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Networked Responsibility Approach for Responsible Innovation: Perspective of the Firm

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Abstract: Responsible innovations in the industry gains important attention, however, a better understanding of the interaction of different components with regard to responsible innovation (RI) in the industry is still needed. Moreover, a firm acting in an open innovation regime has to approach the responsibility criteria from various stakeholders' perspectives, include internal and external stakeholders, and execute innovation in a mutually responsible way. This paper builds on the existing and emerging literature on RI in commercial contexts by providing a networked nature of RI and a set of factors that drive RI in a firm that acts in the open innovation regime. The conceptual framework proposes the analysis of a firm's inner environment (motives for implementing RI, RI practices, and internal stakeholders), outer environment (norms and external stakeholders), and the networked nature of the firm's internal and outer environment components. Such a distinction enables us to gain a better understanding of which factors play a role inside the firm and what induces the firm to implement RI activities from its outer environment. Also, it helps to better understand the networked nature of the firm and its stakeholders.

Keywords: responsible innovation; responsible research and innovation; RI in the industry; industry; networked responsibility; egocentric network; open innovation

1. Introduction

Newly emerging social norms towards the Grand Challenges, that is, global societal, ecological, economic, and ethical issues like social inequality and discrimination, sustainable development, and climate change [1] form new demands for innovating firms to adopt innovative behaviors. Innovations are considered "new social practices and even institutions which transform the ways in which human beings interact with the world around them" [2] (p. 119). Thus, innovative firms are among the key shapers of socio-technical systems.

In this context, the concept of Responsible Innovation (RI) was proposed in order to foster a more responsible development of innovation in terms of including a wider society and in order that the outcomes of innovation would be (ethically) acceptable, sustainable, and socially desirable [3]. Although the use of "Responsible Innovation" is increasing [4,5], it is still unclear how RI should be defined and adopted by the industry [6,7]. This could be due to the primary focus of responsible being on the (research and) innovation in the public sector and, consequently, the lack of research aimed at understanding RI in the industry [6].

Most of the previous studies on RI in the industry have focused on one component of RI: while some authors focused on activities and/or actors [8–11], others were researching norms of RI [7,12,13]. In terms of motivation for RI, economic motives and traditional innovation logic are mostly ignored in RI studies [11,14]. In an empirical study [15], it was found that networks were an important resource of SMEs in achieving more responsible innovations. Thus, holistic approach

to RI in commercial settings is needed, since the very nature of RI concept is towards mutual responsibility [3,16]. In parallel, a commercial firm has to approach the responsibility criteria from various stakeholders' perspectives, include internal and external stakeholders, and execute innovation in a mutually responsible way. Thus, the innovation could be regarded a networked phenomenon and has to be seen from a networked responsibility perspective [17]. Consequently, managers lack an understanding of what constitutes RI and how to shape their organizational activities towards RI [18,19]. Hence, there is a compelling need to develop a unifying conceptual model that would enrich our understanding of how RI could be fostered in a firm. Thus, the following research questions are addressed: what constitutes RI and how could it be fostered from the focal firm perspective in its networked nature?

For the purpose of our analysis, we have used a literature review, as well as a conceptual model. The conceptual framework is built on the emerging literature on a networked approach towards RI in commercial contexts [17,20,21]. In their empirical research, Timmermans et al. [17] showed that "traditional theories of responsibility tend to focus on individual instances of responsibility. While valuable for understanding responsibility, such individualistic theories fail to reflect the complex and multifaceted reality of modern research and innovation ecosystems." (p. 2). The evolutionary economics approach is also used to conceptualize the networked responsibility in the industry with a view towards RI [21]. Collective agents like commercial firms or innovation networks represent the main idea of evolutionary economics. To represent the shared responsibility of different innovators, Schlaile et al. [21] used the social connection model. Therefore, the holistic approach to RI, which analyses the RI components and the networked nature from the firm's perspective, needs to be further explored. For this, Stahl's [22] framework is used to shed a light on the interrelated components of RI in the firm like actors, activities, and norms, representing the networked nature of RI [17] and its openness.

To this end, the relevant literature is first reviewed in Section 2. Section 3 provides a unifying conceptual framework for RI at the firm level based on Stahl's [22] Responsible Innovation Space: actors, activities, norms, and the emerging literature on the networked nature of RI. Section 4 discusses the original conceptualization and the linkages between elements to the literature presented in Section 2 and discusses the theoretical and practical implications. Finally, in Section 5, we provide conclusions and future research directions.

2. Theoretical Background

2.1. The Concept of Responsible Innovation

Responsible innovation as a concept calls for a transformation of values and actual behavior of societal members, towards the socio-ethical issues [23]. Although ideas about responsibility in the innovation process are not new itself, "the major novelty and practical relevance of RI is in integrating existing approaches and in making an explicit link between innovation and responsibility" [5] (p. 2).

In fact, responsibility is the main characteristic that distinguishes the RI concept from other similar ones, such as sustainable innovation and social innovation (see [11] for the conceptual overlaps and differences between the concepts). Responsibility refers to the need to mitigate the grand challenges so that the future generations can live in a better world [3,24] and assess the uncertainty of an innovation and its possible (negative) consequences for society and the environment [3,16]). As Von Schomberg [3] emphasizes, the ethical responsibility should be understood in a positive manner, meaning that responsibility should be understood not as a constraint, but rather as "an incentive to open up alternative research and development trajectories" (p. 19).

2.2. The Networked Nature of Responsible Innovation

Thus, RI is a complex phenomenon and itself represents a wicked problem, therefore, RI needs to be analyzed within a dynamic and networked framework [17,21]. The industry perspective suggests

that RI involves not only a firm, but also its internal and external stakeholders. The question of responsibility should not be related to the individual, but rather it should grasp the collective responsibility, as it is stated in Von Schomberg's [3] definition of RI. Moreover, the notion of open innovation imposes the collaborative nature of innovation, while open innovation ecosystems generate collective and individual outputs for participating firms. Thus, ensuring RI at each network member level becomes an extremely complex and collective task.

Open innovation approaches are also used in RI research to demonstrate the networked nature of RI [20]. Although open innovation has some overlaps with RI activities, it lacks the innovation orientation towards socio-ethical aspects and the wider involvement of non-economic stakeholders into the innovation development, thus, the extension of open innovation 2.0 was developed [20].

Timmermans et al. [17] developed a theoretical model of "networks of responsibility" and introduced a new concept of RRI as a meta-responsibility that reflects the interconnected nature of different actors with regard to RI. In their research, the notion of networked responsibility is used to describe the multiple, reciprocal, or overlapping responsibilities between different actors of society. Timmermans et al. [17] defined networks of responsibility as "sociotechnical ensembles that are enacted by a multitude of actors" (p. 8). In this paper, networked responsibility is analyzed from the firm perspective and, at the same time, firm relation to the firm's outer environment is also considered.

Yaghmaei [7] has also built upon Stahl's [22] theoretical framework of RRI space in the industry by suggesting five RRI implementation stages. However, their focus was on normative aspects on RI in the industry. In this paper, Stahl's [22] framework is extended by adding economic motives next to socio-ethical motives for RI and looking into the inner and outer factors of the firm in executing RI.

2.3. The Egocentric Network Approach towards Responsible Innovation

The egocentric network approach to analyze a firm's behavior with regard to the networked nature of RI is applied. An egocentric network is considered to be the primary unit of the social network analysis, which focus on the focal actor like an individual or organization [25]. If we look from a realistic perspective, the main purpose of the firm is to build up an egocentric network and to use it for its own competitive advantage and economic profit.

As Laszlo [26] states, "to focus beyond the bottom line does not imply forgetting about the "profit motive" but transcending it toward a mode of wealth creation that pursues personal, social, and ecological gains in addition to financial results." (pp. 606–607). The question is how to embrace the change towards RI when their corporate logic is understood. However, understanding and accepting the egocentric nature of firms, that is, "how it actually is" rather than "how it should be", is the first step towards affecting a positive change in firms. Thus, we need to understand how one unit operates and what its logic is in order to shape the whole socio-technical system, which consists of many different units [27]. As the quadruple helix concept suggests, firms are interrelated with internal and external stakeholders in their innovation processes [28]. Thus, there is a need to understand which components of RI exist in the inner environment of a firm and which components are induced by the firm's outer environment.

In the following sections, this paper aims at providing a methodology and a unifying conceptual framework of components and influencing factors on the implementation of RI from a firm perspective in its networked nature.

3. Methods

This article focuses on published research on RI in the industry. A literature review was conducted in order to explore, structure, and synthesize the existing and related knowledge on RI with regard to the private sector in the scholarly discourse. Major databases like Science Direct, Google Scholar, Ebsco, and so forth, were used to identify the relevant literature. Keywords and titles with the words "responsible innovation", "responsible research and innovation", "responsible innovation in industry" were searched. Additionally, reference lists of the selected papers were reviewed to find

related papers that were not revealed through the search. The relevant articles were chosen until the 2nd of February, 2018.

In general, there is a growing number of articles dedicated to RI. According to Genus and Iskandarova [5], the majority of the research on RI has been published over the period of 2011–2015. When looking into the empirical research on RI, the majority of the research was conducted in public sector contexts, related to the governance of the sciences, politics, and the development and dissemination of RI tools and practices via (mostly European-commission) funded projects (cf. [5]). The majority of the relevant papers for this article were found in two special issues of the "Sustainability" journal in 2017 and the "Journal on chain and network science" in 2015 regarding RI in the industry, as well as in the Sustainability Accounting, Management, and Policy Journal, Science and Engineering Ethics, Science and Public Policy. There was one book specifically dedicated to RI in the private sector by Pavie, Scholten, and Carthy [29]. In total, 38 papers were used to perform the analysis.

4. A Conceptual Framework for Responsible Innovation at the Firm Level

In order to depict the networked nature of RI in the industry, a conceptual framework of Responsible (Research and) Innovation (RRI) Space by Stahl [22] is incorporated to extract the different RI dimensions that lead to the overall components of the RI process. Stahl [22] suggests "viewing RRI (Responsible Research and Innovation) as a space constituted by activities, actors, and norms." (p. 709). R(R)I space is an attempt to demonstrate the different kind of processes and activities that already exist, thus, the intention is to understand and gather the interrelated components of R(R)I space into one place. In this vein, this paper is following and building upon Stahl's [22] framework and further analysis of each dimension is conducted to decompose the RI process in the industry.

Based on the literature review and conceptual modeling, a conceptual framework is constructed (Figure 1). Figure 1 suggests that RI in a firm happens in a paradigm of the network and consists of the inner and outer environments of the firm representing the networked nature of the firm and its stakeholders. The firm forms the inner and external egocentric networks that simultaneously impact on RI practices.

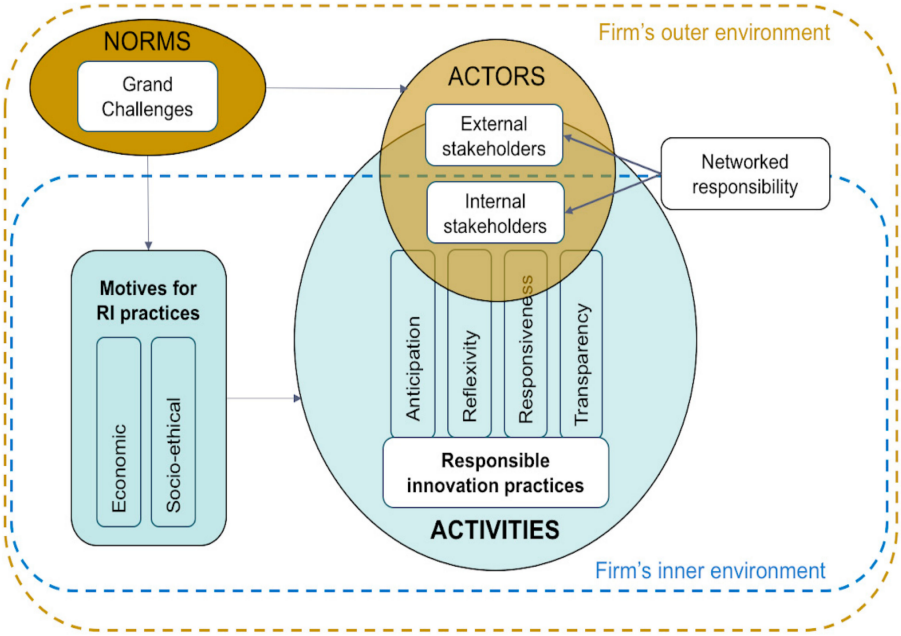

Figure 1. A conceptual framework of RI at the firm level.

The outer environment of the firm is induced by the existing norms or values that are either institutionalized or impacted upon by existing/emerging as social norms. In the RI context, these norms can be summarized as the Grand Challenges because this is the main aspiration of RI to mitigate these "wicked problems" [30]. At the firm level, these norms make the influence on the Actors that consist of both external and internal stakeholders and on the firm's motives for the implementation of RI practices. RI practices consist of anticipation, reflexivity, responsiveness, and transparency, during which internal and some external stakeholders are integrated. The components of the model are elaborated in the subsequent sections.

4.1. The Outer Firm's Environment Regarding Responsible Innovation

Norms as an innovation orientation towards Grand Challenges.

In his conceptual framework, Stahl [22] discusses the normative foundations of RI. These are mainly related to democratic governance and philosophical ethics. However, most of the context discussed by Stahl's [22] is referring to the public governance context at the European level. Thus, Stahl [22], following Von Schomberg [3], referred to the European Treaties and other fundamental documents reflecting on general normative principles like the European Convention on Human Rights, the European Charter of Fundamental Rights.

However, norms and values should be more aligned with the industrial context, which could be transferred more easily into the firm's innovation process. As Stahl [22] mentions, such attempts as to specify the norms with regard to firms (UN Global Compact) and certain industries (UNESCO Draft Code of Ethics for the Information Society) are necessary to provide normative ground for RI because every industry has its own specific issues that should be accordingly reflected.

The need for norms arises in the context of the Grand Challenges that include privacy issues, water pollution, and so forth. The Grand Challenges are caused by multiple and complex actions by the different societal members. These global problems are difficult to manage and mitigate. Therefore, the Grand Challenges are also referred to as "wicked problems" [30].

Thus, the Grand Challenges could be seen as the direction for a firm to move towards while innovating [7]. The issues with regard to the Grand Challenges should be integrated into a firm's innovative activity and, therefore, understood as an innovation orientation. According to Siguaw, Simpson, and Enz [31], innovation orientation is defined as "a multidimensional knowledge structure composed of a learning philosophy, strategic direction, and trans-functional beliefs that, in turn, guide and direct all organizational strategies and actions, including those embedded in the formal and informal systems, behaviors, competencies, and processes of the firm to promote innovative thinking and facilitate [the] successful development, evolution, and execution of innovations" [31] (p. 7). In this guise, the Grand Challenges could be seen as a potential future market for responsible innovative solutions and organizations should take advantage of being the first movers [32] by embedding the Grand Challenges into their innovation strategy.

4.2. The Inner Firm's Environment Regarding Responsible Innovation

Responsible innovation activities.

In his study, Stahl (2013) gave an overview of the activities that could be used for RI, such as risk assessment [33], technology assessment (TA) [34,35], foresight activities in addressing grand challenges [36], and early (upstream) engagement [37]. So far, the ethical-constructive technology assessment [38], value sensitive design [39], design thinking [40], and stakeholder management and engagement [9,41] were also considered to be useful activities for RI.

However, the RI concept goes further than these practices and a more holistic and comprehensive framework is needed to integrate the different aspects of the aforementioned methods. The firm level analysis requests a deeper look into the integration and coordination mechanisms that are available and could be executed by the firm, and also imposed on the stakeholder network of its influence. Such mechanisms are defined as RI activities or practices. According to the literature review done

by Burget et al. [24], the most dominant framework to define the conceptual dimensions related to RI activities is the one established by Stilgoe et al. [16]. Based on the geoengineering project, Stilgoe et al. [16] crystallized four dimensions/activities: anticipation, reflexivity, inclusion, and responsiveness. Each activity raises its own specific questions that could help to assure that innovative ideas are examined in a broader and a more responsible manner. In the following sections, these activities of RI in the context of the industry are discussed.

Anticipation activity is used to reduce the uncertainty of innovation by asking the questions "what if?", trying to forecast what possible (negative) consequences innovation could have after commercialization, and apply scenario thinking [16,20]. The anticipation with the included stakeholders could help to forecast the future risks, benefits, side effects, and other issues of an innovation [42]. This is regarded as a useful tool for managers to anticipate the possible consequences of an innovation, although it is sometimes difficult to this in a comprehensive way [40]. In their empirical study, Timmermans et al. [17] found that anticipation together with the involved stakeholders helps firms "to anticipate and influence the contents of future standards but even may prevent standards from becoming mandatory, for example, by becoming (part of) formal regulation." [17] (p. 19). This can lead a firm to gain a first mover advantage by adjusting an innovation to the future market.

From the networked responsibility perspective, anticipation is a critically important action, as with this, firms seek to influence and adjust external norms to its innovation goals, but, at the same time, to adjust its behavior and decision making to other stakeholders and actors within the network. In this way, innovation goal setting and scope becomes a coordinated and networked action, which is also influenced and defined by the external environment and ecosystem profile. At the innovation ecosystem level, entire actions also carry the risk of a system lock in both the negative and positive, where the need for coordination may block disruptive innovations. Still, leveraging a firm's internal and external stakeholders is of critical importance as the innovation markets are being anticipated with this process. Examples can be far-reaching, such as the incentives of firms within social networking technologies, sustainable fashion, health, food, and so on.

Reflexivity is crucial from the very beginning of the new product development by reflecting on innovation activities, compliance with the standards, etc. in order to avoid detrimental impacts of an innovation [43]. Reflexivity in innovation process usually takes place after the product's launch, in RI case, reflexivity should be applied from the very ideation phase and thus could reduce then the possible failure of the new product [11]. Reflexivity in the firm could be supported by applying formal evaluations, third-party critical appraisal, informal (self-) assessment culture, and so forth [20].

Reflexivity from the networked responsibility perspective is a process of selection of the attention points to be followed up in RI. In other words, a firm selects the innovation responsibility elements that are mutually meaningful for the internal and external stakeholders, and further designs the RI decision-making processes and indicators around them.

Inclusion is about including different stakeholders representing different groups of the society into the innovation process [3,16]. The purpose of inclusion as a principle is not a single, but a consistent process of participation in the whole development of innovation [16]. The main argument is that in most of the cases, society does not have an opportunity to participate in the real-time innovation development [44]. According to Stahl et al. [22], systematic inclusion is the way to integrate various actors of society with different contexts and knowledge, or sometimes even opposing opinions, when seeking the common consensus regarding the new innovation.

The last activity, responsiveness, is "about having the capacity to change the shape or direction of the innovation in response to values of stakeholders and the wider public" [11] (p. 4). Thus, if a firm includes stakeholders in the innovation process, it has to be able to actually change innovation according to their feedback [20].

Responsiveness is a process that not only allows firms to strengthen their network ties with internal and external stakeholders, but also the ties between them. The consolidation process that also takes place, as various dimensions and aspects of RI represented by various stakeholders,

is being integrated into the common innovation effort and response of the firm. This also leads to the prerequisite of transparency.

However, when looking into each dimension and the activities in commercial contexts that were operationalized by Lubberink et al. [11], the inclusion aspect is found in every other dimension: anticipation, reflexivity, and responsiveness. Because firms should include different stakeholders during the whole innovation process, almost every other dimension/practice reflects the inclusion of internal or external stakeholders. With regard to anticipation, for example, Lubberink et al. [11] mentioned that "it is important that actors develop the roadmaps consisting of alternative ways in which the desired impact can be achieved" (p. 11). Regarding the reflexivity, Lubberink et al. [11] stated that "also, activities that encourage [the] reframing of problems and/or solutions, or that encourage involved stakeholders to challenge their own and the firm's approaches, can help the firm to reflect on their thoughts and practices" (p. 12). With a view to responsiveness, "companies can also benefit from collaboration with other firms or stakeholders, for example, to keep up with information flows, changes in the innovation system, and to be able to respond to them [11] (p. 16).

Finally, the definition by Von Schomberg [3] also identifies that innovation is developed by "*societal actors and innovators* [who] *become mutually responsive to each other*". Hence, RI activities or practices should be designed in a way that would require including inner or (more preferably) external stakeholders.

During the literature review (Table 1) transparency as a RI practice emerged [3,9,18,45]. Transparency is primarily mentioned in Von Schomberg's [3] definition of RI. In their empirical research regarding RI in the food industry, Blok et al. [9] included transparency as one of the main characteristics of stakeholder engagement and defined it as "the opening up of the innovation process by sharing knowledge and information among multiple stakeholders" (p. 149). Transparency serves not only as a tool to coordinate interests among stakeholders but also to set common milestones to be achieved by innovation, and its coherence with internal and external norms.

Table 1. RI activities in the industrial context.

Key Activities	Main Characteristics	Advantage	References
Anticipation	• anticipating possible (negative) consequences of innovation • scenario thinking with the firm's stakeholders	➢ awareness of possible future legislation ➢ first mover advantage	[16,17,29,42]
Reflexivity	• reflecting on innovation activities • formal evaluations • third-party critical appraisals • informal (self-) assessment culture	➢ increased quality and success of an innovation	[11,20]
Transparency	• sharing knowledge and information with internal and (some) external stakeholders	➢ increased interpretation of information ➢ effectiveness, efficiency, and commitment of collaboration	[9,18,45]
Responsiveness	• respond to the new information and knowledge • change innovation upon the stakeholders' feedback	➢ increased trust and corporate image regarding stakeholders	[11,20]

At the same time, empirical research showed [9] (Blok et al., 2015) that transparency is difficult to maintain while integrating stakeholders due to a firm's fear of knowledge leakage, of the decrease of their competitive advantage, of their lack of control, of possible collaborations of stakeholders with other firms, and so forth. However, the transparency practices are of high importance in networked innovation development and lead to the success of innovation [46]: when collaborating, transparency has "a positive impact on dissemination and shared interpretation of information, which, in turn, leads to higher effectiveness, efficiency, and commitment." (p. 695). Thus, this organizational characteristic is useful beyond RI contexts and should be increased by applying such managerial practices as intellectual property management, semi-formal protection methods, and so forth [6].

In our model, we propose applying these RI activities as mechanisms bound to the internal and external environments of a firm via the formation of multiple interactions with stakeholders, and also the formation of stakeholders' networks around the firm.

Economic and socio-ethical motives in responsible innovation in the industry.

Economic motives. At the current state, most RI scholars have largely neglected the economic motives of the firms [47]. Firms are mainly self-interested [6] because they seek to be updated with the newest technological developments and rapidly acquire external knowledge that is altogether important supplements in the firm's internal innovative activities [48,49]. Since firms are forced to keep up the speed and progress of innovation to gain market success, they will have economic motives even though they would orient themselves towards the RI process and outcomes. In their empirical study, Garst et al. [14] found that instrumental (regarded as economic) motives "*of fulfilling consumer demand, staying competitive, and managing reputation do not only serve the firm's self-interest, but also support the dissemination of their responsible products. Thus, to implement responsible innovation in a commercial setting, RRI scholars should not only accept the existence of instrumental motives, but even see instrumental motives as a necessary condition for achieving responsible outcomes*" (p. 18). Therefore, it is necessary to integrate the economic motives of a firm into the unifying conceptual framework of RI in the industry.

Socio-ethical motives. Economic motives alone are not enough for RI [8]. Socio-ethical motives are mostly induced by the firm's outer environment through legislation or market mechanisms. The socio-ethical motives are usually related to the meta-norms and values, referring to the Grand Challenges [22]. Because firms scan the environment, consisting of a wide range of different stakeholders, they notice the changing norms and values that have to also be reflected in a firm's inner environment because firms need to have a social license to operate and be accepted by society [18]. However, socio-ethical motives as an important part of RI, are crucial for firms in the way that it can be an extension of existing policies towards corporate social responsibility [50], and thus, help firms to strengthen ties with their stakeholders [47], especially, through the use of social media [51].

4.3. The Inner and Outer Firm's Environment Regarding Responsible Innovation

Internal and external responsible innovation actors.

Regarding RI actors, Stahl [22] emphasizes the role of public and privately funded research organizations, research ethics committees, users, the civil society, policymakers, legislators, educational organizations, and public bodies. However, the industry also plays an important role in RI because innovation commercialization usually takes place in the industry [9]. Therefore, this paper analyses the stakeholders from the firm's perspective and the aforementioned actors are the key stakeholders in the firm's RI practices.

The proposed division of RI actors, as internal and external, is based on the theory of the firm and defines the locus of control and influence in innovation decision making. The behavioral theory of the firm would suggest that internal actors behave on the basis of organizational norms and procedures and thus, their behavior can be easily induced by management decisions, while external stakeholders and norms induce the innovation decision-making frameworks, to which firms have to adjust in order to survive within the networks.

Internal stakeholders. The firm's internal stakeholders are employees or teams who work within an organization. Internal stakeholders work in various areas within the organization, such as in the departments of management, marketing, manufacturing, sales, and so forth [52]. In order for the firm to achieve better results with regard to socially responsible outcomes of a firm's innovation, it is essential to motivate and engage with internal stakeholders. Because internal stakeholders play a key role with regard to RI, it is important to educate them about the benefits that RI could bring [45]. RI principles like the integration of "ethical thinking into [the] design/production process, advocating and encouraging employees to maintain a responsible attitude and discouraging/stigmatizing unethical behavior" [45] (p. 15) should be employed along the whole value chain. With regard to co-responsibility, the degree of involving internal stakeholders into the innovation process should be of a higher level.

External stakeholders. The firm's external stakeholders shape the RI framework and form the network of multiple interactions in the innovation decision-making process. External stakeholders can both be affected or can affect the firm. Usually, a firm's external stakeholders are value-chain-based actors, that is, customers, distributors, suppliers, creditors, user communities, and so forth. In the case of high technology industries, external stakeholders, especially innovation and supply chain partners, are highly important since there are many collaborations and alliances formed for common innovation projects [53]. However, interactive learning for innovation requires intensive trust-based interaction [54], therefore, in order to maintain collaboration with external stakeholders, it is important to build trust and cognitive understanding. This forces firms to behave in a responsible manner towards their external stakeholders in order to ensure long-term relationships. In turn, the corporate reputation is also increased while applying RI practices. Hence, this way of improving corporate reputation causes both investors and potential consumers to be more attracted [45]. Regarding co-responsibility with external stakeholders during the innovation process, the degree is of a lower level due to the uncertainty and possibility of knowledge leakages.

In empirical research on the RI in the industry [17], the dependence of a firm on its external stakeholders like the market, clients, and legislators was found. This interrelated connection of a firm with its internal and external stakeholders shows the need to understand RI as a networked phenomenon since various responsibilities of a firm and its stakeholders intertwine. In addition, the firm has to gain legitimacy from society in order to operate in the market. This is regarded as a social license [14].

Thus, RI in the industry also depends on external actors. The role of external stakeholders is important in a way as they have to search for solutions for how to foster firms to employ RI activities in their conventional innovation processes. The norms and values with regard to the Grand Challenges have to be promoted not only inside the firm, but also outside the firm, thus, making an impact on the firm's motives for RI implementation.

To sum up, the conceptual model proposed by its nature is inductive and integrates the internal and external environment of the firm. RI occurs as a result of the coordination between the firm's internal and external stakeholders and a constant adjustment of the innovation goals of the firm towards the expectations of external stakeholders, and the broader external environment of the firm. However, these two environments in the proposed model cannot be oversimplified as the stakeholders both internally and externally, and, furthermore, transcendentally, form networks, that bind the internal and external environment of the firm in such a way as to form a common RI space. Multiple varieties of network nodes are being formed between any two or more connected elements. However, the ego-centric network approach suggests that all of the actors behave on the basis of their own innovation and organizational and/or societal goals. Within this complex setting, a central coordination role is assigned to norms that induce the framework for self-organized decision making within the common innovation space.

4.4. Defining Responsible Innovation in the Industry

Von Schomberg [3] (p. 9) defined Responsible (Research and) Innovation 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 social desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society)". However, this definition does not fully reflect the existing logic and the processes of the industry with regard to RI.

As Dreyer et al. [18] points out: "the perception within the industry is that this existing research on RRI is not relevant to the industry, either because it uses a "taxonomy" that is too different from current practices (with different words or concepts used to mean similar things), or because it does not (or only vaguely) include elements that [the] industry considers as central" [18] (p. 2). This could be due to the reason that the concept of Responsible (Research and) Innovation primarily emerges in the public context and was oriented towards emerging technologies and related research activities.

It is important to separate "research" and "innovation" since these concepts mean different processes with different actors involved [20]. Regarding the processes, "research" is focused towards generating new knowledge, whereas innovation is mostly focused on commercializing new/existing knowledge or inventions [18]. Regarding the involvement of stakeholders in research, the laboratories and research centers of universities/institutions are the main actors who drive research, usually research that is financed by governments [18].

With regard to innovation, it is usually driven by the for-profit organizations in the industry [20]. Therefore, "responsible innovation" should be used when analyzing commercial contexts. As Owen et al. [55] noted, innovation should be regarded as a non-linear process which involves different or even loosely-connected actors.

This leads to the understanding of RI as a strategic and networked concept. Because the main goal of RI is to anticipate the negative consequences of an innovation with benefits for the future, RI should be understood as strategic value investing [45]. In order to shape the future in a positive way, the actions that are taken at the present time are crucial [56]. Therefore, a specific strategy towards integrating the elements of RI should be adopted at the firm level [45]. Thus, RI in commercial contexts could be defined as a strategic concept that requires forward-thinking by having long-term visions about the innovations and their impact on society and the environment, with specific demands to include the socio-ethical aspects of an innovation and to integrate the related stakeholders from the initial phases of an innovation development.

5. Discussion

The conceptual framework developed proposes the framework of interrelations between the components impacting networked RI from the egocentric network perspective. The conceptual framework is built on Stahl's [22] concept of Responsible Innovation Space: actors, activities, and norms. We proposed the division of the RI space into the inner and outer environments of a firm. The firm's inner RI environment concerns economic and socio-ethical motives as an operating framework and the RI behavior is manifested by the firm-anticipated activities (anticipation, reflexivity, responsiveness, and transparency). In this way, the study extends the previous literature discussion that focuses on the role of moral motivation while seeking RI (outcomes) [3].

In our conceptual model, norms that reflect the Grand Challenges were distinguished as the element of the firm's outer environment that has a critical influence the firm's motives and RI activities. Although some RRI scholars [3,22] stressed the importance of regulatory initiatives like the European Treaties and other fundamental documents reflecting general normative principles like the European Convention on Human Rights, the European Charter of Fundamental Rights, subsequent literature has found that norms can be induced by industrial networks [17,57,58], self-organizing clusters, and associations [59–61], or consumers [21]. Given the importance of norms in defining the principles and the direction of RI, future research should develop more detailed categories derived from the

varieties of norms that shape the innovation space in order to analyze the influencing mechanisms for the RI development inside the firm. This will provide a deeper understanding of how a firm behaves.

In our case, we see the integration of the Grand Challenges as a dominating societal norm that forms a framework for the firm's socio-economic behavior and also impacts the success of innovation. In fact, we see that the notion of the Grand Challenges has modified the strategies and innovation goals of many entrepreneurial firms, as well as large corporations. For instance, the study of "Vittamed technologies" [57] has demonstrated that firms' internal motivation to maximization their returns from R&D also contains a direct focus on resolving health challenges associated with high costs of intracranial blood pressure monitoring and the associated health challenges globally that have not only allowed access to the international innovation platform, but also produced positive flows of innovation funding. In addition, the network was egocentrically chosen as a tool for global market testing and access, which later led to outstanding achievements in innovation development and in the marketplace. Networked responsibility is applied as a tool that allows for the mutual adjustment of firms' behavior within an innovation ecosystem [62]. On the ecosystem level, the role and responsibility of firms, especially SMEs, in addressing the Grand Challenges (also defined as Sustainable Development goals by United Nations [63] are widely recognized and appreciated at the international and national level. For instance, SMEs are seen as the core actors within economies in achieving sustainability, educational, equality, and other societal goals by the United Nations, as they are critically embedded and also accountable to local communities.

Within open innovation networks, the use of RI practices becomes a core principle in competing for resources, talent, and also for the marketplace, especially in the advanced and leading innovation markets that define the future trajectories of innovation. Moreover, the resolution of the Grand Challenges stands with governmental frameworks and policies and builds institutional opportunities and markets for innovation. Thus, the networked approach and coordination between the internal and external actors become critically important. Furthermore, firms participate largely in coordinated innovation goal setting and anticipate the formation of new norms and directions [64], especially in Europe where the innovation efforts of firms are coordinated with smart specialization strategies [65].

The most sensitive question with regard to the inclusion of a firm's external stakeholders during innovation development is the imperative of co-responsibility [3]. Regarding the industry, the co-responsibility aspect is highly questionable due to the information asymmetry [9] which is precisely the competitive advantage for the firm. From the innovation ecosystem perspective [62,66], it is suggested that individual innovation decision making and performance is quite impossible, as well as the consequences and impacts reaching far beyond any single actor within the innovation networks. Thus, future research should search for incentives that would help to integrate the external and internal stakeholders into the industrial RI at the equal scale, while overcoming barriers such as the fear of intellectual capital leakage, additional time and cost resources, and many other barriers discussed in open innovation literature from the resource theory perspective.

6. Conclusions, Implications, and Further Research Directions

This study contributes to the discussion about how RI in the industry should be understood and promoted [11,20]. Thus, the theoretical contribution is based on RI elaboration as a strategic concept from the firm perspective. Thus, we *define responsible innovation in the industry as a strategic concept that requires forward-thinking by having a long-term vision about the innovation and its impact on society and the environment, and also specifically including the socio-ethical aspects of the innovation, and requiring the integration of related stakeholders through the innovation development process from the initial phases and onward.*

This study also provides several important practical implications for managers and policymakers. It is crucial that organizations should be aware of the changing context towards the Grand Challenges and the firm's inner environment would force firms to rethink and restructure innovation processes towards RI approaches in order to maintain their legitimacy in society. Managers can learn that in order to achieve more RI outcomes, the combination of economic and socio-ethical motives can lead to

increased benefits for both the firm and society. The issues that are of a socio-ethical nature like social discrimination, privacy issues, and so forth will require specific solutions and a firm can benefit from the first mover advantage [32]. Accordingly, organizational structures that allow both internal and external stakeholders to become more aware of the existing Grand Challenges should be established. Thus, ideas and processes would be directed towards more RI outcomes.

In particular, policymakers can learn that in order to mitigate the grand challenges, organizations need to be supported by additional incentives that would allow firms to retain economic benefits and, at the same time, be provided with the resources and knowledge in order to establish RI practices/activities that would allow for a wider integration of society into the innovation process. Thus, governments shall clearly try to gather specific issues that can/need to be solved by the industry and support firms with the resources (infrastructure, networks, and so forth) that would allow for the wider inclusion of external stakeholders into the innovation process. In other words, policymakers should establish the directions for solving/mitigating the Grand Challenges for firms and support firms with the required resources. Furthermore, future research directions could also be oriented towards social network analyses in order to reveal the responsibility nodes in the network and, accordingly, shape the institutional environment to enable mechanisms to foster the behavior of different actors towards collaborative RI implementation.

To conclude, this study has developed a conceptual framework that primarily separated the inner and outer environments of a firm. Such a distinction enables us to gain a better understanding of which factors play a role in the firm and what induces a firm to implement RI activities from its outer environment. Furthermore, the paper also provides a set of factors that drive RI at the firm level and analyses the interplay between them.

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