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Responsible Research and Innovation and the Systems of Innovation approach within Horizon 2020

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Abstract

The thesis aims at investigating whether the Horizon 2020 programme incorporates the concept of Responsible Research and Innovation and if this is based on the Systems of Innovation approach, including the Triple Helix model and the Regional System of Innovation approach.

It is a specific concern to understand on what grounds a policy is based on, as the underlying theory provides details about the aim of a policy. Responsible Research and Innovation is a rather new concept but increasingly used in European Union policies. Therefore Horizon 2020 is evaluated against the background of the Responsible Research and Innovation framework defining Responsible Research and Innovation through six criteria ('engagement of all societal actors', 'gender equality', 'science education', 'ethics', 'open access' and 'governance'), which will then be compared to the criteria of the innovation systems. The thesis is based on an exploratory analysis and the data used will be mainly qualitative, comprising scientific literature, as well as policies and communications by the European Union, collected mainly through electronic means.

Based on the findings it is concluded that Responsible Research and Innovation is indeed included in the Horizon 2020 programme (all six criteria are mentioned and promoted) proving that the concept is gaining in importance in policies and that this inclusion is effectively based upon the Systems of Innovation approach.

List of Abbreviations

CSR	Corporate Social Responsibility
EIT	European Institute of Innovation and Technology
ELSA	Ethical, Legal and Social Aspects (research programme)
ELSI	Ethical, Legal and Social Implications (research programme)
ERA	European Research Area
ERC	European Research Council
EU	European Union
FET	Future and Emerging Technologies
FTI	Fast Track to Innovation
LMI	Linear Model of Innovation
KICs	Knowledge and Innovation Communities
MS	Member States
R&D	Research and Development
RRI	Responsible Research Innovation
RSI	Regional System of Innovation
SI approach	System of Innovation approach
SiS	Science in Society
SMEs	Small and Medium enterprises
TEU	Treaty on European Union
TFEU	Treaty on the Functioning of the European Union

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1 Introduction

The term 'Responsible Research and Innovation' (RRI) is gaining interest among European policy makers and more references are made towards the concept. For example, René von Schomberg (2013), a member of the European Commission and the Directorate General for Research and a well-known proponent of RRI, considers RRI as becoming increasingly important within European policies. But what exactly it means is not clear as an exact and accepted definition among scientists and policy makers is missing, and the extent of its use within policies and also its acceptance within the different policy levels is disputable.

Therefore, this thesis is aiming to establish what RRI is made out of, what is necessary to speak of RRI and to analyze its occurrence within European policies by analyzing if RRI can be traced within the programme of the Horizon 2020 policy. Depending on this, it will be further tried to establish if this incorporation takes into account innovation models, namely the System of Innovation (SI) approach, the Triple Helix model and the Regional System of Innovation (RSI), all representing the systemic view of innovation.

RRI is of increasing interest by policy actors because they want to increase the development of technologies being beneficial for society but without losing technological advances, while also simultaneously addressing public fears of unintended consequences (Guston, Fisher, Grunwald, Owen, Swiersra & van der Burg, 2014). In addition, industry representatives, civil society, and scientists, call for the integration of societal and ethical aspects into science and technology (van Oudheusden, 2014). They anticipate problems in regard to the development of technologies, want to create flexible and adaptive governance regulations to better cope with scientific insecurities and to give citizens a right to say in these issues (van Oudheusden, 2014).

RRI can be set in close acquisition to ELSI and ELSA, which were introduced as labels for research considering ethical, legal and social issues/ aspects (the difference is relating to whether one means the American or European version of the programme), in the late 1980s respectively early 1990s Zwart, Landeweerd & van Rooij, 2014). ELSI originated in the United States within the context of the Human genome project (Zwart & Nelis, 2009). It was suggested that a part of the allocated budget for the programme should be used for studying societal issues relating to genetics research and its application (Zwart & Nelis, 2009). It offered an interdisciplinary approach to the societal issues emerging as a result of the conducted research and helped to avoid possible negative consequences by progressing in the field of genetics (Zwart & Nelis, 2009). There is not a strict consensus over what constitutes

an ELSI approach but typical criteria are the study of possible societal impacts (of genomics) in the future, and the ways in which future agendas of (genomics) research can or could be shaped by including public and societal developments (Zwart & Nelis, 2009).

ELSA is now so to say displaced by RRI in the context of recent EU funding initiatives due to a top-down approach, which is mainly practiced by science policy makers and funding agencies (Zwart, Landeweerd & van Rooij, 2014). RRI (and formerly ELSA) is considered important from a policy perspective partly because it makes it mandatory to include the perspectives of the society and if this is the case innovation is accepted easier within society and competitiveness can increase. But research and innovation can also be contested and considered risky by members of the society, which will lead to a failure of introducing the new development. This is e.g. the case with genetically modified corps and food, which is a huge debate in Europe and even so genetic engineering can be seen in positive light as it provides more possibilities to make e.g. crop more resistant to herbicide by simultaneously containing more nutrients it is also refused by many making it responsible for contributing to the damage of the environment and as being unsafe (Gaskell et al, 2010)[1].

Horizon 2020 is the European Research and Innovation programme operating from 2014 until 2020 with a funding of almost €80 billion and is supposed to secure and increase the competitiveness of the European Union (EU) by boosting the economy, creating more jobs and thereby better living conditions (European Commission, n.a.). It was chosen to be evaluated, as it is the current funding programme of the EU for research, combining all existing research programmes and, which is supposed to make the access to funds easier (by now the application process is organized online making it faster and simpler), focuses on tackling challenges like health and is covering more topics of general interest (European Commission, n.a.). Therefore, it provides a perfect point of departure to analyze if it addresses the RRI narrative and the thesis shall establish whether this is the case, being based on the SI approach and to give up-to-date information on the inclusion of new concepts within European policies.

The Systems of Innovation approach has been chosen to be analyzed as a base line for the possible containment of RRI as they are commonly used approaches for innovation. The concepts seemed to attract the interest of policy makers, especially international policy think-tanks such as the OECD, which influenced on the other hand the members of such

[1] The report 'Europeans and biotechnology in 2010' includes a survey among EU countries on whether they support such genetically modified food and found that in 2010, 5% of respondents agreed, 18% tend to agree, 28% tend to disagree, 33% totally disagreed and that 16% that they did no know, showing the disapprove of such innovation (Gaskell et al, 2010).

organizations, which was than promoted within the EU and raised its interests (Chaminade & Edquist, 2010). The approaches are popular as they rely not solely on one theory but are instead based on e.g. the evolutionary theory, institutional approaches and economic structure. Also they promote the inclusion of actors involved in research and innovation, which refers back to the increased reference to RRI favoring this aspect as well. Also two of its subtypes, the Triple Helix and the Regional System of Innovation approach, will be analyzed to provide a more in-depth analysis. This is of interest as it is always useful to know on which grounds policies are created and based upon and the extent to which a specific approach plays a role in that regard. It will make it easier to understand the direction of actions promoted by a policy and also create the possibility to manage them as well as their consequences.

This will contribute to the further understanding of the RRI narrative, the discussion of it and hopefully contributes to a clarification of the SI approaches and their influence on European policies.

The thesis deals with establishing the concept of RRI, understanding the innovation models, how they work, what they are based on etc. and whether the EU is employing these models in the design of the policy studied, meaning that an exploratory analysis is the base of the thesis. This also includes looking at the actors involved in the innovation and research process and whether they are able to contribute to a better competitiveness of the EU and its responsiveness to societal and grand challenges.

As mentioned before the thesis will predominantly concentrate on systemic innovation approaches, which have different ways of expression and started to develop around the 1970s. Following Edquist and Chaminade (2006) striking features of the SI approach are interdependence and non-linearity. Another main characteristic of the SI approach is the promotion of the collaboration between actors of the innovation process referring back to the start of developing such approaches in the 1950s. Actually, social scientists were beginning to work by the second half of the 1950s systematically on issues relating to innovation, technology and science, which included researchers from fields such as economics, sociology and management, later also joined by other professionals (Martin, 2012). By the early 1960s, the different disciplines were starting to come into contact with one another and realized that they shared a common interest, even if their conceptual and methodological approaches may have varied (Martin, 2012).

All of the innovation models have different starting points and or focus, depending on the researcher describing the model in question. There is already much knowledge about the approaches because of the contributions by the various authors who see them slightly

different and are making efforts to improve earlier versions. Still, even so there are many descriptions of the approaches not many researchers tried to connect the models to a specific policy or a concept like RRI to see how they are linked with each other, which is why the thesis will make an important contribution towards the topic of innovation policy studies.
To capture all these different approaches and interests the developed research question formulated in this bachelor thesis is:

> 'How does Horizon 2020 incorporate the Responsible Research and Innovation narrative and to what extent this incorporation takes into account the Systems of Innovation approach?'

To answer this main research question, which is a descriptive one, and to be able to provide a meaningful structure of the paper, it is necessary to give an overview of the main concepts involved, which is why sub-questions are created. The first sub-question is:

> 'What is Responsible Research and Innovation and how could its features be retrieved within the Horizon 2020 programme?'

The next part of the thesis will be dedicated to what exactly the characteristics of the Systems of Innovation approach are and how to differentiate between them. This leads to the question:

> 'What is the Systems of Innovation approach and how are its subtypes differing from each other?'

These questions will be primarily dealt with in the theoretical framework whereas afterwards in the analytical part it will be established whether Horizon 2020 entails the RRI narrative and depending on this, if it is based upon the innovation models. Afterwards, in the methodology section, it will be outlined how the data was collected and processed. In the analysis part, the programme of Horizon 2020 will be put forward and analyzed if RRI is addressed within it. Should this be the case, it will be further evaluated and established to what extent it was relied on innovation models to do so. This will be followed by the conclusion where the research questions are answered and recommendations made on how to proceed from this analysis.

2 Theoretical Framework

The theoretical framework aims at outlining and explaining the concepts and models related to the RRI narrative and the SI approach, including the Triple Helix and the RSI. Providing a clear definition of the concepts and the approaches is rather difficult in regard that different authors and researchers have labeled them differently, and due to the fact that those labels

have changed over time in their meaning (Martin, 2012). Still, definitions are needed to fully grasp and analyze the topic and to be in the position to give an adequate answer to the research question.

The models of innovation analyzed are of relevance as their importance increased during the last decades and they are often referred to in the scientific literature and by politicians to create innovation policies. The increase of their relevance might be explained due to the fact that macroeconomic theory and policy failed in providing useful factors regulating competitiveness and economic development (Lundvall, Johnson, Andersen & Dalum, 2002). The division of specialization among policy institutions and analysts created problems and these are supposed to be solved by applying the approaches (Lundvall et al, 2002). They might also be favored as they go beyond neo-classicism and promote to take into account economic structure, institutions and policies for better learning processes and outcomes (Lundvall, 2009).

2.1 Responsible Research and Innovation

Research

Research as defined by the Oxford Dictionary is "The systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions" (2014).

It is a complex and differentiated activity with a wide variety of functions and contexts related to a number of other activities with a scientific and technological base (Organisation for Economic Co-Operation and Development, n.a.; OECD, 2002). What research means, how to conduct it in an appropriate way and the reasons to conduct it changed during time, which is supported by various studies showing that Research and Development (R&D) activities are done increasingly in a global setting and in co-operation rather than in isolation being dominant in earlier times (OECD, 2002; Flipse, van der Sanden, Radstake, De Winde & Osseweijer, 2014).

When problems arise during the innovation process a firm reverts to its knowledge base, which contains earlier conducted research, as well as technical and practical experience (Organisation for Economic Co-Operation and Development, n.a.). The research system takes up the difficulties, which cannot be settled with the existing knowledge base, and tries to tackle them (Organisation for Economic Co-Operation and Developmentn.a.). The success of research can be seen by being able to answer research problems, proving a hypothesis, and or finding a definite answer by establishing facts and reaching new conclusions.

Generally, research can be categorized in three kinds: basic research, applied research and experimental development (OECD, 2002).

Basic research is of experimental or theoretical nature and completed to gain knowledge without any particular application or use in mind but instead is mainly used to formulate and test hypotheses, theories or laws (OECD, 2002). After World War II, fundamental, largely university-based research was strongly supported, which was research without government or private interference (Calvert, 2004). Therefore from the 1950s, basic research was becoming the key target of public investment throughout the industrialized world (Calvert, 2004). Many industrial countries reduced government spending on science during the late 1960s and 1970s and replaced it by market-oriented research approaches (Calvert, 2004). With the 1980s basic research and free-market strategies for technological innovation and economic competitiveness were combined, which is still the case today (Calvert 2004).

Applied research is undertaken either to determine possible uses for basic research or new methods of achieving specific and predetermined objectives, often with a commercial interest (OECD, 2002). It also includes the extension of available knowledge in order to solve particular problems (OECD, 2002). Academically applied research is more frequently done in collaboration with industrial partners, while public funding agencies increasingly require scientists to justify the research they are interested in. Social aspects should be included to convince them to invest in the research (Flipse et al, 2014). Industrial related R&D, supposed to create new products and services, should also show social or environmental responsibility by contributing to a more positive corporate image (Flipse et al, 2014).

Experimental development relies on knowledge gained from research and practical experience that is directed to produce new materials, products and devices or to install /improve new processes, systems and services (OECD, 2002). Experimental development may be defined as the process of translating knowledge gained through research into operational programmes, including demonstration projects undertaken for testing and evaluation purposes (OECD, 2002).

Innovation

Innovation is defined by the Oxford Dictionary as “The action or process of innovating“ respectively being “A new method, idea, product, etc“(2014).

Innovation is another complex activity including many interacting components (Organisation for Economic Co-Operation and Development, n.a.). The ‘Innovation Union’, part of a strategy to create a better environment for innovation in the EU, sees innovation as a mean for smart growth (replacing products being phased out, developing environment-friendly

products, improving product quality etc.), implying the development of an economy based on knowledge and innovation (von Schomberg, 2013; Organisation for Economic Co-Operation and Development, n.a.). The knowledge-based economy relies increasingly on knowledge, information and high skill levels, and provides easy access to them (Organisation for Economic Co-Operation and Development, n.a.).

Innovations do not take place on their own, instead they require cooperation and rely on interfaces, as they may also be seen as financial exploitation of inventions (Leydesdorff &Meyer, 2007). At the macro-level, innovation is seen as a dominant factor in national economic growth and international patterns of trade (Organisation for Economic Co-Operation and Development, n.a.). A non-linear dynamic is involved in the innovation process, which characterizes new layers as long as the involved institution can construct support structures (Leydesdorff &Meyer, 2007).

The success of an innovation on the market is unpredictable and reflects the shift of needs and desires of consumers (von Schomberg, 2013). This is also reflected in the belief that innovation developmentis not fully controlled by producers of technology, but also by users as they can shift the context of use and thereby trigger new innovations.

Each broad function within the process of innovation involves a number of sub-processes, and their outcomes are often unknown. Therefore, it is often necessary to return to earlier stages in the innovation process to solve the occurring difficulties in the development stage, requiring constant feedback of all parties in the process (Organisation for Economic Co-Operation and Development, n.a.).

Competition on the market is supported on the one hand by openness and on the other by providing access to knowledge so that innovation becomes a goal as such, due to the fact that it may lead to improvements of existing products and services through innovation accomplished by the free market (von Schomberg, 2013).

All taken together, innovation stands for a significant technological improvement regarding e.g. products, production processes or delivery processes meaning that innovation is not occurring if there is no significant change, a change without novelty, or other creative inputs towards them (Organisation for Economic Co-Operation and Development, n.a.).

Responsible Research and Innovation

RRI can be conceptualized as a process, which is transparent as well as interactive and promotes societal actors to work together to better align both the process and its outcomes, with the values, needs and expectations of society (Geoghegan-Quinn, 2012). The actors are connected during the process of research and innovation, so that they become mutually

responsive towards each other and e.g. citizens will have an increasing stake in the European Research Area (ERA) and science in Europe as such (PRO INNO, 2012; Siune, Markus, Calloni, Felt, Gorski, Grunwald, Rip, de Semir & Wyatt, 2009). Simultaneously it is considered what is ethically acceptable, sustainable and socially desirable within the innovation process and its marketable products (von Schomberg, 2013).

ELSA, the predecessor of RRI, was a programme partly based on ELSI, but at the same time highlighted other aspects and tried to overcome some of the restrictions of ELSI (Zwart, Landeweerd & van Rooij, 2014). ELSI has been criticized for not being successful as it had not enough political implications to change agendas and not or only limited effect on policy-making (Zwart & Nelis, 2009). Another point of criticism concerns the proximity between ELSI researchers and their object of study, which can lead to a failure of remaining independent (Zwart & Nelis, 2009).

As the necessity to increase the policy impact of ELSI has been recognized, this was tried to overcome by the ELSA programme (Zwart & Nelis, 2009). It was also supposed to cover more research fields and to focus more on increased collaboration and interaction between experts from various academic areas. Scientific expertise as such was considered to be not enough to direct research and innovation, which is why strategies were needed to avoid public resistance and instead embrace them (Zwart, Landeweerd & van Rooij, 2014).

During the 1990s, ethical issues within the field of science and technology were of growing concern and started to be taken into account by policy makers on all policy levels, making ethics a policy instrument rather than an academic discipline (Zwart, Landeweerd & van Rooij, 2014).

The first decade of the 21st century was the time of ELSA but then, at least within the EU, the term was replaced by Responsible Research and Innovation (Zwart, Landeweerd & van Rooij, 2014). RRI, just like ELSA, is not a new or specific discipline but a strategy to change how research and innovation is conducted. It focuses more explicitly on societal responsibility as by now, science is expected to improve the functioning of society by developing innovations (Zwart, Landeweerd & van Rooij, 2014). Therefore, RRI as such is not a radically new concept as for a definition like that too many criteria of RRI are the same as the ones of ELSA/ ELSI. Nevertheless, it is also not possible to say that RRI is just a new name for ELSA as the overall approach is different. RRI is linked more strongly to innovation and addresses socio-economic challenges by considering the best for society within RRI (Zwart, Landeweerd & van Rooij, 2014). Another difference is the aim of RRI to ensure that the EU

economy remains competitive and stable to be able to create jobs, and secure wealth and well - being for its citizens (Zwart, Landeweerd & van Rooij, 2014).

RRI is an ambitious challenge for the creation of a research and innovation policy driven by the needs of society and to engage all societal actors through inclusive participatory approaches as well as to arrive at a more responsive, adaptive and integrated management of the innovation process (Geoghegan-Quinn, 2012; von Schomberg, 2013). A multidisciplinary approach, with the involvement of stakeholders from various disciplines and other interested parties, is supposed to lead to an inclusive innovation process as technical innovators become attentive to societal needs and societal actors become co-responsible for the innovation process by providing inputs for societal desirable products (von Schomberg, 2013).

RRI as a concept is used to increase the consideration of the needs of societies as well as the likelihood of technological acceptance within it due to early involvement of societal actors and it also helps that impacts, positive or negative, regarding new developments are better governed and exploited at an earlier stage in the research and innovation process (European Commission Services, 2011). RRI is used as an excipient for ethical considerations and societal needs in research as well as innovation (van den Hoven, Jacob, Nielsen, Roure, Rudze, Stilgoe, Blind, Guske, & Riera, 2013). It has the potential to make research and innovation investments more efficient, while at the same time focusing on global societal challenges (van den Hoven et al, 2013).

The criteria of RRI

The Responsible Research and Innovation framework, which, based on Geoghegan-Quinn (2012), consists of six defining points is an adequate reference point to analyze if the EU is implementing the criteria of RRI in its current research and innovation programme.

The first of them is 'engagement of all societal actors'. They can be researchers, policy-makers or members of civil society and industry etc. who are being involved in research and innovation and it is aimed that their joint participation in the research and innovation process is strengthened and furthermore encouraged so that it is actually possible to tackle the challenges facing society via innovative solutions, products and services (Geoghegan-Quinn, 2012). One example of how governments are trying to connect actors is the concept of Corporate Social Responsibility (CSR) where public policies are adopted to promote and encourage businesses to behave in a responsible and sustainable manner due to managing social and environmental impacts by relying on their relationship with stakeholders (Albareda, Lozano & Ysa, 2007). The second criteria 'gender equality', means that both genders are equally involved in the process of innovation and the offered programmes by

having the same chances to participate and that women and men are placed to the same extent in advisory groups addressing these issues, neither of them suffers discrimination and that the underrepresentation of women is addressed (Geoghegan-Quinn, 2012). The next one, 'science education', refers to the need of Europe to increase its number of researchers and enhance the current education process to better equip future researchers and other societal actors with the necessary knowledge and tools to fully participate and take responsibility in the research and innovation process, which also requires increasing the interest of youngsters in fields such as science (Geoghegan-Quinn, 2012). 'Ethics' (fundamental rights, ethical standards etc.), the fourth criteria, must be respected within research and innovation to adequately respond to societal challenges and to ensure societal relevance and acceptability of research and innovation outcomes. Ethics should not be perceived as a constraint to research and innovation, but rather as a way of ensuring high quality results (Geoghegan-Quinn, 2012). The fifth criteria is 'open access'. It is implied that in order to have RRI the process must be shaped transparent and accessible, including the offer of free online access to the results of publicly funded research, increasing innovation potential and the usage of scientific results by all societal actors as it makes the whole process comprehensible (Geoghegan-Quinn, 2012). The final criteria, 'governance', aims for harmonious models for RRI, developed to integrate public engagement, gender equality, science education, open access and ethics (Geoghegan-Quinn, 2012).

Research and innovation is responsible if public values, ideals a society considers important referring for e.g. to behavior and attitude, are considered. In this context, these values are meant to serve the public good, by being appropriately incorporated during the innovation process, implying at first the identification of the public values at stake, and then being actually considered and protected within the process (Taebi, Correljé, Cuppen, Dignum & Pesch, 2014). In RRI, the analysis of potential value conflicts and their solution should be an integral part during the whole process (Taebi et al, 2014). RRI also involves anticipatory governance, meaning that it should also be thought about what may derive from research and innovation (Nordmann, 2014). RRI takes into account the fact that actions and events have consequences for which someone is responsible and that action is taken when they become apparent (Nordmann, 2014).

Therefore, irresponsible research and innovation means not to consider society but rather that the focus is on making profit or benefiting somehow differently as such and that also the consequences that possibly derive from research and innovation are ignored, not considered, not tried to be solved or pushed out of the way. Examples are computer viruses and spy

software made possible through the increased interconnectedness of computers world wide and coal mining where profit is in the foreground but environmental and health issues are to a high extent ignored.

This has also implications for RRI as it can be criticized that it is still a policy innovation project in the process, and that its boundaries are not determined yet (van Oudeusden, 2014). Van Oudheudsen (2014) views RRI rather critically due to reasons like the possible failing of introducing science and technology into society when the procedure and the values of the innovation are in conflict with societal values and also that politics, as well as power, are not sufficiently theorized or acknowledged within the RRI framework yet.

Nevertheless, it can be reasoned that a responsible innovation policy promotes the consideration of ethical and social consequences while trying to foster innovation and that emerging innovation(s) should be beneficial for the whole of society. Countries engaging in RRI are e.g. Norway, Germany and the Netherlands who are using programmes for technology assessments or Denmark initiating consensus conferences to increase the publics' interest (Albareda, Lozano & Ysa, 2007).

2.2 The System of Innovation approach

The Linear Model of Innovation (LMI) influenced the development of the SI approach, which is why the LMI will be shortly introduced.

The model comes from the fields of management and economics, and the ambition to study the origin of, and the factors responsible for, inventions (Godin, 2013). The LMI is primarily concerned with the creation of knowledge and postulates that the innovation process starts out with basic research, which then transcribes into applied research and development, and then ends with the production and diffusion of products and or technology (Godin, 2005).

The model proved to be useful from rhetorical, ideological and political points of view, being used to justify rapidly growing government investments in basic and academic research during the 1950s until the 1970s but was simultaneously an over-simplification of the innovation process (Martin, 2010). The LMI was insufficient to produce a transfer of knowledge and technology and to trigger innovation (Etzkowitz &Leydesdorff, 2000).

In this sense, the System of Innovation approach emerged as a reaction to the lack of plausibility and normative implications of the LMI and due to the perceived inadequacy of the neoclassical theory to explain innovation processes (Chaminade &Edquist, 2010). The approach has its root in several theoretical and institutional approaches like evolutionary theory (the focus there is on the interactive mechanisms that shape the emergence and diffusion of innovation) and sociology (Chaminade &Edquist, 2010).

The SI approach is conceived e.g. by Klein Woolthuis, Lankhuizen, and Gilsing (2005) as an interactive, non-linear process in which actors, also called organizations, e.g. firms interact with a manifold of other organizations (research institutions, customers etc.) and institutions (regulations, culture etc.), which are the rules to be followed during the process (Edquist & Chaminade, 2006). This process, characterized by reciprocity and feedback mechanisms, determines the success of innovation. By focusing on the interactions between actors and institutions, it is possible to detect factors that lead to successful innovation. Klein Woolthuis et al (2005) argue that it provides possibilities to identify the direction of public support and is helpful for policy makers from a practical and specific point of view. The crucial factors of the approach are the environment and the strengthening of working relations to foster innovation and that institutions should not be underestimated, as they are also important in relation to economic behavior and performance (Klein Woolthuis et al., 2005).

Edquist and Chaminade (2006) propose to split up the operation of the SI approach into activities, the role of the government and the interplay between private and public actors. That should enable the researchers to suggest clear recommendations involving detailed plans on how and when public actors should intervene. The striking features of the SI approach are the collective working processes and the involvement of actors and institutions, shifting the focus away from the actions at the level of individual and isolated units (firms, consumers) towards that of the collective actions underlying innovation and the fact that firms do not innovate in isolation but due to continuous interactions with other organizations in the system (Chaminade &Edquist, 2010).

Innovation policy can influence the spontaneous development of innovation systems only to a limited extent. The approach indicates that policy makers should intervene in those areas where the system is not operating well, that is, when there are systemic problems or failures (Chaminade &Edquist, 2010). The SI approach is supposed to help policy makers to adapt policies in regard to identified systemic failures and to eliminate or at least reduce them with the thereby created policies (Chaminade &Edquist, 2010). But as the failures change over time it is necessary that the policy is able to take such developments into account and to keep the option of adjusting the priorities of the policy and therefore to retain a certain degree of flexibility (Chaminade &Edquist, 2010). This also means that it is necessary to include evaluation and verification means in the policy to be aware of possible failures.

Critique on the system is insofar legitimate as various studies have found that even so collaboration between scientists could generate more and better research, collaboration can only be developed through communication by the concerned actors about their opinions and

goals regarding research and innovation (Flipse et al, 2014). Since it takes time to develop a relationship that allows for critical comments, collaboration can only work through constant interaction over a long period making the project time consuming and expensive (Flipse et al, 2014). Also it is necessary that collaboration is done on a voluntary base otherwise productive outcomes are unlikely (Flipse et al, 2014).

Nevertheless, if it should be possible to detect RRI criteria under the Horizon 2020 programme it will be tried to connect them to the systemic view of innovation. To see whether the just carved out characteristics of the SI approach would fit, it will be searched for guidelines trying to promote the collaboration of actors, which is the main criteria of the SI approach, and whether flexibility and incentives for an evaluation plan regarding the implementation and success of the policy are included.

2.2.1 The Triple Helix model

The Triple Helix model concentrates on the interactions between universities, government and industry (Martin, 2010). It is assumed that the interactions increased during the last decades and more overlaps between the distinct helices were established. The underlying presumption of the model is that the interactions of university, industry and government are most pressing to further improve the conditions for innovation in a knowledge- based society (Etzkowitz, 2003). Due to the fact that knowledge has become more directly involved in industrial production and governance, the university plays a new role in society (Etzkowitz, 2003).

The transformation of universities into a source of innovation is a by- product of the transformation of innovation within individual firms to one that takes place among and between firms and knowledge-producing institutions (Etzkowitz, 2003). Therefore, the Triple Helix model is based upon the hypothesis that the university can play an enhanced role in innovation in the increasingly knowledge-based society (Etzkowitz & Leydesdorff, 2000). The university has traditionally been viewed as a support structure for innovation, providing trained persons, research results, and knowledge to industry but recently the university has additionally become involved in the formation of firms, often based on new technologies originating in academically conducted research (Etzkowitz, 2003).

In the Triple Helix industry operates as the place of production, government as guarantying stable relations and continuous exchange, and the university as a source of new knowledge (Etzkowitz, 2003).

The organizing principle of the Triple Helix is the expectation that the university is increasingly an entrepreneur within society, being more independent of industry and government but is still interacting with them (Etzkowitz, 2003). The entrepreneurial

university has still functions like the social reproduction and extension of certified knowledge, but places them in a broader context.

Usually, a Triple Helix starts when university, industry, and government enter into a relationship with each other in which each attempts to enhance the performance of the others (Etzkowitz, 2003). At this initial level of the model, the partners typically begin to interact to improve the local economy and the university gains additional resources from industry and government to enhance its performance (Etzkowitz, 2003). The next step is that each partner takes the role of the other but is also maintaining its primary role and identity. This is supposed to become a source of innovation and supports the emergence of creativity that arises in other spirals (Etzkowitz, 2003). These arrangements are often encouraged, but not controlled, by the government or subordinated agencies (Etzkowitz &Leydesdorff, 2000). More than the development of new products in firms, it is also the creation of new arrangements among the institutional spheres that foster the conditions for innovation and interaction (Etzkowitz &Leydesdorff, 2000; Etzkowitz, 2003).

A Triple Helix in which each strand is connected to the other can be expected to develop an overlay of communications, networks, and organizations (Etzkowitz &Leydesdorff, 2000). This network generates reflexive sub-dynamics of intentions, strategies, and projects that add to the underlying infrastructure in order to achieve the goals set up by the partners. It has to be considered though that the Helix is not expected to be stable but that the relations between the actors may vary, shift or break apart (Etzkowitz &Leydesdorff, 2000).

The existence of civil society, the ability of individuals and groups to freely organize, debate, and take initiatives, without permission from the state, and a democratic order is the basis for a Triple Helix of bottom-up as well as top-down initiatives (Etzkowitz, 2003).

The Triple Helix, as an analytical model, contributes to the description of the variety of institutional arrangements and policy models an explanation of their dynamics (Etzkowitz &Leydesdorff, 2000). It provides a flexible framework to guide knowledge-based economic and social developments (Etzkowitz, 2003).

Still, the creation of such partnerships does not lead necessarily to productivity and the achievement of goals that were set out in the beginning of the partnership. The partnerships often end because of different organizational structures and differences in the nature of their work, which cannot be overcome (Suncica Oberman, Anamarija &Oto, 2012). Another reason for the possible failure of the Triple Helix are the various interests of the sectors and as each sector is seeking to promote its own ambitions the long- term goals are neglected, which also

influences the behavior and possible good cooperation of the actors to take a turn for the worse (Suncica Oberman, Anamarija &Oto, 2012).

To see whether the Triple Helix model could be found under the possible RRI narrative within Horizon 2020 there would be a close look to possible references towards the strengthening of the relationship between universities, companies and government and if civil society is included as well to contribute to the development of research and innovation.

2.2.2 The Regional System of Innovation

The Regional System of Innovation has been gaining much attention from policy makers and academic researchers since the early 1990s partly due to the increased intensity of international competition in a globalizing economy and the emergence of successful clusters of firms and industries in many regions around the world (Doloreux & Parto, 2004).

The RSI is a normative and descriptive approach that aims to capture how technological development takes place within a territory and has been adopted to show the importance of regions as modes of economic and technological organization (Doloreux & Parto, 2004).

The system has no commonly accepted definition, but can be seen as comprising private and public interests, formal institutions and other organizations that function according to organizational and institutional arrangements as well as to the use and dissemination of knowledge (Doloreux & Parto, 2004). A RSI promotes the capacity of the region to implement, apply and adapt innovations originating from elsewhere (Cooke, Uranga & Etxebarria, 1997). Regions can be seen as having evolved along different trajectories through combinations of political, cultural and economic forces (Cooke, Uranga & Etxebarria, 1997). Their territories are smaller than their state, they possess significant supralocal governance capacity and cohesiveness, which differentiates them from their state and other regions (Cooke, Uranga & Etxebarria, 1997).

Regions are often dealt with as an isolated manner, as the interrelationships with other regions or higher government levels, are underestimated (Tödtling & Trippl, 2005). Innovative activities of firms are to a large degree based on localized resources such as labor market and labor forces, learning possibilities and spillover effects, traditions for co-operation and entrepreneurial attitude, supporting agencies and organizations and the presence of customers and users (Doloreu & Parto, 2004). But also non-regional, national and federal interactions are crucial within systems and in almost all of them are global linkages between the regional cluster and innovation partners to be found (Cooke, 2001). More successful innovative firms have the ability to connect to different innovation systems as a source of a competitive

advantage and provide sources of knowledge that not only generate inputs for firms, but also sustain their economic activity (Doloreux & Parto, 2004).

Regions differ with respect to their industrial specialization pattern and their innovation performance (Tödtling & Trippl, 2005). Knowledge spillovers, which play a key role in the innovation process, are often spatially bound and policy competences and institutions are partly bound to subnational territories. Thus, the role of formal (i.e. organizations and laws) and informal institutions (practices, norms and routines) shapes the behavior and interactions of the actors (Tödtling & Trippl, 2005).

Policy actors at this level can be powerful insofar as they shape regional innovation processes, provided that there is sufficient regional autonomy to formulate and implement innovation policies (Tödtling & Trippl, 2005). Regional governance for innovation entails the facilitation of interaction between parties, including where appropriate and available, the competences of Member State (MS) and EU resources (Cooke, 2001). Policies should stimulate the growth of strong private investing organizations that will have the profit-motive as the incentive to be more active (Cooke, 2001). Especially the maintaining and strengthening of the links between actors in the RSI becomes important (Martin, 2010).

The approach makes it possible to take regional differences into account by analyzing the strengths and weaknesses and the interactions in the RSI can be seen in the context of global innovation interactions (Tödtling & Trippl, 2005; Cooke, 2001).

Due to the differences among the regions there is no best regional innovation policy approach, which could be applied to any type of region so that for each ot the region a new policy has to be created (Tödtling & Trippl, 2005). Because of the various definitions of the concepts and factors of the system it is rather complicated to operationalize an innovation strategy using this approach (Uyarra, 2009). Issues regarding the intervention by policy actions are not well addressed in the RSI literature, as the model is unable to clarify how to recognize a RSI in the first place (Uyarra, 2009).

To trace signs of the RSI, if it has been established that within Horizon 2020 the RRI narrative is included, it would be necessary to see what is said in regard to regions. It is important to note that regions do not have to be within one MS but can be transnational.

3 Methodology

The focus of the thesis is on the RRI narrative as well as the systemic innovation models within the Horizon 2020 programme, making the paper an exploratory analysis, addressing

the way in which the concepts and approaches are represented in primary and secondary sources.

As the main purpose of this thesis to analyze Horizon 2020 to see how it integrates the RRI narrative and the SI approach to contribute to an overall picture of European research and innovation policies, the main research question is

> 'How does Horizon 2020 incorporate the Responsible Research and Innovation narrative and to what extent this incorporation takes into account the Systems of Innovation approach?'

This will be answered through carefully and explicitly responding to the sub-questions

> (1) 'What is Responsible Research and Innovation and how could its features be retrieved within the Horizon 2020 programme?'
>
> (2) 'What is the Systems of Innovation approach and how are its subtypes differing from each other?'

The first sub-question is answered through the features of RRI established by the Responsible Research and Innovation framework ('engagement of all societal actors', 'gender equality', 'science education', 'ethics', 'open access' and 'governance') and the second sub- question by focusing on theoretical models. It is necessary to clarify what constitutes the SI approach, the Triple Helix and the RSI – what are the features of it, how can it be applied towards a policy – to then relate that to the possible existence of RRI under the Horizon 2020 programme.

Methodologically, to answer the research question adequately the most important step was to collect the data needed for the appropriate amount of knowledge to be able to provide an answer. Within the thesis data is mainly qualitative, comprising scientific literature, and policies, regulations and communications by the EU. This information was collected mainly through electronic means. Research was conducted on official websites of the EU, especially data of the European Commission, providing reports regarding research and innovation within the EU and the implementation process of the concepts and how this should be achieved. Examples include the report 'Towards Responsible Research and Innovation in the Information and Communication Technologies and Security Technologies Fields' (2011) and 'Responsible Research and Innovation - Europe's ability to respond to societal challenges' (2012). But also other scientific sources, like journal articles from reliable publications and several websites were used to retrieve information, especially in regard to a theoretical understanding of the innovation models e.g. by reading contributions by authors who are

well- known for their work in the field of innovation policy like Charles Edquist in regard to the SI approach and Henry Etzkowitz towards the Triple Helix model.
The collected data were analyzed, weighted against each other and the most valuable information was included in the thesis. Thereby it was important that they would either contribute to a further understanding of the concepts, gave critical input, were providing background information and made understanding the general context easier or gave insights in the use of the concepts in the political sphere. Information, which was not included, concerns actual implementation processes of former research and information policies.
The writer started with marginal knowledge of the topic to write the thesis, so it can be said that a grounded theory approach was used. First information about the topic was gained to get familiar with it, then organized and processed and finally, a plan was developed on how to progress with the writing of the thesis.

4 Analysis

The following part is about analyzing the Horizon 2020 programme, which is more explicitly introduced, and whether it incorporates the RRI narrative. This is done by following the characteristics of RRI outlined in the Responsible Research and Innovation framework. If there are indeed aspects of RRI found, it will be tried to establish in how far that has been done by following the SI approach and its subtypes.

4.1 Horizon 2020

The Horizon 2020 programme is the biggest EU research and innovation programme that has ever been launched and combines all existing Union research and innovation funding, aiming at reducing bureaucracy and promoting transparency (Directorate-General for Research and Innovation, 2014; European Commission, 2011)[2]. The budget of the policy comprises almost €80 billion of funding for a time period of seven years (2014 to 2020) (Directorate-General for Research and Innovation, 2014). Besides, it is assumed that it will attract much investment by private and public stakeholders in which case the programme will be boosted even more.
Investment in research and innovation is essential for the EU's future and is one of the main emphases of the Europe 2020 strategy for smart, sustainable and inclusive growth (Directorate-General for Research and Innovation, 2014). Horizon 2020 is helping to achieve

[2] Horizon 2020 – the Framework Programme for Research and Innovation (2014-2020) was established by the Regulation No 1291/2013 of the European Parliament and of the Council (European Parliament and Council Regulation 1291/ 2013).

this by coupling research to innovation and focusing on three key aspects: ‘excellent science’, ‘industrial leadership’ and ‘societal challenges’ (Directorate-General for Research and Innovation, 2014).

To promote growth and tackle societal challenges Horizon 2020 promotes the integration of research and innovation by providing funding during the process of turning an idea into a market product; to increase the support for innovation and activities close to the market for a direct economic stimulus and to focus on creating business opportunities and more possibilities for new entrants and young scientists to put forward their ideas and gain financial support (European Commission, 2011).

Horizon 2020 encourages that knowledge and ideas are shared across Europe, reducing the risk of duplicating research and that instead money can be spent more strategically (Directorate-General for Research and Innovation, 2014). Each proposal submitted in relation to Horizon 2020 is evaluated by a panel of independent experts in the areas covered by the individual Call. The expert panels score each proposal against a list of criteria and on that basis, the best proposals are selected for funding (Directorate-General for Research and Innovation, 2014).

4.2 Responsible Research and Innovation within Horizon 2020

RRI, defined by the Responsible Research and Innovation framework, consists of six key features, which have been all referred to in section 2.1 (Geoghegan-Quinn, 2012). This framework was chosen as it was developed on the EU - level, by the Directorate – General for Research and Innovation, and is thus well adequate as a reference point to analyze if the EU is implementing the criteria of RRI determined by itself in its current research and innovation programme (Geoghegan-Quinn, 2012). Therefore in the following section each of these characteristics will be evaluated against the content of Horizon 2020.

Engagement of all societal actors

The Horizon 2020 programme sets out various cooperation initiatives between the sectors of industry, government, civil society, education and the like. Nevertheless, it has to be considered whether they aim at a general collaboration policy or a collaboration policy supporting the goals of the RRI narrative like covering values and needs of the European society.

Most of the initiatives promoted in Horizon 2020 target a general improvement of cooperation to benefit innovation and competitiveness within the Union without a clear reference to RRI.

So does e.g. Point 21 of the preamble[3], which is one of the first points where a collaboration of actors is mentioned, state that the programme will "contribute to the aims of the European Innovation Partnerships in line with the flagship initiative 'Innovation Union', bringing together all relevant actors across the whole research and innovation chain" (European Parliament and Council Regulation, 2013, p.106) to be able to have a more efficient organization procedure. Further, it should improve the situation for researchers and the general situation regarding R&D by creating better working conditions to prevent researchers to leave the Union for a more favorable working environment in other countries and to advance the possibilities of innovation becoming market relevant (European Commission, 2013).

Throughout the programme there are such points referring to increased cooperation within the fields of research and innovation as is also visible in Point 24 promoting the task of bringing together all stakeholders who are crucial to the process of research and innovation by recommending that "agendas should be set in close liaison with stakeholders from all sectors concerned" (European Parliament and Council Regulation, 2013, p.107) to transmit influence to the stakeholders, hoping to raise their interest in participating during the process and to improve the procedure and possible programmes of the EU by revealing their knowledge and expertise. Furthermore, external advice is also highly valued, which is why EU related institutions like the European Technology Platforms and Joint Programming Initiatives as well as scientific panels, such as the Scientific Panel for Health will be asked for their opinions. Also Point 41, which sets out that "Horizon 2020 should promote cooperation with third countries based on common interest and mutual benefit" (European Parliament and Council Regulation, 2013, p.108), goes into this direction. But also Articles are dealing with the increased cooperation objective. Article 13 states "the need to build appropriate synergies and complementarities between national and European research and innovation programmes" and Article 25 sets out regulations concerning public-private partnerships "where all the partners concerned commit to supporting the development and implementation of pre-competitive research and of innovation activities of strategic importance to the Union's competitiveness and industrial leadership or to addressing specific societal challenges" (European Parliament and Council Regulation, 2013, p.113, ff.).

[3] All further mentioned Articles are always referring to the Regulation (EU) No 1291 of the European Parliament and of the Council of 11 December 2013 establishing Horizon 2020 – the Framework Programme for Research and Innovation (2014-2020) and the named Points to the preamble of the same regulation.

In comparison it can only be found to some extent that the developed cooperation initiatives within Horizon 2020 are taking into account RRI. That would be on the one hand in Point 22, stating the objective to build stronger relations between science and society, which also includes enforcing the public confidence in science matters. This will by achieved due to the fact that "Horizon 2020 should foster the informed engagement of citizens and civil society in research and innovation matters by promoting science education, by making scientific knowledge more accessible, by developing responsible research and innovation agendas that meet citizens' and civil society's concerns and expectations and by facilitating their participation in Horizon 2020 activities." (European Parliament and Council Regulation, 2013, p.106). To trigger engagement of citizens and civil society, public activities will be planned, which will also affect the establishment and promotion of public support for Horizon 2020. The point clearly mentions RRI and encourages agenda setting referring to the public and the necessity to consider the public objectives like their expressed concerns and expectations. On the other hand is Article 12 declaring that within and for the implementation of Horizon 2020 "advice and inputs provided by independent advisory groups of high level experts set up by the Commission from a broad constituency of stakeholders, including research, industry and civil society, to provide the necessary inter-disciplinary and cross-sectoral perspectives" keeping in mind "transparent and interactive processes that ensure that responsible research and innovation is supported" (European Parliament and Council Regulation, 2013, p. 113) will be taken into account.

In Annex 1 of the programme under the section 'Science and Society' the aims of promoting the relationship between science and society, RRI, science education and culture are expressed (European Parliament and Council Regulation 1291/ 2013). Also the desire to regain public confidence in science through activities of Horizon 2020, which favors the informed engagement of citizens and civil society in research and innovation processes, is stated. That is furthermore set out under Part V under 'Science with and for Society' as "The aim is to build effective cooperation between science and society, to recruit new talent for science and to pair scientific excellence with social awareness and responsibility." (European Parliament and Council Regulation, 2013, p. 121). To achieve this, the focus of activities is among others directed to "integrate society in science and innovation issues, policies and activities in order to meet citizens' interests and values and to increase the quality, relevance, social acceptability and sustainability of research and innovation" (European Parliament and Council Regulation, 2013, p. 121). Another way is to "encourage citizens to engage in science through formal and informal science education" and to develop "governance for the

advancement of responsible research and innovation by all stakeholders […] sensitive to society needs and demands, and promote an ethics framework for research and innovation (European Parliament and Council Regulation, 2013, p. 167).

All in all, it is the aim of Horizon 2020 to promote cooperation between the various actors independently of their field of expertise, and to increase the participation of them within EU projects and to learn from their knowledge to enhance projects, goals and performance. SMEs as part of industry, but also education-related and civil society actors are frequently referred to. This is done more exclusively in the field on general cooperation rather than cooperation aiming to be responsible but still it can be said that the engagement of all actors as a key characteristic of the RRI narrative is fulfilled within Horizon 2020.

Gender equality

Point 25 of the preamble of Horizon 2020 supports gender equality insofar as it states that "activities created under Horizon 2020 should promote equality between women and men in research and innovation" (European Parliament and Council Regulation, 2013, p.107), especially in regard to the underlying causes of gender imbalance, exploiting the full potential of all researchers, and integrating the gender dimension into research and innovation. Activities should also consider the principles relating to equality between women and men as laid down in Articles 2 and 3 of the Treaty on European Union (TEU) and Article 8 of the Treaty on the Functioning of the European Union (TFEU) (European Parliament and Council Regulation 1291/ 2013). Furthermore, Point 30 declares that "Horizon 2020 should have due consideration for equal treatment and non-discrimination in research and innovation content" (European Parliament and Council Regulation, 2013, p.107). Article 14 also sets out that the objectives of Horizon 2020 should be promoted, which also refers to "responsible research and innovation including gender" putting a more direct focus on the issue at stake.

All this is specified in Article 16, as "Horizon 2020 shall ensure the effective promotion of gender equality and the gender dimension in research and innovation content. Particular attention shall be paid to ensuring gender balance […] in evaluation panels and in bodies such as advisory groups and expert groups" (European Parliament and Council Regulation, 2013, p.114).

In Annex 1 it is stated, "Promoting gender equality in science and innovation is a commitment of the Union" (European Parliament and Council Regulation, 2013, p. 122). In Horizon 2020, gender equality will be addressed as a cross- cutting issue to tackle existing imbalances

between the genders, and to be able to integrate a gender dimension in research and innovation activities (European Parliament and Council Regulation 129/ 2013).
So, even the Union is addressing the issue of gender equality in Horizon 2020 by promoting gender equality and a gender balance, it is less clear on how to establish this as no explicit measures are named.

Science Education

To further improve education in Europe Point 14 of the preamble is demanding a contribution of the Knowledge and Innovation Communities (KICs) under the European Institute of Innovation and Technology (EIT) to "strongly contribute to addressing the objectives of Horizon 2020, including the societal challenges, notably by integrating research, innovation and education. The EIT should foster entrepreneurship in its higher education, research and innovation activities. In particular, it should promote excellent entrepreneurial education and support the creation of start-ups and spin-offs" (European Parliament and Council Regulation, 2013, p.106). All of this is also specified in Art. 5 of the programme e.g. by stating "The general objective of Horizon 2020 is to contribute to building a society and an economy based on knowledge and innovation across the Union" (European Parliament and Council Regulation, 2013, p.110). The priority 'Excellent science' aims to reinforce and extend the science base of the Union and to strengthen the ERA by pushing for a more competitive research and innovation system. It is set out in Annex 1 to reach this objective through four specific objectives: 'The European Research Council' (ERC) providing attractive and flexible funding for researchers; the 'Future and emerging technologies' (FET) supporting collaborative research to promote scientific collaboration across disciplines; the 'Marie Skłodowska-Curie actions' providing excellent and innovative research training as well as cross-border and cross-sector mobility of researchers and 'Research infrastructures' developing and supporting excellent European research infrastructures (European Parliament and Council Regulation 1291/ 2013).
Point 38 stresses that "Horizon 2020 should recognise the unique role that universities play within the scientific and technological base of the Union as institutions of excellence in higher education, research and innovation, with an essential role in linking the European Higher Education Area and the ERA" (European Parliament and Council Regulation, 2013, p.108).
In the Annex also cross-cutting measures are named, which are supported by means like "enhancing the attractiveness of the research profession, including the general principles of the European Charter for Researchers; strengthening the evidence base and the development of and support for the ERA […] and the Innovation Union; improving framework conditions

in support of the Innovation Union" (European Parliament and Council Regulation, 2013, p. 122).

The goal set up by the EU is to train a new generation of creative and innovative researchers, able to convert knowledge and ideas into products and services for economic and social benefit (European Parliament and Council Regulation 129/ 2013). Key activities are to provide excellent and innovative training to early-stage researchers by supplying access to interdisciplinary projects, helping researchers to develop their research career and involving universities, research institutions, research infrastructures, businesses, SMEs and other socio-economic groups from different MS, associated countries and/or third countries (European Parliament and Council Regulation 129/ 2013). It is also put forwards in the section "Science and Society" under Annex 1, stressing again that the relationship between science and society as well as the promotion of RRI must be tackled and science education enhanced (European Parliament and Council Regulation 129/ 2013).

It seems like even though education is part of Horizon 2020 it is more directed towards people that already decided to work in research and innovation but no programmes are clearly directed towards youngsters and to encourage them to be more interested towards science and technology, which is nevertheless also part of Science Education under the RRI narrative.

Ethics

Point 29 of the preamble of Horizon 2020 lies down that "Research and innovation activities supported by Horizon 2020 should respect fundamental ethical principles" (European Parliament and Council Regulation, 2013, p.107). Thereby the statements of the European Group on Ethics in Science and New Technologies should be considered as well as Article 13 TFEU and Article 168 TFEU, ensuring a high level of human health protection. Also Point 30 is contributing to this as it aims to expunge inequality and discrimination in research and innovation.

Article 19 therefore defines that "All the research and innovation activities carried out under Horizon 2020 shall comply with ethical principles and relevant national, Union and international legislation" (European Parliament and Council Regulation, 2013, p.114). Research and innovation activities must have a focus on civil applications, and some fields of research will not receive any financial support e.g. research aiming at human cloning for reproductive purposes and there will also be no funding of research activities being prohibited in all MS and no activity will be supported in a MS where such an research activity is prohibited.

As it is seen Ethics is considered in the programme of Horizon 2020 and standards are protected. It even goes so far as to clearly establish that research fields that are forbidden within a state will not receive any support from the EU to respect that embargo.

Open access

This characteristic of RRI is found within Article 18 of the Horizon 2020 programme as well as Art. 31. Article 18 sets out that "Open access to scientific publications resulting from publicly funded research under Horizon 2020 shall be ensured." as well as "Open access to research data resulting from publicly funded research under Horizon 2020 shall be promoted." (European Parliament and Council Regulation, 2013, p.114). Both of these statements will be implemented in accordance with EU Regulation No 1290/2013. Article 31 refers to the fact that "The Commission shall report and make publicly available the results of that monitoring" (European Parliament and Council Regulation, 2013, p.118) meaning the monitoring annually conducted by the Commission towards the implementation process of Horizon 2020, its specific programme and the activities of the EIT.

Still, even though open access is part of the programme it seems as it does not have such a high priority due to the fact that Article 18 mentions only the results achieved under Horizon 2020 will be made public but does not aim to make it mandatory also for other publicly funded projects.

Governance

There might not be concrete models developed covering RRI yet but the concept is nevertheless promoted within the Horizon 2020 programme. There is a first attempt under 'Science with and for Society' to develop a governance framework for RRI. Part V of the Annex is dedicated to set out again the RRI narrative and what has to be done in this regard to fulfill it (European Parliament and Council Regulation 1291/ 2013).

4.3 The System of Innovation approach, the RRI goal, and the Horizon 2020 policy

It was possible to establish that indeed characteristics of RRI are mentioned and promoted in the programme of Horizon 2020 (see section 3.1). Therefore, the next section deals with the question to what extent the RRI incorporation takes into account the Systems of Innovation approach.

The SI approach requires an increased collaboration of actors, the establishment of institutions to regulate the innovation process, the option of flexibility and measures to monitor the progress.

As increased cooperation of actors is rather similar to the aim of engaging societal actors, a characteristic of RRI, it has been established that the SI approach and RRI have this objective in common. Both try to promote collaboration to increase innovation potential while keeping in mind social aspects and to achieve a better outcome. RRI under Horizon 2020 aims at promoting and increasing the amounts of relationships between actors due to funding of research and innovation projects. The integration of research, innovation and education is promoted and a deeper exchange between them is made (European Parliament and Council Regulation 1291/ 2013). That is also visible at the undertaking to attract strong participation of universities, research centers, industry and SMEs and to be open to new participants, as it brings together the full range of research and innovation support in one common strategic framework (European Parliament and Council Regulation 1291/ 2013).

Given this information the policy aims at establishing useful relations between the actors not just regarding research in general but also improving the relations between public and private actors. It fulfills the means of the SI approach regarding the collaboration of actors.

Regarding the second characteristic, the establishment of institutions, it is not an emphasis of RRI and its features as such. Institutions can be traced within the programme related to how Horizon 2020 has to be implemented, but no rules guiding the innovation process as such, which would be the aim of the SI approach.

The third criterion of the SI approach, flexibility, is also not part of the key features of the RRI narrative. The criteria of open access might be touched slightly due to the inclusion of transparency within the concept but still it is rather vague. Under RRI flexibility is not necessary and not considered in Horizon 2020.

The last criterion, evaluation of the policy and monitoring of the implementation process, is also not part of the RRI narrative. Anyhow, Horizon 2020 takes it into account and establishes guidelines on how to proceed in this regard (e.g. Art. 31 and Art. 32) (European Parliament and Council Regulation 1291/ 2013).

Considering all the characteristics of the SI approach and its occurrence under RRI it lhas been considered to some extent. Even so only one characteristic can clearly be assigned to RRI, collaboration of actors, it is the main characteristic of the SI approach and has therefore to be highlighted.

4.3.1 The Triple Helix model

The Triple Helix is based upon the relationship between universities, firms and the government. Therefore it is searched for such a connection within the RRI narrative as well as the existence and inclusion of civil society in the process of research and innovation.

Under Horizon 2020 it is more aimed to deepen the relationship between science and society in general so that there is no explicit mentioning of the specific objective to strengthen the relationship between universities, firms and the government. Indeed the programme aims at bringing stakeholders together but that means all of them independently of their position in the innovation process (European Parliament and Council Regulation 1291/ 2013). Where there might be such a relationship established is within the advisory groups set up by the Commission as it should include, inter alia, experts from research and innovation. Still, others will be also asked to be part of it (e.g. civil society members) so it is not exclusively related to them (European Parliament and Council Regulation 1291/ 2013). Still, also public-private partnerships are encouraged under RRI, which means a partnership where private sector partners, the Union, and where appropriate, other partners, such as public sector bodies, commit to jointly support the development and implementation of research and innovation programmes or activities (European Parliament and Council Regulation 1291/ 2013). This is rather close to this aspect of the Triple Helix, even so all actors of the research and innovation process can decide whether to participate and if so with whom and to what extent.

Indeed universities are especially mentioned in the Horizon 2020 programme and their role in regard to higher education is highlighted but there is no clear connection made towards industry or government (European Parliament and Council Regulation 1291/ 2013). Universities, research institutions, research infrastructures, businesses, SMEs and other socio-economic groups from different MS, associated countries and/or third countries are supposed to contribute towards that aim, which is the closest the RRI narrative comes to implement the Triple Helix (European Parliament and Council Regulation 1291/ 2013). But due to all these different chances to meet and to participate in collaborative activities a network is created and possibilities for further collaboration provided, which means that members of academia, industry and government can decide on their own to create programmes and strengthen their relationship so that the Horizon 2020 programme provides at least all the means to do so.

The RRI narrative nevertheless covers the Triple Helix model by including civil society. It is not just the ambition of the programme to deepen the relationship between science and society, and to reinforce public confidence in science but also simultaneously to encourage them to engage more strongly in research and innovation matters, which also includes specially designed actions to attract interest. Therefore the goal is to promote science education, make scientific knowledge more accessible, develop RRI agendas that meet the concerns of the public as well as expectations and to foster their participation in Horizon 2020 activities (European Parliament and Council Regulation 1291/ 2013).

This all shows that the Triple Helix is relied on in the RRI narrative due to the fact that the engagement of citizens and civil society is postulated and even though it does not contain explicitly within the programme the strengthening of the relation between government, firms and universities it provides opportunities to do so.

4.3.2 The Regional System of Innovation

To trace signs of the RSI it is necessary to see whether regions are involved in regard to the implementation of the RRI narrative in Horizon 2020. The RSI is based upon the premise that each region is different than the other and that concentrates on improving factors like the amount of SMEs within the region, the location in general, the presence of clusters, the education possibilities offered etc. while designing an individual innovation strategy. Thus, it will be investigated whether there are progammes towards the improvement of regions.
In general, there is nothing explicitly to find in regard to regions. Indeed they are involved but rather insofar as that the corresponding authorities are asked for opinions and consulting but no suggestions for regional investment strategies are made (European Parliament and Council Regulation 1291/ 2013). It only might be that it is looked at regional programmes and activities to see what they target at and how that will be achieved for but again there are no strategies for regions developed under the RRI narrative within Horizon 2020. An example for that would be the objective of building closer synergies, which may also take the form of public- public partnerships, including international, national and regional programmes supporting research and innovation which goes somehow in such a direction (European Parliament and Council Regulation 1291/ 2013).
Under the RRI narrative it is more likely that strategies are exchanged between the regional and the EU level but regional innovation as such is not promoted. Nevertheless, one can say that the RSI is indirectly promoted, as there is indeed proof that SMEs and universities are supported within the programme, which would have a regional boost regarding research and innovation and can contribute much to the overall competitiveness of a region.

5 Conclusion

The thesis is based upon three questions, which were answered one after another, starting with the sub- questions, which led to the ability of answering the main research question.
The first sub-question, ‘What is Responsible Research and Innovation and can its features be retrieved within the EU Horizon 2020 programme?’ is answered through the features of RRI established by the Responsible Research and Innovation framework (‘engagement of all

societal actors', 'gender equality', 'science education', 'ethics', 'open access' and 'governance'). RRI is considered a process whereby actors work together reaching research and innovation goals while simultaneously keeping in mind ethical standards and the greater public good. The analysis done shows that all features of RRI are found within the Horizon 2020 programme even though it has to be said that the focus of them is set quite differently as e.g. 'gender equality' was not set out clearly enough on how to actually achieve it and another, 'open access' was only referred to in regard to Horizon 2020 itself and it was not tried to promote the issue in regard to other programmes of the Union (European Parliament and Council Regulation 1291/ 2013). Nevertheless, it proofs that RRI is indeed gaining in importance in European polices.

The second sub- question of the thesis is 'What is the Systems of Innovation approach and how are its subtypes differing from each other?' It was shown that the SI approach explains the innovation process by outlining how innovation happens and what is needed to achieve it as an outcome. The SI approach as such focuses primarily on the collaboration of actors that are involved in the innovation process whereas further criteria are the establishment of institutions, flexibility in policies as well as a monitoring and evaluation plan for the policy.

In contrast, the Triple Helix model is based on the relationship between universities, firms and the government, assuming that each of the helices promotes the other and can contribute to the improved working structure of the others. Another important part of the model is the explicit inclusion of civil society and that the democratic principles have to be guaranteed to ensure innovation.

The RSI is different insofar as it concentrates on the individual regions, and focuses on how to strengthen the factors leading to innovation and to be able to increase the overall innovation potential and the competitiveness of the region.

It can be declared that the approaches vary insofar as the priority setting of its criteria is different although all of them see innovation as a product of cooperation and they all represent the systemic view of innovation.

This finally leads to the main research question underlying the whole thesis 'How does Horizon 2020 incorporate the Responsible Research and Innovation narrative and to what extent this incorporation takes into account the Systems of Innovation approach?'

It was possible to assert that RRI is part of Horizon 2020 and that the characteristics of the System of Innovation approach are insofar relied on as engaging societal actors was found within the policy, which is the main aim of the approach leading to the conclusion that the RRI narrative within Horizon 2020 is at least to some extent based on the SI approach, also it

has to be said that neither of the other criteria can be connected to RRI but are mostly found within the programme of Horizon 2020.

The same is true for the Triple Helix model. It could not be determined that the relation the model is based on, university, industry and government, is as such strengthened but cooperation is nevertheless promoted also bringing these three sectors closer together The other criteria, the inclusion of civil society, is also considered and psuhed through RRI in Horizon 2020. All in all, the Triple Helix was taken into account, while creating the RRI narrative under Horizon 2020.

To trace signs of the Regional System of Innovation within RRI under Horizon 2020 was not directly possible. The findings show that there is no explicit support for a regional innovation strategy but as issues like education possibilities and SMEs ability to innovate were targeted within Horizon 2020 the regional status as such will be improved and innovation promoted, which will lead to an indirect enhancement of a region.

Therefore it can be concluded that Horizon 2020 incorporates RRI and that the later is based upon the systemic view of innovation. It also means that the Horizon 2020 programme, is inter alia, a responsible innovation policy.

It would be interesting to further conduct research to establish the exact amount of influence the SI approach has not just in regard to RRI but also to European policies in general. To do so it would be necessary to evaluate the whole programme of Horizon 2020 (and other policies as well for a comparison) to arrive at a reliable and valid conclusion.

Still, emanating from what has been established so far it is possible to declare some policy implications. Due to the fact that RRI has been found, it can be said that its components are important and will increasingly be part of policies within Europe, meaning that politicians have to take it into account while creating policies. When looking at the Special Eurobaromter survey 401 on Responsible Research and Innovation, Science and Technology from 2013, this is furthermore supported. 55% of respondents say that for decisions regarding science and technology public dialogue is required (TNS Opinion & Social, 2013). 61% think that fundamental rights and moral principles should not be broken for the sake of new scientific or technological discoveries and eight out of ten participants see the EU in duty to promote respect for European ethical principles considering research (TNS Opinion & Social, 2013). Also 65% of respondents think that their government is not doing enough to advocate young people's interest in science (TNS Opinion & Social, 2013). Also equality' is considered and 58% think that it is important to respect gender equality, whereas 79% agree that the results of publicly funded research should be available online for free (TNS Opinion & Social, 2013).

This shows that the concept of RRI is strongly supported by the European public. The survey nevertheless also found out that the public often feels uniformed regarding the developments in science and technology and that is a point where the MS and the EU have to work harder and develop strategies to overcome this (TNS Opinion & Social, 2013).

Also the systemic view of innovation might be more influential than thought. In general the Systems of Innovation approach as such is demanding a realignment of policy objectives and priorities, a new organization of institutions (Berg Jensen, Johnson, Lorenz & Lundvall, 2007). It has to be continued to promote the collaboration of actors and organizations to secure competiveness and growth within the EU.

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