millar, 2017) able to captivate, often for different reasons, the interest of various scientific and policy circles and to interpret needs and expectations of different kinds.

This capacity is also probably due to the fact that RRI, like many other concepts related to science, society and innovation (for example, "Public Engagement", "stakeholders" or "smart technology") is characterised by an interpretive flexibility, making it a buzzword (Bensaude Vincent, 2014) or an umbrella word (Owen, Stilgoe, Macnaghten, Gorman, Fisher & Guston, 2013; Rip, 2016), so it can be used and applied by different (disciplinary and policy) "communities", in principle foster boundary work involving them (Gieryn, 1983).

Precisely this characteristic – which can also be simply interpreted as vagueness and lack of determination – potentially helps RRI to express the **growing interconnections** between science, industry, society, economics and politics (Bensaude Vincent, 2014), as also the **ambivalent status of science** in the post-modern context (considered contemporaneously both increasingly beneficial and increasingly dangerous for society; see Eurobarometer, 2013).

It is, however, also true that the success of RRI (both as policy narrative and practical approach) is much more limited when STEM communities are concerned, which still appear to be little attracted by it (Bensaude Vincent, 2014).

In order to see why, we shall start by discussing the conceptual dimension of RRI.

There is a lot of theoretical literature now available on RRI, and various attempts have been made recently to conduct "meta-analyses" of the different theoretical approaches to RRI. We will consider six meta-analyses, developed respectively by:

- The GREAT Project
- Gwizdala and Sledzik

- Ribeiro, Smith and Millar
- Burget, Bardone and Pedaste
- Glerup and Horst
- Lubberink, Blok, van Ophem and Omta.

### A. GREAT Project

A comparison of the major accounts of RRI (those by Grundwald, Sutcliffe, Von Schomberg, the EU, the RRI Expert Group, etc.) has been carried out the Governance of Responsible Innovation project (GREAT, 2013), drafted by DMU, Job Timmermans and Bernd Stahl. The following table contains a summary of the results of the comparison. The different accounts are described on the basis of four items: what is RRI; why it is should be done; how it works, i.e., what is its core mechanism; who is directly involved.

| | |
|---|---|
| **Von Schomberg (2012)** | |
| What | Process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products |
| Why | Proper embedding of scientific and technological advances in our society |
| How | Mutually responsive to each other; transparent and interactive |
| Who | Social actors and innovators |
| **Owen, Macnaghten & Stilgoe (2013)** | |
| What | Collective commitment of care for the future |
| Why | Responsibility gap, the nature and impact of consequences of R&I; care for the future |
| How | Responsive stewardship of science and innovation in the present |
| Who | Collective |
| **Geoghean-Quinn (2012), reflecting the official position of the EU** | |
| What | Alignment to R&I process and its outcomes to values, needs and expectations of European society |
| Why | Aligns values, needs and expectations of European society |
| How | Working together; inclusive and participatory; gender equality and integration; enhancement of educational processes; open, transparent, engagement |
| Who | All societal actors; research industry; policymakers and civil society |
| **Sutcliffe (2011)** | |
| What | Deliberate focus of research and the products of innovation to achieve a social or environmental benefit |
| Why | Achieve social or environmental benefit; being mindful of the public good |
| How | Deliberate focus; openness and transparency; adapt and respond; oversight mechanisms; assessing and effectively prioritising social, ethical and environmental impacts, risks and opportunities; involvement of society; anticipation and management problems; adapt and respond |
| Who | Society; public & non-governmental groups; civil society stakeholders |
| **Grunwald (2011)** | |
| What | Involving/addressing ethical and social issues in the R&I process |
| Why | N/A |
| How | Responsibility reflections; making distribution of responsibility transparent; bridge the gap between innovation practice and a range of other practices; integrative approaches |

| | |
|---|---|
| Who | Ethicists, political and social scientists, philosophers of science, governance researchers, affected natural scientists |
| **Stahl, Jirotka & Eden (2013)** | |
| What | Social construct of ascription that defines entities and relationships between them; meta-responsibility |
| Why | Socially desirable consequences |
| How | Defining or producing both entities, i.e., actors and stakeholders in R&I and the relationships between these entities |
| Who | N/A |
| **Van den Hoven (2013)** | |
| What | Activity or process which may give rise to previously unknown designs |
| Why | Expand the set of relevant feasible options regarding solving a set of moral problems |
| How | Outcome of innovation processes and activities |
| Who | N/A |
| **Expert Group on the State of Art in Europe on RRI (Jacob et al., 2013)** | |
| What | Part of the R&I process; comprehensive approach of proceeding in research and innovation |
| Why | N/A |
| How | Obtaining knowledge of and evaluating consequences of R&I; in terms of societal needs and moral values; setting functional requirements for design and development of new research, products or services |
| Who | N/A |

Combining the approaches, the authors highlight some emerging orientations.

- **What is RRI**. Three main accounts are provided about the nature of RRI, i.e.:
    - As a process or, better, a second-order process (especially a governance process) orienting R&I (Von Schomberg, Owen et al, Stahl, Jirotka & Eden)
    - As a requirement to be embodied in the R&I process (Grunwald, EU/Georghean-Quinn, Sutcliffe)
    - As part of the R&I process (Expert group, van den Hoven).

  The contents of RRI largely overlap, i.e. ethical and social issues (or goals) and the alignment of values, needs and expectation of European society. The expected outputs also tend to overlap, i.e., activate innovation process incorporating these contents.

- **Why RRI**. Although differing in their phrasing and terminology, the accounts analysed seem to converge in recognising RRI as «*necessary when taking into consideration the current societal problems mankind is facing or 'grand challenges*». In other words, RRI is understood mainly as an attempt to enlarge the responsibility scope of science and innovation (and scientists and innovators) so as to include the so-called "global challenges" or "societal challenges". In this sense, what is at stake with RRI is the social relevance of science and the recognition of its potential benefits and risks (see, in this regard, Hessels, Van Lente & Smits, 2009).

- **How**. The implementation of RRI is in general connected to a set of requirements which should be incorporated, at different levels, into R&I. Some of them concern the R&I process, which – according to the authors – is expected to be transparent, iterative, responsive, anticipatory, reflexive, deliberative, collective, open, inclusive, participative, integrative and connected to education. Other requirements relate to the goals of R&I, i.e., addressing risks and dilemmas, being ethically acceptable, being socially desirable, producing social benefits, sustaining fundamental rights, being respectful of moral values and ethical standards, addressing societal needs and expectations, pursuing the co-evolution of science and society, and so forth.

- **Who**. This aspect is the least developed in the different accounts. All them, however, seem to refer to stakeholder involvement, not excluding, in principle, any actor.

### B. GWIZDALA AND SLEDZIK

On the basis of a literature review (2017), the Polish economists Jerzy P. Gwizdala and Karol Sledzik have made a comparative analysis of RRI, focusing on its conceptual dimensions. The results of their analysis are summarised in the following table.

| DIMENSION | DESCRIPTION | AUTHORS/RESEARCH |
|---|---|---|
| **Inclusion** | Inclusion is a conceptual dimension which can be considered as fundamental for most of the discussions within the RRI area. Inclusion is also associated with all other conceptual dimensions, it engages different stakeholders in the early stages of research and innovation process. When it comes to the discussion of technology transfer and technological issues, it is important not to forget about societal, economic, political and human aspects. Engaging the public stakeholders in early stages of R&D is supposed to positively influence technological development.<br>The example of inclusion in the view of RRI is the Code of Conduct (CoC), which leads various actors to follow the principles of a safe, ethical and effective framework. Many followers of RRI concept see inclusion as the ''ongoing involvement of society'' in various stages of the research and innovation process, without wasting taxpayers' money or time at the same time. Inclusion is the conceptual dimension that characterizes RRI the most. | - Barben, Fisher, Celin & Guston, 2008<br>- Owen, Macnaghten & Stilgoe, 2012<br>- Mejlgaard, Bloch, Degn, Nielsen & Ravn, 2012<br>- Stahl, 2013<br>- Kearnes, 2013<br>- Asante, Owen & Williamson, 2014<br>- Levidow & Neubauer, 2014<br>- Stahl, McBride, Wakunu-ma & Flick, 2014<br>- de Saille, 2015<br>- Bozeman, Rimes & You-tie, 2015<br>- Burget, Bardone & Pe-daste, 2016 |
| **Anticipation** | Anticipation is a dimension that aims at envisioning the future of research and innovation. It takes into account understanding how current dynamics help design the future.<br>In research, RRI is also linked to "Real−Time Technology Assessment" or "anticipatory governance".<br>Anticipatory governance includes the technologies which provide value added advantage and, at the same time, avoid the emergence of potentially negative consequences.<br>Successful anticipation means understanding the dynamics of economy that help shape technological futures. Anticipation of potential impacts of technology serves the purpose of:<br>– reflecting on the motivations and implications of a research project,<br>– being clearer about uncertainties and dilemmas, | - Robinson, 2009<br>- Stirling, 2010<br>- Selin, 2011<br>- Roco, Harthorn, Guston & Shapira, 2011<br>- van den Hove, McGlade, Mottet & Depledge, 2012<br>- Owen, Macnaghten & Stilgoe, 2012<br>- Stilgoe, Owen & Macnaghten, 2013<br>- Stahl, 2013<br>- Stahl, McBride, Wakunu-ma & Flick, 2014<br>- Rose (2014)<br>- Burget, Bardone & Pe-daste, 2016 |

| DIMENSION | DESCRIPTION | AUTHORS/RESEARCH |
|---|---|---|
| | – opening visions to a broader public,<br>– using the outcomes to shape the research and innovation trajectory.<br>Anticipation plays an important initial role in research and development, indicating the direction to take to achieve better and more desirable results. | |
| **Responsive-ness** | Responsiveness is linked to risk, which is the probability of an occurrence of an event multiplied by the cost of that event, which new technologies may bring about.<br>The risks involved in new technologies can be medium or long term, economic, environmental, security or societal. In this case, identification and analysis of risks as part of responsiveness is linked to the anticipation dimension. In research, discussions involving responsiveness are also primarily linked to ethics, risks, transparency and accessibility. | - Pellizzoni, 2004<br>- Owen, Macnaghten & Stilgoe, 2012<br>- Stilgoe, Owen & Macnaghten, 2013<br>- Torgersen & Schmidt, 2013<br>- Schaper-Rinkel, 2013<br>- Levidow & Neubauer, 2014<br>- Maynard, 2015<br>- Burget, Bardone & Pe-daste, 2016 |
| **Reflexivity** | Reflexivity is linked to public dialogue, science and public collaboration, and anticipation. It can be defined as “holding a mirror up to one’s activities, commitments and assumptions, being aware of the limits of knowledge and being mindful that a particular framing of an issue may not be universally held”. Responsibility turns reflexivity into a public matter. Involving the public in the research may help researchers reflect on the ethical and social dimensions of their work.<br>Science and public collaboration is a key component of reflexivity. By linking reflexivity and anticipation we can avoid the risk of making wrong predictions, especially in the early stages of technological development. | - Wynne, 1993<br>- Fisher & Mahajan, 2006<br>- van der Burg, 2009<br>- Schuurbiers (2011)<br>- Stilgoe, Owen & Macnaghten, 2013<br>- Forsberg, Quaglio, O’Kane, Karapiperis, van Woensel & Arnaldi, 2015<br>- Burget, Bardone & Pe-daste, 2016 |
| **Sustainability** | Although sustainability issues can be found in most research work, it is not clearly referred to as a dimension. In recent research, sustainability is identified as a key driver of innovation, research and development. Sustainability is already starting to affect the competitiveness concept, which will force organizations and business to change their strategy.<br>Research focused on science, technology and innovation for sustainable development is also conducted in the economic field. Sustainability often refers to the so-called resource-efficiency of new products. Research and innovation are closely connected to social responsibility, because they can implement more sustainable innovations (products) in economy. In general, therefore, it can be concluded that sustainability as a conceptual dimension may form part of Responsible Research and Innovation. | - Wright, Gellert, Gutwirth & Friedewald, 2011<br>- Flipse, van der Sanden & Osse-weijer, 2013<br>- de Martino, Errichiello, Marasco & Morvillo, 2013<br>- Stahl, McBride, Wakunu-ma & Flick, 2014<br>- Levidow & Neubauer, 2014<br>- Bozeman, Rimes & You-tie, 2015<br>- Bremer, Millar, Wright & Kaiser, 2015<br>- Forsberg, Quaglio, O’Kane, Karapiperis, van Woensel & Arnaldi, 2015<br>- Burget, Bardone & Pe-daste, 2016 |
| **Care** | The main challenge of future-oriented ethics is to answer the question of how to deal with uncertainties derived from social practices like technology and | - Groves, 2009<br>- Stilgoe, Owen & Macnaghten, 2013 |

| DIMENSION | DESCRIPTION | AUTHORS/RESEARCH |
|---|---|---|
| | innovation. Care is a "public domain" dimension so that society is responsible for the decisions and actions carried out on its behalf.<br>Care is also explained as a process through which people develop abilities to perceive, act and judge together. What is important, as regards care as a conceptual dimension of RRI, is the fact that it is crucial not to see inclusion just as a means to meet the "grand challenges" but as a way of bringing together people's high objectives and day–to–day practices. | - Burget, Bardone & Pe-daste, 2016 |
| **Economic** | Concerns about the impact of new technologies on economy and society explain growing calls for the responsible innovation concept, the sustainable transition of social and technical arrangements, and stronger engagement between science-driven innovation and society.<br>Such issues as those related to RRI are better understood as "aspirations" which may never be fully achieved, suggesting they could only be instantiated through the observation of the practice of science-driven innovation. Innovations are not created only for the creation process. Innovations are implemented in the economy and comply with the requirements of meeting needs in terms of value creation for the company, the public and other stakeholders in the process of economic development. | - Schumpeter, 1934<br>- Rogers, 1962<br>- Nelson & Winter, 2002<br>- Geels, 2010<br>- Owen & Goldberg, 2010<br>- Garud & Gehman, 2012<br>- Armstrong, Cornut, Delacôte & Lenglet, 2012<br>- Owen, Bessant & Heinz, 2013<br>- Pandza & Ellwood, 2013<br>- de Saille, 2015 |

According to the authors, from the analysis of the conceptual dimensions of RRI, it can be seen as «*fundamentally a cluster of ideas for promoting an idea of science governance, which are essentially about responsible processes as opposed to processes that are not supervised responsibly*». In fact, they notice, all the conceptual dimensions refer to a particular type of process.

## C. Ribeiro, Smith and Millar

A comparative analysis of different concepts of and approaches to RRI has been made by Barbara E. Ribeiro, Robert D. J. Smith and Kate Millar, who discuss two main issues relevant to theoretical considerations on RRI, i.e. the **definitions of RRI** and the **motivations for developing RRI**.

### C1. Definitions

As for the **definitions of RRI**, the most popular is the one developed by Von Schomberg (2011, 2013) and quoted by many authors (such as: Stahl, McBride, Wakunuma, & Flick, 2014; Owen, Macnaghten & Stilgoe, 2012; Douglas & Stemerding, 2013), in which RRI is viewed as «*a transparent and interactive process that spans and acknowledges mutual responsibility across dif-*

*ferent actors*», which addresses the ethical acceptability, sustainability and societal desirability of R&I. This view of RRI leads to a focus on the "right impact" of R&I (Von Schomberg, 2011).

Owen, Machnagthen and Stilgoe (2012) share this same interpretation of RRI, according the authors, albeit emphasising the notion of "**shared responsibility**" among actors, so as to make R&I pathways more responsive in face of uncertainty. As a consequence, RRI emerges as a process aimed at «*taking care of the future through collective stewardship of science and innovation in the present*» (Stilgoe, Owen and Macnagthen, 2013).

Ribeiro, Smith and Millar also notice that other authors (for example, Guston & Sarewitz, 2002; Pidgeon, Parkhill, Corner & Vaughan, 2013) added to this definition with a focus on **appraisal processes**, which need to be embedded in R&I, to evaluate the worth, impacts, unintended risks and ethical implications of new knowledge and technologies. As a consequence, in addition to early-stage appraisals of potential impacts and ethical implications of emerging technologies, RRI also started to include the ideas of **anticipatory governance** and the **involvement of different actors** in the process (Robinson, 2009; Shaper-Rinkel, 2013, Zwart, 2013), thus fostering the notion of **anticipatory dialogue** to modify R&I trajectories (Rose, 2014).

Another component which comes into play in this conceptual framework is **interdisciplinary collaboration** involving STEM disciplines, social sciences and humanities (van der Burg, 2010; Schuurbiers, 2011; Flipse, van der Sanden & Osseweijer, 2014).

C2. MOTIVATIONS

With reference to the **motivations for developing RRI**, two emerging lines of argumentation are identified by Ribeiro, Smith and Millar.

The first line is focused on the **risks** posed by technology development on the environment and society, which in principle can be anticipated before technologies are fully developed (Owen, Baxter, Maynard & Depledge, 2009; Robinson, 2009; Schaper-Rinkel, 2013; Stahl, McBride, Wakunuma & Flick, 2014).

The second line aims at changing societal and environmental **governance from reactive to proactive forms**, by focusing on the alignment of innovation processes to social expectations and needs (Betten, Roelofsen & Broerse 2013; Rose, 2014; Zenko & Sardi, 2014).

In both cases, the **engagement** of stakeholders and the public is part of the narrative, viewed as necessary to evaluate technologies and embed them socially, countering the tendency towards expert-driven processes (Stahl, 2012) by supporting the participation of societal actors in technology development.

Other motivations include the promotion of **democratic governance** for R&I, fostering an integrated, participatory, reflexive and responsive process vis-à-vis the **uncertainties** and co**nsequences** of R&I and extending the notion of responsibility so as to make it a **collective care duty** (Owen, Macnaghten & Stilgoe, 2012; Stilgoe, Owen & Macnaghten, 2013).

To sum up, in the **definitions of RRI**, the main components are:

- Being an interactive process addressing the ethical acceptability, sustainability and societal desirability of R&I

- Fostering among actors a shared responsibility of R&I
- Oriented to anticipate the future intended and unintended impacts of R&I
- Thus, including early-stage appraisal of such impacts, and
- Grounded in interdisciplinary collaborations.

As for **RRI motivations**, they overlap with the components found in its definitions, i.e.:

- Preventing and promptly managing the risks of R&I
- Aligning R&I to social expectations and needs through proactive governance
- Supporting societal actors in participating in technology development, so as to foster a democratic R&I governance and rendering responsibility on ER&I a collective duty.

### D. Burget, Bardone and Pedaste

Mirjam Burget, Emanuale Bardone and Margus Pedaste (2016) also conducted a literature review in order to identify **definitions** and **conceptual dimensions** of RRI.

#### D1. Definitions

With respect to **definitions**, the authors (following Zwart, Laurens & van Rooij, 2014) make a distinction between **administrative definitions** (developed by science policy makers and funding agencies, especially EC-related entities) and **academic definitions** (developed by scholars).

As pointed out by Sutcliffe (2011), **administrative definitions** tend to include the following:

- **Focus of research and innovation** to achieve social or environmental benefits
- Consistent, ongoing **involvement of society** (including the public and non-governmental stakeholders), from beginning to end, of the innovation process
- Assessment of and priority given to **social, ethical and environmental impacts, risks and opportunities**, both now and in the future, alongside the technical and commercial impacts
- Oversight mechanisms so as to **anticipate and manage problems and opportunities** and to react quickly to changing knowledge and circumstances
- Openness and transparency as part of R&I.

More or less, all these components are included in the definition of RRI developed by Von Schomberg (2011), which is one of the most widely used. This definition, in fact, includes inclusiveness, participation, anticipation, societal desirability and ethical acceptability.

As noticed by some authors (Levidow & Neubauer, 2014; Stahl, McBride, Wakunuma & Flick, 2014), this concept of RRI has been mainly developed in order to **open up a broader policy** prospect capable of redefining actors' roles in society. Von Schomberg (2013) also speaks of RRI as a "**design strategy**" for steering innovation towards socially desirable goals. Similarly, in another European Commission policy document (2013b), RRI is viewed, not as a process, but as an **approach** aimed at orienting R&I.

As for the **academic definitions**, most of them, according to Burget, Bardone and Pedaste, share the same components identified in Von Shomberg's account of RRI. However, the academic definitions seem to distinguish better RRI **levels of analysis**, such as products, process and purposes (Stilgoe, Owen & Macnaghten, 2013) or actors, activities and norms (Stahl, 2013), focusing not only on collective but also on **personal responsibility** in the research and innovation process (Wilford, 2015). The **scope of RRI is also narrowed**, not including the entire innovation process but only its quality, measured in terms of desired outcomes (Spruit, Hoople & Rolfe, 2015).

### D2. Conceptual Dimensions

Burget, Bardone and Pedaste also analysed different conceptual dimensions of RRI, starting with those proposed by European Commission (public engagement, gender equality, science education, ethics, open access and governance), and then other dimensions which were originally not associated with RRI (such as liability, accountability, care, responsiveness) or which emerged from the public debate on RRI, often overlapping (such as transparency, sustainability or reflexivity).

At the end of the analysis, **four major dimensions** were selected by Burget, Bardone and Pedaste as the most significant for RRI, i.e., **inclusion**, **anticipation**, **responsiveness** and **reflexivity**.

**Inclusion** mainly refers to the engagement of different stakeholders in the early stages of research and innovation, thus defining a moral obligation for everyone «to engage in the collective debate that shapes the context for collective decision making» (Von Schomberg, 2007). This also implies the need to define the outcomes which are socially desirable. This, in turn, can be achieved only through public involvement, which becomes a sort of technical requirement for implementing RRI. According to Burget, Bardone and Pedaste, «*Inclusion is the conceptual dimension that characterizes RRI the most*» and «*a major characterizer of RRI needs more reflective and critical academic discussion*».

**Anticipation** means envisioning the future of R&I and understanding how current dynamics help design the future. This dimension is closely linked to governance and, in fact, various authors (e.g., Robinson, 2009; Karinen & Guston, 2010; Schaper-Rinkel, 2013, Stahl, 2013), refer to this dimension as "anticipatory governance". Anticipation emphasizes the importance of being aware of the motivations and implications of a research project, as well as the uncertainties and dilemmas connected to it and the need for opening up to the public and shaping R&I trajectories, so as to finally promote a "desirable application" (Edelenbosch, Kupper & Broerse, 2013) of scientific knowledge.

**Responsiveness**, originally introduced by Pellizzoni (2004), is mainly linked to the proactive management of medium or long term economic, environmental or societal risks involved in new technologies. This implies a capacity to identify related risks (in this sense, responsiveness is connected to anticipation) and develop adequate responses, in ethical terms, too. According to the authors, responsiveness also relates to transparency (responses should be open to the public debate) and accessibility (scientific results about risks and responses should be openly accessible to everyone). Responsiveness is found considerably less often in the articles reviewed by Burget, Bardone and Pedaste.

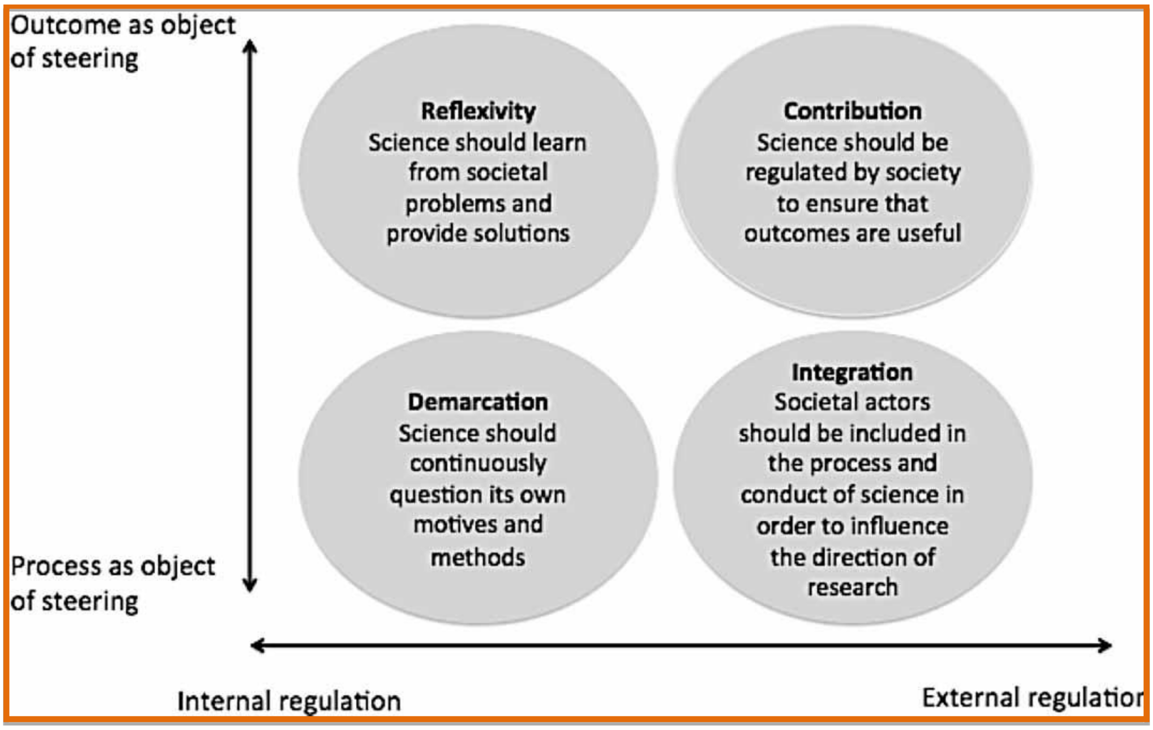
Finally, **reflexivity** is mainly seen as the capacity of the research system to keep control of its own activities and assumptions, to be aware of the limits of the knowledge produced and of the framing processes connected to the identification of the issues to be addressed, as well as to reflect on values and beliefs connected with R&I (Stilgoe, Owen and Macnagthen, 2013). Reflexivity is linked to public dialogue and collaborative approaches in science (Fisher & Mahajan, 2006; Van der Burg, 2009; Schuurbiers, 2011; Stilgoe, Owen & Macnagthen, 2013), dialogue and collaboration being the two main weapons to combat research systems which are self-referential and closed to external inputs.

Burget, Bardone and Pedaste also identify two **emerging conceptual RRI dimensions**: **sustainability** (which mainly concerns control over the use of resources); and **care** (which refers to the capacity of people to play an active role in R&I).

### E. GLERUP AND HORST

Cecile Glerup and Maja Horst (2014) also conducted a literature review based on 263 contributions to academic journals about "social responsibility" in science, with the specific aim of identifying the various "**rationalities**" that have been conceptualised about responsibility in science.

The analysis can be summarised in the form of a matrix, based on two dimensions, the first describing whether regulation of science should be internal or external and the second whether issues of responsibility relate to the process or to the outcomes of science. The resulting matrix can be seen below.




(From: Glerup & Horst, 2014)

**Demarcation rationality** mainly focuses on the research process in a context of internal regulation. It is based on the recognition of science as an «*honourable profession*», but «*increasingly* *tormented by fraud and misconduct threatening its ability to do good for the people*». This rationality tends to connect fraud and misconduct to the increasing pressure placed on scientists to get results and deliver publications (Brice & Bligh, 2005) which in turn may lead to an increase in public mistrust of science. According to demarcation rationality, the solution is to reinforce the moral code covering almost every domain of science, including data management, conflicts of interest, authorship, peer-review or collaboration, so as to create a moral culture favouring the use of a strict scientific method.

**Reflexivity rationality** mainly focuses on research outputs in a context of internal regulation. Differently from demarcation rationality, science is here seen as fully involved in the solution of societal problems but scientists as not fully aware of the risks and wrongs produced by science. Thus, changes need to be made to the scientific profession, so that scientists are able to foresee and manage the consequences of their own scientific activities, incorporating these considerations in their research. Reflexivity rationality considers scientists socially responsible, self-aware of being part of society and prepared not only to produce high-quality scientific products (as in demarcation rationality) but also to oversee and reflect on the consequences of their own practice.

**Contribution rationality** also focuses on research outputs but in a context of external regulation. This rationality considers science as a societal institution (like any other institution, such as healthcare or education systems) pursuing specific goals for the benefit of society. Especially, science is asked to match the demand for innovation (contributing to economic growth) and the demand for democracy (aligning scientific activities to the needs and preferences of society). In this framework, scientists are understood as «*public servants working to materialize the objectives of society in their knowledge production*»; and problems arise precisely because of the tendency of scientists not to perceive themselves in this way, since they are not interested in the use of the knowledge they produce and they have been allowed to cut themselves off from public inquiry and criticisms. The solution, then, is to get scientists to be more responsible, preferably of their own accord but above all by increasing public control over science, at different levels and with different tools.

**Integration rationality** focuses on the research process in a context of external regulation. Under this rationality, science and society are asked to work together, as equal partners, to produce better results. This partnership should include all the different aspect of research activities, starting with the definition of societal objectives up to the use of scientific knowledge, with a view also to preventing the possible negative side effects of science. This entails enhancing dialogue between scientists and other actors to develop a new kind of "integrative" responsibility across roles and specialisations, thus favouring scientific knowledge which is socially contextualised and aligned with societal norms and values.

### F. Lubberink, Blok, van Ophem and Omta

Another literature review addressing the dimensions of RRI was carried out by Rob Lubberink, Vincent Blok, Johan van Ophem and Onno Omta (2017), which turns around the concept of responsible innovation, their interest being focused on the business sector rather than on research itself.

The literature review led to the identification of four main dimensions of RRI, which, according to the authors, can be used heuristically for anticipatory governance of innovation, i.e., anticipation, reflexivity, inclusion/deliberation, responsiveness.

**Anticipation** «*involves systematic thinking about any known, likely, plausible and possible implications of the innovation that is to be developed*», so innovators need to understand the dynamics shaping innovation and envision desirable futures.

**Reflexivity** refers to a critical scrutiny of one's own activities, commitments and assumptions, including an awareness of the limits of knowledge. For innovators, also important is reflexivity focused on the influence of their own values and beliefs on the development of the innovation.

**Inclusion/deliberation** are concepts widely used in literature on RRI. They involve the upstream engagement of stakeholders and the public to identify and manage the social, political and ethical implications of innovation. The two terms – inclusion and deliberation – can be considered as interchangeable, even though those who use "deliberation" tends to emphasize the link between RRI and decision-making.

**Responsiveness** concerns the capacity to change the shape and direction of innovation on the basis of the values and needs of stakeholders and the public. Moreover, responsiveness implies a collective response and therefore co-responsibility of innovation.

### *1.2. Empirical models of R&I governance*

An aspect related to the theoretical approaches to RRI are those that can be labelled "**empirical models of R&I governance**". In the framework of this literature review, this concept is used to include any attempt to identify governance models of R&I actually used or claimed by the concerned actors and therefore not developed by the authors.

We consider these models to be of a theoretical nature insofar as they are developed on the basis of theoretically-based categories or interpretations of RRI.

Five typologies will be analysed, developed by:

- the EC Expert Group on science governance
- Landeweerd, Townend, Mesman and Van Hoyweghen
- Ruggiu
- Felt
- GREAT Project.

#### A. Expert Group on Science Governance

The European Commission Expert Group on science governance, chaired by Brian Wynne and with Ulrike Felt as rapporteur (2007) offered some reflections on the governance of innovation, which may be useful to repeat while discussing RRI.

The authors identify **two main regimes of innovation** (i.e., a model or a "notion of how things must be done") in the policy discourse, called respectively by the authors the **Regime of Economics of Technoscientific Promises** and the **Regime of Collective Experimentation**.

The **Regime of Economics of Technoscientific Promises** is based on a set of assumptions, i.e.:

- If appropriately funded, new technologies can solve human problems
- Our future is increasingly uncertain and uncertainties can be solved through upstream solutions based on innovation
- Europe will only be able to sustain its social model in a context of increasing world competition by boosting innovation
- Scientists and technologies require intellectual property rights to be safeguarded at an early stage, thus fostering new relationships between research, higher education and industry and emphasizing patenting of basic knowledge.

On the basis of these arguments, industrial and scientific entrepreneurs are viewed as performing a pivotal role in innovation and especially in creating the conditions for raising expectations and building "technoscientific promises". Governments and governmental agencies play an ambivalent role, promoting specific interests around the technoscientific promises, taking, at the same time, public interest into account.

The general culture is one of celebration of innovation, requiring civil society not to interfere. Citizens are, in fact, considered not directly involved in innovation but "*happy customers*" of technologies and "*citizens profiting from the European social model*" made sustainable through innovation, while civil society is seen as an outsider, to be taken into account but irrational, prone to irrational fears and monitored by opinion polls

The **Regime of Collective Experimentation** focuses on the idea that innovation is not based on techno-scientific promises but on goals constructed around matters of concern. The assumption is that the participation of a variety of actors is productive, albeit depending on the effort each of them makes.

In such a regime, new forms of interaction between scientists and other actors need to be devised, since the traditional authority of science is not sufficient. Moreover, selective forms of participation should be identified, since what is important is engagement in the experimentation of new solutions, not by the public at large but only the groups concerned. Under such a regime, innovation is likely to become laborious, loosely-coordinated and slow. Moreover, opportunistic behaviours may also occur, whereby people and stakeholders may wait for others to take the risks involved in new experiments.

Although alternative, **both regimes**, according to the authors, are part of the overall trend to recognise **open or distributed innovation**, i.e., the idea of an innovation emerging from the interaction of actors holding complementary pieces of knowledge, thus creating networks or creative communities, able to cooperate in prevalently informal ways and to co-construct and use new technologies.

### B. Landeweerd, Townend, Mesman and Van Hoyweghen

Laurens Landeweerd, David Townend, Jessica Mesman and Ine Van Hoyweghen (2015) identify three main styles in the management of R&I: a **technocratic** style, an **applied ethics** style and a **public participation** style.

The **technocratic style** is dominant. It includes two main aspects of technical regulations. On the one hand, scientists and technologists are given the responsibility, by political powers, to assess the acceptability of risks for society. On the other hand, law and lawyers play the role of framers of governance procedures (e.g., providing suggestions about legal frameworks, self-regulations or new regulations). The focus is on risks and risk assessment and not on ethical issues or other criteria to be potentially used to assess whether a new technology deserves to be developed or not. The technocratic style sees scientific experts as neutral, rational and well-informed and the public as irrational and potentially biased because of a lack of knowledge. This style is mainly linked to "governing" (top down and centralised) as opposed to "governance" (bottom-up and decentralised). The main instrument is the law, viewed as effective and neutral, capable of setting up national or international reference frames (e.g., rights declarations, agreements, etc.) which can be translated into technical tools (e.g., codes of conduct, regulations, laws, etc.) for the structuring of R&I.

Various **deficiencies** in the technocratic style have been highlighted.

- Political decisions are reduced to technical decisions; and this does not work in practical terms since any decision includes a normative side.
- The technocratic style is too narrowly focused on risk assessment and incentive management, while other factors enter into play in the public acceptance of science and technology (for example, attitudes and cultural choices such as techno-scepticism, environmentalism, naturalness, religious orientations, etc.).
- Technocratic style considers societal dynamics only as triggered by products, while increasingly they start being visible upstream of the development chain.
- The pace of science and technology is often too rapid for legal frameworks and ethical discourse to be quickly adjusted.

The **applied ethics style** of governance is based on the positioning of ethical considerations at the core of the governance of science and innovation. Ethics, thus, comes to be institutionalised as a normative instrument placed at the basis of law and regulation, and viewed as a neutral normative tool. The increase in the relevance of this governance style can be also observed in the inclusion of ethical reviews in the evaluation of research applications (as in the case of the "Science in Society" programmes), in the creation of ethical committees inside research institutions, or in the incorporation of ethical experts at different levels of R&I process.

The main **deficiencies** of the applied ethics style are as follows.

- The directly involvement of ethics as a normative instrument led to the criticism that such an approach ends up being the "handmaiden" of science and technology rather than a critical observer or assessor of the impacts they create. In general, the institutionalisation of ethics is seen as problematic.

- There is a gap between moral principle and moral practice. Once ethics is institutionalised, this gap becomes evident and difficult to manage. The risk is that applied ethics becomes increasingly focused on the delimitations of the moral debate and not on its contents.
- The use of a specific "ethics expertise" is not fully justified, given that it is not clear why an expert view would be more reliable than a lay opinion.
- Ethics also risks becoming fully involved in the process as an institutionalised party among the other involved actors. Therefore, its independence may be put at stake when it is too embedded in science research projects.
- The use of applied ethics does not guarantee ethics advice actually being used. In many cases, ethical orientations and recommendations are not implemented.
- Ethics is too focused on intentional individual agency to also be effective in detecting the ethical and social (often unintended) effects of R&I.

The **public participation style** of governance is emerging as an effect of a loss of trust in science, technology, politics and "top-down" governing. It is based on bottom-up activism aimed at orienting decision making by values, including transparency and democracy. This style emerges in the multiple attempts to increase public participation by using different and multiplying Public Engagement approaches, formats and tools, justified on the recognition of participation as necessary both for exercising basic human rights and, instrumentally, for preventing protest against unpopular policies. Moreover, deep knowledge of public opinion helps policy makers and scientists enhance the success rate of innovation processes. More recently, public input starts being increasingly incorporated in national and international governance in formal or informal ways, including technology assessment, even though practical adoption is often viewed critically.

As for the **deficiencies** of the public participation style of governance, the authors highlight the following.

- Public participation suffers from a lack of evidence and empirical consideration over its quality and impact.
- It is not clear to what extent people who participate in Public Engagement initiatives are actually representative of the public at large or of specific parts of it. This fact calls into question the democratic legitimacy itself of participatory mechanisms.
- The ways in which public participation is interpreted and actually practised largely varies according to country and political culture.
- Public participation is exposed to the risk of legitimating self-selection processes (only those who wish to participate actually participate).
- There is the risk of taking any NGO or interest group as representative of the complex and multifaceted public.
- Public engagement formats and mechanisms are pre-formatted by specific political actors and through agenda-setting processes and, therefore, may be used for the benefits of specific actors.
- Public engagement may be also instrumentally applied to de-politicise science and technology, preventing protests and major tensions, and not to actually increase participation in shaping science policies.

The authors see **Responsible Research and Innovation** as a possible **fourth style of governance** of R&I, combining different stances, including the focus on the social and environmental benefits of R&I, the involvement of society at any level of the innovation process, the assessment and prioritisation of social, ethical and environmental risks, impacts and opportunities, both now and in the future, the role of anticipatory and management mechanisms in shaping R&I trajectories and the recognition of openness and transparency as components of R&I.

However, also in RRI the authors see possible deficiencies and risks, including that of allowing private interests to prevail, interpreting needs and desires of the public as mere consumer preferences or limiting the weight of ethical considerations pertaining to R&I.

### c. RUGGIU

Daniele Ruggiu (2015) identifies two different versions of the RRI model: the **social-empirical version** and the **normative version**.

The **social-empirical version** is focused on the social dimension of participatory R&I and, therefore, on interaction processes among different stakeholders engaged in the development of participatory forms of co-responsibility.

In this version, Public Engagement plays a strategic role but it is also viewed in its empirical limitations, prevalently due to the difficulty of adapting participatory processes to the fast development of R&I. In fact, according to Ruggiu, there is a paradox concerning participation and R&I development processes: either participation occurs too early, at the beginning of the process, when it is possible to shape R&I trajectories but information about risks and opportunities are limited, or it occurs too late, when information about risks and opportunities are available but the possibilities to influence the R&I process are limited.

In this social-empirical version, the focus is not only on the products, but also on the purposes of innovation, especially understood in connection with the kind of future expected and the values we want it to be anchored on. Stress is also placed on the equal engagement of all societal actors, considered as an important factor for building a sound framework for excellence in the R&I process and for giving a voice to all represented interests. In this sense, the sole existing value to be preserved is precisely the negotiations leading to the creation of the values on which R&I should be anchored. For this reason, this version of RRI is not normative since it focuses on the deliberative process necessary to produce values and not on the values in themselves, nor does it define prefixed rules and principles to go by. This is the reason why this version can be defined as "empirical", since principles and rules come not at the beginning but at the end of the participatory/deliberative process.

The **normative version** is, on the contrary, focused on the normative dimension of participation. It is focused on the aim of articulating «*processes of stakeholder co-responsibilisation around a set of normative filters by being simultaneously anticipatory and participatory*». These filters are primarily looked for in EU law, as factors steering EU policy towards anticipatory, participatory and responsible outcomes. Therefore, EU objectives are viewed as "normative anchor points" connecting R&I to EU treaties, thus providing RRI with a solid foundation and EU treaties with concrete opportunities for them to be implemented.

According to Ruggiu, using EU objectives to orient RRI may produce ambiguities. For example, one may agree on EU objectives in general but disagree on the meaning attached to them or on their application in concrete situations. Moreover, tension among them can also emerge when they are used as "normative anchor points".

While the social-empirical version of RRI considers values as intrinsically conflictual, especially in the context of the moral pluralism we live in, the normative version addresses very general values, referring to the interests of civil society and expressed in a rather bureaucratic manner (safety of products, individual rights, protection of health, growth of occupation, etc.).

### D. FELT

Ulrike Felt (2016) analyses the dominant "narrative infrastructures" of science and science-society relations, whereas the concept of "narrative infrastructure" refers to a network of narratives «*through which meanings and values of academic knowledge/work and its relation to society can be articulated, circulated and exchanged across space and time*».

Felt identifies **three main narrative infrastructures**.

The **first** focuses on the idea of a substantial **reorganisation in the research system** – often subsumed under the label of new public management – which is expected to increase research organisation outputs and efficiency, as well as support the expectation of ever-faster innovation. On the whole, these narratives favour the establishment of auditing and ranking structures aimed at measuring research quality and outputs and making comparative assessments. In this context, researchers are induced to internalise self-auditing criteria and behaviours. This narrative infrastructure reflects an overall "projectification" of the research work (Ylijoki, 2015), leading to a radical change in the way research is organised and research time is structured (expressed also in the use of terms like "work packages", "deliverables" and "person months"). Overall, this narrative infrastructure is marked by the "obsession" to control and plan the future and pushes researchers into becoming entrepreneurs, who can promote themselves according to the logic of academic capitalism.

The **second cluster** of narratives revolves around the idea of "**reflexive work**". Under these narrative, researchers are expected to reflect on and anticipate potential impacts of their research and to get involved in engagement or, at least, communication activities with other societal actors concerned, with the aim of preventing or managing possible emerging problems. These narratives are now increasingly subsumed under the label RRI. This narrative infrastructure tends to expand the scope of researchers' action up and including the care of the infrastructure supporting academic life, the fulfilment of their civic mission, the care of services addressing communities and engagement with citizens.

The **third cluster** of narratives emerges from the backdrop of tension between the first two sets of narratives calling for auditable and reflexive work respectively. This cluster refers to the **past conditions of academic work**, with its rituals and mythical structures, in which researchers were freer in their research choices, had less time to spend on doing administrative work or selling their findings. This narrative infrastructure is a form of "inventing a tradition", in which the past is depicted as a sort of "golden age" for scientists when there was less time pressure and academic careers were still attractive. This fosters an "academic nostalgia" through which researchers try to feel a sense of continuity and stability in a fast-changing environment.

According to Felt, the **interaction between the three sets of narratives** is problematic, since the first promotes an individual ethic, the second emphasizes a collective ethic, while the third emerges as a form of resistance to both of them.

Finally, the author dwells upon **two risks concerning the implementation of RRI**, prevalently linked to the second set of narratives. On the one hand, there is the risk of translating reflexive work into specific standardised forms which make it a purely formal requirement (as has often happened in the case of some ethical requirements, such as informed consent in the medical sector). On the other hand, there is also the risk of ritualising reflexive work through specific procedures producing the effect of separating research and reflection, especially by entrusting the former to STEM researchers (who keep on working in a business-as-usual manner) and the latter to social scientists or experts in ethical issues.

### E. GREAT PROJECT

In the framework of the GREAT Project (2014), Sophie Pellé and Bernard Reber offer a reflection on RRI starting with a **typology of technology governance** developed by Pierre Benoît Joly (2001) and inspired by Michel Callon (1998). This typology includes four models: the **Standard Model**, the **Consultation Model**, the **Revised Standard Model** and the **Co-construction Model**.

The **Standard Model** views the public as irrational because of their lack of comprehension of technical matters and aversion to novelties and risk, and scientists as rational, neutral and capable of objectively assessing risks. In this model, of a positivist nature, the purity of expertise should be preserved by not mixing facts (science) and values (public) and should be kept independent from any political, economic and social influence.

The **Consultation Model** keeps the opposition between an irrational public and expert rationality, but changes the way in which risks are managed. While in the previous model, only experts are supposed to be able to identify risks (and communicate them to the public), in the consultation model, risks can be correctly perceived both by experts and by laypeople, even though from different perspectives. Hence the need for a two-way communication process to identify risks and for the public to participate in decision making processes to manage them.

The **Revised Standard Model** sees the management of risks as a complex process involving various social groups in the public arena. Thus, the emphasis is placed on the interactions between regulation processes, social groups and media and on the paradoxes and hindrances which characterise them, including the public’s overestimation of risks, the media’s tendency to create an uncertain environment around risks or the incapacity of decision makers to produce effective laws. In this model – which relies upon a technocratic vision – core elements include the delegation of risk management to independent and competent administrative bodies, the distinction between risk assessment and risk management, the need to analyse risks not abstractly but in context, and a view of trust as based on reputation and perception of competence in managing risks.

The **Co-construction Model** adopts a social constructivist approach and calls into question the traditional image of science as based on universal independent truths. In this model, both facts and values are to be equally considered and risks are to be identified through participatory processes involving all the actors concerned.

According to the authors, RRI approaches fall under the consultation and the co-construction models. On this basis, they develop two different RRI models, taking into account five elements: the process of norm construction (substantive vs procedural); the ethics approach; the role of participation (as consultation or co-construction); relation to knowledge (rationalistic vs explorative); and degree of reflexivity (identification of ethical issues vs attempt to open the framing).

**RRI Model 1 (Responsibility grounded in social acceptability)** supports both substantive and procedural methods of norm production, substantive methods in that the model relies upon the existing (especially EU) rules, procedural methods in that it also includes practical norms to be incorporated in the "responsiveness" dynamic. The ethics approach is primarily consequentialist (acts are right to the extent that they produce good results and wrong to the extent that they produce bad results) and largely based on technology assessment and technology foresight. Participation is mainly understood as a consultation process (even though some forms of deliberation are sometimes evoked) aimed at favouring the social acceptability of new technological products, testing their social desirability and preventing costly market failures. As for the relation to knowledge, this approach adopts a rationalistic framework (although the unpredictability of many technology outcomes is acknowledged), while reflexivity is understood as merely aimed at identifying key ethical issues, i.e., a list of problems to be watched and answered (thus establishing a deterministic relationship between ethical issues and technology).

**RRI Model 2 (Responsibility through responsiveness and deliberation)** supports a procedural determination of norms, aims at achieving a co-construction of technology, relies upon anticipatory governance and explorative philosophy as normative tools, and promotes a relation to knowledge which is not purely rationalistic and consequentialist, but one in which the power of imagination and narratives of the actors involved are recognised. Finally, reflexivity is applied, not only on the substantive aspects of the debate (i.e., on the solutions), but also on how the problems are constructed.

### *1.3. RRI implementation models*

In this section, we consider the literature on pathways (roadmaps, methods, principles, etc.) aiming at embedding RRI in R&I governance.

Six main proposals are considered, respectively developed by:

- Res-AGorA Project
- the EC Expert Group on the State of Art in Europe on Responsible Research and Innovation
- Stahl, Obach, Yaghmaei, Ikonen, Chatfield and Brem
- MATTER
- Jirotka, Grimpe, Stahl, Eden and Hartswood
- RRI Tools Project.

## A. RES-AGORA PROJECT

In the framework of the Res-AGorA Project, Sally Randles, Sally Gee and Jakob Edler (2015), identify thirteen lessons on «*the effectiveness of a range of governance instruments and institutionalization processes to achieve the embedding of Responsible Research and Innovation*». These lessons can be viewed not as part of an RRI governance model but as components of an RRI-oriented governance process.

**1. Responsibilisation and deep institutionalisation**. The first lesson helps define the key goals of the entire process, i.e., activating a process of actor responsibilisation to internalise social values and apply these values in regulatory practices, inducing profound organisational and cultural changes favouring the embedment of these values into taken-for-given practices, routines and institutions.

**2. Transformative interaction needs to be inclusive, open and transparent**. This second lesson highlights that for interaction among actors to be transformative, it requires the adoption of a set of approaches, some of a technical nature, to make it inclusive (i.e., able to include the diversity of actors involved), open and transparent. This entails, for example, preparatory work, adequate process management, tools for encouraging the mobilisation of marginalised groups or capacity building processes.

**3. Intermediation and moderation**. Another lesson is that RRI governance needs intermediation and moderation, given that direct interactions are not always reasonable or feasible, because of a clash in interests and values, for example, or contrasting perceptions and framings, or limited willingness or ability to communicate. Intermediators must be credible and their functions and own interests transparent.

**4. Anticipation**. To be implemented, RRI needs to rely upon a set of anticipatory techniques and methods making, it possible to identify future scenarios, technologies and challenges.

**5. Robust, inclusive and contextualised knowledge**. The fifth lesson emphasizes the importance of underpinning the RRI governance process on robust and trusted knowledge, especially in consideration of uncertainties characterising the present and future development of R&I practices and products. Moreover, knowledge needs to be contextualised, by demonstrating that it is, on the one hand, valid in the specific and social condition of a given location and, on the other hand, potentially reproducible for any different local conditions.

**6. The importance of time, timing and managing tensions of different temporal horizons**. This lesson is about the need, for any governance process, to take into account the different dimensions of time (time horizons, timing of governance action, time needed to induce institution change, etc.) but also to balance the imperative for R&I to move fast (to promote use in economic and social terms) with that to move slowly (to promote deeper normative and behavioural changes).

**7. Multi-level governance**. This lesson concerns the importance of taking account of multiple levels of governance, including political levels (city, nation, EU, etc.) and hierarchical levels within the organisation. Multi-level governance also concerns the need to manage, balance and seek synergies between top-down and bottom-up processes.

**8. Alignment**. In this lesson, attention is given to the need to align and synchronise normative goals, objectives and procedures of different instruments and measures, across levels and through effective co-ordination mechanisms.

**9. Boundary objects**. Multi-level governance and alignment also require the recognition of the intermediary role played by boundary objects, i.e., objects of any nature (data, specimens, materials, etc.) which, by virtue of their interpretive flexibility, can link different groups of researchers and stakeholders.

**10. Institutional change**. Another important aspect is that RRI should be able to activate long-term changes in institutions at any level (regulative, normative and cultural-cognitive), modifying rules, routines and organisational forms. It is, however, important to be aware that institutional changes involve parallel processes to de-institutionalise the existing patterns, which usually triggers resistance, reactions and tensions.

**11. Capabilities**. RRI entails capability-building processes across the R&I spectrum encouraging and enabling the formation of reflexive actors that can participate fully in RRI processes.

**12. Capacities**. This lesson focuses on the need to guarantee resources (financial, organisational, and social and human capital) and adequate means (new institutions, new incentives structures, etc.) to create the conditions for responsibilisation processes.

**13. Institutional leadership and entrepreneurship**. This lessons concerns «*the enabling of key actors, groups, organisations and wider society to create spaces, resources, and support for values-driven institutional entrepreneurialism*» in RRI, at the level of key actors and champions, at the middle-management level in organisations, and at the level of organisational culture.

### B. Expert Group on the State of Art in Europe on Responsible Research and Innovation

The Expert Group on the State of Art in Europe on Responsible Research and Innovation, established by the European Commission (2013b), delivered a report aimed at identifying policy options for strengthening RRI at European level.

**Four scenarios** were presented, developed and discussed, each based on a specific option.

#### B1. Business As Usual (Option 1)

In this scenario, the future approach to RRI in EU funding programmes does not change, nor are additional funds envisaged. The main trends in this scenario are: RRI standards remain scattered; no attempt will be made to coordinate the different national approaches towards RRI, while industry will move more and more towards international standards (for example, Corporate Social Responsibility as it is coded under ISO 26000).

#### B2. Improved Business As Usual (Option 2)

This scenario is based on the option of increasing the funding of RRI activities. Three main actions are included in the option.

**Action a.** is aimed at mainstreaming RRI in the EU funding programme, in order to raise awareness of RRI, creating incentives to apply RRI, restructuring research proposal evaluation processes, and including the consideration of RRI into research funding for training activities.

**Action b.** is aimed at increasing the share of funding for trans/interdisciplinary research including funding options for stakeholder participation in research processes.

**Action c.** should establish a specific line of funding for research on RRI, encouraging exchange among researchers, promoting further development of theoretical approaches, and supporting studies on conditions for the successful application of RRI in practice.

#### B3. Improved Coordination with Member States without a Legally Binding Initiative (Option 3)

This third option is based on a scenario which sees the promotion of improved coordination among Member States. It also includes the possibility of directly addressing Member States, business enterprises, research institutions and research funding organisations. Three actions are identified.

**Action a.** is aimed at fostering improved coordination of RRI activities in Member States. Each government could be asked to prepare, on a voluntary basis, a report on RRI activities using a common reporting scheme so as to promote exchange and set benchmarks. Member States may be involved in developing actions addressing barriers to RRI, such as new funding schemes on RRI, incentives, and training activities.

Through **Action b.**, new codes of conduct for RRI activities may be defined, to foster self-governance processes and collective reflection by researchers and innovators. The EU could oversee the process of defining a more general code of conduct.

**Action c.** involves developing RRI standards that can be adopted voluntarily and applicable for the design of research processes. In this scenario, dialogue could be initiated to develop a common framework for RRI activities. In order to harmonise the different standard systems, European RRI standards should be developed, in cooperation, also, with international standardisation bodies, like ISO.

#### B4. Improved Coordination with the Member States with a Legally Binding Initiative (Option 4)

This option is based on a scenario where standards and guidelines already presented in the case of the Option 3 become mandatory through European regulations and directives.

### c. Stahl, Obach, Yaghmaei, Ikonen, Chatfield and Brem

Bernd Carsten Stahl, Michael Obach, Emad Yaghmaei, Veikko Ikonen, Kate Chatfield and Alexander Brem developed the **Responsible Research and Innovation Maturity Model** (2017), aimed at identifying progressions towards RRI in industry contexts.

The model includes an operational definition of the components of RRI, structured around the three main elements of R&I, i.e. purpose (why R&I is undertaken), process (the activities that are undertaken in the pursuit of R&I) and product (the outcomes of R&I). This leads to the following scheme.

| RRI Category | RRI Component |
|---|---|
| **Purpose (motivation)** | Motivation for doing the research<br>Motivation for engaging with RRI<br>Ethics (justification of intended outcomes) |
| **Process (activities undertaken)** | Anticipation<br>Engagement<br>Reflection<br>Governance (research ethics)<br>Responsiveness |
| **Product (outcomes)** | Gender/equality and diversity<br>Open Access<br>Social justice/inclusion<br>Sustainability<br>Science education |

In defining the components, the authors mainly refer to Stilgoe, Owen and Macnaghten (2013) for those included in the category of process and to the RRI keys identified by the European Commission (2012), i.e., public engagement, open access, gender, science education, ethics and governance, for those included in the category of product.

The Maturity Model also includes an evolutionary scheme to assess the extent to which RRI is institutionally embedded in a given industry. Five stages are identified:

**Level 1 – Unaware**. Organisation is not aware of RRI or its components and does not incorporate it in its processes.

**Level 2 – Exploratory/reactive**. Organisation reacts to external pressure concerning aspects of RRI and experiments concerning appropriate processes.

**Level 3 – Defined**. Organisation has a definition of RRI (or components of it) and has integrated these into its business processes.

**Level 4 – Proactive**. Organisation realises the benefits of RRI and seeks to integrate these proactively and increasingly into its business process.

**Level 5 – Strategic**. Organisation has adopted RRI as a component of its strategic framework and aims to ensure all R&I activities cover all (or most) RRI components.

By combining these stages with RRI components and categories, a matrix can be developed to assess the maturity level reached by an organisation in embedding RRI into its procedures and objectives.

| RRI CATEGORY | RRI COMPONENT | L1 UNAWARE | L2 EXPLORATORY /PROACTIVE | L3 DEFINED | L4 PROACTIVE | L5 STRATEGIC |
|---|---|---|---|---|---|---|
| **Purpose** | - Motivation for doing the research<br>- Motivation for engaging with RRI<br>- Ethics (justification of intended outcomes) | | | | | |
| **Process** | - Anticipation<br>- Engagement<br>- Reflection<br>- Governance (research ethics)<br>- Responsiveness | | | | | |
| **Product** | - Gender/equality and diversity<br>- Open Access<br>- Social justice/ inclusion<br>- Sustainability<br>- Science education | | | | | |

### D. MATTER

The UK-based organisation MATTER (2015) developed 8 principles for embedding RRI in a business organisation.

**Principle One - Innovation for social benefit**. The organisation designs its innovations to deliver social, ethical and environmental benefits, in addition to commercial goals.

**Principle Two – Board leadership**. The Board takes a leadership role in championing Responsible Innovation and is accountable for developing and managing its innovation strategy and associated responsibilities.

**Principle Three – Consideration of social, ethical and environmental impacts**. The organisation considers and is responsive to the wider social, ethical and environmental implications and impacts of its innovations, working alone or with others where appropriate.

**Principle Four – Excellent public health, safety and environmental risk management**. The organisation carries out thorough, technology specific, risk assessment and minimises any potential public health, safety or environmental risks relating to its products. It also considers the public health, safety and environmental risks throughout the product lifecycle.

**Principle Five – Excellent worker health and safety**. The organisation ensures high standards of technology-specific occupational health & safety. It also considers occupational health and safety issues for workers at others stages in the product lifecycle.

**Principle Six – Involving commercial partners**. The organisation engages proactively, openly and co-operatively with business partners up and down the supply chain to provide appropriate information and safety data throughout the supply chain.

**Principle Seven – Stakeholder involvement**. The organisation identifies its innovation stakeholders, including the general public, proactively engages with them, involving them in the innovation process and is responsive to their views and concerns.

**Principle Eight – 'Radical Transparency' and disclosure**. The organisation is innovative and daring in its approach to transparency and openness. In particular it is open about its involvement with and management of specific technologies or areas of innovation.

### E. Jirotka, Grimpe, Stahl, Eden and Hartswood

Marina Jirotka, Barbara Grimpe, Bernd Stahl, Grace Eden and Mark Hartswood (2017) developed a framework for embedding RRI in ICTs, being aware that «*RRI in ICT cannot be realised in a prescriptive manner*» but it is to be understood as «a *contextual process*» requiring an «*ongoing cultural dialogue*» that is iterative in nature.

The framework, called "AREA Plus Framework", can be summarised in a matrix where four key RRI components (anticipate, reflect, engage, act) are connected to the different stages of technology development (Process, product, and purpose) and the variable of people participation. Each cell of the framework «*expands into deeper questions, suggesting literature, more detailed discussion and problematisation*».

The matrix is reported below.

| | **Process (rhythm of ICT)** | **Product (logical malleability & interpretive flexibility)** | **Purpose (convergence & pervasiveness)** | **People (problem of many hands)** |
|---|---|---|---|---|
| **Anticipate** | Is the planned research methodology acceptable? | To what extent are we able to anticipate the final product, future uses and impacts? Will the products be socially desirable? How sustainable are the outcomes? | Why should this research be undertaken? | Have we included the right stakeholders? |
| **Reflect** | Which mechanisms are used to reflect on process? How could you do it differently? | How do you know what the consequences might be? What might be the potential use? What do we not know about? How can we ensure societal desirability? | Is the research controversial? How could you do it differently? | Who is affected? How could you do it differently? |

| | Process (rhythm of ICT) | Product (logical malleability & interpretive flexibility) | Purpose (convergence & pervasiveness) | People (problem of many hands) |
|---|---|---|---|---|
| **Engage** | How do you engage a wide group of stakeholders? | What are the viewpoints of a wide group of stakeholders? | Is the research agenda acceptable? | Who prioritises research? For whom is the research done? |
| **Act** | How can your research structure become flexible? What training is required? What infrastructure is required? | What needs to be done to ensure social desirability? What training is required? What infrastructure is required? | How do we ensure that the implied future is desirable? What training is required? What infrastructure is required? | Who matters? What training is required? What infrastructure is required? |

### F. RRI TOOLS PROJECT

Under the EC-funded project RRI Tools, a set of practical guidelines for implementing RRI have been developed (RRI Tools, 2016), providing a wide range of examples concerning how to embed, for example, RRI principles into a business plan, or incorporate RRI principles in a funding call, incorporate RRI in policy or funding institutions or set up a participatory research agenda.

In a broader perspective, five “golden rules for achieving RRI” are proposed below, as they are described in the publication.

**1. Think about what society wants**. Research and innovation should not just take place in society, but for and with society. Citizens should be thought of not only as the end users of science and technology, but as partners in its development. This implies science education needs to play a key role in educating the responsible citizens, researchers and innovators of tomorrow from the early stages to higher education. There are various strategies to embed RRI in education and to engage with the public in the planning, design and implementation stages of R&I – many of which can be found in the RRI Toolkit.

**2. Involve a wide range of stake-holders and societal actors**. Responsibility needs to be shared among many different actors during R&I development. This not only allows the public a say on which and how research and innovation activities are conducted, but can also improve their outcomes by adding a wider range of expertise and perspectives, making R&I more socially acceptable and ultimately more relevant and impactful.

**3. Consider all possible impacts**. Key to truly responsible R&I is anticipation — predicting as many of the potential effects of a project as possible, and not just those that are intended. Impact exploration should be in-depth, considering how the research and innovation might shape our collective future and what these changes might mean for society and the environment. Linked to this is reflection, which means thinking about why research and innovation is being conducted, its goals and its implications. A key part of this deals with uncertainty, which is an understandably inevitable part of R&I. There are various strategies and approaches used to account for uncertainty, such as scenario planning — a systematic way of thinking about the future.

**4. Be open and transparent**. Being open about research and innovation is vital to build public trust. This means disclosing results, methods and data, and engaging in a transparent, meaningful and multiple-way dialogue with all relevant parties. This dialogue can foster social acceptance of R&I advances and lead to more robust outcomes. Openness and transparency are particularly important features of RRI because they lay the foundations for accountability — making scientists and innovators answerable for their actions and the consequences. Open Science also allows those who may not usually be involved in science and technology, such as members of the public or those working in business, to review research and innovation and make their opinions heard.

**5. Respond and adapt**. Opinions are of little use unless they are acted upon. Therefore, the final recommendation is to change ways of thinking, working and, if necessary, entire organisational structures in response to feedback from society. As well as the views of society, it is also important to respond to the perspectives of other stakeholders, such as policy makers and those who commercialise R&I, for which active listening and an open mind are needed. It is also key to adapt to the emergence of new knowledge and changing circumstances, such as changes to the funding landscape.

### *1.4. Discussion*

In this section, attention has been given to the concept of RRI and the governance models designed either to improve management of R&I in the new "post-modern" context or to favour the spread of RRI in European research systems and research institutions.

Some considerations that could feed a discussion on these issues are offered below.

#### A. A POWERFUL CONCEPT

As highlighted at the beginning of the section, RRI is a "**buzzword**" or an "**umbrella word**", flexible and open enough to allow for different interpretations and applications. For this reason, RRI is or can be a **mobilising concept** that can spark the interest of different actors and eventually orient research policies at national or institution level. Probably, a more narrowly defined and less ambivalent concept could not have produced a similar impact on policy discourse on science and technology, although its spread is still limited, in comparison to expectations, especially among STEM disciplines.

Moreover, **RRI did not come out of the blue**, but is the latest t product of discussions and movements developed in the past, each producing different "cognate concepts" (Rip, 2016a). Its wide semantic domain allows it to subsume these concepts and issues and to express social values, needs and expectations related to practically any science-in-society issue such as science communication, transparency and accountability of public services, ethical demands, boost to innovation, equal opportunities, people participation, or good governance. This happens because RRI is grounded in real social processes and «*resonates with the ongoing concerns related to the role of science, particularly in society*» (Rip, 2016b).

Also to be noticed, is the massive extent to which these issues are present, and not just in debates and narratives on science and technology. The idea of "responsibility" has, in fact, already been applied to many life domains, thus generating concepts like "responsible politics", "responsible eating", "responsible consumerism", "responsible religion" or "responsible lifestyle".

In this sense, **RRI is a powerful concept**, precisely because it is a "boundary object" that can reflect, combine and coordinate different sets of meanings shared by different groups of people but intuitively comprehensible, albeit in different ways, to anyone.

### B. A LOGICAL ASSUMPTION

One of the factors making RRI such a fashionable concept is that it is based on the critical assumption according to which science and innovation are (or have been so far) **under-responsible**, i.e., lacking control over the risks they produce, the social desirability of their impacts and the ethical correctness of their methods or outcomes, or **even irresponsible**, i.e., actively pursuing objectives or adopting practices which are, e.g., ethically doubtful or socially questionable. This assumption can be considered as "logical" since it is logically implicated in the very idea of a science and innovation which are required to be responsible, i.e., at least more responsible than they are now. It is also to say that many RRI advocates also fear being "accused" to share this assumption.

To a certain extent, such an assumption reflects quite common views of science and innovation, depicting them as (consciously or unconsciously) risky, increasingly profit-driven, ethically weak or questionable, insensitive to the demand of the public, ambiguous and opaque in their internal mechanisms, unaccountable for in both their inputs (money, resources, etc.) and outputs (results and their impacts, use of the knowledge produced, etc.), having great power over people's life but outside any democratic control.

It could be said that it is absolutely reasonable to knock science and scientists off their pedestal by showing (as science and technology studies started to do in the 1960s) that **science and innovation are like any other social institution** and, as such, exposed to any socially constructive or distortive dynamics. This helps understand the fallacy of once-dominant deterministic approaches to science and technology (in which they could shape society but not be shaped by it), as well as the inconsistency of the claim that science is regulated purely by meritocracy and rationality.

However, it can be equally misleading to take for granted that under-responsibility is a specific feature of science and innovation. As a matter of fact, not only science but all the social institutions of modernity (like politics, public administrations, trade unions, religions or media) can be and actually are often considered as under-responsible, according to current post-modern standards.

Hence the need to **make this assumption more explicit and less generic**: In the case of R&I, what does (or did) "being under-responsible" mean? Which effects and consequences is an under-responsible R&I producing or has produced in the past? And how? To change course, especially in a domain like science, it should be necessary to provide evidence and produce reliable information.

### C. THE NORMATIVE NATURE OF RRI

Another consideration concerns the nature of RRI. Although different, the many interpretations of RRI almost always see it as a **normative approach**, grounded in specific values, aimed at modifying research and innovation processes through different tools and strategies (norms, directions, codes of actions, etc.), regardless of the actual feasibility conditions (in this sense, they are normative rather than simply prescriptive; see Baron, 2012).

Thus, RRI appears to belong to the domain of the "having-to-be" (intentions, norms, ethical issues, etc.) with few connections to the domain of "being" (reality, actual social processes, actions, sentiments, etc.)[3]. Hence the conception of RRI as something necessary, to be built up anyhow and in its entirety, it being related to mandatory ethical standards.

This means that RRI does not have, in principle, limitations in **encompassing any possible desirable feature of science and technology**, including effectiveness, sustainability, inclusiveness, anticipatory orientation, responsiveness, reflexivity, transparency, care, proactivity, deliberation, accountability, equity and efficiency, with the risk that RRI becomes a sort of a "wishlist" about science and technology.

However, we should consider whether adopting a purely normative approach could be effective or only illusory. Promoting RRI should imply a radical change in stakeholder views, mindset and action patterns, which is unrealistic to do exclusively through new normative frames, regardless actual stakeholder interests, attitudes, worries and orientations.

### D. THE DIFFICULT PATHWAY TOWARD RRI

These considerations inevitably also lead us to consider the governance models developed in connection with RRI or to promote it, analysed in Para. 1.2. and Para. 1.3.

As we have seen, the **models of an empirical nature** (i.e., such as those by Felt, Ruggiu, or Landeweerd et al., aimed at identifying the governance approaches actually used or claimed) highlight the presence and sometimes the co-presence of different inclinations towards the implementation of RRI, depending upon, e.g., the weight assigned to ethical issues and societal issues, the tendency to resort to a narrow normative approach or to an open-ended "constructivist" approach, the type of connection (strong or loose) established between RRI and economic objectives, the level of participation expected (from consultation to co-creation) or the scope of RRI (focused on public engagement and ethics or expanded to encompass, e.g., the civic engagement of research organisations, gender issues, science communication or open access).

As for **RRI implementation models** (i.e., those aimed at developing a method for implementing RRI), we can distinguish two main streams:

- On the one hand, there are models interpreting RRI as a lever for deep and direct changes to the management of science (for example, those by MATTER and Res-AGorA). These models are **ambitious** and **unrealistic**, since they replicate, in terms of methodology, the

[3] We are mainly referring here to Martin Heidegger's thinking (Heidegger, 1996) and to the Hans Kelsen's distinction between "being" (*sein*) and "ought" (*sollen*) (Kelsen, 1967).

same tendency to expand the scope of RRI we noticed above as regards theoretical grounds

- On the other hand, there are models (for example, Jirotka et al., RRI Tools or Stahl et al.) which are more **practical in aims**, being mainly interested in providing research organisations with a "compass" or light tools to guide them into the complexity of RRI.

Under both perspectives, **linear pathways towards RRI appear to be difficult both to identify and to pursue consistently**.

The empirical model of R&I governance provides an account of the ambiguities and contradictions which may emerge once RRI is actually implemented. In turn, RRI implementation models either call for an overall and radical reform of scientific institutions for the sake of RRI or tend to provide a pragmatic (and sometimes over-simplistic) view of RRI, according to which the key problem is asking the "right" questions or adopting the "right" cognitive approach.

To overcome these hindrances (being unrealistic or over-simplistic), the only pathway possible is probably to recognise RRI implementation as a **highly context-dependent process**, as concerns RRI contents and dimensions, feasibility conditions and application strategies. This suggests that there is not a single "RRI" but many possible "RRIs", each related to the context of application (mainly at institution level) and its many variables (starting conditions, sensitiveness of key actors towards RRI, policy environment, disciplinary dynamics, private-public cooperation schemes, etc.).

### E. RRI and Changes in Science and Innovation

The strength and direction of changes affecting science and innovation are other variables to take into consideration when speaking of RRI.

Quite paradoxically, RRI seems to be almost exclusively interpreted as something pertaining to science-society relations and not directly the "inner life" of scientific institutions. We could say that RRI concerns the "**foreign affairs**" of R&I processes but not their "**domestic affairs**", if not marginally. Indeed, only incidentally do the interpretations and models examined above consider the possible relations between **RRI** and the **main change processes** affecting science in its most intimate mechanisms (pertaining to, e.g., laboratory work, research assessment, publishing dynamics or scientific careers).

This is actually a strong limitation, since it is quite difficult to "embed" RRI in research systems and organisations without at least interfering with the ongoing change processes.

## 2. RRI in action

In this paragraph, attention shifts from RRI concepts and models to RRI experiences, in order to analyse in depth RRI drivers and barriers.

To this end, two different operations have been conducted:

- An analysis of a selected group of deliverables produced under **EC-funded projects** aiming to promote the spread of and reflection on RRI
- A **literature review of scientific papers** specifically focused on RRI barriers and drivers.

### *2.1. RRI in EC-funded projects: barriers and drivers*

The first source of information consulted on RRI drivers and barriers was a set of EC-funded projects aimed at promoting the spread of and reflection on RRI. This is mainly made up of documents produced on the basis of either consultation and exchange exercises (workshops, meetings, focus groups, etc.) involving different stakeholders or the observation of RRI cases.

#### A. BARRIERS TO RRI

The issue of barriers to RRI is considered in various documents produced under EC-funded projects devoted to RRI or RRI components (typically, public engagement). However, the concept itself of "barrier" has been variably interpreted and different typologies have been developed, based especially on the "nature" of the barriers (for example, barriers related to personal attitudes, political barriers, institutional barriers, etc.).

In this section, a "purposive" typology of barriers is used, i.e., a typology that can help address the key question at the basis of FIT4RRI: why is it that RRI has not become as widespread (especially in STEM disciplines) as it was expected to be?

For the sake of simplicity, **four main explanations** can be identified, not alternative to each other.

- **Lack of awareness**. RRI is not sufficiently widespread because of the limited spread of information on it and the little awareness researchers have of it.
- **Lack of relevance**. RRI is not sufficiently widespread because, although the actors know about it and are aware of it, it is (or is perceived as) not relevant to the main problems the actors (researchers, research institutions, industries, civil society organisations, etc.) are concerned with and worried about.
- **Lack of effectiveness**. RRI is not sufficiently widespread because, although relevant, it is (or is perceived to be) ineffective in solving these very problems.
- **Lack of sustainability**. RRI is not sufficiently widespread because, although relevant and effective, it is (or is perceived to be) unsustainable in the long run.

We will try to distribute the barriers among these four categories, i.e., awareness, relevance, effectiveness, and sustainability. This attribution is **largely conventiona**l and has been done considering **the prevalent impacts** these barriers are supposed to have, according to the sources, on the spread and implementation of RRI.

The documents selected have been drawn from ten EC-funded projects, i.e.:

- RRI Tools (Smallman, Lomme & Faullimmel, 2015)
- Engage2020 (Kuhn et al., 2013)
- PROSO (Bauer, Bogner & Fuchs, 2016; Porth, Timotijevic, Fuchs, Hofmaier & Morrison, 2016)
- FoTTRIS (Karner, Bajmocy, Deblonde, Balázs, Laes, Pataki, Racovita, Thaler, Snick & Wicher, 2016)
- Res-AGorA (Lang & Griessler, 2015)
- PERARES (Steinhaus et al., 2013)
- RRI-PRACTICE (Owen, Ladikas & Forsberg, 2017; Forsberg, Shelley-Egan, Ladikas & Owen, 2017)
- COMPASS (Iordanou, 2017)
- SYN-ENERGENE (König, 2016)
- PE2020 (d'Andrea & Caiati, 2016; Rask, Mačiukaitė-Žvinienė, Tauginienė, Dikčius, Matschoss, Aarrevaara & d'Andrea, 2016).

### A1. Barriers Related to the Awareness about RRI

This section looks at the barriers hindering or impeding the main actors from becoming interested in or aware of RRI and RRI-related issues. Two sets of barriers falling into this first category can be identified.

The first set includes the **overall cultural attitudes of the players involved**. The following barriers have been identified.

- **Resistance to change**. Universities and research institutions – like other large institutions – are difficult to change because of their tendency to reproduce unwritten rules, procedures, norms, and internal practices over time (RRI Tools). RRI can be viewed as a threat to the established procedures, in that it tends to modify roles and responsibilities (RRI-PRACTICE). Therefore, some groups may be damaged by RRI and would put up resistance to change (RRI Tools)
- **Risk aversion**. Another attitude which prevents RRI from becoming widespread is the tendency of research institutions to see RRI as a potential risk for science governance, especially because it may fuel public controversies on scientific issues (RRI Tools).
- **Protection of academic freedom**. In many documents (RRI Tools, ResAGorA, FoTTRIS, Engage2020, RRI-PRACTICE), one of the major obstacles to RRI to be identified is the attitude of researchers who see RRI as a threat to academic freedom, understood both as the freedom of individual researchers to make their own research choices and as the autonomy of research organisations to develop their own policies and devise their own strategies.

- **Self-referentiality of RRI actors**. Research institutions tend to be self-referential and to give priority to what happens inside them, not usually being inclined to interact with external actors (RRI-PRACTICE). This is also true in the case of policy actors, who tend not to take into account scientific expertise, nor provide citizens with real opportunities for participation in the political process (RRI Tools). This is less true in innovation contexts, in which interacting with other actors and especially with end-users is quite a common practice (RRI-PRACTICE).
- **Short-term time frame**. Another attitude which makes it difficult for RRI to become widespread is the tendency for R&I actors to give priority to short-term processes (for example, rapid investment returns, rapid moving from experimentation to publication, etc.) while RRI requires or is perceived to require the adoption of medium to long-term perspectives, especially because of the need to involve many actors and to include additional steps in the research and innovation process (FoTTRIS). Short-term thinking also characterises the policy culture, which tends to focus on the "hot topics" and to neglect issues which need long-term solutions (RRI Tools).
- **Researcher specialisation**. The increasing tendency of researchers to focus on specialised research fields makes it difficult for them to become aware of the societal implications of their own research or investigate the relations between their own research and societal challenges (FoTTRIS).
- **Value systems of RRI actors**. Innovation is based on a value system which is overwhelmingly focused on economics and wealth creation with little room for other principles and criteria, such as those involved in the alignment of innovation outputs to societal needs and values (PROSO). It is also difficult to clearly separate economic benefits and societal benefits (SYN-ENERGENE). Moreover, in many cases, a dominant low-cost/low-quality business culture is still dominant, which tends to belittle any other process or step, which are perceived as unnecessary (COMPASS). Problems related to value systems do not only concern industry, but also citizens and researchers. Their values systems may also not be very compatible with RRI, and it is naive to think that RRI can modify such value systems and make citizens and researchers more responsible. Broader societal changes are needed (COMPASS).
- **Training approaches**. Researchers are not trained to critically observe scientific work and to reflect on its wider implications (ResAGoRA). This makes it more difficult for them to become interested in RRI.

The second set of barriers pertains to the **interaction between the actors concerned**, which is a requirement for any RRI-oriented action. The following barriers can be mentioned in this regard.

- **Stereotypes**. There are often preconceived ideas about particular stakeholder groups, such as researchers and industries (as they may be perceived by civil society organisations) or civil society organisations and researchers (as they may be perceived by researchers) (PROSO).
- **Lack of a collaborative culture**. A lack of a collaborative culture may be observed in many countries, which impedes RRI actors from proactively looking for other stakeholders to co-operate with (RRI Tools). In general, RRI requires high levels of mutual trust, which is often lacking (ResAGorA, PE2020), as is often lacking a shared knowledge about the issues to address (ResAGorA).

- **Diverging visions of societal benefits**. The visions stakeholders and researchers have of the potential societal benefits of R&I are usually so different and even divergent that any collaborative process is discouraged. For example, civil society organisations tend to approach sustainability issues by highlighting the need to limit economic growth, while industries tend to propose solutions based on the development of a synbio-driven bioeconomy precisely to fuel economic growth (SYN-ENERGENE).
- **Conflicts between local, national and international cultures**. RRI often requires interaction between cultures focused on the local, national or international dimension. This may lead to conflicts, since the same process may be differently interpreted and assessed according to the level assumed to be the priority (Engage2020).

A2. BARRIERS RELATED TO RELEVANCE OF RRI

In this paragraph, the focus is on the barriers which make RRI not relevant (or perceived as such) to the problems, interests and worries which concern research actors, stakeholders and the public in general. The overall effect of these barriers is to hinder or limit the interest of the players concerned in getting involved in RRI, even when they are fully aware and informed about this issue.

The first set of barriers includes **existing priority schemes** preventing RRI from becoming a priority. The following barriers may be highlighted.

- **Excellence vs RRI**. Many documents (PROSO, ResAGorA, RRI-PRACTICE) identify a hidden opposition between excellence and RRI, viewed as two competing priorities. As a matter of fact, excellence in science is the absorbing motive for scientists and research organisations, to which all the available resources (time, money, equipment, etc.) should be devoted. The “struggle for excellence” is profoundly embedded in the epics and ethics of science. Also, the review systems are exclusively based on excellence and not on social impacts (PROSO). The entire picture is worsened by the rapid increase in the competition to access decreasing resources, permanent positions, rewards and recognition. In such a context, RRI is not only perceived as marginal, but in many cases a real obstacle to the search for excellence.
- **Pressure to publish**. In this same context, getting research published in the shortest time possible is becoming the number one priority for both researchers and research institutions (see Part Two, Section 2). This priority is so strong that it makes anything else irrelevant, including RRI (RRI Tools, PE2020).
- **Creating growth and making a profit**. Similar dynamics can be observed when the innovation side of the process is considered. The policy imperative for policymakers is making science and creating growth (RRI Tools), while the economic imperative for industries is making a profit, especially to develop new patents and to commercially exploit research results (RRI Tools, PROSO, FoTTRIS). RRI is, therefore, often viewed by both as an impediment to the accomplishment of these imperatives in that, on the one hand, RRI may attract resources that would otherwise go to growth and profit-making activities and, on the other hand, once implemented, it necessarily leads to increased production costs and to longer production times. In this way, RRI may turn into a competitive disadvantage for a firm or for a productive system (PERARES). Additional resources should then be found to balance the need for financial profit with the need to find resources to conduct activities in a responsible manner (COMPASS).

- **Open Access vs IP/patenting**. A specific, well-known but significant priority clash concerns Open Access. As a matter of fact, from an RRI logic, the free flow of scientific information is a requirement for a collective engagement in science and innovation. From an innovation logic, Open Access hinders IP recognition and patenting (RRI Tools). As for scientific publication, the system is still based on "paywalled journals", difficult and costly to access.
- **Distrust in scientific institutions and in RRI**. Another aspect which is necessary to mention is the scepticism that different stakeholders have toward RRI and Public Engagement (PE2020, Engage2020), as well as toward scientific organisations in general (PE2020). This produces a "motivational deficit" hindering these stakeholders from taking part in the implementation of RRI.

The second set of barriers refers to the **dynamics of RRI incentives**. The following issues can be considered in this regard.

- **Lack of material incentives**. RRI is time consuming, costly and, in many cases, its outputs are unpredictable. Therefore, promoting and implementing RRI requires money and resources, which, however, are rarely guaranteed (RRI Tools, Engage2020, RRI-PRACTICES, PROSO).
- **Lack of scientific recognition**. Another factor hindering RRI is the lack of scientific recognition attached to it. Scientists are not rewarded for societal engagement (Engage2020) and other RRI dimensions (RRI-PRACTICE). RRI is also not considered, except episodically and marginally, in the research evaluation process (RRI Tools). This also leaves researchers already involved in RRI-related activities without adequate institutional support (Engage2020).
- **RRI as a disincentive for scientific recognition**. RRI may even play a negative role in the dynamics of scientific reward and recognition. Often, research organisation leaders do not like RRI (PROSO), researchers' involvement in RRI is not acknowledged by peers (FoTTRIS) and may even be perceived as belittling the capacity of researchers to do research.
- **Lack of incentives for non-R&I actors**. The lack of incentives also concerns non-R&I actors. For example, it is not clear what benefits derive from RRI for civil society organisations and the public at large (FoTTRIS). This may also explain, at least partially, the limited interest civil society organisation have in lobbying for RRI (PERARES) and the presence of many relevant stakeholders that, even if asked, do not want to participate (ResAGorA).
- **Unclear benefits of RRI**. For researchers and other stakeholders, the benefits of RRI often remain often unclear or uncertain. Because of this lack of clarity, and in the absence of requirements for RRI, other things would be seen as more relevant to their objectives and interests (RRI Tools).

### A3. Barriers Related to the Effectiveness of RRI

In this paragraph, the focus is on the barriers which make RRI ineffective or not sufficiently effective (or perceived as such). Therefore, these barriers have prevalently to do with how RRI should be implemented and under which conditions the implementation of RRI becomes possible.

The first set of barriers refers to **uncertainty about RRI and RRI implementation**. In particular, the following issues can be mentioned.

- **Uncertainty about the concept**. The conceptual structure of RRI lacks a clear definition and clear rationale (RRI Tools), and is susceptible of different interpretations (RRI-PRACTICE, ResAGorA) and of being applied “to very different things in very different contexts” (PROSO). So not surprisingly, there are also substantial differences among stakeholders in terms of how RRI is framed (RRI-PRACTICE), which makes it more difficult to attain a good level of cooperation among them. An integrated approach to the concept is lacking and little integration can be also observed in its key areas (public engagement, open access, gender equality, etc.), with the risk of encouraging “cherry picking of particular RRI keys that fit the current policy needs” (RRI-PRACTICE).
- **Uncertainty about the promoters**. RRI not only requires resources and incentives, but also groups, leaders and individuals fully engaged in triggering the process. Unfortunately, it is often unclear who the players responsible are and who has the power to activate the process (RRI-PRACTICE, PE2020).
- **Uncertainty about the process**. The lack of reliable visions about what RRI is and how to make it real is another serious obstacle to its implementation (RRI Tools). The same can be said of the uncertainties related to how to manage conflicts which RRI quite inevitably produces or how to manage the cases in which stakeholders are not interested in participating (FoTTRIS). Someone speaks of the “vagueness” of practical RRI (SYN-ENERGENE), especially as regards how RRI notions and principles may be linked to effective policies (SYN-ENERGENE). Lack of a shared methodological framework is also understood as a problematic aspect (RRI Tools).
- **Uncertainty about the impacts**. Finally, also the impacts of RRI are structurally difficult to predict, since many variables come into play, both in the implementation process and in stakeholder interaction (RRI-PRACTICE).

The second set of barriers are more technical in nature, concerning **requirements and conditions for RRI implementation**. The following main issues can be highlighted in this regard.

- **Lack of resources**. As already mentioned above, RRI requires significant investments in terms of money, resources, time and political power (RRI Tools, Engage2020, RRI-PRACTICES, PROSO, FoTTRIS, PE2020), which often are lacking or are largely insufficient to activate successful change processes. Lack of resources is particularly problematic for civic society organisations, since they usually cannot rely upon their own resources (PROSO).
- **Lack of skills and training opportunities**. In many cases, R&I actors and stakeholders also lack the necessary skills and training opportunities to implement RRI (RRI Tools, FoTTRIS, PERARES, Engage2020). This is particularly true for scientists and scientific institutions. In addition, expertise to help them implement RRI is also generally lacking (RRI Tools).
- **Lack of communication channels**. Stakeholders and researchers usually do not communicate with each other, thus making RRI difficult to be actually implemented (COMPASS, PE2020). Communication is even weaker in the case of actors (such as funding agencies and civil society organisations) that have never had common interests and opportunities to work together (Engage2020). The limited presence of communication channels (and shared languages) also reduces chances of communicating science-related issues without falling into oversimplification (ResAGorA).

The third set of barriers can be identified in **technical issues** intrinsically connected to RRI implementation. Among them, two issues deserve to be mentioned.

- **Management of public participation**. The management of public participation is characterised by serious problematic issues, including: how to raise the interest of different stakeholders (Engage2020, PE2020); how to manage the power dynamics among participants, (RRI Tools, PE2020); how can public participation be managed methodologically (RRI Tools); how to address the lack of shared knowledge to take decisions (ResAGora, PE2020), the lack of a common understanding of RRI (ResAGorA), the lack of a mutual trust (ResAGorA, FoTTRIS) or the presence of diverging worldviews and ideas about problems and solutions (PROSO, PE2020) or diverging beliefs about what is socially desirable (FoTTRIS).
- **Turning RRI outputs into policies**. The second technical (but also political) issue is how to turn the outputs of RRI into impacts, in terms of new decisions, policies and measures. There is actually the risk of a gap between RRI exercises and policy making, so that deliberative processes may have little or no effect on political decisions (Engage2020). This is also due to the tendency to consider Public Engagement merely as a set of single participatory events and not as a permanent function of research institutions (PER2020).

A4. BARRIERS RELATED TO THE SUSTAINABILITY OF RRI

This group includes all the factors making it difficult for RRI to be or be perceived as institutionally and temporally sustainable. Lack of sustainability prevents RRI from becoming part of the identity of the organisations, stakeholders or individual researchers concerned. Different sets of barriers or risks to RRI sustainability can be identified.

- **Bureaucratisation**. There is a risk that RRI merely becomes a formal aspect of the life of the organisations concerned, simply requiring ticking the appropriate boxes in a form, or a tokenistic practice, thus making RRI something to exhibit for symbolic reasons (RRI Tools, PROSO). In this way, RRI becomes a further bureaucratic burden for researchers that may hamper creativity, progress and innovation (RRI-PRACTICE) or "window dressing" that reinforces a status quo that continues to cement existing norms, behaviours and power relations (RRI-PRACTICE).
- **Lack of investments**. Embedding RRI in research institutions and stakeholder organisations necessarily requires significant investments at all level (funds, time, expertise, political willingness, political power, etc.) by the organisation and its management (RRI Tools, PE2020, FoTTRIS, PROSO, Engage2020), which are usually lacking or extremely limited.
- **Resistance and institutional barriers**. It is difficult to see RRI as something to be simply added to the existing organisational functions. Rather, it should be incorporated, although prudently, into the major functions and practices of the organisation, which would be modified to different extents (PE2020, RRI-PRACTICE). This inevitably triggers strong resistance to change from both personnel and leaders (RRI Tools), due to the persistence of the existing institutional structures (ResAGorA, RRI-PRACTICE), specific interests and power relations (PE2020), cultural gaps and lack of information (PE2020, RRI-PRACTICE), and consolidated behavioural patterns (PE2020, RRI-PRACTICE).
- **Inadequate legal and regulatory framework**. National legislation can be a serious obstacle to RRI, because it is often inconsistent, unclear and scattered (RRI Tools). This is also true when regulatory frameworks developed for specific research and innovation sectors (such as nanotechnology or health) are considered (COMPASS).
- **Inadequate policy framework**. Similarly, apart from some specific exceptions, EC member states have not developed adequate policy frameworks to promote the spread and con-

solidation of RRI (RRI Tools). The majority do not have national bodies in charge of promoting RRI as a policy framework for research organisations, nor infrastructure and incentives to support RRI (RRI Tools, Engage2020).

- **Difficulties in defining the objectives**. To be implemented, RRI requires, in principle, deep cultural and systemic changes (RRI-PRACTICE, PE2020) affecting, not only the ways in which research and stakeholder organisations work, but also, e.g., the redefinition of the concepts of research quality and excellence (RRI-PRACTICE), the modification of research assessment procedures (PROSO), the reform of research funding schemes (FoTTRIS), the modification of university curricula (ResAGorA), the adoption of new hiring and promotion criteria (PE2020, Engage2020) and the development of engagement infrastructure (for example, science shops) (Engage2020). It is evident that all these objectives cannot be pursued all together and more feasible aims should be identified at different level (e.g., research group level, institution level, national level, etc.) so as to prevent RRI from becoming a simple "wish list" with limited actual applications. However, identifying the "right" objectives for a given organisation or research sector is a difficult and complex exercise, especially in a context where many players are concerned.
- **Difficulties in defining responsibilities and implementation procedures**. As already highlighted above, RRI implementation approaches and methodologies remain largely uncertain and unclear. It is not clear, for example, "whether RRI should be implemented at a management level and be incorporated into programmatic activities (i.e., top-down) or whether it should be implemented at the level of the individual researcher via for example the creation of safe spaces for interaction amongst researchers, free of programmatic assessment criteria, that will feed directly into policy decisions (bottom-up)" (RRI-PRACTICE).
- **Lack of evidence and data about RRI**. Finally, an important barrier to the "institutionalisation" of RRI is the lack of evidence and data about its impacts and benefits. For example, there are "few available data or information on evaluations of societal engagement in research and innovation activities and no creditable outcome-based evaluations that have established that a public participation technique has led to a technically or socially sound outcome that otherwise would not have been reached" (Engage2020). The lack of this information makes it difficult to trigger new and more advanced interpretations of science and science-society relations, or to convince research managers and leaders to invest in RRI.

## A5. A Summary Table

A summary table of the main barriers to RRI drivers is presented below.

| Group of barriers | Sub-set | Barriers |
| --- | --- | --- |
| **Barriers related to awareness**<br>barriers hindering or impeding the main actors from becoming interested in or aware of RRI and RRI-related issues | Barriers related to overall cultural attitudes of the players involved | - Resistance to change<br>- Risk aversion<br>- Protection of academic freedom<br>- Self-referentiality of RRI actors<br>- Short-term time frame<br>- Researcher specialisation<br>- Value systems of RRI actors<br>- University training approaches |
| | Barriers to the interaction between the actors concerned | - Stereotypes<br>- Lack of collaborative culture<br>- Diverging visions of societal benefits<br>- Conflicts between local, national and international cultures |
| **Barriers related to relevance**<br>barriers which make RRI not relevant (or perceived as such) to the problems, interests and worries of research actors, stakeholders and the public in general | Barriers related to existing priority schemes | - Excellence vs RRI<br>- Pressure to publish<br>- Creating growth and making a profit<br>- Open Access vs IP/ patenting<br>- Distrust in scientific institutions and in RRI |
| | Barriers related to the dynamics of RRI incentives | - Lack of material incentives<br>- Lack of scientific recognition<br>- RRI as a disincentive for scientific recognition<br>- Lack of incentives for non-R&I actors<br>- Unclear benefits of RRI |
| **Barriers related to effectiveness**<br>barriers which make RRI ineffective or not sufficiently effective (or create this perception) | Barriers related to uncertainty about RRI and RRI implementation | - Uncertainty about the concept<br>- Uncertainty about the promoters<br>- Uncertainty about the process<br>- Uncertainty about the impacts |
| | Barriers related to requirements and conditions for RRI implementation | - Lack of resources<br>- Lack of skills and training opportunities<br>- Lack of communication channels |
| | Barriers related to specific technical issues intrinsically connected to RRI implementation | - Management of public participation<br>- Turning RRI outputs into policies |
| **Barriers related to sustainability**<br>all the factors make it difficult for RRI to be or be perceived to be sustainable, so it can become part of the identity of the actors concerned | | - Bureaucratisation<br>- Lack of investments<br>- Resistance and institutional barriers<br>- Inadequate legal and regulatory framework<br>- Inadequate policy framework<br>- Difficulties in defining objectives<br>- Difficulties in defining responsibilities and implementation procedures<br>- Lack of evidence and data about RRI |

## B. RRI DRIVERS

It is preliminarily to be noted that the concept of driver is used here in its **broadest meaning**, since the consulted sources deal with different "objects" which can be directly or indirectly referred to the concept of "RRI drivers". They include:

- The **arguments** in support of RRI expressed by different stakeholders
- The actual or perceived **benefits** of RRI
- The **motivations** pushing the actors to adopt RRI
- The **factors** of any kind (social, economic or policy nature) and dimension favouring the adoption of RRI framework and policies.

In various cases, the consulted sources provide a more or less formalised typology of drivers.

For example, under the Engage2020 Project (Hennen & Pfersdorf, 2014), focused on Public Engagement, three types of "motives" are proposed: those which are functional to R&I to improve work; those of a political nature; those of a cultural nature. Similarly, under the MORRI project (Wuketich, Lang, Grießler & Polt, 2016), a typology of "potential RRI benefits" is proposed, including four main "families" of benefits: democratic benefits; economic benefits; societal benefits; benefits for science. In the case of the PROSO project (Bauer, Bogner, & Fuchs, 2016), also focused on Public Engagement, a key distinction is made between "functional positions", including motivations viewing public engagement as a means to pursue a set of objectives, and "normative positions", including motivations viewing it as a «*normative goal in itself*».

Beyond these specific typologies, the proposed drivers largely differ to each other in both **scope** and **level of abstraction**. In some cases, drivers are narrow in scope and concrete (for example, accessing new funds), while in other cases they are broad in scope and abstract (for example, aligning science with society).

We are not interested here in developing a new typology of RRI drivers (motivations, benefits, good reasons, etc.). Rather, we are more interested in identifying the most recurrent "**interpretive frames**" of RRI in which these drivers are grounded.

An "interpretive frame" (Entman, 1993; Porto, 2002) can be defined as a cognitive frame for the interpretation of events and issues. They are prevalently aimed at producing one or more of the following effects:

- Defining and describing the issue (problem, opportunity, event, etc.)
- Attributing responsibility(ies) for and cause(s) of the issue
- Assessing the significance of the issue ("what is at stake")
- Providing arguments about the consequences, and
- Providing recommendations about how to prevent or treat such consequences.

The use of the frame analysis appears to be particularly appropriate in the case of RRI, since such an approach is widely applied for the study of political discourse; and actually, to a large extent, RRI is a political issue which activates a political discourse.

To conduct the analysis, a selection of documents produced in the framework of EC-funded projects has been conducted, including projects dealing only with RRI in general or those pertaining to specific components of RRI (public engagement, education, etc.). At the end of the process, documents referring to 8 projects were selected, namely:

- RRI Tools (Smallman, Lomme & Faullimmel, 2015)
- Engage2020 (Hennen & Pfersdorf, 2014)
- MORRI (Wuketich, Lang, Grießler & Polt, 2016)
- PROSO (Bauer, Bogner & Fuchs, 2016)
- KARIM (Hin, 2014)
- ENGAGE (Okada & Bayram-Jacobs, 2016)
- FoTTRIS (Karner, Bajmocy, Deblonde, Balázs, Laes, Pataki, Racovita, Thaler, Snick & Wicher, 2016)
- Res-AGorA (Kuhlmann, Edler, Ordóñez-Matamoros, Randles, Walhout, Gough & Lindner, 2016).

The analysis led to the identification of **seven major interpretive frames**, which are described below, namely:

- The self-protection frame
- The quality frame
- The opportunity frame
- The democracy frame
- The management-of-future frame
- The alignment frame
- The science communication frame.

### B1. The Self-Protection Frame

The first frame can be referred to as "**self-protection frame**". It assumes the point of view of R&I organisations (including industries) and scientists and highlights the need for them to protect themselves from the risks they are exposed to because of the changing relations between science and society.

RRI is therefore acknowledged as necessary for researchers and R&I organisations in order to prevent controversies (RRI Tools), to increase their trust and reputation (MORRI) in a context of decreasing public trust in science, to avoid litigation costs and conflicts (MORRI), to gain public appreciation for science in general (Engage2020), to increase the legitimacy of science (Engage2020) and their own legitimacy as well (RRI Tools), to prevent potential business loss (MORRI), to get early information about public concerns and resistances towards a new discovery, research path or technology (PROSO), to properly manage the greater public and political scrutiny of research activities and outputs (Res-AGoRA) and to show the benefits of science despite it being ever more politically and economically driven (ENGAGE)

What is at stake is the risk that science loses more authority, social recognition and social status, leading, for example, to diminished R&I funding or diminished influence in the political arena.

### B2. The Quality Frame

The second frame, which can be referred to as the "**quality frame**", establishes a relationship between RRI and the quality of research and innovation, not only in substantive terms but also in terms of efficiency, effectiveness and impacts.

Thus, RRI appears to be necessary to improve the quality of innovation (RRI Tools, MORRI), to make R&I processes more effective (Engage2020), to limit costs (MORRI), to improve cost-effective outcomes and procedures (MORRI), or to favour the diversity of researchers, teams and research organisations, which, in turn, is a factor that has a positive impact on R&I quality (MORRI).

This frame is obviously based on the assumption – to be demonstrated – that RRI influences the quality of science and innovation. This assumption is prevalently motivated by the argument that RRI broadens the very concept of quality by adding new quality criteria (such as the "social robustness" of research) directly related to science-in-society issues.

### B3. The Opportunity Frame

The third frame is the **opportunity frame**. Under this frame, RRI is depicted as a source of opportunities for researchers, research organisations and industries, which otherwise would be precluded to them.

Among these opportunities, the documents mention, e.g., accessing new funds (RRI Tools, MORRI), accessing new networks (RRI Tools, MORRI), improving one's own scientific career (RRI Tools) or acquiring new skills (MORRI). RRI, as interpreted under this frame, is, therefore, proposed as an ally of scientists and research organisations in helping them gain competitiveness in an increasingly complex R&I market.

The assumption at the basis of this frame is that RRI is actually able to provide researchers and R&I institutions with competitive advantages. Another assumption is that researchers and research institutions are actually interested in getting these competitive advantages, even when it would require, e.g., changes in their scientific interests or modifications in their career trajectories.

### B4. The Democracy Frame

The fourth frame – the **democracy frame** – is recurrent in the RRI narrative. The core of this frame is the idea that citizens and stakeholders have the right to contribute both to the R&I decision making process and to the research and innovation process.

In this sense, RRI is understood as a powerful approach to put this into effect, in that it supports participation (RRI Tools, MORRI), makes citizens more informed and engaged (RRI Tools), defines more advanced standards for involving the public (RRI Tools), favours the empowerment of civil society (Engage2020, MORRI), strengthens the democratic system (MORRI), introduces new transparent institutional practices (MORRI), modifies the research system making it more democratic and inclusive (FoTTRISS) and increases the accountability of R&I (Engage2020).

What is at stake with this frame is the right and capacity of people to participate, participation being viewed as a normative goal in itself (PROSO) and a necessary instrument to develop more democratic governance settings for science. The prevalent theoretical dimension of RRI recalled is “inclusiveness”, while public engagement is the most mentioned RRI component.

Some assumptions can be found at the basis of this frame, including, e.g.:

- The interest and willingness of citizens to get involved in science and technology
- The capacity of RRI to ensure a democratic process within R&I and to represent the many societal groups and interests concerned
- The possibility for laypeople and experts to interact on a parity basis in scientific matters.

B5. THE MANAGEMENT-OF-FUTURE FRAME

This frame describes RRI as an approach for the “**management of our future**” by anticipating the future outputs of research and innovation and their intended and unintended consequences. RRI in itself can, therefore, be defined as an “anticipatory process” or an approach favouring an “anticipatory governance” of science and technology.

This frame implies having control over the potentially risky impacts R&I may have on society and citizens (FoTTRIS, Res-AGorA, ENGAGE, KARIM) and the maximisation of the future benefits of science and technology (ENGAGE, KARIM). This does not simply mean “scanning the future”, but learning to manage the future by modifying the present, especially leveraging upon the engagement of citizens and stakeholders (PROSO) and improving the capacity of policy makers to assess R&I risks and benefits (MORRI).

This frame is based on some assumptions which are rarely made explicit, concerning, for example:

- The intrinsically risky nature of science and technology
- The limited capacity of scientists and research institutions as well as of policy makers to predict and manage the impacts of science and technology
- The inadequacy of the present governance arrangements to protect citizens from the risks produced by science and technology or to maximise their future benefits
- The capacity of RRI to promote improved assessment of R&I impacts.

B6. THE ALIGNMENT FRAME

This is probably the most widespread frame under which RRI is interpreted. The **alignment frame** focuses attention on science-society relations and especially on the lack of connections between them.

RRI is, therefore, interpreted as an approach bringing science closer to society (RRI Tools, FoTTRIS), enhancing the capacity of R&I to target societal needs, values and interests so as to increase its social robustness (Engage2020) and enhancing the relevance of research for the specific values and concerns of citizens, also allowing these values and concerns to actually emerge (PROSO). The alignment frame also incorporates the idea of RRI as a tool for introducing socio-ethical thinking in science and technology (ENGAGE) or for developing a new ethical basis for science as a whole (FoTTRIS). This implies a reflective attitude for assessing whether and to what extent a research process or output is socially desirable, ethically acceptable and environmentally sustainable (FoTTRIS). Alignment requires more intense negotiations between science institutions and societal actors, leading also to the redefinition of roles and responsibilities in R&I (Res-AGorA).

This frame mainly relies upon the dimension of "responsiveness", understood as the capacity of science and technology to proactively provide adequate responses to present and future risks (thus, responsiveness is connected to the dimension of "anticipation") and to ethical and societal demands. Moreover, the alignment frame is strongly intertwined with the democracy frame, since public engagement is interpreted as the main enabling tool for science-society alignment.

Moreover, this frame is based on some implicit assumptions, including:

- The lack of alignment between science and society
- The relative "blindness" of scientists and research organisations to societal needs, expectations, interests and values
- The possibility to actually identify widely shared societal needs, ethical values or expectations to be used as reference points for science and innovation, notwithstanding the increasing fragmentation of contemporary societies.

B7. THE SCIENCE COMMUNICATION FRAME

The seventh frame can be referred to as the **science communication frame**. At the core of it there is the view that RRI, and especially Public Engagement, is a more advanced form of communicating science.

Substantially, RRI is interpreted as framework for going beyond the Public Understanding of Science approach, based on the largely questionable assumption that transferring scientific knowledge to the public increases the public's appreciation of science (the so-called "Deficit Model"). In fact, this frame is based on two assumptions, both countering the Deficit Model. The first assumption is that, to be effective, science communication requires equitable relations between experts and other stakeholders (especially laypeople). The second is that people's appreciation of science can only be modified if people are given the chance to really influence the trajectories of R&I.

In this sense, RRI is viewed as extremely helpful in enhancing science communication since it tends to establish new forms of scientific citizenship (Engage2020), improves science education (RRI Tools, Engage2020, MORRI), raises people's awareness about science-related issues (MORRI), contributes to the expansion of a highly competent labour force (MORRI), promotes communication among all stakeholders (Engage2020, MORRI), improves the communication processes among researchers and research teams (ENGAGE) and reinforces the capacity of the media to communicate science (ENGAGE).

This frame can be partially viewed as secondary to the democratic frame and the alignment frame, since better communication between science and society is a sort of pre-requirement for, and a by-product, of democratic participation and better alignment of science with society. However, it should be kept in mind that, in practical terms, many scientists and research organisations just see RRI as a more advanced form of science communication and public understanding of science.

## B8. A Summary Table

A summary table of the main interpretive frames of RRI drivers is presented below.

| FRAME | CORE IDEA | MAIN ASSUMPTION(S) |
|---|---|---|
| **The self-protection frame** | RRI may help researchers and research institutions protect themselves from the risks deriving from changing science-society relations (decreasing public trust, decreasing authority of science, risks of conflicts, costs of litigation, etc.) | - R&I is losing authority, social recognition and social status |
| **The quality frame** | RRI may help researchers and research institutions improve the quality of research and innovation process | - RRI is concerned with the quality of science and innovation, facilitating high quality research and/or introducing new research quality criteria |
| **The opportunity frame** | RRI may help researchers and research institutions seize opportunities otherwise precluded to them in terms of funding, networks, careers and skills | - Researchers and research institutions get real competitive advantages from RRI<br>- Researchers and research institutions are interested in getting these advantages |
| **The democracy frame** | RRI may help citizens and stakeholders contribute to R&I decision making process and in the research and innovation process | - Citizens and stakeholders have the right to contribute<br>- Citizens and stakeholders are interested in getting involved in science and technology<br>- RRI is able to ensure a democratic process within R&I and to represent the many societal groups and interests concerned<br>- Laypeople and experts are able to interact on a parity basis in scientific matters |
| **The management-of-future frame** | RRI may help anticipate R&I risks and benefits, so as to prevent the former and maximise the latter | - Science and technology are intrinsically risky<br>- Scientists, research institutions and policy makers alone have a limited capacity to predict and manage the impacts of R&I<br>- Present research governance arrangements are inadequate to predict and manage the impacts of R&I |

| FRAME | CORE IDEA | MAIN ASSUMPTION(S) |
|---|---|---|
| | | - RRI can improve assessment of R&I impacts |
| **The alignment frame** | RRI may help align science and innovation with societal needs, values, interests and expectations. | - Science is not aligned with society<br>- Scientists and research organisations are relatively "blinded" toward society<br>- It is possible to identify largely shared societal needs, values, interests and expectations |
| **The communication frame** | RRI may help communicate science to the public and enhance communication among researchers and research teams | - Science communication requires equitable relations among stakeholders<br>- Science communication requires that laypeople be given the opportunity to influence the process (communication cannot be completely separated from action) |

### *2.2. RRI in academic journals: barriers and drivers*

This section of the report, drafted by Nina Kahma and Susanna Vase (University of Helsinki), analyses the reception and the adoption of Responsible Research and Innovation (RRI) in two academic databases (ScienceDirect and Scopus). The academic publications (articles, reviews and conference proceedings) offer a specific window to how RRI is received by individual researchers coming from different disciplines and the way in which RRI is perceived by the users responsible for applying the concept into practice.

The section focuses on how RRI and its drivers and barriers are seen and developed in academic journal articles, and further, how the concept is disseminated across academic disciplines and researchers located around European countries as well as outside Europe.

#### A. RRI IN THE ACADEMIC PUBLICATIONS

The theme of RRI is a recent theme in academic discussion, which is reflected in low number of peer reviewed articles on that topic. Moreover, only few articles are focused on RRI as most of the articles focus on other phenomena mentioning the concept of RRI, but not developing it further. As a result, the attitude towards RRI is in most articles very positive or unproblematic at the least. The lack of criticism towards RRI in the articles may relate to the concept being poorly known, but also the way in which it is understood and the standpoint the writers have on RRI.

We will first take a look on the article data and how the concept of RRI is adopted in the academic articles by looking at the year of publication as well as the background of the authors (country, discipline). Thereafter, we will move to the analysis of the content of the articles.

In the analysis, we will focus on the following themes:

- The barriers, hindrances and obstacles to the dissemination of RRI
- The drivers, that are considered to promote RRI.

On the basis of the analysis on the academic article corpus we aim to answer the factual question of why RRI has not yet become as diffused and institutionally embedded as it was initially expected to be (especially in STEM disciplines). In the next paragraph (2.3., point b.), we then sum up the recommendations on what can be done to promote RRI further.

### B. The Article Data

The preliminary data collection was based on the searches being carried out on the basis of titles, abstracts and possible article keywords in ScienceDirect and Scopus databases. Using RRI as a search word produced multiple articles from traffic research and medicine, both disciplines, where the abbreviation RRI has altogether different meaning than "Responsible Research and Innovation." Therefore, we ended up using the term "Responsible Research and Innovation" in combination with the other search words. Other search words included were "drivers", "barriers", "trends" and "changes".

RRI was first mentioned in the article in the databases in 2009, but thereafter the number of articles either focusing on the topic or mentioning it has risen steadily. For the publication search in the two databases the search words "Responsible Research and Innovation" produced altogether 130 articles. The number includes the articles found in searches for "Responsible Research and Innovation" adding different search combinations to the term.

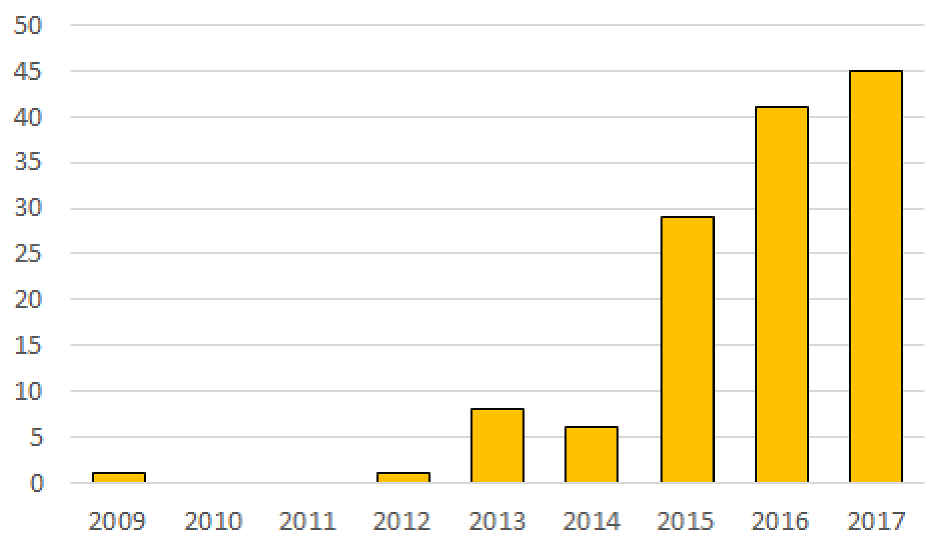



**Figure 1. The number of articles on RRI in ScienceDirect and Scopus journals by the year of publication**[4]

[4] Search on ScienceDirect database produced 85 publications that were published between the years 2009 and 2018 (2009: 1 original research article; 2013: 6 original research articles and 1 other article; 2014; 3 original research articles and 2 other articles; 2015: 14 original research articles, 1 other article (editorial) and 3 encyclopedias; 2016: 13 original research articles, 2 book chapters, 2 review articles and 4 other articles; 2017: 22 original research articles, 1 review article and 5 other articles and 2018: 1 original research article). 60 of all the publications were original re-

The term RRI can be seen as relatively recent in its origin. It has been claimed to appear first in a technology assessment workshop on nanotechnology in the year of 2007 in Netherlands. (Kaldewey & Flink, 2017; Robinson, 2009; De Saille, 2015). RRI was further pushed forward through a conference of the European Commission in April 2012, entitled “Science in Dialogue—Towards a European Model for Responsible Research and Innovation” (RRI Conference Report, 2012). Particularly the Commission’s Directorate General Research and Innovation emphasized the need for bringing society and science closer. A year later RRI was taken abroad and named as one of the cross-cutting issues in Horizon 2020 programme. (Kaldewey & Flink, 2017.) The substantial increase in the number of articles covering RRI in 2015 and subsequent years can be explained by the above mentioned events and the release of the Rome Declaration in November 2014. The rise in the number of articles either developing RRI or considering scientific results from the viewpoint of RRI may simply be a result of RRI being domesticated in the academic research and on a practical level the uptake may relate to new (Horizon, 2020) projects focusing on RRI, but also the establishment of new bodies promoting RRI.

Few articles are focused on RRI and instead in most of the articles the focus is on other phenomena, which means the use of the concept of RRI is unproblematizing, although the need for more RRI is widely recognized throughout the article corpus.

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search articles and the remaining 21 publications consisted of 3 review articles, 2 book chapters, 3 encyclopedias and 13 other articles, and 4 book chapters with no access to content. Scopus search produced altogether 48 publications, that were published between the years 2012 and 2017 (2012: 1 article ; 2013 : 1 article; 2014: 1 article; 2015: 11 articles; 2016: 18 articles; and 2017: 16 articles). The majority, 37, of these articles were research articles, 7 conference papers, 2 books or book chapters and 2 review articles. The five publications with no full text available on the net, included three articles, one book and one book chapter. However, we were able to read the abstracts of these publications. After removing three duplicate articles, the final article corpus included 130 articles.

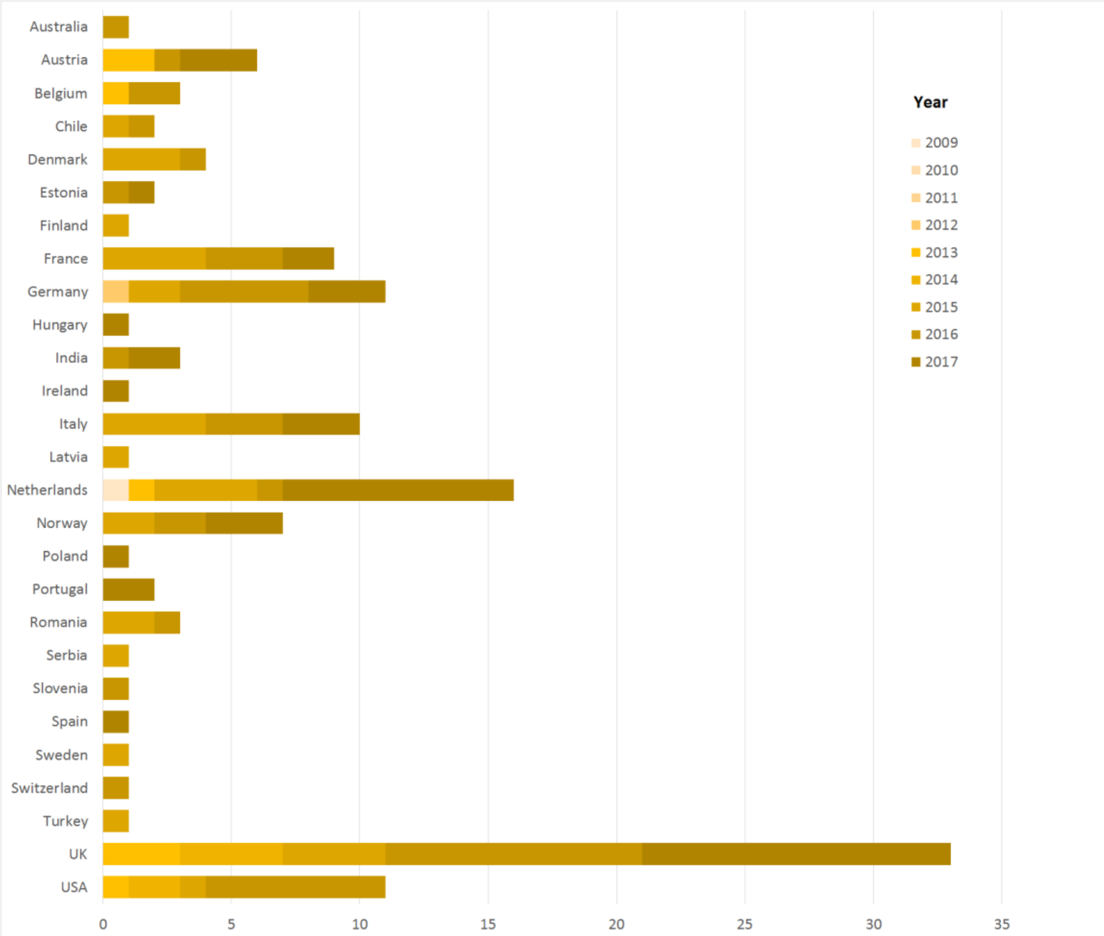



**Figure 2. The number of RRI articles by the country of the first author and the year of publication**

Figure 2. shows the number of published RRI articles by the country of the first author. Researchers with an affiliation in the UK (31 articles) contributed to the theme of RRI the most. Also authors coming from the Netherlands (16 articles), the United States (11 articles), and Italy (10 articles) had published a high number of articles on RRI. In other countries the number of RRI articles was lower.

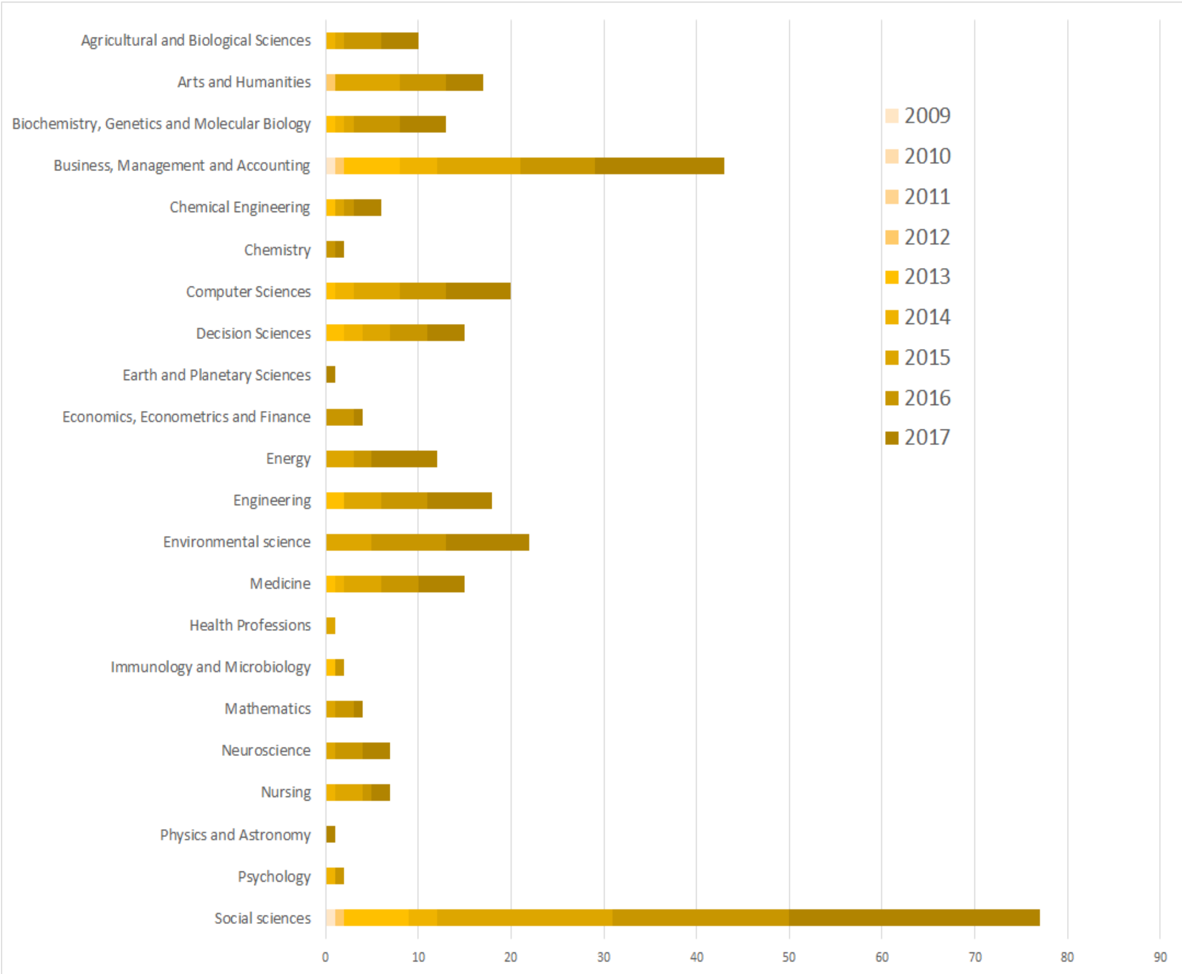


**Figure 3. RRI articles by the discipline and the year of publication**

In our data, most of the articles are multidisciplinary, and therefore the number of articles within disciplines can exceed the number of articles in the data. In Figure 3. we have presented the articles by scientific discipline and the year of publication. RRI received early attention from the researchers in the field of Business management and accounting (Robinson, 2009) followed by Social Sciences and Arts and humanities (Mali et al., 2012 ).

The figure shows, that the number of articles linked to social sciences is large (77 articles). RRI has also been covered by scholars in Business, management and accounting (43 articles) and computer sciences (20 articles). In recent years, RRI has also been mentioned in the articles in different fields such as Arts and humanities (17), Decision sciences (15), Engineering (18), and Medicine (15 articles). In other fields of study, the coverage has been modest, ranging from one to circa ten articles during the couple of years.

The low number of articles in the publication covering the so-called STEM-disciplines (science, technology, engineering and mathematics) may relate to the concept of RRI originating in social sciences and EU governance.

## C. Barriers and Obstacles to RRI

### C1. Conceptual Ambiguity

Conceptual ambiguity is an important hindrance to the adoption of RRI that is recognized in the articles. For example, Flink and Kaldewey (2017) characterize RRI as inclusive in regards to different strands of theorizing interactions of science and society. In the articles, the most frequent remark on RRI relates to the unclear definition of the term. Some of the conceptual confusion may result from the concept of RRI being a rather new concept that is used like a buzzword with a strong normative stance more so than a concept with an exact meaning (cf. Cairns & Krzywonszynska, 2016). Lack of contextualization to other academic discourses scrutinizing the change of science adds to the ambiguity, which may be a result of intentional ignorance or lacking awareness of alternative concepts (Flink & Kaldewey, 2017). The ambiguity of the concept of RRI can also be seen in the number of articles mentioning RRI as a dogmatic and fashionable concept that is used for re-branding and only acknowledged when the validity of results is reflected (cf. Cairns & Krzywonszynska, 2016).

It is clearly brought forward, that it is not yet clear, how RRI approach works in real life and with particular cases (see Ikonen et al., 2015). Unclarity is then translated to difficulties to operationalize and apply RRI (Burget et al., 2017; Lubberink et al., 2017; McLeod et al., 2017; Stahl et al., 2014; Garden et al., 2016; Owen et al., 2012; Blok & Lemmens, 2015).

Even where RRI is seen as an integral part of a programme or institutional strategy, it is not always clear, what is the RRI that is being applied. For instance, in an account on SmartSociety programmes, the principles of RRI are seen as an integral part of the programme. However, the lack of knowledge considering both RRI and its effects is nominated as a major impedance in the agenda (Hartswood & Jirotka, 2016). Therefore, Hartswood & Jirotka (2016) suggest, that the obvious challenge for these programmes is better articulation of the outcomes and social benefits that follow RRI.

### C2. Lack of Ownership Related to Top-Down Governance

It is widely acknowledged across the articles, that EU promotes the concept of RRI as a key governance framework and that EU has made considerable investments in its development through research and technology funding under its vast research programmes. In an article by Ravesteijn and colleagues (2015), RRI is seen as a natural result of innovation actions in a situation in which technologies and innovations provoke serious public concern.

As the focus of RRI lays currently on the project and policy level of publicly funded research instead of industry contexts (see Stahl & Yaghmaei, 2016), lack of ownership is a central problem to its appropriation and development. Tim Flink & David Kaldewey (2017) state that RRI's rhetoric is grounded on a bottom-up approach although it is organized through a top-down approach by the European Commission. They subsequently state that it is unclear whether RRI discourse is relevant outside of the assigned, formal programs especially when it comes to the actual research and identity work of organizations (see also Burget et al., 2017). At the present moment they see RRI more as a bureaucratic frame conducted by policy makers and policy scholars and not by the scientists themselves. However, it is possible that RRI starts to build up its own trajectories and becomes more than one of the concepts related to responsibility (Flink & Kaldewey, 2017).

Governance and research models on a global and a national level can be seen as major a macro level hindrance to RRI posing limitations to what can be considered in the field of research (see Rodriguez, 2017).

Lack of ownership is reflected in the viewpoints on individual disciplines as well as individual researchers. Stahl et al. (2014) are aware of the fact that there may be various actors that see RRI as a threat to the autonomy and academic freedom of research. In their case study focusing on healthcare robotics, Stahl and Coeckelbergh (2016) see, that the underdevelopment of RRI results from that scholars in healthcare robotics do not believe that RRI raises interesting issues in terms of research process and methodology. Moreover, the scholars believe that existing governance mechanisms are insufficient to address such issues where they arise. Stahl and Coeckelbergh (2016) expand their interpretation to cover also other new emerging and poorly understood branches of research, such as synthetic biology. The root cause for the lack of ownership seems to link to the poor ability of governmental institutions to understand the substance of individual disciplines. McLeod et al. (2017) point out that RRI is one of the agendas and structures that are not in scientists' control. Therefore, the lack of ownership may be reflected in the non-adoption of RRI.

C3. LACK OF GUIDELINES FOR IMPLEMENTATION OF RRI

Researchers, policy makers, users and scholars alike were expected to manage and maintain a continuous multi-stakeholder conversation and to implement the different elements of RRI into practice (de Jong et al., 2016; Garden et al., 2016). However, in some accounts on RRI, it was recognized that implementation of RRI was not a simple task. Further, shortcomings in the administrative procedures can manifest as a lack of concrete RRI guidelines for specific areas of research and disciplines. RRI can be seen as distant and inoperative from the viewpoint of rapidly developing disciplines (Rodríguez, 2017).

The relationship between knowledge about RRI and its implementation is seen to relate to complex power relations that can be facilitated through specific methods such as organizing meaningful multi-stakeholder dialogue and active facilitation of the discussion. «*The number of methods of RRI has increased rapidly over the past decades. Some of these methods are designed to facilitate dialogue between citizens, such as consensus conferences, citizen panels and public advisory boards*» (Betten et al., 2013). Yet, few articles address specific methods for implementation of RRI.

McLeod et al. (2017) see the lack of clear guidelines on the operationalization of RRI as a pivotal restraint on applying RRI. They notice, that RRI has been operationalized in a varied of ways depending on governance and geographical contexts (McLeod et al., 2017; de Saille, 2015; Ribeiro et al., 2016; Rip 2014). In the area of engineering, for instance, weak or lacking ethical guidelines tend to lead to individual agents acting on their own and shifting moral responsibility in techno-scientific innovation to others. Also Garden et al. (2016) call for context-specific guidelines. They state that despite the excellent guidance materials and toolkits (for example http://www.rri-tools.eu) that can help in the implementation of RRI, there remain challenges on how to apply the RRI framework to different emerging technologies. They name neurotechnologies as an example of a discipline, where integrating RRI with research and technology development while advancing new kind of innovation is difficult.

The overall uncertainty both in the political and economic realm in Europe has, in recent years posed challenges for implementing RRI. According to Mali et al. (2012) *a situation of heightened uncertainty* is a core feature of any attempt to govern new and emerging science and technology.

### C4. Inadequate Institutional Structures

On a general level, involvement of multiple stakeholders in RRI was recognized as an important challenge. The precarious situation both politically and economically may result in lack of commitment of stakeholders such as policymakers and experts in the RRI process, who are left to questioning the legitimacy of policies and institutions. The barriers that were introduced in the articles were linked to specific stakeholders or societal realms. Some barriers were found also between and within disciplines, between policy actors, and within industries and corporations.

Criticism towards implementation of RRI by institutions concerned a) governmental institutions, b) funding bodies, c) ethical boards, d) academic institutions, e) Industry and corporations, and f) inoperable or non-existent networks between the bodies.

**Governmental institutions**

A central barrier for the dissemination of RRI are the relationship between governmental institution promoting RRI and scientific disciplines. Laird & Wynberg (2016) have in their study on new, emerging, and poorly understood activities such as synthetic biology found, that the integration of RRI into policies has not been a simple task. Based on their findings, they enumerate administrative deficiencies such as limits to government capacity, jurisdictional confusion, shortages in funds, and an absence of strategic approaches (Laird & Wynberg, 2016) as deficiencies of RRI policy. Hence, as Chaturvedi et al. (2016) point out, the poor integration of RRI and science is also result from the complexity of the science and the unpredictability of its effects, and the different speeds and styles of policy-making and research and development (R&D). The non-synchronization of these realms is an important stumbling block to the integration of RRI into new, emerging, or poorly understood fields of study.

On a societal level, weak national RRI policies are believed to have led to the emergence of radical anti-movements against the proponents of science and technology. According to Coenen and Grunwald (2017), France is an example of weak RRI proponent, which can be seen in the emergence of radical anti-movements against quantum technology. Correspondingly, strong national innovation policies are considered an important driver of RRI concurrently impeding public concern from escalating to social movements (see Ravesteijn et al., 2015).

**Funding bodies**

Khan et al. (2016) suggest that in the area of food and health, a gap remains between the research funders and RRI on how innovation is comprehended. In order for RRI to progress cognitive frames need to change. According to Khan et al. (2016) funders' framings on innovation seem currently to be influenced more by the linkage of economic growth and innovation than RRI. They call for a shift on how innovation is perceived in funding decisions to provide more space for research proposals stressing RRI.

The coordination between funding bodies on an international and national level are also seen as a problem. There are differences between EU level funding and national funding schemes in their relation to RRI, although on both levels of research funding, considerable emphasis is placed on consultation and engagement (Hartswood & Jirotka, 2016).

**Ethical boards**

Ethical Advisory Boards all over Europe as well as the professional advice issued by them, are faced with new kind of pressure by multiple stakeholder groups such as decision-makers interested in future advances in science and technology, and academic researchers. In spite of the skeptical outstand, the EABs are expected to secure the good governance of science and technology and of a new strategy of Responsible Research and Innovation. (Mali et al., 2012; Borras, 2003; IRGC, 2006.)

**Academic institutions**

Researchers' and scientists' lack of knowledge about RRI as a reason for not adapting it comes across in many of the articles in our data. In some accounts, adaptation is thought to prerequisite mere awareness of RRI. Bernd Carsten Stahl et al. (2014) also state that researchers' and scientists' unawareness on the nature of the process and how their daily work practices will be affected by it, is one of the barriers on the way towards a successful practical framework of RRI.

In the realm of academic research, niche barriers are seen as structures that hinder discussion and dissemination of knowledge about RRI (Metze et al., 2017). The barriers may also relate to evaluation criteria and structure of study within university. Virgine Pirard (2015) state that scientists need to increasingly define and justify the interest of research in a wider perspective and in relation to its broader impacts. Scientific studies may not, however, prepare researchers enough for the kind of responsibility required.

Putting RRI into practice is sometimes seen as specific task for **certain new disciplines** (such as synthetic biology and nanotechnology), whereas policy makers and regulating bodies set the frame for these implementation of RRI in these disciplines (see Laird & Wynberg, 2016, Chaturvedi et al., 2016). Challenges were thought to concern the research system as a whole, even if they were often approached from a viewpoint of singular disciplines; «*As the main challenge in realizing RRI in the field of synthetic biology and global health, we would point at the difficulty in realizing a transition towards a more responsive research system; a research system that is demand-driven, takes societal responsibility as an important value, and considers the interaction with societal stakeholders and their experiental knowledge to enrich the research process*» (Betten et al., 2013).

Problems with putting RRI into practice may also occur when working in **multidisciplinary teams and performing cross-disciplinary work** (see deGrandis & Efstathiou, 2016; Viseu, 2015, Davies 2011). John Gardner (2017) states that individual researchers may have differing understandings and values based on their own disciplines. Working together may cause tension even if the team members share the same goals. According to Gardner, tensions are not necessarily a negative matter as they can foster a more reflexive and evaluative discussion which is indeed an essential component of RRI (see also Nuffield Council on Bioethics, 2013). In concordance, McLeod, Nerlich and Mohr (2017) see, that the unevenness in the power relations between scientist coming from different disciplines and the government setting up the agenda can be seen both as a barrier, but also as an opportunity: «*Social scientists and anthropologists working with scientists in the same space can facilitate conversations and interactions that bring tensions into the open, thus laying the groundwork for a better management of scientific, economic and RRI expectation*s» (McLeod et al., 2017).

The poor understanding of individual disciplines is linked to lack of funding, jurisdictional confusion and absence of strategic approaches what comes to RRI (Laird et al., 2016; Chaturvedi et al., 2016).

**Industry and corporations**

On one hand, as Chatfield, Borsella et al. (2017) point out, one of the most important barriers for RRI is the lack of ambition in its dissemination, by which they mean the promotion of RRI focusing on publicly funded research and omitting a substantial proportion of the company-based innovation activities.

On the other hand, the disengagement of the stakeholders within the industry has to do with their reluctance and the conservative attitudes prevalent in the industry. An empirical study on the attitudes of industry professionals (Kimmel et al., 2016) revealed that adopting RRI in the industry was a matter of personal characteristics of individuals, their ideological affiliations and sense of social obligation. In other words, RRI was not embedded in the corporate culture nor seen as natural part of the occupational role of an engineer.

An example from the United States on the reception of RRI shows, that institutional incentives to adopt RRI for engineers working in the industry were weak, as they were not experienced as a part of the institutions long-term objectives, but rather as an additional norm (Kimmel et al., 2016).

**Inoperable or non-existing networks**

**Setting goals in multidisciplinary networks.** Stahl & Coeckelbergh (2016) acknowledge that RRI is likely to have many challenges most of which will not be straightforward or simple to solve as different as well as contradictory interests will be involved. They discuss an example of cases where industry wants to sell robots but researchers target for other goals, such as publishing their findings.

The lack of networks to disseminate RRI can be seen as an important barrier in many fields of science. According to Calvert and Frow (2013) responsibility in relation to innovation should be shared among the whole network of different people and organisations that are involved in the research process. According to them, patenting systems, for example, can raise questions about the ownership, distribution and eventual public good of a technology (Calvert & Frow, 2013).

Walter Leal Filho et al. (2017) state that research is still often conducted in silos when it comes to departments within the academia. The same can also be argued when looking at the scientific community as an actor in a vast community of different stakeholders. It is possible that career evaluation criteria are not giving enough encouragement for inter- and trans-disciplinary collaboration, especially in the case of young researchers starting their career. (Ibid.)

### C5. Lack of Proof of the Benefits of RRI

The most important obstacles for engagement in RRI can be found in the stakeholders not being able to see its benefits. RRI is often seen as an external element, a constraint or an additional norm imposed from the outside to science and innovation. As the immediate value for the industry seems absent, the realization of RRI seems secondary (Stahl & Yaghmaei, 2016).

At the core of not seeing the benefits of applying RRI, are financial issues, such as budget constraints and unpredictable costs (Chatfield, Borsella et al., 2017) framing business and industry. In the articles, the scholars widely recognize the imperatives of a global, knowledge-based, capitalist economy (Rodríguez, 2017) which set boundaries for technological innovations and the dissemination of RRI. Lubberink et al. (2017) suggest that the concept of RRI is poorly adaptable in business, which roots in the concept having been developed by researchers and policy makers focused primarily on science and technological development. Therefore, the link between research, development and commercialization remains unproblematized, and issues such as admittance of social innovations and commercialization of innovations remain untouched. They (2017) also note, that the interests and values of the actors in business context may differ from those of the research in the academia.

There are also some arguments related to EU's research policy generally which might affect the attitudes also towards RRI as it is an EU-funded research agenda under the Horizon 2020 programme, even though Pollex & Lenschow (2016) are not speaking of RRI in particular. They state that the article (2016) showed that the evidence of degrowth agenda in the EU's research policy is limited even though there are some degrowth positions found in the policy documents. When it comes to green growth and S&T policy, they appeared to be co-dependent on the frame of GDP-growth, and sustainable development was being used as a bridging concept. Even though there are political groups, societal actors and agendas that are clearly stating a degrowth position (for instance the Beyond GDP & Circular Economy Agenda), GDP-focused growth agendas seemed to dominate in the Horizon 2020-programme. McLeod et al. (2017) also argue that RRI has been chosen as part of the growth agenda.

## D. Drivers

Wide acknowledgement on the benefits of RRI comes across the article corpus although the ideas of the benefits remain abstract and general (see, for instance Stahl & Yaghmaei 2016). We analyse the drivers for RRI by identifying Political (and legal), Economic, Social, Technological, and Environmental factors (so called PESTE model that is widely applied in futures studies, see e.g. Mendonça et al., 2004). Moreover, we will take into account a sixth category of drivers, namely values. The added category consists of general permeable societal concepts such as considerations of responsibility and ethics, public reflection, anticipatory politics and deliberative democracy.

### D1. Political Drivers

Innovation policies are a major driver behind RRI. RRI is seen as a part of strong innovation policies, which is relevant in overcoming the economic crisis and "ensuring smart, sustainable and inclusive growth" (Burget et al., 2017; Forsberg et al., 2015). In the data, EU as an actor carrying out conceptual work that promotes the awareness of RRI well as its strong input on the concept being rooted in EU policies is widely recognized as a key driver for RRI. Evidently, RRI is seen as an important aspect of Horizon 2020 and its different funding programmes that can set new norms for research and commit the whole of research community in RRI.

Strategic RRI programmes have also been introduced in specific local contexts. In an example on a responsible port innovation case, described in the article by Ravesteijn et al. (2015), a strategy for research and innovation in port development considering and reconciling a range of stakeholder values related to topics such as employment, safety, economic growth, participation and livability to natural values. The parties in constructing the strategy included governmental bodies, business and development actors, all contributing to suggestions for improvement as they continued the devilment of the port. By applying the framework of RRI, Ravesteijn et al. (2015) formulated a methodological and procedural plan on how successful application of RRI can be applied.

Another example of successful political action and RRI programmes in the area of nuclear technologies is presented in the article by Turcanu and colleagues (2016). They point out that RRI programmes as such have created an enriching dynamics between relevant organizations and stimulated collective learning and transdisciplinary. In the area of nuclear technologies, there are international radioactive waste management networks (e.g., OECD-NEA, IAEA).

D2. Economic Drivers

European Union has articulated that the main goal of RRI is to «*ensure that research and innovative ideas can be turned into products and services that create jobs and prosperity, as well as help preserve the environment and meet the societal needs of Europe and the world*» (Zwart et al., 2017; Von Schomberg, 2013; Stahl & Yaghmaei, 2016; Rome Declaration, 2014). In the article corpus, **there is a general agreement on that RRI leads increase in economic growth and employment**. As stated by Coenen and Grunwald (2017) the existence of this kind of social impacts can be used to justify the implementation of RRI approaches. Moreover, RRI being an essential part of innovation policies, that are perceived to ensure smart, sustainable and inclusive growth (Burget et al., 2017; Forsberg et al., 2015) can further encourage its implementation.

The driver for the adoption of RRI in the companies could be the value seen in the ability to better understand customer needs and satisfaction (Chatfield, Iatridis et al., 2017b).

D3. Social Drivers

RRI is seen as a relevant concept, on which to build social development projects (and infrastructural projects in general) where the projects involve a variety of goals or values, have a broad set of objectives, and awake public debates and protests (see Ravensteijn et al., 2015). Social drivers manifest in the articles as 1) right kind of culture and environment to putting RRI into practice, but also 2) specific institutions for promoting RRI.

**Culture as social driver for RRI**

Chatfield, Borsella et al. (2017) emphasize the need for RRI values to be embedded within the culture of organizations. They call for conscious efforts for raising awareness and promoting reflection of ethical issues amongst all personnel working in ICT companies.

According to Stahl & Coeckehbergh (2016) the ability of RRI to take contradictory interests into account is one of its benefits. RRI is not suddenly going to make the conflicting or contradictory interests between the actors disappear but it can however help in addressing the problems and subsequently providing grounds for a more intelligent discussion of options and possible solutions.

**Academic institutions and companies as a social driver for RRI**

Universities are seen as the leading institution in conducting the actual RRI procedures (Flick, 2016). The means for promoting RRI are university studies and more specifically researcher training. Discussing topics of cutting edge research and their linkages to RRI among the students was presented as an important tool for raising awareness on RRI in and outside the universities.

The idea of transmitting proper knowledge base through education, as formulated in the Horizon 2020 Science with and for Society Work Programme, is evident in many articles. Teaching proper knowledge on RRI is thought to require both deep technical knowledge and broad disciplinary and social competence irrespective of the specific discipline of the researcher. For example, Burget et al (Burget et al., 2017; Felt, 2014; Levidow & Neubauer, 2014) see the ability of RRI to promote interactions and collaboration between social sciences and humanities and hard sciences and engineering as an important factor indicating its relevance.

Referring to experiences from Great Britain and elsewhere, Coenen and Grunwald (2017) suggest, that educational activities organized as part of large-scale science communication events and science fairs operate as an interesting example of applying RRI. Bringing up, that this kind of project workshops including discussions on RRI issues in quantum science and technology that were not open to the public and didn't include multiple stakeholders. However, they suggest, that "organized discussions and workshops with multiple stakeholders can be used to promote RRI in any field of technology" (Coenen & Grunwald, 2017). According to them, however, the general deliberation and dialogue processes in Germany have tended to focus on stakeholder and expert interactions instead of targeting citizens (Coenen & Grunwald, 2017; Fleischer et al., 2012).

Therefore, the main driving force behind RRI relates to the social and scientific networks that can be achieved. Filho et al. (2017) expect that universities may also address new issues by re-thinking evaluation criteria to better acknowledge inter- and transdisciplinary collaborations as well as foster issue and problem driven thinking in relation to research. Also non-formal education environments could be used for fostering RRI (cf. Gorghiu et al., 2015; Petrescu et al., 2015).

**Citizens as a driver of RRI**

Betten et al. (2013) suggest that research programmes should allow multi-stakeholder dialogue as «*Increasingly – at least in the Netherlands – research agendas are set and research programmes are formulated using multi-stakeholder processes, such as the ILA approach. For example, about half of the Dutch charity funds on disease-related health research have developed a research agenda that explicitly includes the perspectives of patients and sometimes citizens*» (Betten et al., 2013).

## D4. Technological Drivers

Technological drivers to facilitate the uptake of RRI presented in the articles mostly link to developing ICT and different kinds of electronic platforms. In an article *Automated Learning Support System to Provide Sustainable Cooperation between Adult Education Institutions and Enterprises* Andra Jakobsone & Sarma Cakula (2015) present a concept of Knowledge Sharing Platform (KSP) that can be used to federate RRI communities and to make RRI and its key dimensions more effective research and innovation policy support tools. The platform is targeted to be used particularly in adult education in companies. The platform can promote the development of companies through providing content- rich and demonstrative information on RRI for their employees.

The concept of New Product Development (NPD) also concerns end-user involvement and bringing stakeholders into development work. NPD is seen to enhance RRI but at the same time involving different stakeholders is seen as a pivotal challenge. In order to manage end-user involvement and stakeholder participation better, Baskin Yenicioglu and Ahmet Suerdem (2015) discuss the possibilities of an integrative online platform that would be based on the revolutionary principles of Web 2.0. The platform could offer a democratic space for negotiation, integration and coordination of the complex phases in innovation process. Social media are also seen to bring many opportunities in relation to participatory activities that can be organized within an electronic platform.

Another example of a technological platform promoting the relevance of RRI can be found within the area of Synthetic Biology. According to Le Feuvre and colleagues (2016), SYNBIOCHEM's has developed a RRI platform, that “seeks to initiate early multiway dialogue, provide expertise, guidance and training in the responsible governance of SynBio innovation, and foster public engagement and training for the research community, in order to anticipate, prepare for and if necessary mitigate the impacts of SynBio technology in the wider society, economy and environment” (Shapira, 2016; Le Feuvre et al., 2016).

The paradigm of co-creation between the stakeholders and the end-users seems to be at the core of the discussion of the technological drivers of RRI. Concepts, such as user-led innovation as well as human centered design (HCD), are raised as important drivers behind RRI, as these concepts are able to link together interests of multiple stakeholders (Khan et al., 2016). Multiple articles in the data suggest, that involvement of citizens in the development of singular disciplines might prove useful for RRI. For instance, adopting a specific RRI **Interactive Learning and Action (ILA) approach**, Betten and colleagues (2013) build a strategy that could involve stakeholders and end-users in a process, where experiential knowledge is articulated and knowledge co-created in an interplay between science and society. Integrating users early on in the development of technologies is recommended because this way different societal risks and ethical issues in relation to innovations can be reduced (see Chadwick, 2015). In the article *Design and development of a digital farmer field school. Experiences with a digital learning environment for cocoa production and certification in Sierra Leone*, Loes Witteveen et al. (2017) see that RRI perspective enhanced design accountability and encouraged to include co-creation. This led to searching new alternatives for bringing designers and the end users together in a situation where they weren’t located in a close proximity and the contact was hindered by an Ebola context (Ibid.). Baskin Yenicioglu & Ahmet Suerdem (2015) also state that involving stakeholders in New Product Development (NPD) process fosters RRI as well as sustainable development of products.

D5. ENVIRONMENTAL DRIVERS

From the viewpoint of sustainability, RRI is expected to be beneficial as it leads to ethically, environmentally and socially acceptable, sustainable and desirable innovations addressing societal needs (Owen et al., 2012; Von Schomberg, 2013) and emphasizes the importance of transparency and interactiveness within research and innovation projects (Lynch et al., 2017). The acknowledgment that grand social challenges such as climate change cannot be addressed without transdisciplinary approach involving stakeholders from various backgrounds also outside of academia can been seen as a major driver for RRI and its beneficiality in relation to sustainability (Cairns & Krzywoszynska, 2016; De Grandis & Efstathiou, 2016).

RRI can be seen as an instrument focusing on processes and profound changes in society, not just the outcomes and temporary band-aids on some existing structures. RRI is subsequently criticizing the linear model of technological innovation and sees innovation rather as a complex and collective phenomenon that requires a dynamic approach and deliberation on motivations and purposes of innovation. (Markusson et al., 2017; Flink & Kaldewey, 2017; Owen et al., 2012). In between economic, environmental and social drivers, are reflective institutions performing RRI. Effective innovation actions that could help the implementation of RRI in the business context were studied in a review article by Lubberink and colleagues (2017). On the basis of their review, they suggest that in business context reflexivity on the organisations' activities, commitments and assumptions is the key element in explaining the adoption of RRI. However, this reflexivity may not be universally held, but instead linked to new corporate practices in terms of innovation activities.

D6. VALUES AS DRIVERS FOR RRI

**Responsibility and ethics**

Ethical and moral reasons for implementing corporate social responsibility are recognized as important drivers for RRI. Values of individual employees may be reflected in the internal efforts in the companies involving the promotion of RRI in companies (Chatfield, Iatridis et al., 2017).

Social problems are rarely covered in the articles. However, responsibility is thought to be embedded in RRI. Chatfield, Iatridis and colleagues (2017b) state the drivers for the adoption of RRI in the companies could be reputational gains through RRI-based risk management procedures.

The positive outstand towards RRI is manifested as encouraging technological innovations instead of focusing on social concerns related to RRI them: «*in the context of RRI, for instance, ethics is primarily seen as a 'stimulus' for science and technology*» (Zwart et al., 2017; Von Schomberg, 2012). The principles of RRI are also considered as a basis for different ethical guidelines. In the case of ICT, Bernd Carsten Stahl et al. (2014) argue that RRI could be the next phase of computer ethics as well as the next step for fostering ethical framework and concerns within Information systems (IS) "a field of academic research and business practice". Much IS research tends to focus on the organizational aspects and use of ICT taking for granted the different socio-economic contexts of the IS usage. Through the perspective of RRI, IS researchers may better understand grand challenges that societies are facing and be encouraged to contribute to addressing them. They state that a profound reevaluation of the technologies, the way they are used and understood, is needed (Ibid.). Another example of RRI being used as a foundation for ethical guidance is observed in a report on novel neurotechnologies where the following RRI influenced principles were recognized by UK Nuffield Council on Bioethics: 1. Clearly identified need, 2. Securing safety and efficacy, 3. Generating robust evidence, 4. Continuous reflexive evaluation, 5. Coordinated interdisciplinary action, 6. Effective and proportionate oversight (Singh et al., 2017.).

**Public reflection**

In most of the articles RRI is seen as an answer to the need for some kind of a new ethos. Zwart and his colleagues (2017; 2015) claim, that RRI is not a specific method, but rather an attitude that sees the societal stakeholders not as consumers of knowledge, but as sources of information and inspiration.

An important value driving the diffusion of RRI is that it allows responsiveness and has capacity to change shape or direction in response to stakeholder and public values and changing circumstances (Stilgoe, Owen & Macnaghten, 2013; Khan et al. 2016). RRI can also provide a basis for more intelligent discussion of different options and possible solutions in the field of research (Stahl & Coeckelbergh, 2016).

**Deliberative democracy and anticipatory politics**

When it comes to the question of ownership and RRI, it is also possible that the potential impacts of S&T may be brought back to the scientists. The anticipatory nature of RRI may enable them to reflect on the purposes and impacts of their research as well as different uncertainties and dilemmas. They can further open up a broader deliberation with the public on different visions and this way influence the direction of the research and innovation process. (Rose, 2014.) As there is an increasing plurality of different legitimation strategies, scientists may also be able to switch discourses in which they work more easily and thus increase the freedom of scientists (Flink & Kaldewey, 2017).

Public engagement can be seen as essential to RRI, and according to Krishna Ravi Srinivas (2016) it should not be seen as something that distrusts, destabilizes or politicizes science, a concern that was addressed by Marcel Kuntz (2016) in his critique of RRI. Democratizing science rather relates to engaging with public and not assuming it to be irrational, taking the social and ethical aspects of science into account and making scientists more aware of societies' concerns and values.

## *2.3. Discussion*

This section has analysed two issues – RRI **barriers** and **drivers** –, using two different kinds of sources (documents drafted under EC-funded projects and scientific literature). Two different conclusions can be drawn out of the analysis of the two kinds of sources.

### A. CONCLUSIONS FROM THE ANALYSIS OF THE DOCUMENTS OF EC-FUNDED PROJECTS

The analysis of the documents produced under the EC-funded projects lead us to primarily notice the different logic underlying the documents while speaking of barriers and drivers.

Analysing the four groups of barriers (regarding the dimensions of culture, agency, action and identity, respectively), the element that emerges is the **complexity** of the RRI implementation process. RRI entails deep and broad changes of a different nature, and inevitably, in order to succeed, has to deal with deep and broad obstacles and challenges.

The logic underlying the seven major interpretive frames defining motivations and objectives for RRI is radically different. As a matter of fact, RRI is prevalently viewed as a policy framework which "**adds something**" to science and innovation (new quality criteria, new opportunities for researchers, new players to involve, broader timeframes, new values and ethical parameters to take into consideration) on the basis of a "**normative logic**". On the strength of this logic, RRI expands the scope and responsibility of science and scientists on the basis of the need to "be open to society", regardless of the actual feasibility conditions for RRI implementation.

It should also be said that these interpretive frames are indeed "frames" (i.e., narrative constructions serving to convince someone about something) developed by players who wish RRI to be developed. Therefore, they tend to conceal or overlook difficulties and risks as well as emphasize benefits and opportunities.

This logic is in tune with the conceptual models of RRI (see Section 1), defining it as a normative approach potentially embracing everything science and technology should be but are still not (e.g., responsible, anticipatory, sensitive, proactive, efficient, equal, accountable, open, and the like).

We found out again the distinction between "having-to-be" (intentions, norms, ethical issues, etc.) and "being" (reality, actual social processes, actions, sentiments, etc.). In theoretical terms, RRI belongs to the domain of "having-to-be", and seems to be driven by a linear logic. However, its application belongs to the domain of "being", and its implementation seems to be driven by a non-linear logic.

Another issue emerging from the analysis of "RRI in action" is that the **transitional processes affecting science** (such as increasing competition, decreasing pressure on and questionable use of research assessment, the lower reproducibility of scientific data, or the overexploitation of young researchers, especially women) **are substantially ignored**, although many of them are deep, broad in scope and fraught with potentially highly problematic consequences.

As we have seen in the previous section, these trends are not considered in the conceptual models of RRI, apart from those (undoubtedly important) occurring in science-society relationships. In RRI implementation processes, many transitional processes are considered (for example, increasing competition, increasing researcher specialisation, the pressure to publish, the pressure to produce economic benefits through science), but only to the extent that they may hinder RRI implementation, i.e., as contextual factors influencing RRI and not as targets for RRI-oriented actions.

### B. CONCLUSION FROM THE LITERATURE REVIEW OF ACADEMIC JOURNALS

The majority of academic articles that focus on RRI see the concept as a positive and welcome opening which can enhance the effectiveness of academic research. The majority of these positive articles underline the importance to build better connections between science and other realms of society, such as the government and the industry. In a vast majority of the articles in the two academic databases, however, RRI was mentioned without criticizing, developing or thinking the concept further. The large number of non-reflexive articles may relate to the concept of RRI being ambiguous and yet unknown for the academic writer- and readership.

The novelty of the concept of RRI is visible in the article corpus, as the concept was first mentioned in the academic articles in 2009 and again in 2012. Thereafter the number of articles on RRI has risen steadily. However, in 2017, eight years after the publication of the first article, the number of articles was still modest, just 45 articles. Discussing RRI and research on a general level in the body of articles rather than reflecting and developing the concept of RRI can be a symptom of distance felt to RRI, which may link to unawareness and irrelevance. What is discussed, are the relations and the division of work between organizations and researchers in the field of research in applying RRI. In fact, most of the articles discuss, how the field of research and governance could be better arranged to deploy RRI.

The small number of accounts on RRI may result from five kind of barriers we found in the data. First, the conceptual ambiguity of RRI. For the authors of academic journal articles, the concept seems to be too inexact, wide and inclusive. At the core of the conceptual critique is, that the concept can be seen as a buzzword or a new wrap for old concepts. Hence, the relevance of RRI from the viewpoint of real word issues becomes an issue. Second, the lack of ownership felt towards RRI comes across in the articles. RRI promoted forcefully by the EC is sometimes seen as a concept imposed top-down instead of a concept deriving from and in benefit of the scientific community. What follows, is that RRI is in danger of being restricted to publicly funded research. Third, lack of guidelines for implementation of RRI was raised as an essential question for its' dissemination. In research environments with multiple actors and complex power relations the lack of specific methods for the uptake of RRI was seen as a central barrier for its adoption. Fourth, inadequate structures in the training, funding and governance of R&I were regarded as a hindrance for dissemination of RRI. Criticism was targeted at research systems as a whole, in other words governmental institutions, funding bodies, ethical boards, academic institutions, industry and corporations, and inoperable or non-existent networks between them. Fifth, the lack of proof of the benefits of RRI could be seen as a barrier for its uptake. This is certainly a matter of communicating the benefits to researchers and stakeholders.

The drivers of RRI were analysed by using PESTE frame, which can be used to depict political, economic, social, technological and environmental aspects of different phenomena.

**Political drivers** of RRI that were identified in the articles, include the strong vision from the EC and its manifestation in the funding programmes. The programmes also work as a tool for enhancing interaction between different actors in the field of research as well as promoting transdisciplinary research.

**Economic drivers** for RRI are also embedded in the mission of innovation policy. Innovation policy is expected to result in the development of better products and services, but also further in employment and economic growth.

**Social drivers** of RRI were found in the accounts on research and organisational cultures. The main cultural driver for RRI was found in RRI's cultural inclusiveness and its' potential to take into account conflicting and even contradictory interests simultaneously. Academia was also seen as an important driver for RRI, as university teaching was seen at the core of raising awareness of RRI. In accounts on Horizon 2020, the ability of human and social sciences were acknowledged for their potential in raising awareness on RRI also in hard sciences.

**Technological drivers** of RRI were interlinked with the social drivers. Platforms were nominated as an important tool for knowledge sharing between different stakeholders and end-users as well as an important means for involving users in the innovation processes. In disseminating RRI, the concept of co-creation becomes important especially in involving the public.

**Environmental drivers** of RRI could be described as the environmental value that RRI is presumed to have, as it is targeted at fostering environmentally and socially sustainable research. Social sustainability was most clearly articulated in the hopes to encourage more self-reflexive research practices.

The focus on interaction between the stakeholders in RRI is accompanied by accounts on the value of performing RRI, namely the public good it produces and the general value in the involvement of multiple stakeholders, and citizens in particular. Indeed, on the basis of the broad content of RRI, it may be well-suited for addressing complex societal challenges and configuring the direction of scientific and technological development. It appears that these directions in relation to different stakeholders and general terms such as sustainability, need to be addressed and discussed more widely.

# Part Four

# Framing RRI in a changing science

## 1. Summary of the main issues

This literature review was aimed at collecting and organising useful information to start answering the basic question underlying FIT4RRI, i.e., how to match the little dissemination of RRI practices across disciplines and national research systems.

To this end, a pathway was followed, which focused on the changes affecting science and, partially, innovation (Part Two) and on RRI (Part Three).

As for the **transformations affecting science and technology**, the following points deserve to be mentioned.

- **Science and innovation are undergoing a long transitional phase**, variably interpreted through different (half-descriptive and half-prescriptive) models, (Mode 1 - Mode 2, Post-academic science, Post-normal science, Triple Helix approach, Academic Capitalism).

- **This transitional phase is part of a broader shift from modern to so-called post-modern society**, which affects in similar ways all social institutions (politics, religion, family, state administration, etc.). Whereas in the context of modernity they were solid, highly structured, authoritative, standardised and self-contained, in the post-modern context they appear to be weak, uncertain both of their own boundaries and internal procedures, and de-standardised.

- **This critical turn makes science socially weaker**. Indeed, science is now characterised by diminishing authority, uncertainty about internal mechanisms and standards, declining and increasingly uncertain access to resources, while public distrust and disaffection toward it increase.

- The transitional phases is also characterised by a **set of critical changes placing science at risk also in its most intimate mechanisms**, such as:
    - Hypercompetition and accelerated pace of research process
    - Structural shrinking of public research funds in a context of increasing costs of research activities
    - Task diversification and decreasing time devoted to scientific work
    - Increasing staffing combined with growing use of PhD students and Postdocs, mainly paid through research grants, and parallel reduction of permanent positions
    - Staff segmentation and polarization on the basis of age and contractual status, leading, e.g., to overexploitation and overtraining of young researchers, decline in teaching quality, changes in labour relations and modifications in researchers' identity
    - Increasing researchers' mobility, impacting on life quality and gender equality
    - Critical dynamics affecting the quality of research outputs such as, e.g., the crisis of reproducibility of scientific data, the production of redundant or irrelevant publications and the increasing spread of malpractices
    - Decreasing pressure on research assessment systems, due to lower quality peer review, combined with questionable use of quantitative indicators and rankings
    - Governance shift with broader of entrepreneurial models, leading to highly diversified governance approaches

- Increasing openness of research institutions toward external actors, producing benefits but also risky impacts on the life of research organisations.

Such trends suggest that, notwithstanding its advancements, science is not only socially weaker now than it was in the past but also less reliable in terms of its own technical procedures. This not necessarily affects purely innovation-oriented institutions (such as private research firms or developers) which are, on the contrary, acquiring an increasing role also in influencing how science works. This decreasing social relevance of science should be also interpreted as a progressive loss of the "exceptionality" recognised to research institutions in the modern world (Zwiek, 2015).

- All this is happening while the **political steering** of science and innovation is increasing, putting pressure on research institutions to get directly involved in innovation processes. Consequently, the management of science-in-society relations are becoming more complex and difficult to master.

As concerns the **analysis of RRI**, the following points can be highlighted.

- **RRI is a powerful concept**, thanks to its interpretive flexibility, its capacity to mobilise actors of different types, its capacity to encompass other similar concepts and its trendiness (to be noted, in this regard, is the massive presence of concepts referring to "responsibility" in many social domains, such as "responsible politics", "responsible eating", "responsible consumerism", "responsible religion", "responsible management education", "responsible mobility" or "responsible lifestyles").

- **RRI is a normative concept**, aimed at modifying R&I through different tools and strategies (rules, directions, codes of actions, etc.) on the basis of the hidden assumption that R&I has until now been under-responsible. Therefore, it is to be seen as a "system" to be applied wholescale, regardless of the applicability conditions, because of its intrinsic "ethical force". This means that, in principle, RRI has no limitations in terms of encompassing any possible desirable feature of R&I (including effectiveness, sustainability, inclusiveness, anticipatory orientation, responsiveness, reflexivity, transparency, care, proactivity, deliberation, accountability, equity, and efficiency) and has a broad application scope (promoting economic growth and innovation, anticipating risks for society and environment, fostering inclusiveness, etc.).

- **RRI is a social process**. At the same time, RRI is difficult to master since its implementation is a highly context-dependent, requires broad consensus from the many actors, needs considerable investments (in terms of resources and time), and may generate many unintended and undesirable effects. All this suggests that RRI, in practical terms, cannot but be a social process, entailing, e.g., activation of societal actors, new cultural inputs, resource mobilisation and, inevitably, resistance and obstacles

- **RRI is a concept that is almost exclusively applied to science-in-society relationships and not to the inner life of scientific institutions**. We could say that RRI concerns the "foreign affairs" of R&I institutions but not their "domestic affairs", except marginally. This means that many of the critical changes affecting R&I mentioned above (which are at the core of the worries and interests of researchers and research organisations) are not seriously considered or not considered at all by RRI.

## 2. Open questions

In this Section, an attempt is made to provide some possible orientations for the future steps of FIRT4RRI by identifying a set of key issues to be addressed.

As said in Part One of this report, the basic assumption of FIT4RRI is that there is a gap between the actual and the potential role RRI could play in managing the rapid transformation processes affecting science.

This literature review was therefore included in the project precisely with the aim of collecting pieces of information and knowledge that could help gain a **better grasp of the nature and size of this gap**.

Overall, the literature review allows us to single out **two mismatches** which contribute to producing such a gap:

- The mismatch between the concept and practice of RRI
- The mismatch between RRI and the transitional changes affecting R&I.

### *2.1. The mismatch between RRI concept and practice*

There is a mismatch between how RRI is prevalently conceptualised and the actual nature of RRI when attempts are made to implement it.

Conceptually, RRI is prevalently expressed in **normative terms**, as a set of principles or even imperatives to be implemented, sometimes regardless of the actual application conditions (in this sense, it is more a normative than a prescriptive concept). Such principles are numerous and broad in scope, thus making the conceptualisation of RRI quite vague. However, this makes RRI a notion characterised by an interpretive flexibility which undoubtedly has favoured its success at least among the different scientific and policy circles particularly interested in science-in-society issues. Moreover, the reference to the notion of “responsibility” is symbolically effective in a post-modern context, since the weakening of the social structures is producing an emphasis, in every social sphere, of the mechanisms that allow individuals and organisations to be and feel responsible for the long-term effects of their own actions and choices.

The mismatch emerges when one **moves from theory to a practical plan**.

RRI is a notion too broad in scope and vague in its contents to be applied in its entirety. As we have seen in Part Three (Para. 1.3.), the models developed to make RRI actually implementable are either too ambitious and unrealistic or over-simplistic, reducing RRI simply to a set of aspects to keep under control. In both cases, they tend to overlook the many and complex barriers described in Part Three (Section 2), which may make RRI culturally extraneous, irrelevant, ineffective or unsustainable in the long run.

In this sense, RRI can be considered, in practical terms, not a simple approach, a project or a policy, but a **factual process** entailing, e.g., the activation of societal actors, new cultural inputs, resource mobilisation and, inevitably, resistances and obstacles.

These two spheres of RRI (the normative and the social) are often intertwined or confused. Rarely are they clearly distinguished or coordinated, thus making coexistence difficult to manage, since it may lead to paradoxes, simplification and inconsistent approaches.

### *2.2. The mismatch between RRI and changes affecting R&I*

There is a **second mismatch** which can be observed, the one **between RRI and the transitional changes affecting science** (such as the increasing competition, the decreasing reliability and questionable use of research assessment, the lower reproducibility of scientific data, or the overexploitation of young researchers, especially women), which are basically ignored or their relevance and impacts overlooked.

This second mismatch is probably due to the misleading perception that the transitional changes affecting science have **nothing to do with science-in-society relations**.

This is not true at all. All these changes actually reflect general trends occurring in society (see Part Two) and pertain to modifications in culture, social practices, and social configurations which involve a variety of societal actors. This means that issues like peer reviewing, reproducibility of scientific data or the use of PhD students and Postdocs are also the expression of the changing relations between science and society and **may require the adoption of RRI principles** (anticipation, responsiveness, inclusion, reflexivity, etc.) and keys (ethical issues, public engagement, etc.).

This mismatch could be considered another factor which makes it difficult for RRI to become widespread, especially among researchers.

Researchers are challenged and worried by the transitional processes affecting science and innovation, such as publishing papers in as short time as possible, finding permanent positions for Postdocs and PhD students, successfully applying for research funds, performing the increasing number of non-scientific tasks required to compete in the research and innovation market, keeping the quality of research as high as possible. Thus, why should they be interested in RRI, if RRI prevalently concerns things they are not interested in? Why should they help RRI to spread while RRI does not help them to manage their problems?

## 3. A provisional framework for the experimentations

The literature review was aimed at identifying the problems and not to indicate solutions. However, this literature review is part of a broader project which also includes the organisation of RRI experimentations, the development of new training tools and the drafting of guidelines concerning the establishment of effective governance settings for RRI. Hence the need to start drawing a provisional framework for action.

### 3.1. Managing the mismatches

Thus, some possible albeit very provisional suggestions may be made about how to manage this double mismatch and, more in general, to realistically promote RRI in the areas of research less open to it. In particular, three main general orientations may be put forward.

- **RRI as a set of opportunities**. To start with, it might be useful to weaken the normative view of RRI. Rather than a set of principles and orientations to be applied to research practices, RRI should be more usefully viewed as a set of opportunities available to researchers, research institutions and other stakeholders to address the major problems they have to deal with in their daily business.
- **RRI as a regime of change**. It is necessary to recognise RRI as relevant to all transitional changes affecting science (and not only to those related to science-in-society issues), since all of them are connected to the changing relations between science and society. Moreover, RRI could be viewed as a regime helping research institutions, researchers and other relevant actors to manage such changes effectively.
- **RRI as a context-sensitive approach**. It is also important to affirm the context-sensitive nature of RRI. This means that any attempt to implement RRI principles and tools should be necessarily tailored to the actors involved in it.

These three orientations should, at least in principle, be able to reduce the double mismatch we mentioned above.

- If RRI is understood as a set of opportunities for research actors, the mismatch between RRI concept and practice can be managed in a much more flexible way. One takes from RRI only what is relevant to the issues he or she is facing.
- If transitional changes affecting R&I are viewed – as they actually are – as pertaining to science-in-society issues, RRI can be applied to them, both theoretically and practically. In this way the mismatch between RRI and transitional changes can be better managed.
- Finally, if RRI is viewed as a context-sensitive approach, both the first and the second mismatch can be managed not abstractly but within precise and verifiable experiential fields, i.e., those the actors are immersed in (research, innovation, teaching, gender relations, publishing, laboratory work, research grant application, etc.).

### 3.2. A model of social actor

In this perspective, **social actors** come to the forefront.

Indeed, it is up to the actors to identify the problems they are facing, to assess which opportunities RRI may provide to managing them better and to define the context of application in which such opportunities can be actualised.

This suggests that there is **not a unique RRI** but **many RRIs,** according to the actors who apply it in their own environment and work.

All these considerations, however, are of a mere theoretical nature. Practically, how to make them happen?

The basic assumption is that for RRI to function it needs to permeate, to different extents, the way in which social actors think, work, and manage their own internal dynamics and their external relations. “Social actors” here are mainly to be understood as research organisations or any other collective entities concerned with R&I.

In this regard, we could look again at the model sketched above and deepen it to distinguish the different barriers to RRI (Part Three, Section 2), this time in order to provide a model of the actor applicable to our needs.

According to this model, any collective actor can be analysed as made up of four **main components**, each one involved with an aspect of RRI:

- Culture
- Agency
- Action
- Identity.

**Culture** concerns any cognitive and cultural element providing the set of shared meanings necessary for the group to exist as a group. For example, the culture of a research unit may include its research mission and objectives, the disciplinary culture(s) of the members, the governance styles, the attitudes towards novelties, the symbols and rituals shared by all the members, and the like. From the RRI-implementation perspective, culture concerns the level of **awareness** the organisation and its members have about what is at stake in RRI.

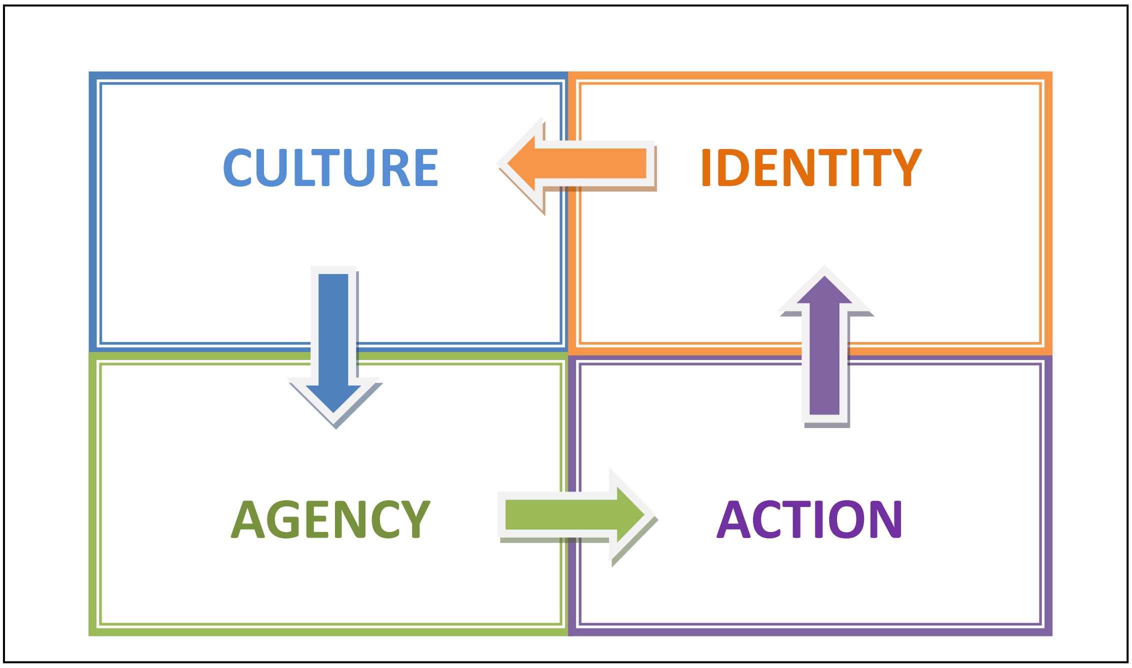
**Agency** concerns the actor’s orientation to act and the energy (in any sense, from money or time to emotional energy) the actor is interested in investing. For example, a research group may be interested in investing in a given kind of research, in cooperating with the private sector, in increasing its visibility in the university, in constantly enlarging the group, in getting engaged with science communication, or in other things. All in all, the concept of agency refers to the the quantity and quality of energy the actor accumulates and is interested in investing and in what. Even though we are speaking of a collective actor, it is quite evident that a pivotal role is played by an individual’s interests, passions and mobilisation. From the RRI-implementation perspective, agency concerns the way in which RRI becomes **relevant**, i.e., something the organisation and its members recognise as useful for them to address the problems they are facing and worried about.

**Action** concerns what the actor actually does, how it is to be done, and what effects are produced. While agency represents the cognitive side of the action, the latter represents the actualisation of the former, even though the overlaps between the two may also be limited because of the many contingencies and constraints of the real world. From the RRI-implementation perspective, the action component concerns the way in which RRI becomes **effective**, i.e., actually useful for the development of the organisation.

**Identity** concerns the way in which actors control their own internal and external environment (Luckmann, 1982). Identity, therefore, includes any action aimed at ensuring this control and, especially, the interaction systems and networks, as well as all the practices enabling the organisation to coordinate internally and externally. The concept of identity is therefore also linked to and partially overlapped with that of **continuity**, intended as “the capacity to embed new activities in existing institutions or otherwise building bridges between separate interventions" (Rask et al., forthcoming). From the RRI-implementation perspective, identity concerns the way in which RRI becomes part of the daily practices of the organisation, thus becoming **sustainable** in the long run.

The four components can be viewed as part of a **cycle**, by virtue of which changes in culture (awareness) are expected to modify actor agency (relevance) and, consequently, to produce changes in the actions performed (effectiveness), up to the modification of the internal and external configuration of the organisation (sustainability).

These dynamics can be schematised as follows.




Now, our assumption here is that RRI can only function if it influences, to a certain extent at least, these four components, thus raising actor awareness and achieving relevance, effectiveness and sustainability.

As a matter of fact, all these components play a pivotal role in these dynamics. In fact:

- Agency mobilisation not based on a RRI culture is **unproductive**, since it leaves mobilised agents isolated within the organisation and without any support
- Agency mobilisation which does not turn into action is **fruitless**
- RRI actions without agency mobilisation reflect a **top-down** and **unrealistic** approach
- RRI actions which do not result in permanent or long-term change in an organization, thus becoming part of the identity of the organization, can be useful from many respects but **useless** for embedding RRI in the ordinary activities of research institutions.
- An identity which does not change the culture of the organisation is **destined to fail.**

In this way, the key questions become why and to what extent RRI may contribute to improving the quality of all the components of an organisation and how to introduce practically the "enzyme" of RRI in the system.

### *3.3. An outline for an action scheme*

To appropriately address these questions, a set of practical orientations can be given, so as to define an outline for an action scheme.

**Four main steps** can be isolated.

The **first step** is to **establish the actor**, i.e., the group which is involved in the RRI implementation process. To do that, it is necessary to start by operationally identifying the actor in, so to speak, institutionally terms (for example, a research group, a university department, a university institution, a firm, a research group in the firm, a civic association, etc.), and attempting to make a self-analysis of it in terms of culture, agency, action, and identity.

The **second step** is to **identify the critical issues** an actor is facing, should face or is interested in facing in the next future. This may include both the general trends affecting R&I in general (mentioned in Part Two) or local problems (for example, access to resources, interactions with other groups or departments, lack of skills, lack of time, etc.).

The third step is **develop a self-tailored profile of RRI**, i.e., an idea or vision of RRI which can be applicable to the nature and features of the actor (first step) and which can help solve the problems the actor is facing (second step). The key here is to understand the added value of RRI for the actor both to address present or future problems and to open up new opportunities. At this stage, the option of not engaging the organisation in RRI-oriented actions is also seriously to be considered.

The fourth step is to **establish an action plan**, identifying problems and issues, RRI-oriented actions and their expected outputs pertaining to the four components, so as to make RRI something useful and feasible.

Needless to say, the complexity of such a scheme is quite variable, depending on the size, nature and organisational structure of the actor.

It is advisable for each step to lead to a **document** summarising outputs and paving the way to the next step. A participatory approach may be adopted, to avoid also any form of tokenism or "imposing" RRI as something external.

The scheme is summarised in the table below.

| STEPS | CONTENTS | OUTPUTS |
|---|---|---|
| **Establishing the actor** | Self-analysis of the actor in terms of culture, agency, action, and identity | Defining boundaries and features of the actor, including internal components and external relations |
| **Identifying critical issues** | Self-analysis of the actor in terms of present or future problems | Defining the problems and risk for the actor and actual or possible consequences |
| **Developing a self-tailored profile of RRI** | Self-analysis of the actor in terms of the added value of RRI in addressing the problems identified | Defining a profile of RRI tailored to the actor's features, needs and expectations |
| **Establishing an action plan** | Identification of problems, issues, actions and expected outputs in applying RRI | Defining an action plan to address the actor's problems |

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Annex 2

# Benchmarking Report

**FOSTERING IMPROVED TRAINING TOOLS FOR RESPONSIBLE RESEARCH AND INNOVATION**

Grant Agreement n. 741477
**Project Acronym: FIT4RRI**

# Benchmarking Report

## Deliverable 1.2

Due date of deliverable: April 30, 2018
Actual submission date: April 30, 2018

**WP leader**: Conoscenza e Innovazione (K&I)
**Deliverable responsible**: Luciano d'Andrea (K&I)
**Status**: Public

| **Function** | **Staff** | **Delivery date** |
|---|---|---|
| Prepared by | Luciano d'Andrea, Maresa Berliri and Federico Luigi Marta (K&I) | March 26, 2018 |
| Internal review | Alfonso Alfonsi (K&I) | April 12, 2018 |
| 1st draft delivered by | Luciano d'Andrea (K&I) | April 20, 2018 |
| Reviewed by | Pedro Principe (University of Minho) | April 27, 2018 |
| Final version | Luciano d'Andrea (K&I) | April 29, 2018 |
| Submitted to EU by | Andrea Riccio | April 30, 2018 |

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**Project full title**: Fostering Improved Training Tools for Responsible Research and Innovation
**Start date of the project**: May 1, 2017
**Duration of the project**: 36 months
**Project funding scheme:** Horizon 2020, SwafS-04-2016 - Opening Research Organisations in the European Research Area
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This project has received funding from the European Union's Horizon 2020 Programme for research and innovation under Grant Agreement no. 741477

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# Introduction

This report includes the results of the benchmarking exercise (Task 1.4) conducted under WP1 (Mapping and benchmarking) of the project “Fostering Improved Training Tools for Responsible Research and Innovation” (FIT4RRI), funded by the EU DG Research and Innovation under Horizon 2020. The project is implemented by a consortium of 13 partners, led by the Sapienza University of Rome.

The overall aim of the project is to contribute to the diffusion and consolidation of Responsible Research and Innovation (RRI) and Open Science (OS) in European Research Funding and Performing Organisations (RFPOs). This involves enhancing RRI competences and skills through improvements in currently available RRI training (in terms of training tools, actions and strategies), as well as promoting the diffusion of more advanced governance settings to foster the institutional embedment of RRI and OS in research organisations.

In this context, WP1, coordinated by Conoscenza e Innovazione (K&I), is specifically aimed at mapping the **drivers** for and **barriers** to the diffusion and embedment of RRI practices and approaches in RFPOs and benchmarking **RRI experiences** that have succeeded in mainstreaming RRI practices in individual RFPOs, groups of RFPOs or specific research fields. WP1 is also expected to provide inputs for the RRI-oriented experiments to be carried out under WP3 (Experiments). This component of the project, focused on governance settings, is also expected to interact with the other FIT4RRI component (WP4), focused on RRI and OS training.

As part of the WP1 activities, as explained below, a benchmarking exercise (Task 1.4) was undertaken based on the results of the inventory of advanced RRI experiences (AEs), conducted under Task 1.3 between October 2017 and January 2018. Therefore, this report concerns the results of both tasks, which are to be regarded as a unitary benchmarking process.

This process included four main steps overall, the first three pertaining to Task 1.3 and the last to Task 1.4:

- Identification of a large number of experiences focused on RRI, on the basis of different sources, leading to a first overall inventory (INV1)
- Selection of the identified RRI-oriented experiences on the basis of a first analysis and screening process, leading to a specific inventory of "Advanced Experiences" (INV2), i.e., RRI-oriented experiences matching some parameters of capacity and transferability (see Chapter One, Section 4) making them “advanced”
- In-depth analysis and screening process of the experiences identified, leading to the compilation of a select inventory (INV3) containing the most innovative AEs in terms of governance settings
- Benchmarking exercise on the selected group of AEs included in the select inventory.

The report is divided into four chapters.

- **Chapter One** describes the objectives and the theoretical framework of the benchmarking process.

- **Chapter Two** provides a description of the methodology adopted and the activities carried out.
- **Chapter Three** dwells upon the results of the benchmarking exercise conducted on the AEs included in the select inventory.
- **Chapter Four** includes some comments about the benchmarking process as a whole.

The first and the second inventories (INV1 and INV2) are attached to the Report.

The text has been drafted by Luciano d'Andrea, Maresa Berliri and Federico Luigi Marta (K&I).

## Chapter One

# Theoretical framework

# 1. Aims

In the overall logic of the FIT4RRI project, the benchmarking process is aimed at getting three main types of information, i.e.:

- The **parameters** that allow us to identify and assess the innovativeness and effectiveness of RRI governance settings (benchmarks)
- The **guiding factors** that bring about results (enablers), and
- The **transferability potentials** they have, i.e., the extent to which extent and the conditions under which the identified governance settings can actually be transferred to other contexts.

This chapter will describe the theoretical framework adopted in pursuing these three aims. In particular, three issues will be considered:

- The concept of governance setting (Section 2)
- The typology of governance settings (Section 3)
- The parameters used to describe and assess the governance settings (Section 4).

# 2. The concept of governance setting

There are no well-established definitions of "governance setting". Most of the time, the concept is generically adopted to refer to the way in which a territory, a company, a public service or an organisation is ruled or managed.

In operationally defining the concept of governance setting, two conceptual oppositions have been made:

- The opposition between government and governance
- The opposition between governance setting and governance structure.

The opposition between "**government**" and "**governance**" is well established in the literature since the 1980s[1].

Whereas "**governance**" is used to refer to networked forms of public management, allowing for the involvement of and interaction among the many actors concerned (stakeholders), "**government**" is indicative of more hierarchical modes based on institutional relations and authority. Focusing precisely on this opposition between government and governance, Jon Pierre[2] describes "governance" as "sustaining coordination and coherence among a wide variety of actors with different purposes and objectives". Thus, on the basis of this first distinction, it be-

[1] See, in this regard, Lo, C. (2017). Between Government and Governance: Opening the Black Box of the Transformation Thesis. *International Journal of Public Administration*, 1-7.
[2] Pierre, J. (Ed.). (2000). *Debating governance: Authority, steering, and democracy*. OUP Oxford.

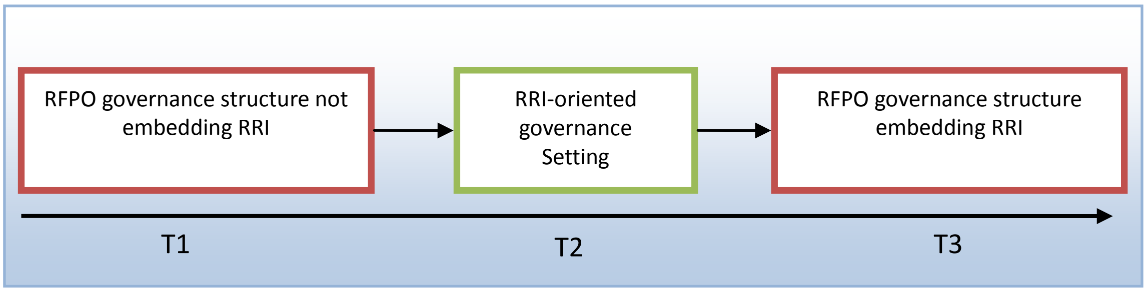
comes clear that, under FIT4RRI, the interest is focused, not on government, but on governance.

The second opposition is between "**governance setting**" and "**governance structure**".

Van Hoof and Kraus[3], we could define a **governance setting** as process, mainly based on negotiations, oriented to the "creation of new solutions stemming from a higher level of coordination among stakeholders". In opposition, "**governance structure**" can be defined as a relatively stable system of arrangements ensuring a specific level of coordination among stakeholders. Therefore, governance setting is aimed at modifying an existing governance structure in order to introduce a new governance structure.

In our case, the focus is on **RRI-oriented governance settings**, which can be understood here as a process through which a given governance structure is modified in a way that permanently incorporates RRI.

The scheme below attempts to clarify these dynamics, showing how RRI is incorporated in the governance structure of an RFPO through an RRI-oriented governance setting.




In identifying and selecting RRI-oriented governance settings, a **broad notion of RRI** has been adopted[4], including:

- **Five RRI keys** (public engagement, gender equality, open access, ethical consideration and formal or informal education)
- The different **RRI dimensions** (anticipation, responsiveness, inclusion, reflexivity, etc.)
- A general or specific **consideration of societal challenges** at any stage of the research and innovation process or of the decision making process.

Therefore, we considered RRI-oriented governance setting any attempt aimed at institutionally embedding in RFPOs new arrangements related to one or more RRI keys, one or more RRI dimensions or a consideration of societal challenges in research and innovation.

[3] Van Hoof, L., & Kraus, G. (2017). Is there a need for a new governance model for regionalised fisheries management? Implications for science and advice. *Marine Policy*, *84*, 152-155.
[4] See, in this regard, the deliverable D1.1, containing an extensive literature review about RRI.

Finally, **Advanced Experiences** (AEs) are considered to be any kind of initiative (project, programme, measure, policy, etc.) in which a governance setting is recognisable. This definition has two implications.

- The first implication is that the benchmarking process did not concern the AEs as such, but **only the governance setting** they applied. Consequently, all the aspects of the AEs which did not pertain to the governance setting were not considered.
- The second implication is that, in this way, **it was possible to compare AEs** which were extremely different in substantive terms (for example, AEs focused on open access and AEs focused on gender equality), but bearing the same type of governance setting.

# 3. A typology of governance settings

As said in the introduction, the first step taken in the framework of the benchmarking exercise was to identify and analyse a large number of experiences focused on RRI. This analysis made it possible to collect a wealth of information about the different strategies adopted to foster the spread and institutional embedment of RRI-related practices in RFPOs. These results were further fine-tuned through an in-depth analysis of smaller groups of AEs, which led to the definition of a typology of governance settings.

This typology identifies **nine models of governance settings**, each adopting a specific approach to the question: "how to get individuals or a group to implement RRI". These models can be identified on the basis of **two main variables**.

The **first variable** concerns where the **triggering point of change** is placed, i.e., which actors are asked to start and manage the process of change in the target RFPO. Again, three cases can be identified.

- **Internally-initiated governance settings**. Governance settings which tend to induce institutional changes on the basis of a model which is shaped by and relies upon actors acting **from inside** the RFPO.
- **Externally-initiated governance settings**. Governance settings which tend to induce institutional changes on the basis of a model which is shaped by and relies upon actors acting **from outside** the RFPO. In this case, therefore, the AE will be attributed to the actors which brought the governance setting model from outside rather than the institution in which such a model is actually applied.
- **Network-initiated governance settings**. Governance settings which tend to induce institutional changes **through cooperation relationships** linking the target RFPO with other organisations.

The **second variable** can be referred to as "**focus**", i.e., the factors in the life of an organisation which the governance setting primarily addresses and leverages upon to trigger the change process. Three main cases can be identified.

- **Social governance settings**. Governance settings which tend to induce institutional changes directly by modifying the **social patterns** (cognitive, emotional, relational, behavioural, etc.) which are taken for granted and shared by the majority of people inside the organisation[5].

- **Normative governance settings**. Governance settings which tend to induce institutional changes directly by modifying the existing **norms** (procedures, guidelines, protocols, rules or organisational charts, etc.), i.e. the "rules of the game" on which the life of the organisation is based[6].
- **Knowledge-oriented governance settings**. Governance settings which tend to induce institutional changes indirectly by primarily engaging the RFPO in producing **knowledge on and through RRI,** i.e. producing knowledge on RRI and/or adopting RRI principles and tools to produce knowledge.

This typology can be represented in the form of a matrix, combining these two variables to generate nine theoretical cases.

| FOCUS / TRIGGERING POINT | Social patterns first | Rules first | Knowledge first |
|---|---|---|---|
| **Changes from inside** | A<br>Internally-initiated social model | B<br>Internally-initiated normative model | C<br>Internally-initiated knowledge-oriented model |
| **Changes from outside** | D<br>Externally-initiated social model | E<br>Externally-initiated normative model | F<br>Externally - initiated knowledge-oriented model |
| **Changes through network** | G<br>Network-initiated social model | H<br>Network-initiated normative model | I<br>Network-initiated knowledge-oriented model |

Some additional observations may help clarify this typology.

- The typology presented above is of a theoretical nature, even though based on the analysis of many empirical cases. In this sense, it should not be considered an anomaly that there are no AEs to represent one of the models identified (Model B). Moreover, in real life, boundaries between different governance setting models are much more blurred. For example, an AE can adopt two governance setting models at the same

[5] This reflects a sociological view of institution; see, for example, Berger, P. L., Luckmann, T. (1966) *The Social Construction of Reality: A Treatise in the Sociology of Knowledge*, Garden City, NY, Anchor Books; North, D. C. (1990) *Institutions, Institutional Change and Economic Performance*, Cambridge University Press, Cambridge.

[6] This reflects an organisational view of institution; see, for example, Coriat B., Weinstein, O. (2002), Organizations, firms and institutions in the generation of innovation Research Policy 31273–290; North D.C. (1990) *Institutions, Institutional Change and Economic Performance*, Cambridge University Press, 1990.

time, by addressing both social patterns and norms or by triggering the process both from inside the target RFPO and by relying on external organisations (this is the case, for example, of many EC-funded institutional change projects). Therefore, AEs have been attributed to the different governance setting models by **identifying the prevailing model shaping them**.

- As for the **triggering point of governance settings**, this concept refers, as mentioned above, exclusively to those who start and guide the process, thus shaping the governance setting, and not to those who pay for it or decide to start it. For example, a governance setting may be either started by creating an internal unit to take charge of it (internally-initiated process) or by hiring external experts in charge of implementing it within the institution (externally-initiated process). In both cases, the decision to start the process was taken by the leadership of the institution concerned.
- As for the **focus of governance settings**, while social and normative models reflect a direct approach to institutional change (i.e., changing the institution by modifying the social patterns or the norms), the knowledge-oriented models reflect an indirect approach to institutional change, based on the (conscious or unconscious) assumption that the inclusion of RRI in research content also has an impact on the life of the organisation, producing or fostering change.

To get a better grasp of the different models, some examples are given below of types of actions falling within each model.

| GOVERNANCE SETTING MODELS | EXAMPLES OF ACTIONS |
|---|---|
| Internally-initiated social model | Development of RRI-oriented internal action plans based on a mobilisation of internal and external stakeholders; internal awareness-raising and RRI training programme |
| Internally-initiated normative model | Adoption of new internal regulations, procedures, guidelines developed by the organisations' leadership; establishment of internal RRI-oriented research funding criteria |
| Internally-initiated knowledge-oriented model | Establishment of a new research unit focused on RRI-related issues; activation of RRI-focused research programmes by the research organisation |
| Externally-initiated social model | Use of external RRI experts; participation in national/international RRI-oriented programmes |
| Externally-initiated normative model | Research funding schemes adopting RRI-oriented selection criteria; RRI-oriented certification processes |
| Externally-initiated knowledge-oriented model | RRI-oriented national research funding schemes |
| Network-initiated social model | Participation of the organisation in RRI-specialised networks; participation of the organisation in cross-institutional RRI-oriented programmes |
| Network-initiated normative model | the organisation signing up to a network-based charter (such as Athena-SWAN) |
| Network-initiated knowledge-oriented model | Establishment within the organisation of RRI-focused research units or research programmes supported by a pool, network, or association of research institutions |

# 4. Parameters for assessing governance settings

So far, we have identified the subject of the benchmarking exercise, which are RRI governance settings and not RRI-oriented experiences as such. We have also identified a typology of governance settings. This should make it easier to understand the logic underlying the benchmarking exercise.

Indeed, the effort made has been that of identifying, for each governance setting model, one or more "**champions**", that is experiences which, on the basis of some parameters, could be identified as "**Advanced Experiences**" (AEs) epitomising such a model in a successful way.

Because of the great diversification both in the governance setting models and the ways in which they can actually be implemented, it has been impossible to conduct a reliable in-depth analysis for each AE (especially in cases such as national funding schemes or national research programmes).

For this reason, a **qualitative approach to benchmarking** has been adopted. This approach is often used both for companies and for regions, for which a quantitative approach is difficult to apply since many data are not available or not consistent.

Differently from quantitative benchmarking, qualitative benchmarking is not aimed at identifying quantitative standards to be attained, but at singling out the key factors which determine successful developments (be it of a company, a region, or a project) and often applies a scoring model which is based on group discussions among stakeholders.

In order to develop this approach, three sets of parameters have been applied:

- **ENTRY THRESHOLDS** – parameters to select the AEs which were actually relevant to the benchmarking exercise
- **CAPACITY** – parameters to get information about the capacity of the governance setting to actually modify the governance structure of the target RFPO(s)
- **TRANSFERABILITY** – parameters to single out the most transferable solutions emerging from the AE making it possible to replicate the governance setting model elsewhere.

In the following sections, each set of parameters will be briefly described, followed by a summary scheme.

## *4.1. Entry thresholds*

In order to make a *prima facie* selection of the experiences to be taken into consideration, the information sources were subjected to a brief analysis on the basis of four criteria, described below, each one regarded as an **entry threshold** for including the experience in the benchmarking process.

- **CONSISTENCY**. The first parameter was consistency, aimed at ascertaining if the experience described in the sources actually existed as such, i.e., it was not a mere study or a plan without any effect in the real world.
- **IMPACTIVITY**. The second parameter was impactivity, aimed at ascertaining if the experience actually produced an impact in the real world.
- **VISIBILITY**. The third parameter was visibility, aimed at ascertaining if the experience was sufficiently well described by its promoters so as to make it a subject of analysis.
- **RRI ORIENTATION**. The final parameter was RRI orientation, aimed at ascertaining if the experience was actually oriented towards promoting RRI as defined in the terms described above (see Section 2 of this chapter).

### *4.2. Capacity*

The second set of parameters regards the capacity of the AEs to actually implement an RRI-oriented governance setting within one or more RFPOs.

To identify these parameters, a simple assumption was adopted, according to which a governance setting should influence, to a certain extent at least, the relevant aspects of the life of a RFPO.

Starting from such an assumption, RFPOs were considered to be made up of four main components[7], namely:

- Culture
- Agency
- Action
- Identity.

**Culture** concerns any cognitive and cultural element forming the set of shared meanings necessary for a group to exist as a group. For example, the culture of a research unit may include its research mission and objectives, the disciplinary culture(s) of the members, governance style, attitudes towards novelty, symbols and rituals shared by all members, and the like. Governance settings that can positively modify the dimension of culture can be regarded as **innovative**.

**Agency** concerns the orientation of an actor to act and the energy the actor wishes to invest (in any sense, from money or time to emotional energy). In this model, agency is presumed to be related to issues which are perceived by RFPOs or part of them as challenging or problematic. Thus, from the RRI-implementation perspective, agency concerns the way in which RRI becomes **relevant**, i.e., something recognised as important enough to mobilise the involved actors.

[7] See, in this regard, d'Andrea, L., Quaranta, G., & Quinti, G. (2005). *Manuale sui processi di socializzazione della ricerca scientifica e tecnologica*. CERFE, Rome.

**Action** means what an actor actually does, how it is done, and what effects are produced. Action represents the actualisation of agency, even though the overlaps between the two may also be limited because of the many contingencies and constraints of the real world. Governance settings that can positively modify the existing governance structure with respect to RRI can be regarded as **effective**.

**Identity** concerns the way in which actors control their own internal and external environment[8]. This control is done by acting (mainly through negotiation processes) on the social configurations among the actors concerned and the practices and arrangements allowing them to work in a given or desired way. Governance settings able to modify the dimension of identity with respect to RRI can be regarded as **sustainable**.

Hence, four parameters regarding capacity have been applied.

- **INNOVATIVENESS**. The first parameter was innovativeness, aimed at describing and assessing the presence of new RRI-oriented ideas and views introduced in the organisation(s) through the governance setting.
- **RELEVANCE**. The second parameter was relevance, aimed at describing and assessing the ways in which the AE mobilised the actors concerned.
- **EFFECTIVENESS**. The third parameter was effectiveness, aimed at describing and assessing the arrangements taken in order to ensure that the actions carried out actually attained the desired results.
- **SUSTAINABILITY**. The final parameter was sustainability, aimed at describing and assessing the arrangements taken in order to make the RRI-oriented changes induced in the organisation actually permanent.

### *4.3. Transferability*

The third set of parameters is qualitative in nature and concerns the solutions adopted in the AE in order to implement the governance setting.

Two main parameters have been considered.

- **TRANSFERABILITY ORIENTATION**. The first parameter was the orientation of the initiator(s) of the AE to circulate and share information. Different aspects have been considered, including: quantity and quality of the information provided on the governance setting; quality and quantity of the information provided about enablers and obstacles; information about actual replications of the AE.
- **TRANSFERABILITY POTENTIAL**. The second parameter was transferability potential, aimed at describing and assessing to what extent and under which conditions the solutions identified for promoting the embedment of RRI can actually be transferred into other institutional contexts.

[8] Luckmann, T. (1982). Individual action and social knowledge. In Von Cranach, B., Harré, R. (Eds.) *The Analysis of Action: Recent Theoretical and Empirical Advances*. Cambridge University Press.

### *4.4. Summary scheme*

Three sets of overall parameters, subdivided into a total of 10 parameters, have been applied, as shown in the table below.

| SET OF PARAMETER | Parameters |
|---|---|
| ENTRY THRESHOLDS | Consistency |
| | Impactivity |
| | Visibility |
| | RRI orientation |
| CAPACITY | Innovativeness |
| | Relevance |
| | Effectiveness |
| | Sustainability |
| TRASFERABILITY | Transferability orientation |
| | Transferability potentials |

Chapter Two

# Methodological framework

This chapter is devoted to the methodological framework and how it has been implemented in the context of the benchmarking exercise.

As already specified above, the benchmarking process included the activities under Task 1.3, focused on the inventory of AEs, and Task 1.4, regarding the benchmarking exercise as such. The inventory was necessary to select the most relevant AEs and the benchmarking exercise to extract useful information from them.

Overall, the following activities have been conducted:

- Selection and analysis of RRI-oriented experiences and establishment of an overall Inventory (INV1)
- Identification of the AEs and establishment of a specific Inventory (INV2)
- Compilation of a select Inventory of AEs (INV3)
- Benchmarking exercise.

# 1. Selection and analysis of RRI experiences (INV1)

The first step in the process was to identify, select and analyse the sources of information in order to set up a first overall Inventory of RRI-oriented experiences (INV1).

A literature analysis was conducted, leveraging also upon the literature review implemented under Task 1.1, using multiple information sources, including: EC-funded projects; national projects; scientific literature; grey literature; websites.

Three approaches were used to identify the experiences.

- The first approach involved identifying those experiences which were explicitly oriented to RRI or RRI keys, i.e., on the basis of the promoters' intents.
- The second approach involved identifying those experiences which were regarded as oriented towards RRI or RRI keys by people not directly concerned with the experience (for example, researchers, governmental officers, etc.) found in literature.
- The third approach involved identifying those experiences regarded as pertaining to RRI or RRI keys by the FIT4RRI project partners.

This process was conducted in the period of October-December 2017 and led to the compilation of the first inventory (INV1) made up of 302 items, each referring to an RRI-oriented experience (see Annex 1).

For each experience, only information about its identification, i.e., title, promoter organisation, and reference to information source used to identify it, was included.

## 2. Identification of the AEs (INV2)

The second step involved the selection of a specific group of experiences which, on the basis of specific parameters, could be considered to be "advanced".

To this aim, two main operations were conducted:

- Application of entry thresholds to the experiences included in INV1 – first selection
- Rapid appraisal of the capacity parameters of the remaining experiences – second selection.

This two-step process, carried out between January and mid-February 2018, led to the establishment of a specific Inventory (INV2), including 43 records, referring to experiences which, on the basis of the analysis done, were considered to be "advanced", i.e., endowed with a capacity to generate and implement a governance setting.

Also this inventory contains some descriptive information about the AEs, including: title; leading institution(s); country or countries; time period. Finally, the governance setting model applied in each AE (see Chapter One) was also included in the database. The distribution of the AEs is detailed in the table below.

The AEs included in INV2 were grouped according to the governance setting model they referred to. In this way, nine classes of AEs were established. Obviously, the size of the classes varied considerably, since some models were much more common than others.

| FOCUS / TRIGGERING POINT | Social patterns first | Rules first | Knowledge first |
|---|---|---|---|
| Changes from inside | MODEL A<br>13 | MODEL B<br>0 | MODEL C<br>4 |
| Changes from outside | MODEL D<br>3 | MODEL E<br>8 | MODEL F<br>1 |
| Changes through network | MODEL G<br>4 | MODEL H<br>2 | MODEL I<br>8 |

## 3. Identification of a select group of AEs (INV3)

The third step involved identifying a select group of 18 AEs (INV3) to be submitted to the benchmarking exercise, conducted between 15th and 28th February 2018.

This group was chosen through the following procedure.

- For each class, AEs were ranked on the basis of the results of the rapid appraisal mentioned above. The results of this process were discussed within the team and approved in their final form.
- For each class, a number of AEs, corresponding as far as possible to the relative size of each group, was selected, thus identifying a group of 18 AEs, which were to be subjected to the benchmarking exercise.

The distribution of the AEs among the classes based on the governance setting models is given in the table below.

| FOCUS / TRIGGERING POINT | Social patterns first | Rules first | Knowledge first |
|---|---|---|---|
| **Changes from inside** | MODEL A<br>4 | MODEL B<br>0 | MODEL C<br>2 |
| **Changes from outside** | MODEL D<br>1 | MODEL E<br>4 | MODEL F<br>1 |
| **Changes through network** | MODEL G<br>1 | MODEL H<br>1 | MODEL I<br>4 |

## 4. Benchmarking exercise

The benchmarking exercise was conducted between March 1st and April 10th, and involved the operations described below:

- For each of the 18 AEs a file with all the relevant available information was compiled
- Each file was analysed in-depth by one of the team members using an analytical grid, based on the theoretical framework described above (Chapter One)
- The results of the analysis were discussed within the team, with the aim of identifying, for each AE, the most innovative and potentially transferable practices, to be regarded as benchmarks in the realm of RRI-oriented governance settings
- Contacts were established, when needed, with the promoters of the AEs in order to get additional information
- The final version of the grids was drawn up, providing the basis for the drafting of this report.

Practices were identified and assessed according to the same capacity-related criteria presented above (Chapter One, 3.2.), applied to select the AEs. i.e.:

- **Innovativeness** (capacity of the practice to introduce new ideas, approaches and orientation in the culture of the organisation)

- **Relevance** (capacity of the practice to address issues which mobilise the interest and passion of the actors concerned)
- **Effectiveness** (capacity of the practice to provide solutions which really attain the expected results)
- **Sustainability** (capacity of the practice to be embedded permanently in the organisation).

Moreover, assessments were also made of the **transferability potential** of the practice (i.e., the tendency of the practice to be transferred to other institutional contexts without activating complex processes or high investments).

The results of the benchmarking exercise are described in Chapter Three.

Chapter Three

# The results of the benchmarking exercise

In this chapter, the results of the benchmarking exercise will be presented. As said above, this exercise involved a group of 18 RRI-oriented Advanced Experiences (AEs), representing, overall, the different governance setting models.

The benchmarking methodology is not applied here in a strictly comparative sense, since the subjects of the analysis – governance setting models – are profoundly different from each other in terms of specific aims, rationales, steps and tools, only sharing a similar overall objective, i.e., promoting the diffusion and the institutional embedment of RRI or part of it. Therefore, it would have been meaningless to rank the AEs according to a set of specific quality criteria.

Rather – as said above – a qualitative approach has been implemented aimed at showing concretely how the different models of governance setting have actually been implemented, thus presenting some of the most innovative and transferable practices adopted to do it (benchmarks), as well as some of the factors which may contribute to making the application of the model successful in reality (enablers).

Needless to say, the benchmarking process also had an evaluative component, which came into play in the selection and interpretation of the AEs.

The 18 AEs will be described in terms of a general scheme divided into **four parts**.

- The **first part** (Short description) gives a brief description of the key features of the AE.
- The **second part** (Benchmarks) will focus on the governance setting practices which can be regarded as benchmarks.
- The **third part** (Capacity and transferability considerations) will dwell upon the reasons why the selected practices can be regarded as benchmarks.
- The **fourth part** (Enablers) reports the major factors that contributed to the successful application of the practice, to be considered in view of their transferability to other institutional contexts.

The table below (see next page) shows the 18 AEs distributed according to the governance setting model they refer to. As may clearly be seen, Model B is not represented by any AEs (a few short considerations are made in this regard in Section 2, of this chapter).

<table>
<tr><th rowspan="2">TRIGGERING POINT</th><th colspan="3">FOCUS</th></tr>
<tr><th>Social patterns first</th><th>Rules first</th><th>Knowledge first</th></tr>
<tr><td>Changes from inside</td><td>MODEL A<br><br>– JERRI Project at TNO<br>– LIBRA Project at CeMM<br>– TRIGGER Project at UPD<br>– RRI policies at UAB</td><td>MODEL B<br><br>None</td><td>MODEL C<br><br>– Synbiochem<br>– Midstream Modulation at TU Delft</td></tr>
<tr><td>Changes from outside</td><td>MODEL D<br><br>– CeRRI, Fraunhofer IAO</td><td>MODEL E<br><br>– MVI, NWO<br>– Biotek 2021, RCN<br>– CDI, VINNOVA<br>– EuroPriSe, ITA</td><td>MODEL F<br><br>– SoScience</td></tr>
<tr><td>Changes through network</td><td>MODEL G<br><br>– University Network Education by Responsibility</td><td>MODEL H<br><br>– Athena SWAN Charter</td><td>MODEL I<br><br>– CSymBi<br>– Mistra Urban Futures<br>– Applied Nanoparticles<br>– Ethics and Society, HBP</td></tr>
</table>

# 1. Internally-initiated social model (Model A)

The AEs considered in this section adopt an internally-initiated social governance setting model (Model A). “Internally-initiated model” means that the model is shaped by and relies upon the actors acting inside the organisation; “social model” means that the model is intended to induce RRI-oriented institutional changes primarily by modifying the social patterns (cognitive, emotional, relational, behavioural, etc.) which are dominant within the organisation.

Four AEs falling within this Model are presented below.

## *1.1. The JERRI Project at TNO (INV1 #105)*

### A. Short Description

The Joining Efforts for Responsible Research and Innovation (JERRI) Project is a project funded by the European Commission under Horizon 2020. Having started in 2016 and expected to be completed in 2019, the project is aimed at developing action plans in two research institutes (Fraunhofer Gesellschaft and the Netherlands Organization for Applied Scientific Research – TNO), focusing on the main RRI keys (Ethics, Societal Engagement, Gender Equality and Gender in Research and Innovation Content, Science Education, and Open Access). In this report, the focus is only on activities conducted at the Netherlands Organisation for Applied Scientific Research (TNO).

### B. Benchmarks

Under the project, the most relevant activities conducted so far concern the design of the action plans. At TNO, this process has been carried out in different steps and by applying different practices. Three of the practices adopted have been considered by the FIT4RRI Team as benchmarks for the development of an effective governance setting based on Model A: the Goal setting process, the RRI institutionalisation level analysis and the Transition roadmap to RRI.

**Goal setting process**

Both internal and external stakeholders have been involved in setting the goals to be pursued under the project. Some goal-setting workshops were organised after a preparatory briefing on workshop contents and methods.

For each key, a workshop was organised with internal stakeholders (involving 6-8 people each), using different approaches (Appreciative Inquiry, Stakeholder Support and Participatory Design) to facilitate goal identification. Bilateral discussions or workshops with specific external stakeholders were then held to fine-tune identified goals.

These workshops produced a draft list of goals. The list is based on some basic operational implementation choices, such as boosting existing initiatives, extending existing initiatives beyond current practice and producing new materials/tools and instruments to establish new organisational requirements (e.g., for training activities or awareness raising initiatives). The goals were defined in such a way as to make it transparent which actions, timelines, internal stakeholders and impacts the proposed goals would entail and which budgets were required to be able to achieve them.

Three members of TNO staff department then reviewed the draft goals providing advice on how they could be pursued. The institutional process for approval by TNO management then followed.

Since more goals (with requests for budgets) were proposed than TNO could fund from the project, the project team presented the goals to internal stakeholders to get their advice on the selection and prioritisation of the goals.

**RRI institutionalisation level analysis**

An analysis of the levels of institutionalisation of the different RRI keys was conducted at the beginning of the project. The institutionalisation level was assessed on the basis of a 5-level maturity scale (developed from the Capability Maturity Model), as regards the new processes which were intended to be introduced. The five levels can be described as follows:

1. INITIAL (ad hoc personal actions are carried out, which are hard to replicate)
2. REPEATABLE (basic processes are established, defined and documented)
3. DEFINED (processes are part of the internal business process)
4. PREDICTABLE (processes are analysed, measured and controlled by the organisation across departmental units)
5. EFFICIENT (processes are a matter of continuous improvements).

This analysis made it possible, among other things: to select the keys which needed more effort; to avoid a proliferation of new targets, projects and activities; to use existing initiatives in the best way; to focus on the alignment of new processes with those performed or planned by the internal stakeholders.

**Transition roadmap to RRI**

The JERRI Project was considered as a triggering factor to attain longer term objectives in the five keys. For that reason, the activities undertaken under the Project were regarded as pilot initiatives and framed into a broader time horizon. In this light, TNO drafted a "transition Roadmap to RRI", detailing pathways from today's pilots to the envisaged long-term goals to guide the process beyond the project's lifetime.

### C. Capacity and Transferability Considerations

The **goal setting process** can be regarded as a benchmark for its capacity to ensure clearly structured, co-ordinated and effective involvement of many internal and external stakeholders from the very beginning of the process, taking specific care to keep a realistic approach to RRI so as to avoid setting over-ambitious goals.

**Institutionalisation level analysis** is based on practices which are often used in the management of business organisations. In this case, conducting a diagnostic of the institutionalisation levels for each RRI key made it possible to take advantage of existing initiatives and to approach RRI keys as framed within a unique integrated perspective.

The **transition roadmap to RRI** is a practice which makes it possible to address from the very beginning the problem of the sustainability of the initiatives launched under the project and to look for a long-term engagement of the leaderships to actually embed them into the mission, practices and norms of the organisation.

#### D. Enablers

The **major enablers** identified for these practices with regard to transferability are as follows:

- Strong commitment from the leadership for RRI, especially the Executive Board (but problems were met with middle management) which had already led to the development of RRI-oriented actions
- Specific funding provided by an external entity (the European Commission)
- High level of efficiency of the organisational process within the TNO
- Close relations established by TNO with external stakeholders and their involvement from the beginning.

## *1.2. The LIBRA Project at CeMM (INV1 #188)*

#### A. Short description

The Leading Innovative measures to reach gender Balance in Research Activities (LIBRA) Project is an EC funded project which brings together ten research institutes in life sciences in ten European countries with the aim of promoting gender equality in the institutions concerned and fostering the inclusion of gender and sex dimension in research contents. This AE, therefore, does not concern RRI as a whole but one of its keys (gender equality). The project includes an initial assessment of the participating organisation, a mutual learning process, and the design and development of 10 institute-tailored Gender Equality Plans, based, also, on a set of cross-cutting activities. The Project started in 2015 and is expected to be completed in 2019.

#### B. Benchmarks

The benchmarking process involved one of the participant organisations, the Research Center for Molecular Medicine of the Austrian Academy of Sciences (CeMM), based in Vienna. Three practices were selected as benchmarks.

**Highly representative extended team**

At CeMM, the team in charge of the Gender Action Plan is made up of a core group and an extended team. Besides the team leader, the core group includes the PhD and Postdoc Program Manager and the Head of Human Resources. The extended team includes the Administrative Director, the Director of Medical Affairs, the Head of Scientific Support, the Head of IT Services, the Media Relations Managers and the Head of Public Relations. Afterwards, two group leaders and an executive assistant joined the team voluntarily.

Even though coordination was difficult at the beginning, teamwork improved quite rapidly overall, thanks to the adoption of a more participative approach, leading to increasing opportunities for discussion and information exchange. The involvement of high-level leaders from the administration, scientific support staff and senior researchers made the action plan institutionally strong, thus facilitating implementation and increasing impact.

It is worth noting that, even though the team is highly representative in institutional terms, team leaders succeeded in not making it a bureaucratic or administrative entity, but a streamlined coordinating structure largely based on the willingness and motivations of its members. The presence of two group leaders who jointed voluntarily was a significant event in this regard.

**RRI-oriented procedures setting process**

A handbook to help foster an inclusive, transparent and gender unbiased recruitment process was developed at CeMM, to be spread and tested in all the ten research institutions involved in the LIBRA project. The development process included several steps, which are particularly effective from the perspective of an RRI-oriented governance setting.

1. CeMM hosted a seminar involving both HR officers and international experts.
2. The results of the seminar were used to produce a draft version of the handbook.
3. The draft version was reviewed by the same experts participating in the seminar. Care was taken to combine the theoretical soundness of the text with the need to provide practical orientations, which could be applied quite easily by research officers.
4. The team in charge of the LIBRA project at CeMM conducted an analysis of the actions included in the handbook, selecting those, which could be considered most relevant and urgent for their own institution.
5. The proposed actions were discussed and improved upon with the Head of Human Resources, in charge of managing recruitment applications.
6. The actions were then submitted to both the Scientific Director and the Administrative Director.
7. Having obtained the support of the directors, the handbook was included in the agenda of a Faculty meeting and discussed by the research group leaders.
8. Finally, most of the actions proposed were approved and the application process started.

**Initial diagnostic analysis**

All LIBRA partners were involved, from the very beginning of the project, in conducting an initial assessment of the situation of the target organisation with reference to gender equality. With the support of an expert organisation on gender, CeMM – as all the other LIBRA partners – assessed their own current policies and procedures in order to identify gender biases and obstacles.

The analysis was conducted on the basis of a common template which concerned both quantitative and qualitative information about the situation of women. Direct support was also given by the expert organisation to the partners though an on-site visit and distance interactions. The process led to the drafting, for each target institution, of a Diagnostic Report, to be used to orient the action plan.

## *1.3. The TRIGGER Project at Université Paris Diderot (INV1 #189)*

### A. Short Description

The TRansforming Institutions by Gendering contents and Gaining Equality in Research (TRIGGER) Project was funded by the EC and the Italian government with the aim of promoting gender-oriented institutional changes in five European research institutions and fostering the use of gender and sex as meaningful variables in research processes. The Project also included a mutual learning process involving not only the project partners but also representatives of other EC-funded projects promoting gender-oriented action plans in research institutions. The Project started in 2014 and ended in 2017.

### B. Benchmarks

The benchmarking process concerned one of the institutions involved in the project, i.e. the Université Paris Diderot – Paris 7 (UPD). From the action plan carried out at UPD, three practices were identified as benchmarks.

**Internal organisational coordination**

The team in charge of the action plan at UPD established a network of "referents", so as to promote the implementation of gender equality actions in all relevant areas of the university. The network was intended to act as the "backbone" of the action plans, since its members would be engaged, on the one hand, in providing information on the actual needs of the department they were working in and, on the other, in cooperating with the team in the implementation of the planned actions and adapting them to their department or service. Other important roles played by the referents were facilitating information sharing on the action plan and ensuring a better link with top and middle managers.

The process was launched by the president of the university and the team was given the task of collecting spontaneous candidatures from each university service and department. Candidatures were then selected and ratified by the University Council.

Some problems were met while establishing and developing the network. To keep the network active, the team tried to assign a specific role to each member in drafting the new university gender plan. Moreover, some problems emerged because, in some cases, network members also had "political" visibility (members of elective bodies or influential professors), which sometimes had a negative impact on the action plan.

However, the network of referents proved to be a pivotal factor for the success of the action plan, supporting it in different ways: co-organising the actions with the team; convening researchers for project activities; contributing to defining the new gender action plan; organising new unplanned actions, related also to topics other than gender (for example, on other forms of discrimination); fostering the institutionalisation of some of the actions conducted under the action plan; extending the scope of the gender policy throughout the University.

**Links with external stakeholders**

One of the factors that most helped the team at UPD to implement the action plan was the establishment of intense and visible links with external stakeholders. They involved other university and research institutions, national institutional entities (starting with the Ministry of Higher Education and the parliamentary delegation on women rights), private enterprises, local authorities, students' associations, and women's organisations. The team was also included in the organisational committee of a European conference devoted to gender equality in higher education, which allowed it to reinforce its relations with national institutional counterparts.

The development of external links played an important role in increasing the team's capacity to activate changes within the institution. The visibility of these links helped address internal opposition, increasing the internal visibility of the action plan and the team in charge of it, getting additional resources, making the leaders' commitments more binding and offering support to the University in developing public relations policies.

**Sustainability plan**

As the other TRIGGER partners, the team at UPD also developed a sustainability plan, i.e., a plan aimed at ensuring as far as possible the continuation of the actions initiated under the action plan after the project lifespan.

The sustainability plan was launched at the midpoint of the Project through a feasibility study defining a roadmap to sustainability. This roadmap included different phases covering the last two years of the action plan:

- A screening phase, aimed at carrying out an in-depth analysis of the Action Plan, in order to select the actions which deserve to be continued after the completion of the project and to scrutinise viable options to make this happen
- A consultation phase, aimed at collecting additional information to complete the screening of the actions through direct consultations with all relevant stakeholders inside and outside the organisation
- A design phase, allowing the team to draft the sustainability plan, defining, for each selected action, grounded hypotheses about how it would continue
- A transitional phase, aimed at testing the hypotheses developed in the design phase and actually start developing the new arrangements envisaged in the sustainability plan.

The whole process led to the drafting of the final sustainability plan which was used at UPD as a basis for negotiation with the university management to ensure a future for the action plan.

### C. Capacity and Transferability Considerations

The **internal organisational coordination** can be regarded as a benchmark for different reasons: being based on volunteering, it is a way to foster the involvement of all the organisational units concerned in the institutional embedment process of RRI; it makes it possible to adapt the RRI-oriented actions to the features of each unit; it fosters the identification of "RRI champions" in the different parts of the organisation, who are able to mobilise their colleagues and staff members vis-à-vis RRI; it makes it possible to create institutional interfaces for the managers at different levels of the organisation.

The **establishment of links with external stakeholders** is a strategy which often proved to be effective in the RRI-oriented governance setting process. In fact, RRI cannot be understood as part of the organisation's "internal affairs". Rather, any RRI-oriented action, regardless of its features and contents, is immediately part of the broader dynamics that go beyond institutional boundaries and affect other stakeholders at national or local level. Thus, the experience at UPD suggests that no institutional embedment of RRI is possible without enlarging the scope of the action to encompass the most important external stakeholders.

The **sustainability plan** can be regarded as a benchmark for two main reasons. First, it provides a feasible and transferable procedure to address the problem of sustainability in explicit and effective ways, fully involving the management of the organisation and key actors through a consultation process. Moreover, the sustainability plan also plays a critical role, allowing for better assessment of the activities carried out in order to select those which proved to be useful and which deserved to be continued.

### D. Enablers

The **major enablers** identified in the case of this AE are:

- Specific funds provided by an external entity (the European Commission)
- The chance to work with other institutions facing similar problems
- The strong commitment of the leadership (especially in launching a network of referents)
- General mobilisation on gender equality also among public institutions and governmental entities (which cannot be taken for granted when other RRI keys are concerned).

## *1.4. RRI policies at Universitat Autonoma de Barcelona (INV1 #237)*

### A. Short Description

The Universitat Autonoma de Barcelona (UAB) has long been engaged in promoting and implementing RRI-oriented actions and strategies, regarding different RRI keys (public engagement, gender equality, ethical issues, education, open access), benefiting also from the participation of UAB in several RRI-focused EC-funded projects. Among the RRI-oriented activities, the following can be mentioned: the establishment of an Observatory for Equality; the creation of an Ethics Committee; the development of different initiatives aimed at public engagement and education (including the creation of an Institute for Science Education and an observatory for the spread of science); the creation of the Intellectual Property and Open Access website for open-access publication (Open Access Institutional Repository) and providing support to the staff about these issues.

### B. Benchmarks

The analysis of the rich experience of UAB on RRI led to the identification of two practices as benchmarks for RRI-oriented governance setting.

#### Multiple focal points for RRI actions

In order to pursue RRI-oriented objectives, UAB adopted an approach aimed at creating multiple focal points for action focused on different RRI keys.

For example, as regards gender equality issues, an Observatory for Equality was established, endowed with its own website, responsible for periodically defining and implementing an equality action plan, disseminating information, conducting studies and collecting data, and the provision of advisory services to groups and offices.

Similarly, as for public engagement and science education, many activities are promoted by the Institute for Science Education, which carries out initiatives of different kinds (including training courses, workshops, meetings, science communication events, outreach activities, etc.), thus playing the role of both institutional referent for these kinds of activities and promoter of cultural change among UAB researchers and administrative staff.

An Ethics Committee was also created to manage ethical issues connected to research activities, which also functions as a reference point for the Catalan research system as a whole.

#### Light integration of RRI keys

As a consequence of the decision to create multiple focal points on RRI, UAB had to address the problem of integrating them, with the aim of developing a unique recognisable RRI policy at university level.

A light integration approach was developed, i.e., integration which did not entail the creation of new organisational units or structures, but based on the establishment of a common policy and communication framework, which includes at least four different forms of integration.

- RRI has become part of UAB's mission.
- RRI has been connected with other basic UAB policies, including HR Excellence in Research policies, recruitment policies and career development policies.
- The many activities and actors engaged in specific RRI keys are conceptually presented and communicated on the institutional website as part of a unique overarching RRI policy, so as to make it clear and visible that the different focal points on RRI are integrated.

### C. Capacity and Transferability Considerations

The **multiple focal points for RRI actions** can be regarded as a benchmark, since they make it possible to address one of the main problems RRI meets on its path towards institutionalisation, i.e., the need to keep a source of mobilisation active (resources, ideas, people, strategies, etc.) to feed the change process permanently. The establishment of various pro-active focal points managed by dedicated teams prevents the risk of bureaucratising the approach to RRI, keeping alive also the interest of staff and students.

The adoption of a **light integration of RRI keys** can be viewed as a benchmark in that it allows for the strategic and communicative integration of different keys (seeing them as part of the same overall strategy aimed at embedding RRI in the organisation), but at the same time it avoids an organisational integration of activities (for example, having a single body of staff to deal with all the keys), which risks overlooking the fact that the keys are very different in nature and require diversified approaches to be implemented.

### D. Enablers

The **major enablers** identified in the case of this AE are:

- A clear and explicit strategic approach from leadership
- The strong commitment of the leadership over time
- The capacity to access different funds
- An advanced approach to institutional communication.

## 2. Internally-initiated normative model (Model B)

The analysis did not succeed in identifying any AEs which adopt an internally-initiated normative model of governance setting (Model B). "Internally-initiated model" means that the model is shaped by and relies upon the actors acting inside the organisation; "normative model" means that the model is designed to induce RRI-oriented institutional changes by first modifying the existing norms (procedures, guidelines, protocols, rules or organisational charters, etc.) which are dominant within the organisation.

This does not mean that the normative dimension is not considered in internally-initiated governance setting models. For example, in the cases presented in the previous section, new rules, standards or reference procedures have been established. Rather, this only means that a normative top-down approach to RRI is very difficult to develop, even in the most hierarchically structured or centralised organisations. For this reason, it is rare to find internally-initiated experiences which start by changing norms in order to then modify the social patterns inside an organisation.

To be implemented, RRI probably anyhow requires the activation of a consensus-building process. This is also true in cases of externally-initiated models (see Section 5 in this regard). The real difference is that, in the latter cases, adopting a normative approach is much easier than in the cases in which an internally-initiated normative model is applied.

# 3. Internally-initiated knowledge-oriented model (Model C)

In this section AEs are considered which adopt an internally-initiated knowledge-oriented model of governance setting (Model C). "Internally-initiated" means that the model is shaped by and relies upon the actors acting inside the organisation; "knowledge-oriented model" means that the model is designed to induce RRI-oriented institutional changes by first modifying the way in which knowledge is produced in the organisation, i.e., producing knowledge on RRI and/or adopting RRI principles and tools in producing knowledge.

Two AEs falling within this Model are presented.

## *3.1. Synbiochem (INV1 #19)*

### A. Short Description

The University of Manchester Synthetic Biology Research Centre for Synthetic Biology of Fine and Speciality Chemicals (Synbiochem) is a research institute aimed at developing cutting-edge research in the field of synthetic biology, leading to new products and methods for drug development. Synbiochem adopts an interdisciplinary approach and works in partnership with all four faculties of the University of Manchester. The institute includes an RRI platform for developing major programmes on the ethical and regulatory aspects of research, also including real-time assessment and anticipation of research and innovation trajectories, deliberation and reflection, and collaborative development.

### B. Benchmarks

Two main practices have been selected as benchmarks for RRI governance setting.

**RRI integration in the productive process**

All the projects at Synbiochem go through a cycle-shaped process which involves three technology platforms, i.e. Design, Build, and Test platforms. They are supported by two other platforms: the data platform provides support at all levels for data acquisition, curation and analysis; the RRI platform develops major programmes on the ethical and regulatory aspects addressed by the projects.

In particular, the RRI platform includes the following processes:

- Real-time assessment and anticipation to assess research targets, commercial applications and innovation pathways
- Ethics and deliberation processes to anticipate potential risks, as well as ethical, legal, and regulatory issues
- Providing the necessary expertise for analysing life-cycle and sustainability implications

- Fostering collaborative development by promoting engagement and deliberation processes with scientists, companies, external stakeholders and publics, as well as by providing researchers with training services.

The RRI Platform is, therefore, fully integrated in the production process in all its steps.

**Establishment of an RRI unit**

Symbiochem created an internal RRI Group in charge of providing RRI expertise, guidance and training, thus defining an RRI process supporting all steps of the research and innovation process at Symbiochem. The unit manages the RRI Platform (see above) and assists Synbiochem in providing training and awareness services to industries, academics, SMEs, young researchers and the public at large.

The role played by the RRI Group is also evident in the organisational structure of Synbiochem. The Synbiochem Cabinet (the organisational structure supporting the three directors in managing the organisation) also includes the head of the RRI Group as permanent member.

### C. Capacity and Transferability Considerations

**RRI integration in the technology process** is regarded as a benchmark for at least three reasons. First, RRI is conceived as a component of the research and innovation process and not as an external or additional (and marginal) part of it. This recognition is even more important considering that Synbiochem's aim is to market new products as rapidly as possible, thus showing that RRI also plays a role in the private sector. Secondly, RRI integration is conducted in an interdisciplinary process of co-creation, involving different competences, thus including those related to RRI. Finally, this practice shows that RRI principles and approaches can be turned into routinary processes, fully embedded into the current organisational practices.

The **establishment of an RRI unit** is probably the most direct way to embed RRI in an organisation. The RRI Group at Synbiochem is visible, has its own budget and responsibilities, develops its own programmes and is represented in the leadership of the institution. It is worth noting that the importance attributed to the RRI Group is connected to and reflects the full embedment of RRI in the research and innovation process through the RRI platform. Therefore, the two practices selected at Synbiochem, although different from each other, are closely interlinked.

### D. Enablers

The **major enablers** identified in the case of this AE are:

- The strong commitment of the leadership
- The advanced approach adopted in developing and managing the production process
- The importance attributed to RRI in the UK research system.

## *3.2. Midstream Modulation at TU Delft (INV1 #12)*

### A. Short Description

At the Technical University of Delft, in the Netherlands, the Midstream Modulation approach was tested in 2008. The core of this approach consists of the inclusion of humanists and social researchers in laboratory work to orient decisions and reflection. The test was developed by adopting a specific protocol, allowing the team in charge of the project to discuss ethically relevant topics with laboratory staff, as well as normative issues and the ways in which decisions are taken. Midstream Modulation has been also applied in other organisational and national contexts.

### B. Benchmarks

One aspect of Midstream Modulation has been identified as a benchmark for RRI governance setting.

**Protocol for interdisciplinary integration**

In two laboratories, a group of social researchers worked with biologists for 12 weeks using the STIR (Socio-Technical Integration Research) protocol. The embedment of social researchers was variable (from 12 hours per week to once per month). A set of ethically relevant topics was discussed in order to drive the decision making process.

The STIR protocol conceptually distinguishes four decision components, i.e., opportunities, considerations, alternatives, and outcomes, from both the technical, and the social perspectives, thus mapping laboratory decisions in real-time. The protocol usually included interactions with research participants consisting of pre- and post interviews, participant observation, and regular application of the protocol and collaborative drafting of visual representations of the research process. It makes it possible to identify otherwise latent values, goals, and other considerations, and creates opportunities to reflect on decisions.

In addition to micro-ethical discussions – lab practices, responsible conduct of research and environmental health and safety concerns – resulting directly from laboratory work, the feedback processes also occasioned discussion of macro-ethical issues, normative issues that apply to the collective social responsibility of a profession, and to societal decisions about technology.

### C. Capacity and Transferability Considerations

The **protocol for interdisciplinary integration** was considered a benchmark for governance setting, since it has the potential to evolve into a more structured procedure allowing for the incorporation of humanists and social scientists into a laboratory staff. The protocol proved to be effective enough to foster reflexive processes, to allow RRI-oriented real-time decisions and to ensure a "light" presence of humanists and social scientists, thus preventing possible conflicts within the staff.

Although the Midstream Modulation approach has been applied as a research tool and not as an institutional procedure in itself, it had many impacts on the concerned research organisations, since it activated long-term cultural changes by pushing engineers and natural scientists to fully embed ethical and societal considerations in their own work. It is worth noticing that Midstream Modulation is the only approach among those identified in the benchmarking process which promotes interdisciplinary work aimed at embedding RRI in the research process in the making.

### D. ENABLERS

The **major enablers** identified in the case of this AE are:

- Close cooperation and strong support from the leaders and researchers concerned
- The involvement of high-quality social scientists and humanists, able to effectively manage and drive the interactions with engineers and natural scientists
- The identification of practicable and economically sustainable forms of institutionalisation of the protocol and, more in general, of the Midstream Modulation approach.

# 4. Externally-initiated social model (Model D)

In this section AEs are considered which adopt an externally-initiated social model of governance setting (Model D). “Externally-initiated model” means that the model is shaped by and relies upon actors acting outside the organisation; “social model” means that the model is designed to induce RRI-oriented institutional change by first modifying the social patterns (cognitive, emotional, relational, behavioural, etc.) which are dominant within the organisation.

One AE falling within this Model is presented.

## *4.1. Fraunhofer Center for Responsible Research and Innovation - CeRRI (INV1 #121)*

### A. Short Description

The Fraunhofer Center for Responsible Research and Innovation (CeRRI) is a research unit based at the Fraunhofer Institute for Industrial Engineering (IAO), which provides services to other institutions and private companies related to Responsible Research and Innovation. In particular, CeRRI developed new approaches and methods that allow research agendas and technology development processes to be need-oriented from the very start, thus increasing the efficient use of research funds and the societal acceptance of future solutions. The staff included members with knowledge and skills from different fields, such as the natural sciences, economics, design, communication, social sciences and computer science.

### B. Benchmarks

Two practices have been selected from CeRRI as benchmarks for RRI governance setting.

**Mainstreaming approach to RRI**

CeRRI offers its clients a wide range of services in which RRI is embedded. This comprehensive approach also emerges from the institute’s organizational structure, which is divided into four teams:

– A team specialised in providing services aimed at fostering **need-oriented research planning**, based on public engagement and including ethical considerations

– A team providing services focused on **process design and transformative methods**, aimed overall at promoting innovation processes based on people’s preferences and initiating new trajectories of socio-technological advances

– A team focused on promoting **diversity in organisations**, by evaluating existing practices, developing recommendations for potential adjustments and facilitating such adjustments

– A team working on **technology transfer research**, seeking to synchronize such advances with public preferences.

RRI is, therefore, viewed as a relevant component of any client's organisational process, including human resources management, research planning, production process, innovation process, and technology transfer, thus resulting in a sort of RRI mainstreaming process.

**Tailored managerial support**

Although the services provided by CeRRI are also directly related to knowledge production and innovation processes, the overall approach involves supporting organisations in modifying their methods or incorporating new ones in their usual working procedures.

Tailored analyses are provided to clients in order to help them initiate the change process, taking into consideration both assessment results and the demands of the organisation for support. Methods and recommendations for actions are also equally tailored to the demands and goals of the client, adopting a fairly flexible mix of tools, which may include, e.g., new leadership and career models, change in the organisational and business culture, co-design, participatory foresight processes or new business models.

### C. Capacity and Transferability Considerations

The **mainstreaming approach to RRI** developed at CeRRI can be viewed as a benchmark since it makes it possible to connect RRI with all the problems that a research institution is facing, thus overcoming an "additive logic" according to which RRI is not a new way to do the old things but something researchers and managers have to do in addition to the already established objectives and practices.

The provision of **tailored managerial support** is a consequence of RRI mainstreaming. CeRRI's efforts involved defining a customised RRI profile for the target organisation, resorting to a wide range of tools. The key concept is that of transforming specific demands from the target organisations in RRI terms, applying a design method allowing the shift from the existing situation to a new advanced one. The underlying objective is that of activating a cultural change process in the organisation towards RRI, even though – especially in case the concerned organisation is a private organisation – the concept of RRI is often not used, since it is not easily comprehensible by the client.

### D. Enablers

Two **major enablers** in terms of transferability can be identified in the case of these practices:

- The real motivation of the organisation that asks a support from an external expert organisation to actually accept an external guidance and to invest its own resources on RRI
- The attitudes of the organisation's staff to cooperate in the process, since the introduction of RRI-oriented managerial schemes necessarily involves widespread commitment from staff.

# 5. Externally-initiated normative model (Model E)

This section considers AEs which adopt an externally-initiated normative model of governance setting (Model E). "Externally-initiated model" means that the model is shaped by and relies upon the actors acting outside the organisation; "normative model" means that the model is designed to induce RRI-oriented institutional changes by first modifying the existing norms (procedures, guidelines, protocols, rules or organisational charts, etc.) which are dominant within the organisation.

Four AEs falling within this Model are presented below.

## *5.1. Responsible Innovation Programme - MVI (INV1 #4)*

### A. Short Description

In 2009, the Dutch Research Council (NWO), which is the major research funding agency in the Netherlands, launched the Responsible Innovation Programme (MVI), characterised by RRI-oriented features and selection criteria, and especially the consideration of the ethical and societal aspects of the proposed innovation projects at an early stage. Moreover, applicants are requested to actively involve stakeholders in project implementation and in the management of its results. An interdisciplinary approach, mixing humanities, natural sciences and social sciences, is also included in the criteria to be adopted.

### B. Benchmarks

Two practices have been selected from MVI as benchmarks for RRI governance setting.

**RRI-related criteria for research funding**

MVI is a funding scheme aiming to make RRI a mainstreaming approach to research and innovation in the Netherlands. On the one hand, it is connected to the other major funding schemes developed by NWO and, on the other hand, it provides research grants for projects involving many societal challenges, including energy transition, health and quality of life, circular and bio-based economy, digital society and sustainable water.

Central characteristics of the projects eligible for funding are as follows:

- Ethical and social aspects should be included in the innovation design process from the onset. Stakeholders are closely involved in research and research results should be suitable for practical implementation
- Researchers in the humanities, exact sciences and social sciences should work together on the projects and take a collaborative, interdisciplinary approach to an issue based on their respective fields
- During the selection process, all research projects are assessed according to social relevance and result applicability. In addition, each project also has a valorisation panel comprising representatives of governments, businesses, civil society organisations and citizens

who use the innovations, who have to take them into account when formulating policy, or who may – unintentionally – be affected by them.

The selection process is done on the basis of:

- The general scientific quality of the proposal
- The scientific quality within the MVI framework, which includes three criteria: multidisciplinary and interdisciplinary scientific collaboration; the incorporation of ethical and societal aspects in the design process of the innovation pathways; the international orientation and/or collaboration of the proposal
- Societal relevance and knowledge utilisation, involving different criteria, such as the societal importance and relevance of the proposal to the Top Sector, as identified at national levels, the involvement of the valorisation panel or the degree to which users are involved in the dissemination and communication of research results.

The size of grants varies from 125,000 to 250,000 Euros.

**RRI-oriented platform and networking**

In 2016, the MVI research programme developed into a platform for responsible innovation to provide information, inspiration and contacts for researchers, companies, government bodies and societal organisations. The platform is also intended as a tool for supporting the so-called "NWO-MVI" community, involving both researchers and private partners, financially contributing to the implementation of the projects. Remarkable efforts were made to involve young researchers, also through the "NWO-MVI Young Responsible Design Award", a competition aimed at students, young researchers, designers and entrepreneurs, requiring them to create an innovative responsible design or idea to solve an urgent societal problem.

Networking is also promoted, fostering exchanges of experience and knowledge on the application of MVI approach. An NWO-MVI Conference is organised each year on issues concerning the application of responsible innovation principles. A newsletter is also issued. In addition, the platform develops customised meetings and events, such as workshops in which research results and experiences can be shared. The platform regularly acts as a partner and takes part in activities organised by third parties.

### C. Capacity and Transferability Considerations

The use of **RRI-oriented criteria in research funding** allows for both the inclusion of RRI in all research phases (as in the case of CeRRI), and the linking of the MVI Programme to the strategic research and innovation objectives of NWO and, more in general, of the government, in all relevant research fields. From this perspective, the practice can be regarded as a benchmark for promoting effective embedment of RRI in research institutions, since it represents a potentially impactful incentive for researchers, research institutions and private companies from any research and innovation sector, thus avoiding the risk of RRI becoming part of one specific research sector. Because of the limited size of the grants, the MVI Programme is little attractive for the private companies.

The **RRI-oriented platform and networking** can be considered a benchmark in that they support a normative approach and a social approach by creating a community of actors around the projects funded under the scheme, who are interested in deepening, promoting, and disseminating RRI among research institutions. This is succeeding in creating a common ground on RRI in the Netherlands.

### D. Enablers

Several **enablers** can be identified in the case of these practices:

- A national strategy (implemented both by the Ministry of Education, Culture and Science and by NWO) promoting RRI and connecting it to the "top sectors" for the Dutch innovation policies
- The availability of research funds devoted to RRI-oriented research
- Strong prior connections between research institutions, private sectors and other stakeholders
- A high level of motivation and interest in RRI on the part of researchers and research institutions.

## *5.2. BIOTEK 2021 (INV1 #7)*

### A. Short Description

In 2012, the Norwegian Research Council (NRC) established the Biotechnology for Innovation – BIOTEK 2021 Programme as part of the implementation of the 2011-2020 National Strategy for Biotechnology and as the continuation of the previous programme on functional genomics (FUGE). BIOTEK 2021 covers four substantive fields (marine sector, medical sector, industrial biotechnology sector, and agricultural sector) and four cross-cutting focus areas, one of which concerns the relations between biotechnology and society.

### B. Benchmarks

Two practices have been selected from BIOTEK 2021 as benchmarks for RRI governance setting.

**RRI embedment in funding schemes as a core issue**

Although BIOTEK 2021 is focused on biotechnology-related innovation, its mission and objectives are described as fully merged with RRI-related considerations. Based on the government's strategy in the biotechnology sector to prioritise "areas in which there is convergence between national competitive advantages or major social challenges and the opportunities inherent in biotechnology", the Biotek 2021 Programme aims "to develop biotechnological innovation and focus on the application of research results as a means of promoting value creation and industrial development geared towards solving major societal challenges in a responsible manner".

This attempt to fully embed RRI as a core issue is also given visibility in the communication of the BIOTEK 2021 Programme. In the official website, RRI is presented as "a strategic priority under the BIOTEK 2021 Programme and refers to an approach in which research, technology development and innovation are viewed as socially interwoven processes".

It is worth noting that other funding schemes developed by the Norwegian Research Council adopt the same approach. This is the case, for example, of the Research Programme on Nanotechnology and Advanced Materials (NANO2021) and the Initiative for ICT and digital innovation (IKTPLUSS).

**RRI framework for applicants**

All BIOTEK 2021 applicants are asked to take into consideration, in preparing their applications, to the "Framework for Responsible Innovation under BIOTEK 2021", a document explaining how RRI is interpreted by the funding agency, why it is considered an essential component of the funding programme and how RRI can be promoted and monitored. The framework is largely based on EC documents.

In this way, applicants are not simply required to use some specific criteria while presenting their project proposals, but are invited to see RRI as one of the major factors entirely shaping the proposal and its logic, assuming – as it were – the point of view of RRI in developing their project ideas.

### C. Capacity and Transferability Considerations

The practice adopted by the Norway Research Council, aimed at placing **RRI at the core of the funding scheme**, has been regarded as a benchmark since it is quite rare to find research programmes in which the research and innovation objectives themselves are described through the "vocabulary" of RRI, which is, therefore, also symbolically displayed as a central axis of the programme.

The development of an **RRI framework** as the reference scheme to be considered in the application process is largely connected to the previous practice. The presentation of a "theoretical" framework adopted by the funding agency urges applicants to see and interpret RRI as part of the project. In this way, RRI cannot be restricted to some specific components of the project and be expressed in some boxes to be ticked in the application form.

### D. Enablers

Several **enablers** can be identified in the case of these practices:

- Having a national RRI strategy
- The availability of research funds devoted to RRI-oriented research
- A high level of motivation and interest in RRI on the part of researchers and research institutions.

## 5.3. Challenge-Driven Innovation - CDI *(INV1 #91)*

### A. Short Description

The Challenge-Driven Innovation (CDI) Programme is a research programme established by the Swedish research funding agency VINNOVA in 2011. The programme promotes the development of new, sustainable solutions with international eminence that can meet crucial societal challenges. Projects under this funding scheme are expected to be "visionary"; challenging existing mental models, in order to contribute to the development of a more sustainable society and solving societal challenges.

### B. Benchmarks

One practice has been selected from CDI as a benchmark for RRI governance setting.

**Three-stage procedure to research funding**

To be selected for funding under CDI, the project proposals should match certain requirements such as: combining social benefit and international business potential; being based on cooperation among different sectors, such as civil society, industry, academia and the public sector; developing solutions jointly with users, customers and other relevant parties; being gender-equal, so that both men and women receive a share of the grant and are involved in the project on equal terms.

A three-stage procedure to research funding was developed for the CDI programme.

In Stage 1 (Initiation), applicants are requested to initiate the project on the basis of the project proposal, further developing the project concept and expanding collaborative network. The maximum grant is SEK 500,000, covering up to 80% of the total costs. The duration of this stage is approximately 9 months.

In Stage 2 (Collaboration), applicants are asked to develop and test the proposed solutions, albeit on a limited scale. The maximum grant is SEK 10,000,000, covering up to 50% of the total costs. The duration of this stage is approximately 2 years.

In Stage 3 (Implementation), applicants should test and implement the solutions on a full scale. The maximum grant is between SEK 5,000,000 and 20,000,000, covering between 25 and 40% of the total costs.

Each stage is more competitive than the one before. Also to be noted is that, as risks lessen and results become better established, applicants' financial participation in the project also increases.

### C. Capacity and Transferability Considerations

The **three-stage procedure to research funding** developed under the CDI programme can be regarded as a benchmark from different angles.

- While based on a top-down normative approach, with strictly defined expected features of the project proposals, it also leaves applicants free to define the key elements of their projects: the societal challenge to be tackled, the solutions to be developed, the actors to be involved and how to involve them.
- The procedure makes it possible to activate a learning process among the applicants, through an iterative process, about how to use RRI to shape innovation projects.
- The approach tends also to progressively move the focus of responsibility on the project from the funding agency to the applicants and the network of actors they involve, thus feeding a sense of ownership of the project and of the RRI-oriented philosophy underlying it.

#### D. Enablers

Different **enablers** can be identified in the case of these practices:

- Having a national RRI strategy
- The availability of research funds devoted to RRI-oriented research
- A high level of motivation and interest towards RRI on the part of researchers and research institutions
- A favourable environment for activating collaborative processes.

## *5.4. EuroPriSe (INV1 #290)*

#### A. Short Description

EuroPriSe (European Privacy Seal) is a privacy certification system for IT products, IT-based services and websites that are compliant with the EU data protection system. The certification system, established in 2008, is managed by the Institute of Technology Assessment (ITA) of the Austrian Academy of Science. The origin of EuroPriSe is to be found in two EC-funded projects carried out by ITA and other partners, which led to the definition of a set of guidelines and criteria for data protection compliant and privacy enhancing security technologies.

#### B. Benchmarks

One practice has been selected from this AE as a benchmark for RRI governance setting.

**Certification process**

EuroPriSe is based on a certification process initiated by the manufacturers or vendors of IT products and IT-based services. The process consists of an evaluation of the product/service by qualified legal and IT experts and a validation of the evaluation report by an independent certification authority. The certification may be obtained through the following steps:

1. Choose and contact a legal and a technical expert from the expert register compiled by EuroPriSe
2. Discuss evaluation with experts

3. Contact the certification authority and schedule a preparatory first meeting
4. Agree on evaluation with experts
5. Apply for certification and conclude a Certification Agreement with the Certification Authority
6. Experts conduct evaluation
7. Manufacturer/Service provider hands in
   - Evaluation Report (confidential) compiled by a legal and technical expert and approved by the manufacturer
   - Short Public Report (public) compiled by a legal and technical expert and approved by the manufacturer.

The EuroPriSe criteria are adapted and updated to changes in EU privacy legislation as well as to developments in information technology. Admission and updating workshops for experts are also organised. The list of certified products/services and public reports on them are available on the EuroPriSe website.

#### C. Capacity and Transferability Considerations

The certification process is evidently important in this report since it concerns an aspect which falls into the sphere of RRI, i.e., developing scientific and technological products, anticipating potential impacts and preventing risks (in this case, preventing a human right violation, namely, the right to privacy).

In principle, this kind of certification should be regarded as aimed at protecting users and citizens and not at embedding RRI-related practices in research and innovation actors.

However, different impacts related to the embedment of RRI are entailed in such a practice:

– It contributes to the visibility of RRI-related instances and issues
– It contributes to developing a community of practices around the application of RRI-oriented criteria in research and innovation
– It contributes to propelling an RRI-oriented culture among researchers and technology developers prompting them, e.g., to prevent risks and anticipate impacts and people’s needs
– It provides clear and updated criteria which make it possible to incorporate ethical or societal considerations in the design of new technologies and technology-based services (in this case, adopting a “privacy by design” approach)
– It helps match the gap between general principles or norms (in this case, those related to privacy protection) and their implementation in tangible criteria, practices and solutions.

### D. ENABLERS

Two main **enablers** can be identified in the case of these practices:

- The capacity to create a demand for certification that is large enough to sustain the certification process and the business model underlying it
- Having initial investments (in this case, two EC-funded projects) for the development of an effective and sustainable certification system.

# 6. Externally-initiated knowledge-oriented model (Model F)

This section considers AEs which adopt an externally-initiated knowledge-oriented model of governance setting (Model F). “Externally initiated model” means that the model is shaped by and relies upon the actors acting outside the organisation; “knowledge-oriented model” means that the model is designed to induce RRI-oriented institutional changes by first modifying the way in which knowledge is produced in the organisation, i.e., producing knowledge on RRI and/or adopting RRI principles and tools in producing knowledge.

One AE falling within this Model is presented.

## *6.1. SoScience (INV1 #76)*

### A. Short Description

SoScience is a small private enterprise based in Paris providing advice and consultancy services to companies and organisations in the development of new research and innovation programmes shaped around RRI. SoScience was established in 2013 but it took two years before getting the first consultancy services.

### B. Benchmarks

Two practices have been selected from this AE as a benchmark for RRI governance setting.

**Business-oriented approach to RRI**

The main element characterising SoScience is their view of RRI, not as a limitation for companies (limiting energy consumption, waste, pollution, resources, etc.), but as a cognitive framework for them to identify new market opportunities linking research and innovation projects to societal and environmental challenges, thus developing new marketable solutions.

This general philosophy led SoScience to develop methods and tools aimed at making it feasible and productive. The consultancy process involves four main steps.

- The first step consists of the organisation of interviews or workshops with the company management and staff, in order to define the issues to be addressed, needs and expectations.
- The second step revolves around the development of an Opportunity Matrix. This is a method developed by SoScience in order to visualize the interactions between drivers, societal challenges and the company’s expertise.
- The third step is aimed at producing an analysis report of the opportunities identified in order to orient the decision making process.
- Finally, in the last step, a Responsible Innovation Taskforce inside the company is created in order to develop the research and innovation pathways emerging from the previous steps.

To define the project further, a set of research criteria for responsible innovation were provided, regarding, among other things, some of major RRI dimensions, including anticipation, reflexivity, responsiveness and inclusion.

**Partnership-like approach to consultancy services**

The second element characterising SoScience is that consultancy services are provided on the basis of a partnership-like approach. The example provided by SoScience actually shows the experts making a direct commitment to the success of the new initiative, so that, even though the consultancy nature of the support given to a company is never in doubt, the motivations and personal commitment of the experts play an important role in the success of the initiative.

It is difficult to define such an approach as a "practice" describable in terms of specific actions or a conceptual framework. Rather, it can be viewed as a sort of psychological orientation of the experts which provides the basis for a "temporary partnership" involving SoScience and its client. This is viewed the only way to addressing the many cultural barriers to RRI.

### C. Capacity and Transferability Considerations

The **business-oriented approach to RRI** is considered a benchmark for three main reasons.

- The approach addresses the perceived disconnection between RRI and business, which is one of the main obstacles preventing companies from embracing RRI-oriented solutions. In fact, companies often experience or view RRI-sensitive solutions as more expensive and less competitive than traditional ones. The efforts made by SoScience focus on bridging this gap, providing companies with tools and methods to find solutions which are both responsible and profitable.
- The approach is logically original but relatively simple to replicate in other contexts, to the extent that it is managed directly by the companies themselves (thus shifting from an externally-initiated to an internally-initiated knowledge-oriented model).
- The method allows for the establishment of a strong partnership between consultants and company staff, based on a "co-creation" approach in which the activation of the interests and motivations of both participants plays a key role.

As for **partnership-like approach to consultancy services**, this is an important, although intangible, element that plays a pivotal role in the case of SoScience, and which is probably present in many other RRI-oriented experiences. It is, in fact, difficult to trigger complex processes of change in a given organisation or company – like those related to RRI – without modifying, at least partially, the way in which managers perceive their work or organise their projects. This can be done only when external support is given, not in a context of "cold" professional relationships but in one where partnership-based co-creation processes are activated.

### D. Enablers

Two main **enablers** can be identified in the case of these practices:

- The company leaders' sensitiveness towards RRI
- The demand for RRI-oriented solutions in the private sector.

# 7. Network-initiated social model (Model G)

This section considers AEs which adopt a network-initiated social model of governance setting (Model G). "Network-initiated model" means that the model is shaped by and relies upon the actors in cooperation relationships involving the RFPO concerned and other organisations; "social model" means that the model is designed to induce RRI-oriented institutional changes by first modifying the social patterns (cognitive, emotional, relational, behavioural, etc.) which are dominant within the organisation.

One AE falling within this Model is presented.

## *7.1. University Network Education by Responsibility (INV1 #213)*

### A. Short Description

The University Network Education by Responsibility (Hochschulnetzwerk Bildung durch Verantwortung) is an association of universities (37 at present) that aims to strengthen the civic engagement of students, teachers and other university members. Formally established as an association in 2015, the University Network provides associate members with expertise, resources, learning and knowledge exchange opportunities, advocacy and lobbying, and joint research programmes. This is mainly done through "Service Learning", a teaching approach which combines lecture hall or classroom and civic involvement, engaging students and teachers in working with communities while learning and teaching.

### B. Benchmarks

One practice has been selected from this AE as a benchmark for RRI governance setting.

**RRI-oriented comprehensive training**

To support colleges on the way to becoming a committed university, the University Network has established the Academy for Education through Responsibility. The Academy offers courses, coaching, and counselling and organises workshops on issues related to university civic engagement and third mission. Academy activities were set in motion thanks to a temporary fund from the Robert Bosch Foundation.

Moreover, the Academy offers the certificate course "Campus and Community", which started in September 2015 and organised in cooperation with the Danube University Krems. The course is aimed at training the participants in developing initiatives and programmes fostering a cooperation between universities and local communities. For this reason, in this case the target group includes, not only the officers in charge of university development and strategy, research and teaching, but also people in positions of responsibility from civil society organisations and associations. The certificate course runs for two semesters and offers 30 credits. In addition, graduates receive a corresponding university certificate.

A toolbox was also developed to address different issues, including public relations and lobbying, civic engagement, community based research, service learning, and social entrepreneurship.

In order to offer better support to university institutes, the Academy also created a pool of experts and instructors to provide advice and counselling on service learning, third university mission and civic engagement and related topics. They can be contacted individually and provide tailored support for university institutes requesting help.

### C. Capacity and Transferability Considerations

Rather than being a single practice, the **RRI-oriented comprehensive training** is a set of coordinated practices revolving around the idea of making universities' societal engagement a subject of research and teaching or even a disciplinary field, the core of which is the development of a scientific education sensitive to societal considerations. The Academy is based on networking relationships involving a considerable number of universities, thus producing an impact at national level. The establishment of a pool of experts in these matters enhances the effectiveness of such an approach, which, due to all these features, can be considered a benchmark which could be replicated in other national contexts.

### D. Enablers

Two main **enablers** can be identified in the case of these practices:

- The availability of initial investments and regular financial support
- A culture of societal engagement among university leaderships and researchers, which is sufficiently developed so as to create a critical mass of higher education institutions interested in participating in the network.

# 8. Network-initiated normative model (Model H)

This section considers AEs which adopt a network-initiated normative model of governance setting (Model H). "Network-initiated model" means that the model is shaped by and relies upon actors in cooperation relationships involving the RFPO concerned and other organisations; "normative model" means that the model is designed to induce RRI-oriented institutional changes by first modifying the existing norms (procedures, guidelines, protocols, rules or organisational charts, etc.) which are dominant within the organisation.

One AEs belonging to this Model is presented.

## *8.1. Athena SWAN Charter (INV1 #120)*

### A. Short Description

Athena SWAN Charter was established in 2005 to encourage and recognise commitment to advancing the careers of women in STEM employment in higher education and research. It was established by the Athena Project, promoted by a group of women academics, with the support of the Scientific Women's Academic Network (SWAN). Athena SWAN promotes a network connecting research institutions who applied for an Athena SWAN Award (bronze, silver and gold). The Charter is managed by the Equality Challenge Unit, a registered charity funded by the Scottish Funding Council, the Higher Education Funding Council for Wales and Universities UK, and through direct subscription from higher education institutions in England and Northern Ireland. Around 590 university departments and 140 research institutions have received awards so far.

### B. Benchmarks

Three practices have been selected from this AE as a benchmark for RRI governance setting.

**Three-level award system**

There are three levels of awards available for institutions and individual departments. Members are encouraged to work through three levels: Bronze, Silver and Gold.

- Bronze awards recognise that an institute has a solid foundation in eliminating gender bias and developing an inclusive culture that values all staff. This includes: 1) an assessment of gender equality in the institute, based on quantitative (staff and student data) and qualitative (staff feedback on policies, practices, systems and arrangements) evidence, and identification of both challenges and opportunities; 2) a four-year plan that builds on this assessment, information on activities that are already in place and what has been learned from these; 3) The development of an organisational structure, including a self-assessment team, to carry proposed actions forward.
- Silver awards recognise that the institute has taken action in response to previously identified challenges and can demonstrate the impact of these actions. Institutes need to dem-

onstrate how well Athena SWAN is embedded within the institution with strong leadership in promoting charter principles and should highlight the impact of Athena SWAN activities.

- Gold awards recognise a significant and sustained record of activity and achievement by the institute in addressing challenges across the full range of the institute and promoting gender equality within and beyond the institute. Applications should demonstrate how Athena SWAN is completely embedded within the institute with strong leadership in promoting and championing charter principles. The institute should also demonstrate that they have taken an intersectional approach to analysing data and devising possible solutions to identified challenges.

Award-holders have to re-apply after a set period of time. These renewals also require evidence of progress and the successful completion of earlier action plans. The withdrawal of an award or the granting of an award at a level below the one applied for is also possible.

**Self-assessment and peer-reviewing process**

The award process is based on a mix of self-assessment and peer-review.

In the first stage of the process, applicants are required to implement a self-assessment of the situation, where obstacles are expected to be identified and then addressed in the action plan. Self-assessment should also include quantitative (staff and student data) and qualitative (staff feedback on policies, practices, systems and arrangements) evidence, and identification of both challenges and opportunities.

In a following stage, applications are reviewed by awards panels, usually made up of five people. Each panel usually review up to five applications per sitting. Presently, around 630 people are registered as potential panellists. They are drawn from different groups of people, including: academics and technical services staff; human resources or equality and diversity practitioners with experience of higher education; specialists (for example industry and research institute representatives, members or employees of learned and professional societies, gender equality and diversity specialists as appropriate); students.

**Local networks**

Under the Athena SWAN, local networks at regional level have been established across UK, allowing representatives from the institutions that are signatory of the Athena SWAN Charter to have a recognised, geographically co-located peer group with whom they can collectively consider gender equality challenges and priorities and to access the Equality Challenge Unit staff members in charge of Athena SWAN to get advice on best practice and guidance on procedure.

The networks pursue a number of aims, including:

- Facilitating knowledge and information sharing and mutual learning
- Developing appropriate approaches to tackle gender equality challenges
- Providing opportunities to update others on planned and on-going work to advance gender equality
- Providing a non-judgemental and non-prejudicial environment in which to network with other staff undertaking work related to the Athena SWAN Charter

– Agreeing, where possible, on joint approaches to tackling challenges, and informing and steering, where relevant, work programmes of the Equality Challenge Unit.

### C. Capacity and Transferability Considerations

The **three-level award system** can be considered a benchmark for its almost unique capacity to create mechanisms which foster visible and continuous improvement, thus making it difficult for any institution "to stay still" or to abandon the system. This approach also uses a set of norms to promote changes in the social patterns of managers and staff members within the institutions concerned. In this sense, although based on a normative governance setting model, this AE also includes a significant social model element.

The combination of **self-assessment and peer-reviewing** within the award process is another aspect of the Athena SWAN Charter which deserves to be considered as a benchmark. Athena SWAN awards do not imply a judgmental assessment from a totally independent entity. Rather, for a university or research institution, making an application means starting a negotiation process about gender equality involving all internal stakeholders (self-assessment) and continuing this negotiation with external co-operating peers (peer-reviewing) who are experts in gender issues. This is probably the most effective way to develop a normative model for triggering changes which are socially, culturally and organisationally complex to implement.

The establishment of **local networks** involving the actors concerned is another important component of the Athena SWAN approach. Through the network, the continuous improvement process which the Charter requires is strongly supported through the creation of "places" where it is possible to exchange experiences, to engage in mutual learning processes and to encourage practitioners and experts to hone their skills. Networks allow informal interactions which make the "formal process" actually feasible.

### D. Enablers

Many **enablers** can be identified in the case of these practices. Three of them deserve to be mentioned here:

– Having a favourable policy framework that can connect gender inequality to national research and innovation policies
– Constant investment or resources and policy commitment on gender issues on the part of both the national research system and single research organisations
– Having a widespread community of experts and practitioners on gender issues.

# 9. Network-initiated knowledge-oriented model (Model I)

This section considers AEs which adopt a network-initiated knowledge-oriented model of governance setting (Model I). “Network-initiated model” means that the model is shaped by and relies upon the actors in a cooperation relationship involving the RFPO concerned and other organisations; “knowledge-oriented model” means that the model is designed to induce RRI-oriented institutional changes by first modifying the way in which knowledge is produced in the organisation, i.e., producing knowledge on RRI and/or adopting RRI principles and tools in producing knowledge.

Four AEs belonging to this Model are presented.

## *9.1. CSynBI (INV1 #47)*

### A. Short Description

CSynBI is a synthetic biology research centre established in 2009 through an EPSRC Science and Innovation award designed to stimulate new activity in areas of synthetic biology of national strategic importance. CSynBI includes scientific researchers at Imperial College London and societal and ethical researchers from the Department of Social Science, Health and Medicine at King's College London, who explore the social, political, economic and ethical dimensions of synthetic biology.

### B. Benchmarks

One practice has been selected from this AE as a benchmark for RRI governance setting.

**STEM and social sciences institutional partnerships**

The Centre is the outcome of a partnership between synthetic biology researchers at Imperial College London and social scientists at the Department of Social Science, Health and Medicine at Kings College London. This collaboration makes it possible to combine cutting-edge research and sensitiveness toward societal and policy implications related to synthetic biology.

This approach is reflected in staff composition (including both STEM researchers and social scientists) as well as in research issues (including, for example, research on participatory forms of governance or the social, ethical and political dimensions of life sciences and biomedicine) and training activities.

Moreover, CSynBI researchers are regularly involved in scientific outreach collaborations with designers and artists and public events like an annual research symposium.

Being both part of the Research Group Lab Global Health & Social Medicine of the Department of the King’s College of London and a component of the UK Hub on synthetic biology hosted at the Imperial College of London, CSynBI can also interact with the many other research and teaching activities carried out in both institutes. In particular, at King’s College, other research groups are working on RRI-related issues, such as the governance of emerging technologies and the application of RRI in synthetic biology.

#### C. Capacity and Transferability Considerations

The **STEM and social sciences institutional partnership** represents a practice of particular interest, especially because it involves two institutions which are characterised by different disciplinary backgrounds, one related to STEMs and the other to social sciences, creating a new RRI-oriented research entity that is considered a benchmark and a transferable practice. The main reason is that this approach takes RRI seriously, recognising it as something not to be simply added to current research practices, but to be placed at the very centre of the research and innovation process. The risk is evidently that the two research communities work separately, thus keeping the partnership only on paper. However, this seems not to be the case, considering the many common activities in which the two institutions are involved.

#### D. Enablers

Two **enablers** can be identified in the case of these practices.

- Having top managers who are sufficiently innovative to accept the risks of investing in a new enterprise involving both STEM researchers and social scientists.
- Having a favourable policy and cultural framework making the joint venture acceptable to both STEM researchers and social scientists and allowing RRI to become an "added value" in accessing public and private funds in the research market.

## *9.2. Mistra (INV1 #51)*

#### A. Short Description

Mistra Urban Futures is an international centre for sustainable urban development based in Sweden and established in 2010. It is financed by the foundations Mistra and Sida, together with a consortium comprising: Chalmers University of Technology, the University of Gothenburg, the City of Gothenburg, the Gothenburg Region Association of Local Authorities (GR), IVL Swedish Environmental Research Institute, the County Administrative Board of Västra Götaland, and the Region of Västra Götaland.

#### B. Benchmarks

Two practices have been selected from this AE as a benchmark for RRI governance setting.

**Local interaction platforms**

Mistra Urban Futures offers an arena for the development and transmission of knowledge, based on cooperation with business, interest groups and the general public. This arena takes the form of a Local Interaction Platform (LIP), i.e., a set of formal agreement among stakeholders aimed at co-creation and knowledge exchange allowing trans-disciplinary work and cooperation among different types of knowledge. Each LIP is endowed with staff to facilitate interaction among the actors involved and drive the knowledge production process. Moreover, LIPs allow the production of specific outputs different from scholarly publications and accessible to everyone. So far, five LIPs have been established.

**Joint knowledge production process**

The approach used at Mistra Urban Future is strongly characterised by a knowledge co-creation process, illustrated in a manual[9] used by the different Local Interaction Platforms.

The process is divided into three phases, devoted, respectively, to project formulation, implementation and evaluation. What is important here is that orientations and suggestions for these three phases are made in a way that allows for a joint knowledge production process, i.e., a knowledge co-creation process that can bring together different disciplines, kinds of knowledge and perspectives. The main reason given in the manual for justifying the relevance of a similar approach is that "sustainable development is a vague and ambiguous concept" so that "what the concept means depends upon whom one asks, and in what context it is used". Thus, "the first challenge concerns how the diversity of perspectives, priorities and evaluations which exist among those who influence and are influenced by urban development can be accommodated". Hence the need to "make use of the broad experience and competence which exists within the various groups who live and work in urban areas". Many sharable and transferable practices usefully applicable in any RRI-sensitive research programme are also provided.

### C. Capacity and Transferability Considerations

Both practices identified in the context of Mistra Urban Futures may be regarded as a benchmark for a governance setting focused on knowledge production.

They are clearly mutually interconnected.

On the one hand, **Local Interaction Platforms** provide a permanent and visible infrastructure to make the co-creation process possible. In the context of an analysis focused on RRI-oriented governance setting, such an infrastructure, although largely intangible, is socially active and plays an important role in making the knowledge co-production process a business-as-usual practice.

On the other hand, the **joint knowledge production process** makes knowledge co-production something really feasible and replicable, avoiding an illusory view of co-creation as something spontaneously emerging from interactive relations, without applying any method or rule.

### D. Enablers

Two main **enablers** can be identified in the case of these practices:

- Having triggering investments and a constant flow of resources of different types (in this case, guaranteed by the institutions which are members of the consortium) to develop the projects
- Close relations between project promoters and local stakeholders willing to cooperate.

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[9] Polk, M., Frid, A., Westberg, L. (2013). Mistra urban futures: manual of joint knowledge production for urban change. First English Draft

## 9.3. *Applied Nanoparticles* *(INV1 #124)*

### A. Short Description

Applied Nanoparticles s.l. (AppNps) is a spin-off of the Catalan Institute of Nanotechnology (ICN2), the University Autonoma of Barcelona (UAB) and the Institut Català de Recerca i Estudis Avançats (ICREA), established in 2013, for the development and production of Biogas+, a biogas ready to use additives based on safe and sustainable engineered iron based nanoparticles directed towards the optimisation of anaerobic digestion processes which increase the production of biogas from organic waste. Among the co-founders, there are scientists from these institutions, international RRI experts (Responsible Research and Innovation), and experts in e-communication, business development and technology transfer. The AppNps offices are in Barcelona and the laboratory is in the UAB campus. AppNps business is based on the principles of Responsible Innovation, focusing on the design processes of nanoparticles and low energy consumption, low toxicity, waste minimisation and reduction of emissions.

### B. Benchmarks

Two practices have been selected from this AE as a benchmark for RRI governance setting.

**RRI-sensitive production process**

The company has a staff of 13 people, of different backgrounds including nanoscience, nanotechnology and environmental science, law, marketing, e-communication and graphic design. Ten of them are engaged with the company full-time. The company's management is organised in a way that there is no actual CEO, but responsibility is delegated according to the needs, skills and availability of each member.

A midstream modulation approach was developed through a set of informal meetings, so as to discuss all the technology and business aspects of the company and to deal together with issues and implications, including those related to the environment, health and safety, sustainability, patenting, long-term research and business strategies, ethical issues and science communication.

**RRI-oriented code of conduct**

AppNps adopts an internal Code of Conduct which defines "the principles and standards of ethical conduct that should govern the actions of the related persons in the exercise of their professional activities in their relationship with the company".

The Code includes Responsible Innovation in the mission and ordinary life of the company. In particular, the Code mentions Responsible Innovation principles from both "the point of view of the product (it has to be useful, sustainable and safe) and process (it has to be collaborative and inclusive)". In this way, the Code defines the core ideas on which the company is based: "Innovation directed towards social benefit; ethical considerations of impacts at social and environmental levels; studies on product security throughout its full life cycle, from production to disposal or reuse, addressing the health and safety of workers and consumers".

The key contents of the Code of Conduct have been discussed among company's shareholders and workers.

### C. Capacity and Transferability Considerations

The adoption of an **RRI-sensitive production process** can be considered a benchmark in that it offers the chance of practically adopting RRI as a guiding orientation, leveraging also upon the different disciplines, specialisations and points of view of staff members. The midstream modulation model (see the Midstream Modulation at TU Delf) has been adopted and adapted so as to include societal and ethical considerations in the day-by-day decision-making processes.

The **RRI-oriented code of conduct** provides the basis (both legal and symbolical) for placing RRI at the core of the company's objectives and activities. It is worth noting that many companies, if not the majority of them, establish code of conducts that also include aspects related to RRI (such as those pertaining to gender equality or ethical issues). What is particular is the explicit reference to Responsible Innovation for both the product and process.

Both practices seem to show the possibility of combining RRI and competitiveness and even using RRI to increase the company's level of competitiveness, while often RRI is described as a constraint since it is viewed as inevitably entailing increases in production costs.

### D. Enablers

The main **enabler** is the fact that there is a favourable cultural environment (provided, in this case, by the different Catalan research institutions involved in the establishment of Applied Nanoparticles s.l.) for the creation of advanced spin-offs sensitive to RRI-related issues.

## *9.4. Ethics and Society in the Human Brain Project (INV1 #241)*

### A. Short Description

Ethics and Society is one of the sub-projects of the Human Brain Project (HBP), a H2020 Flagship Project focused on neuroscience, computing and brain-related medicine. The 10-year Project began in 2013 and directly employs some 500 scientists at more than 100 universities, teaching hospitals and research centres across Europe. The project includes 12 sub-projects that span the development of six ICT-based platforms, as well as data gathering, cognitive and theoretical neuroscience, ethics, and administrative services. The Ethics and Society sub-project aims to study the ethical and societal implications of HBP's work and includes different kind of activities.

## B. BENCHMARKS

Three practices have been selected from this AE as a benchmark for RRI governance setting.

**Multiple approach to RRI embedment in research programmes**

Ethics and Society adopts a multiple approach generally aimed at embedding RRI-related issues in the Human Brain Project as a whole. Among the different components of this approach, the following can be mentioned:

- Foresight studies aimed at identifying and evaluating the future impact of new knowledge and technologies generated by the HBP, using a range of methods from action research, interviews, participant observation to literature reviews, questionnaire surveys and expert workshops
- Organisation of public meetings where ethical, legal, cultural, societal, and legal issues related to HBP research are debated, including also stakeholder dialogue on issues of possible controversy and immediate relevance to the HBP
- Studies on conceptual, social, ethical, and regulatory issues related to neuroscientific research and emerging neurotechnologies
- Provision of ethical support to HBP to manage ethical issues, involving also the establishment of an Ethics Advisory Board providing expert advice and support to HBP staff.

**Ethical concerns registration system**

In the context of the Human Brain Project, a rapid way for people to raise ethical issues and to report them to HBP has been established.

This mechanism is called "POint of REgistration" (PORE), an online system geared to registering and identifying these issues, and keeping track of how they are dealt with. PORE registers issues so they can be followed from start to finish. Requests may be submitted by any person within or outside the project, choosing to be identifiable or remaining anonymous. An online form can be filled in and submitted.

Issues may be related but not limited to the planning of experimentation or a phase of implementation. Each registered issue is reviewed by the Ethics Management Team. The team, which includes an ethics manager, decides how best to deal with the issue. The registered issue may be further directed to the Ethics Advisory Board (EAB) or SP12's Steering Committee.

**Ethics Management Team and Ethics Rapporteurs**

The Human Brain Project has a dedicated Ethics Management Team working in collaboration with the ethics and society researchers and HBP management to support best research practices and in close connection with the Ethics Advisory Board (established to support the Team in implementing its functions).

The team interacts with the subprojects through Ethics Rapporteurs. An Ethics Rapporteur is an academic, a scientist, a technologist or an administrator engaged in HBP work, having the responsibility to communicate with the Ethics and Society programme about the Subproject ethics, science and technology work. Ethics Rapporteurs regularly communicate with the Ethics Advisory Board members and with the Ethics Management team. Joint meetings between the three bodies are held annually. This allowed the establishment of a "community" of people who know each other and are used to work together.

### C. Capacity and Transferability Considerations

Although the Human Brain Project has been the subject of controversy on different grounds, the three practices presented above have been considered promising from an RRI perspective.

The **multiple approach to RRI embedment in research programmes** is to be taken as a benchmark since it is a comprehensive approach which fits in well with the complexity of RRI. It combines anticipatory research, an inclusive approach to research, studies on ethical and societal issues related to pertinent research fields and practical mechanisms to manage ethical issues connected to the research process. This kind of approach is conceptually and practically transferable to smaller research programmes.

In addition, the **ethical concerns registration system** is considered a benchmark since it combines ethical issues with public engagement, allowing everyone inside or outside the project staff to raise ethical issues so they may be taken into consideration in the internal research process. Although the system is less used and effective as expected (the issues raised are often little relevant with the project), the idea to create a rapid and open "entry point" for raising ethical issues remains valid and deserves to be further developed.

Also interesting, from the point of view of the analysis of governance setting models, is the establishment of an **Ethics Management Team** using **Ethics Rapporteurs** to link the team to all project units and structures, thus allowing ethical issues to be incorporated in the research process. This largely increased the visibility of ethical and society issues within and outside the Human Brain Project.

### D. Enablers

Many **enablers** can be identified in the case of these practices. Some of them can be mentioned here.

- The availability of dedicated funds for the development of a differentiated set of actions pertaining to ethical issues (in this case, 3% of the total budget of the project).
- Having managers and researchers that are highly motivated vis-à-vis ethical issues and RRI in general.
- The inclusion of the head of the Ethics and Society sub-project in the main governance bodies of the Human Brain Project.
- A high quality project organisation structure to enable the management of interactions between the ethical team and the organisational units concerned.

Chapter Four

# Comments on the benchmarking exercise

This chapter comments on the results of the benchmarking process summarised in the previous chapter.

The benchmarking exercise focused on 18 Advanced Experiences (AEs), found in 8 out of the 9 governance setting models identified. Overall, six of them are internally-initiated AEs, six externally-initiated AEs and six network-based AEs. Moreover, six AEs focus on social patterns, five on rules and seven on knowledge.

The benchmarking process allowed us to identify **36 different practices which have been regarded as a benchmark** from the perspective of establishing effective RRI-oriented governance settings, defining "governance setting" as a process through which a given governance structure (of an institution, project or company) is modified in a way that it can permanently incorporate RRI (in usual procedures, culture, internal relations, organisational structure, etc.).

The table below lists the AEs and the benchmarked practices.

| MODEL | Description | AE | Benchmark |
|---|---|---|---|
| A | Internally-initiated social model | JERRI Project at TNO | 1. Goal setting process<br>2. RRI institutionalisation level analysis<br>3. Transition roadmap to RRI |
| | | LIBRA Project at CeMM | 4. Highly representative enlarged team<br>5. RRI-oriented procedures setting process<br>6. Initial diagnostic analysis |
| | | TRIGGER Project at UPD | 7. Internal organisational coordination<br>8. Links with external stakeholders<br>9. Sustainability plan |
| | | RRI policies at UAB | 10. Multiple focal points for RRI actions<br>11. Light integration of RRI keys |
| B | Internally-initiated normative model | None | |
| C | Internally-initiated knowledge-oriented model | Symbiochem | 12. RRI integration in the productive process<br>13. Establishment of an RRI Unit |
| | | Midstream Modulation at TU Delft | 14. Protocol for interdisciplinary integration |
| D | Externally-initiated social model | CeRRI | 15. Mainstreaming approach to RRI<br>16. Tailored managerial support |
| E | Externally-initiated normative model | MVI, NWO | 17. RRI-related criteria for research funding<br>18. RRI-oriented platform and networking |
| | | Biotek 2021, RCN | 19. RRI embedment in funding scheme as a core issue<br>20. RRI framework for applicants |
| | | CDI, VINNOVA | 21. Three-stage procedure to research funding |

| MODEL | Description | AE | Benchmark |
|---|---|---|---|
| | | EuroPriSe, ITA | 22. Certification process |
| F | Externally-initiated knowledge-oriented model | SoScience | 23. Business-oriented approach to RRI<br>24. Partnership-like approach in consultancy services |
| G | Network-based social model | University Network Education by Responsibility | 25. RRI-oriented comprehensive training |
| H | Network-based normative model | Athena SWAN Charter | 26. Three-level award system<br>27. Self-assessment and peer-reviewing process<br>28. Local networks |
| I | Network-based knowledge-oriented model | CSymBi | 29. STEM and social sciences institutional partnerships |
| | | Mistra Urban Futures | 30. Local co-creation platforms<br>31. Joint knowledge production process |
| | | Applied Nanoparticles | 32. RRI-sensitive production process<br>33. RRI-oriented code of conduct |
| | | Ethics and Society, HBP | 34. Multiple approach to RRI embedment in research programmes<br>35. Ethical concerns registration system<br>36. Ethics Management Team and Ethics Rapporteurs |

The following comments are to be considered provisional, and require more in-depth work and verification in the next steps of the FIT4RRI project.

# 1. The distribution of AEs among the governance setting models

It is useful to first focus on the distribution of AEs among the nine governance setting models identified in the first chapters of this report.

As may be observed in the distribution of the AEs included in INV2 (see Chapter 2, Section 2), 29 out 43 AEs (i.e., almost 70% of AEs) fall within three governance setting models: 13 AEs in Model A (internally-initiated social model); 8 in Model E (externally initiated normative model); 8 in Model H (network-initiated knowledge-oriented model).

This shows that there are **three dominant correspondences** between the two variables (regarding respectively the triggering point and the focus) placed at the basis of the typology of the governance setting models. They are presented below.

– When the governance setting is shaped and promoted internally, within the organisation, it is difficult to start from norms, following a top-down approach, at least when a complex issue like RRI needs to be transferred into the organisation. This does not mean that norms, formal procedures, standards and protocols are not involved in this process. However, they tend to be introduced later or in support of a broader change of social patterns (ideas and visions, dominant behaviours, languages, interaction models, etc.).

- Governance settings shaped and promoted externally, from outside the organisation, are instead more likely to start from a normative approach. This is typically the case of research funding schemes applying RRI-inspired criteria to applicants. A normative approach is evidently easier to apply when the actor triggering the process is different from the organisation embedding RRI and is endowed with some form of power (e.g., that of providing research grants) over the target organisation, allowing it to "impose" some sort of norms.
- Finally, governance settings based on networks are more likely to start from the production of new knowledge. This is probably due to the general trend in science in which research is increasingly based on ever-expanding networks. This facilitates access to many types of knowledge and disciplines, including those related to RRI.

The distribution of the 18 AEs selected for the benchmarking exercise clearly reproduces this general trend.

## 2. The role of initial investments

A second fact to be noticed concerns the role of initial public investments in activating an RRI-oriented embedding process. Overall, at least 10 AEs out of 18 started thanks to institutional funds from the EC (5 cases: JERRI, LIBRA, TRIGGER, EUROPRISE and Ethics and Society) or national governments (5 cases: MVI, Biotek 2021, CDI, CSymBI and Mistra Urban Futures). Initial public investments also play an important role in other AEs (for example, RRI policies at UAB and Athena SWAN Charter).

This circumstance suggests that initiating RRI-oriented processes is still **partially dependent upon specific public policies**. It is not by chance that all the AEs that started through initial public investments fall within the three dominant models (Model A, Model E, and Model I) identified above, which are also probably dominant because they are better supported by public policies than other models are.

At the same time, the analysis also shows that the process of change, once started, can often keep going and evolve, even in the absence of external investments. This is the case, for example, of AEs like JERRI at TNO, TRIGGER at UPD or CSynBI. Moreover, many other AEs considered in this chapter started without external funds and, in some cases (for example, Athena SWAN) through a bottom-up mobilisation process.

## 3. The distribution of benchmarks among the governance setting models

Finally, it should be observed that the 36 benchmarked practices tend to act on different aspects of the RRI-oriented governance setting, intended as a process of institutional change aimed at embedding RRI into research institutions.

In this regard, four different components of the process of institutional change can be considered here.

- **Transformational agent.** The first component is the existence of a group of people (a team) that can progressively activate and sustain the process over time, becoming a transformational agent within its organisation, i.e., increasingly capable of managing the complexity inherent in RRI-oriented institutional change.
- **Mobilisation.** The second component refers to the need to mobilise and involve key actors and individuals, achieving the consent, energy and support necessary to trigger a process of change.
- **Impact making.** The third component refers to the capacity to actually alter existing institutional arrangements, activating a process of change, modifying social patterns, normative structures or the way in which knowledge is designed, implemented and used.
- **Sustainability.** The last component concerns the capacity to activate mechanisms that allow RRI-oriented arrangements to last and evolve over time, thus becoming part of the current practices and culture of the organisation[10].

The table below shows which component the different benchmarked practices primarily focus on, at least in the interpretation given to them in this report.

| MODEL | AE | Benchmark | Dominant component |
|---|---|---|---|
| A | JERRI Project at TNO | 1. Goal setting process | MOBILISATION |
| | | 2. RRI institutionalisation level analysis | IMPACT MAKING |
| | | 3. Transition roadmap to RRI | SUSTAINABILITY |
| | LIBRA Project at CeMM | 4. Highly representative enlarged team | TRANSFORMATIONAL AGENT |
| | | 5. RRI-oriented procedures setting process | MOBILISATION |
| | | 6. Initial diagnostic analysis | IMPACT MAKING |
| | TRIGGER Project at UPD | 7. Internal organisational coordination | TRANSFORMATIONAL AGENT |
| | | 8. Links with external stakeholders | MOBILISATION |
| | | 9. Sustainability plan | SUSTAINABILITY |
| | RRI policies at UAB | 10. Multiple focal points for RRI actions | TRANSFORMATIONAL AGENT |
| | | 11. Light integration of RRI keys | SUSTAINABILITY |
| C | Symbiochem | 12. RRI integration in the productive process | IMPACT MAKING |
| | | 13. Establishment of an RRI Unit | TRANSFORMATIONAL AGENT |
| | Midstream Modulation at TU Delft | 14. Protocol for interdisciplinary integration | IMPACT MAKING |
| D | CeRRI | 15. Mainstreaming approach to | IMPACT MAKING |

[10] The concept of sustainability has been already applied on the practices to be included in the benchmarking process (see Chapter Two, Section 4) to refer to the capacity of the practice to be sustainable over time. In this case, the concept of sustainability is applied on the primary function of a practice, i.e., if the practice is primarily aimed at making RRI-oriented changes sustainable over time. This means that, while all the practices considered are sustainable, only few of them are aimed to sustainability.

| MODEL | AE | Benchmark | Dominant component |
|---|---|---|---|
| | | RRI | |
| | | 16. Tailored managerial support | MOBILISATION |
| E | MVI, NWO | 17. RRI-related criteria for research funding | IMPACT MAKING |
| | | 18. RRI-oriented platform and networking | MOBILISATION |
| | Biotek 2021, RCN | 19. RRI embedment in funding scheme as a core issue | IMPACT MAKING |
| | | 20. RRI framework for applicants | MOBILISATION |
| | CDI, VINNOVA | 21. Three-stage procedure to research funding | IMPACT MAKING |
| | EuroPriSe, ITA | 22. Certification process | IMPACT MAKING |
| F | SoScience | 23. Business-oriented approach to RRI | IMPACT MAKING |
| | | 24. Partnership-like approach in consultancy services | MOBILISATION |
| G | University Network Education by Responsibility | 25. RRI-oriented comprehensive training | MOBILISATION |
| H | Athena SWAN Charter | 26. Three-level award system | SUSTAINABILITY |
| | | 27. Self-assessment and peer-reviewing process | IMPACT MAKING |
| | | 28. Local networks | MOBILISATION |
| I | CSymBi | 29. STEM and social sciences institutional partnerships | TRANSFORMATIONAL AGENT |
| | Mistra Urban Futures | 30. Local co-creation platforms | MOBILISATION |
| | | 31. Joint knowledge production process | MOBILISATION |
| | Applied Nanoparticles | 32. RRI-sensitive production process | IMPACT MAKING |
| | | 33. RRI-oriented code of conduct | IMPACT MAKING |
| | Ethics and Society, HBP | 34. Multiple approach to RRI embedment in research programmes | IMPACT MAKING |
| | | 35. Ethical concerns registration system | MOBILISATION |
| | | 36. Ethics Management Team and Ethics Rapporteurs | TRANSFORMATIONAL AGENT |

Overall:

- 14 practices are focused on the **impact making** component
- 12 practices are focused on the **mobilisation** component
- 6 practices are focused on the **transformational agent** component
- 4 practices are focused on the **sustainability** component.

The distribution of the practices per governance setting models is given below.

| TRIGGER-ING POINT | FOCUS | | | |
|---|---|---|---|---|
| | **Social patterns first** | **Rules first** | **Knowledge first** | **TOTAL** |
| **Changes from inside** | MODEL A<br>Tran. Agent: 3<br>Mobilisation: 3<br>Imp. making: 2<br>Sustainability: 3 | MODEL B<br>Tran. Agent: 0<br>Mobilisation: 0<br>Imp. Making: 0<br>Sustainability: 0 | MODEL C<br>Tran. Agent: 1<br>Mobilisation: 0<br>Imp. making: 2<br>Sustainability: 0 | INTERNALLY-INITIATED MODELS<br>Tran. Agent: 4<br>Mobilisation: 3<br>Imp. making: 4<br>Sustainability: 3 |
| **Changes from out-side** | MODEL D<br>Tran. Agent: 0<br>Mobilisation: 1<br>Imp. making: 1<br>Sustainability: 0 | MODEL E<br>Tran. Agent: 0<br>Mobilisation: 2<br>Imp. Making: 4<br>Sustainability: 0 | MODEL F<br>Tran. Agent: 0<br>Mobilisation: 1<br>Imp. making: 1<br>Sustainability: 0 | EXTERNALLY-INITIATED MODELS<br>Tran. Agent: 0<br>Mobilisation: 4<br>Imp. making: 6<br>Sustainability: 0 |
| **Changes through network** | MODEL G<br>Tran. Agent: 0<br>Mobilisation: 1<br>Imp. making: 0<br>Sustainability: 0 | MODEL H<br>Tran. Agent: 0<br>Mobilisation: 1<br>Imp. making: 1<br>Sustainability: 1 | MODEL I<br>Tran. Agent: 2<br>Mobilisation: 3<br>Imp. making: 3<br>Sustainability: 0 | NETWORK-BASED MODELS<br>Tran. Agent: 2<br>Mobilisation: 5<br>Imp. making: 4<br>Sustainability: 1 |
| **TOTAL** | SOCIAL MODELS<br>Tran. Agent: 3<br>Mobilisation: 5<br>Imp. making: 3<br>Sustainability: 3 | NORMATIVE MODELS<br>Tran. Agent: 0<br>Mobilisation: 3<br>Imp. making: 5<br>Sustainability: 1 | KNOWLEDGE-ORIENTED MODELS<br>Tran. Agent: 3<br>Mobilisation: 4<br>Imp. making: 6<br>Sustainability: 0 | ALL MODELS<br>Tran. Agent: 6<br>Mobilisation: 12<br>Imp. making: 14<br>Sustainability: 4 |

This distribution is evidently based on few qualitative data and cannot be at all meaningful in statistical terms. Moreover, the practices to be benchmarked have been selected according to qualitative criteria and each practice has been attributed to a governance setting component according to the criterion of prevalence (in some cases, the practice may involve more than one component), on the basis, also, of how the practice was presented by the promoters themselves, thus interpreting somehow their point of view.

However, this distribution allows us to highlight some possible general trends related to the different governance setting models.

### *3.1. Sustainability*

We will start with the component of sustainability, which is the least represented among the benchmarked practices (four times).

In particular, this component is represented three times out of four in the case of Model A governance setting (internally-initiated social model). This can be partially explained by taking into consideration that the AEs belonging to this model mainly use the “action plan” approach, i.e., an integrated multi-year plan involving many (if not all) internal units of the institution, as well as internal and often external stakeholders. In this framework, sustainability – i.e., permanently institutionalising the solutions developed under the action plans – becomes a pivotal issue for preventing long-term failures.

The remaining case refers to Athena SWAN, falling within Model H (Network-based normative model). This case is interesting since the normative mechanism (the award) is conceived and organised in a way that encourages the institutions concerned to enhance their engagement continuously and to embed it permanently into institutional arrangements.

In the other cases, sustainability is less relevant. For example, in the case of externally-initiated normative models (typically the RRI-oriented research funding schemes), sustainability is not considered an issue, since it affects only indirectly the individual institutions concerned (e.g., those applying for research funds), and the norms, once formally established, are “sustainable” by their very nature, at least until they are changed by someone else.

However, other practices which have been connected to other components also play a function in making RRI sustainable over time, such as the local co-creation platforms developed under the Mistra Urban Futures (practice no. 30), or RRI integration in the productive process (practice no. 12), as found in the case of Symbiochem.

### *3.2. Transformational agent*

The number of practices pertaining to the transformational agent are six and they only fall within three governance setting models, namely, Model A, Model C, and Model I.

The issue is evidently important in the case of Model A (internally-initiated social model) for the same reason detailed above: the AEs belonging to this group adopt an integrated approach to RRI (typically, a comprehensive action plan) and, therefore, they need to identify a specific group as the one responsible for activating the change.

In the cases of Model C (Internally-initiated knowledge-oriented model) and Model I (network-based knowledge-oriented model), the transformational agent is represented by a unit or other forms of institutional structure allowing experts on RRI-related issues to contribute to the production of scientific knowledge in a visible and recognised way.

In the case of normative models, the need to establish an “agent” supporting RRI appears to be less relevant, since they are not, in principle, concerned with changing the dominant social patterns, for which a “transformational agent” supporting the change is more important.

Other practices, labelled under other components, probably contribute to establishing a transformational agent. We can mention here, as examples, the business-oriented approach to RRI (practice no. 23), the last step of which is precisely the creation of a Responsible Innovation Taskforce inside the company supported by SoScience, and the three-level award system (practice no. 26) promoted by Athena SWAN, which also includes, among the requirements for attaining the award, the creation of a group in charge of managing a gender equality action plan.

### *3.3. Mobilisation*

Mobilisation is a component which is present to a large extent in any kind of governance setting model and twelve times overall.

It is worth noting that the mobilisation component is also represented in the case of normative-oriented models. For example, RRI-oriented funding schemes usually combine a normative approach (expressed in, e.g., criteria applied for selecting applications, templates specifying how to include RRI in project proposals, RRI-oriented requirements, etc.) with initiatives aimed at “mobilising” the potential or actual applicants (for example, providing them with information on RRI, training services and tailored support services).

This makes us think that RRI cannot be transferred to research organisations simply on the basis of a set of norms and formal procedures, following a mere top-down approach, even when matching these norms is required to access opportunities such as getting extra-funds or getting an award. Rather, RRI implies, to a certain extent, that researchers and research managers are motivated enough to modify their business-as-usual practices, which is always problematic.

### *3.4. Impact-making*

The impact-making component, recurring fourteen times, is also widespread in all governance setting models. This fact is not surprisingly at all, since this component includes all the practices concerning the capacity to actually alter existing institutional arrangements, activating a process of change.

However, the nature of the solutions adopted vary widely. For example, in some cases (practices 2, 6 and 27), the focus is on diagnosing the situation of the organisation concerned from the point of view of RRI or specific aspects of it.

In other cases (practices 12, 14, 15, 19, 23 and 34), the problem on the table is how to integrate RRI in the research and innovation process so as to avoid RRI becoming only a marginal component of it.

Finally, there are practices (17, 21, 22, 32 and 33) which appear to be more focused on how to make an RRI-oriented approach practically feasible, modifying or enriching current practices.

Annex 1

# Overall Inventory of RRI-oriented experiences (INV1)

This annex contains the entire list of all RRI-oriented experiences collected during the literature analysis conducted also leveraging upon the literature review implemented under Task 1.1, using multiple information sources, including: EC-funded projects; National projects; Scientific literature; Gray literature; Websites.

This first inventory, called "Overall Inventory of RRI-oriented experiences", contains 302 records, each one referring to a specific RRI-oriented experience. For each experience, only information allowing its identification has been included. Each record included the following information:

- A progressive number
- The title of the experience
- The promoter
- The reference to the information source used for identifying the experience.

The references are represented by a link to a website (last access: 12th April, 2018).

1 Framework for Responsible Innovation

Engineering and Physical Science Research Council - EPSRC

https://www.epsrc.ac.uk/research/framework/

2 Risk Register

Engineering and Physical Science Research Council - EPSRC

https://www.epsrc.ac.uk/about/

3 Stratospheric Particle Injection for Climate Engineering - SPICE

School of Earth Sciences, University of Bristol

http://www.spice.ac.uk/

4 Responsible Innovation Programme - MVI

Dutch Research Council - NWO

https://www.nwo.nl/en/research-and-results/programmes/responsible+innovation

5 Nanonext Programme

NanoNextNL Foundation

http://www.nanonextnl.nl/

6 Norwegian Technology Board

Norway Research Council - NRF

https://www.euroscientist.com/towards-responsible-research-innovation/

7 BIOTEK 2021

Norway Research Council - NRF

https://www.forskningsradet.no/prognett-biotek2021/Home_page/1253970728140

8 NGOs Consultation on OGM Potatoes

BASF

https://www.basf.com/it/it/products-and-industries/agriculture.html

9 REACH Directive

European Chemicals Agency - ECHA

https://echa.europa.eu/it/regulations/reach/understanding-reach

10 European Charters for Researchers and Codes of Conduct

European Commission and European Parliament

http://ec.europa.eu/research/science-society/document_library/pdf

11 EU Code of Conduct and Local Laboratory Practices in Italy

Università degli studi di Padova

http://res-agora.eu/assets/Padua-1-Stage-2.pdf

12 Midstream Modulation at Delft TU

Delft University of Technology - TU

https://cspo.org/legacy/library/1301291041F35042430WO_lib_Schuurbiers.pdf

13 Dutch Rathenau Institute

Dutch Rathenau Institute

https://www.rathenau.nl/en/page/mission

14 Innovation Management Approach

Fidelity Worldwide Investment

https://www.fidelityinternational.com/global/about/default.page

15 Open Source Biotechnology

CAMBIA

http://www.cambia.org/daisy/cambia/home.html

16 Engaging the Young with Responsible Research and Innovation - IRRESISTIBLE

ScienceLinX Department, Groningen University

http://www.irresistible-project.eu/index.php/en/

17 New Understanding of Communication, Learning and Engagement in Universities and Scientific Institutions - NUCLEUS

Rhine-Waal University

http://www.nucleus-project.eu/

18 Rethinking Innovation Together. Engaging Citizens in Health Research - SPARKS

ECSITE

http://sparksproject.eu/

19 Manchester Synthetic Biology Research Centre for Synthetic Biology of Fine and Speciality Chemicals - SYNBIOCHEM

Manchester Institute of Biotechnology

http://synbiochem.co.uk/responsible-research-and-innovation/

20 RoadMAPs to Societal Mobilisation for the Advancement of Responsible Industrial Technologies - SMART-map

Aarhus University

http://projectsmartmap.eu/about/

21 Governance for Responsible Innovation - GREAT

University of Namur

http://www.great-project.eu/

**22** Global Model and Observatory for International Responsible Research and Innovation - RESPONSIBILITY

Fraunhofer Gesellschaft Institute - IPK

http://responsibility-rri.eu/

**23** Responsible Research and Innovation in a Distributed Anticipatory Governance Frame: a Constructive Socio-Normative Approach - Res AGorA

Fraunhofer Institute for Systems and Innovation Research - ISI

http://res-agora.eu/news/

**24** Promoting Global Responsible Research and Social and Scientific Innovation - PROGRESS

University of Central Lancashire

http://www.progressproject.eu/

**25** RRI Tools

La Caixa Foundation

https://www.rri-tools.eu/

**26** Equipping the Next Generation for Responsible Research and Innovation - ENGAGE

Centre for Science Education, Sheffield University

http://www.engagingscience.eu/en/

**27** Responsible Industry Project

De Montfort University

http://www.responsible-industry.eu/

**28** Promoting Attainment of Responsible Research & Innovation in Science Education - PARRISE

Utrecht University

https://www.parrise.eu/

**29** Supporting and promoting responsible research and innovation in ICT

Nexa Center for Internet & Society, Politecnico di Torino

https://nexa.polito.it/rri-ict-forum

**30** Stakeholders Acting Together on the Ethical Impact Assessment of Resarch and Innovation - SATORI

University of Twente

http://satoriproject.eu/

**31** Framework for Responsible Innovation in ICT

Oxford University, De Montfort University

https://www.orbit-rri.org/

**32** Civil Society Organisations in Research Governance - CONSIDER

De Montfort University

http://www.consider-project.eu/

**33** Promoting Integrity as an Integral Dimension of Excellence in Research - PRINTEGER

Radboud University

http://printeger.eu/

**34** Responsible Innovation COMPASS

Institute for Managing Sustainability, Vienna University of Economics and Business

https://innovation-compass.eu/

**35** Being in Augmented Multi-Modal Naturally Networking Gatherings - BEAMING

Starlab Living Science

http://beaming-eu.org

36 Intelligent Information System Supporting Observation, Searching and Detection for Security of Citizens in Urban Environment - INDECT

AGH University of Science and Technology

https://cordis.europa.eu/result/rcn/175782_en.html

37 Human Monitoring and Authentication using Biodynamic Indicators and Behavioural Analysis - HUMABIO

Centre for Research and Technology Hellas

http://www.humabio-eu.org

38 Built Environment Sustainability and Technology in Energy - BEST Energy

Fomento de San Sebastian

http://www.bestenergyproject.eu

39 Cooperative Research on the Governance of Radioactive Waste Management - COWAM

Mutadis

http://www.cowam.com

40 Multi-Modal Interactions Analysis and Exploration of Users within a Controlled Environment - MIAUCE

Centre Nationnal de la Recherche Scientifique - CNRS

http://www.visual-tools.com/en/technology/research-projects/completed-projects/i/233/129/miauce-2006-2009

41 Genetically Modified Wine

French National Institute for Agricultural Research - INRA

http://www.redorbit.com/news/science/250893/genetically_modified_wines_worry_french_winemakers

42 The Human Genome Project - HGP

National Institutes of Health, National Human Genome Research Institute - NHGRI

https://www.genome.gov/10001772/all-about-the--human-genome-project-hgp/

**43** Yellow Card

Medicines & Healthcare products Regulatory Agency - MHRA

https://yellowcard.mhra.gov.uk/

**44** Berkeley Earth

Berkeley Earth

http://berkeleyearth.org/

**45** UK Biobank Ethics and Governance Council - ECG

Wellcome Trust Medical Research Council

http://www.egcukbiobank.org.uk/

**46** Sciencewise

Department for Business, Energy and Industrial Strategy, UK Government

http://www.sciencewise-erc.org.uk/

**47** Centre for Synthetic Biology and Innovation - CSYNBI

King's College, London

https://www.kcl.ac.uk/sspp/departments/sshm/research/Research-Labs/CSynBI@KCL.aspx

**48** Observatory for Responsible Research and Innovation in ICT - ORBIT

De Montfort University, Oxford University

http://www.orbit-rri.org/

**49** Involvement in Patent Pools for Neglected Disease and Open Innovation

GlaxoSmithKline - GSK

https://www.gsk.com/en-gb/research/our-approach/open-innovation/

50 QRD (Quality Research in Dementia) Network

Alzheimer's Society

https://www.alzheimers.org.uk/download/downloads/id/2765/extended_history_of_the_research_network.pdf

51 Mistra Urban Futures

Chalmers University of Technology

https://www.mistraurbanfutures.org/en

52 Integrated and Sustainable Water Management of Red-Thai Binh Rivers System in Changing Climate - IMRR

Dipartimento di Elettronica e Informazione, Politecnico di Milano

http://xake.elet.polimi.it/mediawiki/index.php

53 Responsibility and Human Enhancement

Jacques Maritain Institute

https://www.responsibleenhancement.eu/

54 3DNovation

Hao2.eu

https://www.hao2.eu/about

55 Belgian Ageing Studies - BAS

Free University of Brussels, University College Gent

http://www.belgianageingstudies.be/

56 MyCROWDscopy and MalariaSpot Projects

Biomedical Imaging Technologies, Technical University of Madrid

http://www2.die.upm.es/im/

57 Chagas Coalition

Instituto de Salud Global de Barcelona - ISGlobal

https://www.isglobal.org/en/project/-/asset_publisher/qf6QOKuKkIC3/content/coalicion-global-de-la-enfermedad-de-chagas

58 Nachhaltige Gestaltung der Landnutzung und Energieversorgung auf kommunaler Ebene. Umsetzung für die Modellregion Kreis Ahrweiler - EnAHRgie

European Academy of Technology and Innovation Assessment

http://www.enahrgie.de/

59 Environmental DNA and Citizen Science

Universidad de Oviedo

http://efarri.eu/finalist/environmental-dna-and-citizen-science/

60 Food Touring Tours

IREA-Consiglio Nazionale delle Ricerche, Centro Comune di Ricerca - CCR

http://foodfuturingtours.irea.cnr.it/en/

61 Democratising progress in healthcare through the development of wearable, low-cost technological platforms - IncluSens

Laboratory of Nanosensors, Universitat Rovira i Virgili

http://www.quimica.urv.cat/quimio/nanosensors/index.php/2016/11/23/inclusens-project-finalist-at-the-european-foundations-award-for-responsible-research-innovation-efarri/

62 Land Rush and Local Livelihoods in Central Africa Project

Université Catholique de Louvain

https://www.land-rush.org/en/home/home

63 Methods for Health Technology Assessment of Medical Devices: A European Perspective - MedtecHTA

Centre for Research on Social and Healthcare Management - CERGAS

http://www.medtechta.eu/wps/wcm/connect/Site/MedtecHTA/Home

64 Sensory Assistive Technologies for Impaired Persons

Robotics, Brain and Cognitive Sciences Department, Fondazione Istituto Italiano di Tecnologia

https://www.iit.it/research/lines/robotics-brain-and-cognitive-sciences

65 Serious Game about Renewable Energy Technologies for Girls - SERENA Project

Bonn Science Shop, Technische Universitat Dresden and Game Studio the Good Evil

http://serena.thegoodevil.com/projekt/serenaproject/

66 Space4Agri

Institute for Electromagnetic Sensing for the Environment

http://space4agri.irea.cnr.it/it

67 Monitoring public opinion on Nanotechnology in Europe - NanOpinion

Centre for Social Innovation

www.nanopinion.eu

68 Neuro-Enhancement: Responsible Research and Innovation - NERRI

Ciencia Viva Agencia Nacional para a Cultura Cientifica e Tecnologica

www.nerri.eu

69 Views, Opinions and Ideas of Citizens in Europe on Science - VOICES

ECSITE

http://www.voicesforinnovation.eu/

70 Social Innovation Factory

Sociale Innovatie Fabriek

http://www.socialeinnovatiefabriek.be/nl/english#sthash.MxrNRL1a.dpbs

71 Homoresponsabilis in the Globalized World

Lodz University

http://www.responsabilis.eu/

72 Inno+

Blue InnoShip

http://www.blaainno.dk/

73 Innovative Health Promotion Exhibition Engaging Families - PULSE

Steno Diabetes Centre

https://www.sdcc.dk/forskning/forskningsaktivitet/forskningsprojekter/Sider/PULSE-Innovative-health-promotion-exhibition-engaging-families.aspx

74 The Blueprint for Change Programme

Novo Nordisk

https://www.novonordisk.com/

75 Vers un Agenda Pluridisciplinaire sur l'Eau

Bordeaux University

https://www.u-bordeaux.fr/Actualites/De-la-recherche/Vers-un-agenda-pluridisciplinaire-sur-l-eau

76 SoScience

SoScience

http://www.soscience.org/

77 Bürger Schaffen Wissen

Wissenschaft im Dialog and Museum fur Naturkunde Berlin

http://www.buergerschaffenwissen.de/en

78 Forschungswende

Zivilgesellschaftliche Plattform Forschungswende

http://www.forschungswende.de/

79 KimaAlltag - Low Carbon Lifestyles in the Zero Emission City

Institute for Social Ecological Research - ISOE

http://www.klima-alltag.de/

80 UNIAKTIV

Centre for Societal Learning and Civic Responsibility, University of Duisburg-Essen

https://www.uniaktiv.org/

81 European Bioethics in Action - EuroBioAct

Faculty of Medicine, University of Rijeka

http://eurobioact.uniri.hr/en/about-the-project.html

82 Food Policy of City of Milano

Comune di Milano

https://www.rri-tools.eu/documents/10184/107098/RRITools_D1.4-CatalogueOfGoodRRIPractices.pdf/0a9e0b86-a07c-4164-ba98-88912db9cabe

83 Knowledge for Climate

Knowledge for Climate Foundation

http://www.knowledgeforclimate.nl/

84 SCREEN

De Bascule, VU University Medical Centre and University of Amsterdam - UvA

https://www.rri-tools.eu/documents/10184/107098/RRITools_D1.4-CatalogueOfGoodRRIPractices.pdf/0a9e0b86-a07c-4164-ba98-88912db9cabe

**85** Stakeholder Engagement in Marine Research

Portuguese Institute of the Sea and Atmosphere - IPMA

https://www.rri-tools.eu/documents/10184/193151/3_RRITools_IPMA_showcase_final.pdf/e62c4577-2886-4d91-8c5c-ed7d9e7f3687

**86** The Economic Value of Oceans in Portugal

Gulbenkian Oceans Initiative, Calouse Gulbenkina Foundation

https://gulbenkian.pt/iniciativas/gulbenkian-oceanos/

**87** Marine Litter in European Seas: Social Awareness and Co-responsibility - MARLISCO

Provincia di Teramo (Italia)

http://www.marlisco.eu/

**88** Fundación Ibercivis

Fundación Ibercivis

www.ibercivis.es

**89** InnovAcciones 360°

Instituto de Ciencia y Tecnologia de Polimeros - ICTP

http://www.ictp.csic.es/ICTP2/es/InnovAcciones360

**90** Xplore Health

IrisCaixa

http://www.xplorehealth.eu/

**91** Challenge-Driven Innovation - CDI

Vinnova

https://www.vinnova.se/en/publikationer/challenge-driven-innovation/

92 A United Force for Game #Diversity

Diversi

http://diversi.nu/

93 Smedpack

Sweden´s Research Institute - RISE

http://www.innventia.com/en/Projects/Past-projects/Smedpack/

94 The Reward Alliance: Research, Increasing Value, Reducing Waste

The Lancet

http://rewardalliance.net/

95 Responsible Research and Innovation in Synthetic Biology - SYNENERGENE

Karlsruhe Institute of Technology

www.synenergene.eu

96 Public Involvement with Exhibition on Responsible Research and Innovation - PIER

Fondazione IDIS-Città della Scienza

https://cordis.europa.eu/result/rcn/165387_en.html

97 NanoDiode

IVAM

http://www.nanodiode.eu

98 Monitoring the Evolution and Benefits of Responsible Research and Innovation - MORRI

Tecnopolis Group

http://www.technopolis-group.com/morri

| | |
|---|---|
| 99 | Higher Institutions & Responsible Research and Innovation - HEIRRI |
| | Universitat Pompeu Fabra Barcelona |
| | http://heirri.eu |
| 100 | Ark of Inquiry |
| | University of Tartu |
| | http://www.arkofinquiry.eu |
| 101 | Fostering a Transition Towards Responsible Research and Innovation Systems - FOTRRIS |
| | European Centre of Studies and Initiatives - CESIE |
| | http://fotrris-h2020.eu |
| 102 | Promoting Societal Engagement in Research and Innovation - PROSO |
| | Dialogik |
| | http://www.proso-project.eu |
| 103 | Equitable Research Partnership - TRUST |
| | Centre for Professional Ethics, University of Central Lancashire |
| | http://trust-project.eu/ |
| 104 | Responsible Research and Innovation in Practice - RRI-Practice |
| | Oslo and Akershus University College of Applied Sciences - HiOA |
| | https://www.rri-practice.eu/ |
| 105 | Joining Efforts for Responsible Research and Innovation - JERRI: Action Plan at TNO |
| | Netherlands Organization for Applied Scientific Research - TNO |
| | https://www.jerri-project.eu/jerri-wAssets/docs/deliverables/wp-3/JERRI_Deliverable_D3_2_Description-of-specified-RRI-goals-at-TNO.pdf |

**106** Piloting Responsible Research and Innovation in Industry - PRISMA

Delft University of Technology

http://www.rri-prisma.eu/

**107** NewHorrizon

Institute for Advanced Studies

http://newhorrizon.eu

**108** Xenotransplantation Research: a Case of Attempted Self Governance

Institute for Higher Studies

http://res-agora.eu/assets/ResAGORA-case-lessons-report-D-3_5-final.pdf

**109** Bio-Ethics Committees in Austria and Germany

Institute for Higher Studies

http://res-agora.eu/assets/ResAGORA-case-lessons-report-D-3_5-final.pdf

**110** Integration of RRI in policy advice – A review of the UK synthetic biology roadmap

Fraunhofer Institute for Systems and Innovation Research ISI

http://res-agora.eu/assets/Fraunhofer-2.pdf

**111** Technology Assessment in Synthetic Biology

Fraunhofer Institute for Systems and Innovation Research ISI

http://res-agora.eu/assets/Fraunhofer-1-Stage-1.pdf

112 Occupational Health and Safety Protection: Standards-Setting as an Example of Self Regulation in the Handling of Nanomaterials

Veneto Region Research Cluster on Nanotechnology and European Centre for the Sustainable Impact of Nanotechnologies - ECSIN

http://res-agora.eu/assets/Padua-2-Stage-1.pdf

113 Nanosafety Governance in the Netherlands

University of Twente

http://res-agora.eu/assets/Twente.-Stage1.pdf

114 Public Engagement and RRI in Germany

Fraunhofer Institute for Systems and Innovation Research ISI

http://res-agora.eu/case-studies/

115 Hydraulik Fracking Technology in Austria and UK

Governments of Austria and UK

http://res-agora.eu/assets/IHS-1-Stage-2_final.pdf

116 Re-Design a Government Instrument (Fuel Standards) of Bio-Fuel in USA

US Government

http://res-agora.eu/assets/MIOIR-1-Stage-2neu.pdf

117 Garage Innovation: 3D Printer in UK

LATTS/IFRIS, Écoles des Ponts/Université Paris-Est

http://res-agora.eu/assets/IFRIS-1-Stage-2.pdf

118 Responsible Innovation in Sustainable Agri-Food Systems. Explorations of the Intersections Between Voluntary Standards and Value Chains

Food and Agriculture Organization - FAO and French National Institute for Agricultural Research - INRA

http://res-agora.eu/assets/IFRIS-2-Stage-2.pdf

119 Horizontal Foresight to address Societal Challenges in Danish Priority Setting for Strategic Research

Danish Board of Technology

http://res-agora.eu/assets/TEKNO-1-Stage-2.pdf

120 Athena SWAN Charter

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277 The Choice of Patent Experts

STN International Europe

http://www.stn-international.com/stn_home.html?&L=%2Fcontac

278 Open Science Monitor Initiative

RAND Europe

http://ec.europa.eu/research/openscience/index.cfm?pg=home&section=monitor

279 OpenScience Project

University of Notre Dame

http://openscience.org/about-openscience/

280 Practising Gender Equality in Science - PRAGES

Department for Equal Opportunities, Italian Presidency of the Council of Ministers

www.asdo-info.org

281 European Intersectoral Summit on Research and Innovation - EISRI

Atomium – European Institute for Science, Media and Democracy

http://www.eisri-summit.eu/

282 Gender Equality Network in the European Research Area - GENERA

Deutsches Elektronen-Synchrotron - DESY

http://genera-project.com/index.php

283 Center for Sustainable Energy Studies - CenSES

Center for Sustainable Energy Studies - CenSES

https://www.ntnu.edu/censes

284 Green Economy Coalition

Green Economy Coalition, International Institute of Environment & Development

http://www.greeneconomycoalition.org/

285 Entrepreneurial Behaviours and Organisation Culture

Dundalk Institute of Technology

https://www.dkit.ie/

286 Shared Governance Leadership and Regional Development

University of Limerick, Limerick Institute of Technology

https://heinnovate.eu/sites/default/files/shared_governance_leadership_and_regional_development_-_a_case_study.pdf

287 Knowledge Exchange and Collaboration Program

Institute of Technology of Tallaght

http://www.it-tallaght.ie/knowledge-exchange-activities

288 European Innovation Partnership - EIP on Active and Healthy Ageing - AHA

European Commission

https://ec.europa.eu/eip/ageing/home_en

289 Open Responsible Research and Innovation to Further Outstanding Knowledge - ORION

Centre de Regulació Genomica

http://www.crg.eu/en/news/crg-coordinates-orion-new-european-initiative-open-research-society

290 European Privacy Seal - EUROPRISE

Austrian Academy of Sciences, Institute of Technology Assessment - ITA

https://www.european-privacy-seal.eu/EPS-en/Home

291 Transdisciplinary Approach to the Emerging Challenges of Novel Technologies: Lifeworld and Imaginaries in Foresight and Ethics - TECHNOLIFE

Centre for the Study of Sciences and the Humanities - SVT, University of Bergen

http://www.uib.no/en/svt/22771/eu-fp7-technolife-project

292 Privacy and Emerging Sciences and Technologies - PRESCIENT

Fraunhofer Institute for Systems and Innovation Research ISI

https://www.prescient-project.eu/prescient/index.php

293 Privacy Awareness through Security Branding - PATS

Technical University of Berlin

http://cordis.europa.eu/project/rcn/91291_en.html

294 Ethical Issues of Emerging ICT Applications - ETHICA

De Montfort University

http://www.eurosfaire.prd.fr/7pc/doc/1304928786_eiex06etica2.pdf

295 Privacy - Appraising Challenges to Technologies and Ethics - PRACTIS

The Interdisciplinary Research Centre - ICCR

https://iccr-foundation.org/practis/

296 Ethical Frameworks for Telecare Technologies for Older People at Home - EFORTT

Department of Sociology, Lancaster Medical School, Lancaster University

http://www.lancaster.ac.uk/efortt/index.html

297 Mapping Normative Frameworks for Ethics and Integrity of Research - ENTIRE

Stichting Vumc

http://cordis.europa.eu/project/rcn/210253_it.html

298 Crossover Research: Well-Constructed Systems Biology

Norwegian University of Science and Technology - NTU

https://www.ntnu.edu/crossover-research/crossover1

299 ZEB Book

Research Centre on Zero Emission Buildings - ZEB

http://www.zeb.no/index.php/en/

300 Reflexive Systems Biology: Towards an Appreciation of Biological, Scientific and Ethical Complexity

Centre for the Study of Sciences and Humanities, University of Bergen - UIB

http://www.uib.no/svt/22773/nfr-reflexive-systems-biology

301 Social Robust Solar Cells Project - SOROSOL

Norwegian University of Science and Technology - NTNU

https://www.ntnu.edu/physics/sorosol/summary

302 RoboCare

Norwegian University of Science and Technology - NTNU

https://www.ntnu.edu/kult/weltech

Annex 2

# Specific Inventory of RRI-oriented advanced experiences (INV2)

This annex contains the Specific Inventory of RRI-oriented advanced experiences (INV2), including 43 records selected among the 302 listed in the Overall inventory (see Annex 1). These records refer to experiences which, on the basis of the analysis done, were considered as “advanced”, i.e., endowed with a capacity to generate and implement a governance setting.

Also this inventory contains few descriptive information about the AE, including:

- A progressive number (that is the same of the Overall Inventory)
- The title of the experience
- The promoter
- The country of the promoter
- The implementation period (from/to)
- The main information source used for identifying it
- The model of governance setting applied in the AE (see Chapter One).

A summary table of the nine governance setting models is given below.

# SUMMARY TABLE OF THE NINE GOVERNANCE SETTING MODELS

| Model A<br>Internally-initiated / Social model | Model B<br>Intenally-initiated / Normative model | Model C<br>Internally-initiated / Knowledge model |
|---|---|---|
| **23** RES AGORA; **33** PRINTEGER; **80** UNIAKTIV; **105** JERRI Action Plan at TNO; **129** ENRRICH; **135** GARCIA; **143** FESTA; **145** GENDERTIME; **185** STARBIOS2; **187** STAGES; **188**; Libra Action Plan at CeMM; **189** Trigger Action Plan at UPD; **237** RRI Programme at UAB | | **12** Midstream Modulation at Delft;<br>**19** SYNBIOCHEM;<br>**141** Midstream Modulation at ASU;<br>**283** CENSES |
| **Model D<br>Esternally-initiated / Social model** | **Model E<br>Externally-initiated / Normative model** | **Model F<br>Externally-initiated / Knowledge model** |
| **25** RRI Tools Project;<br>**121** CERRI;<br>**134** FOSTER Plus | **1** Framework for Responsible Innovation; **4** Responsible Innovation Programme; **7** Biotek 2021; **42** HGP Project; **91** Challenge-Driven Innovation; **195** Human Resources Strategy for Researcher; **253** UGO Certification; **290** EuroPrise | **76** SOSCIENCE |
| **Model G<br>Network-initiated / Social model** | **Model H<br>Network-initiated / Normative model** | **Model I<br>Network-initiated / Knowledge model** |
| **94** The Reward Alliance;<br>**196** Nordic Sustainable Campus Network;<br>**213** University Network Education by Responsibility;<br>**260** KARIM | **120** Athena SWAN Charter;<br>**193** Italian University Network of Sustainable Development | **47** CSYNBI; **51** Mistra Urban Futures; **53** Responsibility and Human Enhancement; **83** Knowledge for Climate; **124** Applied Nanoparticles; **214** Institute for Innovation Generation in the Life Sciences; **241** Human Brain Project; **279** OpenScience Project |

## 1. Framework for Responsible Innovation

**Promoter**: Engineering and Physical Science Research Council - EPSRC

**Time period from**: 2006 **To**: on going

**Country**: United Kingdom

**Sources**: https://www.epsrc.ac.uk/research/framework/

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 4. Responsible Innovation Programme

**Promoter**: Dutch Research Council - NWO

**Time period from**: 2009 **To**: on going

**Country**: The Netherlands

**Sources**: https://www.nwo.nl/en/research-and-results/programmes/responsible+innovation

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 7. BIOTEK 2021

**Promoter**: Norway Research Council - NRF

**Time period from**: 2012 **To**: 2021

**Country**: Norway

**Sources**: https://www.forskningsradet.no/prognett-biotek2021/Home_page/1253970728140

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 12. Midstream Modulation at Delft TU

**Promoter**: Delft University of Technology - TU

**Time period from**: 2007 **To**: 2007

**Country**: The Netherlands

**Sources**: https://cspo.org/legacy/library/1301291041F35042430WO_lib_Schuurbiers.pdf

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 19. SYNBIOCHEM

**Promoter**: Manchester Institute of Biotechnology

**Time period from**: 2014 **To**: on going

**Country**: United Kingdom

**Sources**: http://synbiochem.co.uk/responsible-research-and-innovation/

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | **Model C** |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 23. Res AGorA

**Promoter**: Fraunhofer Institute for Systems and Innovation Research - ISI

**Time period from**: 2013 **To**: 2017

**Country**: Germany

**Sources**: http://res-agora.eu/news/

Governance setting model:

| | | |
|---|---|---|
| **Model A** | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 25. RRI Tools

**Promoter**: La Caixa Foundation

**Time period from**: 2014 **To**: 2017

**Country**: Spain

**Sources**: https://www.rri-tools.eu/

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| **Model D** | Model E | Model F |
| Model G | Model H | Model I |

## 33. PRINTEGER

**Promoter**: Radboud University

**Time period from**: 2015 **To**: 2018

**Country**: The Netherlands

**Sources**: http://printeger.eu/

Governance setting model:

| | | |
|---|---|---|
| **Model A** | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 42. *The Human Genoma Project - HGP*

**Promoter**: National Human Genome Research Institute - NHGRI

**Time period from**: 1990 **To**: on going

**Country**: United States

**Sources**: https://www.genome.gov/10001772/all-about-the--human-genome-project-hgp/

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 47. *CSynBI*

**Promoter**: King's College, London

**Time period from**: 2009 **To**: on going

**Country**: United Kingdom

**Sources**: https://www.kcl.ac.uk/sspp/departments/sshm/research/Research-Labs/CSynBI@KCL.aspx

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 51. Mistra Urban Futures

**Promoter**: Chalmers University of Technology

**Time period from**: 2010 **To**: on going

**Country**: Sweden

**Sources**: https://www.mistraurbanfutures.org/en

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 53. Responsibility and Human Enhancement

**Promoter**: Jacques Maritain Institute

**Time period from**: 2016 **To**: on going

**Country**: Italy

**Sources**: https://www.responsibleenhancement.eu/

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 76. SoScience

**Promoter**: SoScience

**Time period from**: 2013 **To**: on going

**Country**: France

**Sources**: http://www.soscience.org/

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | **Model E** | Model F |
| Model G | Model H | Model I |

## 80. UNIAKTIV

**Promoter**: Centre for Societal Learning and Civic Responsibility, University of Duisburg-Essen

**Time period from**: 2005 **To**: On going

**Country**: Germany

**Sources**: https://www.uniaktiv.org/

Governance setting model:

| | | |
|---|---|---|
| **Model A** | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 83. *Knowledge for Climate*

**Promoter**: Knowledge for Climate Foundation

**Time period from**: 2007 **To**: 2014

**Country**: The Netherlands

**Sources**: http://www.knowledgeforclimate.nl/

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 91. *Challenge-Driven Innovation - CDI*

**Promoter**: Vinnova

**Time period from**: 2009 **To**: On going

**Country**: Sweden

**Sources**: https://www.vinnova.se/en/publikationer/challenge-driven-innovation/

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## *94. The Reward Alliance*

**Promoter**: The Lancet

**Time period from**: 2014 **To**: on going

**Country**: United Kingdom

**Sources**: http://rewardalliance.net/

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## *105. JERRI: Action Plan at TNO*

**Promoter**: Netherlands Organization for Applied Scientific Research - TNO

**Time period from**: 2016 **To**: 2019

**Country**: The Netherlands

**Sources**: https://www.jerri-project.eu/jerri-wAssets/docs/deliverables/wp-3/JERRI_Deliverable_D3_2_Description-of-specified-RRI-goals-at-TNO.pdf

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## *120. Athena SWAN Charter*

**Promoter**: Equality Challenge Unit - ECU

**Time period from**: 2005 **To**: on going

**Country**: United Kingdom

**Sources**: https://www.ecu.ac.uk/equality-charters/athena-swan/

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## *121. Fraunhofer Center for RRI - CeRRI*

**Promoter**: Fraunhofer Society

**Time period from**: 2014 **To**: 2019

**Country**: Germany

**Sources**: www.cerri.iao.fraunhofer.de/en.html

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## *124. Applied Nanoparticles*

**Promoter**: Applied Nanoparticles SL - AppNP

**Time period from**: 2013 **To**: on going

**Country**: United Kingdom

**Sources**: https://www.appliednanoparticles.eu/

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## *129. EnRRICH*

**Promoter**: Free University of Brussels

**Time period from**: 2015 **To**: 2017

**Country**: Belgium

**Sources**: http://www.livingknowledge.org/projects/enrrich/

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## *134. FOSTER Plus*

**Promoter**: University of Minho

**Time period from**: 2014 **To**: 2017

**Country**: Portugal

**Sources**: https://www.fosteropenscience.eu/about#theproject

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| **Model D** | Model E | Model F |
| Model G | Model H | Model I |

## *135. GARCIA*

**Promoter**: University of Trento

**Time period from**: 2014 **To**: 2017

**Country**: Italy

**Sources**: http://garciaproject.eu/

Governance setting model:

| | | |
|---|---|---|
| **Model A** | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 141. Midstream Modulation at ASU

**Promoter**: Arizona State University - ASU

**Time period from**: 2006 **To**: 2010

**Country**: United States

**Sources**: https://cns.asu.edu/research/stir

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 143. FESTA

**Promoter**: Uppsala University

**Time period from**: 2012 **To**: 2016

**Country**: Sweden

**Sources**: http://www.festa-europa.eu/

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## *145. GenderTime*

**Promoter**: Egalité des Chances dans les Etudes e la Profession d'Ingenieur - ECEPIE

**Time period from**: 2012 **To**: 2016

**Country**: France

**Sources**: http://www.gendertime.org/

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## *185. STARBIOS2*

**Promoter**: Tor Vergata University of Rome

**Time period from**: 2016 **To**: 2020

**Country**: Italy

**Sources**: https://starbios2.eu/

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 187. STAGES

**Promoter**: Department for Equal Opportunities, Italian Presidency of the Council of Ministers

**Time period from**: 2012 **To**: 2016

**Country**: Italy

**Sources**: http://www.projectstages.it/index.php/it/

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 188. LIBRA Action Plan at CeMM

**Promoter**: Research Center for Molecular Medicine - CeMM

**Time period from**: 2015 **To**: 2019

**Country**: Austria

**Sources**: http://cemm.at/career/libra/

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 189. TRIGGER Action Plan at the UPD

**Promoter**: Université Paris Didérot - UPD (Paris7)

**Time period from**: 2014 **To**: 2017

**Country**: France

**Sources**: https://universite.univ-paris-diderot.fr/une-universite-engagee/egalite-femmes-hommes/trigger-un-projet-europeen

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 193. Italian University Network for Sustainable Development - RUS

**Promoter**: Cà Foscari University of Venice

**Time period from**: 2015 **To**: on going

**Country**: Italy

**Sources**: https://www.crui.it/rus-rete-delle-universita-per-la-sostenibilita.html

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 195. *Human Resources Strategy for Researchers - HRS4R*

**Promoter**: University La Sapienza of Rome

**Time period from**: 2016 **To**: on going

**Country**: Italy

**Sources**: https://www.uniroma1.it/it/pagina/human-resources-strategy-researchers-hrs4r

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 196. *Nordic Sustainable Campus Network - NSCN*

**Promoter**: Aalto University

**Time period from**: 2011 **To**: on going

**Country**: Finland

**Sources**: https://nordicsustainablecampusnetwork.wordpress.com/

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## *213. University Network Education by Responsibility*

**Promoter**: University of Kassel

**Time period from**: 2015 **To**: on going

**Country**: Germany

**Sources**: http://www.bildung-durch-verantwortung.de

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## *214. Institute for Innovation Generation in the Life Sciences*

**Promoter**: Centre for Social and Economic Research on Innovation in Genomics

**Time period from**: 2012 **To**: on going

**Country**: United Kingdom

**Sources:** https://www.innogen.ac.uk/

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 237. RRI Programme at UAB

**Promoter**: Universitat Autonoma de Barcelona - UAB

**Time period from**: 2012 **To**: on going

**Country**: Spain

**Sources**: http://www.uab.cat/web/research/itineraries/uab-research/euraxess-uab/responsible-research-and-innovation-1345717923318.htmlUniversitat Autonoma de Barcelona - UAB

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 241. Ethics and Society, Human Brain Project - HBP

**Promoter**: Ecole Polytechnique Federale de Lausanne

**Time period from**: 2013 **To**: 2023

**Country**: Switzerland

**Sources**: https://www.humanbrainproject.eu/en/open-ethical-engaged/ethics/

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## 253. UGO Certification - Responsible Innovation

**Promoter**: Centre for Innovation and Economic Development - CISE

**Time period from**: 2011 **To**: on going

**Country**: Italy

**Sources**: http://www.ugocertification.org/index.htm?lang=ENG

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | **Model E** | Model F |
| Model G | Model H | Model I |

## 260. KARIM

**Promoter**: University College Dublin

**Time period from**: 2011 **To**: 2015

**Country**: Ireland

**Sources**: http://www.ucd.ie/karim/

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| **Model G** | Model H | Model I |

## 279. OpenScience Project

**Promoter**: University of Notre Dame

**Time period from**: n.a. **To**: on going

**Country**: United States

**Sources**: http://openscience.org/about-openscience/

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | **Model I** |

## 283. CenSES

**Promoter**: Center for Sustainable Energy Studies - CenSES

**Time period from**: 2011 **To**: on going

**Country**: Norway

**Sources**: https://www.ntnu.edu/censes

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | **Model C** |
| Model D | Model E | Model F |
| Model G | Model H | Model I |

## *290. EuroPriSe*

**Promoter**: Austrian Academy of Sciences, Institute of Technology Assessment

**Time period from**: 2008 **To**: on going

**Country**: Austria

**Sources**: https://www.european-privacy-seal.eu/EPS-en/Home

Governance setting model:

| | | |
|---|---|---|
| Model A | Model B | Model C |
| Model D | Model E | Model F |
| Model G | Model H | Model I |