



Creating a developmental framework for evaluating RRI implementation in research organisations

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ABSTRACT

The evaluation of Responsible Research and Innovation (RRI) actions presents important challenges for the key stakeholders engaged in the process of RRI implementation, such as policy makers, programme managers, and researchers. While there is a considerable body of literature on the conceptualization of responsibility in research and a plethora of attempts to practice RRI, there is a need for increased attention to the monitoring and evaluation of case studies of RRI implementations in research organisations, in particular regarding their structural change effects. This paper aims to discuss a contextualised developmental framework for evaluating RRI implementation in research organisations, with a specific focus on achieving structural change through tailor-made action plans. The framework, developed through RRI evaluation work in the field of biosciences, adopts a systemic and process-oriented perspective, encompassing participatory, anticipatory, reflexive, and responsive dimensions. Concrete empirical examples from bioscience organizations are provided to illustrate how the framework relates to specific conditions, experiences, and solutions, demonstrating how conceptual insights have emerged from real-life practices and data analysis. While the framework was initially customized for the specific contexts of six bioscience research organizations, it holds potential for broader relevance and applicability in addressing challenges related to RRI design, implementation, and evaluation.

1. Introduction

Responsible Research and Innovation (RRI) activities are far from new. As already established in the literature, such activities have been carried out by research organisations for decades, albeit under different labels, such as social innovation, sustainable innovation and corporate social responsibility. What sets the current concept of RRI apart is its systematic approach and expanded scope, involving a wider range of stakeholders through public engagement and adopts a more pro-active stance (Stilgoe et al., 2013, Van den Hoven, 2013; Van de Poel, 2020).

RRI as a policy discourse, adopted mainly by the European Commissions (EC) “Science in Society” and “Science With and For Society” programmes has gained ground over the last two decades (Owen et al., 2012, Owen & Pansera, 2019; Van de Poel, 2020). The most common definition of RRI in the EC policy perspective states: “Responsible Research and Innovation is 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)” (Von Schomberg, 2012, p. 9). The central idea behind the RRI introduction by the EC was that research could become the driving force in addressing the “grand challenges” and in contributing to solving crucial present-day problems (Gardner & Williams, 2015; Von Schomberg, 2012). The launch of the RRI concept by the EC has thus been considered as an attempt to rethink research and innovation as public goods (Felt, 2018), anticipating and assessing implications and societal expectations “with the aim to foster the design of inclusive and sustainable research and innovation”. According to the EC definition, RRI implies that societal actors “work together during the whole research and innovation process in order to better align both the process and its outcomes with the values, needs and expectations of society” (European Commission, 2014:73).

In addition to the RRI concept used by the EC, there are other conceptualizations of responsible innovations (Ribeiro et al., 2017). Stilgoe et al. (2013: 1570) offer a broad and widely used definition of RRI, which although similar to the one used in European policies, has its roots in a different context: “Responsible innovation means taking care of the future through collective stewardship of science and innovation in the present”. Other scholars perceive RRI primarily as a cluster of ideas for

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promoting science governance focusing mainly on responsible processes (Burget et al., 2017), while others again emphasize the science and society reconfiguring character of RRI (Rip, 2014).

While the conceptualization of responsibility in research is well covered in the literature, and there is a plethora of attempts to practice RRI, first and foremost in Europe, the evaluation of RRI implementations within research organisations, in particular their structural change effects need more attention. In fact, the monitoring and assessment of the implementation of RRI actions, for example within specific contexts (such as the biosciences), and their effects as regards structural change, lack attention in the literature (Declich 2020). Typically, RRI evaluation has had a broad focus while less consideration has been given to contextual embeddedness and the type of organisations they involve (Nieminen & Ikonen, 2020). Moreover, scholars point to the lack of case studies (Schuijff & Dijkstra, 2020) and emphasize their importance for testing RRI theories (Wiarda et al., 2021).

This paper aims to contribute to the existing literature on RRI evaluation by paying special attention to the above-mentioned factors. It presents a framework for evaluating the actual experiences of promoting RRI actions and fostering structural change within specific research organisations. The framework, grounded in the European context and EU policies, goes beyond current practices and considers important contextual issues, such as the field of science, type of organisation, and institutional settings. Reference to the contexts is made through concrete illustrative empirical examples of various conditions, experiences and solutions from six European research organisations¹ implementing RRI to show how conceptual points have emerged from real-life practice and data analysis (See supplementary file 3).² Consequently, the evaluation framework proposed in this paper is built on a robust, context-specific foundation. The main focus lies in articulating a framework for assessing the implementation and impact of the structural change process. The framework is informed by the RRI action plans implemented within the field of biosciences³ as part of a European project.

The paper is structured as follows. In Section 2, concepts and approaches are introduced. In Section 3, we discuss the creation of the evaluation framework and its different stages while in Section 4, we point to some issues that need further attention. Conclusions are offered in the final section.

2. Concepts and approaches

There are different approaches to RRI and hence to the understanding of the RRI concept. While some scholars frame RRI in terms of governance, others put emphasis on its co-creating research and innovation character, and the participation of a broad range of stakeholders (Klaassen et al., 2020). A seminal contribution, and frequently used conceptualization of RRI, frames it as *systemic*, involving the dimensions of anticipation, inclusion, reflexivity and responsiveness (Owen et al., 2012; Stilgoe et al., 2013). Paying attention to the different dimensions, in particular the dimensions of anticipation, inclusion and responsiveness, require that the framework is rooted in an institutional context and designed to consider its characteristics. Another research strand perceives RRI as a far-reaching *reconfiguration* of the science and society relationship (Gulbrandsen, 2016; Rip, 2014), while a third strand of conceptual approach understands RRI primarily as a *learning process* (Egeland et al., 2019; Kupper et al., 2015). Other scholars (Wickson &

Carew, 2014) suggest a RRI concept that involves (i) a focus on socio-ecological challenges; (ii) a commitment to engage stakeholders for mutual learning and improved decision-making; (iii) an anticipation of problems and a reflection on stakeholders values and beliefs; and (iv) a readiness among all actors to work based on the RRI principles.

While responsibility in research and innovation is not a new concept, the way responsibility has been framed has varied over time and space. Scholars point out that while individuals may not be or act irresponsible, the complex systems of research and innovation create “organized irresponsibility” (Beck, 2000), or what von Schomberg (2007) identified as a manifestation of irresponsible innovation, which includes technology push, neglect of ethical principles, policy pull and lack of precaution and foresight. This implies a collective responsibility (Grinbaum & Groves, 2013) or co-responsibility to consider in the research process (Mitcham, 2003). Stilgoe et al. (2013) argue that reframing responsibility requires adopting a systemic approach, which is fundamental to the RRI concept (Hellström, 2003). Other scholars emphasize that responsibility in research and innovation is shared among stakeholders (Mitcham, 2003; Von Schomberg 2007), while Kieslinger et al. (2018) focus on the concept of Citizen Science as a means to promote shared responsibility.

As a result of these developments, an increasing number of evaluation scholars are focusing on the systemic nature of organizations, the complexity of processes, and the multiple interactions between various factors and actors involved in RRI practice. This shift involves moving away from linear, causal thinking about inputs, outcomes, and impacts (Kalpazidou Schmidt & Graversen, 2020; Mowles, 2014; Nieminen & Hyttinen, 2015; Nieminen & Ikonen, 2020). Linear approaches are increasingly being criticized for their limited ability to comprehend complex processes (Patton, 2010), leading to a notable inclination towards systems thinking. According to Nieminen and Ikonen (2020:254) these different approaches share a common focus on the interrelationships among actors, the entire system, its parts, and the actions within its context.

Evaluating the impact of complex interventions becomes challenging when the focus is solely on attribution and linear causality (Kalpazidou Schmidt & Cacace, 2017; Dotti & Walczyk, 2022). Therefore, we argue that the solution lies in acknowledging complexity and adopting a systemic view as a frame of reference, taking an anticipatory, reflexive, inclusive, learning, and responsive standpoint. Anticipation is crucial for analyzing the different types of impacts of research and innovation. Reflexivity involves actors considering their motivations and purposes for participating in research and innovation, remaining open to input from other actors. Inclusiveness brings together various stakeholder interests, values, and perspectives, while responsiveness entails continuous learning and adapting targets, strategies, and practices (Kupper et al., 2015; Loeber & Cohen, 2018; Owen et al., 2012; Rip, 2014). Therefore, our approach is based on the premise that the implementation of RRI in research organizations is influenced by the complex interactions among internal and external factors, as well as the involvement of multiple actors, alongside the conditions and dynamics during the practice of RRI.

The implementation process in our study involves the development and execution of tailor-made action plans that target the five key

¹ The research organisations are located in Bulgaria, Germany, Italy, Slovenia, Poland, and the UK.

² The presented illustrative anonymised examples refer to the RRI implementation in the six bioscience organisations and are based on the empirical material and experiences discussed in the Final Report on Monitoring and Assessment and the project Guidelines.

³ The biosciences disciplines included here are biomedicine, biology, systems biology, biochemistry, nature conservation, and biotechnology.

components of the RRI concept: gender, education, ethics, open access, and public engagement⁴ with the aim of achieving structural change. In this context, structural change refers to a comprehensive, contextualized, inclusive, and irreversible institutional transformation. By placing emphasis on structural change, we explore an aspect that has received limited attention in the context of RRI, namely the sustainability of actions and the long-term outcomes of RRI action plans after their completion.

3. A complexity and developmental approach to RRI evaluation

From the beginning, the key questions have revolved around how to conceptualize and operationalize RRI in bioscience research organisations, and how to develop an evaluation framework that captures the complexity of RRI implementation and impact. Given the complexity of RRI as a concept, it is challenging to anticipate the full range of RRI processes, outcomes and impacts in a straight line, especially when evaluation is conducted simultaneously with RRI practice. Therefore, the evaluation framework needs to reflect this complexity.

As mentioned earlier, the notion of *complexity* implies a non-linear approach that focuses on the context and local dynamics of the research organisations, as well as the continuous monitoring and adaptation of RRI implementation to new emerging conditions and unintended effects, with the aim to achieve structural change by disrupting self-organisation processes that maintain traditional norms and practices. Complex systems adapt to changes (Halpern 2014), which means that contextual conditions may shift over time due to constant interactions with a range of internal and external factors within research organisations (Marra, 2022; Kalpazidou Schmidt & Cacace, 2017).

Adopting a complexity perspective in RRI implementation and evaluation adds to the systemic and structural view of organizational transformation (cf. Nieminen & Ikonen, 2020). It recognizes the complex interrelations between different actors and conditions that produce impacts, which should be reflected in the evaluation approach and methodologies. Transforming dynamic systems through RRI practice involves factors that cannot be controlled by traditional methodologies, as traditional evaluations are typically based on an input-process-output-outcome-impact logic. Thus, having a system in place to monitor and evaluate change as it happens (Dawson, 2011), e.g. throughout the implementation lifecycle, provides valuable data and insights to manage unforeseen and emerging issues. According to Patton (2010), evaluation and monitoring activities, rather than standard research, can be more helpful in supporting a reflexive analysis of the change process. Such activities assist in managing the highly contextual character of RRI implementation and encourage the adoption of flexible and tailored evaluation tools.

To address complexity, a *developmental evaluation* approach was adopted, which helped capture emerging issues and their implications, reflecting and feeding back into the implementation process to inform subsequent steps. Developmental evaluation, as described by Patton (2010: 1), supports the development of innovation “to guide adaptation to emergent and dynamic realities in complex environments”. In this approach, the evaluator becomes part of the development team, actively involved in conceptualizing, designing, and testing new approaches in

an ongoing process of continuous development, adaptation, and experimentation, with a keen sensitivity to unintended results and side effects (Patton, 2010). This form of evaluation supports organisational development, as it is integrated into the intervention itself and provides real time feedback during the implementation process, which is in contrast to accountability and summative approaches. Evaluators work in close collaboration with the RRI implementation team to conceptualize, design and test new approaches in the change and development process, facilitating real time, continuous data-based implementation, and mapping implications and results (Guijt et al., 2012).

3.1. RRI operationalization and evaluation in bioscience research organisations

To enable operationalization of RRI in the specific contexts of the six bioscience research organisations, it was important to avoid hyper-theorization (Van de Poel, 2020) and involve key stakeholders in the process. This engagement allowed stakeholders to reflect on and take responsibility for what RRI practicing meant for their respective organisations (Klaassen et al., 2020) and how to effectively operationalize and implement RRI principles (Yaghmaei & van de Poel, 2021). The process involved mapping past experiences, anticipating opportunities and risks, and reflecting on potential challenges related to RRI implementation (see [supplementary file 3](#), example 1). Additionally, a mutual learning process was initiated among the six research organisations, using the insights gained during the action design and implementation, which facilitated timely responses to expected and unforeseen local issues ([Supplementary file 3, example 2](#)).

Once the customization of RRI operationalization was finalized with the design of a concrete action plan distinct for each research organisation (see [supplementary file 4](#)), based on the literature and taking into consideration the contextual conditions, the criteria for evaluation were established. Subsequently, a tailored monitoring and evaluation approach was implemented for each individual organisation. Through a participatory developmental approach, the evaluators acted as a “critical friend” throughout the implementation process, monitoring activities and mapping what was functioning and what required more attention in a continuous mutual learning and formative process (see [supplementary file 3, example 3](#)). Therefore, in contrast to evaluations focusing solely on for example accountability, which produce outcomes that are rarely adequate to feedback into the RRI implementation process, our approach acknowledging the complexity of research and innovation, focused on reflexivity and learning as essential developmental aspects ([Supplementary file 3, example 4](#)). This approach enhanced the ongoing RRI implementation, as it was designed to consider the perspectives, concerns, and learning needs of the actors and stakeholders involved in or connected to the actions (Klaassen et al., 2020).

The evaluation activities considered both short, medium, and long-term objectives. From the outset, in the frame of a close monitoring process, all observations, outcomes and findings fed back to the RRI implementing organisations to facilitate further development of the activities in a formative manner. As the action plans progressed, the evaluation activities successively shifted focus to efficiency, effectiveness and accountability, while simultaneously collecting data on the implementation effects. Throughout the process, emphasis was placed on maintaining “local” protocols established by the RRI implementing organizations, documenting facilitating and hindering factors, as well as successes and failures. Furthermore, the evaluation activities contributed to creating a comprehensive knowledge base for future work beyond the project’s duration and served as a basis for identifying initiatives to build upon and draw inspiration from in the pursuit of sustainability and continuity of certain actions.

The developmental approach was consequently informed by the *formative* evaluation exercise, which was adopted to feed into the ongoing RRI design and implementation process, while *summative*

⁴ **Education:** enhancing the education process to provide future researchers and other societal actors with new capacities for taking responsibility in the R&I process and attracting children and youth to Science and Technology, Engineering and Mathematics (STEM); **Gender:** promoting gender equality within research organisations and the incorporation of the gender dimension in R&I content; **Open Access:** making R&I more transparent and accessible through the promotion of open access; **Public Engagement:** encouraging the engagement of all societal actors, including researchers, citizens, policy makers, business and industry, in the R&I process; **Ethics:** promoting ethical standards to ensuring high quality research results.

evaluation was employed to assess the overall merit, outcomes, and impact of the RRI intervention in terms of structural change. The formative phase served as a foundation for the summative evaluation. However, both formative and summative evaluations can and do manage both processes and results (Patton, 2010). This challenges the traditional understanding that formative evaluation focuses solely on processes, while summative evaluation focuses only on results (Molas-Gallart, 2015). Furthermore, the transformation process continued even after the completion of the RRI implementation period and the summative evaluation, through specific sustainability-oriented actions and dedicated sustainability plans developed by each research organization involved in the study. The sustainability plans identified areas requiring ongoing attention beyond the duration of RRI implementation. In this regard, new tailor-made RRI actions were designed to be implemented after the study period, and the evaluation activities played a crucial role in identifying these areas and supporting the development of new actions.

The developmental evaluation employed was hence far from a standardised and routinized approach. It involved a designing and implementation phase, responding in real-time to emerging conditions, lessons learned, and changing needs within the RRI implementing organisations. Consistent with the concept of developmental evaluation, the evaluation process constantly adapted, balancing an internal and external role. The evaluators served as facilitators and critical colleagues, overseeing the progress of the RRI action plans, identifying hindering factors, and intervening promptly. Additionally, capturing and documenting facilitating factors was an essential aspect of the mutual learning process occurring among the implementing teams. Overall, both formative and summative approaches had their own value and specific purpose in the implementation, monitoring, and evaluation process (Patton, 2010). Fig. 1 illustrates the evaluation approach.

3.2. An itinerary approach - steps in developing the evaluation framework

Grounded in the complexity, nonlinear rational, and the developmental, participatory evaluation, a systematic itinerary approach was initiated to develop the evaluation framework. The first step in the RRI overall practice involved the building of a (core) transformational team to start conceptualising and operationalising RRI in a way that was consistent with the mission of each research organisation (Supplementary file 3, example 5). The process started hence with the conceptualization of RRI by a team endowed with the task of operationalizing and applying the concept in its research organisation through the progressive mobilization of various supportive internal and external stakeholders (extended team). This aimed at defining a specific set of research and innovation practices to pursue RRI objectives within a given organisational context. Six implementing core teams were hence established each with distinct local expertise and competence. In most cases members of the leadership of the organisations participated in the teams, which greatly facilitated action plan implementation (Supplementary file 3, example 6). In some cases, additional expertise with a social science or humanities background, familiar with the RRI concept, was recruited to support the implementation process.

As there is not a universal set of operationalising and practicing RRI, each of the bioscience research organisations had to define its own action plan and practice based on the interpretation of its features and wider contextual settings. Thus, the action plans were formulated and carried out based on an analysis of the contextual conditions and needs, anticipating opportunities, risks and impacts, reflecting on them, and responding upon them, involving the relevant actors (Supplementary file 3, example 7). At the same time, the importance of embedding RRI (where possible) in already existing organisational practices was acknowledged as an important factor facilitating implementation (Supplementary file 3, example 8). The evaluators have been engaged in the entire process, supporting the implementing teams from the beginning. Fig. 2 offers an illustration of the open itinerary approach used

during the RRI structural change implementation in the six bioscience organisations.

To begin with, the most important step in the structural change process addressed the question of how RRI was understood in the local context of the bioscience organisations and how it could be turned into social action, i.e. into concrete activities to achieve change. In this perspective, it was assumed that the notion of RRI structural change was linked to that of social change, entailing both a transformation of the structures, and identification and mobilization of change-oriented agents among the key stakeholders (Cacace et al., 2016). Accordingly, the mobilization of actors implied that they were committed and able to create a common vision and take action that could lead to achieving set objectives (Rotmans & Loorbach, 2009).

To the aim of action plan implementation, the broad concept of structure was operationalized to indicate the general framework and conditions, where the action plans took place, i.e. the bioscience organisations, and anticipate the facilitating and hindering factors, which were expected to be manifested during the RRI implementation process. Identification and mobilization of the relevant actors and agents of change was carried out in the local environments on the basis of the different players' capacity, willingness and "room to maneuver" to actively support the action plans (Supplementary file 3, example 14). The dynamics of RRI were observable as further activities, manifested in various ways, for instance as structural frictions and various types of hindering or facilitating factors (Forsberg et al., 2018; Kalpazidou Schmidt et al., 2020; Palmén and Kalpazidou Schmidt, 2019).

The tool of negotiation⁵ was used in action plan design, and RRI legitimization and implementation, as well as management of potential frictions, and in order to address upcoming issues (Supplementary file 3, example 9). Negotiation processes varied greatly between the different bioscience organisations implementing RRI and were closely linked to how the core and extended teams were composed and organised (Supplementary file 3, example 10). The core teams made a continuous effort to mobilise actors, keep them engaged in promoting RRI as well as identifying and including new actors in the implementation process. Simultaneously, institutional and operational negotiations were employed to pursue change in the structures of the organizations (cf. Cacace et al., 2016). The main building blocks of the structural change activation in the research organizations, and the basis for the evaluation activities, have hence been: (a) the creation of a core transformational team in each organisation being in charge of RRI implementation (involving also the evaluators); (b) a context analysis to identify relevant conditions, issues, needs and key actors; (c) the designing of a detailed RRI action plan tailored to each organisation; (d) the mobilization of internal and external agency; (e) identification of "room to maneuver" locally and a set of negotiation processes with relevant actors and organisational bodies; (f) identification of structural change potentials and sustainability issues to address.

In a monitoring and evaluation perspective - the following mechanisms have proved central to managing the process: *first*, the local transformational agent (core and extended teams) and degree of mobilization of other agency for change; *second*, the inclusion and activation of agents with the arousal of supportive or conflicting attitudes (potential frictions) and behaviors towards RRI practicing (leadership, staff, beneficiaries and other agents willing to support RRI practices, agents resisting change, external stakeholders involvement, etc.); *third*, the anticipation, reflexivity, (mutual) learning and responding processes, which helped quality RRI implementation; and *finally*, the mapping of successes and failures in a structural change and sustainability

⁵ For a more detailed description of the concept of negotiation, see Grobler 2007; Habermas 1987; Luhmann, 2000.

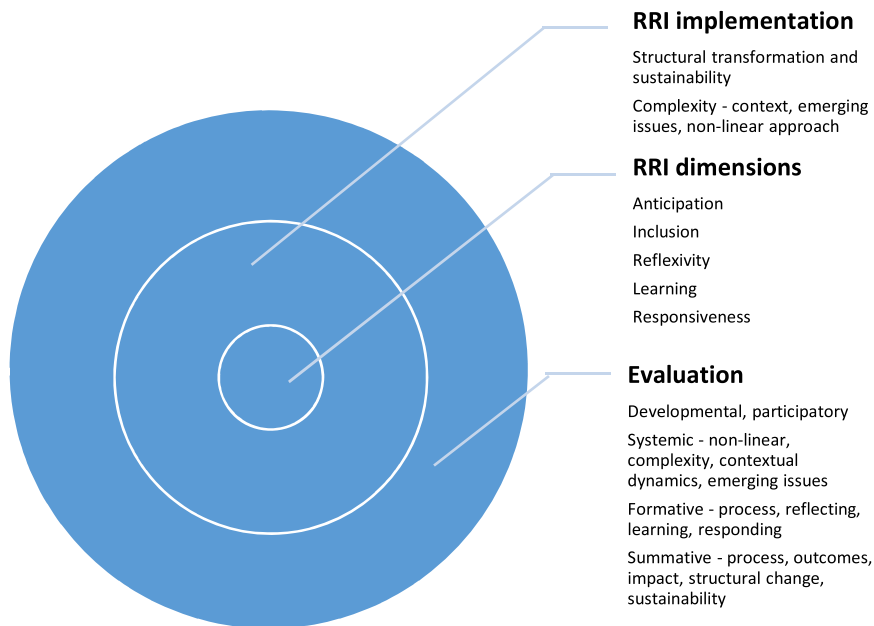


Fig. 1. A contextualised developmental RRI evaluation approach.

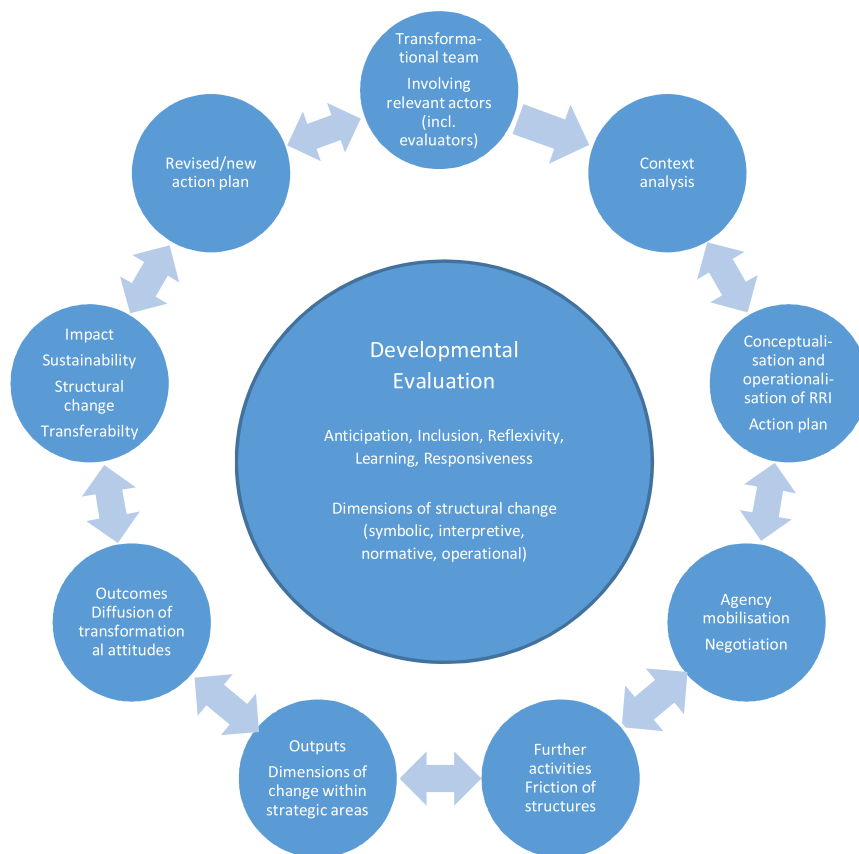


Fig. 2. An itinerary approach to RRI implementation and evaluation (Developed from Cacace et al., 2016, Kalpazidou Schmidt et al., 2019).

perspective (Cacace et al., 2016).

The catalyst of achieving change has been identified as the transformational agent,⁶ i.e. the core and extended team involved in the implementation. Key features of an efficient transformational agent were identified in the capacity of the team to operationalize RRI, according to the local needs of each bioscience organisation, and develop a strategic view of the action plan, involving key actors. Keeping internal cohesion and commitment to the RRI action plan have proved of paramount importance to implementation. The transformational team needed to involve and activate other internal and external actors directly or indirectly concerned (research groups, leadership, organizational units, administrative staff, students, external stakeholders, ministries, industry, media, citizens, etc.), to gain their active support and contribution to the action plans. Specific structural features within each bioscience organisation facilitated or hindered the work of the transformational group. Manifold friction dynamics of agency and structure took place locally. Issues such as the availability of information and data as to the RRI keys and technical, financial and human resources, time constraints, rules, laws and regulations in effect, dominant organisational patterns, prevailing policies, procedures, etc., proved to be of significance for the implementation of the RRI principles and the change process (Kalpazidou Schmidt et al., 2019).

The structural approach to RRI action plan implementation referred to the capacity of the actions to activate institutional change processes in the research organisations. Four dimensions of structural change were considered in the evaluation, the symbolic, the interpretive, the normative and the operational (see Fig. 3). The *symbolic* dimension is linked to the visibility and recognition of RRI in the daily life of each research organization (e.g., institutional mission statement and communication, websites, language, etc.) (Supplementary file 3, example 11). The *interpretive* dimension refers to the meaning and relevance attached to RRI and thus the development of new understandings of RRI (Supplementary file 3, example 7), as well as increased interdisciplinary and transdisciplinary work (Supplementary file 3, example 12). The *normative* dimension concerns change in the bioscience organisations in terms of new rules, regulations, procedures, bodies, and tasks stemming from RRI implementation (Supplementary file 3, example 13). Finally, the *operational* dimension is linked to the diffusion of new practices, skills, tools and methods in the research organisations concerned (Supplementary file 3, example 8) (cf. Cacace et al., 2016).

In order to assess sustainable impacts, structural change had to be considered in terms of the four dimensions mentioned above, i.e. the capacity of the core and extended team to translate concepts and commitments into action; uptake of the RRI activities by the organization; the redefinition of rules and procedures, and the creation of new ones adopting the RRI principles; and other changes of sustainable character. Some illustrative examples of different dimensions of structural change accomplished by the six RRI implementing bioscience organizations involve: a) introduction of a unified educational study programme for all faculties covering a social responsibility module; b) provision of training for young plant biotechnologists on research integrity; c) introduction of gender in research content in gender medicine courses; d) establishment of a kindergarten as a tool for strengthening career planning support programmes; e) development of a code of conduct for biology research; f) an interdisciplinary chair in biotechnology and sustainable development; g) establishment of a working group for open access policy; h) a new plant biotechnology information centre aimed at promoting societal engagement and science communication on emerging research, ethical and societal issues.

The evaluation framework set out to identify the multiple aspects

⁶ As to the gender of the transformation agents most of the core teams consisted primarily of female implementing agents while most of the extended teams involved a majority of male implementing agents.

and variables at play activated by the implementation of tailored RRI action plans and the processes that followed. As linear patterns were challenging to identify due to the variability and unpredictability of the processes taking place in the research organisations, structural change activities needed rather to focus on fostering the crucial conditions to increase the probability that change can occur in a long-term perspective. This was made by taking into account the multiple dimensions of change, and by involving various actors to negotiate and steer the process, being aware that establishing a direct connection between actions and outcomes and impacts is not straightforward (Kalpazidou Schmidt et al., 2019; Reale et al., 2014).

3.3. Methodological itinerary

In line with the developmental evaluation approach, the evaluation team developed a methodological itinerary with a customized, mixed methods design. The design employed both quantitative and qualitative methods, such as interviews and on-site visits (to get more in-depth information about local dynamics and procedures), evaluation grids to collect data and map ongoing change. The aim with the mixed methods design has been to maximize both the validity of evaluation and the value of the implementation work by using feedback loops. To this aim, the two components of formative and summative evaluation proved to be useful tools (See supplementary file 1 and 2 for examples of formative and summative grids used to evaluate RRI implementation). They provided feedback to better manage implementation and social dynamics within the bioscience organisations, thus forming the activities, and pointing to the direction for further enhancement of the action plans towards sustainable results. Finally, in a learning perspective, the evaluation contributed to opening up of the black box of the space between the initiation of the actions and the impacts by closely following the process of implementation, through a participatory but critical standpoint, generating insights in what worked and what needed to be improved (Pawson and Tilly, 1997).

Overall, in line with the developmental evaluation principles, the process involved a balancing of the internal and the external perspective of the role of the evaluators. The internal role of the evaluators, as embedded in the project, provided the advantage of becoming acquainted with all the activities in a high level of detail. This was utilized for the benefit of identifying the most adequate instruments for assessing and documenting progress and results. This closeness minimized the risk of an overly ethnocentric stance with shortages as to relevance and ability to capture the complex context-sensitive aspects of RRI implementation in each organisational setting. At the same time, in-built in the evaluation task lied also an imperative to take on a more distanced perspective to allow an independent assessment of the action plan progress (Declich, 2020). The evaluation perspective impersonated hence an outside view of a critical friend, avoiding “going native” (Lindlof, 1995). This was carried out in a deeply committed way that supported the implementation process and assessed the results, bearing in mind local conditions. Familiarizing with the local conditions and needs was crucial for the monitoring and evaluation activities, as the bioscience research organisations implementing RRI activities varied in terms of history, national and socio-political contexts, cultural and structural settings.

3.4. Formulating criteria and tools

Based on current literature and a recently tested set of criteria in other similar frameworks (Cartwright & Hardie, 2012; Dahler-Larsen, 2012; Kalpazidou Schmidt & Cacace, 2017; Nieminen & Ikonen, 2020; Reale et al., 2014; Rog, 2012; van de Poel, 2020), the evaluation process adopted six criteria (Fig. 4), i.e. *effectiveness* (addressing the attainment of the objectives with the implementation of RRI in bioscience); *efficiency* (referring to the implementation process, use of resources, frugality and managerial capacity to achieve the set objectives);

Symbolic dimension	Interpretive dimension	Normative dimension	Operational dimension
<ul style="list-style-type: none"> •RRI visibility •RRI recognition •Changes in mission, acts, statements •Changes in communication, websites •Changes in language 	<ul style="list-style-type: none"> •RRI meaning •RRI relevance •New understandings of RRI •Increased interdisciplinarity •Increased transdisciplinarity 	<ul style="list-style-type: none"> •New rules •New regulations •Changes in procedures •Changes in tasks 	<ul style="list-style-type: none"> •Establishment and diffusion of new practices •Diffusion of new skills •Diffusion of new tools and methods •Establishment of new bodies

Fig. 3. Dimensions of structural change considered in the evaluation (Developed from Cacace et al., 2016).

effectiveness	•attaining set objectives
efficiency	•implementation process and use of resources
relevance	•adequacy of the actions during the entire implementation process
impact	•subjective impact •objective impact
sustainability	•structural effects beyond end of actions
transferability	•transferring actions to other contexts

Fig. 4. Evaluation criteria (Adapted from Kalpazidou Schmidt, 2020).

relevance (addressing the adequacy of the initiatives during the implementation process and the capacity of the teams to address emerging issues and solve problems within the bioscience environments); sustainability (considering structural effects beyond end of the RRI action implementation); transferability (transferring part of the RRI activities to another context to be tailor-made to a new research environment) and impact (assessing short-, medium- and long-term effects of RRI implementation).

For analytical purposes, impact was categorized as subjective and objective. Subjective impact relates to the level of acceptance and approval of RRI actions among the beneficiaries, as well as the ability of the implementing team to foster consensus among different actors, paving the way for further transformative change. On the other hand, objective impact addresses measurable outcomes and structural changes resulting from RRI initiatives. This includes quantitative factors like the increase in women holding leadership positions, open access publications, development of ethics handbooks, and the introduction of new educational courses on RRI. It also encompasses qualitative factors such as cultural, organizational, and policy changes, including modified work procedures, and the implementation of solutions aligned with RRI principles. Objective impact, particularly in terms of norms, values, or culture, encompasses various factors. This includes, among others, the adoption of open science principles, the establishment of bodies to promote ethics and ethical conduct in research, promotion of gender equality, active engagement of stakeholders in decision-making, and training initiatives to enhance awareness and understanding of RRI principles and competencies.

Indicators were developed for each criterion considering the local contexts.⁷ The evaluation activities encompassed a variety of different

elements, including tailor-made evaluation grids (formative and summative)⁸ targeting each RRI action plan. Written responses to the evaluation grids were collected from all corresponding core teams, responsible for action plan implementation in each research organisation, and periodic interviews were conducted with the core teams based on the evaluation grids. In addition, on-site visits, coordination and information meetings, mutual learning workshops, and a range of bilateral ad hoc activities between the evaluation team and the RRI implementing teams were arranged. Ad hoc activities included support to develop survey questionnaires and evaluation templates, feedback to internal documents, e.g. policy booklets and recommendations, and provision of relevant literature.

3.5. Context-sensitiveness

Within the project, contextualization has been understood and defined in terms of (i) organisational contextualization (embedding RRI in the individual research institution); sectoral contextualization (adapting the RRI approach to the particular field or sector, e.g. biosciences); cultural contextualization (reshaping RRI to be applied in specific cultural contexts, considering national R&I systems, etc.); and historical contextualization (linked to the ability of R&I to respond to challenges throughout the implementation timeframe and at the same time prepare the continuation of part of the activities, where necessary, in a sustainability perspective) (cf. Declich, 2020).

Besides, the organisational and cultural contextualisation discussed earlier, RRI implementation needed to be interpreted by contextualizing it within the sector in which it was practiced. The field of biosciences comprises organisations of different nature, which carry out research activities within biomedicine, biochemistry, biology, system biology,

⁷ Indicators were also derived from the European projects MoRRI and SUPERMoRRI, which are large-scale European attempts at creating a monitoring and evaluation system for RRI.

⁸ See additional files for anonymized Evaluation Grids (formative and summative)

nature conservation and biotechnology sciences. Yet, as all the bioscience areas focus on living organisms and life processes, they faced similar issues of scientific, methodological, socio-economic, organisational and ethical character (Declich, 2020). The awareness of sector specificity entailed considerations as regards the critical developments and challenges that the sector faced throughout the RRI implementation timeframe (see supplementary file 3, example 14, 15). Taking them into account from the beginning enabled smooth RRI practicing, addressing existing gaps and societal concerns raised by research and innovation in the biosciences (Supplementary file 3, example 15).

As discussed earlier, in contexts with high levels of uncertainty and complexity as in bioscience organisations, structural change processes rarely assume a linear trajectory. On the contrary, they proved to be nonlinear, characterised by sudden progress or setbacks, intended and unintended effects, unexpected issues and deviations from the original action plan. As a consequence, the RRI implementation phase required a more pro-active stance, flexibility and a capacity to react rapidly to unforeseen conditions. The activation of a reflexivity, monitoring and learning process, supported by the tool of monitoring and formative evaluation, has been crucial in addressing unforeseen situations.

A major concern for the evaluation team has been to familiarize with the natural environments of the action plans in order to get insights in the activities, events and procedures, which may not come down on paper, about the conditions and everyday opportunities and challenges, obstacles, experiences and interpretations of RRI and its enactment in the different settings. This specific role mitigated the risk of missing out on capturing the context-sensitive aspects of the action plan settings. This was facilitated through dialog (virtual and in person) and on-site visits to the six organisations.

The main purpose of the visits was to acquire the best possible knowledge and information to understand each RRI action plan in its specific context. The visits involved, except for the core, extended and technical assistance teams, other key actors (such as rectors, vice-rectors, deans, technology transfer offices, librarians, staff responsible for human resources, researchers, doctoral and master students, etc.) implementing the action plan in a daily basis or in other ways engaged in the implementation process. Inspired by Patton (2015), on-site visits were used as an important means to discover and unpack variations between RRI action plan practices, enabling the understanding of the conditionality of achieving structural change in each contextual setting and detecting obstacles and potential pitfalls in due time to facilitate their solution. Visits also supported the identification of possible venues of further interest or benefit for the implementation and structural change process, as well as the collaboration between the action plans implementing teams for mutual learning purposes. Speeding up the process was made possible through promptly reflection over implementation practices, allowing for an assessment of their expediency, tracking changes in each organization that could affect rapid progress, and adaptation of evaluation design to address evolving issues.

4. Points for further attention

Implementing and evaluating RRI calls attention to a range of issues that need further research to gain additional insights in the dynamics at work in complex research organisations. As van de Poel (2020: 340) stresses "If tools for RRI measurement, assessment and incentivizing are to be effective, they need not only to result in a measurement of RRI performance that is reliable and valid, but also to contribute to behavior incentives that contribute to an increased uptake of RRI and its underlying aims". Obviously, this is not straightforward.

First, there is not one concept of RRI that fits all, nor is RRI implemented at the same pace or in the same way, which makes the evaluation process even more challenging as the evaluators need to identify the evaluation approach that is most appropriate for each specific context (Rog, 2012). Owen et al. (2013) demonstrate through concrete examples the various ways of implementing responsible innovation, emphasizing

the not prescriptive or rules based approach that implementers need to adopt and the flexibility needed to take this forward in a way that is valued by the actors and suits the context of application. Every organisation has to define and implement the RRI concept most suitable for its context, while practicing context-sensitive, tailor-made evaluation. Thus, context is moved to the foreground and the increased awareness of the role of context is embraced in the entire evaluation process with feedback loops to facilitate RRI implementation. Accordingly, context defines the evaluation understanding, design and practice (Rog, 2012).

Second, RRI implementation prerequisites strong institutional commitment to provide the necessary space to all actors to participate in this challenging effort, fostering the capability and willingness of researchers and other key actors to engage in the new forms of producing research and innovation. As a normative concept, RRI needs first and foremost to be understood as an approach acknowledging complexities and uncertainties (Felt, 2017). Thus, it is important to take into account the emerging, unforeseen effects of complexity and "...acknowledge from the start the need for plural viewpoints and collective learning" (Jasanoff, 2003:240). "Therefore RRI would need to become integral part of the knowledge creation. This means developing, nurturing and valuing researchers' capacities of anticipation, reflexivity, inclusion and responsiveness" (Felt, 2016:16). While this is vital, the responsibility for such an effort cannot utterly be passed over to researchers. There is a need to create certain institutional structures as RRI implementation is a collective, organisational endeavor, aiming at structural change. The participatory developmental evaluation may be an effective instrument, supporting such an effort (Owen et al., 2013).

Third, in dynamic contexts as the bioscience organisations implementing RRI actions, a great number of opportunities and issues emerge during the implementation phase. Despite anticipation efforts during the design phase, results, opportunities and barriers cannot be foreseen in their full range. Furthermore, both implementation and evaluation themselves change the contextual and organisational conditions - at least, the internal conditions. In addition, the vision and orientation of RRI evolve due to the implementation process and during the practice of the developmental evaluation. This may lead to an enhanced definition of the RRI concept that better suits the needs of the specific organisation and result to a more mature vision of how RRI can benefit the research organisation. Thus, mapping of contextual conditions should be a continuous effort, carried out throughout the whole lifetime of RRI implementation and evaluation, and feedback to the initial design to update and redesign activities (Declich, 2020).

Fourth, RRI implementation is expected to be open to trans-disciplinarity, involving diverse actors. This implies opening the frame for questioning and negotiating concepts and actions among the manifold actors. Questions such as "what does RRI practice mean for my research organisation", "who are the key actors and beneficiaries", "why implement particular RRI actions", and "when to implement actions" may create frictions that have to be addressed (cf. Felt, 2017). RRI implementation requires openness to all interested actors to participate in the process, and time for the organisation to create a shared vision and embed the activities in the environment, acknowledging their unique value. RRI implementation has to be based on "consensus-seeking collaborations" since stakeholders are not a homogenous group sharing a common vision or understanding of the RRI concept (Thurston et al., 2012). Stakeholders have different values, beliefs and perspectives and may not appreciate to the same degree RRI implementation or evaluation. Agency is important to "overcome structure, test new behaviors, and encourage other actors to behave correspondingly" (Owen et al., 2021:3). Through mobilization of various stakeholders and based on negotiations, agency can challenge existing structures and offer new solutions to organisations and alternative forms of institutional work (Lawrence et al., 2013 Maguire et al., 2004). The diversity of the involved actors and stakeholders are a critical part of the implementation and hence the evaluation process. In order to mobilize and engage a plethora of stakeholders in the anticipation, reflection and

responsiveness process, evaluation needs to be designed, and generate data and information that are relevant to all actors.

Fifth, in RRI processes that involve multiple actors with diverse values, the challenge lies in considering the values of all key stakeholders. However, addressing this challenge is not a straightforward task due to varying interests among stakeholders, which leads to different understandings and perspectives on problems and solutions (Klaassen et al., 2020; Blok & Lemmens, 2015). As a result, there are different interests and motivations for engaging in RRI implementation and evaluation. These include demonstrating compliance with stakeholders' standards, enhancing transparency, accountability, and trust in cases where standards are lacking, learning and improving RRI performance by gaining insights into effective parameters and areas needing attention, and demonstrating responsible practices to avoid governmental regulations (Van de Poel, 2020). In the context of structural change, it is crucial not only to identify the actors involved but also to understand their motivations and interests that underlie RRI implementation and evaluation. This understanding is essential for identifying facilitating and hindering factors that can contribute to the change process. However, these aspects remain understudied and require further attention in research.

Sixth, there is a risk that the reflexive work, which is vital both for the RRI implementation and evaluation process, becomes a token, a symbolic act, providing only formalized evidence about what has been considered. A form is a standardization instrument of the formal completion of the reflexive effort, allowing control, but can be a box-ticking exercise rather than triggering broader reflexivity during the implementation and the formative evaluation process. This needs special attention throughout RRI implementation, also to avoid the "ritualization trap", overlooking the RRI principles of engaging with society and the need for continuous adaptation to changing conditions (Felt, 2016). Moreover, as interdisciplinary work and close collaboration between the different disciplines is central to RRI practice, there is a risk of separation between research and reflection in cases where reflexive work within natural sciences is outsourced to scientists from the social sciences and humanities. This may lead to failure to embed the RRI principles in the core of research (Felt et al., 2013).

Seventh, building capacity at the local level to initiate and implement actions, address frictions and establish stakeholder buy-in is crucial to achieving RRI goals and ensuring the sustainability of the actions (cf. Thurston et al., 2012). Despite the fact that all research organisations to some degree practice RRI, the concept is often perceived as "external" to the organisations when it is introduced at the local level. The recognition that responsible research is already part of the current organizational culture, practices and routines may facilitate buy-in, the overall RRI practice, as well as the evaluation process.

Finally, one of the key challenges in implementing and evaluating RRI initiatives is assessing long-term effects or impacts in the narrower sense. This involves addressing the complexity and multifaceted nature of impacts, considering the temporal dimension and target groups involved. To address this challenge effectively, the following aspects should be considered: a. the distinction between objective and subjective impacts, ensuring that the evaluation criteria capture both dimensions adequately, b. Understanding and differentiating between different types of effects, e.g. short-term, intermediate, and long-term effects to enable a more accurate assessment of the temporal dimension, c. Analyzing impacts on various target groups to gain a comprehensive understanding of effects, d. utilizing mixed-methods approaches, using a combination of qualitative and quantitative methods to capture the complexity of long-term effects, and e. considering timeframes and sustainability, assessing impacts over time and examining their sustained effects.

5. Concluding remarks

Despite numerous attempts to practice RRI, there is still a need for

more attention to the evaluation of RRI implementations and their contextual embeddedness and structural change effects. This article aims to contribute to the literature on RRI evaluation by focusing specifically on these factors. It presents an evaluation framework that adopts a systemic view of RRI and takes a developmental and process-oriented perspective.

The framework is developed based on a contextualized viewpoint, drawing on solid data and information obtained from six bioscience research organizations that have implemented customized RRI actions. The framework follows an itinerary approach, incorporating key RRI dimensions, such as anticipation, inclusion, reflexivity, and responsiveness throughout the implementation and evaluation process. The point of departure for the development of the framework is the complexity lens, on the one hand and the participatory, developmental evaluation, on the other. It encompasses a set of relevant evaluation criteria (effectiveness, efficiency, relevance, impact, sustainability, and transferability) to assess the adoption of RRI principles and pursue of structural change effects. The combination of fine-tuned criteria and developmental evaluation helps to bring together and understand the simultaneous implementation and assessment of the highly abstract RRI concept by adapting and tailoring it to specific organisational contexts.

The evaluation framework places significant emphasis on anticipating results, engaging stakeholders, and reflecting on organizational factors, opportunities, uncertainties, and risks. This approach enables learning and responsiveness to contextual and emerging conditions. In complex contexts, such as the bioscience organizations under study, actors encounter dynamic interactions, internal and external obstacles, and unforeseen situations. The introduction of RRI structural changes within these organizations create turbulence in the research environment. Traditional evaluation approaches are ill-suited to address these challenges. Developmental evaluation embraces and acknowledges this turbulence as an inherent aspect of the complex and nonlinear dynamics of innovation, allowing for adaptation to the realities of complexity.

The framework tested and discussed herein, which encompasses all the essential components of RRI implementation and evaluation with a strong focus on the dynamics of local structural change in bioscience research organisations, may have broader relevance and application value in addressing RRI implementation and evaluation challenges. It has the potential to generate several benefits for the organisations involved. Therefore, it deserves further elaboration and testing of its complexity and developmental-oriented approach in similar research organizations.

Author statement

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.evalprogplan.2023.102350](https://doi.org/10.1016/j.evalprogplan.2023.102350).

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