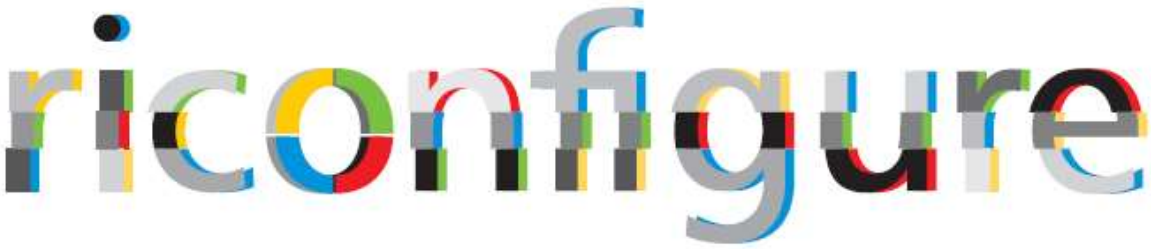

RiConfigure

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Abstract

The analytical framework consolidates research and key insights from previous projects relevant for researching quadruple helix-collaborations, the role of governance frameworks in shaping such collaborations as well as the potential for addressing issues of responsible research and innovation (RRI) in these collaborations. The analytical framework provides a comprehensive research concept for investigating quadruple helix-collaborations and thus stimulates the planning of the social lab leaders, enables hypothesis formation for a comparative analysis as well as provides a useful vocabulary for the project consortium itself as well as for networking, communication and training. Integrating relevant literature and existing research, and based on the comprehensive research concept, the analytical framework develops an appropriate and coherent set of variables to enable the research process in the social labs. Finally, it operationalizes the variables and provides research templates that apply both the research concept and variables to the steps of the RiConfigure-project.

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1 Introduction

The **aim of the RiConfigure project** is to enable the diversification of collaborative constellations in research and innovation (R&I) by engaging stakeholders and enhancing conceptual clarity on new constellations, institutions and actors. Building on the quadruple helix (QH) approach to R&I, RiConfigure will use the QH concept as a general framework within which to understand and discuss new constellations of institutions and actors in R&I. QH-collaboration is defined as "an innovation cooperation model or innovation environment in which users, firms, universities and public authorities cooperate in order to produce innovations. These innovations can be anything that is considered useful for the cooperating partners; they can be, for example, technological, social, product, services, commercial and non-commercial innovations" (Arnkil *et al.* 2010). The project adopts this definition with the modification that 'users' is replaced by 'civil society'.

In order to describe best practices, the RiConfigure project needs to provide an ideal model of QH-collaboration practices characterizing key success factors as well as challenges for effective QH-collaboration. The **aim of the analytical framework** is thus to provide assumptions about successful QH-collaboration practices that can be tested, examined and verified in the course of the project. To this end, this document presents four basic assumptions about ideal QH-collaboration practices and forms hypotheses for each of the four assumptions. Both the assumptions as well as the corresponding hypotheses are derived from an extensive literature study in the relevant research fields.

As a result of the literature review this document is based on, we first identified a crucial gap in the field of QH-research. The **research gap** lies in the lack of operationalizations for empirical analyses of concrete QH-collaboration practices. Most literature and research on QH-innovation addresses the macro level of innovation systems querying how systemic changes include e.g. new roles or how new actors emerge. What has been neglected so far, however, is the micro-level of QH-collaborations, i.e. how such collaborations emerge, how the actors actually interact and how value is ultimately created. To explore this site of QH-collaboration for the first time, we therefore consulted the closest research literature, which has already undertaken extensive empirical studies and developed corresponding frameworks, namely research on cross-sector collaboration and partnerships. This document is hence based on a **literature review** of both QH-innovation and cross-sector collaboration and partnerships.

2 Developing an analytical framework for analyzing QH-collaborations

2.1 Background: Identifying a research gap

Collaborative forms of innovation, which connect institutions and actors in new constellations, are generally understood to enhance the capacity for effectively addressing the complex and 'wicked' public problems, which make up the grand challenges of our time. By "linking and sharing of information, resources, activities, and capabilities", it is expected that such collaborations may "achieve jointly an outcome that could not be achieved by organizations in one sector alone" (Bryson *et al.* 2006, p. 44). However, a number of factors contribute to 'collaboration failure', including actors' different problem understandings, framings, values, and motivations.

The quadruple helix (QH) model (Carayannis and Campbell 2009; Etzkowitz and Leydesdorff 2000b) focusses on the interaction of four major subsystems in knowledge-driven innovation systems, namely academic research, business, government, and society (see elaboration below). This model acknowledges on the one hand that successful research and innovation depend not only on intra-organisational activities, but also on collaboration among businesses, research establishments, government actors and the public. On the other hand, this model particular stresses the value of increased integration between R&I and society. Innovation processes that adopt a QH-model are then, processes inclusive of "all stakeholders as active players in jointly creating and experimenting in the new ways of doing things and creating new services and products" (European Commission 2015).

Crucially, though, we identified a gap in the current state of research on quadruple helix-collaboration relevant to the RiConfigure project. In part because of the historical origins of the concept (*see below*), current literature on quadruple helix innovation addresses the level of innovation systems and the interaction of different actors on a systemic level. While this provides valuable insights on systemic dynamics and structural changes for innovation systems, such a perspective does not allow findings on the micro-level of actual quadruple helix-collaboration practices. Thus, current quadruple helix literature does not provide an analytical framework or concept based on which collaboration practices between QH-actors can be explored. As RiConfigure seeks to study actual QH-collaboration practices, a framework is needed that enables to investigate concrete interactions between QH-actors. To this end, we consulted the closest and most relevant strand of research, cross-sector collaboration and partnerships, that is able to provide suitable assumptions for empirical analysis of quadruple helix-collaboration practices. Cross-sectoral collaboration engages particularly with questions of how organizations in two or more sectors achieve jointly an outcome that could not be achieved by organizations in one sector separately. Thereby, this literature analyses "the linking or sharing of information, resources, activities, and capabilities by organizations in two or more sectors" (Bryson *et al.* 2006). A second rationale for taking into account both strands of literature is that cross-sector collaboration focuses on collaboration

whereas current QH-literature focuses on innovation. In the cross-sectoral collaboration literature authors are thus interested in how such collaborative partnerships form by differentiating three phases or stages of a collaborative partnership, namely *formation*, *implementation*, *outcomes* (e.g. Bryson *et al.* 2006; Selsky and Parker 2005; Seitanidi and Crane 2009). In QH-literature, by contrast, focus is rather on the roles that different sectors play in the innovation process. In QH-innovation processes, government actors for example could occupy the role(s) of "enabler", "decision maker", "supporter", "utiliser", "developer", "marketer" and/or "quality controller" to make an innovation successful (cf. Arnkil *et al.* 2010). Recently, scholars identified also stages of QH-collaborations, differentiating the degree of stability and integration of society (Kriz *et al.* 2018).

In the RiConfigure analytical framework we combine both strands of literature, QH-innovation and cross-sector collaboration, and build assumptions based on the cross-sector collaboration literature. In the following section, we present four assumptions derived from cross-sector collaboration studies that allow us to perform an empirical analysis of the quadruple helix-model as actual collaboration practices for innovation. The four assumptions refer to key elements of collaboration practices that we assume to contribute to successful QH-collaboration.

2.2 Four assumptions about QH-collaboration practices

In this section we present four basic assumptions about key elements for successful QH-collaboration practices as derived from the literature review of empirical research on cross-sector collaboration. In order to identify best practices and specify both success factors as well as challenges we will examine QH-collaboration practices on these four assumptions. For analysing these assumptions we form hypotheses for each of the four assumptions.

Assumption 1 | Building Structure

For QH-collaborations to be successful, processes of building a structure are key.

Hypothesis 1

In order to effectively build a structure for QH-collaboration, formal procedures for partner selection, reporting, and communication have to be developed.

Hypothesis 2

In order to effectively build a structure for QH-collaboration, a common goal has to be identified and agreed upon.

Assumption 2 | Fostering Interaction

For QH-collaborations to be successful, measures/processes to foster the interaction are key.

Hypothesis 1

In order to effectively foster the interaction in QH-collaboration practices, a clear definition and shared understanding of roles is needed.

Hypothesis 2

In order to effectively foster the interaction in QH-collaboration practices, different collaboration methods from e.g. Design Thínking to project and conflict management should be employed.

Assumption 3 | Creating Value

For QH-collaborations to be successful, they need to create different kinds of value.

Hypothesis 1

Successful QH-collaborations produce direct outcomes, such as new products, services or new standards.

Hypothesis 2

Successful QH-collaborations create value through the impact of their direct outcomes.

Hypothesis 3

Successful QH-collaborations create value through the broader effects of the collaboration.

Assumption 4 | Learning

In successful QH-collaborations, actors of the collaboration need to perform activities aiming at trust-building and learning.

Hypothesis 1

Successful QH-collaborations create learning effects regarding method expertise, team aptitude as well as an increased understanding of different perspectives.

Hypothesis 2

Successful QH-collaborations help building trust between the actors involved and establish legitimacy for the values created by the collaboration.

3 Background

3.1 Connecting Quadruple Helix-Innovation, RRI, and Public Governance Frameworks

In order to understand QH collaboration practices, we conceive QH-collaboration as a new social order analyzing how they form, establish and maintain over a longer period of time. This conception is based on a theoretical understanding, which considers the constitution of social order as a dualistic process between structure and practice. Structure and interaction among agents are mutually interdependent (Giddens 1984). Structure enables and defines patterns of interaction and interaction reproduces and modifies structure. Elements of structure are (formal and informal) rules and (material and human) resources. Elements of interaction are knowledge, skills and power. Structure and interaction are constitutive for social order to emerge, to establish, as well as to sustain.

Looking abstractly at structure and interaction, however, would not be sufficient for our research interest. As our research objective combines a double interest in on the one hand the question how new collaborations form and modify and on the other how such collaborations innovate and produce value, we need to specify these dimensions further. We do this by two means. First, we distinguish between structure and practices internal and external to the collaboration. As an external structure, we understand the governance framework, which shapes the quadruple helix collaboration. Governance frameworks are broadly understood as comprising all cultural, economic and policy conditions that are relevant for establishing, running, and working in the quadruple collaboration. It remains an empirical question, which factors are relevant for collaborations and how they shape their interaction, structure and outcome. Second, we adapt the elements of both dimensions into dimensions of the internal processes "building structure", which comprises formal and informal rules, and "creating value", comprising material and human resources. For activities related to acquiring and using knowledge, we suggest the dimension "learning" and for remaining collaboration activities, we use the term "fostering interaction". In the RiConfigure analytical framework, this distinction between internal and external structure translates into two layers of analysis, namely "collaboration practice" and "public governance frameworks", each with a separate set of factors and sub-factors.

In between these two layers of analysis, we add an additional layer for "responsible research and innovation" (RRI) in QH-collaborations. While the two layers of collaboration and public governance frameworks focus on researching the structures and interactions of the collaboration processes, the RRI layer of analysis can be seen as adding a specific normative perspective on such collaborations. This means that beyond investigating new quadruple helix-constellations in research and innovation by itself, we also query whether and how such collaborations can help making innovation processes more responsible and better attuned to the values of society.

As "responsibility" we understand what is broadly agreed to be the focus of RRI (e.g. the European Council's Rome Declaration on Responsible Research and Innovation, 2014) namely, first, that outcomes (products, services, intangible outcomes, etc.) and processes of innovation should be more responsive towards society, its needs and values, and secondly, that the responsibility for the outcomes and the impact of innovations as well as for the processes leading to them should be shared between all affected stakeholders in a fair manner. To investigate whether and how this normative quality of responsible innovation can be promoted in quadruple helix constellations, we employ five of the six keys of RRI as developed by the European Commission and operationalized by the MoRRI-project. The five RRI-keys that should be addressed by research and innovation to some extent in order to count as responsible are *public engagement*, *science literacy and education*, *gender equality*, *ethics*, and *open access*. Their definitions and how they are operationalized can be found in greater detail below. Note that at this level we leave the "governance" key from the MoRRI framework out, because – as mentioned earlier - governance is addressed as an overarching issue on its own level of analysis.

In order to eventually evaluate whether and how responsible innovation may have been achieved in and through quadruple helix-collaborations, we may also draw on further conceptualizations and approaches to RRI (e.g. Owen *et al.* 2013; Stilgoe *et al.* 2013; Blok 2018). Developing an analytical strategy for this broader question falls within the remit of the comparative analysis in WP6.

In summart, while the first two layers of collaboration and governance focus on research how new constellations in research and innovation form, establish and sustain, the layer of RRI adds a particular normative perspective and thus focuses on a specific quality of the collaboration which aims at the relation of innovation and societal expectations, needs and values.

3.2 What is QH-collaboration?

The QH-concept as prominently developed by Elias G. Carayannis and his colleagues (Carayannis and Campbell 2009; Carayannis and Grigoroudis 2016) emphasizes the interaction of four sectors for innovation, namely academic research, business, government and civil society. This concept is rooted in and expands on the system-oriented *triple helix* innovation (Etzkowitz and Leydesdorff 2000b; Leydesdorff and Etzkowitz 2001). In the triple helix concept, the central element of innovation processes is the interaction of government, business and the academic sector and the concomitant learning that takes place in this interaction. The concept recognizes that interaction, complex interdependencies and integration of diverse perspectives and actors are crucial for the success of an innovation system (Carayannis and Campbell 2009; Etzkowitz and Leydesdorff 2000a). Whereas earlier theories had conceptualized innovation as a linear, often intra-firm process or as processes contained in national innovation systems, both the triple helix as well as the quadruple helix approaches focus on the production and diffusion of knowledge for innovation in a an open, knowledge-based society. They

acknowledge that knowledge is increasingly produced by heterogeneous groups of actors in a variety of contexts, through so-called mode-2 knowledge production (Gibbons *et al.* 1994).

The QH-concept developed by Campbell and Carayannis takes this expansion of our understanding of knowledge production even further. They claim that in an emerging "mode-3", a central feature of knowledge production is the ability to combine various bodies of knowledge and perspectives with a particular focus on innovation in a manner that integrates the existing expertise and knowledge production dynamics of all actors involved. Three processes are crucial in this respect, namely "co-evolution", or joint development and mutual adaptation, "co-specialisation", i.e. joint and coordinated specialisation, and "co-opetition", which is a productive duality of competition and cooperation (Campbell and Carayannis 2006; Carayannis and Campbell 2009; Carayannis and Campbell 2012).

Underlying all of these concepts is an understanding of innovation that goes beyond a purely technological understanding. Innovation, as these models understand it, comprises both technological and social innovations. Thus, traditional channels of interaction between business, government and the academic sector do not sufficiently reflect all necessary interactions for innovation. Therefore, the role of users for developing and diffusing innovation becomes a central point of interest in the QH literature. Originally described as "users" (Arnkil *et al.* 2010), conceptualizations of what comprises and define the fourth helix vary. These conceptualization ranges from users (Arnkil *et al.* 2010) to civil society (Carlos Moedas 22 June 2015; Cavallini *et al.* 2016) to media-based culture (Carayannis and Campbell 2012) and values, culture and general backdrop to innovation processes (Nordberg 2015). Accompanying these different understandings are two different conceptualizations of how the fourth helix relates to the other three. In a first conceptualization, the fourth helix encompasses the other three helixes as general backdrop. It describes the norms, values and culture that enables the other three innovation stakeholders to innovate successfully (Nordberg 2015). In a second conceptualization, the fourth helix describes an independent fourth group of stakeholders in the innovation process that interacts "with university, industry and government as customers, citizens or members of a community in order to contribute to build new innovation paths" (Cavallini *et al.* 2016).

In the RiConfigure project, our concept of the fourth helix and our understanding of QH links to the latter concept, as we understand QH cooperation as cooperation among civil society, firms, universities and public authorities in order to produce innovations.

4 Illustrating our basic ideas

To illustrate our basic ideas about quadruple helix collaborations and the variables that we believe are important for understanding how QH-collaborations work and identifying best practices and success factors, the following five illustrations present our research approach. In this way, we avoid making one over-complicated illustration and provide a step-wise pedagogical presentation of the framework. It helps us to highlight how the variables are part of the different layers of analysis. The question of whether and how they fit together, however, remains part of the integrative analysis in task 6.4.

The five illustrations are meant to illustrate our answers to the questions:

1. How does a single case of quadruple helix collaboration relate to the broader context of a particular sector or industry?
2. On which levels (from the collaboration to the governance level) do we analyze quadruple helix collaborations?
3. What are the internal factors that determine the success or failure of quadruple helix collaborations?
4. How does a quadruple helix collaboration assume responsibility vis-à-vis society, how can it be shared between the partners of the collaboration?
5. How can public governance actors shape quadruple helix collaborations? Which roles of public governance actors can be distinguished?

An explanation for how to read each of the five illustrations is listed below.

Illustration 1: Where does a single case of quadruple helix collaboration fit into a given sector?

Fig.1: The sector model as big picture

This is 'the big picture'. In Figure 1 we show that a single case of quadruple helix collaboration can serve as an 'alignment engine' for the actors in the different helixes and their patterns of interaction. Take for instance the energy sector. Here we have more or less functioning and productive patterns of interaction between science, research and technology development, the energy industry, regulation and policy-making, as well as civil society through advocacy organizations and eco-communities. A single case of quadruple helix collaboration can help specific actors – those who participate in the collaboration – to become better aligned and to begin working together on common solutions. But it can also have the broader effect of contributing to better alignment between other actors through a kind of resonance or ripple effect. We understand alignment to be a better general agreement on the cooperation, on common challenges and objectives between the partners. By developing constructive patterns of alignment between the partners of the collaboration, the quadruple helix case can show what a constructive pattern of collaboration looks like and thereby help to shape the overall patterns of interaction in the sector as a whole. The particular relevance of this kind of alignment within quadruple helix collaborations lies in the quality and scope of the (societal) challenge that they address. This means that to be able to respond to the grand societal challenges of our time which each quadruple helix collaboration is contributing to, a new kind of stakeholder engagement and collaboration is required. Based on the quadruple helix model, we investigate how such a collaboration of different stakeholders that develops new strategies, approaches, products, services etc. addressing grand societal challenges can be realized. By alignment we thus mean the capacity of the collaboration to engage different stakeholders of the quadruple helix to address the relevant grand challenges. This 'big picture' on the impact of QH-collaborations and the relation of case and sector level thus provides a background narrative for our project and is making some crucial assumptions visible.

There are some choices involved here, which are important to explicate. The proposal text was not very clear on our assumptions about the sector-case relationship. It would also be fair to say that the quadruple helix literature itself is also not very clear on this. So, this is a bit of an invention on our part, although hopefully not one that would be controversial or, in fact, very new.

One choice that we are making here is to rely on a 'soft' kind of impact of the quadruple helix case and the overall interactions in a sector. When organizations get together in a collaboration and then move on to other things, their experiences can affect the rest of the sector in a number of ways. At this point, we haven't explicated the mechanisms for such 'soft' impact, and it's not certain that we need to. However, think of this impact in terms of background experience, good examples, new habits and so on. Of course, knowledge sharing and new governance mechanisms to support duplication of the experienced benefits are important mechanisms, which are already part of the theory of change embedded in the RiConfigure project. Impact therefore means to us the potential of a case quadruple helix collaboration to sustainably influence the cooperation patterns of the relevant actors in the context of a respective major challenge, so that they can more effectively address it.

Another choice we are making is that we are talking about a 'sector' as the landscape in which a quadruple helix case is embedded. Talking about a 'sector' is different from talking about a 'technology area' or a specific 'grand challenge'. Focusing too narrowly on a technology area might make the focus too narrowly on the technology itself rather than the societal actor-networks in which it is embedded. On the other hand, focusing on a 'grand challenge' and all of the actors working to solve it would risk making the scope so broad and so cross-sectoral. Of course, talking about a 'sector' begs the question at which level we are delimiting the sector – local, regional, national, or international? In this regard we are deliberately keeping the scope vague as all the levels may prove to be relevant.

Illustration 2: Which levels of analysis do we focus on to understand quadruple helix collaborations?

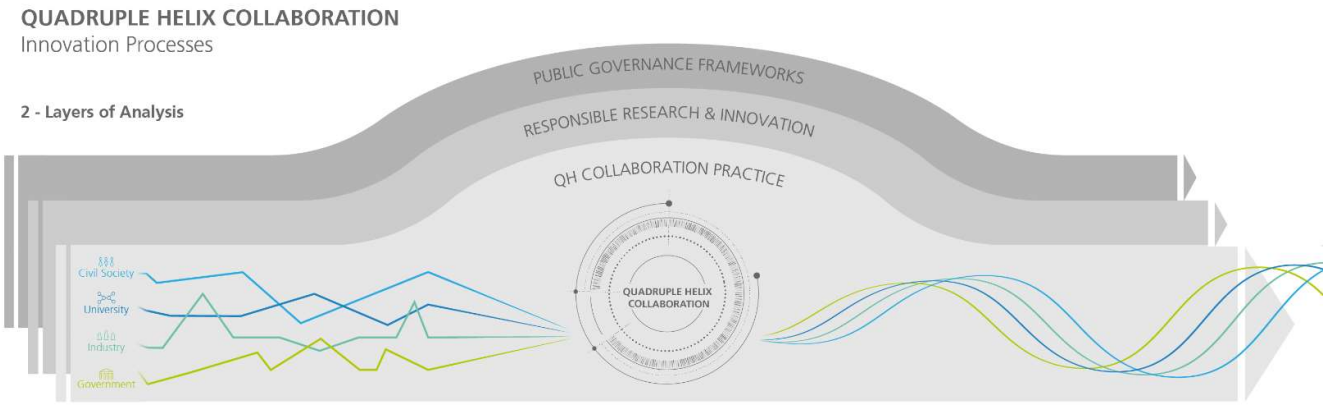

Fig. 2: Three layers of analysis

This is the overview of our approach. In illustration 2 we are trying to show that we look at three layers that we believe are important to understand the trajectories of quadruple helix collaborations. Collaboration is the inner layer of dynamics between the actors (i.e. organizations) involved as participants in the collaboration. RRI is the layer of dynamics of interaction through various means between the collaboration as a unit and the society around it. Governance is the layer of dynamics through which public sector actors act wittingly or unwittingly to affect the conditions for collaboration.

The illustration shows each layer as separate, but as having the same overall shape. This implies that we look at each layer with the specific objective of understanding how they shape the trajectory of the collaboration. In other words, we allow ourselves to take a view that is strictly guided by what we want to know, namely what works and what does not work when it comes to quadruple helix collaborations on innovative solutions to societal challenges. It would be possible to ask many other research questions, but these are not our concern.

Illustration 3: Which are the internal factors that determine the success or failure of QH collaborations?

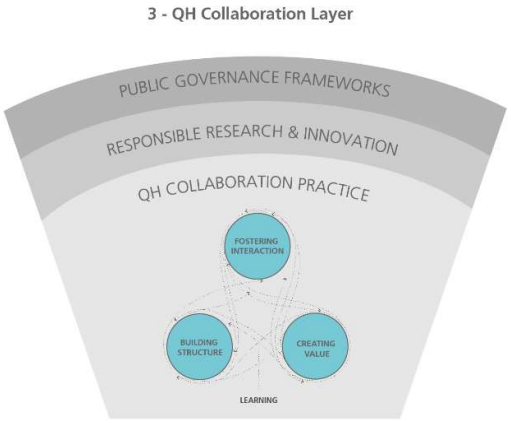

Fig. 3: Four dimensions i*nside the collabo-*

This is the collaboration layer of analysis. Illustration 3 shows the four dimensions, which are important in order to understand the internal dynamics of QH-collaboration. To investigate the collaborations we apply a concept based on three dimensions – building structure, fostering interaction, and creating value. The remaining dimension of learning focuses on the dynamic effects that the process of collaboration has on the actors involved and the relations between them.

These four dimensions provide the overarching concept on the basis of which we analyze the collaboration of the different actors. In situations where we need to be brief and concise – e.g. when we present the framework in the social lab setting – we may focus on these four dimensions. But in situations where we have more time and we need to get deeper into the analysis – e.g. when we code the findings from the social labs - these dimensions can each be 'exploded' in a number of variables. You can see the breadth of (sub-)variables currently included if you look into the 'list' version of the framework.

As derived from the literature, we believe that by focusing on these variables we are able to document the development and learning and alignment processes of quadruple helix collaborations.

Illustration 4: How can a collaboration assume responsibility vis-à-vis society?

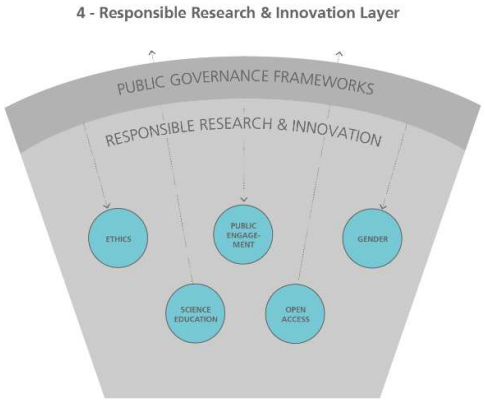

Fig.4: The RRI-layer

This is the RRI layer of analysis. Illustration 4 shows the mechanisms by which a collaboration, once established, can assume responsibility vis-à-vis society. Each of the five main variables included here – the five RRI 'keys' – each in their own way serves as a bridge by which the actors in the collaboration can reach out to establish some kind of anchorage in the society around the collaboration. Three of the main variables – public engagement, ethics, and gender – mainly serve to feed societal values and concerns into the collaboration, including values and concerns that are not neatly aligned with the pursuit of the specific societal challenge to which the collaboration is dedicated. The two other variables – open access and science education – mainly allow the collaboration to give back to society, even in cases where the attempt at finding new solutions may fail.

Just as with the collaboration level, these main RRI variables each have a number of sub-variables that you will find in the operationalization section below (2.2). The sub-variables included there are taken from the MoRRI indicators, which in this context serve the purpose of being able to recognize many different practices and structures as contributing to the five RRI keys. (Note that the MoRRI project operates with six keys, the sixth of which is 'governance'. We have chosen to exclude that here, instead integrating it where appropriate with our own 'governance' layer of variables.)

There is a very significant choice made here, which is to focus on the RRI keys, and to exclude the AREA framework from this layer of analysis. We propose instead to use the AREA framework at the highest level of analysis, i.e. the integrative analysis in task 6.4. Please see 'Proposed illustration 6' below before commenting. Of course, this proposal is something we need to discuss and agree on.

Illustration 5: Which roles can public governance actors play in relation to quadruple helix collaborations?

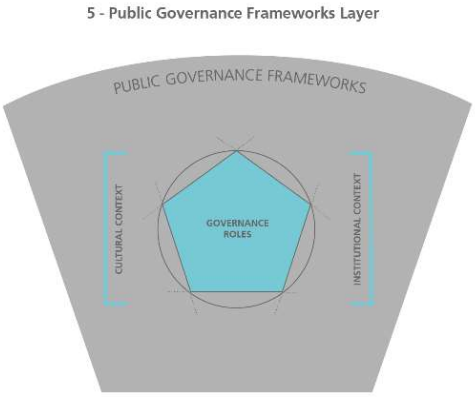

Fig.5: The governance layer

This is the 'public governance' layer of analysis. Illustration 5 shows the roles that public governance actors, who are outside of the collaboration itself, play in relation to the collaboration and which aspects of the cultural and institutional contexts are relevant for establishing, running and working in a QH-collaboration. The roles should be seen as separate from the roles that public sector organizations play when they participate actively in the collaboration on an equal footing with other actors. In other words, we must distinguish between the public sector as frame setter (governance actor) and as participant (innovation actor).

The governance roles can be very significant and, in some cases, directly determinant for the existence of the collaboration in the first place. Such directly impactful roles are, for instance, enabling the collaboration by making funding available. Other roles have a softer and more indirect impact on the collaboration and the direction it takes, for instance, the role of providing directionality through high-level foresight exercises and strategy statements. The overall roles listed as sub-variables here are taken from the 'CLIQ' project (Arnkil *et al.* 2010; Ahonen and Hämäläinen 2012). We group further roles coming from other projects under these. While the sub-variables focus on governance roles relating to the quadruple helix collaboration as such, there are even more roles, which we have grouped under the 'support' role that focus on actors from the individual helixes. For instance, public sector governance of universities has a great deal of influence on how ready an individual university will be to engage in quadruple helix collaborations. These aspects are central to the Committee of the Regions-project on the quadruple helix (Cavallini *et al.* 2016) and could help to deepen our understanding of the background factors motiving individual participants in our cases.

In addition to the multiple roles of governance actors, the two variables of cultural and institutional context focus on further governance aspects relevant for establishing, running and working in QH-collaboration. While relevant aspects of the cultural context include whether or not there is a special momentum or a particularly high entrepreneurial culture, relevant aspects of the institutional context cover sector failures, preexisting histories or institutional linking mechanisms.

5 Set of variables and operationalization

In this section, the translation of the research framework into individual variables including their operationalization will be presented.

Following the three-layered approach to investigate quadruple helix collaboration, this section describes how each of the three layers – collaboration, RRI, governance frameworks – will be examined within the social labs. While the layer focusing on collaboration is divided in four dimensions – building structure, fostering interaction, creating value, learning – both remaining layers governance and RRI are not further subdivided into different dimensions. To analyze each layer a set of variables has been developed consisting of 17 main- and 56 sub-variables. As described in Chapter 2 above, we built assumptions and hypotheses to explore QH-collaboration practices. The main variables correspond to the hypotheses above. While the main-variables are used directly as research category in order to gather data (e.g. in interviews or research protocols), the sub-variables can be applied for further differentiation *where appropriate*. This may apply when, for example, the interviewed person is responding to a question based on a main variable into the direction of a particular sub-variable. Above all, however, the sub-variables will be used for later analysis of the collected data, for example as a codebook for interview data. Since the number of (sub-)variables is too high for direct use in data collection, this will be the primary use of the sub-variables.

Based on a literature research of relevant publications, the set of variables has been developed covering all relevant aspects of quadruple helix collaboration. As the project investigates quadruple helix collaboration in four different social labs, it is important that all researchers involved share the same understanding of these variables, their definition and purpose. To this end, this chapter provides definitions and descriptions of each variable. References to relevant publications are added to underline the importance and usefulness of the variables and to illustrate the procedure and their origin. The further operationalization of the variables that is how and by which questions they will be addressed in the research process is part of the research protocols. They can be found at the end of this document. In the following, the variables for the collaboration layer will be described first, followed by those for the RRI layer and finally the variables examining the governance layer are explained.

Collaboration				Governance	RRI
Building Structure	**Fostering Interaction**	**Creating Value**	**Learning**	**Governance**	**RRI**
Formal procedure	Roles	Outcomes	Learning effects	Cultural context	Public engagement
Goal setting	Collaboration methods	Impact	Trust-building	Institutional context	Science literacy
		Effects		Roles	Gender equality
					Ethics
					Open access

Fig. 6: Research concept building on three layers and its 17 main variables

3.1 Focus: Collaboration

The layer investigating quadruple helix collaboration is divided into the following four different dimensions: *building structure, fostering interaction, creating value,* and *learning.* The four dimensions are derived from the three common phases of cross-sector collaborations and partnerships: *formation*, *implementation*, *outcomes* (cf. Bryson *et al.* 2006; Seitanidi and Crane 2009; Selsky and Parker 2005). Taking into account the dynamic and highly iterative processes of quadruple helix collaborations, the three phases are however no longer considered as successive steps of a linear process. Instead, they are adapted as being dimensions and key elements rather than "phases": *building structure, fostering interaction, creating value.* In addition, there is a fourth dimension, which underlines the special importance of learning processes in and for quadruple helix collaboration. This means that we apply a research concept for quadruple helix collaboration which further develops established models of collaboration based on three phases by highlighting the non-linear and iterative character of quadruple helix collaboration.

Building Structure

This dimension is defined as all formal rules, procedures, goals and agreements the collaborations sets up to govern its collaboration. It is based on two main variables (*formal procedure* and *goal setting*) and includes overall eight sub-variables.

The first main variable, ***formal procedure***, includes all formal steps that are part of the process of building the structure of quadruple helix collaboration. These steps include aspects that are covered by the following sub-variables, but may also go beyond them.

The sub-variable *commitment to collaborate in initial agreement* grasps the nature and extent of the initial collaboration agreement including the definition of the legal entity representing all actors in the quadruple helix collaboration (cf. Selsky and Parker 2005, p. 855; Bryson *et al.* 2006, p. 47; Seitanidi and Crane 2009, pp. 418–419; Bryson *et al.* 2016, p. 6; Arnkil *et al.* 2010, p. 77). It helps to assess whether certain types of collaboration agreement are correlated with more or less constructive collaboration and what obstacles may have to be circumnavigated.

The sub-variable *ongoing reporting* captures the kind and practices of documentation and reporting of projects and activities used (e.g. real-time reports) to improve the quadruple helix collaboration (Arnkil *et al.* 2010, p. 79).

The sub-variable *partner selection* focuses on the selection of diverse organizational partners to ensure inclusive participation. The variable covers steps and duration of the partner selection process, as well as the number and diversity of partners considered and selected (cf. Selsky and Parker 2005, p. 864; Seitanidi and Crane 2009, pp. 418–419; Blok 2018, p. 15; Bryson *et al.* 2015, 2,8).

The sub-variable *internal communication strategy*, finally, seeks to investigate the *c*ommunication strategy to communicate within the quadruple helix collaboration, as well as to communicate the achievements of the quadruple helix collaboration to the outside (cf. Arnkil *et al.* 2010, p. 79) (cf. Arnkil et al. 2010, 79; (Zoethout *et al.* 2017; Bryson *et al.* 2015, p. 7). The internal communication strategy can be task-related (leading to learning) or affective/meta-cognitive (creating the context for learning).

The second main variable for the dimension of building structure is ***goal setting***. It includes four sub-variables. In general, this variable examines whether or not and to which extent the partners involved in the quadruple helix collaboration share a common understanding of the goals and what the goals are.

The first sub-variable is examining whether a *societal challenge* has been identified and how a *common problem understanding* has been reached. Thereby, the (depth of the) understanding of the problem(s) addressed by the collaboration can be assessed (cf. Bryson *et al.* 2015, p. 2). This comprises whether the collaboration knows which challenge it is trying to solve, whether there is a common understanding of the challenge in the collaboration partner group as well as what kinds of methods have been used to explore and define the challenge. Furthermore, this also includes whether a given challenge is generally being recognized (in policy, for example) and embedded in e.g. horizon scanning or whether there is momentum around the challenge, that is whether there are, for example, lots of other people working on this challenge and several competing solutions?

The second sub-variable focuses on *the quadruple helix* aspect of the collaboration. This variable thus aims at the (common) understanding and definition of quadruple helix collaboration which helps to manage the partner's expectations and motivations (cf. Arnkil *et al.* 2010, p. 79; Bryson *et al.* 2006, p. 44; Selsky and Parker 2005, p. 863).

The third sub-variable is *assessing risks* related to quadruple helix collaboration. It is defined as the assessment of operational risks related to quadruple helix activities and cooperation before launching a structured quadruple helix environment (cf. Arnkil *et al.* 2010, p. 79; Selsky and Parker 2005, p. 864).

The fourth and final sub-variable is *identifying the available resources*. This means that the variable is focusing on the nature and extent of available resources, i.e. the means that can be drawn on for the design, development, diffusion and implementation of an innovation (cf. Selsky and Parker 2005, p. 855; Bryson *et al.* 2015, p. 2; Popper and Velasco 2017, p. 39).

Fostering Interaction

The second dimension, fostering interaction, is defined as all methods used, roles taken, and attitudes of the various actors in the collaboration with the aim of creating value. It is based on two overarching main variables, *roles* and *collaboration methods*, including nine sub-variables.

The first main variable, ***roles***, is focusing on the formal and informal roles that exist in the quadruple helix collaboration and how they are established.

To this end, the first sub-variable is investigating whether and how *formal roles are clarified*. This aims at the accurate description of the roles of different quadruple helix partners before a structured quadruple helix environment is launched (cf. Arnkil *et al.* 2010, p. 79; Selsky and Parker 2005, 855, 864; Bryson *et al.* 2006, p. 50; Lew *et al.* 2018, p. 44; Höglund and Linton 2018, p. 60; Kriz *et al.* 2018, p. 26).

The second sub-variable is concentrating on the *leadership dynamics* within the quadruple helix collaboration. It seeks to describe the leadership dynamics in various formal and informal roles, i.e. through the number and types of leadership roles, the quality of leadership, and changing leadership dynamics (cf. Bryson *et al.* 2006, p. 47; Bryson *et al.* 2015, 6,8).

The third sub-variable is closely related to the previous one as it focuses on the aspect of *power* more generally (e.g. power structures & power relations) between the partners involved. This includes for example how and which hierarchies are established or how power influences the collaboration or individual participants and contributes to the measures taken and decisions made (cf. Hoffmann *et al.* 2017; Selsky and Parker 2005, 855, 864; Bryson *et al.* 2006, p. 50; Lew *et al.* 2018, p. 44; Höglund and Linton 2018, p. 60; Kriz *et al.* 2018, p. 26).

The fourth sub-variable is about the *mobilization of stakeholders*. To investigate this, the sub-variable is focusing on the capacity to identify, reach and involve key stakeholders (cf. Arnkil *et al.* 2010, p. 78; Popper and Velasco 2017, p. 39).

The fifth sub-variable is about the inclusion of *quadruple helix experts*. This can be defined as the contact with researchers specialized in user involvement and quadruple helix innovation activities (cf. Arnkil *et al.* 2010, p. 79).

The sixth sub-variable are the *navigating attitudes* within the quadruple helix environment. This refers to the type of behavior of people involved in the quadruple helix collaboration and responsible for the design; development, implementation and diffusion of an innovation (cf. Popper and Velasco 2017, p. 39).

The second main variable is examining the ***collaboration methods*** used to foster interaction in the quadruple helix process. This is covered by three sub-variables.

The first sub-variable is about *idea creation mechanisms* such as, for example, Design Thinking for idea development and/or demand creation suitable for providing new ideas (cf. Arnkil *et al.* 2010, p. 78).

The second sub-variable is about *project management*, that is about the general practice of project management within the quadruple helix collaboration (cf. Arnkil *et al.* 2010, p. 79).

The third and final sub-variable is focusing on the *development of conflict management techniques*. This includes the level of conflict preparedness, in particular, strategies to explicate and manage conflicting interests, i.e. making conflicting interests explicit and to discuss them openly (cf. Seitanidi and Crane 2009, p. 421; Bryson *et al.* 2015, pp. 9–10; Blok 2018, pp. 5–6; Arnkil *et al.* 2010, p. 79).

Creating Value

The third dimension, creating value, is defined as all measurable outcomes of quadruple helix collaborations be they short-, mid- or long-term outcomes and impacts. It is based on three overarching main variables, including six sub-variables.

The first main variable of this dimension is covering the ***outcomes*** of the quadruple helix collaboration.

This narrow focus comprises only one sub-variable that is asking what the *outcome* of the quadruple helix collaboration has been, e.g. whether a product, service or new standard has been produced (cf. Selsky and Parker 2005, 855, 864; Bryson *et al.* 2006, p. 51; Bryson *et al.* 2015, p. 10; Arnkil *et al.* 2010, pp. 77–79).

The second main variable is focusing on ***impact*** of the outcomes of the quadruple helix collaboration. This can be specified by two sub-variables.

The first one is about whether or not *transformation* has been achieved. This means to query whether positive changes in the quadruple helix of innovation and knowledge production have been achieved (cf. Popper and Velasco 2017, p. 39; Bryson *et al.* 2006, p. 50). In general, this means to investigate the uptake of the outcome of the innovation process.

The second sub-variable aims at the impact on *sustainability*. Thereby, the changes in the socio-technical system in which the innovation operates that lead to positive economic, social, infrastructural, environmental, and governmental transformations are captured (cf. Popper and Velasco 2017, p. 39; Bryson *et al.* 2006, p. 50).

The third main variable is about the ***effects*** of of the quadruple helix collaboration.

The first sub-variable focuses on whether a *greater mutual understanding* has been achieved. Here, a greater mutual understanding may include new coordination and joint action, changes in practices and perceptions, or new institutions and new norms (cf. Bryson *et al.* 2006, p. 51; Seitanidi and Crane 2009, pp. 421–422; Bryson *et al.* 2015, p. 11).

The second sub-variable examines whether a *collaboration culture* has been created by the quadruple helix collaboration (Bryson *et al.* 2006, p. 51; Bryson *et al.* 2015, p. 11).

The third and final sub-variable is focusing on the *promotion of trust-building* by the quadruple helix collaboration. To evaluate this, trust-building can be described as open positive arena and internal legitimacy that is

based on trust between the partners (cf. Selsky and Parker 2005, 855, 864; Bryson *et al.* 2006, pp. 47–48; Bryson *et al.* 2015, pp. 6–7; Kriz *et al.* 2018, p. 29; Arnkil *et al.* 2010, p. 79).

Learning

The fourth dimension, learning, is defined as all activities performed by the actors of the quadruple helix collaboration with the aim of gaining, sharing and providing new knowledge about (quadruple helix) collaboration as well as the value the collaboration aims at. Its two main variables, ***learning effects*** and ***trust-building***, includes seven sub-variables covering the learning effects of the quadruple helix collaboration.

The first sub-variable to investigate the **learning effects** is focusing on the *engagement in learning activities*. This comprises team activities resulting in an implicit transfer of knowledge, boundary crossing (whether the team members seek or give information and interact with other individuals and units), reflexivity as the extent to which team members overtly reflect upon and communicate about the group's objectives, strategies and processes, team adaptation as a result of reflection as well as transactivity when team members base their contributions on previous contributions (cf. Zoethout *et al.* 2017).

The second sub-variable focuses on *capitalizing on and developing the inherent aptitude of team members*. This puts emphasis on the skill set or competences of people involved in the design, development, implementation and diffusion of an innovation (e.g. leadership, charisma, creativity, knowledge) (cf. Popper and Velasco 2017, p. 39).

The third sub-variable is learning to *understand different perspectives*. This variable helps to examine whether and how actors identify and are able to understand the different perspectives of the quadruple helix-partners on the challenge and innovation at hand (cf. Arnkil *et al.* 2010, p. 79).

The final sub-variable for researching the learning effects focuses on the *method expertise*. This variable thus analyzes which and whether the right and adequate methods in different phases of the quadruple helix-process (cf. Arnkil *et al.* 2010, p. 79).

The second main variable for the dimension of learning is **trust-building**. It is covered by three sub-variables.

The first sub-variable is *building trust and openness.* It aims at investigating how partners manage to create an open positive arena that is based on trust between them (cf. Selsky and Parker 2005, p. 864; Bryson *et al.* 2006, pp. 47–48; Bryson *et al.* 2015, pp. 6–7; Kriz *et al.* 2018, p. 29; Arnkil *et al.* 2010, p. 79).

The second sub-variable covers the aspect of *legitimacy*. It can be employed to analyze how partners establish internal legitimacy for the quadruple helix-innovation (cf. Selsky and Parker 2005, p. 864; Bryson *et al.* 2006, p. 47; Bryson *et al.* 2015, p. 7).

The third sub-variable is focusing on *conflicting interests*. This means that by this variable one can analyze how partners learn to make conflicting interests explicit and to discuss openly about them as well as to which degree they are prepared for conflicts (cf. Bryson *et al.* 2006, p. 48; Seitanidi and Crane 2009, p. 421; Bryson *et al.* 2015, pp. 9–10; Blok 2018; Arnkil *et al.* 2010, p. 79).

3.2 Focus: Responsible Research and Innovation

The second research focus (or layer) of the RiConfigure-project is how and to which extent the quadruple helix collaborations investigated engage in RRI or such measures that promote the six dimensions of RRI. As already indicated above, the consortium agreed to use the RRI framework based on the six keys developed by the European Commission (2012). Above all, this helps to establish further comparability with other projects that also investigate aspects of RRI. In order to ensure this in the best possible way, we rely on the most comprehensive research project on RRI to describe the indicators, as its objective was to monitor the evolution and benefits of RRI (MoRRI). However, we will skip the sixth key of governance as this aspect is covered by a third research focus in addition to quadruple helix collaboration and RRI (see below). In the following, we will describe the five main variables *public engagement, science education, gender equality, ethics* and *open access* based on 16 sub-variables following the categorizations from the MoRRI-project (D3.2).

The first main variable is focusing on the ***public engagement*** of the quadruple helix collaboration. Five sub-variables cover the different aspects of public engagement mechanisms and initiatives.

The first sub-variable is *public communication,* understanding public engagement as information and education of citizens. Crucially, the path of communication is unidirectional from "from sponsors to public representatives, and no specific mechanisms exist to handle public feedback" (Ravn *et al.* 2015, 12ff.).

The second sub-variable is *public activism* aiming to inform decision-makers and create awareness to influence decision-making processes. Here, too, communication only goes in one direction, but from society to decision-makers, initiated by societal actors and interests.

The third sub-variable is focusing on public engagement as *public consultation*. While here again information also flows from society to decision-makers, this time it is based on an initiative of the decision-makers themselves.

The fourth sub-variable is highlighting the *deliberation* aspect of public engagement. This means that based on a genuine dialogue information is exchanged between various actors, including society and decision-makers, and deliberation facilitated. In addition, the outcome of the deliberation process as two-way communication may have an impact on the decision that is eventually made.

The fifth sub-variable is emphasizing the participatory notion of public engagement. *Public participation* thus captures instances where partly or full decision-making power is assigned to society. Based on two-way communication a dialogue is facilitated between society and decision-makers.

The second main variable is ***science education*** examining whether and how the quadruple helix collaboration promotes science literacy and education. To investigate this, three sub-variables can be employed.

The first sub-variable is called *science education* too as it focuses on the educating aspect of the quadruple helix collaboration. This means that this variable comprises all mechanisms, effects or initiatives where (young) citizens learn about scientific facts, the norms of science and how science is done. These measures may not only enable people to critically reflect on science, they also help to convey a positive image of science.

The second sub-variable is called *science communication* and captures all activities that educate citizens by generating awareness by raising awareness of science-related issues. Such activities can be both in direct form as well as in a more indirect way.

The third sub-variable is the *co-production of knowledge*, covering all instances where knowledge is produced by a (new) cooperation of experts and non-experts, say citizens or laypersons. This kind of co-creation of knowledge can help to expand opportunities for scientific data collection as in, for example, initiatives of Citizen Science.

The third main variable is ***gender equality*** covered by three sub-variables.

The first sub-variable employed to research gender equality is focusing on the *participation of women* in fields where they are underrepresented. This includes, amongst other things, women's participation in management and decision-making processes and measures used to promote their participation.

The second sub-variable is focusing on the *structural change in institutions* in relation to gender equality. This comprises all measures that aim at revising organizational structures and eliminate barriers that impede women's advancement to top positions.

The third sub-variable is covering the aspect of *gender in research content.* This means to ask whether a gender dimension has been integrated in research and innovation content or if, in the worst case, only male research subjects have been considered.

The fourth main variable is about how the quadruple helix collaboration is addressing ***ethics***. This is covered by three sub-variables.

The first sub-variable is addressing the *governance of ethics*. This aims at how ethics debates are institution-alized and how ethical standards are implemented.

The second sub-variable is focusing on *ethical deliberation* querying how ethics debates are institutionalized that raise issues in science, technological development and innovation.

The last sub-variable emphasizes the reflective dimension of ethics. This means that *ethical reflection* captures how institutionalizing ethics debate supports critical reflection and engagement on ethical issues such as research standards, emerging technology issues or social justice.

The fifth main variable researching RRI is covering the ***open access*** part. It is divided in two sub-variables.

The first sub-variable is *open access* itself focusing on the results of the research project. This means that the focus here is on the free availability of research results to the general public.

The second sub-variable, *open data*, focuses on the research data itself. The sub-variable thus examines whether, to which extent and how research data is made freely accessible.

3.3 Focus: Governance

The third and final research focus is how relevant governance frameworks shape the quadruple helix collaboration. In this context, governance frameworks is broadly understood as comprising all cultural, economic and policy conditions that are relevant for establishing, running, and working in the quadruple collaboration. Insofar as they are relevant for shaping the collaboration, they can be on a local, regional, national as well as international (European) level. The layer governance framework is restricted to external conditions and does not comprise the internal governance. Furthermore, this layer is restricted to the conditions and does not comprise governmental actors playing a certain role within the quadruple helix collaboration. To investigate this, three main variables including ten sub-variables are used.

The first main variable is focusing on the ***cultural context***. It is based on two sub-variables. The first sub-variable is focusing on the *momentum,* examining whether or not there is a particular force that gets innovation moving forward shaped by political setting, exemplars, and problems (cf. Popper and Velasco 2017, p. 39).

The second sub-variable seeks to find out more about the *entrepreneurial culture* that may influence the quadruple helix collaboration. Particularly, this can be a factor in traditionally non-entrepreneurial contexts, such as universities or sectors characterized by large corporations (Cavallini *et al.* 2016, p. 81).

The second main variable is focusing on the ***institutional context***. It is based on three sub-variables each highlighting an aspect of the institutional background that is relevant for establishing, running, and working in the quadruple collaboration.

The first sub-variable is focusing on the aspect of *sector failure*. This variable helps to examine the history of prior single-sector endeavors to solve the societal problem at hand as well as the level of success in prior single-sector endeavors (cf. Bryson *et al.* 2006, pp. 44–46; Bryson *et al.* 2015, pp. 5–6). The second sub-variable, *institutional and political linking mechanisms*, focuses on the interconnectedness of the quadruple helix collaboration both within a sector and with external actors. Thereby, one can evaluate the level of interconnectedness and interdependence among partners and their sector as well as the quality of external political and/or institutional support or challenges for collaboration efforts (cf. Bryson *et al.* 2006, pp. 44–46).

The third sub-variable highlights *preexisting histories*. This means to ask whether there are preexisting histories among the partners of a quadruple helix collaboration and what their specific qualities are (Bryson *et al.* 2015, pp. 4–6).

The third main variable employed to analyze the governance layer is focusing on the various ***roles*** that local, regional and national governance frameworks and actors may play for supporting or hindering quadruple helix collaboration. While the list of possible roles can be completed during the course of the project, we initially distinguish five roles in the following sub-variables.

The first sub-variable covers the role of an *enabler*. Governance actors and/or frameworks are enabler when, for example, they act as financier (e.g. through project funding, ownership, investments and public procurements) or they provide infrastructure (incl. ICT infrastructure, building lots) (cf. Arnkil *et al.* 2010, p. 90).

The second role is captured by the second sub-variable called *decision maker*. This role is given when a governance actor, for example, intervenes as member of the steering group of a quadruple helix innovation, is the maker of regional/local quadruple helix innovation policies (e.g. guidelines, financial incentives, R&D&I programs supporting quadruple helix- and user-oriented innovation), or provides future-oriented strategic drive of an innovation (foresight) (cf. Arnkil *et al.* 2010, p. 90; Popper and Velasco 2017, p. 39).

The third role and sub-variable comprises all instances where governance actors/frameworks are act as *supporter* of quadruple helix collaborations. As supporter, the governance actor encourages the development of the quadruple helix partners as well as the linking, networking and interactive learning of different groups and stakeholders (incl. collaboration with users). Support can also be provided by the systematic collection and utilization of user information (incl. public sector data), the knowledge and capability development related to quadruple helix collaboration (e.g. research, education, methods and tools) or the empowerment and assistance for citizens in their innovation activities (cf. Arnkil *et al.* 2010, p. 90; Cavallini *et al.* 2016, 81, 94, 106). Finally, support can also aim to transform (public) organizations into ones that welcome learning, experimentation and self-discovery, to build symbiotic public-private partnerships to properly share and distribute risks and rewards (cf. Mazzucato 2015, p. 11).

The fourth sub-variable covers the role the governance actor/framework as *marketer*. By acting as marketer a governance actor raises awareness of quadruple helix innovation among citizens, businesses and the public sector and/or markets quadruple helix innovation models and practices to businesses, users or other financiers (cf. Arnkil *et al.* 2010, p. 90).

The fifth and final role distinguished here is *quality controller*. This role, for example, supports the development of 'quality checks' or standards for quadruple helix type of activities and for other co-creation environments to assess the quality of the QH type of activities by means of these standards (cf. Arnkil *et al.* 2010, p. 90; Mazzucato 2015, p. 11).

4 Methodology and data collection

Data collection is carried out based on a social lab-methodology. In general, four steps of data gathering can be distinguished.

First, each case including main, mirror and reference cases will be analyzed through desk research (**case profiles**) and, if possible, through an interview (**case interviews**). For each case, this will only be done once, ideally before the first meeting takes place. Reference cases can be analyzed over the entire course of the respective WP. The task of case mapping and analysis will provide the basis for the social labs and leads to the collection of case reports as required by deliverables 2/3/4/5.1.

Secondly, in preparation of each of the four rounds of social lab panel meetings and process implementations, the participating cases, that is main and reference cases will fill in a short **state of play-report** in order to capture the current situation as well as changes in the run-up to each round. These reports will be collected by the responsible lab manager. They provide valuable input for the preparation of the upcoming meeting. In total, each main and mirror case should fill in four state of play-reports.

Thirdly, the social lab managers will observe and monitor each of the four panel meetings based on a specific protocol (**meeting protocols**). In addition, they may also take photographs and conduct (journalistic) video interviews particularly relevant for the WPs 8 and 9. In total, each SL manager will create four meeting protocols.

Fourthly, each round of implementation of process methods as realized by the main case will be observed and documented by the corresponding social lab manager (**intervention protocols**). This may also include photo and video reporting relevant for the WPs 8 and 9. In total, each SL manager will create four intervention protocols. Together, the four workshop and four implementation reports provide the collection of data reports as required be deliverables 2/3/4/5.2.

The overall procedure thus depends on a number of research templates. The required documents are:

[1] Template for case profiles based on desk research [*case profile*]
[2] Template for case interviews [*case interview*]
[3] Template for a questionnaire to be completed by main and mirror cases [*state of play-report*]
[4] Template for documenting the social lab panel meetings [*meeting protocol*]
[5] Template for documenting interventions carried out by the main case partner [*intervention protocol*]

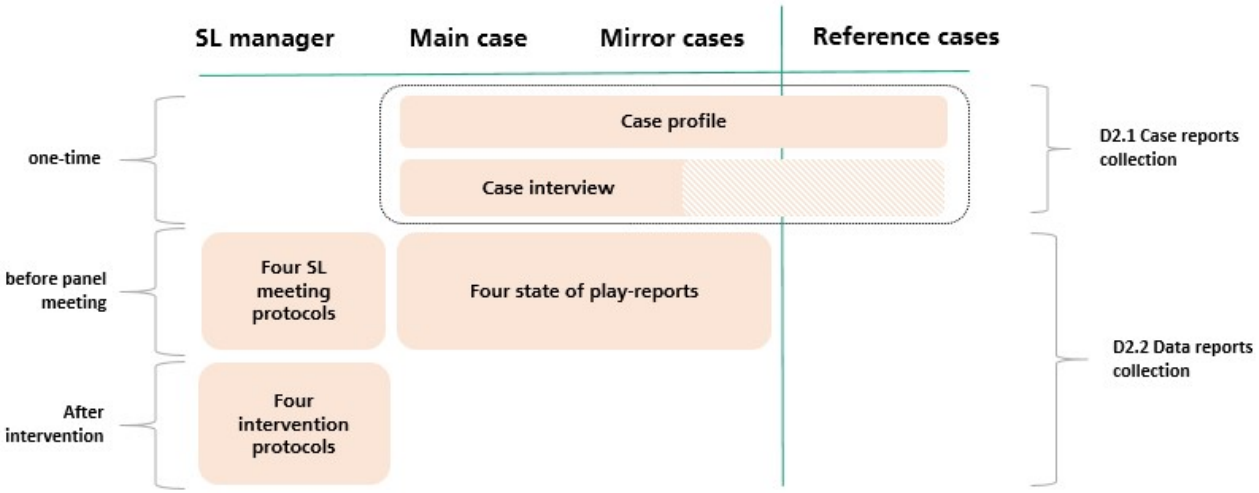

Fig. 7: Illustration of the process of data collection based on the social lab methodol-

In order to create a manageable research process while gathering all the relevant data, the selected dimensions and variables will be operationalized for and assigned to one or several steps of the data collection process (see above). The allocation of variables to the individual steps of data collection within the social labs has been made based on where the most relevant and significant data in the research process can be best collected. However, it is important to consider that each of the four social labs will be realized in a different language none of which is English. This requires that each lab manager adapts and creates the research protocols suitable for their specific context of the lab.

5 Research protocols

Case profile

WHO:	wp leaders, plus FAO
WHEN:	for main and mirror cases with the setup of the labs, for reference cases continuously
METHOD:	desk research & analysis of available data
RESEARCH QUESTION:	what are the central characteristics of the case of quadruple helix-collaboration?

[1] Case (working) title

[2] Added by [*name*]

[3] Part of [social lab I, II, III or IV]

[4] Short case description.

[5] How does the case qualify as quadruple helix?

[6] How does it relate to the substantial theme of the social lab?

[7] How does it relate geographically to the other cases of the social lab?

[8] Further information [*website etc*.]

Case interview

WHO:	wp leaders, plus FAO
WHEN:	with the setup of the labs (main and mirror cases), for reference cases continuously (when possible)
METHOD:	face-to-face or telephone interview
RESEARCH QUESTION:	how exactly does the quadruple helix-collaboration work, what are central elements, challenges and success factors?

[1] Please tell us more about the general character of the collaboration, how do the different actors of the quadruple helix work together?

[2] Can you describe how the collaboration has been established? How did the partners get together, how was the partnership initiated? How do you organize the collaboration?
[*Which steps were/are part of the process of building the structure of QH-collaboration?]*

[3] Can you describe the goals of the collaboration? Do the partners share a common understanding of these goals?
[What are your goals for the QH-collaboration? Do you and your partners share a common understanding of the QH-collaboration's goals?]

[4] Can you identify different (formal and informal) roles in the collaboration? How are they established?
[*Which formal and informal roles exist in the QH-collaboration? How are they established?]*

[5] Do you use specific tools and methods to support the cooperation of the partners?
[Which collaboration methods does the QH-collaboration actively use to foster interaction?]

[6] Which are the tangible outputs that the collaboration did or that you plan to produce?

[7] Which intangible outcomes or added value did the collaboration or do you plan to produce?

[8] Has there been a systemic impact of the QH-collaboration? (*if already applicable*)

[9] What did you and your partners learn in and through the collaboration?

[10] What role does trust play for the collaboration? Could it be strengthened during the process?

[11] How do you assume responsibility towards society? How is responsibility shared within the collaboration? (How do you address ethical issues or questions of gender equality)

[12] Which cultural factors have been important for the collaboration?

[13] Which institutional factors have been important for the collaboration?

[14] Which kind of support did you receive from regional/national/international governments? Which roles did policy (actors) play for the collaboration in general?

State of play-report

WHO:	main and mirror cases
WHEN:	in preparation of the next panel meeting
METHOD:	brief questionnaire
RESEARCH QUESTION:	what did change since the last meeting/intervention for the collaboration?

[1] Has the structure of the collaboration been further strengthened? [YES/NO]

[2] Did the goals of the collaboration change [YES/NO]

[3] Has the mutual understanding of the partners increased? [YES/NO]

[4] Which methods/tools did you use/experiment with?

[5] How did it help the collaboration? What were the main benefits and challenges?

[6] What did you learn?

[7] Did the roles within the collaboration change? Have new ones been added?

[8] What value has been created (tangible & intangible results, impact)?

[9] How did you take responsibility towards society? Have you been able to improve this?

[10] Have new cultural factors emerged for the collaboration?

[11] Have new institutional factors emerged for the collaboration?

[12] Did the role of policy change for the collaboration?

Meeting protocol

WHO:	social lab managers
WHEN:	during/after panel meeting
METHOD:	observation and documentation based on template
RESEARCH QUESTION:	what and how did the participants discuss during the panel meeting in relation to the research questions?

[1] What has been discussed regarding the building of the (formal) structure of quadruple helix-collaborations? Which challenges and success factors have been identified?

[2] What did the participants discuss concerning the goal setting of collaborations?

[3] Which roles could you identify? How have they been discussed?

[4] Which methods to foster interaction did the participants mention and discuss?

[5] Which outputs (tangible/intangible results; impact) have been discussed?

[6] Which learning effects do/did you observe? Which did the participants discuss?

[7] What has been discussed regarding trust-building in quadruple helix-collaborations?

[8] What did the participants discuss in relation to responsibility and RRI?

[9] Which aspects of the cultural context did the participants mention as relevant for establishing, running and working in quadruple helix-collaborations?

[10] Which aspects of the institutional context did the participants mention as relevant for establishing, running and working in quadruple helix-collaborations?

[11] Which roles did policy (frameworks) and government actors play for the participants and quadruple helix-collaborations?

Intervention protocol

WHO:	*social lab managers*
WHEN:	during/after intervention
METHOD:	observation and documentation based on template
RESEARCH QUESTION:	what do you observe in the intervention relating to the variables?

[1] How was the (formal) structure of the quadruple helix-collaboration been established?

[2] How did the goal setting of collaboration take place?

[3] Which roles have been established?

[4] Which methods to foster interaction have been used? How did it work? What were challenges and success factors?

[5] Which outputs (tangible/intangible results; impact) have been achieved?

[6] Which learning effects did you observe? Which did the participants discuss?

[7] How has trust been built between the quadruple helix-actors?

[8] How has responsibility been assumed?

[9] Which aspects of the cultural context were relevant for establishing, running and working in the quadruple helix-collaboration?

[10] Which aspects of the institutional context were relevant for establishing, running and working in the quadruple helix-collaboration?

[11] Which roles did policy (frameworks) and government actors play for the quadruple helix-collaboration?

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