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Article

A processual approach to friction in quadruple helix collaborations

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Abstract

R&D collaborations between industry, government, civil society, and research (also known as 'quadruple helix collaborations' (QHCs)) have recently gained attention from R&D theorists and practitioners. In aiming to come to grips with their complexity, past models have generally taken a stakeholder-analytical approach based on stakeholder types. Yet stakeholder types are difficult to operationalise. We therefore argue that a processual model is more suited for studying the interaction in QHCs because it eschews matters of titles and identities. We develop such a model in which the QHC is represented as a process of generating four types of value: research value, market value, political value, and societal value. We then apply this processual model in analysing real-life cases of friction in QHCs. Friction is seen, not as an interpersonal clash, but as a discrepancy between two or more value-creation processes that compete for limited resources (some over-performing while others under-performing).

Key words: quadruple helix collaborations; stakeholder analysis; process analysis; friction; value co-creation

1. Introduction

A quadruple helix collaboration (QHC) is a form of research and innovation (R&I) in which representatives of industry, government, knowledge institutes, and civil society collaborate towards mutually-recognised innovation goals (Carayannis and Campbell 2009). The concept of QHC inherits the conceptual fundamentals from the earlier concept of triple helix collaboration (THC), which referred to exclusive collaboration between industry, government, and knowledge institutes (Etzkowitz and Leydesdorff 2000). QHCs have received a lot of attention recently, from both a practical and a theoretical perspective. Some studies focus more on concrete instantiations of QHCs (García-Terán and Skoglund 2019; Höglund and Linton 2018; Kriz et al. 2018) while others look at QHC as a model for innovation systems and the knowledge economy (Carayannis and Campbell 2014; Cavallini et al. 2016; McAdam et al. 2018). Additionally, the opportunities and challenges ensuing from bringing together the aforementioned groups have also been studied in scholarship that does not necessarily employ the term 'quadruple helix'. For instance, valuable practical and theoretical insights can be encountered in literature on 'cross-sector collaborations' (Andrews and Entwistle 2010; Bryson et al. 2006; Le Ber and Branzei 2010) and 'multi-stakeholder alliances' (Bäckstrand 2006; Dentoni and Peterson 2011).

Whether they adhere to the QHC vocabulary or not, the predominant perspective within these studies is a *stakeholder-analytical* one meaning that the basic unit of analysis is the type of stakeholder participating in the innovation process. In a stakeholder-analytical perspective, the investigator seeks to understand challenges and opportunities brought forth by QHCs by looking at the stakeholders' sectors of origin and the assumed interests and goals that are prototypical in those sectors. Diversity of stakeholder types and the resulting diversity in forms of knowledge is thus the main asset and the main liability of the QHC—its source of 'effectiveness and sustainability' (Carayannis and Campbell 2009) but also conflict (Cuppen 2012). In a stakeholder-analytical approach, it is therefore always something about the type of stakeholders involved that should hold the key towards a better understanding of how QHCs work and how they can work better.

Recently, calls have been made for a *processual turn* in the study of QHCs where more attention is given to the participants' interactions and the output of these interactions, less so to the participants' identities and the sectors they may or may not represent (Cunningham et al. 2018; García-Terán and Skoglund 2019). It has

been remarked, specifically, that in the traditional stakeholder perspective the actual process of innovation systems remains 'surprisingly veiled' (Kolehmainen et al. 2016). More specifically, it is doubtful whether the stakeholder-analytical perspective is the most productive way to investigate sub-optimal collaboration, that is, collaboration *barriers* (Fernandez et al. 2017; Trianni et al. 2016), collaboration *conflicts* (Cuppen 2012; Mikkelsen and Clegg 2018; Rahim 2017), and *friction* (Cunningham et al. 2018). In order to study these phenomena, scholars have urged to complement the macro-analytical perspective which trades in identities and titles with the micro-analytical world of 'dynamic relationships, synergies, collaborations, coordinated environments, and value-creating activities' (Hasche et al. 2019: 2; Kriz et al. 2018: 2)

In this article, we answer this call for alternative perspectives by showing how the processual perspective can be of use in analysing sub-optimal collaboration events, events we will refer to as *friction between helixes*. To take a processual perspective to friction means to focus the analysis on aspects of friction that are relevant to the event's understanding and overcoming. Through theorising on a processual model of QHC and illustrating the use of this model with actual examples of friction, we would like to show that a processual approach opens the door for a more nuanced understanding of these events and, as such, puts us in a better position to tackle them.

The article is structured as follows. In Section 2, we explain the need for a processual turn in conceptualising QHCs and we answer this need by providing a processual model of QHCs in which the four helixes can be conceptualised as processes of value co-creation. In the rest of the article, we put this mode into application. In Section 3, we explain the methodology for applying the model and in Section 4, we illustrate the use of the model by applying it to real-life cases of QHC. In Section 5, we discuss the policy implications of the obtained results and the model lying at the basis of this research. We conclude in Section 6 with suggestions for further research.

2. The quadruple helix from stakeholders to processes

2.1 The stakeholder-analytical approach to QHC

The origins of the term 'quadruple helix' need to be sought in the late 1980s when scholars and practitioners of innovation studies expressed a general disagreement with traditional models of innovation (see e.g. Arnkil et al. 2010; Kline and Rosenberg 1986; Teece 1992). These traditional models viewed innovation as a linear process from fundamental research to applied technology and assumed that innovation was primarily an interplay between the state and businesses. Of the many alternatives to this tradition that were subsequently proposed, one is relevant for the present purposes: the *triple helix* (TH) *model* (Etzkowitz and Leydesdorff 2000; Leydesdorff and Etzkowitz 1996, 1998).

The TH model postulated that innovation results from collaborations between industry, knowledge institutes, and policymakers. The model was proposed by Etzkowitz and Leydesdorff as an analytical tool, meaning that its function was to shed light upon the immensely complex process of innovation (Leydesdorff and Etzkowitz 1998). Specifically, the TH model was initially introduced to understand the new role played by *knowledge institutes* in innovation given that the output of these institutes has an increasing, long-lasting, systemic effect on society and economy (Carayannis and Campbell 2010).

Subsequently, just as knowledge institutes were introduced in the pre-existing state–industry configurations (to form the TH), so was the civil society introduced into the TH model to form the *quadruple helix* (Carayannis and Campbell 2009, 2010). The fourth helix is often defined as 'media-based and culture-based public', which effectively includes any individual who is or could be affected by a certain research and development process and thus has a reasonably clear stake in the process (Carayannis and Campbell 2012). The public, while not necessarily trained to grasp the technological and economical dimensions of an innovation process, shapes this process in indirect ways: 'culture and values, on the one hand, and the way how "public reality" is being constructed and communicated by the media, on the other hand, influences every national innovation system' (Carayannis and Campbell 2009). A QHC event is thus, according to the model, the direct or indirect participation of at least one organisation from each of the four helixes.

To exemplify these features of the stakeholder-analytical approach, let us look at one concrete and recent example provided by Cunningham et al. (2018). Other models will of course differ on details, but they share with this one the assumption that the QHC is, in essence, a social phenomenon to be defined by the type of stakeholder involved. The illustration based on Cunningham et al. (2018) will also be useful later in this article because we will take up their concept of *friction* and apply it in our cases.

In their approach, Cunningham et al. (2018) use a stakeholder-analytical model to study the boundary work of principal investigators ('PIs' in the figure) and the friction resulting from that work (see also Mangematin et al. (2014) for a similar approach). The study is a typical example of labouring under stakeholder-analytical assumptions: the basic unit of analysis is the stakeholder type and each stakeholder type is defined according to a set of distinguishing attributes (motivation, goals, etc.).

Various similar stakeholder-analytical figures have been produced within the literature on QHCs. Although it is difficult to identify with precision the studies that take a stakeholder-analytical approach—since methodological assumptions have not always been made explicit—the term 'helix' translates in this approach to a group of stakeholders joined together by some 'salient characteristics' (McAdam et al., 2018). In the example above, Cunningham et al. (2018) are working towards conclusions regarding the values and interests of one particular actor (the PI) and how this actor manages to balance these values and interests with the more general duty of fostering public values (143).

The stakeholder-analytical model of QHCs has duly set up a level of abstraction that is in our view optimal for the study of science–society relationships. The QH model is very much in line with Merton's claim that research should be studied with 'middle-range theories' that give enough space for the incidental and the general, the event, and the landscape (Merton 1973; Pawson 2000). Aside from setting the stage through this middle-level theorising, the model also brings forth a very important distinction that has proven its utility in studies such as those by Cunningham mentioned above: the four-fold distinction between helixes. This distinction comes with important assumptions that, although implicit, determine at a fundamental level the study of R&I. For example, the four-fold distinction between sectors implies that the diversity we intuitively notice in complex R&I projects is a diversity of work-related aims (or 'goals', 'values', 'interests', etc.). As a result, other possible sources of the observed diversity, for example, cultural differences, differences in skill or personality, linguistic/rhetorical differences, are subordinated to this assumedly more relevant difference in

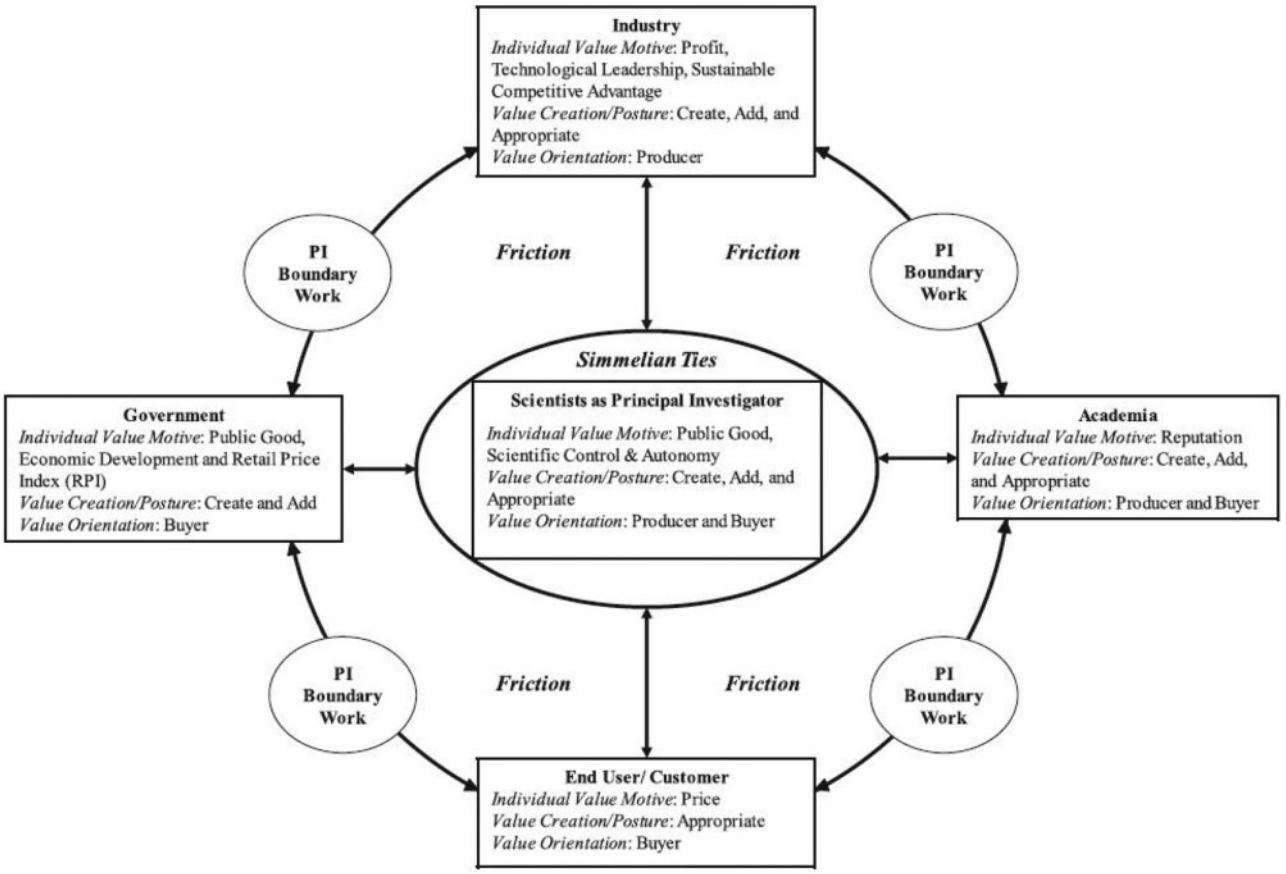

Figure 1. The model used by Cunningham et al. (2018) for the study of PIs and their work in QHC.

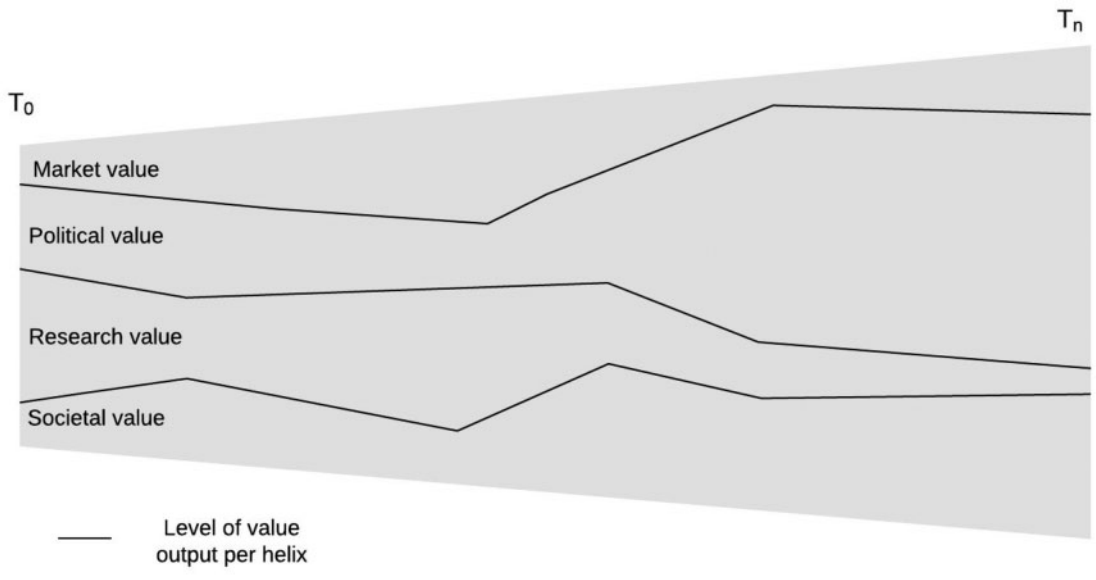

Figure 2. A processual model of QHC.

work-related aims. Another important assumption in the QH model is the assumption of stability of R&I phenomena and organisations. Under this assumption, R&I becomes a bounded, observable event, as opposed to being a diffuse property within a system, as it is the case for example with 'sociotechnological transitions' (Geels and Schot 2007) or national innovation systems (Godin 2009).

These contributions notwithstanding, the stakeholder-analytical perspective engrained within the QH model presents us with some

points for improvement. It has been noted recently (Hasche et al. 2019; McAdam et al. 2018) that the obtained level of abstraction is still too high, compelling those who work on QH and TH collaborations to make macro-level observations to the detriment of micro-level observations regarding the 'dynamic relationships, synergies, collaborations, coordinated environments, and value-creating activities' (Hasche et al. 2019: 2). This micro-level perspective is needed in order to 'fully understand the complexity of activities that take place in a quadruple helix setting' (6).

The current call for more micro-level investigations is highly justified, yet we doubt whether it can be satisfactorily answered from a purely stakeholder-analytical perspective. In the process of 'zooming in' to the fine-grained reality of QHC, scholars will need concepts that allow for a clear operationalisation. We doubt whether the concept of *stakeholder type*—the basic unit of analysis in past QHC models—is up for the task. Two basic problems seem to occur.

The first problem in operationalising stakeholder-analytical models is that labels for stakeholder types remain fuzzy. In the one much-quoted formulation, the four helixes are defined as follows: (1) academia/universities, (2) industry/businesses, (3) state/government, (4) media-based or culture-based public (Carayannis and Campbell 2009). A similar delineation is employed by Bryson, Crosby, and Stone in the following definition of cross-sectoral partnerships: 'by cross-sector collaboration, we mean partnerships involving government, business, nonprofits and philanthropies, communities, and/or the public as a whole' (Bryson et al. 2006). But what is behind these abstract labels? There is no universally accepted definition of 'research', 'industry', 'state', and 'public'. Furthermore, given the complexity of these phenomena, one might even wonder whether such a definition is possible or useful.

Let us clarify the point further by looking at an example and then apply mutatis mutandis the conclusions. Take the helix of *research*. At first glance research (or 'academia') is easy to pinpoint: it consists of stakeholders that carry out research. Furthermore, we will have no trouble identifying prototypical cases of researchers that participate in a QHC with the interest of carrying out research and publishing results. Yet going beyond this almost tautological definition will place us in a landmine, for what counts as the research helix. Does it include unpublished R&D carried out within a business organisation for economic purposes? If so, will it also include market and consumer research carried out for the same purposes? If peer review is not a condition, should we include the highly valuable and insightful research carried out by journalists? An even more thorny problem occurs when we seek to decide whether or not to include research-oriented governmental organisations—health councils, agencies, and advisory boards. They are, by statute, governmental organisations but their statue is that of carrying out research. Finally, with the fall of the so-called deficit model that identified a clear line between science 'proper' and science communication (Selin et al. 2017), it is difficult to say whether activities of public engagement in science are a form of research or a form of science communication. Similar considerations can be brought to bear on the other helixes, revealing that beyond a small semantic core, the four helixes are complexly intertwined, preventing a clear-cut delineation. And while it might be expected that labels for complex phenomena will have furry edges, there is a second problem that combines with the first one to bring us into increased difficulty of using the four labels.

The second problem in operationalising the model comes not from the operationalisation of the helixes themselves but from the identification of the organisations that are to be assigned to the helixes. As socially constructed entities, organisations—their resources, their activity, and their output—will inevitably evade strict definitions and classifications. Complex institutions that are active on a variety of fields will have more than one (overlapping identities) and it is not immediately clear which ones of these identities are to claim pre-eminence over others. An institutional identity is always in the eye of the beholder (Powell and DiMaggio 2012). Going back to the task of assigning organisations to groups, we must ask ourselves: What feature of an organisation do we then take as the decisive ones for assigning an organisation to a certain group? Are we to divide groups based on their institutional aim, the organisation's actual activity, or on their institutional alliances and allegiances?

Let us illustrate this second problem by taking the example of a concrete organisation: the Institute for Sustainable Process Technology (ISPT) active in The Netherlands. The Institute describes itself as a network organisation for the process industry in The Netherlands, so the first instinct could place it under the industry helix; on the other hand, the Institute is actively involved in tackling sustainability issues within these industries (energy reduction, circularity, etc.), so we might also say that they are lending their efforts to a socio-ethical cause. Thus, given that ISPT is not simply there to help the industry turn investment into profit but has a broader social agenda, ISPT is part of the civil society. Further, within ISPT, there are PhD candidates and Master students carrying out research and their research output is actively used within the institution and by other scientists. In this light, ISPT is a research centre. And finally, given a broad definition of policymaking (Fischer 2012), one that would include not only the activities of actual policymakers but also other bodies that participate in agenda-setting and public–private interaction, ISPT is influencing the overall governance of the process industry. So this organisation can also be placed in this public sector. We see therefore how, by placing ISPT on the backdrop of its different contexts of activity, we can reveal a multitude of helixes in which it can be justly placed.

We therefore agree with Yang et al. (2012) that the helix 'frameworks are in need of further clarification when it comes to transferring the relatively abstract theoretical framework to operational variables in order to guide empirical investigations' (377). But we argue, based on the reasons advanced above, that these clarifications cannot emerge solely from a stakeholder-analytical perspective. This 'plurality of agents, actors and organizations' (378) cannot be solved through a more thorough categorisation (see e.g. Ivanova 2014) because the building blocks of that typology would still be actors and sectors—two concepts that, we have argued, avoid operationalisation.

In the next section, we develop the proposal that a *process*-analytical perspective to QHCs, along lines that have started to be explored by recent research, can complement the stakeholder-analytical perspective and provide a solution to the aforementioned operationalisation problems. As explained above, for some purposes, QHCs can still be defined as collaborations between four actor types (universities, businesses, policy, and society); yet a micro-level analysis will, we argue, benefit from the more stable unit of analysis which is the (value-creation) process.

2.2 From stakeholders to processes

That a process-analytical perspective could be beneficial for the study of innovation has already been discussed in the QH literature(García-Terán and Skoglund 2019; Hjorth et al. 2015). It has been argued that 'to conceptualize how things unfold and

emerge in comparison to theoretical frameworks that focus on how static objects exist' has practical advantages and because 'when we accept that things change, we are also enabled to better understand how things interrelate' (García-Terán and Skoglund 2019: 1276). Additionally, as seen in the previous section, advocates of the micro-level analyses of QHC tend to focus on processes such as 'value-creating activities' (Hasche et al. 2019) and thus leave behind matters of identity and titles. In this sense, advocates of the micro-level analysis are, indirectly, favouring a focus on the process.

These movements towards a processual approach notwithstanding, we have yet to see an attempt to provide a QHC model that accompanies this view. In our view, a full-fledged processual approach needs to provide an additional level of analysis where *processes* are the highlighted building block. The processual analysis must not contradict the stakeholder-analytical one but rather complement it and enrich its ontology. We do so through a series of inter-related questions.

First, we must ask: What are the *processes* within a QHC?

We suggest that helixes can be conceptualised as processes of *value co-creation* in which participants—regardless of their title and identity—collaborate and compete for the production of different types of value (Echeverri and Skålén 2011; Galvagno and Dalli 2014). Because the concept of value co-creation is not dependent on any form of organisational or sectoral identity, it is the first step in the process-analytical approach. Value co-creation can be defined as 'the joint, collaborative, concurrent, peer-like process of producing new value, both materially and symbolically' (Galvagno and Dalli 2014: 644). This view on innovation is sometimes referred to as 'co-innovation' and postulates that innovation takes place on a 'platform where new ideas or approaches from various internal and external sources are applied differently to create new value or experience for all stakeholders' (Lee et al. 2012: 824). Notice also that value co-creation processes cut across traditional delineation of sectors and organisations. If we model QHCs not as a grouping of stakeholders but as value-creation processes, the four initial groups (academia, industry, state, and the public) are now being defined as value co-creation processes. Crucially, then, in this view, *it is the process that constitutes the basic unit of analysis*.

Second, we must ask: How do we identify something as valuable in a helix?

The reliance of process analysis on value identification has been showcased by past studies of QH and TH constellations (Cunningham et al. 2018; Hasche et al. 2019). There are various methods employed in these studies for identifying value and the caveat remains that value identification 'is based on perceptions' and thus ultimately 'is in the eyes of the beholder' (Hasche et al. 2019: 5). We prefer a more *emic* (Pike 1967) approach in which we subscribe fully to the observed behaviour of those under study. To this end, the values co-created in each helix have can be identified by observing the reward systems that are functional in each helix, that is, by identifying those actions that are accompanied in each helix by rewards or 'recognition' (Honneth 1996; Honneth and Farrell 1997). We thus take as a starting point 'the idea that human self-esteem and dignity are constituted inter-subjectively through participation in forms of social life' (Islam 2012: 38) and that this self-esteem and dignity is encapsulated in objects, acts, and relations (Sebrechts et al. 2019; Voswinkel 2012). Importantly, we do not wish to restrict the inquiries into each helix to those scholars that explicitly employ the (Hegelian) concept of recognition (Honneth 1996). There are important variations in this respect that can be taken into consideration. For example, considering the academic helix, much of the early Science and Technology Studies (or STS) belonging to the 'Mertonian' tradition has been concerned with characterising the *reward system* that controls academic behaviour and understanding its functioning (Gaston 1970; Merton 1973; Storer 1966). Although not employing the term 'recognition', these studies are clearly aligned in their empirical intent. Similar studies have looked into the reward system of businesses and other organisations (Grover 2014). For the purpose of getting a better grip on QHCs, such 'pit stops' into the sociology of each helix are essential. However, for the present purposes, a brief illustrative explanation of the values pertaining to each helix will suffice.

We thus arrive at our final question: What are the specific values co-created in each helix? Maintaining the *quadruple* helix structure of our model, we define the following four types of value: research value, business value, political value, ad socio-ethical value.

i. The research helix will refer to co-creation of *research value*. As a social system, academia is organised along the gifts offered by researchers to the community (Hackett et al. 2017). These gifts take the form of publications, patents, etc. and each create credit (authority) for the authors and those building upon it. Gradually, as more colleagues employ these gifts in their own work, the value proposition is co-created and thus actualised (Cole and Cole 1967; Crane 1976; Storer 1966). In short, the value output consists of:

→ publications, patents, academic books, obtained titles, citations, reputation, invitations to academic meetings

ii. The business helix will refer to the co-creation of *business value*. Business value is perhaps the easiest to define because it has a concrete, measurable correspondent in 'the worth in monetary terms of the technical, economic, service, and social benefits a customer receives in exchange for the price it pays for a market offering' (Anderson et al. 2006). Unlike academia, where scholars are not directly paid for their academic output, in industry, products are exchanged at a price. Thus, along these lines, the business value of a QHC output is typically its pecuniary worth on the market but it can also refer to non-pecuniary worth that translates into pecuniary worth only indirectly and in longer timespans, for example, learning, reputation gains, and symbolic rewards (Chesbrough et al. 2018: 932). The value output in industry is thus observable by investigating:

→ market share, revenue, employer knowledge, assets, brand recognition

iii. The policy helix is the co-creation of *political value*. The political dimension of an action pertains to its capacity of creating or maintaining the rights promoted within that system and thus to the continuation of the system in question (Dworkin 1977). What these rights are is a matter of context but for now we can take a general stance and say that, in a democratic system, the political value of a QHC output is its capacity of leading to the preservation of *democratic rights* (Brettschneider 2010). Following the work of Brettschneider, we can further say that the political value of a QHC output is measured against the ideal of 'dual commitments to rule by and for the people' (2010: 22). In other words, that output is not only the expression of people's will ('by the people') but it is also an output that serves their interest ('for the people').

→ efficient policy for democratic rights, support of that policy, political power

iv. The civil society helix pertains to the creation of *social value*. The social value of innovation has been the topic of many approaches such as corporate social responsibility, responsible research and innovation (Owen et al. 2013; Stilgoe et al. 2013), technology assessment (Rip and Te Kulve 2008), and value-sensitive design (Van Wynsberghe 2013). In general, we can follow Garst et al. (2019) and say that the social value of R&D refers to the capacity of an output to answer socially-recognized needs and thus be in line with the norms that are inter-subjectively accepted within a certain context. What constitutes social and ethical acceptability is of course subject to variation, but in principle it revolves around the idea that innovation (its input, throughput, and output) should be sensitive to the moral and practical needs of society and include these needs early on in the innovation process (Garst et al. 2019: 5–7). For example, it will be generally the case that products should be safe for both individuals and the environment, that they should diminish or abolish injustice, that they should contribute to welfare, foster participation, etc.

→ safety, justice, well-being, participation

Having defined each helix as the process of co-producing a specific type of value, we must now create a new visual that can supplement the stakeholder-analytical one. In Fig. 3, the four helixes are presented as strips that stand for value output; the value output is measured by the width of the strip—the wider the strip, the more of that value is being produced. Each strip is a value co-creation process and the totality of the four strips constitute the socio-techincal transition from one system state to the other. Of course, this transition is also a process, but in order to avoid ambiguity, we reserve the term 'process' for co-creation of each of the four specific values. The large-scale movement from T_0 to T_n is more commonly referred to as a transition (Geels 2002) rather than a more small-scale (co-creation) process. The model represents R&D as the movement from an initial distribution of value along the four helixes (marked 'T_0' in the figure) and, through processes of resource allocation and use, creates the final output of value at (marked 'T_n' in the figure). In Fig. 3, the value outputs are randomly assigned for illustration purposes.

Notice, first, that no stakeholder identities are included in the model because we assume (from the idea of co-creation) that all actors are in fact contributing to all values and that each actor can in some instances contribute to any value even when they do not have the associated titles and backgrounds. The values remain separate in the model because their production by various actors need not mean their melting into one 'super-value'. To give an example, if industry players contribute to the research output of a project, for example, they contribute to an academic paper by participating in a study or by renouncing intellectual copyright for the shared information, then the co-creation of that research output does not somehow melt into market value. It is still an academic publication worthy of academic recognition. Thus, because the criteria specified for each value are different, and despite their co-creation process, the four remain different, separate strips in our model.

With this model, we move towards a processual description of economic behaviour around these values. However, a processual approach does not *deny* the stakeholder-analytical approach nor does it deny the presence of cognitive and the psychological alongside the (trans)*actions* that have now taken central stage. We do not wish to say, a la Wittgenstein, that there is nothing beyond the act. Quite the contrary, it is with the common-sense language of mental states of mind that we intuitively look at innovation. We see individuals fulfilling certain societal roles and statuses engaging in cognitive phenomena such as wishing, aiming, thinking, expecting, etc. This remains the most natural entry point. What we argue is that once phenomena have been identified through this language, a translation

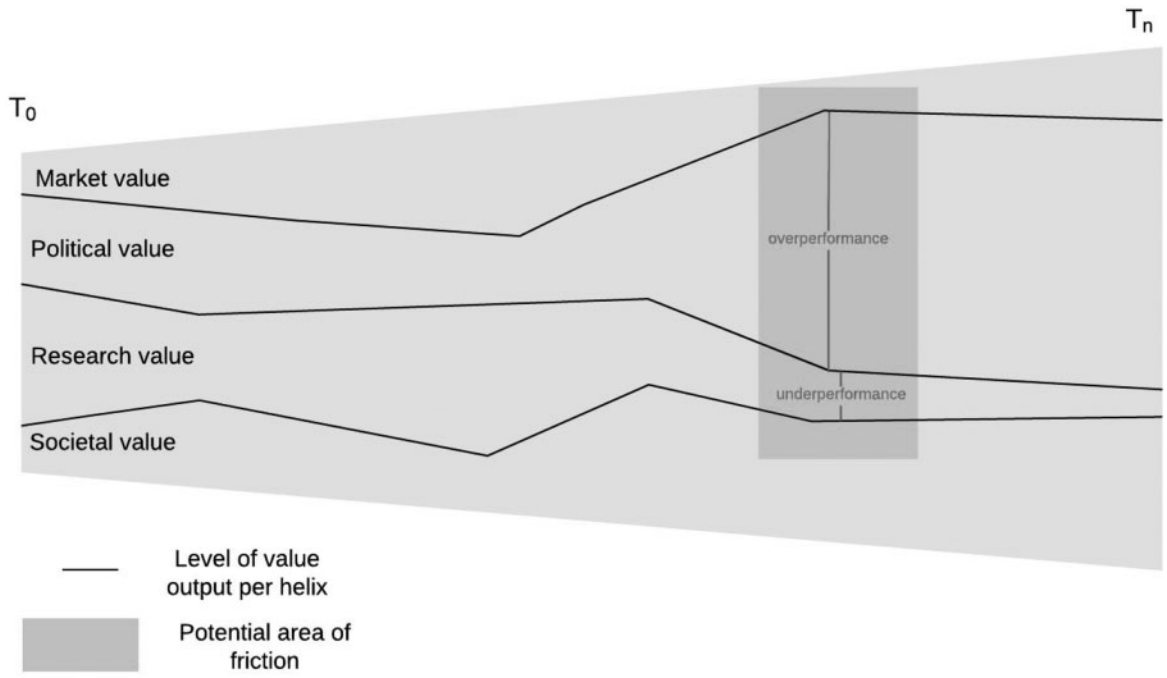

Figure 3. Friction as conflict between over-performance versus under-performance.

into processual terms creates a more stable basis for scientific investigation. This translation will be exemplified in our discussion of real-life cases of friction below.

2.3 Friction between processes

As shown in Section 2.1, the study of QHCs is moving from the macro-level of the original models towards the micro-level of interpersonal interactions (McAdam et al. 2018). In our view, an important part of this endeavour must consist of tackling a situation where the marriage between helixes does not function in an ideal way. While promising as innovation pathways, QHCs present specific challenges stemming from the difference in nature of the four types of values, challenges that would otherwise not occur in R&D trajectories involving just one organisation. (Andrews and Entwistle 2010; Clarke and Fuller 2010). Since these collaborations bring together organisations that have markedly different reward systems, it is not self-evident that every joint effort is a successful one—or a good idea, for that matter.

Problems in the marriage between helixes can occur in a variety of forms and with a variety of consequences. These sub-optimal forms of value-creation have been studied under the general label of *conflict* (Anicich et al. 2016; Blok 2019; Brand et al. 2020; De Dreu and Gelfand 2008; Garst et al. 2019; Medina et al. 2005; Mikkelsen and Clegg 2018; Rahim 2017). Here we would like to focus on a specific type of conflict, the situation where one value over-performs at the expense of another that is underperforming. We will refer to this type of conflict as *friction* following past literature on conflicts within QHC (Cunningham et al. 2018)

Friction has been characterised as a situation 'where the value added that is anticipated is not realised by one or all the parties' (Cunningham et al. 2018: 142). We will pursue this definition but add to it that the misfire on one helix leads to overachievement on at least one other helix. If all helixes are systematically underperforming, then we would not see this as friction but rather as a period of systemic stagnation on all accounts. Friction defined as overachievement on one helix combined with underachievement on other(s) is particularly interesting for QHCs because it brings to fore the essential independence of each helix as discussed in the previous section. For it is certainly not self-evident that growth in one helix automatically brings about growth in others. History provides scores of examples where extraordinary value on one helix is pursued at the expense of other helixes (Agency 2013; EEA 2001). The prototypical example in this regard is the creation of health hazards through oversized market value. Everything that we nowadays know to be a health hazard but we once hailed as innovation with extraordinary market value falls under that category (X-rays, tobacco, asbestos, PCBs, TBT, etc.). An analogous situation occurs when innovation is couched within the academic field and leads to publications and academic rewards but has little or no impact on other helixes (Wallis 1979).

Building on these considerations, we put forward the following definition:

> *Friction* is a relationship between two value-creation processes (i.e., helixes) in which one process over-performs at the expense of another that under-performs, these relative to the explicit or implicit predictions made about these helixes before the state occurred.

The model introduced above can also help provide a visual representation of friction. In Fig. 3, we represent friction as a 'red zone' created by a difference in value output between political and academic value. This can happen, for example, in periods of crisis where research is carried out to solve that immediate crisis and not so much to advance science through publications. The current research-driven search for a vaccine against the Covid-19 disease is one such case. In Fig. 3, friction only occurs between political value and research value and not between political value and market value, the latter also being shrunk. With this, we aim to show that *over-* and *under*-performance only occurs relative to predicted performance (according to the definition given above). For example, if market performance was low anyway, or predicted to decrease, then the over-performance of the helix at that point does not create friction. This can happen, for instance, in the case of theoretical or philosophical research that is not meant to have direct (or short-term) market impact. Overperformance on the research helix will not, in this case, dissapoint any expectations from other helixes.

3. Method: analysis of friction between processes

In order to identify cases of friction in QHCs, we interviewed fifteen practitioners who have participated in such collaborations in the past 5–8 years in The Netherlands. The interviews were identified either through websites in which participants in past projects are mentioned or through the network we and our colleagues have created in past projects. Interviews took place between September 2018 and May 2019 in The Netherlands. In preparation for the interview, we sent respondents a list of questions that we would ask about recent projects (past five to eight years). As a result, the respondents themselves chose the projects they discussed as examples of QHC. The projects they chose to discuss were set up in the area of sustainability (CO_2 reduction), digitalisation, smart cities, and education (see Fig. 4). The selected individuals were part of the coordinating team of the QHC project so that we can expect them to give us a bird's-eye view of friction and their effect on the collaboration.

Each interview was carried out individually, mostly on-site at the interviewer's organisation and in one case at their home. In four cases, the interviews were carried out over the phone. Each interview consisted of three parts of approximately 15 min each (45–60 min in total per interview). In the first part, we asked informative questions about the chosen QHC from the past: the partners involved, the funding, the goals, and the timeline. These questions were simultaneously intended for information acquisition and to bring our respondents back into the context of QHCs. Most of the information we asked for was already publicly available on the Internet, and yet we started with such a discussion every time in order to call back the details of the stakeholder interaction. Subsequently, in the second part, we asked questions regarding the interaction itself: first, we focused on the verbal aspects (questions about communication) and second, we focused on the non-verbal aspects (questions about the parties' emotions and attitudes). We assumed that looking back at the interaction (verbal and non-verbal) participants will either themselves take a normative stance or else recall aspects that can be evaluated later. In the third part, we gave respondents the opportunity to evaluate the progress of the project and identify barriers. We first asked the question as openly as possible: 'What were the barriers encountered in the collaboration between the stakeholders?' (Note that we did not specifically direct respondents towards a specific type of barrier, since the

	Gender	Self-identify	Topic
1	Male	Researcher	Digitalization
2	Female	Industry Manager	Sustainabiltiy (Process Industry)
3	Male	Industry Manager	Sustainabiltiy (Process Industry)
4	Male	Industry Manager	Digitalization
5	Male	NGO	Education
6	Female	Industry Association	Sustainability (Process industry)
7	Male	Researcher	Sustainability (Food)
8	Male	Industry manager	Sustainability (Process Industry)
9	Female	Industry Consultant	Sustainability (Energy efficiency)
10	Male	Industry Association	Sustainability (Process industry)
11	Female	Industry Association	Sustainability (Process industry)
12	Male	NGO	Sustainability (Energy efficiency)
13	Female	State employee	Smart cities (Transportation)
14	Female	State employee	Smart cities (Urban development)
15	Male	State employee	Education

Figure 4. Interviewees and the topic of their QHC.

Analytical Overview for a Case of Friction		
Aspect	Prototypical question	Illustration from the case of dominance
Definition	What is the essential opposition between expectation and reality?	Predict a reasonable or equal distribution of resources; in reality distribute unevenly to the advantage of one helix
Timing	When does the friction arise during the collaboration?	Primarily in the beginning phases of a project as these tensions are typically addressed and corrected once noticed
Signal	What acts or facts signal the existence or persistence of friction?	A helix is systematically under-performing while the other helix is systematically over-performing (in the perception of those dominated)
Scale	How serious is the friction? What are its consequences?	Depends on the resource misallocation and whether the issue is addressed.
Frame	How do partners frame it (talk about it) - what is the leading metaphor?	'alpha male', 'those who pay, have a say'
Solution	What is the solution envisioned by the participants and what barriers do they encounter in implementing that solution?	Discuss re-distribution or re-allocation of resources

Figure 5. Questions in an analytical overview of friction.

question can be understood to refer to both intra- and inter-helix barriers.).

Our discussions with the interviewees did *not* take place in process-analytical terms. There are two reasons for this, both of practical nature. First, we allowed our respondents to describe conflict in stakeholder-analytical terms (i.e. as actors having certain character traits, groups having certain 'salient features', interests, wishes, etc) because we expected the stakeholder-analytical language to be closer to the interviewees' everyday interpretive apparatus. Secondly, we allowed this language because we wanted to avoid priming our respondents towards highlighting certain aspects of their experience and minimising others. The risk of bringing in the processual language from the start by designing the interviews along those lines is that, as a result, interviewees exhibit *experimenter bias* (Cozby 2007) by following the implicit 'instructions' of the scientist at the table. This would have diminished our chances of

checking whether the model can be applied on freely-produced narratives. Thus, once the data were gathered, we undertook the processual turn ourselves by reconstructing the episodes of friction in process-analytical term.

Each interview was transcribed verbatim and coded by the person who carried out the interview. For coding, we used a list of pain points or 'hot issues' for QHC (and related cross-sectoral collaborations) as a starting point but our goal was to move beyond these barriers rather than simply 'verify' their presence in the selected QHC. This working list was compiled from anecdotal mentions of *conflict* (Ligtvoet et al. 2016), *constraints* (Bryson et al. 2006), and *friction* (Cunningham et al. 2018). The list was not shared with the interviewees in order not to influence them to come up with stories that match the presented categories. During the coding, we filtered out instances of sub-optimal collaboration that did not seem to us a good illustration of friction defined as over- versus underperformance. Otherwise important but for the present purposes irrelevant instances of sub-optimal collaboration were, for example, impact of economic recession, personality mismatch, cultural differences, miscommunication and misunderstanding, impact of missed deadlines. Subsequently, of the cases of friction we discovered, we checked within the team and, using the first version of this article, with the interviewees themselves, whether the interpretations could be inter-subjectively validated. For the examples we now discuss, the interpretations matched. In the initial version there were two other examples for which not enough consensus could be reached. Those examples are not included in the results so as to not distract from the theoretical point we are making.

Given this set-up but also given the relative novelty of the topic and approach, a cross-sectional study of the participants' narratives about the value-creation process turned out to be the most practical option. It is a vastly interesting question whether the processual view aids reflection and interaction in ongoing cases of QHC; yet we felt that this relatively novel view first needs clarification and fine-tuning before undertaking a longitudinal analysis.

In what follows, we select three examples of friction that we discovered through our interviews. We selected these cases because they have greater illustrative power than other mentioned ones and they are all sufficiently different from each other to represent a broad spectrum of friction. Some words and phrases needed to be replaced in order to conceal the identity of the respondents and the projects in question.

4. Three cases of friction analysed

4.1 Dominance

Friction sometimes arises through *dominance*. Dominance is typically initiated by the stakeholder who is (seen as) the most knowledgeable, experienced, or as having a better network. In many cases, the process is skewed towards the values defended by the stakeholder in question. When respondents described this, they related their description to the character traits of one or more stakeholders who were then described as dominant or submissive.

In two identified cases, the dominance stemmed from financial contributions. Two of our respondents independently used the following expression to describe how things sometimes work: 'Those who pay have a say', that is, the more you bring in the more you have to say. But the dominance also came from normative or political power. For example, in the excerpt below, the respondent describes a situation where the government created a product that was meant to serve the industry's needs and those of the public but encountered much resistance. Initially, government representatives were surprised since the industry players were the ones who were supposed to be served by the product in question. The following exchange occurred in relation to a series of workshops during the product-creation phase:

> Interviewer: And were people from the business sector invited?
> Respondent: No. And that was immediately a learning point for us. The businesses, although not necessarily well organized as a sector, held on to their identity. The businesses have always experienced this as a centrally set-up initiative. So even though the sector is not capable of standing up and articulate their question, to then substantiate that, they still experienced that as something that was imposed. They started saying that they don't want this, that they don't need that.

In one particular case, the respondent acknowledged their *own* dominance and spoke of a 'learning experience'. For example:

> Respondent: We noticed that if you want to make [product] you need all parties. We made the mistake of looking *too late* at society and industry. We at least had the local government. In any case, we learn is that you're allowed to have an opinion, to have a vision and to push, but you have to speak to your stakeholders earlier [...] a serious stakeholder analysis. Support is something you create *in the beginning*. (emphasis in original)

If we analyse these situations from a process-analytical perspective, we have to ask the questions formulated in Section 2 and seek to answer those questions without reference to individual identities and mental states.

As a closing remark, it is important to note that instances of *attempted* dominance were also mentioned. In other words, before the process gets skewed towards one direction or another, some managers noticed the tendency to overpower and acted against it. In one case, the dominating parties were, more or less directly, thrown out of the QHC by the project manager. In order to preserve the untraceability of the situation, we will conceal which helixes were involved in this situation. Here is nevertheless the project manager's experience with the situation

> Interviewer: How was the relationship with the [helix 1]
> Respondent: In the first year, after what might be called a preparatory year, we realized that the [helix 1 representatives] were interfering too much. So I thought – hey what are *you* doing here? You don't bring anything except for annoyance and you don't have the entrepreneur's mentality that we need in order to realize this project. So I said: 'Out!'
> Interviewer: So that's how the [new project] came about.
> Respondent: Yes. That's when I said let's bring in more [helix 2 representatives] or more [helix 3 representatives] and [helix 1] out. Sounds a bit denigrating, I don't mean it like that.

Relevant for this form of friction is the assumption that sectors should benefit equally from a certain innovation process. At the very least, it is expected that the helix predicted to benefit more than others does not benefit too much at the expense of the other helixes. In one of the cases, where the friction arose from research activities dominating business activities, the project manager felt that the nature of the QHC was skewed too much towards 'fundamental research'. In another case, the relationships were skewed towards policy, so that the QHC project became too much a bureaucratic matter of budgeting and spending, which resulted in a diminishing of the freedom and trust you need for research and innovating.

4.2 Opacity

This next friction occurs when the allocated resources are not used in a transparent way. Unlike the previous example, this is not an issue with the resource allocation as stakeholders might be in full agreement on that point. Rather, the friction pertains to the manner in which the resources are used—more specifically, to the fact that little or no resources are used to communicate about the value-production process. This form of friction is in a sense the opposite of the previous one: if dominance is achieved by being overly present during the decision-making process, lack of transparency is achieved by being overly absent.

We can illustrate this with the following example. In the excerpt below, the respondent is describing a friction that ensued when the innovation process created an output slightly more valuable from a market perspective (a solution with immediate applicability in the market) than from a scientific perspective (a more general method that might in the future be applied universally).

> Respondent: [the stakeholder] failed to inform others [of his decisions] resulting in the fact that other team members say 'OK but I do not want this solution you are proposing'. Then you have a major problem...
> Interviewer: ... a communication problem.
> Respondent: Communication is an aspect of it. There's something behind that: the fact that you share a common philosophy of being a team and doing things together. If someone says: ok this is going to be my problem, then you've lost contact with the team.
> Interviewer: What are the signals of such behaviour?
> Respondent: Often that you don't hear from them in a long time.

Because of its general applicability, the friction can ensue between any value-creation processes that have different conventions for reporting. In the example above, the friction ensued between the production of market and scientific value, where the stakeholder focused too much on market value, producing a solution that was *too specifically attuned to an organisation* as opposed to seeking a more general solution of scientific value. But we have observed the stakeholder also in the opposite direction. Sometimes the stakeholder produces results that are too general (too 'scientific', so to speak) and not specific enough to apply it to market. This is the case in the following example, where the respondent shared the frustration ensuing from the friction:

> Respondent: I'm not going to say a lot about it because I just *hate* how things went... [The other organisation] thought, 'OK, we have money, we're going to do some nice things'. It was a European project so they thought 'Oh, I have European money so I'm going to simply do what I want'. That's my experience also in other projects.
> [...]
> Interviewer: What do you think their agenda was?
> Respondent: Well, they have the money! They go ahead and [follow their objectives]. I'm exaggerating a bit but that's what it boils down to. And when they have money they say 'so we did this, so we decided to do that'... No, YOU decided to do that. You never aligned with. That is a huge annoyance.

We can see that even though the friction is theoretically speaking more mild (since the stakeholders might, in their absence, produce results of the expected value distribution), it can still produce significant irritation for the stakeholders who are thereby excluded from the decision-making process. Emotionally, the stakeholder might feel as a passive form of dominance—through absence—and thus feel as a contradiction and even contrariety. In the example above, the respondent does not say that the solution brought by the stakeholder is completely wrong: it is the (decision-making) process that was perceived as inappropriate.

4.3 Disparity

It appeared to be a commonplace that the four value-creation processes have completely different speeds; all respondents have acknowledged this difference one way or the other and have seemed to accept it as a given. One respondent, when asked how often these differences become apparent in the life of a QH process, paused for a second and replied: 'Almost daily'. However, because in R&D, speed typically means competitive advantage, the hare (the organisation that works at a fast pace) is more often critical of the tortoise (the organisation that works at a slow pace). On the other hand, the tortoise is in a better position to identify risks and get a better grip on what is happening and thus promotes its lower speed as a source of stability and prudence. The advantages and disadvantages of each approach cancel each other out and create a stalemate.

In the following example, the respondent describes the difference in dynamics between value-creation processes in industry and a governmental institution.

> Respondent: There is a huge difference in speed between [industry] and [government]. The way of working, decisions, who-does-what... [...] Industry is oriented towards the exterior because they are dependent on the wishes of their customers – so that's what they want to develop. While [name government institution] is very much oriented towards the interior. So, after they're trained they work as [civil servant] and stop looking outside. They do their job and that's it. And because of this the dynamics is different. That's what I meant by speed [...] That leads to disagreements. A [civil servant] can very well postpone a task for wo weeks whereas in the industry they think: 'OK, but I need to know now, am I assigning people to this or not?'

In another case, the hare acknowledged dismissed the tortoise's prudence as being overly cautious. In fact, the hare went as far as considering doing that specific project without the tortoise. In the following exchange, the respondent showed visible irritation regarding the recounted situation:

> Interviewer: Do you remember what the problem was there?
> Respondent: They [the tortoise] were very much into accountability. That [we] need to follow all kinds of statutes, and 'By the way, where do we stand with the risks? Let's imagine we're going to lose a lot of invested money, who's responsible... that sort of business.'

The respondent explained that the situation was experienced as being 'held back' by the sluggish tortoise and that at one point was thinking 'well if this is how it's going to be we might as well drop it'.

The barrier has also been encountered in the relationship between (local) governmental organisations and academia. In one of the investigated projects, led by a knowledge institute, the research partners wanted to investigate an issue thoroughly and get to the bottom of the problem whereas the local government decided to go much faster (and thus riskier) towards an output even if this output was not necessarily scientifically researched. In the same problem, the knowledge institute was following the European regulations regarding privacy to the letter whereas the governmental organisations were looking for ways to avoid this:

> Respondent: I thought, oh my, I'm sure this can be done faster. All these protocols and bureaucracy. As a practitioner, I find that a difficult issue – all those European processes and protocols, accounting mechaisms... That's quite something. I'm more for the approach: you start a collaboration, you get a certain amount of money, I think that you don't need to follow every point and comma, but you have to be pragmatic about it.

5. Discussion

5.1 The process-analytical perspective

The study of QHCs from a processual perspective is a way of understanding innovation without relying on stakeholder identities, labels, and titles. While assigning identities might be useful for some purposes, the path we have opened with our process-analytical perspective appears to be better suited for operationalisation and 'micro-level' investigation (Cunningham et al. 2018; McAdam et al. 2018). Even though interviewees (and theorists) see the reality of inter-organisational collaborations through stakeholder-analytical lenses, the switch to processual lenses is possible and, from a methodological standpoint, desirable. It is essential to highlight that friction as defined in this article is only one type of sub-optimal situation that can occur. We do not suggest a reduction of sub-optimal collaboration to the concept of friction as defined here. Using the distinction between intra-value and inter-value conflicts (Blok and Lemmens 2015; Dignum et al. 2016), we can say that friction as defined above is merely a form of inter-value conflict where two or more processes compete for optimal performance. Whether the processual approach applies to other forms of sub-optimal collaboration remains to be investigated. For now we wish to warn against reducing sub-optimality to friction as defined above.

In the transition from stakeholders to process, we notice a parallel transition from the cognitive to the behavioural, meaning that reconstructing narratives in processual terms comes with a switch from the cognitive vocabulary of *thoughts, wishes, interests* to the behavioural vocabulary of *actions, resources, input–output, etc.* While we have not explored this here, we suggest tentatively that this vocabulary can be employed when trying to come out of a sub-optimal situation; when the sub-optimal situation presents itself in processual terms, solutions might be sought in those terms. If dominance is a problem, then from a stakeholder-analytical perspective it is the individual who is dominant and thus the individual who must change; if transparency is a problem, then from the same perspective it is the individual who is opaque and thus the individual who must change. From a process perspective, friction—and other types of conflict—could be solved by adjusting processes and behaviour, not identities and organisations.

The advantages of a processual approach have been noted already in recent studies (García-Terán and Skoglund 2019) and it is certainly not the case that the processual approach has been discovered by the QHC community. Similar pleas have been made in the studies of entrepreneurship—another term, just as innovation, that faces a person/process ambiguity—and have led to the conclusion that processual theories are 'not in a dominant position in current research, even if they are often called vital' and an adoption of processual theories might depend on our ability to 'embrace different ontologies, epistemologies, and practices of researching and knowing' (Steyaert 2007: 472). We salute these endeavors and we would like to subscribe to these authors' viewpoints. However, it does not seem essential in this initial phase to already make a commitment towards a *specific* processual approach. Of the thirteen processual approaches mentioned by Steyaert (2007), it would seem that our topic, our focus, and our 'reconstructive' analyses bring us closest to Latour's actor–network theory (ANT), yet we see more resemblance to the early social constructivists studies of science (Latour and Woolgar 2013) than ANT studies as such (Latour 2005). In any case, we would like to desist from declaring any strong allegiance to any approach because, at this point, the topic (QHC) and the task (understanding processes) are to us more important than the particulars of the research design.

5.2. Further analysis of friction

For practical purposes such as policy design or project management, it might be necessary to do justice to the complexity of the phenomenon of friction. What we noticed to know in order to understand friction is not only the two or more processes that are characterised by a tension between over-performance and under-performance, but also a series of other determinants. To this end, we propose the following five determinants (or 'dimensions') of friction that can be applied to real-life cases: definition, timing, signal, scale, framing, and solution. Each dimension can be further specified by a prototypical question that can be asked about each newly discovered case of friction. The questions are organised as in Fig. 4 and they make up what we call an *analytical overview* of a case of friction. Notice that, in line with the processual approach, these questions do not require the analyst to make any appeal to organisational identities or psychological states of mind. Based on the table introduced in the previous section, a process-analytical characterisation of friction thus follows these steps (not necessarily in the given order): We *define* the friction by noting the contrast between predictions (or plans) and reality (or execution); we identify *timing* by noting the phase in which the friction occurred; we try to understand what triggered the parties' observation of friction by isolating concrete *signals*; we approximate the seriousness or *scale* of the friction by looking at the consequences; we identify the mainframes or metaphors that participants employ to describe the friction; and we reproduce what is perceived as being a *solution*.

If we relate this approach to the study of sub-optimal interactions in the past, we notice that past literature is still very much tinted by the stakeholder-analytical approach, often combined with a macro-level perspective. This is surely the case system-of-innovation approaches (Freeman 1995; Woolthuis et al. 2005) and the multi-level perspective (Geels 2011). In these approaches, sub-optimal R&D is still identified 'from above' and primarily based on the sector of origin; in these approaches, we see innovation encountering scientific barriers, policy barriers, cultural barriers, industry barriers, etc. (see e.g. Cagno et al. 2013).

6. Conclusion

In the present article, we have proposed a processual model of QHCs and we have illustrated the use of this model in the study of a specific type of conflict, namely *friction*. We submitted our approach as a supplement to the process-analytical approach, one that helps us avoid questions of names and affiliations and focuses on the value co-creation. We have identified these as: research value, business value, political value, and societal value. The value co-creation processes in QHC are supposed to intertwine smoothly but in reality they often undergo friction because of limited resources which can

lead to over-performance on one value process and under-performance on others.

As a strategy for further research, we suggest investigating other types of sub-optimal collaboration also from a processual perspective. Friction is a rather simple form of conflict between value-production processes—which made it a good starting point—but more fundamental conflicts can also be studied from the same perspective. For example, fundamental differences in world view as might occur between industry players and NGOs have traditionally been investigated in stakeholder-analytical terms. However, we can see these fundamental differences in world view not as stakeholder features or character traits but as different predictions regarding the right-most values in a certain context. This would not be a case of friction because it is far more fundamental than operational phenomena of over-performance and under-performance. And yet, it makes sense in our view to see them from a processual perspective because this approach will throw a new light on their constitution. In a processual view, the industry giant and the NGO are fundamentally different not because of their states of mind (although that might be the case for all we know) but because their activities do not create space for the other—or, to put it in terms of resources, because they spend most of their resources strengthening their position in their antagonism with the other rather than weakening their position by integrating the other.

These lines of research can open the way for a positive appreciation of conflict, not as a clash between individuals that need to be solved, managed, or contained (De Dreu and Weingart 2003; Medina et al. 2005), but rather as an in-built improvement process. From a process perspective, friction (and conflict more generally) can be sought because of their epistemic content: we learn from conflicts most when we do not do away with them but rather become responsive to the others without trying to reduce them to our views or the other way around. This focus on process and performance 'provides a strategy to no longer be involved in the ideal of harmony and alignment among multiple stakeholders, but instead to acknowledge fundamental differences among multiple stakeholders in corporate actors' ethical responsiveness to their demands and needs' (Blok 2019: 250). We have not explored this path in the present article, but we see that there are commonalities between our processual approach and the call for a 'shift from the actors' intentions to the actors' performance' (Blok 2019: 251) in the study of interpersonal conflict.

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