



Editorial

Responsible Research and Innovation in Industry—Challenges, Insights and Perspectives

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Received: 24 February 2018; Accepted: 27 February 2018; Published: 5 March 2018

Abstract: The responsibility of industry towards society and the environment is a much discussed topic, both in academia and in business. Responsible Research and Innovation (RRI) has recently emerged as a new concept with the potential to advance this discourse in light of two major challenges industry is facing today. The first relates to the accelerating race to innovate in order to stay competitive in a rapidly changing world. The second concerns the need to maintain public trust in industry through innovations that generate social value in addition to economic returns. This Special Issue provides empirical and conceptual contributions that explore corporate motivations to adopt RRI, the state of implementation of concrete RRI practices, the role of stakeholders in responsible innovation processes, as well as drivers and barriers to the further diffusion of RRI in industry. Overall, these contributions highlight the relevance of RRI for firms of different sizes and sectors. They also provide insights and suggestions for managers, policymakers and researchers wishing to engage with responsibility in innovation. This editorial summarizes the most pertinent conclusions across the individual articles published in this Special Issue and concludes by outlining some fruitful avenues for future research in this space.

Keywords: responsible research and innovation; RRI; responsible innovation; R&D management; social innovation; sustainable innovation; corporate social responsibility; CSR; industry; business ethics

1. Background

The discourse on the responsibility of business for their impacts on society and the environment has matured over the past 70 years, resulting in a comprehensive stock of literature across several fields of research. This includes research on Corporate Social Responsibility (CSR) [1], Corporate Sustainability [2] and Business Ethics [3], among others. Major lines of inquiry within these fields are concerned with ethical–normative demands on corporations [4,5], the business-relevance of societal and political concepts that go beyond the maximization of shareholder value [6–8] as well as the establishment of a business case for corporate responsibility [9,10].

Recurring themes are the conflicting priorities of corporate aspirations in terms of profits, growth, competitive advantage, and market shares, on the one hand, and societal objectives

including prosperity, well-being, and sustainability, on the other hand [11]. This tension escalates when the realization of individual interests (e.g., of corporations) happens at the expense of other stakeholders (e.g., future generations) or the natural environment (e.g., climate change, biodiversity) [5,7]. Corporate strategies to mitigate or avoid such trade-offs have only been partially successful so far [12]:

- (1) Corporate philanthropy is highly visible and serves to return some of the proceeds of business in a way that is of public benefit. However, it rarely touches upon core business processes [13].
- (2) Resource efficiency has significantly lowered resource-intensity per unit of value-added. However, these efficiency gains are frequently offset by higher consumption rates and rebound effects [14].
- (3) Eco-friendly and ethically traded products have been successfully established in niche markets. However, they are generally not fit for developing mass markets and therefore fail to achieve economies of scale [15].
- (4) Management systems provide standardized and quality assured processes for engagement with environmental and social issues. However, they tend to be viewed as bureaucratic exercises, thus failing to become part of organizational culture and practice [16,17].

Responsible Research and Innovation (RRI), which has recently emerged as a new approach in this context, is associated with great hopes that it will be possible to tackle these shortfalls in a more comprehensive manner, building on, and going beyond, CSR [18]. RRI expands on concepts and theoretical approaches previously used in scientific inquiries into the responsibility of business by drawing on technology assessment [19,20], but also science and technology studies [21], ethics and philosophy of technology, as well as ethical, legal and social aspects of research (ELSA/ELSI) [22,23]. As such, it embeds responsibility at very early stages of research and innovation by drawing attention to questions of research integrity, different institutional environments, and dynamics with a strong bearing on societal impacts of business. Research and innovation can be responsible in many ways: environmentally, ethically, socially, or politically. The agents whose responsibility it is to make research and innovation responsible can be highly diverse from researchers to research funders, policy makers or businesses. Consequently, implementing RRI requires collaboration of various stakeholders in order to find sustainable solutions based on the ethical acceptability, sustainability, and societal desirability of the innovation process (how it is done) and its marketable products (impact on society) [20,24,25].

RRI links up with two key challenges dominating the current business landscape: the accelerating global race to innovate in order to maintain competitive advantage [26], and the struggle to maintain public trust in business [27,28]. Regarding the former, RRI offers the potential to bring CSR from the margins into core strategic decision processes, achieving a stronger integration of the creation of social value in addition to economic returns [29]. This may open up previously untapped resources and avenues for innovation, but may also spawn new conflicts. Consider, for example, the question of Intellectual Property Rights in inclusive, participatory innovation settings [30,31]. Regarding the latter, RRI connects core business concerns to overarching societal challenges and is therefore considered a promising way for firms to navigate these issues for the well-being of individuals, communities, countries, regions, and global society [32]. Overall, RRI strives to honor the promise of incorporating responsibility into the DNA of corporations [33]. If successful, it may help business re-gain public trust and legitimacy by systematically anticipating problems before they become pressing, orienting innovation capacity towards areas with a significant potential for positive social impact, and leveraging multi-stakeholder networks for the development of systemic solutions to grand societal challenges [34,35].

However, despite the benefits that RRI offers to industry, the concept does not yet resonate widely with business [36]. Several explanations for this have been offered. Some argue that the variety of concepts and approaches in this field (responsible innovation, sustainable innovation, social innovation, open innovation, and others) have led to confusion [37,38]. Others propose that the concept has mainly been implemented in the context of publicly funded research and needs to be operationalized and

adapted for the business context [39,40]. Finally, some scholars raise the question whether RRI is applicable to industry at all, and call for the fundamental reconceptualization of both responsibility and innovation in order to achieve RRI in the business context [41]. Efforts have already been made to show the relevance of RRI for industry [42]. However, given the importance of industry for innovation, on the one hand, and the numerous open questions concerning RRI in industry, on the other hand, a broadening of the discussion is called for.

2. Key Findings on RRI in Industry

This Special Issue offers a variety of contributions, including a literature review that expounds on the current state-of-play of the discourse on RRI in industry, empirical work that provides new insights into the motivations and practices of firms as well as the drivers and barriers for RRI in industry, and conceptual papers that offer potentially fruitful new avenues of research in this emerging field. Many of these contributions build on established concepts from adjacent discourses, particularly CSR and innovation management, such as risk [43], organizational motives [44], eco-innovation [45] and maturity models [25]. In doing so, they expand the field of application of these concepts and make them useful for understanding RRI in industry. Moreover, the empirical papers published in this Special Issue cover industry sectors that are characterized by high research innovation-intensity (attributable to fast technology cycles, high innovation-based competition and highly dynamic markets), as well as high relevance in terms of their impacts on society and the natural environment: the Information and Communication Technology industry, the health care and the food sector.

The literature review of responsible, social, and sustainable innovation practices by Lubberink et al. [46] offers a valuable overview of the field by embedding RRI within the larger context of adjacent discourses on responsibility in organizations and in innovation. Their qualitative analysis of 72 empirical articles is rooted in a set of RRI governance principles [24] and results in a refined framework for responsible innovation in the business context. In doing so, the authors provide a first integrated operationalization of RRI governance for industry, which aims at achieving both a contribution to theory and practice relevance. Interestingly, the authors find that participatory approaches in industry tend to primarily focus on clients and end-users, while wider societal inclusion is still rare. Moreover, the authors suggest that 'knowledge management' is a hitherto overlooked important governance principle and propose a research agenda for responsible innovation in industry.

Dreyer et al. [47] provide a complementary view from industry, stressing, in particular, the distinction between Responsible Research and Responsible Innovation. This conceptual contribution is a commentary by the members of the European Industrial Research Management Association (EIRMA), which has spearheaded a Task Force on RRI for the past several years. The authors criticize the misalignment of RRI concepts, tools, and methodologies as used in the scientific and policy discourse with current industry practices, which tend to be rooted in the long-standing debates around CSR, Shared Value, and ethical leadership. RRI practices in industry, they argue, are much more established and mature than they first appear. They propose a clear distinction between the discourses on responsible research, which revolves around issues of research integrity, and responsible innovation, which focuses on wider societal impacts of innovations. Since research and innovation processes differ substantially, the authors suggest that programs, tools, and criteria for defining best practice, as well as governance mechanisms, must also follow different rules and principles.

Van de Poel et al. [48] develop a conceptual model for company strategies with a view to specifying the RRI concept into operational terms, down to the level of Key Performance Indicators (KPIs). They argue that RRI requires methods that enable more reciprocity between innovating firms and the wider stakeholder landscape, considering the non-linear nature of innovation and the inherent uncertainty in predicting innovation outcomes. Consequently, the model places RRI strategy into a broader context (taking account of factors, such as type of technology, innovation patterns, and market structure). The model is derived from eight case studies focusing on transformative

technologies in the areas of synthetic biology, automated cars, and Internet of Things. Drawing on this empirical foundation, it distinguishes between strategy and operational level RRI aims and outcomes. This provides a basis for monitoring RRI by a dedicated set of KPIs and equips firms with a blueprint for assessing and benchmarking their RRI performance.

Organizational motives for RRI are at the center of Garst et al.'s [44] empirical examination of product innovation processes aiming at socially responsible outcomes. Their multiple case study of eight food firms in the Netherlands draws on semi-structured interview data, which specifically explores the critical decision-making moments in different phases of the innovation process. Their findings are complemented by food labelling data. The authors find that both instrumental motives, such as seeking profits, counter-acting regulatory pressure through voluntary self-regulation, or the desire to maintain legitimacy, as well as moral motives, which are derived from ethical and normative theories as perceived by firm employees, are of high importance for engaging with RRI. Garst et al. [44] conclude that implementing RRI in a company setting may require broader acceptance of instrumental motives as a necessary pre-condition for achieving responsible innovation outcomes.

Gurzawska et al. [49] equally address corporate motivations when they investigate the role of different types of incentives for RRI adoption in firms. Their article strives to elucidate a set of incentives that matches policy objectives and may prove effective in encouraging firms to implement RRI. In order to collect, synthesize and build consensus around the various perceptions from a wide set of stakeholders, the authors have carried out two stakeholder dialogues and a Delphi survey. They formalize their findings in a causal loop diagram, which demonstrates how such approaches may be used for developing a business case for RRI. Gurzawska et al. [49] stress that the successful diffusion of responsibility and sustainability paradigms in innovation relies on the participation of multiple societal groups, including consumers, employees and institutional actors.

In their article 'Innovating Responsibly in ICT for Ageing', Chatfield et al. [50] examine the drivers, obstacles and implementation of RRI in key ICT industries across Europe on the basis of 30 expert interviews. They explore the tension between costs (for stakeholder consultations, ethical reviews, and risk assessments) and benefits (better alignment with end user needs and resulting profits, better image), and highlight several examples of firms that have achieved a balance between financial and altruistic goals in this space. Stakeholder involvement is perceived as an essential component of RRI, because it enhances both quality of innovation outcomes and their societal acceptance. The authors also found a highly polarized practice and a clear lack of guidance in predicting the long-term outcomes of new technologies. While the most important drivers are corporate culture, awareness of RRI, and ethical codes of conduct, an important moderating variable may be the sector in which a company operates.

Auer and Jarmai [45] also analyze drivers and barriers for RRI, albeit in a different sector, notably medical devices, and with a special focus on Small and Medium-Sized Enterprises (SMEs). Conceptually, they draw on adjacent discourses such as eco-innovation and sustainability innovation. Empirically, they conducted expert interviews with CEOs from eight highly innovative Austrian medical device companies. They found that, while their interviewees were largely unaware of the RRI concept, they implemented RRI practices at an operational level, including practices for anticipating innovation outcomes and including different stakeholders into the innovation process. Their investigation revealed six distinct factors that have the potential influence the adoption of such practices, including the regulatory framework, availability of financial resources, market-orientation, customer knowledge, organizational structure, and knowledge among innovation partners. The authors conclude that future research should further investigate the ambiguities arising among these different factors to better define opportunities for the practical implementation of RRI.

Risk perceptions within industry are framed as a core component of RRI in the article by Chatfield et al. [43], who focus on examining how ethical and societal risks of innovation in the ICT industry may influence the understanding and uptake of RRI. They investigate the extent to which risk, risk assessment, or risk management, including ethical and social issues, are relevant to

companies based on data from 30 in-depth interviews and a two-phase Delphi study including 35 industry representatives. They find an association between risk assessment and stakeholder involvement in the development of new products and services. The broader impacts, or perceived long-term consequences of R&I activities, were found to be of secondary or minor concern. Moreover, they show that risk, primarily perceived in economic terms, is frequently associated with issues of data management, data protection, and compliance with legal and ethical rules. Finally, the authors conclude that the role of the CEO is not to implement the individual risk management strategies, but rather to cultivate and support the development of a risk-sensitive culture.

In the final contribution, Stahl et al. [25] present a maturity model for RRI that strives to provide a relevant and easily-applicable method for representing and reflecting upon the level of RRI implementation within companies. For this purpose, they break down RRI into several components, including purpose, process, and product aspects and identify five maturity levels (unaware, exploratory, defined, proactive, and strategic). The model was further refined and empirically tested in a mixed-method research design including case studies, focus groups, and a Delphi-study. The validity and usefulness of this model was tested across different industry environments, including a welfare technology firm, a healthcare service firm, and an ICT firm. For RRI research, the model allows moving beyond the one-dimensional view of RRI to a multi-dimensional account, and for RRI in business practice, it supports companies in evaluating the degree to which its practices already align with RRI.

3. Outlook to Future Research on RRI in Industry

Overall, the contributions in this Special Issue highlight the relevance of RRI for companies of different sizes and across different industries. They specify the RRI concept for application in a business context and enrich the scientific discourse on Responsible Innovation by providing empirically-based findings and insights from industry practice. They provide suggestions for managers, policymakers, and researchers wishing to more profoundly engage with responsibility in innovation (cp. Table 1). Some of the most pertinent conclusions and avenues for future research are:

Searching for a business case: Several contributions in this Special Issue have elaborated on the potential tension between the ethical, social, and democratizing mandate of RRI and the profit-oriented rationale of micro-economic decision-making. For instance, Van de Poel et al. [48] conclude that RRI needs to be translated into business-relevant Key Performance Indicators if it is to penetrate managerial practice. On the one hand, several papers mention potential returns of RRI routed in better processes, such as better understanding of consumer needs, avoiding innovation failure, better fit of innovation, and user needs, and in more trust of stakeholders: consumer loyalty, license to operate, employee engagement, alignment with regulatory expectation. On the other hand, Chatfield et al. [43] suggest that “there could be marked conflicts between the adoption of RRI and commercial interests”. Finding an answer to the question “Does it pay off?” is also likely to be even more complex than in adjacent fields. The direct and indirect impacts of innovation are difficult to quantify and economic returns frequently depend on the behavior of external stakeholders, such as customers, peers, and regulatory bodies. In addition, innovations may become transformative game changers, which entails having to contend with societal effects that cannot be foreseen with any certainty. Future conceptual work may want to specifically engage with the question of how this complexity can be addressed in RRI research.

Assessing the foundations of RRI: As theorizing on RRI in industry matures, the foundations of RRI and their applicability to an industry context need to be further assessed in order to address a number of fundamental concerns. First, many societal challenges, such as climate change or social equity, are contested issues, which limits the ability of stakeholders to find common ground when defining what is responsible. When consensus is lacking, ambiguities arise and innovations are likely to encounter a ‘techlash’ rather than societal acceptance. Second, openness and inclusiveness in innovation processes are at odds with the prevalent conception of innovation, which holds that innovations are rooted in information asymmetries in the market. Companies, therefore, have marked

incentives to not engage with stakeholders [44]. Third, the creative destruction that characterizes commercial innovation is often deeply at odds with the promise of the social good, of acceptability and desirability of process and outcomes that are meant to characterize RRI. We thus see that there are significantly different conceptual approaches to responsible innovation in industry, as well as a number of open questions ranging from first principles to application [22,51].

Getting from perceptions to evidence: This Special Issue mainly consists of conceptual contributions and empirical papers employing qualitative research designs (including case studies and small-scale Delphi-studies). These contributions prepare the ground for more encompassing empirical work and theorizing. As the discourse on RRI in industry matures, it will likely follow the path of adjacent fields of research towards larger scale-theorizing and quantitative empirical testing, i.e., going beyond perceptions and motivations towards the generation of more fact-based evidence. This is also important for enhancing the managerial and practice relevance of research. Prior experience has shown that managerial decision-making is frequently based in quantifiable evidence and objective fact, making more quantitative research essential for the future development of the field.

Considering context: As some of the contributions in this Special Issue have demonstrated, RRI is a context-dependent concept. Future research will need to expend some effort on clarifying the importance of factors, such as industry sector, firm size, organizational culture, governance structure, regulatory framework, and others that have been shown to be relevant for the embedding of responsibility into industry (e.g., [52,53]). For RRI, an examination of such factors in relation to drivers of innovation (e.g., the race to innovation, competitive pressures, stakeholder visibility and others) will require particular attention. Such contributions could enrich our understanding of the interrelationships of firms, stakeholders, and society. A key aspect of the context that needs to be considered refers to the institutional context that sets incentives and boundaries for action, not only including regulation and legislation, but also customs and culture, which can shape the way RRI is perceived and implemented. Context-sensitive research could also contribute to further eliciting the (conditions for) transferability of this Europe-centric concept to other regions of the world.

Networking RRI: As Chatfield et al. [43] highlight “responsibilities are never individual but always embedded in networks or ecosystems of responsibility”. This suggests that it may be a fruitful avenue for further research to consider the networked nature of RRI in industry beyond its implementation in individual firms. Future work might, for instance, examine the interfaces and value chains where industry and societal groups jointly negotiate the meaning of responsibility [35]. The opportunities related to a more networked understanding of RRI in industry are also highlighted in Garst et al. [44] and Gurzawska et al. [49], further suggesting that the development of a more collaborative approach to RRI in industry may be promising.

The authors who have contributed to this Special Issue have embarked on a journey that will evolve as RRI is more widely adopted by industry. Currently, the European Commission is funding several projects (COMPASS, www.innovation-compass.eu; SMART-map, www.projectsmap.eu; PRISMA, www.rri-prisma.eu; LIVING INNOVATION, www.living-innovation.net) which aim at generating, expanding, and disseminating evidence on RRI in industry. These projects strive to further explore the specific interests, conceptual framings, and context of firms in implementing RRI in practice. We are therefore optimistic that the discourse on RRI in industry will evolve quickly in the coming years. This Special Issue documents the first steps of the scientific community in this emerging field of research, always conscious of the fact that the journey has just begun.

Table 1. Research questions and major themes addressed in this Special Issue.

Major Research Questions	Important Themes	Contributions
What are motivations to integrate RRI in industry?	<ul style="list-style-type: none"> • Managing ethical and societal risks of innovation • Achieving better alignment with end user needs and resulting profits, better image • Public recognition and consumer awareness, employee engagement • Importance of instrumental motives (such as seeking profits, counter-acting regulatory pressure through voluntary self-regulation, or the desire to maintain legitimacy) 	Chatfield et al. [43] Chatfield et al. [50] Gurzawska et al. [49] Garst et al. [44]
What is the state of implementation of RRI in industry?	<ul style="list-style-type: none"> • RRI Maturity Model for determining level of RRI implementation • Companies are largely unaware of the RRI concept, but implement RRI practices at an operational level • Critical decision-making points in product innovation processes aiming at socially responsible outcomes 	Stahl et al. [25] Auer and Jarmai [45] Garst et al. [44]
What are responsible practices in innovation?	<ul style="list-style-type: none"> • Measuring RRI through Key Performance Indicators (KPIs) • Anticipating innovation outcomes • Including different stakeholders into innovation processes 	Van de Poel et al. [48] Auer and Jarmai [45]
Who are the stakeholders involved in RRI?	<ul style="list-style-type: none"> • Internal stakeholders (employees, owners, company representatives and managers) • External stakeholders (suppliers, customers, CSOs, governments, creditors, shareholders) 	Gurzawska et al. [49]
Which factors have a bearing on RRI implementation in industry?	<ul style="list-style-type: none"> • Regulatory framework, availability of financial resources, market-orientation, customer knowledge, organisational structure and knowledge among innovation partners • Corporate culture, awareness of RRI, ethical codes of conduct, sector • Incentives 	Auer and Jarmai [45] Chatfield et al. [50] Gurzawska et al. [49]
How does RRI relate to adjacent discourses on responsibility of/in business?	<ul style="list-style-type: none"> • RRI governance principles • Need for better alignment of RRI concepts, tools and methodologies with current industrial practices • Distinction between Responsible Research and Responsible Innovation • Purpose, process, and product aspects of responsibility 	Lubberink et al. [46] Dreyer et al. [47] Stahl et al. [25]

Acknowledgments: We thank Doris Schröder for her constructive feedback and editorial support in drafting this article.

Conflicts of Interest: The authors declare no conflict of interest.

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