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Responsible innovation across societal sectors: a practice perspective on Quadruple Helix collaboration

Johannes Starkbaum [a], Robert Braun[a], Vincent Blok[b], Fabian Schroth[c], Johann Jakob Häußermann[c,d], Claudia Colonnello[e], Eugen Popa[f], Renate Wesselink [g] and Anna Gerhardus[a]

[a]Institute for Advanced Studies (IHS), Vienna, Austria; [b]Philosophy Group, Wageningen University (WU), Wageningen, the Netherlands; [c]Center for Responsible Research and Innovation (CeRRI), Fraunhofer IAO, Berlin, Germany; [d]TUM School of Governance, TU Munich, Munich, Germany; [e]Knowledge and Innovation – K&I (Fondazione Adriano Olivetti consultant), Rome, Italy; [f]Department of Ethics and Philosophy of Technology, Faculty of Technology, Policy and Management, Delft University of Technology, Delft, the Netherlands; [g]Education and Learning Sciences, Wageningen University (WU), Wageningen, the Netherlands

ABSTRACT

To address societal challenges, research and innovation approaches, involving a wide range of actors, are increasingly promoted by policy communities. This paper explores the practice of Quadruple Helix collaborations for responsible innovation and how these implement the theoretical ambition of including actors from different societal sectors in innovation, including actors from the fields of arts, media and civil society, which is conceptualized as the Fourth Helix in this concept. Referring to cross-sector collaboration literature and based on an empirical investigation, we explore which actors, representing the Fourth Helix, actually engage in innovation collaborations, how this engagement plays out in practice, and the institutional and systemic dynamics involved in output and value creation. We rely on data from three Social Labs in Austria, Germany, and the Netherlands, which constitute qualitative, change-oriented research processes, where we researched and engaged with actors from cases constituting- or aiming for a Quadruple Helix collaboration. This was accompanied by a desktop study including qualitative interviews of 51 further cases. We find that the actual engagement of actors from civil society is fragile and that forces beyond Quadruple Helix cases impact these quite firmly in some cases.

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Quadruple Helix; cross-sector collaboration; RRI; triple Helix; public engagement

Introduction

To address societal challenges, research and innovation (R&I) approaches, involving a wide range of actors, including those from civil society, are increasingly promoted by

CONTACT Johannes Starkbaum starkbaum@ihs.ac.at Institute for Advanced Studies, Josefstädterstraße 39, 1080, Vienna, Austria.

policy communities. While the participation of citizens and stakeholders representing civil society in R&I has been promoted for a long time (The Royal Society 1985), its actual practice is debated.

The core premise of creating multi-institutional innovation ecosystems is reciprocal linkages between actors from government, universities/academia, and industry, forming the crux of the well-established Triple Helix (TH) innovation model (Etzkowitz and Leydesdorff 2000). Open Innovation 1.0 fosters co-production and transparency across actors from these three sectors (Chesbrough 2003). In these approaches, knowledge is ascribed to 'traditional experts' only and citizens are merely subject to innovation outputs. This perception excludes relevant knowledge and experiences that exist in different parts of civil society.

Responsible Innovation (RI) (and Responsible Research and Innovation, RRI) actively promotes the engagement of diverse actors, including those from civil society, in R&I (Blok and Lemmens 2015; Braun and Griessler 2018; Owen and Pansera 2019). However, scholars have criticized that (R)RI emphasizes technology orientation and a top-down perspective (Novitzky et al. 2020; Silva, Miller, and Denis 2018). Others point out that RI provides limited guidance for practice implementation in R&I (Blok and Lemmens 2015; Jakobsen, Fløysand, and Overton 2019; Sigl, Felt, and Fochler 2020).

The Quadruple Helix (QH) innovation model shares a similar overall ambition and is often linked with (R)RI in the context of innovation theory and in EU R&I policies (Campbell, Carayannis, and Rehman 2015; Carayannis and Campbell 2009). This concept promotes collaboration across societal sectors and the active inclusion of the 'Fourth Helix', which consists of a vaguely defined group of 'societal' actors including, e.g. the civil society or media- and culture-based public. Proponents of the QH model name it a democratic mode of knowledge production. The normative claims of the QH literature remain widely on a theoretical level and do not explicate the actual roles of the Fourth Helix in innovation.

Practice-oriented QH literature typically focuses on the economic level (Campbell, Carayannis, and Rehman 2015; Monteiro and Carayannis 2017), regional development and innovation systems (Grundel and Dahlström 2016; Kolehmainen et al. 2016; Kriz, Bankins, and Molloy 2018), as well as at the context of innovation hubs such as Living Labs (Fitzpatrick and Malmborg 2018; Gascó 2017). While these mainly give insights into systemic and broader dynamics in innovation, they provide limited findings on the actual collaboration practices due to their high level of abstractness (Popa, Blok, and Wesselink 2020). A practice perspective is of interest because it is at this level where the interactions between people and professionals, who represent stakeholders from different helices, take place (McAdam, Miller, and McAdam 2018), which help to 'fully understand the complexity of activities that take place in a QH setting' (Hasche, Höglung, and Linton 2019, 6).

In this paper, we, therefore, examine (a) which actors, representing the Fourth Helix, actually, engage in innovation collaborations and how this engagement plays out in practice, and (b) the institutional and systemic dynamics involved in output and value creation. The latter is where RI substitutes QH and cross-sector literature through sensitivity to the institutional and policy dimension of innovation (Owen and Pansera 2019).

Our paper starts from an identified research gap in RI and QH literature, which provides limited guidance for incorporating actors from civil society in multi-actor R&I

constellations. Linking this with cross-sector collaboration literature strengthens our theoretical foundation of collaboration practice(Arnkil et al. 2010; Bryson, Crosby, and Stone 2006) while bringing the role of civil society into focus. This paper then draws on findings from an empirical study, where cases that aim for a QH for responsible innovation were analyzed. Throughout this empirical study, we have also co-created, together with a selection of these cases, ideas to foster the engagement of the Fourth Helix through Social Labs (Timmermans et al. 2020) (see section 3). We bring the observed cases in conversation with cross-sector literature by presenting our findings along three dimensions relevant to QH cases: Formation, Implementation, and Outcome, as outlined in the next section. We discuss our findings to better understand the involvement of the Fourth Helix in collaboration practices and the importance of institutional and systemic dynamics.

Bridging responsibility and Quadruple Helix with cross-sector collaboration literature

Addressing responsibility has a long tradition in R&I with links to ambitions for public engagement and deliberation (Owen, vonSchomberg, and Macnaghten 2021). The concept of RI strives for innovation 'that is more anticipatory, more reflexive, more inclusive, deliberative, open and, in total, more responsive' (Owen and Pansera 2019, 27). It is thus concerned with the futures that innovations may create (Stilgoe, Owen, and Macnaghten 2013). Starting around 2010, RRI became a widespread concept in EU R&I policy, stemming from former policy ambitions for more inclusive and responsive knowledge creation (Owen, vonSchomberg, and Macnaghten 2021). Thus, RRI is not radically new but re-articulates 'long-standing claims and concerns about innovation and society in new ways' (Felt 2018, 113).

RRI, RI and the QH model share some of their main ambitions, particularly in addressing societal challenges through inclusion (Carayannis and Campbell 2009). QH innovation focuses on the collaboration of stakeholders from four major subsystems in knowledge-driven innovation, namely academia/research, business/industry, public sector/government, and civil society/arts and media (Fourth Helix) (Kriz, Bankins, and Molloy 2018). Through the involvement of the Fourth Helix, proponents of this model claim to bring 'in the dimension of democracy or the context of democracy for knowledge, knowledge production, and innovation' (Carayannis and Campbell 2014, 14). As such, QH is framed in contrast to innovation between business, government and the academic sector (TH model), which does not explicitly reflect or include aspects of democracy. However, in which ways QH democratizes innovation processes is debated.

Conceptualization of what comprises the Fourth Helix and how they engage in innovation vary. Definitions range from actors representing civil society (Cavallini et al. 2016), the media- and culture-based public, art-based R&I (Carayannis and Campbell 2014; 2009), actors that democratize innovation (Nordberg 2015), to users (Arnkil et al. 2010). Accompanying these different understandings there are two different conceptualizations of how the Fourth Helix relates to the other three. It may be theorized as encompassing the other three helices as a general backdrop, by representing the norms, values, and culture that enable the other three types of stakeholders to innovate

successfully (Nordberg 2015). In a second conceptualization, it is described as an independent and active stakeholder in the innovation process that 'contribute[s] to build new innovation paths' (Cavallini et al. 2016, 18). In this conception, actors representing the Fourth Helix are not only involved, 'but also able to shape new types of research and innovation strategies' (Deakin, Mora, and Reid 2018, 96). Thus, QH literature describes a broad spectrum of potential actors and roles for the fourth Helix, which poses challenges for exploring actual collaboration practice.

Cross-sectoral collaboration literature, a business-oriented relevant strand of literature, engages particularly with questions of how organizations and institutions in two or more sectors achieve jointly an outcome, by 'linking or sharing of information, resources, activities, and capabilities' (Bryson, Crosby, and Stone 2006, 44). Here, the involvement of actors from civil society refers often to institutionalized actors, such as Civil Society Organizations (CSOs) (Hutter and O'Mahony 2004). In this literature, several authors differentiate three dimensions of a collaborative partnership, namely (1) Formation, (2) Implementation, and (3) Outcomes (Seitanidi and Crane 2009; Selsky and Parker 2005; Shutmate, Fu, and Cooper 2018). This perspective is thus sensitive to processes and developments across time (Rey-García, Calvo, and Mato-Santiso 2019) and aligns well with the processual perspective to QH innovation, taken by Popa, Blok, and Wesselink (2020). The latter emphasizes the temporal dimension of QH innovation and displays how the dominance of actors and represented values might change over time. We build on these three dimensions as a theoretical lens to analyse the practice of QH collaboration.

(1) The formation of collaborations for innovation encompasses, from the perspective of the reviewed literature, all formal and informal rules, procedures, goals and agreements the collaborations set up to govern its collaboration and to include actors from civil society. Literature suggests developing (formal) procedures for partner selection, reporting, and communication. Good management and effective orchestration of collaboration among stakeholders are critical to the successful innovation process (Bacon, Williams, and Davies 2019; Rabelo and Bernus 2015). In this context, Schütz (2020) emphasizes the importance of evolving the work models of individual partners 'from an individual, organizational logic to a collaborative logic' (Schütz 2020, 269). Others emphasize the importance and complexity of identifying and agreeing upon a shared understanding of the problem to be addressed and a common goal (Arnkil et al. 2010; Blok 2019; Popper, Velasco, and Popper 2017; Seitanidi and Crane 2009; Selsky and Parker 2005; Zoethout et al. 2017). The initial phase of QH collaborations is thus said to be particularly relevant for their further progress, their success, and a key element for avoiding 'collaboration failure' (Bryson, Crosby, and Stone 2006). However, having a common understanding is not sufficient from an RI perspective as this may neglect relevant aspects of responsibility and ethics (Blok 2019), which, as the QH literature argues, may be covered by the Fourth Helix. However, Ahrweiler et al. (2019) made clear that actors like CSOs are hardly involved in R&I consortia and do not take part in this formation process, but other partners may take up reflection and civil society perspectives.
(2) The second dimension, implementation, encompasses all methods used and roles taken by the actors in a collaboration, to foster collaboration. According to Schütz (2020), interaction enablers, as experts in the design of collaborative processes,

hold a key position for collaboration by bringing together the relevant knowledge bases and translating them between heterogeneous actors. These processes are expected to entail a definition and shared understanding of roles and the application of different collaboration methods, e.g. from Design Thinking or conflict management (Arnkil et al. 2010; Höglund and Linton 2018; Popper, Velasco, and Popper 2017; Selsky and Parker 2005). Adaption, learning, and trust-building are other key elements named, which include the transfer of knowledge and the shared development of skills and competencies (Bryson, Crosby, and Stone 2015; Kriz, Bankins, and Molloy 2018; Seitanidi and Crane 2009; Zoethout et al. 2017).

(3) The third and final dimension focuses on outcomes and value-creation in innovation, which is relevant already in the formation phase. Cross-sector literature often defines such values as measurable results, including products, services or new standards (Arnkil et al. 2010; Bryson, Crosby, and Stone 2015; Selsky and Parker 2005) as well as their impacts and effects (Ahrweiler et al. 2019; Bryson, Crosby, and Stone 2006; Popper, Velasco, and Popper 2017; Seitanidi and Crane 2009). Social innovation and knowledge creation are referred to less often. Some authors argue that a single goal, value or mission needs to be defined to be able to align the ambitions of the actors involved. However, other scholars claim that this kind of goal alignment between different stakeholders and societal systems is not always achievable, especially in the context of wicked problems (Blok 2014). From this perspective, different stakeholders might join a collaboration for different kinds of ambitions. Popa, Blok, and Wesselink (2020), for instance, suggest that the helices themselves can be conceptualized as 'processes of value co-creation in which participants (…) collaborate and compete for the production of different types of value' (Popa, Blok, and Wesselink 2020, 5). Developing outputs and value is a process that should involve, from a QH perspective, actors from all four Helixes.

Methodology and research design

This paper stems from the EU-funded project RiConfigure (https://riconfigure.eu/) which explored, between 2018 and 2021, cases that constituted or had some ambition to become a QH by bringing together actors from different societal sectors including the Fourth Helix (Carayannis and Campbell 2009).

The research that informs this paper started from three pre-selected main cases, which all worked towards a QH collaboration.[1] These were our major points of investigation and co-creation. Researchers selected the main cases at the very start of the RiConfigure project. Selection criteria in each national context were the type of actor who mainly initiated the collaboration, following the intention that each main case is initiated by a different Helix. Our main cases are the following: First, a research-initiated Living Lab for Industry 4.0 by Fraunhofer IOSB-INA in Germany. Second, a collaborative project on sustainable and connected mobility, was initiated by the publicly owned Austrian Railways in Vienna. Third, an industry-driven cross-sector project on hydrogen energy in the Netherlands.

These three main cases were the starting points of three Social Labs (Timmermans et al. 2020), a participatory action research process where we engaged with actors

from research, industry, the public sector, and civil society to explore how each of them collaborates and in how far they consider aspects of RI, especially inclusion (Stilgoe, Owen, and Macnaghten 2013). The Social Labs were thus initiated by the RiConfigure partner institutions together with their main case. Social Labs stem from action research and bring together stakeholders for reflection and co-creation to tackle complex challenges (Timmermans et al. 2020). One major social challenge (Hassan 2014) identified in all Social Labs was the involvement of the Fourth Helix partners in the innovation process.

Before the co-creation started, a case study was initiated to build a knowledge base. For each Social Lab, additional innovation cases, i.e. reference cases, that constituted or aimed for a QH constellation, were identified through desktop research. The three main cases guided the selection of similar reference cases for each Social Lab, in terms of the initiating sector of the collaboration (e.g. the public sector in Austria), the geographic proximity and topical focus (e.g. energy in the Dutch case). Search engines, innovation-related webpages and policy documents were used to localize cases. This paper considers 51 reference cases. These varied considerably from small (sometimes local) endeavors including few people, to larger initiatives that included several persons and institutions from the four Helices. Based on a shared template, we documented key information for each case based on publicly available data from webpages and documents. Additionally, 34 qualitative interviews were conducted with persons who were involved in main and reference cases to supplement the desktop study. They were asked about their views on their innovation project, activities and expected outcomes, as well as their experiences with the collaboration and the involvement of actors representing the Fourth Helix.

A central element of the Social Labs was a co-creative workshop series, consisting of three learning circles (Kolb 1984), i.e. three workshops per Lab. Participant selection for each workshop was guided by the specific challenges of each main case and included persons from main and selected reference cases as well as additional stakeholders. Overall, there were 66 participants across the nine workshops (individuals who participated in more than one workshop were counted multiple times for each workshop, see Table 1). Along these workshops, the participants identified challenges for collaboration, developed ideas to overcome these, and implemented small pilot projects, between the workshops, to support the QH collaboration of the main case and to foster the active inclusion of the Fourth Helix, most often actors from civil society. The major aim of this approach was to share knowledge and to initiate change towards more inclusive innovation.

Table 1. Social Lab workshops with main and reference cases.

Partner Institutions		
CeRRI	IHS	WUR
Initiating sector of QH cases		
Academia	Public sector	Industry
Social Lab workshops		
3	3	3
Cases present at the three workshops (main and reference cases)		
4/4/5	3/3/1	6/5/7
Participants present at the workshops		
4/4/5	10/16/6	8/7/6/

Each research team of the three Social Labs collected and documented data. This was structured by the scientific literature on QH and collaborative innovation, compiled in a theoretical framework.[2] Interviews and some parts of the Social Lab workshops were also audio-recorded. This article builds on three major data sources: (a) The desktop study on reference cases and the qualitative interviews were documented, for each of the 48 reference cases, by us using a shared template which included a common structure, filled out by the researcher, to foster comparability. Besides general information and a basic description of each case, this template included sections on how cases relate to the main case, how the collaboration was established and how it works in practice, what outputs, visions and external impacts exist, and how the Fourth Helix is engaged. (b) The Social Lab workshops were documented similarly through a shared template that researchers of each Lab filled out after every workshop (n = 9). This included also verbatim quotes from participants. Besides basic information on participants, this template specifically asked for general reflection (e.g. 'what went well?'), what happened during the different sessions of the workshop and how, and which aspects of collaboration were discussed and addressed through pilots (e.g. challenges and solutions). Finally, (c) we developed a third template, filled out by researchers of each Social Lab. The aim of this third template was to bring together, comparably, knowledge from the case study, the interviews and the Social Labs with a specific focus on collaboration practice. Researchers from each Social Lab filled out the template containing sections on major challenges of collaboration practice and how these are addressed, the role of actors representing the Fourth Helix and the role of external actors, how cases build the structure to innovate together, how they foster interaction, and how they create (shared) values. These praxis-analysis-templates were coded based on content analysis techniques (Saldaña 2016) guided deductively by the theoretical framework of RiConfigure and complemented by inductive categories.

A practice perspective on Quadruple Helix innovation

We present findings along the three dimensions of cross-sector collaboration outlined above (Seitanidi and Crane 2009). The observed reference and main cases varied in size, were formed and financed differently, and worked towards different types of output. However, they all have been initiated by TH actors and shared the challenge of involving the Fourth Helix.

Formation of QH cases

Aspects related to the formation of QH collaborations affect, in many ways, the roles and possibilities for actors from civil society in collaboration practice. The actual setting-up of a QH collaboration is rarely a process that involves actors of all helices from the first moment on, and these are mainly initiated by actors from the public sector, academia, or industry. The selection of further partners to enter a collaboration is, in most cases, connected to available finances and specific expertise. Those partners, who initiate a collaboration, also hold decisive power over the inclusion of other partners. In the Austrian main case, for example, actors from the public sector developed first ideas of the collaboration (for the management of the Austrian Railways), then included mainly actors

from business and research as the CEO argued to 'bring in know-how and start-up culture'. Representatives of the Fourth Helix entered at a later stage. We observed similar patterns, of involving the Fourth Helix at a later stage, if at all, in several reference cases. Geographical proximity is another relevant factor. This was illustrated by the German main case where belonging and responsibility towards the region were named as a driver for engaging in collaboration. Moreover, German main case partners also emphasized the difficulty of identifying and involve civil society representatives beyond labour unions. The Fourth Helix is often the last one to enter the formation process of QH collaborations.

Establishing a financial framework is not only a key prerequisite for the formation of QH collaborations and their continuation but also impacts the roles of involved actors. Many of the observed cases were, at least partially, funded by public funds, offering a stable funding framework for actors of all helices to actively engage in innovation. Actors representing the Fourth Helix, particularly often lacked sufficient financing (e.g. for personal or travel costs). In some observed cases, the lack of financial or time resources was compensated by efforts of individuals who performed 'on top' of their daily official duties, e.g. in their private time. However, as one actor expressed: '*the one who funds it can decide where to go. That's how the funding mechanism works' (reference case, Austria).* This leads, in several cases, to a situation where partners of the Fourth Helix were merely consulted rather than engaged as equal partners in collaborations.

Frameworks have been established, in different cases, to govern processes and responsibilities. In other cases, work was based on rather loose legal and non-legal governance frameworks but it was emphasized in interviews that clearer guidelines would help to collaborate better. Some actors of the Fourth Helix were reluctant to sign legal documents, also, as these actors often lacked institutional embeddedness and financial resources needed to enter into formalized collaboration. Yet, formal engagement can also be challenging for others. In a reference case, from the Netherlands, a corporate partner was interested in potential outcomes; however, until some innovation output was not in sight, the corporation management prohibited formal engagement.

Implementation and engagement of the Fourth Helix

Actors representing the Fourth Helix varied across these cases and ranged from individual citizens to (potential) users and institutionalized actors like CSOs or NGOs. The media and arts-based public, referred to by Carayannis and Campbell (2009), was hardly present in the cases observed.

While the ambition of involving actors of the Fourth Helix was a selection criterion in our study, in several cases, their engagement never translated into actual practice. Here, we rather observed the willingness to consider 'societal values' in a broader sense. An academic actor from the industry-initiated main case in the Netherlands described the limited engagement of civil society as follows: 'the agreed-upon thought is that everything is within limits and that problems are to be solved through technical knowledge and testing. At the same time, (…) we have noticed that the partners have a very keen eye for societal values (safety, freedom of choice, technological determinism, precaution, etc.) so a case could be made that through them societal values are implemented in the R&D process' (actor from academia, main case, Netherlands).

Of the 51 cases considered in this paper, only 13 actively included actors of the Fourth Helix in the collaboration process and/or included these in relevant decisions about the innovation process (see Table 2, chapter 3). Of our sample, QH cases initiated by the public sector were much more likely to actively include the Fourth Helix (10 out of 12) than those initiated by academia (3 out of 14) or industry (1 out of 25). Most cases explained the passive role of the Fourth Helix for identifying potential partners that were available and willing to join. We also documented, in some cases, reluctance coupled with the fear that these may slow down the innovation process, which was discussed in the Social Lab with the industry-initiated main case in the Netherlands. Similar concerns were expressed, in another reference case, for partners of the public sector.

We observed several methods across the observed cases to foster interaction and collaboration. Most prominent were meetings that involved all partners. These were repeatedly named, in interviews and Social Labs, as key resources for collaboration through the exchange of perspectives and the alignment of goals. Furthermore, such meetings were said to help overcome communication barriers (e.g. understanding the 'language' of scientists) and power gaps (e.g. industry partners holding financial and infrastructure power), which is particularly relevant for the engagement of the Fourth Helix. Another strategy of cases we observed, to improve collaboration, was to develop knowledge on good-practice examples. For this reason, several cases have been exchanged with other collaborative innovation projects and experts, particularly in earlier phases of the collaborations. In the Austrian main case, e.g. we documented site visits, informal meetings and training organized by actors from the public sector. They also initiated meetings for a wider set of actors where partners or potential partners of the collaboration spoke about their experiences, expectations, and goals.

Table 2. Reference case study.

Partner Institutions		
CeRRI	IHS	WUR
Initiating sector of QH cases		
Academia	Public sector	Industry
Main cases		
The **SmartFactoryOWL** is a cooperation project of the Fraunhofer-Gesellschaft and the Hochschule OWL providing an independent and open industry 4.0 research and demonstration platform. As a living lab, it not only enables companies and research organizations to co-create technological solutions but it also involves political-administrative actors as well as labour unions and citizens.	**Open Innovation at the Austrian Railways** (ÖBB): ÖBB is the largest train and mobility corporation which is owned by the Republic of Austria. The initial main case was a planned innovation campus, a large building to host innovators in the mobility of different sectors. The project developed into an innovation community that merely constitutes a platform for knowledge exchange.	In the **GIGAWATT project**, a consortium of companies, universities and knowledge institutes discuss the design of an industrial-scale electrolysis plant that would produce 'green hydrogen' (i.e. hydrogen produced with green energy) on a gigawatt scale. Five regions are involved and for each region, potential locations were identified, and assessments of feasibility took place.
Common selection criteria for reference cases beyond QH ambition		
Initiated by the same helix as the main case; located in Germany or neighbour countries; topical focus on industrial automation or digital innovation.	Initiated by the same helix as the main case; located in Austria or neighbour country; topical focus on mobility.	Initiated by the same helix as the main case; the topical focus is on hydrogen or energy more broadly.
Cases analyzed through desktop research (including the main case)		
14	12	25
Qualitative interviews with actors from cases		
6	16	12
Cases that actively included civil society (main and reference case)		
3	10	1

Alignment of values and outcomes

A certain alignment of values and visions was anticipated by all cases to innovate together and overcome challenges. In one of the reference cases in the Netherlands, working towards the common goal for more sustainability was named, by a case member, as a driver of collaboration that helped partners to overcome barriers.

Yet, the ambitions of involved actors and helices differed in many cases, and their alignment was repeatedly described as a challenge. We observed, among different actors, interest in solutions to specific problems, innovation and the profits it might bring, in forming new partnerships, or a desire for new knowledge and opportunities for learning. A Social Lab participant from an Austrian reference case described it to the point: 'The biggest problem is to align interest, because the interests of a city, of a national company, and of higher education systems are extremely different'. Actors of the first three Helices repeatedly described the value of the Fourth Helix as bringing in a 'societal' perspective from 'civil society', representative of the needs of 'people' or a 'region'. We found that the engagement of the Fouth Helix was more pronounced in projects with specific often regional challenges. In some cases, goals changed over time and were negotiated among the partners. One actor from the public sector, involved in an Austrian reference case for regional growth, who launched several smaller projects, stated: 'it was imagined, at the beginning, to foster the development of new technology but the most successful ones [projects] are about social innovation'. This is a rare case where actors of the Fourth Helix had a real and lasting impact on innovation.

While the management and alignment of goals and values 'within' a QH matter for collaboration and the engagement of all helices, we find that it is also relevant to consider values, goals, and expectations of actors not part of the QH cases. We delimit QH collaborations to those representatives actively involved in a joint innovation endeavour. Besides individuals, this may include institutions, but sometimes only selective parts thereof. We consider everything beyond that as the 'environment' of the collaboration which may include other units of the involved institutions, as well as actors and institutions not actively involved. Such external actors influenced some cases in profound ways, by holding decisive power on financial resources, and strategic or policy decisions relevant to the practice or maintenance of the collaboration. In one of the reference cases, e.g. a supplier pushed the strategy of innovation in a new direction. In other cases, changes in the regulatory or political environment became relevant. In the Austrian main case, where the publicly owned corporate partner had a change in management, both on the highest level (CEO) and on the level of the person responsible for the collaboration strategies, and visions and their mode of implementation changed. This created a need for a new alignment of goals and mission also for the QH collaboration. An envisioned infrastructure project was thus adopted for a more flexible stakeholder network. In this case, it was the NGO partner involved who was the least adaptive: other partners that were more accustomed to such changes in management and power distribution could accommodate the change more easily.

Discussion

The inclusion of diverse stakeholders in research and innovation is a shared ambition of responsible innovation and the QH model (Carayannis and Campbell 2009). In line,

the literature on collaborative innovation suggests that interaction and integration of diverse perspectives are crucial for a better alignment of R&I processes, practices and outcomes with the values and needs of the involved helices (Gomes et al. 2018; Lopes and Franco 2019; Schütz 2020). Our research highlights that further clarification is needed about which Fourth Helix stakeholders are engaged in which ways in innovation (Braun and Starkbaum 2023), and about the roles of institutions and broader socio-political systems (Owen, vonSchomberg, and Macnaghten 2021) for aligning values and outcomes.

Engagement of the Fourth Helix

QH literature provides a broad spectrum of actors and stakeholders that may constitute the Fourth Helix (Arnkil et al. 2010; Carayannis and Campbell 2014). In our case study, we mainly observed either (a) institutionalized actors representing civil society, like CSOs or NGOs, (b) individuals who participated in their role as members of the civil society or as potential users of an anticipated innovation, or (c) no actual presence of actors who represent this helix. We documented several challenges for inclusion across the three dimensions formation, implementation and outcomes.

In the investigated QH cases, the Fourth Helix was most often the last one to enter a collaboration and the least integrated one. Furthermore, many cases engaged actors from this helix at selective stages, or, while ambition was there, eventually did not actively engage them at all. Observed rationales for the low engagement of Fourth Helix actors include challenges of finding adequate partners from this sector and a lack of knowledge on the 'how' and the 'methods' to do so. This confirms earlier findings on CSO engagement in industry-stakeholder collaborations (Ahrweiler et al. 2019; Blok, Hoffmans, and Wubben 2015).

The processual approach to QH, where civil society is merely represented through considering its perspective, suggested, e.g. by Popa, Blok, and Wesselink (2020), comes close to this 'empirical reality'. It might be a relevant conclusion that collaborative innovation practice does not request the active presence of all helices all the time but rather the inclusion of societal values in different forms and representational modes. While the authors acknowledge potential frictions stemming from overrepresentation of certain value types (e.g. market value), it is suggested that the potential absence of actors from civil society may be considered valid in this perspective if the value is represented within the process. This is in line with the finding by Ahrweiler et al. (2019) who found that there is much more 'de facto CSO' than expected; RI was performed by organizations that were (at first sight, and formally, officially) not CSOs. This study illustrated also that SMEs took up this role in a large part of the projects they investigated. On the other hand, we see contributions from the cross-sector literature that assert that for-profit organizations may also collaborate to achieve social impact thus to orient towards-, or to 'cover' societal values (Bode, Rogan, and Singh 2019). We discussed that QH literature also conceptualizes the Fourth Helix in different ways, even as the representation of 'values' or as an enabler for collaborations to open up towards society (Nordberg 2015). Additionally, researchers have highlighted that power dynamics in collaborations receive too little attention while collaboration as such is taken for granted (Skritsovali, Randles, and Hannibal 2023). Indeed, it is debated if the active inclusion of the Fourth Helix brings democratization to innovation.

However, the actual absence of actors representing civil society can be seen as problematic from a QH and RI perspective (Braun and Griessler 2018; Campbell, Carayannis, and Rehman 2015). It is a widely shared claim of RI literature that values, needs and expectations of society may be better considered by actually involving actors from civil society, like citizens or CSOs (Braun and Starkbaum 2023). This is also similar to what Carayannis and Campbell (2009) suggest by integrating the dimension of democracy.

Either way, to foster responsible innovation, including the consideration of societal needs and aspects, our research suggests that actors, or their values, should be engaged or identified at the implementation phase, when most of the decisions, setting-up of collaboration structures and actual operational and cooperation processes are decided. In line, we have also witnessed that the availability of project-related public funds facilitates engagement and helps create a level playing field. One may ask: what would the public rationale be in investing public funds in a private and (at least partially) business value creation process? Our findings confirm that this rationale may be that while some entities that engage in business or knowledge value creation may expect a return on investment (specifically, a financial return or more knowledge created that may further the cause of the research partner) this is not necessarily the case with the Fourth Helix partner. Thus, there is a clear incentive to invest public funds to help engage the Fourth Helix as the 'return' may also come in social or public value creation. This leads to a clear policy recommendation that stems from this research: policy-makers on the national or European level should facilitate a QH collaboration model as indicated in Horizon Europe funding instrument strategic and scoping documents (EC 2021). It is a policy implementation task to provide dedicated funds and other auxiliary financial instruments for involving and engaging the Fourth Helix in the innovation process early on. In line with Ahrweiler et al. (2019) we argue that although RI is stimulated by EU and national governments, it is something that only grows when dedicated resources are available.

This said an important question to reflect on is the argument made by Carayannis and Campbell (2021, 2056) that QH 'can be seen as a model that integrates the dimension of democracy or the context of democracy in order to promote knowledge, knowledge production, and innovation'. This is a rather general and overarching claim. We found that such generalization borders on overpromising. The authors (ibid) are right in claiming that a QH collaboration adds an element of 'knowledge democracy' to the innovation collaboration, even if it does not democratize innovation as such. Our research shows, however, that these hardly exist in practice and that collaborations oftentimes represent societal values rather than actively including these.

Our findings thus point to procedural democracy: proceduralism defines democracy as the very political process that it puts in motion; normative values reside in the process' capacity to protect and promote the inclusion of values and ambitions of participants of the democratic process (Saffon and Urbinati 2013). In the Austrian case, the process was managed in a way that initiators from the public sector included a wide array of stakeholders, and formalized collaboration as well as institutionalized events to share knowledge across helices and to initiate knowledge and value transfer. One could say that procedural democracy worked well in this case and social values of specific entities (e.g. sustainability, decarbonization, equity, gender equality) were included in the process. However, in all collaborations, also the Austrian main case,

the values and social ambitions of the Fourth Helix were particular and limited by the specific interests of partners from all helices. Furthermore, actors representing the Fourth Helix are also subject to bias. Like all actors, they often acted on particular interests and did not necessarily represent societal values at large.

Institutional and systemic dynamics

An RI-inspired perspective to QH is sensitive to the roles of institutions and broader socio-political systems. Collaborations do not innovate in isolation. Some external actors and structures significantly impact QH cases and their trajectories. Collaborations, and any potential ambition for democratizing innovation, may be influenced by external entities if a QH aligns its values and outcomes with expectations of such other actors, e.g. to secure funding or political support. In some cases, external factors even hinder or are in some cases detrimental to QH collaboration. Change of management, shift in corporate vision, redefinition of institutional goals or political ambitions have led to a withdrawal of support or resources that may prove to be key to the collaboration. This seriously impacts the engagement and commitment of the Fourth Helix actors as their involvement and mode of operation is less hierarchical, value and social impact driven, and based on more informal institutional or personal commitments (Figure 1).

In this visualization, the four darker inner circles represent the actual QH collaboration (QHC), with the further layers indicated by the larger ellipses. The public sector is displayed in green and is as an example for describing these dynamics

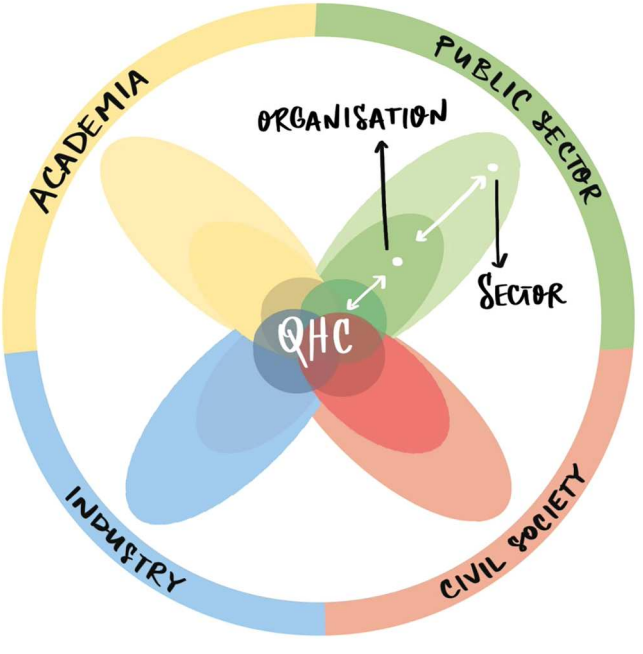

Figure 1. Quadruple Helix flower model: layers described for the public sector. The model developed by the authors based on the QH model by Carayannis and Campbell (2009); visualization by Chiara de Eccher.

beyond the collaboration. The inner circle in this Helix may be, e.g. a unit of a larger publicly owned company that is part of a QH collaboration with a specific aim for value creation. The brighter green ellipse represents the whole company including the governance board and its wider corporate strategy. The larger ellipse represents the public R&I sector, including relevant parts of the government, ministries, and other public bodies. These define goals for R&I and issue respective funding, which impacts the governance and funding strategies of publicly owned companies. Goals and funding opportunities are – at organizational and sector levels – subject to change, which demands adaption by the QHC to secure political and financial support within the Helix. We have observed similar dynamics in other helices, such as industry, including, e.g. questions of intellectual property, and technical and financial support. Relevant decision-making power is thus often located 'outside' the QH collaboration, in governance boards of the involved entities or even beyond (e.g. governments, holdings, associations). External impacts typically intensify once collaborations grow in size or importance as these then begin to impact the finances, branding and governance of their environment. In QH collaborations, the 'dimension of democracy' (Carayannis and Campbell 2009), which is linked to the engagement and inputs of the Fourth Helix in this concept, is thus affected in practice, sometimes hindered, by the necessity to align outcomes and values according to external impacts.

Finally, QH literature may benefit from discussions and research on public engagement in R&I. Respective debates from Sociology, Science and Technology Studies as well as some literature from the field of RI may be instructive as to how the value of inputs from citizens and other societal groups may support collaborative R&I and how these may be embedded given institutional dynamics. While the QH model makes a normative claim for the Fourth Helix engagement, it discusses its politics and practice to a limited extent. The concept of RI, which is often aligned with QH, is sensitive towards process, power, and politics. There is a potential that the inclusion or consideration of the Fourth Helix may lead to a better alignment of outputs and values with societal needs (Owen and Pansera 2019), but given the dynamics within and beyond the collaborations, this does not always play out in practice. The procedural approach to RI (Stilgoe, Owen, and Macnaghten 2013) may offer structures for creating appropriate processes in QH collaborations; stage gates (Cooper 1990) present reflection and stop-go options for all parties involved. Owen et al. (2020) have shown how the implementation of RI faces institutional barriers as engagement and reflexivity is seen to be in contradiction to traditional ways of doing R&I. Such 'external' forces typically hold political and financial power that may interfere with or have a strong impact on collaborations, its goals, as well as its continuation or termination. While our research emphasizes the benefits of shared and aligned goals, we also see that there are always various and even conflicting interests within and beyond the collaborations.

Notes

1. This article refers only to project data of three out of five main cases.
2. https://riconfigure.eu/wp-content/uploads/2019/10/D01.1_Analytical-Framework_v3.0.3-1.pdf.

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Data availability material

In accordance with the EU open data policy, much of source data are available through the EU funding and tender portal. Some findings of this article have been published in RiConfigure deliverable No. 6.5, available through the EU funding and tender portal.

ORCID

Johannes Starkbaum http://orcid.org/0000-0003-2514-3289
Renate Wesselink http://orcid.org/0000-0002-2737-8471

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