Exploring Synergies

Comparative analysis of technology assessment and RRI in European industrial contexts

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42. Exploring synergies: comparative analysis of technology assessment and RRI in European industrial contexts

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THE INTERSECTION OF TA AND RRI IN THEORIES AND PRACTICES

Responsible research and innovation (RRI) and technology assessment (TA) are both approaches to guide the social construction of technology by identifying and minimizing unintended and undesirable consequences of emerging technologies in broader contexts (for example, social, cultural). Despite this common goal, they have distinct features. Attempts to compare these notions are often viewed as controversial and remain unresolved (see, e.g., Nentwich 2017; van Lente et al. 2017; Delvenne 2017; van Est 2017). We believe that it is important to further dissect their differences in order to learn from the past and identify synergies, particularly considering the recent exclusion of RRI from the European Commission's funding programmes. This exclusion may create space for a new generation of emerging technology appraisals. In this chapter, we outline key commonalities and differences between TA and RRI that are often perceived as such in Horizon 2020 projects. We first explore distinct TA approaches, followed by different understandings of RRI, then discuss how the notions may complement each other.

Constructive TA (CTA) – arguably the most widespread form of TA – is described as an approach to 'reduce the human costs of trial and error learning in society's handling of new technologies, and to do so by anticipating potential impacts and feeding these insights back into decision-making, and into actors' strategies' (Schot/Rip 1997, p. 251; see also chap. 27). This understanding thus relates to decision-making practices (in the form of strategies) of 'actors'. These actors remain somewhat unspecified in this article, but we envision that for CTA it may concern those in some way working with, or affected by, the technology that is being assessed. CTA (see van Merkerk/Smits 2008) focuses on dialogue among, and early interaction with, such actors in technology development to broaden the design of new technologies.

Along with CTA, numerous other TA forms have been developed, such as participatory TA (Durant 1999; see chap. 7), TA in social context (Russell et al. 2010), integrative TA (Berloznik/van Langenhove 1998) and real-time TA (Guston/Sarewitz 2002). Needless to say, we recognize that there are numerous other variants which can be classified as TA.

We now turn to two, widely and interchangeably used, understandings of RRI (Wiarda et al. 2021). Following von Schomberg (2012, p. 39), he envisions 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 sci-

entific and technological advances in our society).' Stilgoe et al. (2013), however, advance this debate by constructing a framework that distinguishes product-, process- and purpose-oriented questions in relation to responsible innovation (notably, not research and innovation) and urge those working on (research and) innovation (for example, institutions, scientists and researchers) to engage in anticipatory, inclusive, reflexive and responsive practices.

While this chapter is not primarily concerned with semantics, we draw attention to the different terminologies and conceptualizations used in the TA and RRI literature because working with both concepts requires us to recognize their pluralities of constructs and styles (see also Fisher et al. 2024).

SIMILARITIES AND DIFFERENCES BETWEEN TA AND RRI

Against this heterogeneous background, we observe a number of potential similarities and differences between TA and RRI that we will now discuss (Tables 42.1 and 42.2). One similarity of TA and RRI is their emphasis on social considerations. Both approaches assess the societal implications of technological advancements. This shared commitment to social considerations underscores their common goal of aligning technologies with societal values and norms.

Table 42.1 Key similarities between TA and RRI

Similarity	TA and RRI
Emphasis on social considerations	Both prioritize assessing societal impacts of technology, fostering social responsibility among stakeholders.
Principle of stakeholder inclusion	Both involve diverse stakeholders (e.g., citizens and experts) in decision-making processes.
Interdisciplinarity	Both acknowledge complexity and foster collaboration across fields for a comprehensive evaluation of impacts.
Anticipatory approaches	Both engage diverse stakeholders in forward-looking practices for proactive measures and envisioning desirable futures.

Table 42.2 Key differences between TA and RRI

Difference	TA	RRI
Historical roots	Emerged in the United States in the 1970s and was brought to the European Union (EU).	Emerged and supported in the EU through the European Commission's Horizon 2020 programme.
Object of reflection	Focuses on emerging technologies.	Focuses on research and innovation in the broader sense. This may include non-technological innovations.
Timing	Often conducted as a distinct process at various stages of technology development, providing timely information to policymakers.	Integrated as an ongoing and continuous process throughout the entire research and innovation lifecycle, starting from idea generation to implementation and beyond.

Another area of convergence between TA and RRI is the principle of stakeholder inclusion. Although there are various substantiations and understandings of this principle – such as engagement, involvement, participation, and so on (see, e.g., Arnstein 1969; Rowe/Frewer 2005) – we have left these nuances out of this chapter's reflections. Both TA and RRI recognize the significance of stakeholder involvement, such as the public (for example, citizens), in decision-making processes. RRI engages with stakeholders to integrate diverse perspectives throughout the research and innovation processes. TA commonly employs deliberative formats, conventionally done with expert and other representatives, to assess the impacts of specific technologies (for example, societal, environmental and ethical). This commonality of stakeholder inclusion underscores their shared objective of incorporating diverse viewpoints to make more informed and ethically sound choices regarding technology.

Both TA and RRI promote interdisciplinarity. Although TA started off as a rather monodisciplinary 'expert'-based approach in the 1970s, modern forms are increasingly recognized as transdisciplinary appraisals (Grunwald/Achternbosch 2013; see chap. 35). And while RRI's interdisciplinarity has been a topic of debate (Ryan/Blok 2023), we observe that both frameworks acknowledge the complexity of technological issues, recognizing that a comprehensive understanding is not possible from a monodisciplinary perspective. RRI emphasizes interdisciplinary collaboration, mobilizing actors from various fields such as engineering, ethics, economics, and more. This interdisciplinarity fosters a relatively comprehensive evaluation of the societal, ethical and environmental dimensions of innovations, underscoring the broader goal of responsible practices in research and innovation. Similarly, TA leverages diverse disciplinary input to assess the potential impacts of emerging technologies in broader contexts (Grunwald 2007). The inclusion of disciplines such as environmental science, economics, ethics and social sciences during assessments helps to yield a relatively comprehensive evaluation of (un)intended consequences.

Furthermore, both concepts are anticipatory approaches to research and innovation. Inclusive forward-looking practices yield insights into a technology's potential impacts, enabling proactive measures that promote benefits, mitigate negative consequences and help to collectively envision desirable futures (see chap. 37).

Although debatable and controversial, we also observe differences in how TA and RRI are understood, studied and used. TA and RRI differ in their historical roots. TA emerged in the United States during the 1970s as a result of the ambitions of the American Office of Technology Assessment (see chapters 6 and 16). It was only later that the Danish Board of Technology (now known as the Danish Board of Technology Foundation) and the Netherlands Organisation for Technology Assessment (now known as the Rathenau Instituut) largely brought TA to Europe (Grunwald/Achternbosch 2013; Palm/Hansson 2006). In contrast, RRI has primarily European roots due to its introduction by European policymakers. This is not to say that European researchers have not influenced the debate on TA, and that American scholars have not influence RRI: on the contrary. We argue, however, that both notions are believed to differ in the ways that historical factors have shaped their debates.

While TA revolves around emerging technologies such as robotics (Decker et al. 2017), medical drugs (Ciani/Jommi 2014) and nanotechnology (Robinson 2010), RRI focuses on innovation in the broader sense. This may include non-technical forms of environmental innovation (for example, reuse and reduce strategies; see Inigo/Blok 2019) and institutional innovation (for example, guidelines and standards; see Wiarda et al. 2022). Although both

notions consider technology or innovation in a broader context, the central object of reflection in RRI is not necessarily technical in nature.

A less explicit difference between TA and RRI pertains to timing. We observe that most TA studies are conducted in early developmental phases of emerging technologies. While RRI may also do this, it does not have to be confined to this phase. RRI also encourages reflexivity and responsiveness in the implementation and evaluation of technologies.

TECHNOLOGY AND INNOVATION MANAGEMENT IN INDUSTRY: TA AND RRI SYNERGIES

While TA and RRI share common goals related to the responsible development of technology, they differ in their emergence, focus and timing. Depending on the context, they can complement each other in ensuring that technology benefits society while minimizing negative impacts.

Their interdisciplinarity strengthens their ability to address multifaceted challenges posed by technology. Leveraging this interdisciplinarity can lead to more comprehensive decision-making processes in technology development, ultimately contributing to the development of ethically sound innovation. Moreover, the anticipatory nature of the two concepts helps to foresee ethical, social and environmental implications of emerging technologies, which is essential to proactively shape responsible technological developments.

The synergy between TA and RRI holds significant promise for enhancing technology and innovation management within industry. By integrating TA and RRI, industries can engage in early, interdisciplinary assessments of technological advancements, considering long-term consequences, and involving stakeholders in the decision-making process. This collaborative approach not only fosters responsible innovation but also aids in the development of transparent, accountable and ethically grounded policies and practices, contributing to the overall sustainability of industrial processes.

One of the key benefits of integrating TA and RRI in industry is the ability to address ethical and social dimensions of innovation systematically. TA provides the tools for systematic analysis, while RRI encourages industries to consider the broader societal implications of their technologies. This alignment allows for the identification of potential risks and opportunities early in the innovation process. As stakeholders, including industry representatives, engage in deliberative processes, the outcomes of TA can inform the development of RRI policies and practices, leading to more responsible and ethical industrial innovation.

The integration of TA and RRI in industrial contexts promotes a holistic and forward-thinking approach to technology and innovation management. Their shared goals and collaborative potential help industries to make informed decisions that consider not only economic gains but also ethical, social and environmental impacts. This integrated framework provides a robust mechanism for regulatory compliance, policy development and the cultivation of a culture that values responsible innovation. It also emphasizes the importance of education and training, ensuring that industry professionals have the knowledge and tools required to navigate the complex landscape of TA and RRI. Ultimately, integrating these notions fosters a more ethically sound approach to industrial processes and policies, benefiting both businesses and society.

The integration of TA and RRI also helps industrial contexts to engage with the four dimensions of RRI: anticipation, inclusion, reflexivity and responsiveness (Stilgoe et al. 2013). By weaving these dimensions into an integrative TA and RRI framework, industries can improve their responsiveness to evolving societal challenges and opportunities. This approach could therefore promote a more sustainable and inclusive model of industrial innovation. In the next section we explore some of this possible overlap related to industrial innovation specifically.

RRI IN INDUSTRY AND ITS LINKS WITH TA

In this section, we cover our RRI experiences from two EU-funded projects, PRISMA and SuperMoRRI. Within the PRISMA project (RRI-PRISMA 2020) we conducted pilot studies with eight companies, to help them better integrate RRI in their innovation process and business practices. We distilled various lessons from this project (van de Poel et al. 2020) and concluded that an RRI implementation should do justice to contextual factors and start bottom-up. At the same time, bottom-up efforts need to be supplemented by more top-down measures and activities. The six lessons may also be related to TA.

First, strategizing for stakeholder engagement, such as public engagement. Anticipatory activities in industry, particularly in the context of TA, emphasize a scientific approach to forecasting. In industrial scenarios, anticipation encompasses not only normative and substantive reasoning, but also instrumental reasoning, evaluating its potential contribution to future profit. This instrumental rationale aligns with conventional business considerations, though its integration into TA activities within policy contexts may be subject to critical scrutiny, where the normative angle is often stressed. The evaluation of anticipatory activities thus involves a multifaceted analysis, addressing both normative principles and instrumental utility within the broader framework of technology assessment.

Second, broadening current assessments beyond, for example, economic and risk assessments and including, for example, values and external perspectives. The question is when TA should be organized for industrial innovation. Some would argue, 'as early as possible', and the trade-off then needs to be made: Do we invest (much) effort (time/money) now for a thorough assessment, while we are not sure whether we will pursue this technology further within our organization? Or, do we continue development at the risk of being 'too late' with our assessments to allow them to feed back into development processes? At the same time, assessments 'too early' might be obsolete later, due to (societal, economic or technical) developments. One possible 'solution' might be to attune assessment intensity to the intensity level of innovation development, allowing for an appropriate, continuous, real-time assessment. Waiting passively is deemed the least preferable option, emphasizing the importance of proactive engagement in navigating the dynamic landscape of industrial innovation.

Third, place values at the centre. Especially, value conflicts (for example, sustainability versus reliability, or data openness versus privacy) can help to elucidate certain choices, and making these choices explicit supports organizations in being transparent. TA does not explicitly prescribe such transparency as a value for corporate innovation processes. RRI, with possibly more of a process focus than TA, does place emphasis on this transparency (see Fraaije/Flipse 2020).

Fourth, experiment for responsiveness. TA advocates for creating opportunities to feed back acquired insights (of anticipatory TA activities) in technology development. However, we feel

that RRI has provided more practical guidelines on how to establish such integrations, for example through the use of small, controlled, experimental settings in, for example, living labs or otherwise protected testing zones. This may enhance learning about a technology, but also about stakeholder reactions and ethical, legal and societal aspects. In addition, it may simultaneously create opportunities for aligning these insights with innovations and societal needs.

Fifth, monitor RRI progress. With the process focus of RRI, it makes sense to adopt a methodology that allows for continuous monitoring of RRI. This entails the incorporation of continuous monitoring mechanisms, such as key performance indicators (KPIs), as outlined by Yaghmaei et al. (2019). Notably, the field of TA, to the best of our current knowledge, lacks explicit references to KPIs and (self-)assessment as viable tools, with the notable exception of health technology assessment (HTA), which is largely methodized yet has a slightly different origin and is relatively disconnected from other TA approaches (Banta 2003; see also chap. 13). The application of KPIs in the context of RRI represents an ongoing experimental exploration, as demonstrated by initiatives such as SuperMoRRI (2023). This experimentation suggests a nascent but evolving integration of performance metrics and self-assessment methodologies within the broader framework of RRI, contributing to a more systematic and evidence-driven evaluation of responsible and innovative research practices.

Sixth, aim for shared value. We discussed that RRI may contribute to building trust and legitimacy, for example by making sure that innovations and societal values align. However, trust works both ways: if 'customers' are to trust companies, then the opposite also has to work. Under some circumstances such trust is absent and adopting this concept of shared value is bound to fail. Companies may be reluctant to be open and inclusive, and consumers less willing to trust. And this trust cannot easily be instrumentalised as it is difficult to earn and easy to lose. Instead, we argue that it may be good for companies to aim to be trustworthy, rather than 'create trust'. This refers to organizations being transparent about their actions, decisions, values and having that as a starting point of further interactions. In TA, such activities may also be considered.

The SuperMoRRI (2023) project concerns Scientific Understanding and Provision of an Enhanced and Robust Monitoring system for RRI. This monitoring system is currently under development and is a continuous assessment of innovation processes in the form of a digital tool (https://promise4era.eu/). With this tool, those working on scientific and technological projects (for example, internal and also external team members) can self-assess how they feel they are performing on numerous RRI elements; not with the goal to create a score as high as possible (reducing the exercise to a check-box ethics exercise), but to create a platform where people can understand how they feel about a number of RRI-relevant parameters (stakeholder engagement, data management, communication, governance, ethics, gender, and so on), and also discuss with others why they feel differently about certain elements. We include here explicitly things about data and open access which in early TA activities had not yet been discussed, since these were not so explicitly on the (open) innovation agenda as they are currently.

As such, we observe some overlaps and differences between TA and RRI in our operationalization efforts of RRI in industry. In particular, as above, differences between the more process-oriented perspectives of RRI in which innovation and research are seen as ongoing processes that might be tweaked along the way, and the more outcome-oriented focus of TA that focus on a specific technology and how it may or may not be socially embedded.

MAY PROBLEMS WE ENCOUNTERED WITH RRI BE RESOLVED BY TA?

Below we highlight various elements that may be considered from both a TA and an RRI perspective, that we found to be problematic in our activities at stimulating RRI in industry. These have also been listed in earlier literature (Kwee et al. 2021), yet here we add the TA perspective.

Absorptive Capacity

As the TA and RRI uptake could contribute to learning experiences, we propose to use the influential construct of absorptive capacity (Cohen/Levinthal 1990). Absorptive capacity proposes that the focus on research and development (R&D) in companies should not be too dominating: that it hinders the learning process to assimilate and exploit externally acquired knowledge, such as learning of RRI practices through stakeholder engagement. For managers, this implies that they need to create an internal knowledge-sharing network to gain benefit from externally acquired knowledge. Social underpinnings of absorptive capacity (Tortoriello 2015) may help to explain how, through learning experience of RRI and TA, managers may create the ability to leverage external knowledge to generate innovation inside the companies in a responsible way.

Responsibility Ascriptions within the Organization

Responsibility ascriptions are essential in shaping its ethical and operational framework. It involves the allocation of specific tasks and roles to individuals and teams, aligning their roles with the broader values of an organization. Instead of being static, responsibility ascriptions require a dynamic approach to adapt to changing circumstances (for example, emerging technologies and shifting of priorities). The idea is to periodically review and adjust responsibilities. In a project with diverse stakeholders, allocating responsibility for unforeseen outcomes is challenging. In this situation, a collaborative and transparent approach may empower individuals and teams to take ownership of their roles in the accountability process.

'Projectification' and Funding/Commitment Issues after Projects End

Projects receive dedicated funding with a clear endpoint. However, once a project is concluded, committing resources and financial support for ongoing maintenance can become very challenging. Furthermore, commitment of project team members and stakeholders may wane after the project ends. To mitigate these post-project issues, companies have to proactively develop strategies for resource allocation to establish mechanisms and practices for sustaining the impact of the project. This includes effective knowledge transfer and documentation to ensure that valuable knowledge and best practices from the project are integrated into the company's collective knowledge base.

Fatigue that Pops Up after a While

It can be organizationally demanding to deal with the complexities associated with TA and RRI when balancing ethical considerations, responsibilities and assessment of technological impacts. Over time, this can contribute to a sense of continuous pressure that can lead to fatigue. It is crucial to take proactive measures to sustain momentum and motivation, such as through interactive training and feedback sessions, knowledge-sharing platforms and open communication channels as safe spaces for discussions.

Ownership and Data Protection

Ownership and data protection are two important issues of safeguarding privacy and maintaining trust within TA and RRI uptake. Ownership entails issues such as intellectual property and decision-making authority. Here it is essential to have an equitable distribution of ownership to prevent concentration of power in the hands of a few stakeholders. In the era of digital transformation, data protection is fundamental to safeguard sensitive information collected during the research (for example, personal data, proprietary research findings and other confidential information). Adhering to robust data management and protection measures establishes a foundation of trust between technology developers, researchers, users and the wider public.

CONCLUSION: LOOKING AHEAD

In conclusion, the comparative usefulness of TA and RRI in industry presents a fascinating area of further inquiry. The nuanced exploration of this inquiry leads to a question for further research: Can TA surpass RRI in terms of its usefulness in industry (that is, its uptake in industry)?

As we traverse this uncharted territory, an interesting focus can be on HTA, particularly in the health technology and medicine sector. HTA, as a rather disconnected manifestation of TA in practice, raises pertinent questions about how TA can be operationalized and applied to navigate the complexities of the evolving technological landscape (Hofmann 2020).

Looking towards the horizon, the future of both TA and RRI emerges as a dynamic force, closely interconnected with technology development, advancements and societal impacts. Their anticipatory governance and foresight approaches stand as indispensable tools, influencing the direction of innovation and technological transformation to ensure a future that is both innovative and socially responsible.

Within this landscape, the lens of open science perspectives emerges as a crucial factor. By fostering transparency, encouraging data-sharing and promoting collaborative research, open science perspectives contribute to the democratization of knowledge. In doing so, they play a pivotal role in nurturing collective responsibility and building trust between researchers, companies, institutions and the public.

In essence, as we face the evolving dynamics of technology, the interplay between TA (for example, HTA) and RRI (for example, open science) offers diverse possibilities for future research avenues. The search for a balanced strategy, aligning technological advancement with societal values, remains the focal point of this discussion, at the heart of this discourse,

guiding us towards a future where innovation is not only just groundbreaking but also ethically grounded.

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