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RESEARCH ARTICLE

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Challenges in the implementation of responsible research and innovation across Horizon 2020

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ABSTRACT

In the last decade, the European Commission (EC) developed an ambitious strategy to promote RRI across the Horizon 2020 Framework Programme for Research and Innovation (H2020). This effort resulted in a significant number of European-funded projects that substantially expanded the available knowledge of the theory, methods and implementation of RRI. However, various evaluations and studies revealed a limited and diffuse implementation of the concept. In this article, we aim to shed some light on this matter with a study covering eight programme lines of H2020 (ERC, MSCA, LEIT, FOOD, ENV, SEC, WIDENING and EURATOM). We employ an extensive policy document analysis and 112 semi-structured interviews carried out with various stakeholders. We argue that the limited implementation of RRI in H2020 is the result of conflicts with existing values, science cultures, economic objectives, restricted resources for its implementation and a lack of clarification around what RRI means.

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Introduction

In 2014, the 8th Framework Programme for Research and Technological Development, Horizon 2020 (hereinafter called H2020), featured the policy concept of RRI. The concept built on funding norms operationalised in preceding EU Framework Programmes to procure a better alignment of science and society (for the history of RRI as a policy concept see de Saille 2015; Macq, Tancoigne, and Strasser 2020; Owen, von Schomberg, and Macnaghten 2021; Rip 2014). By including RRI in its funding policy, the EC intended to 'anticipate […] and assess […] potential implications and societal expectations with regard to research and innovation, with the aim to foster the design of inclusive and sustainable research and innovation' (European Commission 2017).

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To boost the use of RRI as a concept, H2020 included a dedicated programme line, 'Science with and for Society' (SwafS),[1] to further RRI (Delaney et al. 2020) and make the concept a cross-cutting issue in H2020. This resulted in a number of EU-funded projects and the development of a significant collection of tools, methodologies, knowledge and experiences on the diffusion, adoption and institutionalisation of RRI in different socio-technical contexts (Owen, von Schomberg, and Macnaghten 2021). RRI investments also supported inquiry into socio-ethical issues raised by disruptive technologies such as nanotechnology and digitalisation (Gutiérrez and Ezponda 2019; High-Level Expert Group on Artificial Intelligence 2019; Stahl et al. 2014).

Despite these efforts, internal EC evaluations in 2017 (European Commission 2017, 245) and 2020 showed that RRI implementation was limited and diffuse. Further research also indicated that RRI implementation in H2020 lacked consistency and institutionalisation (Carrier and Gartzlaff 2020; Novitzky et al. 2020), exhibiting an irregular adoption across the EU territory (Christensen et al. 2020; Mejlgaard, Bloch, and Madsen 2018). Several authors observed that diffusion efforts encountered resistance from a variety of actors and institutions, often connected to a widely held conception that science, technology and innovation (STI) are neutral and/or objective technical processes rather than value-laden ones (Papaioannou 2020; van Oudheusden 2014). Furthermore, others observed that innovation is seen as an economic imperative not to be constrained by socio-ethical concerns (Eizagirre, Rodríguez, and Ibarra 2017; Pfotenhauer and Jasanoff 2017).

In this article, we aim to shed additional light on the uneven uptake of RRI in the specific case of EU research and innovation (R&I) under H2020. For this purpose, the paper draws on empirical research (document analysis and in-depth interviews) carried out in the EU-funded NewHoRRIzon project.[2] In the project, a so-called diagnosis was carried out as a baseline assessment to observe the extent to which RRI was implemented in each of the 19 programme lines by 2018. In our current inquiry, we present the results of our investigation into eight of the 19 Work Programmes to provide a detailed, differentiated account representative of the breadth of H2020 programming.

With this study, we aim to contribute to the emerging RRI implementation literature (Fraaije and Flipse 2020; Loeber, Bernstein, and Nieminen 2022; Schuijff and Dijkstra 2020) which has been revealed in recent years as an important research gap (Wiarda et al. 2021). This literature displays a diversity of practices involved in implementing RRI as well as the significant complexity of translating and contextualising this academic concept across diverse fields of R&I. Our study offers a deep look at the structural, cultural and interchange barriers hampering the implementation of RRI in H2020 (Wittrock et al. 2021). This article represents a unique contribution to understanding how RRI has been implemented within a large, multi-annual, transnational research funding programme. Our findings indicate the majority of programme lines analysed had no meaningful or systematic RRI implementation across the programme, call and project levels. Specifically, we argue that conflicts among existing values, cultures of science, economic objectives, restricted resources for implementation and a lack of clarification around what RRI means contributed to a limited implementation of RRI in H2020.

Research context and methods

RRI as a concept was first coined in 2011 (Macq, Tancoigne, and Strasser 2020; Owen, Macnaghten, and Stilgoe 2012) and was initially translated into EU policies via several funding activities in the 7th Framework Programme. After internal resistance from within the EC, and with support mustered by RRI advocates from Member States and the European Parliament (Owen, von Schomberg, and Macnaghten 2021), RRI was successfully launched as a cross-cutting issue for the entire H2020 framework programme. At its pinnacle in EC policy, RRI was affirmed in 2014 in the European Union's Rome Declaration (Griessler et al. 2022; SIS Conference 2014).

Rather than a concrete work plan, RRI entails a vision of how R&I processes might take into account the social and ethical aspects of science and technology development (European Commission 2013), along with its economic, socio-cultural and environmental implications (Blok and Lemmens 2015). Regardless of the differences between the various conceptualisations of RRI and RI (Timmermans and Blok 2018), they all build on common ancestries (Burget, Bardone, and Pedaste 2017; Ribeiro, Smith, and Millar 2017; Thapa, Iakovleva, and Foss 2019; Zwart, Landeweerd, and van Rooij 2014) which include technology assessment (TA), science and technology studies (STS), the ethical, the legal and social aspects of emerging sciences and technologies (ELSA) (Zwart, Landeweerd, and van Rooij 2014), and corporate social responsibility (CSR) (van de Poel et al. 2017).

Academia developed the concept of RI in different directions (Stilgoe, Owen, and Macnaghten 2013) leading to a recognisable difference between RRI as a policy concept in the EU and RI as a theoretical construct with significant academic roots (Rip 2014). The latter aims at institutional and systemic transformation of how innovation may be produced in more anticipatory, reflexive, inclusive and deliberative ways (Owen, Macnaghten, and Stilgoe 2012; Owen and Pansera 2019; Stilgoe, Owen, and Macnaghten 2013). The EC's interpretation, as outlined above, loosely builds on Von Schomberg's (2013, 19) oft-cited definition of RRI as a

> transparent, interactive 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 (in order to allow a proper embedding of scientific and technological advances in our society).

The SwafS unit in charge of promoting RRI within H2020 did not emphasise the procedural aspects of Von Schomberg's definition (Owen, von Schomberg, and Macnaghten 2021). Instead, in order to create support and connectivity within the Commission, it linked RRI to pre-existing, related and partly overlapping EC policies and conceptualised it as an umbrella concept to connect six key themes in R&I funding policies: public engagement, open access, gender, ethics, science education and governance (de Saille 2015; Geoghegan-Quinn 2012). These 'six keys' formed the heart of RRI and its envisioned implementation across H2020.

To study the implementation of RRI in the H2020 programme lines, we analysed policy documents covering aspects of H2020 at three levels: (a) framework policy strategy, (b) bi-annual programme objectives, and (c) annual call-specific objectives. These documents provided detailed insights into the programme lines and EU-funded projects.

In addition to document analysis, we conducted semi-structured interviews with a range of stakeholders from each programme line. We identified stakeholders involved in EU-funded projects as coordinators, partners, applicants or evaluators. This approach to identifying stakeholders enabled us to interview researchers from universities and research centres, as well as business and industry actors. In addition, we interviewed people involved in policymaking at the Commission and at country-level research-funding organisations; national contact points[3]; and civil society organisations. The common interview protocol,[4] developed by our NewHoRRIzon project team, focused on four themes: (1) the challenges participants faced regarding social-ethical issues in research, (2) the practices of dealing with these challenges, (3) experiences of the drivers, and (4) barriers to the uptake of RRI and related practices. On these themes, interviewees were asked open questions that encouraged them to elaborate on their opinions, perspectives and experiences.[5]

In total, we conducted 112 interviews across the eight cases featured in this manuscript. We sought to maintain geographical balance involving participants from the 25 countries across the EU, whilst also seeking to maintain a gender balance. The number of interviewees per programme line ranged from 11 to 18. Typically, interviews lasted between 30 and 60 minutes. When consent was given for recording, we recorded and transcribed interviews. All researchers were tasked with summarising the interview results in a standardised analytic template to highlight the main themes. We analysed interviews focusing on the identification of major themes in the form of opinions, reflections, conceptualisations and experiences (Ryan and Bernard 2003) to better understand the way participants conceptualised and were engaged in RRI. Table provides an overview on the objectives and budgets associated to each of the programme lines featured in this study (see Figure 1).

The findings were collected in four separate reports: three covering the H2020 pillars 'Excellent Science', 'Industrial Leadership' and 'Societal Challenges'; and one covering 'the diversity of approaches' that gathered specific objectives and instruments of H2020. These four reports (Bernstein et al. 2018; Griessler et al. 2018; Novitzky et al. 2018; Prill et al. 2018) form the backbone of our analysis. The eight programme lines selected for the present analysis include different aspects promoted by H2020 (promotion of basic research, transnational mobility of researchers, communication of science, research in industry, etc.). They also represent a window into the broad range of tensions and obstacles associated with RRI implementation in EU research funding.

Implementation of RRI in H2020

In the following pages, we provide a summary of the uptake of RRI in the eight selected programme lines. The findings are further elaborated in an in-depth analysis of the deterrents we identified as hindering RRI implementation within them.

European Research Council (ERC)

The ERC was established in 2007, and in H2020 it became part of the first pillar, 'Excellent science.' The ERC's objective is to 'fund excellent scientists and their most creative ideas' (Bernstein et al. 2018). The ERC is committed to a number of key principles,

		H2020 funding (M€)
Excellent Science Pillar	European Research Council*	13.095
	Future and Emerging Technologies	2.696
	Marie Skłodowska-Curie Actions*	6.162
	Research infrastructures	2.488
Industrial Leadership Pillar	Leadership in Enabling & Industrial Technologies*	13.557
	Access to risk finance	2.842
	Innovation in SMEs	616
Societal Challenges Pillar	Health, demographic change & wellbeing	7.472
	Food security, sustainable agriculture and forestry, marine / maritime / inland water research and the bioeconomy*	3.851
	Secure, clean & efficient energy	5.931
	Smart, green & integrated transport	6.339
	Climate action, environment, resource efficiency & raw materials*	3.081
	Inclusive, innovative & reflective societies	1.310
	Secure Societies*	1.695
Specific Objectives	Spreading excellence & widening participation*	816
	Science with and for Society	462
(Own treaty)	European Atomic Energy Community*	1.603

Figure 1. H2020 structure and budget associated. Programme lines marked with an asterisk were selected to conduct our study.[18]

including safeguarding the funding of high-quality basic research; maintaining strict openness to all researchers and disciplines; funding bottom-up, curiosity-driven research without thematic priorities; using scientific excellence as a sole funding criterion; ensuring self-governance by scientists; and prioritising autonomy from the European Commission (ibid.). The budget of the ERC in H2020 was 13 billion euros (2014–2020).

The ERC did not use the term RRI in associated programme documents, but it has addressed some RRI keys with varying intensity in some working groups, projects, and events. The concept was little known by most interviewees, excepting a few applicants. In contrast, a high awareness of open access was noted, and several interviewees showed greater awareness of specific RRI keys (mainly ethics, gender equality and public engagement) and RI dimensions (reflexivity and anticipation). Interviews with ERC applicants, grantees, individuals from research funding organisations, representatives of civil society organisations, and a researcher who studied the ERC were consistent with the findings, indicating that there was little awareness and appreciation of RRI in this programme line. Many interviewees, particularly those from research-funding organisations who coach ERC applicants in proposal writing, displayed scepticism towards RRI as diluting the ERC's guiding principle of excellence above all. As an example, one interviewee perceived RRI as an additional and unnecessary burden, taking up valuable space in research applications that could otherwise be used for

indicating the excellence of the proposed research, thereby potentially diminishing the chances of the success of the application.

Some interviewees also argued that the ERC is very keen not to be framed, directed or controlled by what its constituents perceive as political interests. These testimonies emphasised how important it is to have a programme line focused on 'science first' and 'excellence only.' Some interviewees also stressed how the ERC's perspective implies basic research need not adhere to any claim of responsibility towards society and public engagement, as these may conflict with the freedom of science (NewHoRRIzon interviews). This perception was shared by other interviewees, who stressed how ERC tries to avoid bureaucracy and safeguard its autonomy from the EC.

Based on interviews and document analysis, and considering the ERC's quest for autonomy from the EC, there seemed to be serious frictions between the participants' image of the ERC community and the broader policy context and the H2020 prioritisation of RRI. Traditional understandings of science were purported with dominant neutrality and in contradiction with the science-society relationship advanced by RRI in H2020.

Marie Skłodowska-Curie Actions (MSCA)

Established in 1996 as 'Marie Curie Actions', and renamed in 2014 as 'Marie Skłodowska-Curie Actions', this area of the Excellent Science pillar aims to promote the careers of academics by supporting research training and career development, notably by funding worldwide and cross-sector mobility.[6] The MSCA budget in H2020 was approximately 6.1 billion euros. MSCA ambitions, in principle, mirror the themes and ideas developed under the RRI label. Attention to ethics is formalised in almost every call on a proposal template level, asking candidate grantees to specify ethics issues in a table. The same holds for gender equality, which is invariably stressed in MSCA (perhaps as a result, more than 40% of MSCA-supported researchers are women).

Furthermore, the programme provides its grantees the space to spend a considerable part of their time on science education, a popular RRI key in this programme line (Bernstein et al. 2018). The unit responsible for MSCA at the EC level soon recognised RRI as relevant. In the first H2020 MSCA work programme, RRI was not mentioned; yet from 2016 on, the Rome declaration (SIS Conference 2014) and the standard EC webpage on RRI (European Commission 2017) were included in MSCA work programme texts. Despite RRI as a concept not being found at the call level, single keys were referred to. Several funded projects included keys such as gender equality and open access, and select keys were also present in evaluation criteria.

While RRI was mentioned in many MSCA documents as a concept, and specific aspects of it were present throughout the various levels of programme implementation, we found a strong awareness of RRI only at the level of the policy actors involved. Among the interviewees, awareness of the RRI concept ranged from limited to non-existent. Many of the (former) grantees and grantee representatives indicated it was unclear to them what the concept entails and what its implications are. As one member of the MSCA Alumni Policy Working group stated after discussing the concept of RRI with its members: 'The name, designation, doesn't tell them anything. […] It is not that people are not aware of the issues that are [grouped] under the RRI label. But as a whole, they do not know,' (NewHoRRIzon interviews).

Furthermore, there seemed a gap between RRI-reflecting policies and its practice. For instance, MSCA evaluators were explicitly instructed not to look at ethical issues. As one interviewee noted: 'There's a whole ethics review board that I was never really informed about when I was briefed as an evaluator,' (NewHoRRIzon interviews). This suggests that even though ethics seems to be well institutionalised in the MSCA, RRI institutionalisation is far from being adopted, as ethics is treated as separable from other criteria such as research quality. Interviewees indicated that applicants indeed assume this to imply merely a need to 'fill in the boxes' of the ethics table in the proposal form, thus effectively reducing ethics to data management. Possibly because of the emphasis on science education, public engagement in practice is predominantly interpreted in terms of one-way engagement. As one national contact point officer stated: 'proposals [under this heading] mainly discuss communication. Involvement is more of an activity of communication than actually letting stakeholders influence research' (NewHoRRIzon interviews).

Leadership in enabling and industrial technologies (LEIT)

LEIT was part of the Industrial Leadership pillar in H2020. The objective of LEIT was to support and promote R&I in industry (companies of all sizes, including small and medium enterprises) by improving the investment climate, providing investment itself and by supporting the growth of businesses (Novitzky et al. 2018). In LEIT, specific emphasis was placed on new technological opportunities that would drive economic development and focus on information and communications technology (LEIT-ICT), nanotechnology, advanced materials, biotechnology, advanced manufacturing and processing (LEIT-NMBP), and space (LEIT-Space). The budget of LEIT in H2020 was 13.035 billion euros.

In LEIT, the term RRI could be found only sporadically, although some keys were found in calls and were traceable during the interviews and through the requirement to address societal challenges throughout H2020. Interviewees highlighted the importance of ethics and responsibility within research in H2020. RRI was seen as a potential approach to incorporate safety, societal impact and effective governance to address societal challenges. The interviewees also saw possibilities to connect RRI to regulatory standards (e.g. privacy, safety, data protection and General Data Protection Regulation). Some interviewees were afraid of competitive disadvantages caused by open access and open science policies, ethical standards, limitations to collaborate with adversary countries and sustainability, etc. Overall, the contribution of business to meet societal challenges was mainly framed in terms of economic objectives (Novitzky et al. 2018).

A high awareness of open access and some awareness of gender, ethics and science literacy could be observed in the documents. This picture was confirmed during the interviews, when some interviewees argued why some RRI keys were important (gender, ethics and public engagement) while no awareness was found of the general dimension of RRI. The interviewees indicated, for instance, the importance of gender equality in R&I projects, which means that gender equality-related goals should be included in the project descriptions. But although gender in theory is incorporated and seemingly important, it was admitted that in practice it often trickles down to a bare minimum of actions. In academia, the focus on gender equality is sometimes felt

as another topic that keeps researchers away from research as such (Novitzky et al. 2018). We can conclude that, nonetheless, there was some awareness of RRI and its keys in LEIT-related projects, and even though ethical compliance and responsibility for societal challenges were viewed as important, the lack of implementation of the keys in project proposals and evaluation documents demonstrated that only a few projects considered RRI keys as something more than a box-ticking exercise.

Food security, sustainable agriculture and forestry, marine and maritime and inland water research, and the bioeconomy (FOOD)

Part of the scope of the 3.7-billion-euro Societal Challenge programme, FOOD, was

> to secure sufficient supplies of safe, healthy and high-quality food and other bio-based products, by developing productive, sustainable and resource-efficient primary production systems, fostering related ecosystem services and the recovery of biological diversity, alongside competitive and low-carbon supply, processing and marketing chains. (Prill et al. 2018)

A particular hallmark of much of the FOOD programme was the multi-actor approach to R&I. Several participants expressed how encouragement around multi-actor engagement, in addition to positioning FOOD as responsive to societal challenges, helped align the programme with certain aspects of responsibility in R&I from the outset.

Document analysis of the FOOD programme revealed strengths in the form of RRI implementation in stakeholder engagement and gender balance, data management and protection, governance and open access issues. In one case, a respondent noted that attempting to introduce RRI into a project they worked on triggered a negative response from colleagues, who reacted as if to ask: 'Do you mean that we have been irresponsible so far?' (NewHoRRIzon interviews). This illuminates the importance of a thorough and contextualised explanation of RRI in parallel with the more concrete keys advanced by the Commission. Despite broad success with multi-actor approaches, the interviewees noted how even conversations with diverse external advisory boards could be invaluable in enriching projects. Programme stakeholders noted how, depending on a project's foci, certain sectors were often more difficult to engage than others (e.g. agricultural workers or grocery retailers).

In the interviews, several respondents commented on the importance of multi-actor approaches, as well as the challenge of reaching the people they 'really have to reach' to generate sustained, long-term impact among NGOs, farmers, companies and other actors affected by FOOD research. Linked to this, one interviewee noted the difficulty of a short-term project, when in some cases it might take a year or more to forge a common language and understanding among stakeholders before projects can be effectively implemented. The RRI concept, in general, had moderate integration. Some sub-keys were included in depth (e.g. open innovation through multi-actor approaches) while others more superficially (ethics, public engagement). The respondents noted that ethics compliance usually boiled down to the submission of data management plans, consent forms and a privacy policy, rather than more substantive macro-ethical issues such as questions of rights and access to genetic resources of genetically modified plants or on the treatment of animals. In conclusion, as one interviewee noted, an added benefit of explicitly considering diverse stakeholders from an RRI perspective also helped reveal

diversity among scientists themselves. For instance, projects bringing together foresters, geneticists, and ecologists – all scientists – still bring different forms of specialised knowledge and worldviews that need to be reconciled for projects to run successfully.

Climate action, environment, resource efficiency and raw materials (ENV)

ENV was part of the third 'Societal Challenges' pillar of H2020 and covered several broad lines of activities:

> Climate Action—informed decisions for a climate-resilient low-carbon society; Cultural Heritage—engaging a new cultural heritage agenda for economic growth; Earth Observations—crucial info on climate, energy, natural hazards and other societal challenges; Nature-Based Solutions—providing viable solutions for natural ecosystems; and Systemic Eco-Innovation—generating and sharing economic and environmental benefits.

Their activities were designed to

> increase European competitiveness, raw materials security and improve wellbeing. At the same time, they will assure environmental integrity, resilience and sustainability with the aim of keeping average global warming below 2°C and enabling ecosystems and society to adapt to climate change and other environmental changes. (Prill et al. 2018)

The overall budget for the 2014–2020 period was 2.9657 billion euros.

As it covered a wide range of activities, this societal challenge addressed and included a diverse set of R&I communities, research cultures and traditions. RRI as a concept was well known to some interviewees. Some could easily relate to specific keys, such as open access or public engagement, already of relevance to their work in a manner that can be framed as 'de facto RRI'; that is, the embedded understandings of responsibility in R&I contexts, situations, settings and practices (Randles et al. 2016). Most interviewees were open to reflecting on the promises of the concept to improve the societal embeddedness and the impact of their work. Reference was made to certain RRI aspects in some calls and topics, such as citizen engagement and citizen science related to the topic 'Coordination of citizens' observatories initiatives' (SC5-19-2017) in the 2016–17 work programme. Citizen science was positively considered as a recent success story in terms of RRI by some interviewees, but it was framed as one-way communication and not mutually responsive:

> [Citizen Science] is a way of involving citizens and it can solve many problems regarding lack of trust to science, authorities, increasing awareness of the citizens and also it is educative […] you can train and educate young people when […] they can collect data […]. (NewHoRRIzon interviews)

The concentration of RRI-relevance in certain calls was remarkable, while others lacked any mention of RRI-aspects altogether. At the project level, interviewees referred to good practices of co-creation in some instances, providing space for stakeholder involvement, integrating alternative knowledge through citizen observatories or involving SMEs to produce marketable solutions for identified problems (e.g. GREEN-WIN,[7] GroundTruth 2.0,[8] LandSense[9]). In some project reviews, the RRI concept was mentioned positively. As reported by one interviewee, these reviews not only strengthened the methodological approach, but also stimulated other project partners to engage in

multi-stakeholder processes in subsequent proposals. In conclusion, RRI was connected to certain RRI-related projects with specific contents, participants, practices and understandings of excellence and innovation, rather than integrated in a common R&I strategy.

Secure societies – protecting the freedom and security of Europe and its citizens (SEC)

The Europe 2020 Security Strategy formed the basis for the SEC programme line. Its objectives were related to crime, illegal trafficking and terrorism, resilience of critical infrastructures, supply chains and transport modes, border management, cyber security, resilience to crises and disasters, privacy and freedom, standardisation and systems interoperability, and to the Union's external security policies. The estimated final budget of SEC was 1.695 billion euros, and the realised amount based on the Participant Portal (16.1.2018) was 670.2 million euros with 235 financed projects (Prill et al. 2018).

While RRI was present as a concept in the final two biennial work programmes, at the project level it was mostly lacking. Some of the keys were recognised, and fundamental rights played a major role at all programme levels, concentrating especially on the data security and privacy issues of technologies. Open access to research data and sharing project results were also supported at all programme levels. Stakeholder engagement was seen as important for successful security R&I, but the engagement methods and identification of key stakeholders varied. Citizens were mentioned as a stakeholder group, but further explanations about engagement practices indicated practitioners, public authorities and industry representatives as 'citizens'.

At the project level, RRI was not well known (with some exceptions). The concept was understood mostly in terms of good research practices, risk management and following legislation. Ethics was mostly understood to concern human rights, law and personal data protection-related topics. On the whole, data security and privacy, risk management and secrecy requirements narrowed the idea of RRI in SEC. These narrowing dimensions are reflected in responses from interviewees such as: 'For the company, the ethical dimension is not the most prominent one, but GDPR changes things and we want to make sure we fulfil the mandatory requirements,' (NewHoRRIzon interviews) and,

> concerning the implementation of the project itself, one of the key aspects that we had was, that we were asked by the commission to fulfil a number of ethics requirements, not only in terms of the development of the system and acceptance of this service, but also that we had been able to reach out to the data protection authorities, and we had been given clearance to proceed with demonstrations. (NewHoRRIzon interviews)

Interestingly, in some cases where EU-funded projects had a dedicated RRI work package, it seemed this project component was an isolated effort. One interviewee noted in this line:

> Sometimes you see projects saying that they are doing a responsible research work package, and you wonder how much the people in this work package interact with the other work packages, or if they are just doing their own thing. The key should probably be (responsible research) education and monitoring that extends through the whole project. (NewHoRRIzon interviews)

Spreading excellence and widening participation (WIDENING)

WIDENING was implemented as a new specific objective in H2020 but its origins can be traced to the earlier Research Potential (REGPOT) work programme that was set up during the previous 7th Framework Programme (Claude et al. 2011; Tabarés and Bierwirth 2022). The objective of this programme line was to mitigate the innovation divide that exists between member states (European Commission 2014). It was specifically oriented to countries that joined the EU after 2004 and associated countries,[10] establishing significant synergies with European and Structural Investment Funds (ESIF). WIDENING is structured into three main actions: teaming (the promotion of research excellence centres in WIDENING countries), twinning (EU research networking), and ERA Chairs (attraction of research talent to WIDENING countries). From 2014 to 2020 the total budget of WIDENING was estimated to be around 886 million euros.

RRI was not mentioned at all in the 2014–2015 work programme, but it was introduced in those of 2016–2017 and 2018–2020. In these programmes, the concept was generically embedded through a formal statement:

> The Work Programme is in line with the Horizon 2020 Responsible Research and Innovation (RRI) cross-cutting issue, engaging society, integrating the gender and ethical dimensions, ensuring the access to research outcomes and encouraging formal and informal science education. (Griessler et al. 2018)

The results from the interviews stressed that the concept was unfamiliar to many project coordinators as well as several members of the national contact point network who support researchers in project applications at national levels. For instance, one interviewee noted: 'RRI is seen as not crucial by researchers. They prefer to remain focused on the research as they see RRI as a policy-related issue that [they] have to check in their funding applications,' (NewHoRRIzon interviews).

Some awareness of ethics, open access and public engagement was observed, but this was mainly related to controversial or bottleneck issues in the development of different actions. WIDENING supported only coordination and support actions (i.e. not research or innovation actions), which significantly limited the relevance of RRI in this programme line. In conclusion, no mention of RRI was found at the call level, some dimensions were mentioned at the project level, and low awareness was observed among project representatives and other stakeholders.

The European Atomic Energy Community (EURATOM)

EURATOM was founded in 1957 with the EURATOM treaty, considered one of the three founding treaties of the EU. The treaty covers all policy aspects relevant for the civil use of nuclear energy, such as nuclear safety, safeguards, radiation protection, radioactive waste management, external relations, and the security of supply of ores and nuclear materials (Griessler et al. 2018). By contributing to these objectives, the EURATOM reinforced outcomes under the three priorities of H2020 (excellent science, industrial leadership and societal challenges) and supported the development of the Energy Union. The total budget of EURATOM for the 2014–2018 period amounted to 1.6033 billion euros.

The RRI concept was not mentioned in key programme documents, and RRI or RRI keys (other than the standard ethics requirements) were not included in any evaluation criteria. At the project level, public engagement appeared more in the form of dissemination than in actual engagement of the general public. In the working papers and projects, gender equality was mostly understood as gender balance in research teams. Open access is an official EC policy, and therefore this key had some prominence in the project calls. Open science was mentioned in some working papers, but RRI as a concept was not part of the official EURATOM documents. These results are consistent with previous research findings published in the literature that deny the diffusion of RRI as an official policy strategy in this subsection of H2020 (Van Oudheusden, Turcanu, and Molyneux-Hodgson 2018).

However, despite the lack of explicit mentions of RRI, its keys and practices, some 'de facto RRI' (Randles et al. 2016) could be found. Most stakeholders reported experiences with public engagement, and some stakeholders were in favour of this. For instance, one of the interviewees argued: 'Engaging the public was helpful for the acceptance of their research, and public consultations will provide input for Horizon Europe' (NewHoRRIzon interviews). Others, in contrast, stressed some perceived limitations of the approach: 'A real technical problem needs to be solved without the public' (NewHoRRIzon interviews). It was also stated that to engage the public meaningfully, the public needs to be educated first to understand the complexity of nuclear research: 'Awareness of the importance of nuclear research must be raised' (NewHoRRIzon interviews). This ambivalence among practices and opinions about public engagement made it hard to draw definitive conclusions about whether public engagement was seen as a way to improve research practices within EURATOM or, rather, instrumentally, to improve public opinion of nuclear research.

Uneven, irregular and limited implementation

Our overview of the eight programme lines illustrates the uneven, irregular and limited implementation of RRI across H2020. In Figure 2, the extent of RRI implementation across different programme lines is presented. We distinguish between extensive implementation of RRI (++), narrow implementation of RRI (+) and insignificant implementation of RRI (-).[11] We employ the term 'extensive' to refer to a considerable presence of RRI and its keys into the documents analysed in each of the programme lines, 'narrow' to refer to a limited presence, and 'insignificant' to refer to a complete lack of presence.

Figure 2 shows different types of RRI implementation: first, there are programme lines with no implementation, in which RRI does not exist as a concept at the programme, call or project level, nor as an evaluation criterion (ERC and EUROATOM). The LEIT programme line is an interesting case because, even though there are some RRI aspects at the project level, RRI is not mentioned at the programme or call level, nor in evaluation criteria. Second, in the WIDENING programme lines, RRI implementation remains at a rhetorical level. The concept is mentioned at the programme level (the concept was introduced in the 2016 work programme), but no evidence was found at the call and project levels (although some keys were addressed by some projects). MSCA, ENV and SEC offer examples of incomplete implementation. RRI is mentioned at the work programme levels

	Pillar / Specific Objective	Description	H2020 funding (M€)
ERC European Research Council	Excellent Science	Fund excellent scientists and their most creative ideas	13.095
MSCA Marie Skłodowska-Curie Actions	Excellent Science	Promote careers of academics by supporting research training and career development through transnational mobility	6.162
LEIT Leadership in Enabling & Industrial Technologies	Industrial Leadership	Support and promote R&I in industry by improving investment climate, investment and supporting growht of businesses	13.557
FOOD Food security, sustainable agriculture and forestry, marine / maritime / inland water research and the bioeconomy	Societal Challenges	Secure sufficient supplies of safe, healthy and high-quality food and other bio-based products	3.851
ENV Climate action, environment, resource efficiency & raw materials	Societal Challenges	Increase European competitiveness, raw materials security and improve wellbeing. Assure environmental integrity, resilience and sustainability with the aim of keeping average global warming below 2° C and enabling ecosystems and society to adapt to climate change and other environmental changes	3.081
SEC Secure Societies	Societal Challenges	Combate crime, illegal trafficking and terrorism, increase resilience of critical infrastructures, supply chains and transport modes, border management, cyber security, resilience to crises and disasters, privacy and freedom, standardisation and systems interoperability, and to the Union's external security policies	1.695
WIDENING Spreading excellence & widening participation	Spreading Excellence and Widening Participation	Mitigate the innovation divide that exists between Member States	886
EURATOM European Atomic Energy Community	EUROATOM Treaty	Promote policy aspects relevant for the civil use of nuclear energy, such as nuclear safety, safeguards, radiation protection, radioactive waste management, external relations, and security of supply of ores and nuclear materials	1.603

Figure 2. Overview of programme lines analysed.

and, in addition, at the call and project levels, but RRI does not reach the important evaluation criteria. The FOOD programme line provides example of a full implementation of RRI which goes all the way from the programme to the call and project levels and includes evaluation criteria.

Following Wittrock et al. (2021), we observed different structural, cultural and interchange barriers (and interactions among these) affecting RRI implementation across different programme lines (Figure 3 and 4).[12] In some cases, RRI is not implemented due to the lack of skills, resources and incentives (structural barriers). In other cases, RRI creates conflicts with core beliefs and values in place in a certain field of expertise. The lack of diffusion of the RRI concept – what it entails, and its more integrative and ambitious vision, rather than the isolated vision of RRI keys – constitutes the problem of its adoption in several programme lines (cultural barriers). Additionally, the non-existence of clear mandates along with privacy and commercial interests are also reasons for not implementing it (interchange barriers). We identified a majority of factors constraining implementation of RRI in H2020, and we explain the factors behind these barriers in the following subsections.

Structural barriers for implementing RRI in H2020

In our study, we identified selective and variable institutionalisation of the Commission's specific RRI keys. This may relate closely to the lack of support for RRI implementation and, concurrently, to the lack of a necessary shared understanding of how to integrate RRI practices into EU R&I practices. This was visible in SEC with its relatively strong technology and innovation orientation, but also in other programme lines such as WIDENING, LEIT or EUROATOM. For instance, most national contact points of these programme lines were unaware about the concept and did not have the skills and competences to help applicants to address RRI keys in project proposals. Work programmes did not offer specific information or dedicated resources to help applicants incorporate the concept in their proposals, nor did they indicate resource availability from the SwafS programme line. In this context, wider ethical and societal impact-related questions were translated into regulation, risk and data management-related topics, which are more familiar to researchers and innovators than the RRI concept.

	Programme level	Call level	Project level	Evaluation criteria
ERC	-	-	-	-
MSCA	+	-	+	-
LEIT	-	-	+	-
FOOD	++	+	+	+
ENV	+	+	+	-
SEC	+	+	-	-
WIDENING	+	-	-	-
EURATOM	-	-	-	-

Figure 3. Uneven implementation of RRI in the programme lines. (++ means extensive, + means narrow, - means insignificant implementation of RRI).

	Structural barriers	Cultural barriers	Interchange barriers	Interaction of structural, cultural and interchange barriers
ERC		●	●	●
MSCA	●	●		●
LEIT	●	●	●	●
FOOD			●	
ENV		●		
SEC	●	●	●	●
WIDENING	●	●	●	●
EURATOM	●	●	●	●

Figure 4. Organisational barriers deterring RRI implementation in H2020.

Cultural barriers for implementing RRI in H2020

Several participants in our study revealed or alluded to diverse conflicts with core beliefs in science practices or R&I objectives pursued by their organisations when implementing RRI (ERC, MSCA, LEIT and SEC). This conflict was particularly clear in the ERC, where any shift towards 'external quality control' of science was rejected. Actors from the ERC considered RRI to be questioning the principles guiding its programme line (creativity, scientific excellence and autonomy) and when the participants of ERC addressed some of the keys in their applications, it occurred only through their own initiative. In some cases, requirements for engagement with stakeholders and citizens, and related calls for social acceptability of R&I, were received by ERC as a threat to the scientific enterprise.

In addition, some programme lines did integrate select RRI keys such as ethics, gender or public engagement, but this often occurred with a limited understanding of the concept and a generic lack of awareness about what RRI means, what it entails and how it can help to reflectively guide R&I. For instance, in some programme lines, ethics was mostly considered a box-ticking exercise (MSCA and FOOD), gender equality was mainly understood as gender balance in research teams (ERC, MSCA and LEIT) and public engagement as information sharing, often limited to only certain stakeholder groups (SEC, WIDENING, EURATOM). RRI was commonly understood as good research practices (ENV, SEC and WIDENING), and in most programme lines it was often viewed as an add-on, rather than an integrative guide, to the existing activities of professionals and organisations. Most interviewees reported low awareness of RRI and its propositions, lack of conceptual clarification about it and little guidance for its implementation (EURATOM, WIDENING, LEIT or ERC). In some cases, there was awareness in relation to RRI objectives, but in these cases, interviewees found their research to be responsible through its association with societal challenges (FOOD).

Last, RRI seemed to be perceived in very different ways by different fields of expertise and generations of researchers and innovators among the programme lines. We observed how younger generations were more prone to be engaged in RRI issues. In contrast, particular fields of expertise mainly related to technology development and engineering, like LEIT, SEC and EUROATOM, were not interested in RRI propositions.

Interchange barriers for implementing RRI in H2020

Privacy and commercial interests were also stressed as barriers to the implementation of RRI. For instance, in the SEC programme line, secrecy requirements alongside industry interests left a significant imprint on the programme line. Citizens, as such, were not perceived as a relevant group of stakeholders to contribute to technological development in this area. This was also clear in the LEIT programme line, where actors had a diminished sense of responsibility because of the dominant business logic prioritising economic objectives in R&I. Innovation activities in programme lines such as those of ERC, LEIT or SEC were mainly understood as expert activities not requiring citizen engagement at all.

Conclusions and discussion

The strategy envisioned by the EC at the beginning of H2020 for the adoption of RRI has faced structural, cultural and interchange barriers (Wittrock et al. 2021) that have deterred its implementation. Our findings show that behind these barriers, different factors such as conflicts with existing values, different science cultures, economic objectives pursued by R&I organisations, restricted resources for RRI implementation and a lack of conceptual clarification on what RRI means, what it entails and how it can reflexively guide R&I, led to a limited implementation of the concept in H2020. The majority of programme lines analysed did not demonstrate meaningful or systematic RRI implementation across programme, call and project levels. Only two programme lines (FOOD and ENV) indicated RRI implementation at all levels, but even then, for example in the case of FOOD, it was a matter of 'de facto RRI' (Randles et al. 2016), rather than RRI as stipulated by the EC. This empirical evidence is in line with other studies that have highlighted an uneven, irregular and limited implementation of RRI in H2020 (c.f., Carrier and Gartzlaff 2020; Christensen et al. 2020; Mejlgaard, Bloch, and Madsen 2018; Novitzky et al. 2020).

These barriers to RRI implementation might have been overcome by specific measures. For instance, structural barriers could have benefited from tailored guidance and specific support from the EC, or even dedicated training on RRI as a pre-requisite for access to EU funds. Fragmented or limited visions of RRI would have benefited from specific work, informed by practice, to further guide the implementation of the concept in different research contexts (Fraaije and Flipse 2020; Schuijff and Dijkstra 2020; Wiarda et al. 2021). Whilst in the Science with and for Society programme line, significant RRI materials, guides and resources were produced (Delaney et al. 2020), other programme lines did not benefit from them or were not aware of them. Incorporating or including these resources would have contributed to the adoption of RRI in these contexts. It is important to remark that even though RRI was conceived as a cross-cutting issue in H2020, from a budget perspective, it was a marginal issue that was heavily concentrated in the SwafS programme line (Macq, Tancoigne, and Strasser 2020).[13]

Barriers of a cultural nature seemed the most common and persistent kind observed in our study, comprised of many factors concerning core beliefs, science cultures, economic objectives and a lack of clarification about what RRI is and what it entails (Owen, von Schomberg, and Macnaghten 2021). These barriers need to be addressed by specific narratives and discourses that can legitimise RRI implementation from an organisational perspective whilst challenging dominant ideas of academic excellence and innovation.

In this sense, and even with the limited RRI integration in EC policy, there are indications of various forms of 'de facto RRI' (Randles et al. 2016).[14] Other policy initiatives at EU level could have been leveraged, integrated and articulated to promote RRI implementation across H2020. These included advancing AI ethics in EU R&I (High-Level Expert Group on Artificial Intelligence 2019), a more responsive utilisation of technologies to address grand challenges (Kuhlmann and Rip 2018) or the embedding of sustainability values in smart specialisation strategies, to cite a few examples (McCann and Soete 2020). These transversal lines could have reinforced the role of RRI, allocating more discursive and practical space in policymaking.[15]

In addition, interchange barriers observed in different programme lines could have been overcome with the introduction of specific evaluation criteria. Forcing projects to comply not only with the RRI keys but also with its underlying integrative vision would have facilitated the implementation of the concept, adding clarity and a clear mandate about its implementation in H2020. Certainly, the risk of reinforcing 'RRI as a box-ticking exercise' could have emerged too, but monitoring this legal requirement as well as providing guidance, resources and support would have created important synergies and drivers for the implementation of RRI across H2020.

RRI implementation may demand intensive and extensive deliberation processes in organisations, likely requiring changes in common practices, values or routines (Papaioannou 2020; van Oudheusden 2014). Such changes doubtlessly require time to be effectively institutionalised. The logic of H2020 project funding, operating on short term cycles (3–5 years), ignores this reality of RRI implementation. The tensions that we observed between the conceptualisations of innovation as a way to increase competitiveness as well as economic growth (Godin 2020) and new understandings of the concept as a way to address societal challenges (Kuhlmann and Rip 2018; Schot and Steinmueller 2018) seemed to 'suffocate' the RRI discourse in H2020.

European R&I policies are oriented towards economic growth as their primary objective (de Saille et al. 2020; Eizagirre, Rodríguez, and Ibarra 2017; Pfotenhauer and Jasanoff 2017) and the prioritisation of societal engagement by RRI fits poorly into this predominant ideology of societal progress associated with R&I. The lack of awareness of RRI that we observed in our study is, in part, understandable, given the lack of prior work on RRI as such at the start of H2020.[16] The persistence of this lack of awareness even after the uneven efforts of the EC to advance RRI through SwafS[17] in H2020 makes it troubling to observe the elimination of the programme in Horizon Europe. Addressing these cultural barriers to implementing RRI demands a vision in which actions and resources are executed in a long-term planning effort, not restricted to a particular EU framework programme.

Despite this limited implementation of RRI in H2020, we should applaud the efforts carried out by the EC during the last decade. Without a doubt, this has been a 'unique policy experiment' that has produced significant contributions towards strengthening science-society interactions in EU R&I (Owen, von Schomberg, and Macnaghten 2021). But the legacy of RRI for Horizon Europe is not only about sharing and mobilising the conclusions of this policy experiment. The next EU framework programme and its 'mission-driven innovation' structure confers to citizens several active roles in the way that EU R&I will be developed in the coming years (Robinson, Simone, and Mazzonetto 2021). In this sense, RRI is not only well equipped with a set of tools to meet the oncoming sociotechnical ethical challenges that can arise in emerging technologies or around scientific-technological

public controversies, but it also constitutes a robust philosophy full of guiding questions to help reflect on existing values, economic drivers, extant institutional logics and standing epistemic practices in different research and innovation contexts. Both elements will be required in coming years in order to reinforce science-society interactions in European R&I.

Notes

1. The SwafS unit was a continuation and extension of programme lines which had existed in sequence since Framework Programme 5; i.e., 'Ethical Legal and Social Aspects', 'Science for Society' and 'Science in Society' which followed after one another. It was dissolved and reorganised in 2019.
2. For more information see www.newhorrizon.eu.
3. NCPs are representatives of a national structure established and financed by Member States and associated with framework programmes.
4. All participants signed an informed consent form, in accordance with the EU Regulation 2016/679 (GDPR), reviewed and approved by the NewHoRRIzon consortium.
5. See the Annex for the full interview script.
6. The MSCA is comprised of various funding schemes: individual fellowships (offering support for researchers to move between countries), European Researcher's Nights (which are set up to boost public awareness of the role of research in society), research networks (ITN), co-funding of regional, national and international programmes involving mobility (COFUND), and research and innovation staff exchanges (RISE).
7. https://www.green-win-project.eu/
8. https://gt20.eu/
9. https://landsense.eu/
10. For a detailed list of countries and the objectives of the work programme see https://ec.europa.eu/programmes/horizon2020/en/h2020-section/spreading-excellence-and-widening-participation
11. Figure 2 is a simplification and interpretation of complex qualitative data and differing situations which are, as the cases demonstrate, more nuanced. For example, and as discussed above, the ways particular programme lines address single keys, such as open access, gender equality, public engagement and ethics. As a case in point, with the ERC, some RRI keys were addressed in a few projects, often on an applicant's own initiative. Despite such exceptions, the overall conclusion for ERC remains that implementation of RRI is insignificant at the project level.
12. Figure 3 and Figure 4 both attempt to create a simplification and interpretation of complex qualitative data that can be more nuanced.
13. The total budget for SwafS in H2020 was 462 million euros, which is considerably less than other budgets for the programme lines analysed. For a full breakdown of H2020 see Figure 1.
14. For instance, in our study, issues such as gender equality or data protection were considered important dimensions in the projects, but they were not linked to the concept of RRI.
15. For instance, mission-driven innovations have a prominent space in the new framework programme, Horizon Europe, greatly shaping the content and structure of work programmes and project funding requirements. Equally, the open science policy will be enforced in Horizon Europe by a set of measures to make mandatory open access publications and open data in EC-funded projects. See https://ec.europa.eu/info/research-and-innovation/strategy/strategy-2020-2024/our-digital-future/open-science_en
16. Although much prior work existed on ethics and gender keys, for example, before H2020.
17. SwafS has been redesigned and merged with WIDENING, giving birth to a new work programme named 'Widening participation and strengthening the European Research Area'. See https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/wp-call/2021-2022/wp-11-widening-participation-and-strengthening-the-european-research-area_horizon-2021-2022_en.pdf

18. Own elaboration based on data available at https://ec.europa.eu/research/participants/docs/h2020-funding-guide/grants/applying-for-funding/find-a-call/h2020-structure-and-budget_en.htm

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References

Bernstein, M. J., T. Brandstätter, E. Griessler, J. Cohen, A. Loeber, L. M. Seebacher, I. Marschalek, and E. Unterfrauner. 2018. *D2.1: Diagnosis: RRI in Excellent Science*.

Blok, V., and P. Lemmens. 2015. "The Emerging Concept of Responsible Innovation. Three Reasons Why It Is Questionable and Calls for a Radical Transformation of the Concept of Innovation." In *Responsible Innovation 2: Concepts, Approaches, and Applications*, edited by B.-J. Koops, I. Oosterlaken, H. Romijn, T. Swierstra, and J. van den Hoven, 19–35. London: Springer. https://doi.org/10.1007/978-3-319-17308-5.

Burget, M., E. Bardone, and M. Pedaste. 2017. "Definitions and Conceptual Dimensions of Responsible Research and Innovation: A Literature Review." *Science and Engineering Ethics* 23 (1): 1–19. doi:10.1007/s11948-016-9782-1.

Carrier, M., and M. Gartzlaff. 2020. "Responsible Research and Innovation: Hopes and Fears in the Scientific Community in Europe." *Journal of Responsible Innovation* 7 (2): 149–169. doi:10.1080/23299460.2019.1692571.

Christensen, M. V., M. Nieminen, M. Altenhofer, E. Tangcoigne, N. Mejlgaard, E. Griessler, and A. Filacek. 2020. "What's in a Name? Perceptions and Promotion of Responsible Research and Innovation Practices Across Europe." *Science and Public Policy* 47 (3): 360–370. doi:10.1093/scipol/scaa018.

Claude, J., O. Flores, J. K. Frackowiak, C. Iacovou, A. Lehmann, G. León, D. Lindley, L. Miron, F. P. Russo, and Y. Smits. 2011. *Analysis and Recommendations for the Future Evolution of the "Research Potential" Activity. Expert Group report on Research Potential project portfolio* (Issue May). https://doi.org/10.2777/74285.

de Saille, S. 2015. "Innovating Innovation Policy: The Emergence of 'Responsible Research and Innovation.'." *Journal of Responsible Innovation* 2 (2): 152–168. doi:10.1080/23299460.2015.1045280.

de Saille, S., F. Medvecky, M. van Oudheusden, K. Albertson, E. Amanatidou, T. Birabi, and M. Pansera. 2020. *Responsibility Beyond Growth: A Case for Responsible Stagnation*. Bristol: Bristol University Press.

Delaney, N., Z. Tornasi, R. Lagher, R. Monachello, and C. Warin. 2020. *Science with and for Society in Horizon 2020. Achievements and recommendations for Horizon Europe*. https://doi.org/10.2777/32018.

Eizagirre, A., H. Rodríguez, and A. Ibarra. 2017. "Politicizing Responsible Innovation: Responsibility as Inclusive Governance." *International Journal of Innovation Studies* 1 (1): 20–36. doi:10.3724/SP.J.1440.101003.

European Commission. 2013. *Horizon 2020 – the EU's New Research and Innovation Programme*. Press Release. http://europa.eu/rapid/press-release_MEMO-13-1085_en.htm.

European Commission. 2014. *Innovation Union Competitiveness Report* 2013. https://doi.org/10.2777/87066.

European Commission. 2017. *Responsible RESEARCH & innovation Implementing RRI in Horizon* 2020. Horizon 2020. https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation#Article.

Fraaije, A., and S. M. Flipse. 2020. "Synthesizing an Implementation Framework for Responsible Research and Innovation." *Journal of Responsible Innovation* 7 (1): 113–137. doi:10.1080/23299460.2019.1676685.

Geoghegan-Quinn, M. 2012. *Responsible Research and Innovation. Europe's ability to Respond to Societal Challenges*. https://doi.org/10.2777/11739.

Godin, B. 2020. *The Idea of Technological Innovation*. Cheltenham: Edward Elgar Publishing.

Griessler, E., E. Álvarez, M. Bernstein, A. Bierwirth, R. Braun, M. V. Christensen, Stephanie Daimer, et al. 2018. *D5.1: Diagnosis: RRI in Diversity of Approaches*.

Griessler, E., R. Braun, M. Wichert, and M. Yorulmaz. 2022. "The Drama of Responsible Research and Innovation: The ups and Downs of a Policy Concept." In *Responsible Research and Innovation: An Evidence-Based Reconceptualization*, edited by Vincent Blok. London: Springer.

Gutiérrez, R. T., and J. E. Ezponda. 2019. "Technodata and the Need of a Responsible Industry 4.0." In *Handbook of Research on Industrial Advancement in Scientific Knowledge*, edited by J. P. Z. Bonilla, and V. G.-P. Diaz, 1–19. Hershey: IGI Global. https://doi.org/10.4018/978-1-5225-7152-0.

High-Level Expert Group on Artificial Intelligence. 2019. *Ethics Guidelines for Trustworthy AI*.

Kuhlmann, S., and A. Rip. 2018. "Next-generation Innovation Policy and Grand Challenges." *Science and Public Policy* 45 (4): 448–454. doi:10.1093/SCIPOL/SCY011.

Loeber, A., M. J. Bernstein, and M. Nieminen. 2022. "Implementing Responsible Research and Innovation: From New Public Management to New Public Governance." In *Responsible Research and Innovation: An Evidence-Based Reconceptualization*, edited by Vincent Blok, 147–159. London: Springer.

Macq, H., É Tancoigne, and B. J. Strasser. 2020. "From Deliberation to Production: Public Participation in Science and Technology Policies of the European Commission (1998–2019)." *Minerva* 58 (4): 489–512. doi:10.1007/s11024-020-09405-6.

McCann, P., and L. Soete. 2020. *Place-based Innovation for Sustainability*. https://doi.org/10.2760/250023.

Mejlgaard, N., C. Bloch, and E. B. Madsen. 2018. "Responsible Research and Innovation in Europe: A Cross-Country Comparative Analysis." *Science and Public Policy* July: 1–12. doi:10.1093/scipol/scy048.

Novitzky, P., M. J. Bernstein, V. Blok, R. Braun, T. T. Chan, W. Lamers, A. Loeber, I. Meijer, R. Lindner, and E. Griessler. 2020. "Improve Alignment of Research Policy and Societal Values." *Science* 369 (6499): 39–41. doi:10.1126/science.abb3415.

Novitzky, P., V. Blok, J. Timmermans, J. Dvořáčková, V. Kebo, L. Macenauer, Z. Machát, and F. Vostál. 2018. *D3.1: Diagnosis: RRI in Industrial Leadership*.

Owen, R., P. Macnaghten, and J. Stilgoe. 2012. "Responsible Research and Innovation: From Science in Society to Science for Society, with Society." *Science and Public Policy* 39 (6): 751–760. doi:10.1093/scipol/scs093.

Owen, R., and M. Pansera. 2019. "Responsible Innovation and Responsible Research and Innovation." In *Handbook on Science and Public Policy*, edited by D. Simon, S. Kuhlmann, J. Stamm, and W. Canzle, 26–48. Cheltenham: Edward Elgar publishing.

Owen, R., R. von Schomberg, and P. Macnaghten. 2021. "An Unfinished Journey? Reflections on a Decade of Responsible Research and Innovation." *Journal of Responsible Innovation* 8: 217–233. doi:10.1080/23299460.2021.1948789.

Papaioannou, T. 2020. "Innovation, Value-Neutrality and the Question of Politics: Unmasking the Rhetorical and Ideological Abuse of Evolutionary Theory." *Journal of Responsible Innovation* 7 (2): 238–255. doi:10.1080/23299460.2019.1605484.

Pfotenhauer, S., and S. Jasanoff. 2017. "Panacea or Diagnosis? Imaginaries of Innovation and the 'MIT Model' in Three Political Cultures." *Social Studies of Science* 47 (6): 783–810. doi:10.1177/0306312717706110.

Prill, M. A., R. Lindner, M. Allinger, M. J. Bernstein, T. Bratan, R. Braun, R. Gianni, et al. 2018. *D4.1: Diagnosis: RRI in Societal Challenges*.

Randles, S., P. Larédo, A. M. Loconto, B. Walhout, and R. Lindner. 2016. "Framings and Frameworks: Six Grand Narratives of de Facto RRI." In *Navigating Towards Shared Responsibility in Re- Search and Innovation. Approach, Process and Results of the Res-AGorA Project*, 31–36. Fraunhofer Institute for Systems and Innovation Research (ISI).

Ribeiro, B. E., R. D. J. Smith, and K. Millar. 2017. "A Mobilising Concept? Unpacking Academic Representations of Responsible Research and Innovation." *Science and Engineering Ethics* 23 (1): 81–103. doi:10.1007/s11948-016-9761-6.

Rip, A. 2014. "The Past and Future of RRI." *Life Sciences, Society and Policy* 10 (17): 1–15. doi:10.1902/jop.1939.10.1.31.

Robinson, D. K. R., A. Simone, and M. Mazzonetto. 2021. "RRI Legacies: Co-Creation for Responsible, Equitable and Fair Innovation in Horizon Europe." *Journal of Responsible Innovation* 8 (2): 209–216. doi:10.1080/23299460.2020.1842633.

Ryan, G. W., and H. R. Bernard. 2003. "Techniques to Identify Themes." *Field Methods* 15 (1): 85–109. doi:10.1177/1525822X02239569.

Schot, J., and W. E. Steinmueller. 2018. "Three Frames for Innovation Policy: R & D, Systems of Innovation and Transformative Change." *Research Policy* 47 (August): 1554–1567. doi:10.1016/j.respol.2018.08.011.

Schuijff, M., and A. M. Dijkstra. 2020. "Practices of Responsible Research and Innovation: A Review." *Science and Engineering Ethics* 26 (2): 533–574. doi:10.1007/s11948-019-00167-3.

SIS Conference. 2014. *Rome Declaration on Responsible Research and Innovation in Europe* (Issue November, pp. 1–2).

Stahl, B. C., G. Eden, M. Jirotka, and M. Coeckelbergh. 2014. "From Computer Ethics to Responsible Research and Innovation in ICT." *Information & Management* 51 (6): 810–818. doi:10.1016/j.im.2014.01.001.

Stilgoe, J., R. Owen, and P. Macnaghten. 2013. "Developing a Framework for Responsible Innovation." *Research Policy* 42 (9): 1568–1580. doi:10.1016/j.respol.2013.05.008.

Tabarés, R., and A. Bierwirth. 2022. "Cultural Particularities and its Role in the "Innovation Divide": A Closer Look at the Origins of "Spreading Excellence and Widening Participation"." In *Responsible Research and Innovation: An Evidence-Based Reconceptualization*, edited by Vincent Blok, 46–60. Heidelberg: Springer.

Thapa, R. K., T. Iakovleva, and L. Foss. 2019. "Responsible Research and Innovation: A Systematic Review of the Literature and its Applications to Regional Studies." *European Planning Studies* 27 (12): 2470–2490. doi:10.1080/09654313.2019.1625871.

Timmermans, J., and V. Blok. 2018. "A Critical Hermeneutic Reflection on the Paradigm-Level Assumptions Underlying Responsible Innovation." *Synthese* 198: 1–32. doi:10.1007/s11229-018-1839-z.

van de Poel, I., L. Asveld, S. Flipse, P. Klaassen, V. Scholten, and E. Yaghmaei. 2017. "Company Strategies for Responsible Research and Innovation (RRI): A Conceptual Model." *Sustainability* 9 (11): 1–18. doi:10.3390/su9112045.

van Oudheusden, M. 2014. "Where are the Politics in Responsible Innovation? European Governance, Technology Assessments, and Beyond." *Journal of Responsible Innovation* 1 (1): 67–86. doi:10.1080/23299460.2014.882097.

Van Oudheusden, M., C. Turcanu, and S. Molyneux-Hodgson. 2018. "Absent, yet Present? Moving with 'Responsible Research and Innovation'." *in Radiation Protection Research. Journal of Responsible Innovation* 5 (2): 241–246. doi:10.1080/23299460.2018.1457403.

Von Schomberg, R. (2013). "A vision of responsible innovation". In *Responsible Innovation*, edited by R. Owen, M. Heintz and J Bessant. London: John Wiley.

Wiarda, M., G. van de Kaa, E. Yaghmaei, and N. Doorn. 2021. "A Comprehensive Appraisal of Responsible Research and Innovation: From Roots to Leaves." *Technological Forecasting and Social Change* 172: 121053. doi:10.1016/j.techfore.2021.121053.

Wittrock, C., E.-M. Forsberg, A. Pols, P. Macnaghten, and D. Ludwig. 2021. *Implementing Responsible Research and Innovation Organisational and National Conditions*.

Zwart, H., L. Landeweerd, and A. van Rooij. 2014. "Adapt or Perish? Assessing the Recent Shift in the European Research Funding Arena from 'ELSA' to 'RRI'." *Life Sciences, Society and Policy* 10 (1): 1–19. doi:10.1186/s40504-014-0011-x.