From Theory to Practice: Assessing the Implementation of Innovation Indicators in ERDF and Teaming Research Infrastructures

a comparative analysis of Czech Research Infrastructures

by Lieve Dessing

Solis-ID: 2284286/ Učo no.: 520821

Double Degree Master Program in European Governance

Masaryk University and Utrecht University

7 July 2023

First supervisor: Drs. Linda Keijzer (Utrecht University)
Second supervisor: Mgr. Petra Kuchyňková, Ph.D. (Masaryk University)
Internship supervisor: MSc. et Mgr. Joep Bresser (Neth-ER)

Acknowledgements

I would like to express my gratitude to my friends and family who have supported me throughout the journey of completing my master's in European Governance. Their unwavering encouragement, understanding, and patience have been invaluable to me during this process. I would also like to extend my appreciation to my colleagues at Neth-ER who provided a welcoming learning environment in which I truly felt appreciated. I especially would like to thank Joep Bresser, who shared his wisdom on research and innovation policy in the CEE area with me, and thereby provided me with many insightful comments which have significantly contributed to the improvement of my thesis. I would also like to thank all my professors from both Masaryk University and Utrecht University who have taught me more than I could have hoped for, and who have guided me along this, sometimes challenging, master program. Lastly, I am immensely grateful for my classmates who have supported me throughout my writing process, but above all, have made the past two years an unforgettable experience.

Abstract

Despite their significant economic growth since joining the euro area, the Central and Eastern European (CEE) Member States are still lagging behind on their Western European counterparts in socio-economic terms. This economic gap goes hand in hand with an innovation cleavage that has its roots in its communist past. The EU has several programs in place to bridge this gap: Cohesion Policy and the Research and Innovation Framework Programs (Horizon). This thesis zoomed into two specific funds within these programs to understand what innovative output the synergies between of Cohesion Policy and Horizon funds can have: the European Regional Development Fund (ERDF) and Teaming. These funds create and build upon Research Infrastructures, which are critical research and innovation projects needed to tackle 21st century challenges. This research conducted a case study analysis of Research Infrastructures located in the Czech Republic, and analyzed how these infrastructures implemented innovation indicators during the ERDF-phase and Teaming phase. The conclusion argues that the use of synergies between the two programs can enhance the impact of Research Infrastructures, and thereby contribute to closing the innovation gap between the CEE area and its counterparts. Although, a strengthening of the implementation of these synergies is needed to make use of its full potential.

Table of contents

Abbreviations

CB – Central Bohemia

CEE – Central and Eastern European Member States

CoE – Centers of Excellence

ERA – European Research Area

ERDF – European Regional Development Fund

ESFRI – European Strategy for Research Infrastructures

FP – Framework Program

OP RDE – Operational Program Research Development Education

QHM – Quadruple Helix Model

R&I – Research and Innovation

RI – Research Infrastructure

S3 – Smart Specialization

SEWP – Spreading Excellence and Widening

SMR – South Moravia

1.Introduction

Despite their significant economic growth since joining the euro area, the Central and Eastern European (CEE) Member States are still lagging behind on their Western European counterparts in socio-economic terms (e.g. Dumford, 1994; Tiits, et al. 2008; Iammrino, 2019). This economic cleavage is paired with an innovation cleavage which is rooted in its communist past and the rough transformation period following the fall of the Soviet empire. During the communist era, these countries were characterized by centrally planned economies, state ownership of industries, and limited private entrepreneurship. This resulted in a lack of incentives for innovation and stifled creativity within the region. The state-controlled nature of the economies meant that research and development activities were primarily focused on meeting the needs of the state, rather than fostering technological advancement (Suurna and Kettel, 2010). Since the fall of communism, the Central and Eastern European countries have made significant strides in transitioning to market-based economies and embracing innovation. The CEE countries have received help in the past from the EU and other Foreign Direct Investments to boost their economies (Suurna and Kettel, 2010). However, the communist legacy continues to present challenges, and the CEE Member States still remain laggards compared to their older counterparts.

To address these challenges, the EU still has several programs in place to increase the innovative output of the Union as a whole, and close the innovation gap between the Member States. This thesis focusses on two of the EU's innovation strategies: Horizon 2020 (now Horizon Europe)[1] and the European Regional Development Fund (ERDF), which is an integral part of Cohesion Policy. Both programs invest in Research and Innovation (R&I) projects. Cohesion Policy exists to support socio-economic, and territorial cohesion across the Member States and within regions. In doing so, it tries to bridge an economic and innovative gap and create more equality by investing in regional economies. Regional authorities, in turn, are responsible for the implementation of these funds and it thus constitutes a bottom-up approach. R&I projects funded by ERDF, in turn, aim to support the economic development of the region by a strong focus on translating research outcomes to the industry. On the other hand, the Horizon programs exist to support excellent

[1] also referred to as the Framework Program for Research and Innovation (FP)

research, and to translate the results of this excellent research into innovative output to tackle 21st century challenges. It is based on a competitive funding scheme in which researchers and research institutions apply for grants at the European level. It does not aim to provide economic support for lagging regions and instead provides a top-down competitive program which should contribute to the establishment of the European Research Area (ERA). The ERA, in turn, should create an open market without borders for research and researchers to foster collaboration on research topics to tackle 21st century challenges.

This thesis will analyze how ERDF and Horizon have been used to create innovative output in Research Infrastructures (RI). Research infrastructure host state-of-the-art research facilities used by an international network of researchers. RI's, in turn, supply the region with increased R&I capacities ultimately boosting the innovative output of the region and enhance the level of research conducted. They can be either physical or digital, as long as they provide an open access policy for researchers, and thereby contribute to the establishment of the ERA. An example of such an infrastructure are laser technology machines used for health research, or mega-computers used for quantum computing. They are regarded as critical R&I projects that can have an immense impact on advancing and creating solutions for societal problems such as climate change (Zakaria and Grant, 2021).

RI's can be funded both through Cohesion Policy, and through Horizon. ERDF, of which the largest part of the budget goes to R&I projects, can be used to set up RI's which are closely embedded in the region to increase economic and innovative output and decrease disparities between regions. The Horizon program can invest in RI's through different ways. Relevant for this thesis is the investments in RI's through the Spreading Excellence and Widening Participation (SEWP or Widening in short), which is a Horizon program for countries lagging behind on excellent research (referred to as Widening countries). Widening aims to enhance the participation of these countries in Horizon and thereby increase innovative growth.

There are several measures within Widening that try to increase the participation of researchers and research institutions. This thesis focuses on one of these measures: Teaming projects. Teaming projects aim to set up or build upon "Centers of Excellence" (CoE) in CEE regions. These centers host state-of-the-art research facilities used by an international network of researchers. Throughout

this thesis, these CoE are referred to as Research Infrastructures (RI). The Widening funds used to invest in these RI's aims to increase the quantity and quality of excellent research in Widening countries and transform the R&I environment in lagging regions. Unlike the ERDF-funded RI's, Teaming-funded RI's do not aim to boost the economy of the region. However, to increase the effective implementation of the infrastructures, the Teaming projects not only make use of European funds of Horizon 2020/Europe funding, but require additional funding of at least 50%, which often comes from Cohesion Policy funding. When Horizon funds are combined with ERDF-funds, they both have to adhere to the top-down strategies of excellent research that the Teaming-project require, and the bottom-up Cohesion Policy objectives that ERDF-funds require.

This study, in turn, analyzes how Research Infrastructures set-up through ERDF-funding, who later evolved into Teaming projects, have enhanced their innovative output. This will be done through a qualitative case study analysis that researches how both ERDF Research Infrastructures and Teaming RI's have implemented certain innovation indicators. The innovation indicators used in this study are constructed through a theoretical framework that aims to establish a coherent evaluation framework to access the innovative output of Research Infrastructures. The study assumes that there is a difference in the implementation of the innovation indicators in the ERDF-funded phase, and in the Teaming-funded phase, and that the differences of the implementation constitute an advancement of the implementation. In turn, a better implementation of the indicators translates into more innovative output of the RI. An innovative RI will increase the level of competitiveness of a region and as well as economic growth, which results in a decline in the innovation cleavage between European regions and EU Member States.

To research this, the following research question is answered through both a qualitative document analysis and interviews with the managing authorities of three RI's in the Czech Republic that were founded with ERDF and later evolved to Teaming projects:

How do the differences in the implementation of innovation indicators in ERDF-funded and Teaming-funded Research Infrastructures constitute an advancement of the implementation of these indicators?

The document analysis, in turn, will be used to research how the innovation indicators are reflected in both Cohesion Policy strategies and Horizon 2020 strategies. The second part of the study relies

on an analysis conducted through interviews that aims to understand in what ways the innovation indicators have been implemented in the ERDF-funded phase, and in the Teaming-funded phase.

The research problem presented here is an inherently multidisciplinary problem. It is an economic issue as it analyzes the implementation of EU funding sources in practice. To do so, the foundation of this thesis rests upon economic theories. On the other hand, the implementation of EU funding is highly dependent on the governance of these projects. Therefore, governance theories are combined with the economic theories to accurately understand the nature of the problem. The theory, in turn, is used to form hypothesis which will be tested during the analysis. This provides insights about how the innovation indicators are implemented in the chosen Research Infrastructures.

1.1 Societal and Academic relevance

Europe is falling behind the United States and China in terms of Research Infrastructures (RIs). To address this, Europe needs to prioritize the maintenance and creation of RIs, for which substantial resources are needed. However, there is a lack of academic research examining the impact of RIs, which hinders Member States' ability to compare the returns on investment which creates difficulties for a stable flow of resources for RI's (Dannsy, 2022). This study aims to fill this gap by developing an evaluation framework to assess the innovative impact of investments in RIs made by the European Regional Development Fund (ERDF) and Teaming.

The European Council does recognizes the importance of investing in RIs to stay competitive and urges Member States to invest in the infrastructures (Dansy, 2022). Cohesion Policy and Teaming are two investment strategies of the EU, but the implementation of these strategies face some challenges. Cohesion Policy aims to decrease regional disparities and increase innovation output, but disparities are still growing (e.g., Mogila, et al. 2022; Balas 2017; Monfort, et al., 2021). Strengthening synergies between Horizon and Cohesion Policy in Widening actions is believed to enhance RI impacts, but challenges remain. Scholars and the European Commission have identified problems in the implementation and setup of Widening policies and the implementation of synergies e.g. Pelle 2015; Frietsch 2015; ECA, 2022). Analyzing the implementation of innovation indicators in projects that make use of these synergies therefore gives relevant insights into the effectiveness of synergies.

The RI's analyzed in this study are located in the Czech Republic, which is a Widening country in the CEE area that has been proactive in the development of Research Infrastructures (Naujokaitytė 2022). In the late 2000s, the Czech Republic established a strategy to build Research Infrastructures in the country through Cohesion policy. However, it is argued that the exploitation and dissemination of the results from these infrastructures could be better ingrained in society, as well as the creation of sustainable strategies (idem.). It is the combination of on the one hand a very proactive attitude on creating an extensive RI network by using Cohesion Policy, and on the other hand, the problems of many RI's of translating the results of research projects to society and creating sustainable strategies that makes the Czech Republic an interesting case. Furthermore, this study only focuses on one country as this eliminates potentially confounding differences in governance, politics, and policies between different countries. This choice constitutes a fairer comparison between the RI's, including its strategies.

Overall, this research contributes to the debate on reducing the innovation gap between European regions and provides valuable information for EU policymakers involved in cohesion and research and innovation policies.

1.2 Reader's guide

This thesis will first provide a historical context to the innovation cleavage between the CEE countries and the older Member States (Chapter 2). Hereafter the different EU instruments in place to tackle this innovation cleavage (Cohesion Policy and Horizon 2020) are discussed in more detail (Chapter 3). Chapter 4 goes into the relevance of this research, both highlighting the academic and societal value. The following chapters discuss the theoretical and methodological framework (Chapter 5 and 6), which after the results, and the implications of these results, are discusses (Chapters 7 to 12). The conclusion of this thesis presents a summary of the analysis conducted, aims to answer the research question, and provides suggestions for future research (Chapter 11).

2.The Innovation Cleavage

The innovation cleavage between the Central and Eastern European member states and the older Member States has its roots in its communist past. The communist legacy of the Eastern European member states has hampered the development of their innovation systems, limiting the development of these countries. The question at hand is whether they will ever be able to catch-up. Some scholars point out that through investments in innovation, this gap can in be bridged (e.g., Petrariu et al. 2013; Edler, 2009). The following section gives an overview of the history of innovation systems in the CEE area during the Soviet system and the harsh transition period that followed.

2.1 The Soviet System and its breakdown

The Soviet system severely hampered the innovation process of the Eastern European countries through its centralized state system (Schuch, 2014). The system relied on extensive state control and state investments and science and research were also controlled by the state which limited the autonomy of researchers and the competitiveness of funding for research. Due to this system, there were no proper evaluations of the research and innovation system (Balazs, Faulkner, & Schimank, 1995). Furthermore, the Communist system relied on a linear model of innovation, rather than a complex and dynamic system of innovation (Balázs, 1998). This practice meant that the communist state's policies were built on the assumption that basic research would flow into readymade innovations that would immediately be implemented by the industry. It separated the various phases of research and assumed that innovations occurred in isolation. This, in turn, hampered the transition from basic to applied research (Darvas, 1998). Moreover, the basic research conducted was related to industrial advancements contributing to the Communist system. It is these factors that contributed to the deadlock of the innovation systems in the Communist CEE states, and no further progression could be made until the breakdown of the communist period. In contrast, its Western counterparts had a more dynamic system in place that involved stakeholders from several levels and sectors, such as businesses and educational institutions. And in which there was academic freedom and competitiveness for funding, which has proven to be more fruitful for economic and innovative advancements (Balázs, 1988).

When the Soviet system fell, the CEE countries had to make a transition from an autocratic and centralized state towards a competitive and pluralistic market system (Müller, 1995). The

transition period was an overall harsh period with many recessions and led to negative consequences for the innovative capacities of CEE regions (Krammer, 2009). The CEE area experienced academic freedom for the first time, however, the funding of research institutions was severely cut (Keszei, et al. 2015). Several factors led to decreased resources for R&I. Firstly, a higher budget for education as well as research did not go hand in hand. The funds were distributed in separate streams, and more funding was available for educational aims. This caused higher education institutions to focus more on educating instead of on conducting research (Kwiek, 2012). Secondly, the liberalized market underwent severe decentralization and privatization. During the communist regime, research was closely connected to centralized industrial aims. However, with privatization and decentralization setting the stage, this strategic aim was eliminated and the public funding for R&I was cut (Müller, 1995). Thirdly, even though there was a large sum of money pumped into the transition countries through Foreign Direct Investment, knowledge spillovers to research institutions remained limited. This was caused by a lack of connection to the regional research institutions (Biegelbauer, Griessler, & Leuthold, 2001).

The worsening economic conditions, combined with the adverse conditions in the research field, made the 1990s a period that experienced an elevated level of brain drain, leading to a declining number of researchers while the demographic that stayed was severely aging (van der Lande, 1998). Furthermore, the conditions during the transition period also undermined the upkeep of research infrastructures, causing outdated infrastructures to be in need of modernization (Schuch, 2005).

These developments explain the innovation cleavage between the CEE member states and the older member states. However, as already mentioned above, the EU had an influence in shaping the governance systems of the CEE countries, and in this way also helped shape the R&I policies of the countries in question.

2.2 The innovation paradox

Several scholars argue that the Europeanization of innovation policies in the CEE member states during the transition period was far-reaching (e.g., Suurna, Kettel, 2010 , Reinert, et al., 2009). The EU set high criteria for potential member states to join the EU and did so as well for the former Communist countries. The prospect of joining the EU gave the countries enough incentive to want to adhere to the set criteria (Suurna and Kettel 2010), although the countries faced some challenges

in reaching the standards. As these criteria were mostly economic standards, the EU invested funds in the economies of the future CEE member states by setting up the PHARE program to ensure gradual democratic development in the former Soviet states. PHARE was, among other things, used for projects that boosted innovation in the CEE area (Martens, 2001; Grabbe, 2006) and the implementation of the program enabled the CEE area to reach the EU accession criteria (Suurna and Kettel, 2010). The PHARE program aimed to develop a bottom-up implementation through regional governance and forced the CEE countries to set up agencies that monitor EU and national funds. However, the weak administrative capacity of the governance systems of the CEE countries did not fit this 'agencyfication' which undermined cooperation and coordination between the ministries and the agencies (ESPON, 2005). The inefficiency of the policies in place during the transition period impeded the development of the R&I landscape of the CEE area. This inefficiency is why the EU took matters into its own hands and provided a centralized approach to facilitate economic growth (Bache, 2010; Marcou 2002; Leonardi, 2005). After the accession of the new Member States the economic investments in, among other things, research and innovation remained and was now implemented through Cohesion Policy.

Despite these previous attempts to remedy the disparities between the CEE area and the west, the innovation gap remains a challenge to this day. According to Suurna and Kettel (2010), there remains an over-emphasis on the linear innovation model of innovation. On top of that, there has been insufficient administrative compliance at the local level of European strategies, which causes a weak innovation system that does not respond adequately to the wants and needs at this level.

The regional innovation paradox (Oughton et al. 2002) explains why the innovation cleavage still exists between European Member States, but also within those member states. The innovation paradox refers to the contradiction between the need to invest in research and innovation in certain regions, while those are the regions that have trouble effectively implementing the additional funding and translating them to innovative output (Oughton, et al. 2002). Furthermore, the increasing openness of our economies and innovation systems impedes the regions' ability to retain brain circulation (Gassmann et al. 2010). Thus, effective investments in research and innovation are higher in wealthier regions. Countries in the CEE area then score low on existing innovation scoreboards (Frietsch, et al. 2015) even though there are investments made in research and innovation in these areas. However, there is low dissemination and integration of the research

results in society (idem.). The question then is whether the current EU R&I strategies try to tackle this innovation paradox and whether the strategies in fact enhance innovative output in lagging regions. This thesis analyzes these processes in two specific R&I policies: ERDF and Teaming, which will be discussed in the following chapter.

3. EU Research and Innovation policies

As the information in the historical context above provided, the CEE suffers from a severe disadvantage in its innovation systems compared to older Member States. The EU, therefore, introduced strategies that have been placed to bridge the innovation gap between the member states. The research conducted for this thesis investigates whether Cohesion Policy and Teaming enhance have led to the implementation of innovation indicators. This investigation gives more insight into the effectiveness of European investments in research and innovation aiming to decrease the innovation gap in Europe, as well as the use of synergies between Cohesion Policy and Horizon funding. To understand how the two strategies contribute to innovation, the strategies themselves need to be discussed. The following chapter will do so.

3.1 Cohesion Policy

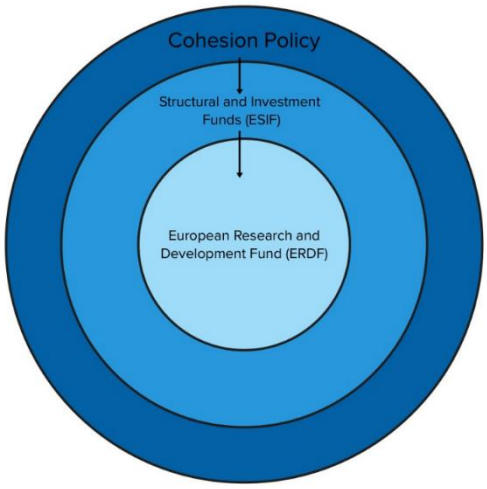


Figure 1: Cohesion Policy. Author's design.

A multitude of studies has researched the effectiveness of Cohesion Policy to help bridge the innovation cleavage in Europe and address the innovation paradox (e.g., Mogila et al, 2022, Sielker et al. 2021, Rauhut and Humer, 2020). According to some scholars (e.g., Dall'erba and Le Gallo, 2008; Sosvilla-Rivero et al., 2006; Ulltveit-Moe, 2007, Suurna, Kettel, 2010), Cohesion Policy played a significant role in boosting innovative output in the CEE area from 2004 onward. The EU launched this extensive regional policy to combat innovation disparities between European regions. By investing in regions, the EU aims to boost economic growth and innovation. More specifically, Cohesion Policy aims to bridge economic, social, and territorial disparities and increase regional development (Kolodziejski 2023). To do so, Cohesion Policy consists of different funds (Figure 1). All Cohesion Policy funds are funded through the European Structural Investment Fund (ESIF). Structural funds take up the largest part of the EU's budget. The Structural Funds, in turn, fund other Cohesion Policy funds, one being the European Regional Development Fund (ERDF). The ERDF is one of the main financial instruments of the EU's Cohesion Policy and aims to reduce "disparities between the levels of

development of European regions and to improve living standards in the least-developed regions." (Kołodziejski 2022 p.1). ERDF is mainly used for R&I projects with a requirement of 70 percent of the funds to be distributed towards R&I (idem.). The funds are more specifically targeted to set up R&I projects that have a large innovation output in the region (The Guild, 2023). Investments under this structure are mostly made in deep- and high-tech sectors that emphasize the cooperation between research and industry. This study will refer to Cohesion Policy and ERDF interchangeably.

During the CEE accession talks (prior to 2004) it became clear that the CEE countries would have to take on a more state-centered involvement of innovation policies to be able to implement the EU's Cohesion Policy and manage the planning that comes with it. The financial support provided through Cohesion Policy further enhanced the ability of the EU to shape the first innovation-oriented policies in the CEE area, as well as the ability to set up new agencies in the member states to implement these funds. As a first step, PHARE was again decentralized and made fit to deal with Cohesion Policy. But, even though regional funds should increase innovation investments, differences remain. There has been a long range of academic publications that have researched the impact of Cohesion Policy on the innovation potential of European regions (above mentioned, and: Rodriguez-Pose et al. 2002; Cappelen et al. 2003; Ederveen, et al. 2006). The studies give a mixed picture as some scholars argue for positive effects, while others argue that the implementation of Cohesion Policy does not cause regional development and economic growth. According to Reid et al. (2010), one of the main reasons for this disparity is that there was a mismatch between the supply and demand for innovation. With this statement, the authors refer to the lack of private demand for research and innovation advancements and the weak connection of research infrastructures to the region. More specifically, the relationships between the actors of research institutions with the industry are weak impeding the valorization of research results into innovative output. Other scholars (Ederveen et al. 2006) argue that inequalities arise because of the differences in the capacities of regional authorities to ensure adequate implementation of funding. The access to structural funds, therefore, varies across regions in the CEE (Michie and Oughton 2001). As regions are quite autonomous in organizing their funds, it has become apparent that some regions are better at managing the implementation of these funds than others. The different pre-existing socioeconomic and institutional structures of different regions, therefore, need to be considered when developing innovation strategies (McCann and Ortega-Argilés, 2015). Hollander, et al.

(2012) pointed out that regional disparities within European countries are even increasing, even though Cohesion Policy was already a core instrument in the CEE area since 2004. This could then be regarded as a criticism of Cohesion Policy.

Due to the clear shortcomings that the scholars mentioned above identified, the Commission sought ways to improve the impact of Cohesion Policy, and therefore implemented Smart Specialization strategies in 2014. This served as a new attempt to close the gap between the CEE area and older Member states and increase the effectiveness of Cohesion Policy.

3.2 Smart Specialization

Since the wants and needs of every region differ, the so-called Smart Specialization (S3) strategy was set in place to create place-based approaches to innovation that more accurately accommodate the wants, needs, strengths, and weaknesses of different regions. The S3 strategy aims to adequately define the unique qualities and challenges of each region to enhance the implementation of the innovation indicators that should incite innovative outputs. The concept has been widely debated in academic literature on innovation policy (e.g. Di Cataldo et al. 2020; Foray, et al. 2009) and managed to gain a prominent position in EU policy making from 2014 onwards, some scholars even calling it a "policy running ahead of theory" (Foray et al. 2009, p.3). However, what exactly does it mean? Midtkandal and Sörvik (2012) provided one of the first definitions, describing it as a process that defines the areas of intervention for each region that show strategic potential to create long-term visions. Through the use of specific guidelines, the priority areas of each region are identified, this is referred to as the entrepreneurial discovery process (Di Cataldo, et al. 2020). The guidelines analyze the regional embeddedness of certain sectors and the linkages across domains, aiming to support sectors that increase the diversification of technological activities built upon knowledge structures already in base in that region (Balland et al., 2019). The involvement of different actors is also important (Foray, 2015; McCann and Ortega-Argilés, 2015, Di Cataldo, 2020). The strategy calls for the involvement of different stakeholders from government, industry, academia, and civil society, thus, in accordance with the quadruple helix model (Roman et al. 2020).

In this way, a place-based approach is developed that includes the priority areas of each region as well the implementation of a multilevel stakeholder system. For lagging regions, it provides a way to concentrate resources in selective priority areas that show potential on generating economic

growth and the specialization of the economy in a "smart" way (Forey et al. 2015; Asheim, et al. 2017).

The start of the Smart Specialization strategies in Cohesion Policy management highlights the transition from a top-down approach to a bottom-up approach to enhance local development (Di Caraldo, et al. 2020). More specifically, Smart Specialization provides top-down priorities implemented through a bottom-up implementation. The effectiveness of the S3 strategies, however, has been doubted. Although there were some early attempts on identifying the impact of S3 strategies in improving the implementation of cohesion policy (e.g., Crescenzi et al., 2020; Gianelle et al., 2020; Iacobucci and Guzzini, 2016; McCann and Ortega-Argilés, 2016), the true measurement of the potential of S3 strategies could only be done after the ending of the program period. More recent scholarly debates surround around the evaluation of the strategies. One of the criticisms to the strategies is provided by Benner (2022). He argues that the regional level has the largest autonomy in the implementation of Cohesion Policy, but that the regional level faces challenges in effectively implementing the funds which hampers the disappearance of the regional innovation paradox. There seems to be a big discrepancy between the identification of Smart Specialization indicators, and the actual implementation of these indicators (Benner 2022). Di Cataldo et al. (2020) in turn, aimed to evaluate the impact of S3 on innovative growth in regions, arguing that S3 strategies are loosely connected to the wants and needs of the region. Only regions with a good quality of governance have well-suited S3 strategies. The authors argue that in lagging regions there are often "copycat-practices" in place, in which a region defines their priority areas based on what neighboring regions are doing. This phenomenon has also been articulated by Capello and Kroll (2016) who argue that Smart Specialization strategies are difficult to implement for lagging regions as they do not have the capacity, or correct institutions on the local level to implement the funds. In addition, the political willingness to implement the strategies is also often lacking. Another problem CEE Member States face is that the mobilization of relevant stakeholders from the Quadruple Helix model remains limited (Karo et al. 2017). Thus, according to these scholars, a large autonomy for a region has over the implementation of Cohesion Policy projects is not always successful. On the other hand, McCann and Ortega-Argilés (2016) highlight that there seems to be overlap between the national and regional RIS3 strategies, providing proof that S3 approaches have resulted into a R&I landscape more adapted to the local circumstances.

However, recent research has shown that despite the practices of Cohesion Policy, the inequalities between regions have only increased more (Monfort, et al. 2022). Other research (Cresinzi, 2020) has rearticulated these results. The effectiveness of Cohesion Policy can therefore be questioned.

In conclusion, this academic review points out that a bottom-up approach of Cohesion Policy does not work out well in practice. It is therefore interesting to research whether adding top-down criteria from Horizon enhances the effective implementation of Cohesion Policy funds. The following section discusses the Horizon program and Teaming-projects in more detail.

3.3 EU Framework Programs for R&I: Horizon 2020

It has so far become apparent that the history of EU Research and Innovation policy is an evolving narrative. Cohesion Policy has played a significant role in this narrative, however, the R&I projects that fall under Cohesion Policy are aimed to invest in lagging regions to decrease inequalities across regions (Reid, 2010). It can therefore be concluded that they are not aimed at increasing the competitiveness of the EU as a whole. Therefore, there are R&I policies in place that purely aim to advance R&I cooperation within the EU and are focused on the competition for excellent research (Reid, 2010). These policies, in turn, are aimed at boosting the competitiveness level of the Union as a whole. The policies in question are referred to as the EU's Framework Programs (FP). Researchers and research institutions can apply to these funding programs at the European level. Thus, this is a top-down program, where both the set-up of priorities and the implementation of these priorities lies at the European level.

The FP already have their roots in the Treaty of Rome (1957). Even though the Treaty of Rome focused on economic cooperation and integration, the treaty also included several provisions on technical and scientific cooperation (Schot and Misa 2006). This cooperation, however, developed over the decades and integration in R&I policies became increasingly more important. In 1984 the first framework program (FP1) for research and technology was established (Meier and Schuch, 2017). This Framework Program and its successors (up to FP 9) provide budgets allocated towards collaboration on excellent research across Europe. After the Lisbon Treaty introduced a new aim to spend three percent of Europe's GPD on research and innovation, the Framework Programs started to gain more societal relevance and increasingly higher budgets (Stevienna, 2015).

Most recent and well-known FPs are FP 8 and 9, also known as Horizon 2020 and Horizon Europe. Horizon 2020 covered the period 2014-2020 and had a budget of almost €80 billion. And Horizon

Europe covers the period 2021-2027. As it is too early to analyze the impact of Horizon Europe projects, this thesis looks at Teaming-projects that have been funded through Horizon 2020. This section gives an overview of this FP. The recommendations chapter of this thesis then further discusses the improvements made during the Horizon Europe program and further builds upon possible transformations for the next Framework Program starting in 2027.

Horizon 2020 for the first time introduced an enhanced focus on societal challenges and introduced simplification measures to support research and innovation in Europe. On top of that, the budget was increased. Its main aim was to enhance innovation-driven economic growth through the translation of research into innovative output (Frietsch, et al 2015). Horizon 2020 also puts more emphasis on strengthening the synergies between the funds for the FP and Cohesion policy (Frietsch, et al. 2015). To aims of the program were reflected in three main pillars (Figure 2):

- Excellent Science: This pillar aimed to reinforce the scientific excellence of Europe by supporting fundamental research and fostering the development of world-class research infrastructures.
- Industrial leadership: the Industrial Leadership pillar aim to strengthen Europe's industrial competitiveness by supporting technological advancements, inn ovation, and access to finance for businesses.

Figure 2: Horizon 2020. Source: EC. (2017). Interim evaluation of Horizon 2020. https://op.europa.eu/en/publication-detail/-/publication/33dc9472-d8c9-11e8-afb3-01aa75ed71a1/language-en

- Societal challenges: this pillar aimed to address major societal challenges by fostering interdisciplinary collaboration and innovation to find solutions to issues affecting European citizens.

Next to the programs and activities instituted by the three pillars, there are additional Horizon programs in place (fourth column in Figure 2). One of such programs is the Widening Participation strategy. This programs tries to bridge the innovation cleavage of which Central and Eastern Europe seem to suffer. This way, it aims to create a more balanced and inclusive European Research Area and ensure that the benefits of R&I are distributed more equally across the continent. The predecessors of Horizon 2020 were solely focused on excellent research and aimed to create a competitive level for research funding. Spatial differences were not taken into account. Several academic publications have indeed highlighted that the investments were mostly made in already integrated and well-developed research ecosystems, which are mostly located in the older member states (Reid 2010). These publications argue that, to receive the funds of FPs, there needs to be a well-developed regional innovation system with high levels of human capital. The majority of the regions that have profited from the FPs pre-2010, in turn, have been in regions with well-developed regional innovation ecosystems (Hollanders et al, 2012; 2014; Reid 2010).

Similar findings were highlighted in the interim evaluations of the 7th FP. The EU then recognized the growing disparities between European regions (EC, 2017) and installed a more holistic approach that considered the differences between well-developed and lagging regions. The new strategy, Spreading Excellence and Widening Participation, was implemented to increase the participation of researchers and research institutions in the FP's (EC, 2021a). This strategy supports the 'Widening' countries (Bulgaria, Croatia, Cyprus, the Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, Slovenia and all associated countries with equivalent characteristics in terms of R&I performance and the outermost Regions (EC, 2021b). The widening strategy aims to "strengthen their potential for successful participation in transnational research and innovation processes, promote networking and access to excellence" idem.).

There are several "areas of intervention", or widening tools, to address the innovation cleavage and enhance the impact of the widening strategy. These tools are used to facilitate knowledge transfer, collaboration, and capacity building. The most important Widening instruments being Teaming, Twinning, and ERA Chairs (EC 2016, Figure 3). This study will look at one such measure, the Teaming projects. The Teaming tool is aimed to enhance the research and innovation capacities of specific regions or institutions by supporting the creation or upgrading of centers of

excellence. It involves partnerships between a high-level institution (usually from a more developed region) and a center from a less-developed region to foster knowledge transfer and research collaboration. These Centers of Excellence are also referred to as Research Infrastructures, or a network thereof with a physical infrastructure in a Widening region. The aim of these centers is to boost excellent research and support the reform of national R&I systems in the Widening region (EC 2021b). The Teaming-projects make use of funding sources coming from different levels within the multi-level governance system of the EU. The Teaming-projects make use of funding from Horizon 2020, as well as other (national) funding that has to be at least 50% of the overall budget. For the case studies selected in this research, the additional funding comes from ERDF-funding, (or Cohesion Policy). In this way, an analysis of the potential additional value of combining Cohesion Policy funds with the EU's FP's funds can be made. To do so, the implementation of innovation indicators, as constructed by the theoretical framework in ERDF-funded and Teaming-funded RI's, is researched.

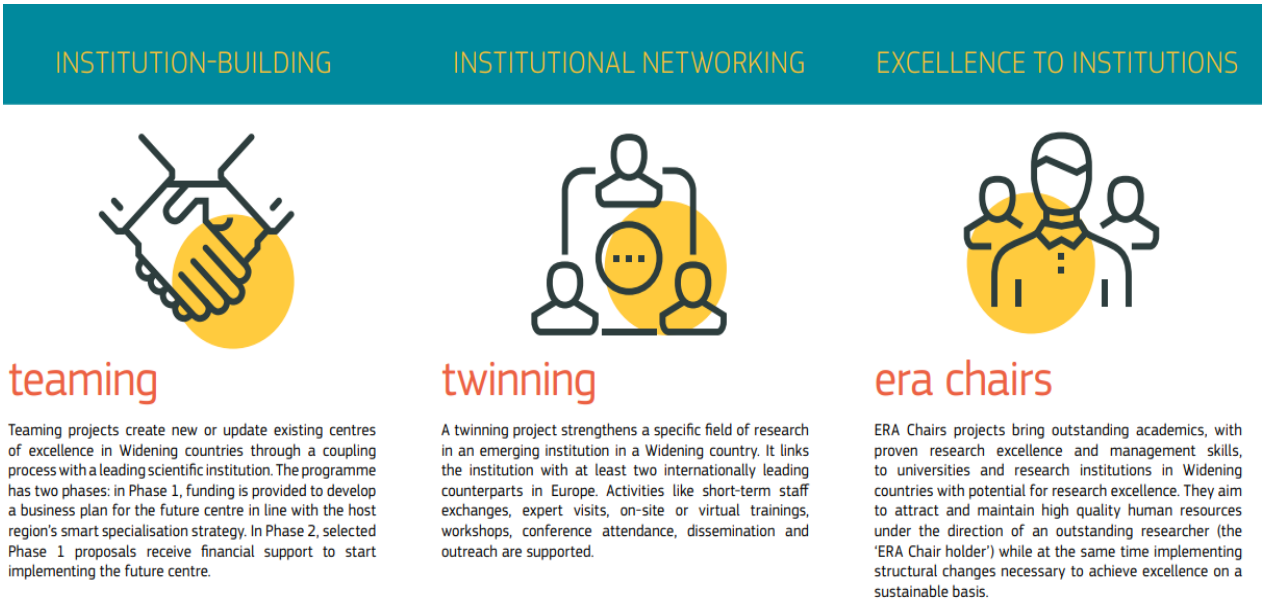


Figure 3: Widening tools. European Commission, Directorate-General for Research and Innovation, (2016). Widening actions in Horizon 2020 : bridging the research & innovation divide in Europe, Publications Office. https://data.europa.eu/doi/10.2777/348646

3.4 Research infrastructures and synergies

To further understand the impact of the different funding sources as discussed above (Cohesion Policy and Horizon 2020) and the synergies between them on Research Infrastructures, it is important to spend some time on defining both RI's and synergies.

It is important to separate two types of research infrastructures here: European Research Infrastructures and local Research Infrastructures. The two types of infrastructures have largely overlapping definitions. That is, Research Infrastructures are defined as facilities that provide resources and services for research communities to conduct research and foster innovation. This includes major scientific equipment or sets of instruments, collections, archives or scientific data, computing systems and communication networks, any other research and innovation infrastructure of a unique nature that is open to external users. It does not have to be a single-sited infrastructure placed in one region, but can consist of multiple sites all over the world. A RI is not limited to physical infrastructures as it can also come in the form of a computer system or a virtual construction (Lossau, 2012). With these aims, a Research Infrastructure contributes to the creation of the European Research Area.

However, the goals of European RI's and Local RI's are different. The goal of European RI's is to open up projects to researchers from all over Europe. By doing so, the competition level of the region increases as it attracts researchers, and businesses alike to the region to make use of the facilities that the research infrastructure provides. These RIs are identified by European Research Communities, such as the European Strategy for Research Infrastructures (ESFRI) as infrastructures that conduct research activities at the top level in any given research field. These European RIs, are often funded both through European funds from the Horizon programs, as well as national funding or ERDF-funding. Thus, a European RI enhances the use of synergies between different funding levels (EC 2020). Teaming projects, in turn, is one of the Horizon instruments to fund such European RIs. Its aim is to establish and build upon Centers of Excellence. CoE are prestigious RI's that conduct top-level research and make use of both ERDF-funding and Horizon funds. The CoE set up through Teaming-funds can therefore be defined as European RI's. These European RI's, in turn, have been recognized by the ESFRI roadmap. For the sake of this study, this type of European RI is referred to as a Teaming-funded RI.

The main aim of a locally embedded Research Infrastructure is to boost the development of the region, and does not aim to boost excellent research per se. These RI's are set up through ERDF-funding and national funding, and do not receive money from the Horizon programs. However, it is important to note that although RI's are rarely set up with the support of EU R&I funding and merely use ERDF and national funds as their primary resources, they are often defined as European

RI's later on (EC, 2020). This type of RI will be referred to as an ERDF-funded RI. This study, in turn, analyzed RI's that were set up through ERDF-funds, and later developed to Teaming-funded RI's. It researched how the innovation indicators as set up through the theoretical and methodological frameworks (e.g. international dimension, connection to different actors, and human capital) were implemented in both funding phases. The difference in the implementation of the indicators might constitute an advancement of the implementation of the indicators. This advancement, in turn, constitutes a growth in innovative output. The study will then ultimately be able to show if and how the synergies between the two funding programs improve the innovative output.

4.Relevance

Europe is currently falling behind the United States and China in terms of Research Infrastructures (Dansby, 2022). In order to bridge this gap, Europe needs to maintain and enhance the existing RI's, while also creating new ones. However, there is currently a lack of academic research that researches the impact of RI's, while this is highly relevant as it equips Member States with the right information to compare the returns on investment in RIs. This study aims to create an evaluation framework that assesses the innovative impact of investments made by ERDF and Teaming and thereby contributes to the methodological gap of assessing the impact of RI's.

As the EU does not want to fall behind the US and China the investments in RI's are a key priority of the European Council (Dansby, 2022). The EU already has several investment strategies in place that should increase the impact of RI's. Two of them are analyzed here: Cohesion Policy and Teaming. However, there seem to be some issues with these strategies. Although Cohesion Policy aims to increase the social, economic and territorial cohesion of the EU and decrease disparities between regions, as well as it aims to increase the innovative output of the EU as a whole, regional disparities are still increasing (e.g., Mogila et al. 2022; Balas 2017; Monfort, et al., 2022). Going from this assumption, the fitness of the Cohesion Policy can be criticized (Pelligrini, et al., 2013). It is therefore relevant to understand how RI's funded by ERDF have implemented innovation indicators that should foster regional development.

Furthermore, the Council believes that the strengthening of synergies between different funds will enhance the impact of the RI's and therefore calls for more evidence to build on best practices to implement such synergies, as there are still several problems in the implementation of synergies. There especially appear some problems in the implementation of Horizon and Cohesion Policy synergies in widening actions. Scholars have identified multiple problems in the implementation and set-up of Widening policies. There is an administrative overload and lack of awareness (e.g. Pelle 2015; Frietsch, 2015). Criticism not only comes from academic publications, but also from the European level itself. The European Commission has previously pointed out that European RI's experience problems with the funding sources coming from different levels as national and local roadmaps often do not fit the roadmaps of that on the EU level (EC, 2020). On the other hand, a rapport on Widening has pointed out that Widening measures have little impact when the

measures do not make use of additional funding through national funds or Cohesion Policy. The synergies are thus crucial for effective implementation of Widening funds, but the effective implementation of these synergies remains difficult (ECA, 2022). The analysis of the implementation of innovation indicators in Teaming-funded RI's therefore provide an interesting opportunity to broaden the understanding of the effectiveness of the implementation of these synergies.

Overall, this research is relevant as the study presents an academic research based on one of the key issues in EU R&I policymaking, through which the study on the one hand adds to the theoretical debate about decreasing the innovation cleavage between European regions, and on the other hand, provides useful information for EU policymakers involved in the implementation of cohesion policy and EU R&I policy.

4.1 The Czech Republic

This study focusses on the analysis of RI's in one country, to limit potentially confounding differences in governance, politics, and policies between different countries. This choice constitutes a fairer comparison between the RI's, including its strategies. The Czech Republic is selected because it is a Widening country which has created an extensive RI network. Already when the Czech Republic became a European Member State in 2004 it was active in Research Infrastructure management. The Czech Republic is an interesting case study as the investments were made from the first round of Cohesion Policy funds that the Czech Republic ever received. The Czech Republic's budget grew considerably with the additional funds from Cohesion Policy and the country felt the need to invest in something big. Interestingly enough, around this time the commission was not convinced about the idea to use Cohesion Policy to invest in RI's as they did not see how this would lead to more territorial cohesion, because, investments in excellent science would not benefit society immediately (Naujokaiyté, 2022). But it was the Czech Republic who lobbied for investments to be made in RI's through Cohesion Policy (idem.). Their plan was not simply to invest in technical facilities, but to enhance the cooperation between different sectors to ensure the adequate embedment of the RI in the region. The Commission eventually agreed and by doing so, the Czech Republic managed to create an extensive Research Infrastructure network (Benner, 2022).

It did take a while for Czech researchers and innovators to adopt to the new, European centered R&I system. However, after a while the Czechs started to create international networks, contributing to the European RI's. These RI's are identified in the Czech Republic's Roadmap for Large Research Infrastructures[2]. The success of these RI's is not only thanks to the researchers, but the RI's also enjoyed strong support from the public sector. The government invested a lot in the sustainability of the projects, creating innovation centers in Czech regions tasked with creating links between the RI's and society in order to boost innovation. Investments from the national level are made through the government's Operational Program Research, Development, and Education (OP RDE). It aims to support research, development, and innovation activities in the country. The program is part of Cohesion Policy, specifically the European Regional Development Fund, and focuses on promoting research and development as key drivers of economic growth and competitiveness. OP RDE provides financial resources to various entities, including universities, research organizations, businesses, and public administration, to carry out projects that contribute to the advancement of science, technology, and innovation. The program aims to enhance the development of research infrastructures, promote excellence in research, and improve the quality and relevance of research outcomes. This involves supporting the construction and modernization of research facilities, promoting the establishment of research centers of excellence, and fostering collaboration between research institutions (Košťálová, 2017). The Czech Republic's activities to boost RI's then served as a key example to Poland, Slovakia and others who, a few years later, also aimed to increase investments in RI's.

However, there are also downsides to the Czech system of managing Research Infrastructures. Suurna and Kettel (2010) emphasized that a lack of human resources for research and development practices is a problem in the Czech research landscape. This has been reemphasized by more recent voices (e.g. Naujokaitytė 2022; Brent 2022) who argue that the Czech RI's often suffer from a lack of talent to work with the technologies of the RI's. The development of skills to run the RI's was then also not part of the initial strategies to build upon and create new RI's. Furthermore, there also needs to be improvements in the ecosystem the RI is based in. The ecosystems need to expand their reach and need to translate science into economic outputs. Suurna and Kettel identified an insufficient cooperation between universities/research institutions on the one hand and the business

[2] Roadmap of Large Research Infrastructures of the Czech Republic: https://www.vyzkumne-infrastruktury.cz/en/roadmap-of-large-research-infrastructures-of-the-czech-republic/

sector on the other hand. Recently actors have argued that the amount of spin-off companies and projects needs to be increased (Naujokaiyte 2022). This contributes to the sustainability of the Research projects, something which should be given more attention to in the future as well as the Czech Republic's economy is gradually improving which means that the allocation of funding from Cohesion Policy will decline in the future (Brent 2022). The Czech R&I landscape has become very dependent on funding from Cohesion Policy, as it is seen as access to "easy money" (Brent 2022), this limits the motivation to apply for European grants in the Horizon programs as this is highly competitive.

It is the combination of on the one hand a very proactive attitude on creating an extensive RI network by using Cohesion Policy, and on the other hand, the problems of many RI's of translating the results of research projects to society and creating sustainable strategies that makes the Czech Republic an interesting case.

5.Theory

This section of the thesis provides an overview of the academic debate surrounding the conceptualization of innovation. This is then linked to the different theories of innovation and what role Research Infrastructures play within these theories. Three theories are used to set up the evaluation framework to analyze the innovative output of ERDF and Teaming RI's. Each of these theories provides one innovation indicators, on which one hypothesis is build. First, the Systems Innovation Theory defines the system of innovation for ERDF and Teaming RI's and argues that this system is a supra-national structure. Within the supra-national structure there are different actors involved who interact with each other through networks. These networks are active in both place-based and international levels. The RI's role in the place-based level is further underlined by the Quadruple Helix Model (QHM), which aims to strengthen the cooperation between different sectors and actors to enhance the level of human capital in the region. The QHM provides the first innovation indicator of the evaluation framework. Second, the international dimension in the supra-national structure of innovation is further expanded with both Social Capital Theory and Economic Network Theory. Social Capital Theory argued that international networks are needed to enhance human capital, and the Economic Network theory states that an international component in the networks is essential to enhance the sustainable resource mobilization of an RI, ultimately contributing to the competitiveness of a region. International human capital strategies derived from Social Capital theory and international resource mobilization derived from Economic Network Theory are then the second and third innovation indicator.

After discussing the innovation indicators and hypothesis, the indicators will be operationalized in a framework. Furthermore, as the theory of Europeanization is needed to analyze the innovation indicators, this theory will be discussed under the operationalization section of this theory chapter as well. Europeanization is needed to operationalize the document analysis conducted for this research as S3 documents on three levels of governance will be analyzed to understand how the innovation indicators are reflected in the bottom-up Smart Specialization strategies. In turn, these bottom-up objectives will be compared with the top-down criteria of Teaming-strategies to understand the impact of different R&I strategies. This section will provide the fourth and last hypothesis.

5.1 Innovation

One of the first attempts to conceptualize innovation was done by Schumpeterian economics. Innovation is defined here as the implementation of new or improved products, processes, methods or practices (Schumpeter, 1939, 1954). The first conceptualizations of innovation all revolved around linear terms. Meaning that the knowledge institutions (e.g. universities, research institutions) would invest in research to enhance the output of inventions which would be implemented in the market economy (e.g. Lundvall, 1999; Colapinto and Porlezza, 2013). Herein, the different phases of research would be separated, stimulating a flow from basic research, to applied research, to market innovations. As the literature review of this thesis has already pointed out, the Soviet System relied upon this linear model. However, the linear model of innovation did not accurately reflect the innovation system as innovations are not created in a vacuum, and the separate phases of innovation cannot be separated. That is why later definitions of innovation evolved to non-linear models that included a range of different actors and factors such as academia, government, and industry (Freeman, 1989). The point was that rather than innovation being created in a linear line from basic research to market implementations, innovations are created in a complex structure involving many different actors, processes, and factors. These actors all play a role in the creation and implementation of knowledge, creating innovation (Lundvall, 1999). This requires cooperation and coordination between the different levels. Innovation policy, according to Suurna and Kettel (2010), can then be defined as public orientated efforts to steer these networks of actors in the right direction to create innovative outputs. The work of several European Innovation policy scholars (e.g. Radosevic, 1999; Lundvall and Borrás, 1997) agree with this definition, and it provides a good basis to evaluate the innovation potential of Research Infrastructures.

5.2 Innovations systems theory and Research Infrastructures

The non-linear, complex models of innovation fit within the Innovation Systems Theory. This theory relies on non-linear innovation policy analysis. The Innovation Systems Theory takes the differences between countries, regions and their economies into account when monitoring the level of innovation and looks at the interdependencies and interactions between the elements of the system, as well as how the system learns (Edquist, 1997). Herein, different actors of the system are defined: academics, government, education, and civil society, also referred to as the Quadruple Helix Model (Carayannis and Rakhmatullin, 2014). Freeman (1989) first introduced the theory,

which after other academics built on it. This way, different levels of innovation systems were defined: national systems of innovation (Lundvall, 1992; Freeman, 1995), regional and local systems of innovation (Cooke, 2001); and sectoral systems of innovation (Malerba, 2004).

The question is then how Research Infrastructures are placed in such an innovation system. Both ERDF infrastructures and Teaming infrastructures might be placed on an additional level of the innovation system: the supra-national level. Herein, the Research Infrastructure involves different actors and factors across different levels of governance (Kowalski, 2015). The ERDF infrastructures can be placed on this level as they make use of EU funding to boost regional development, thus involving the European level, national level, and local level. Teaming-projects also make use of EU-funding and can thus be placed on the same level. However, it is mandatory for the Teaming projects to have international partners involved in their infrastructure, thus, next to the three governance levels (local, national, EU), the Teaming projects also make use of cross-boundary cooperation that aims to establish an international network of researchers and research institutions that enhances the innovative output of the EU. This provides a fourth layer of cooperation to the governance of the RI.

The different actors in the supra-national structure of the RI's interact with each other through networks. These networks can in turn be analyzed through three different perspectives. These perspectives are further presented below and will form the basis for the hypotheses of the innovation indicators to which the case studies will be tested.

1. Quadruple Helix Model
2. The international dimension of Social Capital Networks
3. International resource mobilization of Economic Networks

5.3 Quadruple Helix Model: place-based human capital strategies

The Quadruple Helix Model (QHM) refers to a place-based network of governance that takes the relationship between industry, academia, government, and civil society into account in order to enhance the creation, attraction, and enhancement of human capital and innovative output (Carayannis and Campbell 2012). The aim of this is to increase the knowledge production and the dissemination of research results. Several scholars have highlighted the importance of the involvement of different actors in the innovation process (e.g. Putnam, 2000; Adler and Kwon, 2002). Lundvall (1999) and Ougthon, et al. (2002) both highlight the importance of the relationship

between research and industry. Good relations between both sectors would promote convergence, and stimulate the effective implementation of European R&I funds. Grillo and Landabaso (2011) note the importance of public-private relations as it creates a shared vision of the capabilities and goals of the region. Doing so, a level playing field is established in which regions create a self-sustaining innovative ecosystem. The fourth layer in the Quadruple Helix model also takes civil society into account as an important actor within the innovation system. Several scholars define the civil society layer as NGOs, other civil society organizations, and citizens themselves, as important actors in the fourth layer (e.g. González-Martinez, et al., 2021; Roman, et al. 2020). The EU in turn, has taken on the latter definition and argues that increased partnerships between all four layers is essential to match the right skills with the industry (EC 2014).

This study assumes that when the RI's involve the actors from the Quadruple Helix Model in their human capital strategies, the innovative output will be enhanced. What role should RI's then play in such a network? Several scholars have identified the value of the systems innovation theory in RI's. Herein, the quadruple helix model connects the different actors to increase innovation output. Smith (1997) argued that a RI can contribute to the diffusion of knowledge and the enhancement of human capital when it works effectively in the innovation system. RI's enhance the acquisition of skills of employers and researchers in the region as the RI increase the opportunities for training activities. Furthermore, the establishment of a RI sets the foundation for the establishment of new business and companies that use the knowledge made available through the research infrastructures, thus, implementing the knowledge to economic outputs. Another valuable input was given by Pero (2015) who adds that RI's contribute to the production of research results that open up opportunities to spin-off projects, ultimately increasing employment opportunities and the attraction of skills. It is then crucial that innovation policy is catered towards the needs and wants of the region, especially to enhance Widening participation. The different actors, in turn, should cooperate and coordinate innovation strategies that effectively incorporate the relationships between universities and industries and couple this to the skills, wants, and needs of civil society.

Thus, the quadruple helix model is important in constructing an effective innovation system, and provides important roles for RI's with as ultimate aim the dissemination of knowledge to society. A successful dissemination of knowledge is defined here as an increase of human capital. More specifically, the creation, acquisition, and retainment of skills of both (future) employers, and

researchers, as well as the establishment of spin-off companies and the increase of jobs from both the RI and the spin-off companies. This research assumes that the innovative output of Teaming-RI's is higher as the projects have to adhere to the criteria of Smart Specializations as well as the criteria of Teaming-projects. The Teaming-projects, in turn, put a lot of focus on the development of the relationships between the actors of the Quadruple Helix Model as it is the Widening countries that face difficulties in implementing and enhancing these relationships (Karo et al. 2017; Morawska-Jancelewicz, 2022). It is then assumed that the combination of both S3 strategies and Widening-strategies establish high criteria for the Teaming-projects, which have ultimately led to a better implementation of the human capital criteria in the context of the Quadruple-helix model. From this assumption, the first hypothesis is derived which will be analyzed in the document analysis and interviews:

H1: (a) Teaming-strategies have stronger criteria to involve the actors of the QHM in the human capital management of RI's; (b) the actors of the QHM are closer involved in human capital strategies of Teaming RI's.

Human capital is defined in this research as follows:

a) The acquisition of international talent, the re- and up-skilling of workers and researchers in the region, and the retainment of brains in the region.
b) The increase of employment opportunities through the RI's activities as well as through the creation of spin-off companies (research and business related).

5.4 Social Capital Networks: internationalizing human capital strategies

Social Capital Theory encompasses the positive effects derived from social and institutionalized relationships, which in turn stimulate the flow of people and skills (Fukuyama, 2000; Florida, 2002). According to Florida (2002), Social Capital Theory calls for the establishment of networks with external stakeholders. A crucial aspect of these relationships is that they are built on equal recognition and trust, which is vital for effectively managing research and innovation (R&I) projects (Kowalski, 2015). Therefore, long-term investment and cooperation play a critical role in fostering successful outcomes (idem.). In the context of RI's, Social Capital refers to the trust and norms embedded within the relationships among various actors involved, facilitating the development of best practices and knowledge sharing (Florida, 2003; Landry, 2001). This aspect

is important as RI's rely on robust connections between actors, as previously emphasized by the Quadruple Helix Model.

Next to the value of the place-based networks, it is argued here that an international dimension is a critical component to implement innovative output of a RI (Kowalski, 2015). RI's that establish networks that involve partners in other countries which build on the values of Social Capital Theory (e.g. norms, trust, cooperation) will increase the innovative output of RI's. The international dimension, in turn, is crucial to increase the competition level of the region as it attracts researchers, and businesses alike to the region to make use of the facilities that the research infrastructure provides. This allows for a smart specialization of innovation that fits the wants and needs of the region and avoids copy-catting strategies from nearby regions. A lack of an international dimension, in turn, undermines the establishment of an interdisciplinary research team (Hantrais, 2005), and limits the creation of spin-off companies, as well as the attraction of skills. Furthermore, the establishment of international partnerships aligns with the EU's objective to foster open access to research within the European Research Area and facilitate the integration of trained professionals from abroad. This influx of expertise enables valuable knowledge exchange, fosters diversity, and enhances creativity within the research environment. As a result, innovative and creative ideas are cultivated. Thus, international recruitment strategies are essential, as well as establishing sound international partnerships that foster knowledge sharing and best practices.

This study assumes that Teaming-funded RI's have established more extensive international partnerships based on the values of Social Capital Theory. ERDF RI's aims to increase the development of a region through the use of S3 strategies, these S3 strategies might provide certain objectives of implementing an international strategy, however, these objectives can be broad and implemented in various ways. Furthermore, as the S3 strategies depend on a bottom-up implementation, the ERDF RI's rely on the governance the region and Member State. It is them who set the guidelines for basic research, workforce skills, the degree of competitiveness, and systems of local governance (Pavitt and Patel 1999). This perspective limits the ability of the RI to establish an international network in order to pool resources and skills (researchers and skilled labor) from the international level (Griniece, et al. 2015). Teaming RI's, in contrast, do require an international component and are more oriented towards cross-border cooperation (EC, 2022).

Furthermore, as they are also governed through the European level, they are not hampered by the national perspective which ERDF RI's suffer from. Thus, when assuming that an international component in a research infrastructure is needed to increase the research capacities and innovation output of the region, Teaming projects would deliver large results. This formulates the second hypothesis that the case studies will be tested on:

H2: (a) Teaming-strategies have more extensive objectives in place related to the establishment of international networks than S3 strategies; (b) Teaming RI's have better internationalized their human capital strategies to attract talent, share best practices, and establish spin-off projects.

5.5 International resource mobilization - Economic networks Economics of network

The international dimension has so far only been analyzed from a governance approach to increase human capital, while more attention needs to be given to the economic benefits of the international dimension. The Economic Network Theory can explain the benefits of an international partnership to stimulate the innovative output of the RI. The theory of economic networks focusses on the economic benefits derived from the social relationships established in the Social Capital Theory. It defines how social interactions impact economic outcomes (Goyal, 2007). In the networks of Social Capital the connections and relationships among external actors can lead to positive outcomes, one being an increase in resource mobilization. The relationships built on trust, mutual recognition and cooperation enhance the motivation of foreign partners to invest in the RI and spin-off projects. Additionally, social capital can be associated with ties between actors from different networks, this, in turn, allows the resources of one relationship to be used in others (Coleman, 1988). This provides the basis for the rationale behind Economics of Network theory as the RI's bring together fundings from different actors and levels. Economics Network Theory focusses on the structure of the network, and the formation of this network. Which after it defines the economic behavior that takes place within the network and discusses the benefits of the network. To do so, it applies concepts from network governance (for an overview see Sørensen & Torfing, 2009; Saurugger, 2013) to study how the actors within a network are connected and how this impacts the economic outcome of an organization.

The stable flow of financial resources for RI's is extremely important as they require substantial investments to maintain them and sustain the production of results. As EU funding is not an ever flowing source of resources, it is important for RI's to be able to formulate strategic plans beyond

their designated tasks in order to enhance the level of competitiveness of the region in the long term. Economic Network Theory highlights the significance of international cooperation to increase resource mobilization. According to this theory, networks and collaborations between countries and organizations can enhance the efficiency and effectiveness of resource allocation and utilization. By forming international partnerships, countries can tap into a broader pool of financial resources. International cooperation facilitates the exchange and flow of resources across borders, enabling countries to access resources that may be scarce or unavailable domestically. This collaboration allows for specialization, where countries can focus on their comparative advantages and allocate resources accordingly. It promotes the efficient allocation of resources by directing them to areas where they can generate the highest returns and contribute to economic growth and development. Through cooperation, countries can share risks, reduce costs, and achieve economies of scale, thereby maximizing the impact of resource mobilization efforts and increase their competitiveness in a specific sector. Therefore, to increase innovative output of Research Infrastructures the RI should establish international partnerships that provide a basis for sustainable resource mobilization outside of EU-funding programs. This way, the projects become sustainable in the long term and are able to create strategic plans outside of the EU-projects under which they have been established. This ultimately contributes to the level of economic competitiveness of the region as it specializes in a smart way built on extensive international partnerships and stable funding.

Both ERDF-funded RI's and Teaming-funded RI's should therefore have established international partnerships that actively invest in the RI's and enhance the RI's ability to developed sustainable strategies for the future. This study assumes that the Teaming-funded RI's are actively working towards creating sustainable plans for when the Teaming-funding ends, while ERDF-funds lack these strategies. This assumptions forms the basis for the third and last hypothesis:

H3: (a) Teaming-strategies set requirements for formulating sustainable resource strategies post-EU funding based on the involvement of international actors while S3 strategies lack these objectives; (b) Teaming-funded RI's have implemented international resource strategies, while ERDF infrastructures have not.

5.6 Operationalization

Based on these theoretical conceptions, an overall theoretical framework is established that operationalizes the relevant innovation indicators. When using the theories we can define three main categories of innovative output. The Systems Innovation Theory states the different roles RI's play in enhancing innovative output. These roles are based on increasing human capital in a place based system and an international setting, as well as the international resource mobilization on the supra-national level. The place based system of human capital strategies has been further described by the Quadruple Helix Model. Social Capital Theory argued that international networks are needed to enhance human capital, and the Economic Network theory, in turn, states that an international component in the networks is essential to enhance the sustainable resource mobilization of an RI, ultimately contributing to the competitiveness of a region. The three main indicators derived from the theory are visible in Figure 3.

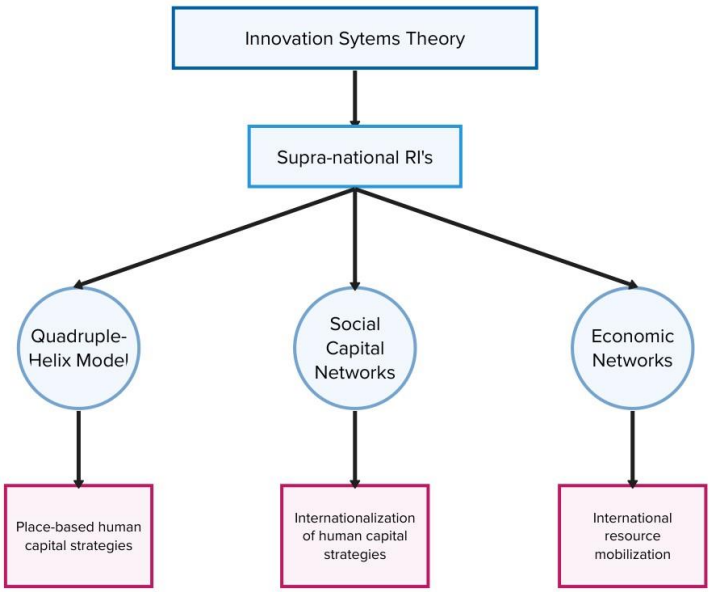


Figure 4: Innovation Indicators. Author's design.

5.7 Europeanization

The operationalization of the innovation indicators provides a methodological framework through which the innovative output of ERDF and Teaming RI's can be analyzed. This analysis has to be conducted in a complex supra-national structure that involves different levels of governance:

1. Local level
2. National level
3. EU level
4. Cross-national cooperation (only mandatory in Teaming-projects)

Europeanization is needed here to research to what extend the bottom-up objectives of S3 and top-down objectives of Teaming influence the implementation of the innovation indicators. The different levels were taken into account by analyzing the implementation of the innovation indicators in the documents on all levels. The S3 strategies of the EU, Czech Republic, and the regions in which the RI's are based. A document analysis of the EU Teaming-strategy was also conducted.

Europeanization is a contested concept amongst scholars. It is defined differently based on the differences in implementation of EU policy. Some scholars define Europeanization based on the "goodness of fit" of national policies to the EU level (Mastenbroek et al, 2006; Mendez et al. 2008). Other scholars adopt a rational choice perspective of Europeanization in which policymakers and local actors adopt to the European level to increase financial sources (Bulmer, 2007). However, Europeanization can very broadly be described as the adaptation of governance structures on the domestic level to EU policies or institutions (Risse et al. 2011). The regional level has gained an increased importance in the Europeanization conceptualizations as well (Marshall, 2005 and Hix et al, 2011), therefore, it can also be said that Europeanization is about the adaptation of the regions to the European level. This is defined as the 'bottom-up process' of Europeanization (Börzel and Risse, 2000). Knill and Lehmkuhl (2002) further define Europeanization from a top-down perspective. They see it as a regulatory process and their research measures the influence of EU regulatory policies on a certain area in the member state to understand to what extent this regulation is implemented. Both Börzel and Risse and Knill's definitions of Europeanization, in turn, are useful in understanding the transformative period of the CEE Member States and the influence of European Research and innovation policy, even today.

As has become clear in the historical review above, ERDF-funds are implemented by local authorities that set up strategies in line with European guidelines. Thus, the implementation of the funds is largely a bottom-up approach. Teaming-funds, on the other hand, add a top-down perspective at the European level with regard to the implemented of the funds from the Framework Programs. The question that this research tries to answer is whether the added top-down approach of the Horizon program, in combination with the bottom-up approach of the ERDF-funds, translates to more innovative output for Research Infrastructures. The bottom-up approach of Europeanization is especially relevant when analyzing the innovation indicators in the Smart Specialization documents. As the EU has provided guidelines that are interpreted by the national and regional authorities themselves, it is important to know what the eventual regional strategies have taken on from the EU level, and how these strategies have been implemented in practice. This gives relevant insights into what impact EU S3 strategies have to influence the innovative output of regions. The top-down perspective of Europeanization, in turn, is relevant in analyzing the implementation of Teaming-strategies. As this is a direct implementation from the EU level into research projects, it shows important insights how the EU R&I Framework Programs impact the innovative output of regions. By analyzing the differences in implementation of innovation indicators during these two funding periods, the additional value of combining Cohesion Policy with Horizon funds can be analyzed.

As the literature review of this thesis has highlighted, Smart Specialization strategies can be criticized. Especially the issue that the regional level has the largest autonomy in the implementation of Cohesion Policy, but that the regional level faces challenges in effectively implementing the funds is a strong criticism. Authors argue that it S3 practices are only successfully implemented in well-developed regions (Capello and Kroll, 2016; Benner, 2022). The Europeanization of the Smart Specialization strategies to influence local R&I ecosystems can therefore also be doubted. This leads to less successful ERDF-projects, which, in turn, makes the implementation of synergies between Cohesion Policy and Horizon more difficult as they will be less suited to accommodate the criteria of Teaming-projects.

This leads to the fourth and final hypothesis:

H4: (a). Research Infrastructures located in less-developed areas have not implemented the innovation indicators as well in the ERDF-phase compared to RI's located in well-developed areas; (b). the Teaming-projects are less successful in RI's located in less-developed areas.

6. Methods

The section below provides an overview of the methodological framework. It shall first discuss the subdimensions of the research, including its operationalization. Which after it will be justified why the study relies on a qualitative case study analysis. The last part discusses the data analyses methods used in the study.

6.1 Sub Questions

To answer the research question *How do the differences in the implementation of innovation indicators in Research Infrastructures funded through ERDF projects and Research Infrastructures funded through Teaming projects constitute an advancement of the implementation of the indicators?* The study relies on a two part analysis. This analysis takes into account the different funding phases of the research infrastructures, as well as it takes into account the phases of the policy making cycle: the planning phase, and the operationalization phase. The first part of the study analyzes the planning strategies of the R&I strategies through a document analysis of innovation indicators. The second part of the study analyzes how these indicators have been implemented in practice by conducting interviews with the managing authorities of the selected Research Infrastructures. This methodology justifies the internal validity as a triangulation of methods is used, as well as cross-case comparisons (Moon, 2019). Furthermore, the cases will be tested against the theoretical framework, which ultimately also validates the theoretical framework (McNabb, 2010).

6.2 Sub question 1 – Innovation indicators

The first phase of the research consists of analyzing key-strategic documents of Teaming and ERDF funded research infrastructures across multiple levels. The strategic documents of ERDF projects are the Smart Specialization strategies (S3) on the EU level, national level, and regional levels. And the Teaming strategies are the relevant Horizon 2020 workprograms. Through conducting an analysis of both strategies it is possible to define how the innovation indicators set up in the theoretical framework are reflected in the strategic documents of the funds. This, in turn, creates a coherent methodological framework on which the interview guides are based. It is then a deductive content analysis as the analysis will be coded based on the formulated innovation indicators of the theory section of this thesis. It is qualitative as the analysis will not look for the

amount of times a specific word is mentioned, however, it will bring the pre-formulated codes into connection with a passage of the text, further defining the practical meaning of the concepts (Stejskal, 2018).

The sub question is as follows:

1. How are the innovation indicators reflected in the 2014-2020 S3 strategies and Horizon 2020 Teaming strategy?
    1. S3 framework at EU level
    2. S3 of Czech republic
    3. S3 of regions
    4. Teaming strategy at EU level

Deductive qualitative content analysis of Teaming and ERDF RI's

The content analysis will code the results through a deductive category application process. It will follow a few logical steps:

1. The deductive analysis of EU policy documents based on the theoretical framework presented above. It will be analyzed how the indicators presented in the framework are incorporated in the documents. A few deductive codes were established at the beginning of the analysis of the European Smart Specialization strategy, and the coding scheme will be expanded in each round of document analysis (e.g. national and regional S3 and Teaming strategy). This procedure is illustrated in Figure 5. Using this approach, a holistic coding scheme is established which highlight the goals and ambitions of the ERDF and Teaming-funded RI's. The coding tree can be found in the appendixes (See appendix I).

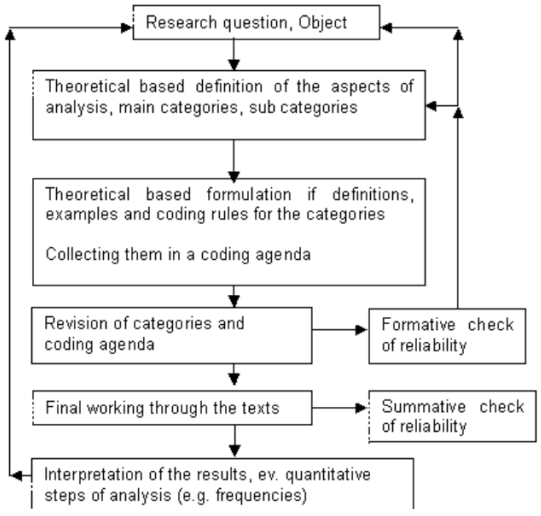


Figure 5: Qualitative content anlaysis. Mayring, P. (2004). Qualitative content analysis. A companion to qualitative research, 1(2), 159-176.

2. The document analysis will be repeated based on the holistic coding scheme to ensure reliability of the study (see Figure 5). This way, the results of the study will be able to be reproduced and the methods will be standardized (Baskarada, 2014).
3. The coded results of the document analysis will be summarized in tables. The interview questions, in turn, are based on the information in these tables.

After analyzing the "planning" of the implementation of the innovation indicators, it can be analyzed how they have been implemented in the "operationalization" phase. The implementation of these indicators will be researched through interviews.

6.3 Sub question 2 – implementation of indicators

This part of the study deals with the implementation of the innovation indicators in practice, thus, in the operationalization phase. Through an in depth-case study analysis and interviews, it will be analyzed how the research infrastructure has implemented the indicators. An interview guide will be established based on the document analysis.

The results of this sub question will be able to give some insights of how Teaming-funds have, or have not, led to better implementation of the innovation indicators.

The sub question is therefore as follows:

2. How have the innovation indicators been implemented in the RI's during the ERDF-funded phase and the Teaming-funded phase?

Interviews

The document analysis cannot show to what extend the Research Infrastructures have implemented the innovation indicators, therefore, interviews are needed. The coded results of the document analysis created in the first part of the analysis will provide an extensive and complete framework that takes into account the relevant innovation indicators. Based on this framework, a semi-structured interview guide will be set up. Reliability in the interviews is reached as the interview guides are based on the document analysis. Furthermore, the same interview guide will be used for all interviews, which are based on a sound theoretical framework. The interviews, in turn, will follow the holistic coding tree as established during the document analysis. Doing so, the similarities and differences between the implementation of the indicators in the documents and in practice in the analyzed case studies can be pointed out.

The study shall take three Research Infrastructures in two different Czech regions as case studies. All of these RI's have first been funded by ERDF funds and later received Teaming funds. When the projects were developed and set up they received funding under the operationalization program of the Czech government (OP RDE, for an explanation see chapter 5). These funds consists of a combination of national funding and Cohesion Policy funding. Thus, they have to adhere to the S3 strategies which were created at the EU level and were further expanded on the national level in the Czech Republic. The guidelines set up on the national level have in turn been implemented in the regional strategies. As the case studies selected for this research dissent from two different regions, it is expected that their S3 strategies are different, and that the projects from Central Bohemia and South Moravia have implemented the innovation indicators in different ways.

The interviewees will be chosen through purposive sampling which allows the selection of interviewees of pre-defined criteria (Campbell, et al. 2020). For this research, managing authorities from the Research Infrastructures were chosen. These authorities were closely involved in the implementation of the project during both the ERDF-funded phase, as well as the Teaming-funded phase. The three Teaming projects of the Czech Republic were chosen as the selected Research Infrastructures: the HiLASE infrastructure, the RICAIP infrastructure and the RECETOX infrastructure.

6.4 Qualitative analysis

The research question will be answered through a qualitative approach. Qualitative research does not, or makes limited use of, statistical data and methods. Instead of quantifying the problem, it aims to answer a research question through analyzing the nature of the problem (Strauss & Corbin, 1994). In addition, a qualitative approach is meaningful as qualitative researchers approach a research problem through interpreting and contextualizing people's practices (Denzin & Lincoln, 2011). As this research wants to understand how the innovation indicators are implemented in the different funding phases, and wants to analyze the differences in the implementation of these indicators in a cross-case study analysis, a qualitative research is more meaningful. This way, it can be analyzed, in depth, what the specific strategies of the Smart Specialization and Teaming strategies were, putting words and phrases into the context of the text and interpreting them meaningfully, instead of creating statistical data which only shows how often words occur. Furthermore, the in depth-interviews give valuable insights into how these strategies were

implemented in practice. Qualitative insights are valuable here to build best practices to be able to improve the use of Synergies between Horizon and Cohesion Policy. This is especially relevant as the EU is looking for case studies that out the specific problems in the implementation of ERDF funding (ECA, 2022). The EU is especially interested in these studies as they want to increase the use of synergies between Horizon Europe and Cohesion policy. The synergies, in turn, are aimed to maximize the output of R&I projects by combining the funds of the two programs. Therefore both the European Court of Auditors (ECA) and the Council agree that extended information on "inter alia, synergy opportunities, good examples, guidelines and legal framework conditions be bundled and published in an appropriate manner" (European Council, 2023, p.6).

Furthermore, a qualitative case study analysis is the only viable method to conduct this research as the data on research infrastructures that is publicly available is quite limited (Kowalski, 2015). Therefore, the data needs to be collected through direct research in case studies. As there is currently no coherent framework in place that analyses the impact of Research Infrastructures it would too time consuming to research many cases as the indicators range on a broad variety of topics.

6.5 Most-similar case study design

For this research, a case study analysis is needed as the research wants to highlight how innovation indicators are implemented in ERDF-funded RI's and Teaming-funded RI's, and whether the processes of implementation differ between these funding types. The implementation of the indicators can only be studied in a case study as this is the place where the processes and interactions take place. That is why a case-study research is the only viable option to analyze this research question a study (McNabb, 2010).

Defining the units of analysis is key in designing a sound case study research (Yin, 2009). This study rests upon a multiple case studies analysis of most-similar character. Having multiple cases is important in the external validity of case study analysis as the cases and data needs to generalizable, as well as it leads to more robust outcomes (Eisenhardt & Gaebner, 2007). A most similar case study method rests upon the comparison of cases that are of similar characters, but are different in the independent variable of interest (Seawritght and Gerring, 2008). The goal of this research is to understand how variations in the independent variable, the implementation of innovation indicators in RI's, affect the dependent variable, which is how the RI's have

implemented the innovation indicators. Thus, the cases are most-similar case studies as the selected Research Infrastructures have similar characteristics, but might have implemented the innovation indicators differently (Anckar, 2008).

The selected case studies are located in the Czech Republic, and all of them were set up by ERDF-funds under de OP RDE program, and later received a Teaming-grant under Horizon 2020:

1. The HiLASE project is located in a town outside of Prague in Central Bohemia and aims to create a state-of-the-art laser facility. The project has received significant funding from Cohesion Policy under the Czech OP RDE program starting in 2011. It is a collaborative effort between the Institute of Physics (IoP) in the Czech Republic and the Central Laser Facility (CLF) at STFC's Rutherford Appleton Laboratory (RAL) in the UK. Together with these partners, the project received a Horizon 2020 grant phase 2 in 2017.[3]
2. The RICAIP (Research and Innovation Center on Advanced Industrial Production) infrastructure is located in Central Bohemia and serves as a hub for advanced research and innovation in industrial production. The infrastructure is equipped with advanced facilities and resources, including cutting-edge laboratories, experimental setups, and computational resources. It partnered up with a research institute in Saarbrücken, Germany at ZeMA and DFKI, also located in Germany The center has received Cohesion Policy funding since 2013 and Teaming phase 2 since 2019.[4]
3. The RECETOX RI is a scientific facility located at Masaryk University in Brno, South Moravia, Czech Republic. RECETOX stands for Research Centre for Toxic Compounds in the Environment. It provides advanced laboratory facilities, expertise, and collaborative opportunities to study the fate and effects of chemical pollutants in the environment. The international partners of RECETOX are UCL in London and ETH Zurich, in Switzerland. The RECETOX infrastructure has already been in existence for over 40 years, and received significant amounts of Cohesion Policy along the way. The Teaming phase 2 started in 2018.[5]

As illustrated in this description, the RI's have followed a similar path regarding their funding sources. The only relevant difference between the cases is the location of the infrastructures. the

[3] For more background information see: https://www.hilase.cz/en/about-us/
[4] For more background information see: https://ricaip.eu/
[5] For more background information see: https://www.recetox.muni.cz/en/teaming/about-the-project

RICAIP infrastructure is located in Prague in the Central Bohemia region, the HiLASE infrastructure is located in a small town outside of Prague, also in Central Bohemia, and the RECETOX infrastructure is located in Brno, South Moravia. The different locations are a key difference that could influence the variation in the implementation of the indicators. The regional S3 strategies are different from each other, and while HiLASE and RECETOX are both located in CB, one of them is located in the capital while the other is not, which could lead to varying strategies and implementations of the indicators. The case study selection is therefore relevant as it allows to compare the implementation of innovation indicators across different regional contexts and explore how regional factors may influence the outcomes or approaches in each case.

6.6 Explanation building

The most-similar case study design is used to conduct an explanatory analysis. An explanatory case study analysis is a research method that involves in-depth exploration and understanding of a specific case or phenomenon. This type of analysis aims to provide explanations and insights into why and how certain events, behaviors, or outcomes occur within a given context (Tsang, 2013). It thus aims to highlight causal relationships through testing the cases against the theoretical framework. More specifically, an explanatory case study analysis allows to research the relationships between the different strands of theory (Yin 2009). This provides a useful framework of analysis for researching how innovation indicators are implemented in different Research Infrastructures. The goal of this research is to understand how ERDF-funding and Teaming-funding influences the implementation of innovation indicators.

To do so, this research has performed a theoretical analysis in which the different indicators are constructed and hypotheses were formulated. The selected case studies will be tested against these hypotheses to discover how the different funding mechanisms contribute to the implementation of the indicators, and what the underlying reasons for the difference in the implementation of the indicators are. The study is therefore a comparative study that analysis the differences between the implementation of the indicators between the cases. However, it is also a temporal comparison as it will be researched how the implementation of innovation indicators differed between the ERDF-phase and the Teaming-phase comparing the strategies outlined in project documents with the actual implementation in each case. By doing so, the research aims to identify and understand any changes, differences, or improvements in the implementation of innovation indicators over time.

The results of the analysis will be able to state whether the Teaming-grants have enhanced the implementation of the innovation indicators, and thus, whether combining funding from Cohesion Policy and from Horizon adds to the innovative output of R&I projects in Widening countries. These results are generalizable for other cases that have undergone the same path (created by Cohesion Policy and later receiving Teaming-grants). This legitimizes the methods as it is researched how the processes are implemented in a few case studies on which generalizable statements can be made for other similar cases (McNAbb, 2010).

7. Data analysis

Before turning to the results of the study, it is important to understand how the documents of Smart Specialization strategies and Teaming strategies are constructed. Moreover, it is important to discuss the innovation profiles of the regions in which the RI's are located.

7.1 Smart Specialization

S3 involves, to a large extend, a bottom-up process. The S3 guidelines are provided by the European level who provide extensive but broad guidelines on how to set up a S3 strategy on the national and regional level. The national level has thus interpreted these broad guidelines and specified it to their national circumstances. In turn, the local level specifies the national strategy even more and adapts the strategy to the wants and needs of the region. It is interesting to see how the innovation indicators have been identified on the European level and how these have been implemented by national and local authorities. This, in turn, shows the Europeanization of the RIS3 strategies from a top-down approach, and thus, the power the EU has to reform local and national innovation ecosystems. To show how this bottom-up Europeanization process has taken place and understand which indicators have been implemented in what way, the document analysis will discuss the regional strategies in depth and in turn identify the similarities and differences between the regional strategies and the EU and Czech strategies.

The case studies are located in Central Bohemia (CB) and South Moravia (SMR), and before turning to the results their innovation profile needs to be discussed. The Central Bohemian region is one of the most economically developed regional in the CEE area. The economy is built upon industrial production, however, this industry has undergone immense transformations. It has increased its relations with research and development, which has enhanced the innovation of the industry. Still, the manufacturing industry is key in the regional economy, and accounts for 30% of the jobs in the region (SIC, n.d.). The manufacturing business has even increased its importance, unlike most EU countries. The Smart Specialization strategy of the CB therefore takes into account this dynamic between the industry and research and tries to enhance the innovative output of the region through three areas of change:

a) Human resources for R&D;
b) Innovation performance of firms;

c) Supporting a functional regional R&D system.

It is within these three areas of change that specific objectives are formulated that the Cohesion Policy projects should adhere to. It is then also within these areas that the innovation indicators are, or are not implemented.

The South Moravian Region in the Czech Republic has a strong innovation profile, as the second largest and most important city, Brno is located here. Brno shows many similarities with Prague, which contributes to the South Moravian Region's high place in innovative and economic development in the Czech It actively engages in regional and international cooperation, which, in turn, contributes to the innovative and economic output of the region. Unlike the CB region, the SMR region has a broad variation of industry sectors. Main areas of research and industry are done in engineering, electrical technology, biotechnology (life sciences), and especially the specialization of creating tools for medical research (SMR, 2014). The SMR strategy, in turn, also focuses on the translation of research to industry and has five priority areas in which these actions lie:

a) pro-innovation administration and governance
b) Excellence in research
c) Competitive innovation companies
d) Top European education
e) Attractive region

7.2 Teaming

The Teaming strategies, in turn, only add a top-down approach from the European level as the program is ultimately a competitive battle to gain EU funding for excellent research projects. However, as Teaming projects require additional funding of at least 50%, they also have to adhere to the local RIS3 strategies. This raises an intriguing point of analysis: Do Teaming strategies introduce distinct top-down criteria compared to RIS3 strategies, thereby resulting in divergent implementations of innovation indicators within research institutions (RI's)? Furthermore, does this divergence potentially contribute to an enhancement of the indicators themselves? By delving into these questions, a deeper understanding can be gained regarding the potential impact of synergies between the Framework Programs and Cohesion Policy on funding allocation, research priorities, and the assessment of innovation within the realm of RI's.

The Teaming projects consist of two Teaming phases: phase 1 in which the RI's constructed an extensive business plan and conducted feasibility studies. The first phase was then used to apply for the second Teaming phase. As the documents of the applications for both phase 1 and phase 2 are not available, the Teaming strategies as included in the Horizon 2020 Spreading Excellence and Widening Participation work programs is analyzed. The RECETOX and RICAIP case Teaming-projects were applied to during the H2020 2018-2020 work program. The HiLASE infrastructure acquired its Teaming-strategy in 2017, and thus its application fell within the 2016-2017 work program. The 2016-2017 work programs are quite similar, and add a few important criteria to enhance the quality of excellent research. The 2016-2017 framework, however, spends more time on the Teaming-phase 1 than the 2018-2020 framework, as during the latter years there were only project calls for Teaming-phase 2. Overall, no large discrepancies were identified, however, when there is a difference, it will be referred to what the difference is.

7.3 Coding

The document analysis followed the coding procedures as identified in the methodology chapter. The coding tree is included in the appendixes (see Appendix I). All codes that fell under the quadruple helix model (e.g. partner, sector, transfer) have been coded in red. The codes for internationalization (e.g. international, open, foreign) have been coded yellow and the codes for resource mobilization (e.g. resource, sustainable, economic-growth) have been coded green. Codes for human capital (e.g. skills and education as well as jobs and spin-offs) have been coded in separate colors as they could relate to both internationalization or the quadruple helix model. It was determined after the coding procedure whether the codes related to the internationalization of human capital strategies, or place-based strategies. Codes related to skills have been coded blue, and codes related to jobs and spin-offs pink.

7.4 Interviews

Three interviews were conducted with managing authorities of three different Teaming projects, that were originally set up by ERDF. The managing authorities worked for the HiLASE infrastructure, RICAIP infrastructure and RECETOX infrastructure. The managing authorities interviewed were all involved in developing and implementing the innovation strategies of the projects during both the ERDF-phase and the Teaming-phase. The interviews were recorded and transcribed. The interviews were then coded by using the same coding tree as created in the

document analysis. This way, the similarities and differences between the implementation of the indicators in the documents, and the implementation in practice can be analyzed.

7.5 Reader's guide

The following chapters will provide an analysis of the data collected through the document analysis and the interviews conducted with the managing authorities of the chosen Research Infrastructures. It does so by analyzing the innovation indicators as introduced in the theory section of this thesis. First, the document analysis analyzes the implementation of these indicators in the strategies of ERDF-projects (Smart Specialization) and in Teaming strategies (Horizon 2020 work programs). The aim of the document analysis is to highlight how the innovation indicators that were set up in the theoretical framework have been implemented in the planning documents of the R&I strategies. Hereafter, interviews were conducted to understand how the indicators have been implemented in practice. After the results, two more chapters follow that discuss the added value of Teaming and discuss the fourth hypothesis of this research which assumes that RI's located in less-developed areas are less-successful in implementing the innovation indicators.

The results section of this thesis will follow a few logical steps that will be repeated for each indicator (Quadruple Helix, Internationalization, International resource mobilization). The results will then consist of three chapters, each discussing one innovation indicator. The general layout of each chapter is as follows:

1. Document analysis
    a) Identification of indicators. It first discusses how the regional S3 strategies (South Moravia and Central Bohemia) have incorporated the given innovation indicator. The aim is to outline these strategies in more detail as the analyzed RI's are located in these regions.
    b) Cross-document analysis. Hereafter follows a cross-document analysis in which a comparison is made between the EU S3 strategy, the Czech strategy, and the two regional strategies. The point of this comparison is to understand what priorities and criteria the EU emphasized have been actually implemented by the regions, thus understanding to what extend the EU has Europeanized the R&I field on a regional level using Cohesion Policy.

c) Teaming – top down criteria. After the cross-document comparison an additional comparison is made, this time, with the Teaming strategies. First, the top-down criteria of the Teaming projects are identified, after which it highlights the differences with the S3 strategies. The same coding tree was used to code the documents of the Widening Participation and Spreading Excellence strategies of the work programs during which the RI's submitted their proposals of their Second Teaming call.

d) Interim conclusion which discusses the hypothesis and a summarizing table.

2. Interviews

a) Hereafter, it analyzes how the indicators set up in the strategies have been implemented in practice. This is done through an analysis of the coded interviews. Respondent 1 (R1) was the interviewee of the HiLASE infrastucure, Respondent 2 (R2) worked for RICAIP, and Respondent 3 (R3) was involved with the RECETOX center.

b) The results of the interviews will be constructed along the lines of the ERDF-phase and Teaming-phase respectively to understand how the implementation of the indicators changed during the Teaming-phase.

c) Interim conclusion which discussed the hypothesis.

8. Quadruple Helix Model

8.1 Introduction

The Innovation Systems Theory has highlighted that innovations take place within a complex system that involve different factors and actors, the system that the theory identifies is referred to here as the innovation ecosystem. This ecosystem has multiple dimensions. The RI has both international dimensions as well as place-based dimensions. The place based system is referred to here as the Quadruple Helix Model. This model, as has been explained before, states that impactful innovations are created when actors from academia-government-industry- and civil society are involved. How do the bottom-up Smart Specialization strategies implement this indicator? And does the Teaming strategy add new, top-down criteria that have resulted into different implementations of the Quadruple Helix in practice? This section will first discuss the results of the document analysis and shall turn to the implementation of the indicator after.

8.2 Identification of indicators - South Moravia

The RIS3 strategy of South Moravia (SMR) has been set up with the involvement of relevant stakeholders from the Quadruple Helix model (p.6). In turn, one of the main priorities of the South Moravian strategy is the transfer of technologies into human resources (HR) to increase innovative output (p.11).

Skills and Education

The strategy of South Moravia acknowledges the importance of talent creation and retainment to increase the competitiveness level of the region (p.8). However, the strategy points out that graduates lack the necessary skills and competencies desired by employers, hindering their competitiveness in the job market. Education often fails to meet industry demands, resulting in wasted talent and resources (p.22). Therefore, Education should anticipate future demand, not just react to the present (p.22). To create better links between skills, education and the industry, cooperation between research organizations, industry and academics (education) should be created. Examples of how to achieve this are as follows:

a) The creation of an innovation platform “comprising representatives from the business sphere and academic partners” (P.31).
b) Activities to popularize science among youth and acquire talented youth (p.35).

c) Science management training to learn how to manage human resources and cooperation with the corporate sector (p.36).
d) Improve the quality and relevance of (university) education so that it reflects the wants and needs of the industry of the region (p.43).

Jobs and spin-offs

Although the aim of a better connection between skills and industry is to create more jobs, there are also a few other objectives to increase job and company growth in South Moravia. The main strategy is to increase the number of companies that want to create a dominant position on the market, and to support companies to be able to do so (p.39). The strategy also aims to set up activities that support the development of knowledge-intensive companies and spin-off projects (p.41). However, the involvement of the actors from the Quadruple Helix Model are not mentioned to reach these objectives.

Research Infrastructures

The above stated strategies and objectives apply to all Cohesion Policy projects. The strategy includes the involvement of several actors, both public and private, that can help boost the impact of Cohesion Policy projects in the region. However, the role of RI to increase such developments is not noted.

8.3 Identification of indicators - Central Bohemia

The Central Bohemian S3 strategy also included the involvement of several actors of the Quadruple Helix Model in its creation, establishing both the priority topics and main areas of change as described in the data analysis chapter. These main areas of change represent the involvement of different actors and sectors to increase human capital. For example, the key area of change *supporting a functional regional innovation system*, states that one of the main aims is to increase and deepen the partnerships between private actors, research institutions, knowledge and support institutions (civil society) and public administration which will increase the effectiveness of research activities (p.28).

Skills and Education

The strategy mentions that HR capacity increases the potential of creating diversified fields with influx of new perspectives and solutions, ultimately enhancing the competitive level of the region

(p.19). The HR strategy of CB then argues for a need for companies and research organizations to establish strong partnerships with secondary and elementary schools in the region (especially in the framework of support for technical and natural sciences). The goal is to better reflect the wants and needs of regional companies through developing an adequate skills set. Pupils lack practical experience and that is why there should be an increased focus on internships and other work experience for students in companies, especially for students in VET education (P.24). Specific actions to develop a better skills set include:

a) Enhancing the skills set of students in vocational excellence by encouraging entrepreneurship skills and offering possibilities for internships.
b) To increase the interest in technical and science-oriented topics among students and the wider public through cooperation with research organization, universities and companies (p.26).

Jobs and Spin-offs.

The Central Bohemian strategy has quite some job and spin-off actions in place that involve several actors of the Quadruple Helix Model. The key area of change, *Innovation performance of firms*, aims to strengthen the research and innovation activities of companies through cooperation. Network events between companies and research organization should be enhanced and the level of entrepreneurial activity, spin-offs and start-ups, should be supported through development programs. Thus, the focus is here is on an enhanced partnership of industry and research organizations which emphasizes the importance of research in innovation.

Research Infrastructures

The strategy took into account a range of different actors when setting up the RIS3 strategy and doing so, identified the main actors of a healthy innovation ecosystem. These are a varying composition of companies, research institutions, and research infrastructures from both the public and private sector. Thus, the S3 notes attention to all actors of the Quadruple Helix model, but notes RI's as a separate actor in this system, and not as a structure in which the different actors are connected.

8.4 Cross-document analysis

Both the SMR and CB strategies involved several actors from the Quadruple Helix model in setting up the regional S3 strategies. This, in turn, is in line with the EU and Czech strategies that

encouraged the involvement of all actors in the Quadruple Helix model to be involved in identifying the priority areas and specific points of action (EC, p. 68; Czechia, p.9).

Skills and education

The SMR and CB approaches with regard to the involvement of academics seems to be similar. Both emphasize the need for strong cooperation between education and industry. This, in turn, is in line with the both The European and Czech strategy. The EU does indeed argue that there should be a public-private balance in the creation of skills set for effective research and innovation projects and that the focus on education and skills development across sectors and clusters will ultimately result into increased innovative output (EC, p.68). However, the EU strategy argues for the involvement of all actors of the Quadruple helix actor, not just that of education and industry. The EU suggests that firms, universities, development agencies, and regional governments need therefore to be involved and actively try to establish trans-sectoral relationships. Each actor can then contribute with its own knowledge and skill set. More specifically, each sector will either contribute through a substantive knowledge set (know what), professional networks (know who) and skills (know how). The actors are supposed to use these knowledge and skills set in their respective body to create a healthy innovation system (EC, p. 41).

On the other hand, the European strategy does mention the education sector in more detail, and especially emphasized the role of universities in the innovation ecosystem. By fostering cooperation between businesses and educational institutions, the region can strengthen its ability to attract and retain talented individuals. Additionally, universities can contribute significantly to vocational training, further bridging the gap between education and industry needs (EC, p. 78). Ultimately, it will foster "graduates with regional relevant competences and with transversal skills including entrepreneurial attitude." (EC, p. 79). This point has been implemented by the CB strategy, but not by the SMR strategy.

In turn, the Czech strategy argued that maintaining a high level of knowledge is vital for competitive success and to develop innovative solutions that are difficult to replicate. Research quality and practical relevance can coexist, fostering synergies that enhance research quality and benefit society and the economy. Effective research management and alignment with long-term challenges are key to achieving these outcomes (CZ, p. 43). These objectives, in turn, have been implemented by the SMR strategy, but not by the CB strategy.

The Czech strategy set up three priority areas to involve education in more effective research and innovation projects. Although differently from the EU strategy, the Czech strategy also focused on primary and secondary education. The first stage involves equipping individuals with practical knowledge and skills (soft skills, language abilities) through connecting education with industry (CZ, p. 70-71) in order to create a favorable environment for innovative companies (p. 134-135). The second stage addresses the identification and development of talented individuals from a young age onward for research and development careers. This is crucial for effectively utilizing HR sources and create success in the labor market (CZ, p.74; p. 134-135). The final stage emphasizes the adjustments of HR management of research organizations and universities to, among other things, increase the mobility between public research institutions and the business sector (CZ, p.74-76; P. 134-135.).

Interesting here is that the although the European strategy mostly focused on the involvement of universities to increase the human resource capacity, the Czech strategy implemented this objective in a broader way and included both primary and secondary education in its strategy, which, in turn, have been adopted by the regional strategies who emphasize skill development in primary and secondary education, as well as university education. The objectives set by the Czech Republic, in turn, seem to be largely adopted by the regional strategies.

Thus, there are some differences among the strategies. The European RIS3 strategy underlines the need for the involvement of all actors of the Quadruple Helix model, although it emphasizes the role of universities in the S3 as well. The Czech RIS3 strategy focuses on improving practical experience, awareness of market demands, and soft skills development in the education system. Both regional strategies have the same goal, that is, to better align the skills set of the people in the region with the industry. The South Moravian RIS3 strategy places emphasis on involving relevant stakeholders from the business sphere and academic partners, as well as science management training and popularizing and acquiring talented youth while the CB strategy puts more emphasis on skills development through developing practical work experience.

Jobs and Spin-Offs

To create more jobs, the CB strategy also puts emphasis on cooperation between companies and research organizations, and specific development programs between the sectors should be established to enhance start-ups and spin-offs. The South Moravian strategy, however, puts more

emphasis on increasing competitive companies and argues for enhanced cooperation with further developed companies but leaves out the academic and research side. The Czech strategy emphasized the importance of cooperation between public research and the application sector to enhance jobs. Thus, the CB strategy has better implemented the involvement of different sectors in economic growth strategies. The EU S3 strategy emphasizes the role of RI in creating arguing that they play a key role in the establishment of spin-off companies and industrial contracts (p.74). SMEs and spin-offs can, in turn, accurately define the wants and needs of their customers through the RI (CZ, p.75).

Research Infrastructures

The CB acknowledges the RI to be an important actor in the Quadruple Helix Model to further boost innovative solutions, but it does not regard RI's to be a connecting actor between the actors of the Quadruple Helix, thus, it does not recognize the role RI's could play in creating cross-sectoral partnerships. The SMR strategy does not note the role of RI in general when talking about the involvement of several actors. The Czech strategy does not mention RI's in connection to the Quadruple Helix Model either. This is in contrast with the EU RIS3 strategy which assumes that RI work in a quadruple helix model that contribute to the creation of complex innovation ecosystems. The know-how of RI is essential in solving societal challenges. Furthermore, they "propel collaboration across borders and disciplines, promote mobility of people and ideas, and enhance quality in education. The resulting innovation ecosystem spurs new ideas, solutions and innovations of benefit to the European economy and society, as well as science." (EC, p.74). Furthermore, the strategy, as highlighted above, acknowledges the role of RI in connecting SMEs and spin-off companies (EC, p.75).

8.5 Cross-program analysis - Teaming

The Horizon 2020 program does put a lot of emphasis on the involvement of the Quadruple Helix actors in general, and all Horizon 2020 R&I projects should adhere to these criteria. It is especially important in Widening projects, as it is these countries that have underdeveloped innovation ecosystems. That is why the Widening strategy of in general aims to improve this, and should engage society and academia to ensure access to research outcomes (EC, 2018-2020, p.3). This in turn, increases high quality human capital outcomes, which is one of the goals of Teaming (EC, 2018-2020, p.16). Furthermore, the Teaming strategy explicitly states that the Teaming proposal

for phase 1 should include strategies on the involvement of different actors and sectors in the hosting region to increase a healthy innovation ecosystem (EC, 2016-2017, p.15). Nonetheless, these are broad guidelines to be implemented by the applicants who have to submit an ambitious proposal that addresses these objectives. As the S3 strategies already implement quite an extensive S3 strategy with specific actions, the Teaming-strategy does not add any new top-down criteria.

However, the strategy does also state that to increase human resources in a place based system the research and innovation culture has to change (EC, 2016-2017 p.16). Meaning that the innovation performance, and culture, and general attitudes towards innovation and research have to be addressed. This is relevant as a critique from the current management of current R&I projects, as illustrated by the Smart Specialization strategies, is that the projects are weakly connected to society. The lack of the ambitions of researchers and public agencies to increase this connection could be a reason for this.

8.6 Interim conclusion

Hypothesis 1(a) stated that Teaming-strategies have stronger criteria to involve the actors of the QHM in the human capital management of RI's. As the document analysis has shown, the implementation of QHM strategies to increase human capital are already quite extensive in the S3 documents. The South Moravian strategy focuses on the skills set (know how) and how to make this more relevant to the regional industry. However, the strategy does not have any Quadruple Helix Model practices in place that support job creation and spin-offs. The Central Bohemian strategy does emphasize the importance of the connection of research institutions and the industry to create economic growth. However, it is noticeable that both strategies mostly talk about industry-academia relations and the civil society layer is often completely neglected while the public sector is also not addressed.

It has become apparent that most objectives set by the EU and Czech republic have been implemented by the regional strategies, although sometimes in slightly different ways, e.g., the involvement of primary and secondary education in the regions instead of a strong focus on universities, as suggested by the European strategy. Furthermore, regarding the role of RI's, the European strategy has quite a detailed section on how RIs should be integrated into the S3 strategies as they serve as connecting agents through which excellent Teams and spin-off projects

can be created, however, these objectives have seemed to got lost in translation in the regional strategies.

The Teaming strategies, in turn, build upon the EU objectives as reflected in the EU S3. It calls for the involvement of the different actors from the quadruple Helix Model for a healthy innovation ecosystem, especially the involvement of academia and civil society needs to be taken into account. Furthermore, the Teaming strategies need to include strategies on how to change the attitude in the research environment. A more outward attitude needs to be created in which researchers actively want to contribute to creating a healthy innovation ecosystem.

Summary	EU	Czech Republic	South Moravia	Central Bohemia	Teaming
Quadruple Helix Model	Improves (a). skills development by emphasizing role of different actors in the innovation ecosystem, especially emphasizing the role of universities in providing strategic advice, networks of experts, and incubation for science and technology spin-offs. (b). recognizes the value of the know-how of RI in improving excellent research and enhancement of employment opportunities.	(a). Skills development in all levels of education to be equipped to deal with effective research management and alignment with long-term challenges (b). enhancing the cooperation between public research and the application sector to enhance employment opportunities.	Focusses on (a). adapting the training of pupils to the wants and needs of the regional industry and; (b) increasing competitive companies and enhancing cooperation with further developed companies to boost number of spin-off companies	Focusses on (a). skill development and strong education-industry partnerships, and; (b) increasing employment opportunities through cooperation between companies and research organizations, and specific development programs between the sectors should be established to enhance start-ups and spin-offs	Human capital will increase through: (a). The involvement of the different actors from the Quadruple Helix Model and engage society and academia to ensure access to research outcomes and increase a healthy innovation ecosystem. (b). the change of attitude in the research and innovation culture in the place-based system

8.7 Implementation of the QHM – Examples from practice

To what extend have the innovation indicators from both the regional S3 strategies and the Teaming-strategies been implemented in practice? This section of the chapter tries to answer this question for the Quadruple Helix Model. It does so by discussing the results of interviews conducted with the managing authorities of three Research Infrastructures in the Czech Republic. The HiLASE center, located in Central Bohemia, the RICAIP center, also located in CB, and the RECETOX infrastructure located in South Moravia.

ERDF-phase: first attempts to QHM partnerships

There were some similarities among the respondents. Most importantly, when being asked how the projects were connected to the actors of the QHM all the respondents from the projects emphasized the importance of creating an innovation ecosystem in which the RI is accurately connected to all sectors of the region. They emphasized that the interplay between the regional actors, is extremely important to create and enhance the development of skills, as well as retain talent, and the creation of jobs, and spin-offs. Although all cases showed similarities in the implementation of the Quadruple Helix indicator, there are some differences between how and when the projects involved the different actors.

Industry collaboration

The RICAIP respondent (R2), for example stated that they achieved human capital goals already before the Teaming project started, acknowledging the importance of the industry as well. The respondent continued by arguing that the location of the center in Prague offered them many advantages such as the access to a big pool of large companies like car manufacturers. This motivated them to create partnerships with the industry from the beginning onwards. Thus, R2 of the RICAIP infrastructure underlines the

> R2: *It was 2017 when we applied to the second Teaming phase, so it was within these four years that we tracked, these HR strategies. So how many people do we need for R&D [Research and Development], how many people do you have for tech transfer, for Grant acquisition, for project management and so on and so on. And we achieved that even before applying to the Teaming grant. Regarding the industry, since we are focused on a manual for advanced manufacturing, it's clear that without the ecosystem of collaborators from industry, you cannot achieve that [HR goals]. (p.4)*

> R2: *So we were, you know, trying to from the very beginning, we were trying to define industrial driven projects together with these companies and we secured additional funding from the private resources as well. (p.4).*

importance of the connection to industry to adequately define where, what, and how, the priorities of increasing knowledge dissemination and implementation to society lie, how to realize this, and how many people you need to accomplish this. Already during the ERDF-phase the RICAIP infrastructure has achieved these partnerships. This is thus in line with the S3 strategy of the EU which acknowledges the value of each sector in creating a substantive knowledge set (know what), professional networks (know who) and skills (know how), and how this creates to a healthy innovation ecosystem. The regional strategies, in turn have followed this concept as well. It is quite interesting to note that collaboration with the industry did not remain at defining the wants and needs of the industry of the region but that the RICAIP project went even further in establishing cross-sector relationships, and actually set up joint strategies, even receiving funding from the partnerships. The CB strategy indeed underlined the importance of cross-sector relationships, more so than the SMR strategy. This could then be regarded as a well achieved implementation of the indicator. However, the partnerships that the respondent mentioned were all industry-research partnerships, while he left out the other actors of the QHM.

Civil society

The RECETOX respondent mentioned that they involved actors from the Quadruple Helix Model already before the Teaming-phase as well. The center conducted several population studies in the ERDF-phase in which it took into account the wants, needs, and skill of civil society, and in turn aimed to adapt the project to the results of the study. Furthermore, the local government contributes to the enhancement of involving citizens in Cohesion Policy funded projects. The RECETOX infrastructure then implementation all actors of the QHM to define the level of human capital in the region and how to further expand it. This strategy went further than what was included in the SMR S3 strategy, as this strategy failed to mention the involvement of civil society and the public sector.

> R3: "*one of the good examples is that the Brno is actually giving some money or something to the people, to the citizens who are participating in our population studies*." p.6.

No strategies at all

The implementation of the Quadruple Helix Model of the HiLASE infrastructure happened in a different time span than the other two projects. The respondent from the HiLASE center argued that during the ERDF-phase they had limited strategies in place on how to engage with industrial

partners and noted that during this period they spent most of the time and budget on actually building the center and developing the technology. Everything that happened next to this, like publishing and conducting science was "*rather a bonus to the project, not the main reason*" (R1, p.2). When the respondent was asked about strategies to create employment opportunities and enhance spin-off strategies during the ERDF-phase, the respondent noted that the establishment of the center created jobs as it was a new market in the region, but that no strategies between the different actors of the QHM were implemented to enhance the employment opportunities.

Teaming-phase: implementing and strengthening visions

The respondents were asked how the strategies involved the actors from the Quadruple Helix Model during the Teaming-funded phase, and how this contributed to the development of human capital in the region. The HiLASE respondent pointed out in his answer that the business plan created during Teaming-phase 1 provided the perfect opportunity to conduct visibility studies. As the program managers of the HiLASE center had very strong visions from the beginning of the project onwards that revolved around creating a center which would benefit society. As the Teaming-strategy required the involvement of these actors, the Teaming project allowed them to implement this vision.

> R1: "*But we didn't want to do it just for ourselves, so most of the time in phase one, we spent to ask the outside world. The three segments academia (universities), research institutes and companies. Uh, what they would appreciate… we ran some series of questionnaires all around the world and then we evaluated this feedback from the global, let's say, market in the field of advanced laser technologies*. (p.2)

QHM and skills

Furthermore, during the Teaming-phase the HiLASE infrastructure worked on building excellent teams. They created quite an extensive Human Resources department as part of the infrastructure that was tasked with hiring people, not only with the right professional skills, but also with the right team skills. Through hiring such people, the human capital of the region could be built from the ground up, taking into account the needs of the region. The infrastructure invested in several workshops, seminars, and courses to support career development of the people they hired, and to increase the technical skills of how to work with the technology of the research infrastructure to aim to align the skills of their employees with the wants and needs of the region, equipping them with the skills to effectively translate knowledge into innovative output. The HiLASE infrastructure then credits the Teaming project for the further development of human capital as it

gave them extra resources to implement the visions they had for the center while during the ERDF-phase they mostly focused on building the center. Similarly, the RICAIP infrastructure also saw the Teaming-funded phase as an opportunity to expand the skill-set of their employers and build an excellent team. The Teaming-project allowed them to build a sustainable network of trained and skilled professionals. This strategy is not based on a direct partnership with the actors from the QMH model, however, it does take into account the actors within the model and adapt the skills set of their employees to work effectively with the actors of the QHM.

QHM and Spin-Offs

However, the respondent from the RICAIP infrastructure argued that the key challenge now is to utilize these Teams and human capital for innovative tech transfer. The respondent then also argued that enhanced connections to the industry are needed. This will allow them to develop a sustainable project. The RICAIP project has so far one or two spin-off projects, according to the respondents, however, this is something that will hopefully increase in the next few years. According to him it is quite difficult to focus on innovative outputs, like the creation of spin-off companies during the first phases of the RI as you need two or three years to actually build the infrastructure and acquire the right material, as well as building the Team. However, the respondent believes that because of the Teaming-project they are now ready for the future.

The respondent of the RECETOX infrastructure highlighted the importance of the involvement of Masaryk University in their strategy to create jobs and spin-offs. Especially during the Teaming-phase the amount of spin-off companies increased as it gave the infrastructure a boost. This is an implementation of the European S3 strategy that argued that universities play an important role in resource mobilization. Although it did not implement the regional objective of increasing competitive companies and enhancing cooperation with further developed companies to boost number of spin-off companies.

The respondent of the RECETOX infrastructure noted the partnership with the South Moravian Innovation center who really foster the innovative output of the region through providing support for spin-off projects and manages to attract international companies and investors. This innovation center, in turn, is a governmental center and is thus the governmental actor in QHM model. The success of such an innovation center has been highlighted by the HiLASE respondents who noted

Brno as a leading example in creating innovation ecosystems. The Central Bohemian region, in turn, has established a similar center that really helps to connect the RI with the region.

Noticeable as well was that the Smart Specialization strategies all seemed to focus on the educational sector, however, the respondents did not emphasize partnerships with education in either funding-phase, and mostly emphasized the need for connections with industry to be able to translate the results of their research into economic output.

Changing culture in Teaming projects

> R1: *"What we were doing 20-30 years ago and what many institutes are still doing, is that the researcher is living in a cycle: apply for grant, get it, develop something, publish the result. But there is no genuine intention to make a step towards commercialization, to transfer the knowledge. So in my experience, and I have been a researcher for 30 years, was that most of my colleagues were just locked-up in their laboratory working for themselves. They don't care at all what's going on outside. They don't care about companies." P.8*

Noticeable is that all respondents highlighted the importance of strong visions that the managing authorities of the Research Infrastructures had for their projects. The Teaming-phase, in turn, allowed the authorities to actually implement these visions. The HiLASE infrastructure, for example, credited the Teaming-project for the enhancement of partnerships with the actors of the QHM as it allowed them to focus on changing the culture within the innovation ecosystem, as is a key requirement in the Teaming-strategies. He argued that as the CEE area does not have long historical practices of creating innovative output, this is still something that needs to be worked on. The researchers from the RI should be aware that a large sum of the budget that they work with comes from public funding, and that is why their research should also be useful to society. As the HiLASE infrastructure tried to change this culture step by step, the respondent believes that his team does understand this key concept and that this has really progressed since six years ago. This, in turn, represents a slow development towards creating innovative ecosystems. The change in culture will contribute to human capital development by enhancing the establishment of spin-off companies. The importance of a strong vision was also emphasized by the other respondents (R2 RICAIP, p.7 and R3 RECETOX).

8.8 Interim conclusion

Hypothesis 1(b) stated that the actors of the QHM are closer involved in human capital strategies of Teaming RI's. The results of this section call for a more nuanced hypothesis. Most RI's had already implemented QHM relationships to boost human capital during the ERDF-phase. During the ERDF-funded phase, the RECETOX and RICAIP infrastructures had already begun implementing strategies to establish these connections, while the HiLASE infrastructure primarily focused on center development and technology during this phase, with limited strategies in place for engaging industrial partners and enhancing employment opportunities.

It should be noted, however, that the implementation of the QHM strategies significantly improved during the Teaming-phase, crediting the changing culture and additional resources as reasons. The Teaming projects provided additional resources and opportunities to further develop human capital, enhance skills, and promote the translation of knowledge into innovative outputs. All respondents, in turn, argued that the Teaming-phase functioned as an accelerator to boost the implementation of their place-based human capital strategies in the QHM. Furthermore, the HiLASE center valued the changing culture of research as a way to better implement QHM relationships.

9. Internationalization

9.1 Introduction

The openness of a research environment is extremely important to build a healthy innovation ecosystem, this is what the Social Capital Theory states. International recruitment strategies are needed and international partnerships are essential in sustaining a healthy international approach and build good human capital practices. The following section analyzes how the Smart Specialization strategies and Teaming strategies have implemented an international approach and assumes that Teaming projects, eventually, have a broader international strategy and therefore better human capital practices in place.

9.2 Identification of indicators – South Moravia

One of the key objectives of the strategy of South Moravia is to internationalize the R&I environment. The strategy of SMR mostly emphasized the creation of international research teams (p.35). The strategy also includes provision on increased support for the "inclusion of companies and research organizations into foreign research projects" (P.13). Moreover, one of the objectives of the strategy aims to increase the internationalization of universities by implementing practices to increase foreign students and staff (p.48).

The strategy notes quite some attention to the role of RI's in boosting the internationalization of the research environment. To boost the quality of research teams, the number of research infrastructures on the European level should be increased (p.35). It notes the importance of funding for long-term international research partnerships by investing in research infrastructures, supporting the mobility of researchers, and international networking. It also focuses on attracting foreign researchers, strengthening support services, and fostering research cooperation with neighboring regions (p.35).

9.3 Identification of indicators – Central Bohemia

Interestingly, the S3 strategy of Central Bohemia acknowledges the value of establishing international partners, however, the strategy does not provide any strategies to internationalize the R&I field. It does not provide such strategies because it argues that Cohesion Policy projects are still in development in the region itself, and this should be the main focus right now (p.5). However, in its human resource strategy one of the indicators of change is the number of

researchers form another region or abroad, which should ultimately improve the quality of human capital in the region (p. 25). Both attracting international talents to establish multidisciplinary teams and supporting the mobility of researchers abroad is important to achieve this objective (p.25). Furthermore, it does recognize the importance of international cooperation in European research programs such as Horizon 2020, and encourages the investment of Cohesion policy in ESFRI infrastructures. However, it does not recognize a role for Cohesion Policy in these investments.

9.4 Cross-document analysis

Thus, both the SMR and CB strategies note the creation of interdisciplinary, international research teams as an objective. This, in turn, increases the human resource capacity of the project and region, which then contributes to the overall competitiveness of the region. This is in line with the European strategy which argues that mixing regional experts with international experts contributes to enhancing the competition level of the region as well (EC, p.32). The Czech national strategy built upon the guidelines on internationalization from the EU and acknowledges the existing inadequacy in incorporating an international dimension into Cohesion Policy projects. The main problem revolves around the establishment of international research teams with scholars from multiple disciplines. The limited prestige of Czech research organizations and teams is the main reason why the Czech Republic does not participate in many international research projects such as the European Research Infrastructures (CZ, p.44). In addition, the low rate of international mobility among Czech researches contributes to the relatively low involvement of international collaborations (such as Horizon 2020) which undermines the synergies between H2020 and Cohesion Policy (CZ, p.63). To create international, multidisciplinary, excellent research teams, policies that enhance mobility of Czech researchers should be embraced, adequate HR recruitment practices should be in place, and the Czech research environment should become more attractive to foreign researchers (CZ, p.24 and p.63). When the openness of the research system, including brain circulation, is not addressed, it is unlikely that Czech research becomes of better quality, which undermines the participation in the EU's framework programs (CZ, p.63).

Thus, the objective to create international research teams has been adopted in all strategies. However, the EU mentioned the value of establishing international partnerships, which, has not been implemented by all strategies. The SMR strategy does provide objectives for establishing

international partnerships, while the CB strategy does not. More specifically, the SMR strategy identifies the role of RI's as a key player in enhancing these partnerships, this is also in line with the strategies of both the EU and Czech Republic. The EU S3 strategy suggests that the national and regional RIS3 strategies should support the free circulation of knowledge, that is why international partnerships for research projects should be facilitated and the mobility of researchers should be supported (EC, p.63). In turn, it is argued that the establishment of international oriented RI's in the region will ultimately contribute to the establishment of international partnerships and brain circulation (EC, p.74). ERDF provides financial support for setting up these infrastructures which will boost the participation in international partnerships, but also the participation in international research programs such as Horizon 2020 as the EU will fund projects that contribute to the establishment of European RI's and international cooperation (EC, p.77).

The Czech strategy acknowledges the importance of investments in RI, but also argues that there need to be further improvements in the management of the RI's arguing that the lack of openness of the Czech research environment undermines the quality of RI management (CZ, p.44). The openness of the research environment should be addressed through investing in RI and supporting European cooperation in the RI's, and support acquiring staff to build excellent teams (CZ, p.128). establishing new international cooperation projects (such as Teaming projects, CZ, p. 129) and increasing the number of foreign researchers in research institutions will also contribute to the openness of the Czech research environment. Thus, this objective has been rearticulated by the SMR strategy, while the CB strategy ignores it. It can then be assumed that the RECETOX infrastructure, located in South Moravia, had a more extensive international strategy during the ERDF-phase than its counterparts in Central Bohemia.

9.5 Cross-program analysis: Teaming

Although the S3 strategies, except for the CB strategy, argue for the establishment of international partnerships, the main focus remains on talent attraction from abroad to create excellent research Teams. The Teaming-strategies, however, make the international partnerships a mandatory objective.

The Teaming project partners must consist of a research funding agency, a university or a research organization located in the Widening country. The other partner needs to be a university or research organization with an international reputation in research and innovation excellence (EC, 2016-

2017, p.13). The Teaming strategy makes the collaboration between Member States mandatory. At least two countries have to be involved who "display the willingness to engage together on this (decreasing research and innovation gap) purpose" (EC, 2016-2017, P.15). furthermore, The business plan submitted in the first Teaming phase should highlight the strong engagement of the partners in the RI located in the widening area (EC, 2016-2017, p.16) and, for the case of RICAIP and RECETOX how this also benefits the partner countries (p. 15. 2018-2020).

9.6 Interim conclusion

Overall, the objective to create international research teams is present in all strategies, but the implementation of international partnerships varies. While the EU S3 emphasis the free circulation of knowledge, supporting international partnerships, and fostering international cooperation through research infrastructures, not all strategies echo these objectives. The SMR strategy does provide specific guidelines on setting up international partnerships, but these guidelines lack in the Central Bohemian strategy. Teaming, in turn, makes the establishment of international partnerships mandatory and is, therefore, more in line with the European objectives. We can then say that H2(a) which stated that Teaming-strategies have more extensive objectives in place related to the establishment of international networks than S3 strategies is in line with these results.

Summary	EU	Czech Republic	South Moravia	Central Bohemia	Teaming
Internationalization	The EU wants (a). a mixture of regional and international experts in a research team to enhance the competitiveness and (b). to establish international partnerships, especially through RI's.	The Czech Republic emphasizes (a) the need for international excellent teams. Policies enhancing mobility of Czech researchers, new HR recruitment practices, and creating an attractive research environment contribute to	South Moravia focusses on (a). the integration of companies and research organizations into foreign research projects (b). increase foreign students and staff, and (c). investing in European RI's to enhance international excellent	The CB strategy does not have any strategies in place to establish international partnerships. The international policies in place are the attraction of foreign researchers, increased support of mobility of Czech researchers,	The Teaming strategy makes the establishment of international partnerships mandatory. The Teaming-projects must at least consist of a research institution in a Widening country and one other Member State or associated

		this objective. And (b). investing in RI's, enhancing European cooperation in RI's, and support building excellent teams in RI's will make the Czech research environment more open.	teams and establish international partnerships.	and investments in RI's.	country with an international reputation.

9.7 Implementation of internationalization – examples from practice

To what extend have the internationalization objectives from the regional strategies, in turn, been implemented by the projects? By discussing the results of the interviews this question will be answered.

Scientific partnerships and international strategies for talent - The ERDF phase

Most of the RI's included an international strategy from the beginning onward. For example, the HiLASE infrastructure in the CB region put effort into creating an international research team already from the ERDF-phase onward. About half of the researchers were recruited from abroad as there were simply not enough Czech researchers available who were qualified to work for the infrastructure. During the ERDF-phase the HiLASE infrastructure also worked together with international partners in the UK, however, the collaboration was mainly focused on scientific cooperation. The main human capital strategy to improve the skill-sets of the employees of the RI was learning by doing during the ERDF-phase, the international partners did not contribute to these strategies.

The RICAIP infrastructure (CB region) also established international partners during the ERDF-phase. However, important to note here is that the cooperation grew from a geopolitical interest, and was formed through high governmental narratives instead of an ambitious vision of researchers. Although, the respondent did highlight that the researchers were fully committed to

the international cooperation from the beginning onward. Still, the RICAIP emphasized that it was quite difficult to attract the brightest minds in the world when the project started, as it has not proven its prestige and value yet. The project then first aimed to convince Czech researchers abroad to return back to the Czech Republic, however, the Czech researchers were limited in numbers, and therefore the project decided to develop quite extensive international strategies to attract researchers from other nationalities as well, next to the political cooperation they benefited from. Doing so, they were actively involved in setting up pan-European initiatives in their field, which contributed to the visibility of the RI.

R2: *So we really managed to create a great international collaboration all across Europe…We collaborate with these prominent centers of excellence all over Europe, particularly in the field of manufacturing. And you know, we are quite visible now because we are a core member of these prominent projects which are running. P.5*

The HiLASE and RICAIP infrastructures both argued that they had to develop international strategies because there were not enough Czech researchers they could hire. This is thus an implementation of the S3 strategies that argued in favor of this, however, it might have been more a consequence of the lack of available Czech researchers than a visionary international strategy. The international dimension was further implemented by developing international partners during the ERDF-phase, even though the Central Bohemian strategy in which the projects are located does not provide objectives to set up such partners. However, as emphasized by the HiLASE respondent, the cooperation during the ERDF phase was mostly related to scientific developments instead of the creation of skills-sets.

According to the RECETOX respondent (R3) in the SMR region, the willingness to establish international partners came solely from the intrinsic motivation of a strong vision of the project managers from the RI, instead of from the Smart Specialization objectives. The Cohesion Policy funds, in turn, were used for building the center in the Czech Republic, as well as hiring a research team through the Excellent Team Programs from the Commission's calls in Cohesion Policy which aimed to build strong international, interdisciplinary research team. This is a clear implementation of using an international strategy to enhance the human capital level of

R3: *"So the director brought them back to Czech Republic and it was actually enabled by the [Cohesion] funds because you could offer them a deal, I don't know package, and invite them here and pay them."* P.5

R3: "*ESIF funds actually enabled us, to submit a proposal for a Teaming-grant because it's better to submit it with someone who you know and who knows you, of course, because to come for example to Oxford to say, OK come on, I'm from the Czech Republic let's do a Teaming it wouldn't work of course."* P.4

the region. By using the ERDF-funds to recruit people from institutions abroad, the RI managed to establish close relationships with international institutions during the ERDF phase. When RECETOX wanted to apply for a Teaming-grant they turned to these partners, who were indeed willing to apply for a Teaming-grant together. Thus, Cohesion Funds were enabling them to establish international partners and apply to a Teaming-grant.

Sustainable international cooperation during Teaming

All the respondents pointed out that although they had established international networks during the ERDF-phase already, the cooperation during the Teaming-phase expanded. Especially because the Teaming projects contributed to the visibility of the Research Infrastructures. They gained more prestige, which ultimately contributed to the competitiveness level of the project. R3 of the RICAIP infrastructure, for example, highlighted that the Teaming-project allowed them to build a sustainable network of trained and skilled professionals through their connections with research institutions abroad.

R1: "*being in central Europe, especially in the in the post communistic country, is very, very different from the UK which has been evolving without any occupation and significant political changes. They didn't do the homework for us, but they provided some insights and mainly inspiration." P.3*

The HiLASE infrastructure credits the Teaming-phase for stabilizing international human capital practices. The respondent (R1) pointed out that international collaboration is very important to create visibility, and to recruit people from abroad in order to expand the skills set of the region, which significantly improved during Teaming. The respondent also mentioned that the international partners primarily functioned as "an inspiration" on how to train people in the region as the communist past impeded the development of their human capital practices. The international collaboration between the HiLASE infrastructure and its international partners then expanded during the Teaming-phase. They started to cooperate on topics like the efficient management of the infrastructure and the expansion of the skills-set of

R1: *"I think the one of the biggest added value was that teaming provided the way how to improve [the international cooperation], how to work more on the career development and training of our staff.*"p.5

employees which would contribute to spin-off projects. Czech employees were sent to the UK for specific training programs, as well as people from the UK were invited to the Czech Republic.

9.8 Interim conclusion

H2(b) which stated that Teaming RI's have better internationalized their human capital strategies to attract talent, share best practices, and establish spin-off projects is partially correct. The implementation of international HR strategies was already visible during the ERDF-phase, especially because the Cohesion funds were used to recruit people from abroad. Moreover, the establishment of international partnerships to enhance the internationalization of HR practices was also in practice already during the ERDF-phase, except for the HiLASE infrastructure. The respondents of the projects highlighted that it was mostly the vision of the managers of the RI's that contributed to extensive international cooperation. That is a reason why the international dimension was already strongly visible during the ERDF-phase. This is especially in contradiction with the CB strategies for internationalization as they did not refer to establishing partnerships. Nonetheless, the respondents also argued that the international partnerships further stabilized during the Teaming-phase. Teaming makes it mandatory to have international partners that are committed to a joint-venture cooperation exceeding mere scientific cooperation. This is visible in the implementation of the international strategies during the Teaming-phase, thus, highlighting the added value of Teaming. The respondents agree, especially crediting the Teaming-phase with increased visibility which helps expand their international network and recruit people from abroad.

10. International Resource Mobilization

10.1 Introduction

The theory of Economic Networks stated that the establishment of international partnerships in research projects can have immense positive benefits for resource mobilization. By having a broad network it becomes easier to pool resources together and effectively implement them. This, in turn, leads to more sustainable strategies for the projects. When the autonomy of research projects is created, they will be able to formulate strategic plans outside of the original aim of the project, in turn, increasing spin-off companies and increased innovative output. This section analyzes how the S3 strategies have implemented strategies for sustainable economic strategies after the ending of Cohesion funding.

10.2 Identification of indicators – South Moravia

The strategy of South Moravia does not include any specifics on how to improve resource mobilization and sustainability of research and innovation projects through an international network. It does identify the deterioration of the regulation framework for research, characterized by a fragmentation of resources (p.23). To improve this, the strategy suggests providing support for international grant projects such as Horizon 2020, noting the value this could be for research infrastructures (p.35). However, the strategy fails to mention how international grant projects will contribute to the long-term sustainability of the projects, and if the international partnerships established through RI's play a role in this sustainability.

10.3 Identification of indicators – Central Bohemia

The key areas of change that the Central Bohemian strategy identifies do not say anything about the value of an international network for increased resource mobilization to create self-sustainability. In contrast, it does question the economic sustainability of Research infrastructures when Cohesion Policy funding will end. The strategy then argues that when the right human resources and financial resources are mobilized, this sustainability is created (p.9). The S3 does not provide any specific objectives on how this can be reached (p.27). Furthermore, the strategy acknowledges the value of synergies in RI's to enhance a long-term vision for innovative business in the region (p.27), thus, referring to the European grant programs to enhance the economic security. It does not go further than this and leaves out other sources of becoming economically independent.

10.4 Cross-document analysis

The findings from the document analysis of the regional S3 strategies seem to be largely in line with both European and Czech strategies. Both the EU strategy and the Czech strategy include limited information on creating sustainable financing for the projects when funding from either cohesion policy projects ends, or from the EU framework programs. Especially the international dimension does not get noted to enhancing sustainability and competitiveness.

The European strategy mostly emphasizes the increase of competitiveness of the region as a main goal of the economic sustainability of Cohesion Policy. Especially the creation of international value chains is key to increase the competitiveness. The international dimension is named here as choosing smart priority areas through which copy-catting strategies from neighboring regions is avoided (EC, p.51). Thus, they create a dominant position on the international value chain. It then also asks national and regional strategies to take action in support of the internationalization of SMEs to make a connection to the global value chain (EC, p. 115). The Czech S3 strategy mentions an internationalization of SMEs to enhance economic benefit as well (CZ, p.119), arguing that when SMEs enter the global market it will ultimately contribute to the Czech republic's economic growth as it increases the sales abroad. Thus, both strategies aim to increase the competitiveness by constructing an outward look in its management of Cohesion Policy, especially through an increased internationalization of SMEs, however, it does not include any specific strategy on how to do this. Research and innovative output is needed to create effective SME's, but the S3's do not give any credit to international networks contributing to healthy innovation ecosystems in which these SMEs can thrive. The establishment of international partners to increase resource mobilization and competitiveness is then also not specifically mentioned. The EU strategy outlines the importance of universities in the innovation ecosystem (EC, p. 79) and mentions that they could play an important role in resource mobilization of R&I projects and increase the innovative output. The strategy does not mention that these universities have to be foreign. However, this objective is not returned to in the national and regional strategies.

The European strategy does not mention strategies to reach sustainable economic security for RI's. This is in contrast with the Czech strategy which defines the lack of sustainable, long-term financing of Research Infrastructures as a problem. There remain problems in the long-term visions and financing of Research Infrastructures. They need to be further developed, as the

development of the RI will allow them to expand their international network through establishing partnerships (CZ, p.50). Thus, resource mobilization for RI's is extremely important.

10.5 Cross-program analysis: Teaming

Unlike the S3 strategies, the Teaming strategies put quite a lot of emphasis on creating self-sufficient, autonomous projects. The proposal for the Teaming funds already had to demonstrate that the project is based on a true joint venture between the partners of the Teaming projects. Thus, those in the Widening country and other Member States. The Teaming-strategy assumes that this joint venture partnership will continue, also when the Teaming-funds end. It is then important that the partners are "fully committed to continue supporting the new Centre in view of achieving sustainability in the long run and hopefully financial autonomy (also by successfully competing for European and international funding programs)" (EC, 2016-2017, P.14)This commitment should be reflected in the business plan of Teaming phase 1 in which the partner organizations need to provide an extensive strategy that explains the vision of the center and the long-term science and innovation strategy of the center. The focus herein should be on the good management of the projects between the partners (EC, 2016-2017, p.13 and 2018-2020, p.6). Furthermore, the business plan should include specific strategies on the long-term self-sustainability of the projects (EC, 2016-2017, p.16 and 2018-2020, p.7). The teaming projects, in turn, aim to create a strategic growth path and long-term opportunities for economic development (EC, 2016-2017, p.16 and 2018-2020, p.7). By improving the scientific capabilities through international cooperation the Widening countries will ultimately be able to increase their chances to receive funding on the international level, including those from Horizon 2020 (EC, 2016-2017, p.16 and 2018-2020, p.8).

10.6 Interim Conclusion

The results of the document analysis are in line with H3(a) which stated that Teaming-strategies set requirements for formulating sustainable resource strategies post-EU funding based on the involvement of international actors while S3 strategies lack these objectives. The Smart Specialization strategies note little attention to the economic sustainability of Cohesion projects. Although there are some strategies in place that should enhance the ability to mobilize resources, the value of international cooperation seems to be lacking in their approach. This is visible in the strategies on all three levels. In contrast, the Teaming projects do put quite a lot of emphasis on the international cooperation as a source of economic sustainability. These results are in line with the hypothesis which suggests that Teaming-funded RI's have established international

partnerships which enables the ability to formulate sustainable resource strategies post-EU funding. ERDF-funded infrastructures, in turn, lack an international resource strategy.

Summary	EU	Czech	South Moravia	Central Bohemia	Teaming
Resource mobilization and sustainable vision	The EU wants to (a). promote the competitiveness of the region through creating international value chains and internationalization of SMEs and (b). promote the role of universities in resource mobilization. But the EU leaves out the role of international partnerships in RI's as a source of sustainability.	Czech strategy focusses on (a). internationalization of SMEs and (b). the further development of RI through the establishment of international partnerships.	The strategy of South Moravia does not include any specifics on how to improve resource mobilization and sustainability of research and innovation projects through an international network.	The key areas of change that the central bohemian strategy identifies do not say anything about the value of an international network for increased resource mobilization to create self-sustainability. However, it does question the sustainability of RI's, naming the value of synergies with Horizon 2020 as a solution.	Teaming strategies put quite a lot of emphasis on creating self-sufficient, autonomous projects by putting obligations on (a). establishing international partnerships based on a true joint venture that will continue after the Teaming-funds stop (b). asking for long-term sustainability of economics strategies in Teaming-phase 1.

10.7 Implementation of international resource mobilization – examples from practice

Even though the Smart Specialization strategies did not have any specific objectives in place during the ERDF-phase, the question is if this was also the case in practice. The following section discusses whether the case studies had implemented international resource mobilization strategies during the ERDF-phase and Teaming-phase.

No strategies, but a recognized need for them – The ERDF-phase

None of the respondents from the RIs mentioned specific strategies during the ERDF-phase that were directly in place to stabilize the flow of resources. However, the respondent from the HiLASE infrastructure did note that the Czech Republic is increasingly developing and getting richer, and the funds from Cohesion Policy will therefore go down. This has also been mentioned in the literature review of this research which highlighted the sustainability of the RI as a problem (see chapter 4). Due to the development of the Czech republic, the projects cannot solely rely on Cohesion Policy anymore, and that is why there need to be alternative, sustainable ways for resource mobilization. These strategies, however, have mostly been implemented during the Teaming phase.

Teaming: visibility

The respondent of the RICAIP infrastructure underlined the importance of European cooperation in the manufacturing research sector to "*maintain and increase the competitiveness and innovation*" (R2 p.2). International partners are especially important to create visibility. The respondent continued by arguing that the strong international position that the Research Infrastructure has acquired is like a "*crown*" (R2 p.8). The international position has grown immensely during the Teaming-phase, and their position in the international field is only getting stronger. According to respondent 2, having international partners makes it easier to apply for international grants and big research projects, which thus leads to a sustainable approach. Thus, the fact that the Teaming projects require to set up sustainable international partnerships has resulted into a broad and stable international network who are committed to the partnerships and help the Widening country to get access to international grants and additional resources.

> R2: "[international partners makes it easier to] *just easily say, hey, we would like to go for this call. We have this idea. Would you like to join it now?*" (p.9).

The HiLASE respondent also mentioned that international cooperation has led to increased visibility and smarter specialization. This has attracted several high-tech companies to the region with which they have established joint-activities. However, not all credit was given to the increased visibility. The respondent noted that a sustainable infrastructure is created through the cooperation with the private sector, both within the region and on the international level. A public-private investment balance would be ideal because the funds from Cohesion Policy will go down and

investments from the private branch then have to increase. This is why the authorities from the HiLASE center applied for a Teaming grant: to reach a new level of sustainability. The teaming-phase provides valuable time and money to build these connections and increase a sustainable strategy for the RI when the Teaming funding ends. The strategies of Teaming require a strategy for sustainable management, and although the Teaming strategy emphasizes the importance of strong partnerships, a sustainable strategy can also take other considerations into account, which is what the HiLASE center decided to focus on.

Likewise, the RECETOX respondent also pointed out that international partnerships are not almighty in creating sustainable innovation ecosystems with a healthy flow of resources. He argues that there are Teaming-projects who have great international partners, however, they still walked into problems when establishing their own legal identity as they are highly dependent on resources from the Commission or National government. That is why RECETOX decided to stay a part of Masaryk University and to only use the Teaming-funds as an accelerator to implement more spin-off projects. This way, it provided a helping hand in acquiring more Horizon funded research projects for the university, which in turn, has led to a sustainable resource flow. However, the next challenge is to utilize the excellent teams and spin-off projects created within the Teaming project for tech transfer. The respondent, just like the HiLASE infrastructure, argued that enhanced connections to the industry are needed. This will allow them to sustain the project and create industrial revenues, in order for them to not be dependent on grants anymore.

10.8 Interim conclusion

H3(b) stated that Teaming-funded RI's have implemented international resource strategies, while ERDF infrastructures have not. The hypothesis can largely be justified, as Teaming-funded RI's have stabilized and expanded their international networks which enables them to formulate sustainable resource strategies post-EU funding. ERDF-funded infrastructures, in turn, lack an international resource strategy. However, nuance must be given to it as two out of three RI's emphasize different factors to be more important than the international network for resource mobilization. Thus, it is not the international dimension per se that enabled them to do so.

11. The added value of Teaming

The results in the previous chapters suggest that Teaming is of added value, as all innovation indicators are implemented to a wider extend in the Teaming-funded phase. However, some important nuances should be made.

11.1 The smart implementation of ERDF-funds

What is striking is that the ERDF-funds were used for different ends in the three RI's. Although the HiLASE center used it to set up their Physical RI, using it for practical ends. This is in contrast to the RICAIP center that used national funding to build the RI but when the infrastructure was built they used Cohesion Policy to create sustainable teams to actually make effectively use of the infrastructure. There was a call at the Commission at the time that called for research projects to set up "excellent teams". They then received the Cohesion Policy funds to implement and strategically set up excellent teams that would target the dissemination of knowledge acquired through research at the RI and increase human capital resources. The RECETOX Research Infrastructure used Cohesion Policy for creating excellent teams, as well as for building the scientific center. They applied to a similar Cohesion Policy grant at the European Commission which also helped them with setting up an interdisciplinary, international, excellent teams. Both the RECETOX and the RICAIP infrastructure were able to recruit people from abroad this way.

> *R2: When you have built the building, you have the concept, you have the vision, you need to follow up with teams and other equipment. So then we applied for ESIF [Cohesion Policy] funding to build the scientific teams of excellence. We were lucky because there was a new call open for creating the teams, which enabled us to really grow. And we received almost €20 or €30 million of ESIF funds before acquiring the Teaming Grant. So in the time when we applied for the Teaming grant, we already had the building, we had the startup teams, like 50 really excellent researchers which were returning from abroad to the Czech Republic based on this initial capacity building grant. And then with this track record, we applied to the Teaming call. (p.3).*

R2 from the RICAIP infrastructure also argued that the project went further than the S3 strategies during the ERDF-phase. It was more about the vision of the project than it was about creating a strategy that suited the Smart Specialization strategy of the region as these were very broad

guidelines. The RICAIP project already had very ambitious goals from the beginning onwards and created strategies to enhance human capital and innovative output, which, according to the respondent, went further than the broad guidelines the RIS3 strategies set-up. The RECETOX and HiLASE center recognized similar visions, which both respondents argued to be a key factor in creating successful ERDF-projects. The RECETOX respondent pointed out the value of Cohesion policy as well. He argued that they did not use the funds solely for the development of the physical RI, but they implemented the funds in a smart way. When they applied to the Teaming project, in turn, it was easy for them to come up with an S3 strategy for the RI as the Teaming vision was more radical than the ERDF infrastructure.

> *R2: So the strategy [S3] is defined from the high level perspective with which you need to comply, but there are also specific strategies which actually go out of these umbrellas, in our case this was the strategy for Industry 4.0 of the Czech Republic. These national strategies approved by the government were codeveloped by us. P.6*
>
> *And we went much further with the specific industry for 4.0 strategy and AI strategy which was specifically designed for the Czech Republic. So I think it is going far beyond the general framework of S3 strategies. P.7*

11.2 Key enabling indicators within Teaming

The respondents of the RI's were also asked whether they believed Teaming allowed them to reach larger innovative output in their Research Infrastructures, and if so, what was the key indicator within the Teaming-phase that increased the level of innovation. The respondent from the HiLASE center focused on the change of culture within the innovation ecosystem that is needed, and that the RI tries to change. He argues in favor of creating open innovation ecosystem in which research is closely connected to all sectors of the region. Teaming, in turn, really allowed them to establish these QHM relations. The respondent then argued that without Teaming, the infrastructure would just be one of many RI's. The Teaming, in turn, allowed them to build on "*a diversified portfolio of our users and partners*" (P.8), which was one of the main goals.

The RICAIP infrastructure saw the Teaming-funded phase as an opportunity to expand the skill-set of their employers and build an excellent team. Especially an interesting observation was that, according to him, the creation of human capital and the dissemination of results to society were three separate phases, and the project is now placed in the second phase. The first phase was to set up a RI through ERDF funds. The second phase was to create even more excellent teams through additional resources coming from the Teaming grants. The second phase allowed them to combine their extensive strategies already in place during the ERDF-funded phase with the increased

international cooperation, visibility, and prestige that came along with Teaming. The third phase symbolized the challenges the RI still has to overcome: increasing industrial revenues to become sustainable. According to him, it is quite difficult to focus on innovative outputs, like the creation of spin-off companies during the first two phases of the RI as you need two or three years to actually build the infrastructure and acquire the right material, as well as building the team. However, the respondent believes that because of the Teaming-project they are now ready for the future.

The respondent of the RECETOX infrastructure was less enthusiastic about the added value of Teaming. On the one hand, he highlighted that the objective of the Teaming-project was quite different from the ERDF-funded phase of the project. Its aim was to transform the center from an environmental oriented center to an environmental health science center. This meant an increasingly interdisciplinary nature of the project. The Teaming-funds were used to expand the center and create spin-off projects related to the new objectives of the center, which helped them to reach their more ambitious objectives. However, when asked what the key indicator for increased innovative output was for the RI the RECETOX respondent underlined the strong visions that the director of the RI had for the infrastructure. Moreover, he strongly underlined that the Teaming-funds were not a huge change for the project, and that they would have gotten the same results with solely the ERDF-funding but that it might would take a longer time, thus, Teaming served as the accelerator to reach the results faster.

12. The exclusiveness of Teaming grants

Noticeable is that all projects had very ambitious strategies from the ERDF-phase onward, although the implementation of these visions was more fruitful during the Teaming phase. Still, their ambition to spend ERDF-funds on more than material products and the physical infrastructure allowed them to create a solid foundation that helped them to apply for a Teaming grant successfully.

Furthermore, the fact that the projects had implemented the S3 strategies quite well, and sometimes even went beyond it, also accounts for the lack of differences between the Research Infrastructures located in South Moravia and Central Bohemia. For example, regarding the establishment of international partners, there was a difference between the two regional strategies, the CB one being the one not including provisions on establishing international partners. However, all of the projects already established such partners during the ERDF-phase, thus, exceeding the S3 strategies. However, there did seem to be a difference in the implementation of the ERDF-strategies of the HiLASE infrastructure and the other two. The HiLASE infrastructure is located in a rural town in Central Bohemia, but still closely connected to Prague. Although the respondent of the HiLASE infrastructure underlined the importance of the strong visions the managing authorities had for the Research Infrastructure, he did mention that the Teaming funds were absolutely necessary to implement all of these visions. This could provide an argument that projects that are not located in the most developed areas of the Czech Republic struggle more with the smart implementation of Cohesion Policy funds. This is in line with hypothesis 4 which stated that Research Infrastructures located in less-developed areas have not implemented the innovation indicators as well in both the ERDF-phase and Teaming-phase compared to Research Infrastructures located in well-developed areas. The results highlight that the infrastructure located in a less developed area did not implement the S3 strategies as far as the other RIs. Nonetheless, having strong visions from the beginning onward still enabled the HiLASE infrastructure to develop ambitious strategies, which might not have been implemented as well during the ERDF-phase, but still enabled them to create a successful project with international partners, which, in turn, made it easier for them to apply to a Teaming grant. No large differences between the implementation of the innovation indicators during the Teaming-projects were found, which is an argumentation against the part of the

hypothesis that states that the innovation indicators are also not well-implemented during the Teaming-phase.

It might be that because the ERDF-projects were successful already, it enabled the RI's to successfully implement the Teaming-funds, and thus, the synergies between Horizon 2020 and Cohesion Policy. It was easier to combine the Teaming-funds with the ERDF funds as the strategies during the ERDF phase were already visionary and exceeded the objectives of the Smart Specialization in many ways. However, the fact that successful ERDF projects have gained the Teaming grants could provide a criticism of Widening itself. As the Horizon 2020 grants have a low success rate (about 70% of the proposals gets rejected, EC, 2017), to be able to get access to a Teaming-grant it helps if you already have extensive strategies in place, and know what and how you want to improve those strategies as the Horizon funds are based on a competitive model of funding. Thus, the projects have to be visionary. This is different than getting access to ERDF-funds, which is often seen as access to easy money (Gorzalek, 2017). The relatively smart implementation of ERDF-funds through the strong visions of the managing authorities in the analyzed Research Infrastructures, in turn, provided a stepping stone to reaching the Teaming grants.

In addition, the fact that all three Teaming projects are located in the two most developed regions of the Czech Republic adds to the reasoning that Teaming proposals already have to be successful at the time of application. As the literature review of this thesis argued, the Czech Republic has invested a lot in its Research Infrastructure network with ERDF funds all over the country. Some of the ERDF RI's located in less developed regions have applied to Teaming grants as well, and received the Teaming phase 1 in which they could construct a business plan[6] but never the second. It could be that these ERDF projects were not as successful or visionary in their implementation of Cohesion Policy funds. It could also mean that the Smart Specialization strategies in these regions are less well-developed, or the projects do not implement the strategies as well. The results of the HiLASE infrastructure add to this argumentation and also provide a foundation to partially approve the last hypothesis. Should Teaming really make an impact, the synergies in less developed regions should be enhanced. Further research into the effective implementation Cohesion Policy funds in ERDF-funded RI's in less developed regions could then be interesting.

[6] E.g. IT4Innovations located in Ostrava, Czech republic (https://www.it4i.cz/en)

Furthermore, it would be interesting to conduct research in a comparative analysis of ERDF infrastructures that have never received teaming funds with Teaming projects that have been set up with Teaming funds, instead of building upon ERDF centers. This gives a better picture of how less successful research infrastructures have implemented the innovation indicators.

12.1 Recommendations

As the results of this study argue, Teaming-funds in fact have added value. The synergies between Cohesion Policy and Horizon funding enhance the capacity to implement the innovation indicators, in turn, increasing the innovative output of the Research Infrastructures and the region. However, Teaming can create a bigger impact when the synergies of Horizon funds and Cohesion funds are enhanced in less-developed regions. To be able to do this, Teaming-grants should be more accessible for ERDF-projects that did not go over and beyond the S3 strategies. Especially because S3 strategies in less-developed regions might not have the same priorities as the Teaming-strategies which makes the creation of synergy strategies more difficult. For example, the S3 could focus on the specialization of regional SMEs while leaving out internationalization strategies or QHM strategies. This, in turn, makes it more difficult for such infrastructures to acquire a Teaming-grant. The EU could try to enhance the inclusiveness of Teaming grants in several ways:

- Strengthening the Seal of Excellence. Horizon Europe is the follow-up R&I FP of Horizon 2020 and started in 2021. Horizon Europe has taken efforts to make the Widening tools more inclusive. One way it did so was to make more efficient use of the Seal of Excellence which provides funding to high-quality projects who have been rejected to a Horizon grant due to budgetary constraints (Lopriore, 2022). Although the Seal of Excellence has great potential and has increased its effectiveness, there are still a few points that should improve. At the moment, Member States do not provide enough additional resources to projects that have received a Seal of Excellence which undermines the innovative outcome of the projects. Thus, synergies are not used to the full potential which limits the effectiveness of EU R&I funding. Member States should therefore make sure that additional resources are available. The EU should promote the Seal of Excellence better and provide Member States with support on how to increase the effectiveness of Seal of Excellence projects (European Council, 2018).
- Increase the budget of future Research and Innovation Framework Programs and simplify the application procedure. To increase the inclusiveness of Widening actions, next to the enhanced

use of the Seal of Excellence, there should be an increase of the budget of Horizon and a simplification of the application procedure. The application procedure for Horizon grants is a long and complicated process. Many research institutions have EU departments, or grant departments that deal with these applications, however, this is often lacking in less developed research institutions, leading to a disadvantage for these institutions. The application procedure should be more accessible, should Widening want to increase its impact. Furthermore, the budget should increase to be able to fund more excellent research projects. This will help bridge the gap between more and less developed regions in Widening countries.

- Facilitate the sharing of best practices. Practices of Smart Specialization should be built upon by sharing best practices. This way less developed regions can learn from each other and build an adequate Smart Specialization strategy for themselves. By doing so, ERDF-funded projects become more successful which will ultimately increase their changes of gaining Horizon funds. Member States should actively be involved in creating conditions in which regional strategies are well-suited to EU R&I funding, to optimize the effectiveness of EU funding.
- Enhance the legitimacy of Widening Participation among non-Widening countries. An international network for R&I projects through which the Widening countries can acquire help from their partners in developing regional innovation ecosystems in lagging regions and countries is also essential, as the results from this thesis have shown. However, it is a problem that more developed Member States often do not see the added value of Widening projects, as they believe this will not lead to any benefits for them (Gębalska, et al, 2018). Widening actions should therefore be promoted more so that Member States come to understand the additional value of Widening actions. Because Widening actions expand the possibilities of conducting more excellent research with researchers from different backgrounds, which is something in the interest of the more developed Member States. Furthermore, Widening actions contribute to the establishment of the European Research Area as the open research environment of the projects enhances the flow of knowledge.

13. Conclusions

As the results of this research highlight, the innovation indicators in ERDF and Teaming infrastructures have been implemented in different ways, and overall, the innovation indicators were better implemented during the Teaming-phase of the projects. Therefore, the hypotheses that argued that Teaming RI's have better strategies in place to implement the innovation indicators, are mostly in line with the results of this thesis, although some nuances must be given to it.

Regarding the Quadruple Helix Model which was derived from the Innovations Systems Theory, the Document analysis has shown that the implementation of QHM strategies to increase human capital were already quite extensive in the S3 documents. Teaming-strategies only add an objective about changing the research culture to increase relationships among the QHM actors. In turn, the analyzed RI's had already implemented QHM relationships to boost human capital during the ERDF-phase. However, it is true that the implementation of these strategies significantly improved during the Teaming-phase, crediting the changing culture and additional resources as reasons. Hypothesis 1 which states that Teaming-funded RI's have better strategies for the management of strategic partnerships between the different sectors of the Quadruple Helix Model, and have implemented these strategies to a wider extend than the ERDF-funded RI's, is then in line with the results. Add something about differences in RI's

Similar results are visible in the internationalization strategies of human capital. All the S3 strategies include extensive objectives to establish talent attraction strategies, however, the SMR Smart Specialization strategy also provides specific guidelines on setting up international partnerships, while these guidelines lack in the Central Bohemian strategy. This was however a strong objective of the EU S3. Teaming, in turn, makes the establishment of international partnerships mandatory and is, therefore, more in line with the European objectives. The results of the analyzed RI's highlighted that Teaming-funded RI's indeed engage more in international cooperation than ERDF-funded RI's, although the implementation of international strategies was already visible during the ERDF-phase, which is especially striking for the CB projects. The international HR practices were then already quite present as well during the ERDF-phase, especially because the Cohesion funds were used to recruit people from abroad. Nonetheless, the international strategies during Teaming expanded and stabilized, leading to an even better

implementation of human capital strategies during the Teaming-phase. The hypothesis that states that Teaming-funded RI's have a stronger international network and use this network to enhance human capital strategies is correct, although some nuances must be given to it as the ERDF-projects were quite successful in this area as well.

The hypothesis for the indicator derived from Economic Network Theory, international resource mobilization, can also be justified to a certain extend. Although the Smart Specialization strategies had some strategies in place that should enhance the ability to mobilize resources, the value of international cooperation was lacking in these strategies. In contrast, the Teaming projects do put quite a lot of emphasis on international cooperation as a source of economic sustainability. These results are in line with the hypothesis which suggests that Teaming-funded RI's have established international partnerships which enables them to formulate sustainable resource strategies post-EU funding. The hypothesis can therefore largely be justified. However, nuance must be given to it as two out of three RI's emphasized private-public relations and strong visions to be more important for the sustainability of financial flows than having a broad international network. Thus, even though the Teaming-strategies added top-down criteria that made the establishment of a sustainable resource strategy mandatory (good governance of partnerships based on a true-joint venture), the analyzed RIs also took other factors into account when creating their sustainable strategies. This shows that they have indeed implemented sustainable resource strategies based on the joint-venture cooperation with international partners, however, two out of three respondents argued that they have implemented QHM dynamics to a further extent, or are planning to do so, to create a sustainable vision of their RI.

Noticeable was that the regional S3 strategies showed quite some differences from the European strategies, in turn, the ERDF-funded phase with S3 strategies alone was less effective than when combined with the top-down implementation of the Teaming funds. This provides an argumentation that adding a top-down Europeanization approach to the bottom-up approach of Smart Specialization strategies can increase the innovative output of RI's. Thus, the use of synergies within Teaming-funded RI's has an added value to the implementation of Cohesion Policy funds. By combining the funding sources the Research Infrastructures were able to implement strategies for place-based human resource management, international resource management, and resource mobilization to a larger extend. Although the S3 strategies were

sometimes quite extensive already, for example, those of the QHM human capital management, the implementation of these strategies during the ERDF-phase was not always as extensive (e.g. the HiLASE infrastructure). The mishaps between S3 strategies and the actual implementation of these indicators in practice could mean that there are some shortcomings in the functioning of Smart Specialization and the effectiveness of the implementation of Cohesion funds. It also provides a criticism of the Europeanization power of Cohesion Policy on local R&I innovation ecosystems. The added top-down criteria and strengthening of synergies could offer a solution to these shortcomings, and close the gap between the S3 strategies and the implementation thereof.

However, as the last chapter of this thesis argued, if Teaming wants to create an actual impact, it is important that the synergies in less developed regions, and less-successful ERDF-projects can be implemented as well. The results highlight that synergies have an actual impact on the innovative output of the Research Infrastructures, and therefore, strengthening these synergies is highly relevant. To be able to do so, the budget of the EU R&I Framework Programs should increase to be able to fund more projects, the Seal of Excellence should be used more effectively, and the application procedure for Horizon grants should be simplified, or additional help to less-developed regions should be provided in their application procedure. To be able to create this change, the Widening actions should increase its legitimacy among the non-Widening Member States. They often do not understand that Widening actions can also benefit them, as this creates more possibilities for research and enhances the development of the European Research Area. All Member States should therefore support Widening more, which could ultimately lead to an increase in budget and therefore a strengthening of synergies.

Finally, this study aimed to provide a coherent framework for the evaluation of innovation in RI's. Nonetheless, there are some weaknesses to this framework. For example, Social Capital Theory was used in this study to highlight the importance of an international dimension to increase human capital, however, Social Capital Theory also underlines the importance of trust and mutual recognition between the actors within innovation networks. This study did not take into account these governance relations as it falls outside the scope of this research. It is important to note however that the knowledge and power of certain actors in the system can severely limit the effective implementation of innovation indicators of a RI. Future research into the governance structures between the actors of the innovation network would then be interesting. Especially

because as the European Court of Auditors has pointed out in its Widening participation report of 2022, Teaming projects are often difficult to set up: they face difficulties in accessing the additional funding, they face difficulties in the long-term commitment of local authorities to the R&I projects, and the domestic politics in the CEE area make collaboration more difficult. In addition, the fact that two out of three respondents of the Research Infrastructures valued QHM relations more than international networks with regards to creating sustainable strategies also shows a weakness of the evaluation framework as it merely focussed on enhanced human capital strategies in the QHM dynamics. But as the results have highlighted, it might have been better to take on a broader approach. Overall, this study has only analyzed three indicators, but it could be interesting to widen the scope of the indicators to provide a more detailed description of how RI's specifically contribute to innovative output. However, this is very time-consuming research and should therefore either be quantified or researched in one generalizable case.

Nonetheless, this research has successfully contributed to the research on innovation policy and provided highly relevant insights for politicians and policymakers, on all levels of governance. It has given insights into the effective implementation of Cohesion Policy to reach the European objectives of increasing economic and innovative output, and it has given insights on the use of synergies to strengthen these ambitions. In turn, the results conclude that Teaming, and thus, the use of synergies, has important added value. However, as the analyzed RI's were all successful R&I projects, it is important to research less successful ERDF-projects in less developed regions that were unsuccessful in receiving Teaming-grants to improve the accessibility of these Widening grants. It is in the interest of the entire Union to strengthen these synergies to increase the capacities of creating solutions needed to stay competitive in the world and tackle 21st-century challenges.

Bibliography

Anckar, C. (2008). On the applicability of the most similar systems design and the most different systems design in comparative research. *International Journal of Social Research Methodology*. 11(5), 389-401.

Asheim, B., Grillitsch, M. and Trippl, M. (2017). Smart Specialisation as an Innovation-driven Strategy for Economic Diversification'. In Radosevic, S.et al. (eds.). *Advances in the Theory and Practice of Smart Specialisation*. (pp. 74-97). Elsevier Science Publishers, Amsterdam.

Bache, I. (2010). Europeanization and multi-level governance: EU cohesion policy and pre-accession aid in Southeast Europe. *Southeast European and Black Sea Studies*. 10(1), 1-12

Balázs, K. (1988). Market-Oriented Scientific Research and Development after the Economic Reform. *Acta Oeconomics*, 39(3), 271-290.

Balazs, K., Faulkner, W., & Schimank, U. (1995). Transformation of the research systems of postcommunist Central and Eastern Europe: An introduction. *Social Studies of Science*. 25(4), 613-632.

Balland, P.A., Boschma, R., Crespo, J. and Rigby, D.L. (2019). Smart Specialization Policy in the European Union: Relatedness, Knowledge Complexity and Regional Diversification. *Regional Studies*. 53(9), 1252–68.

Ballas, D., Dorling, D. and Hennig, B. (2017) Analysing the regional geography of poverty, austerity and inequality in Europe: A human cartographic perspective. *Regional Studies*, 51(1), p. 174-185

Baškarada, S. (2014). Qualitative case studies guidelines. *The Qualitative Report*. 19(40), 1-25

Benner. (2022). An institutionalist perspective on smart specialization: Towards a political economy of regional innovation policy. *Science and Public Policy. (49), 878-889.*

Biegelbauer, P., Griessler, E., & Leuthold, M. (2001). The Impact of Foreign Direct Investment on the Knowledge Base of Central and Eastern European Countries. *Reihe Politikwissenschaft*, 77.

Börzel, T and Risse, T. (2000). When Europe hits home: Europeanization and domestic change? *European Integration*. 4(15), 1–23.

Brent, T. *(2022).* Czech Republic looks to prepare the ground for end of cohesion funding.

Science|Business. Retrieved from: https://sciencebusiness.net/widening/news/czech-republic-looks-prepare-ground-end-cohesion-funding

Bulmer, S. (2007). Theorizing Europeanization. In *Europeanization: New research agendas* (pp. 46-58). London: Palgrave Macmillan UK.

Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., ... & Walker, K. (2020). Purposive sampling: complex or simple? Research case examples. *Journal of research in Nursing*, *25*(8), 652-661.

Capello, R. and Kroll, H. (2016) 'From Theory to Practice in Smart Specialization Strategy: Emerging Limits and Possible Future Trajectories. *European Planning Studies*, 24: 1393–406

Cappelen, A., F. Castellacci, J. Fagerberg, and B. Verspagen. (2003). The Impact of EU Regional Support on Growth and Convergence in the European Union. *JCMS: Journal of Common Market Studies.* 41, 621–644.

Carayannis, E. G., & Rakhmatullin, R. (2014). The Quadruple Helix: A Game Changer for the European Union? *Journal of Innovation and Entrepreneurship*. 3(1), 1-12.

Carayannis, E., and Campbell, D. (2012). Triple Helix, Quadruple Helix and Quintuple Helix and How Do Knowledge, Innovation and the Environment Relate To Each Other?. *International Journal of Social Ecology and Sustainable Development*. 1, 41-69.

Central Bohemian Region. (2014). Regional annex to the national RIS 3.

Colapinto, C., Porlezza, C. (2013). Systems Theory and Innovation. In: Carayannis, E.G. (eds) *Encyclopedia of Creativity, Invention, Innovation and Entrepreneurship*. (pp. 1764–1768). Springer, New York, NY.

Coleman J.S. (1988). Social capital in the creation of human capital. *American Journal of Sociology*. 94, 95-120.

Cooke, P. (2001). Regional Innovation Systems, Clusters, and the Knowledge Economy. *Industrial and Corporate Change*. 10(4), 945–974

Crescenzi, R., de Blasio, G. and Giua, M. (2020). Cohesion Policy Incentives for Collaborative Industrial Research: Evaluation of a Smart Specialisation Forerunner Programme. *Regional Studies.* 54(10), 1341–1353

Dall'erba, S. Le Gallo, J. (2008). Regional convergence and the impact of European structural funds over 1989–1999: A spatial econometric analysis. *Regional Science*. 87(2), 219–244.

Dansby, A. (2022). Attracting investment for research infrastructures - Science|Business Special Report. *Elsevier*, 1-11.

Darvas, G. (1988). Science and Technology in Eastern Europe. London: Logmans

Denzin, N. K., & Lincoln, Y. S. (2011). *The Sage handbook of qualitative research*. Thousand Oaks, CA: Sage.

Di Cataldo, M. Monastiriotis, V. Rodríguez-Pose, A. (2020). How 'Smart' Are Smart Specialization Strategies?. *Journal of Common Market Studies*, 60.

Ederveen, S., H. L. F. Groot, and R. Nahuis. (2006). Fertile Soil for Structural Funds? A Panel Data Analysis of the Conditional Effectiveness of European Cohesion Policy. *Kyklos*. 59.

Edler, J. (2009). *Demand Policies for Innovation in EU CEE Countries.* (SSRN Scholarly Paper No. 1509473).

Edler, J., & Georghiou, L. (2007). Public procurement and innovation—Resurrecting the demand side. *Research Policy*. 36(7), 949-963.

Edquist, C. (1997). Systems of innovation approaches: the emergence and characteristics. In: C. Edquist (ed.), *Systems of Innovation: Technologies, Institutions and Organizations*. (pp, 1-35). Pinter, London.

Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: Opportunities and challenges. *Academy of Management Journal*. 50(1), 25-32.

ESPON. (2005). ESPON 2.2.2 *Pre-Accession Aid Impact Analysis. Final Report*. Germany: Institut für Regionalentwicklung und Strukturplanung.

European Commission. (2017). *Interim evaluation of Horizon 2020*. Pubications Office. Retrieved from: https://op.europa.eu/en/publication-detail/-/publication/33dc9472-d8c9-11e8-afb3-01aa75ed71a1/language-en

European Commission. (2020). *Supporting the transformative impact of research infrastructures on European research: report of the High-Level Expert Group to assess the progress of ESFRI and other world class research infrastructures towards implementation and long-term sustainability*. Publications Office. Retrieved from: https://data.europa.eu/doi/10.2777/3423

(a) European Commission. (2021). Horizon Europe, the EU research and innovation programme (2021-27): for a green, healthy, digital and inclusive Europe, *Publications Office of the European Union.* https://data.europa.eu/doi/10.2777/052084

(b) European Commission. (2021). Horizon Europe: widening participation and spreading excellence across Europe : boosting research and innovation performance throughout the Union, *Publications Office of the European Union*. https://data.europa.eu/doi/10.2777/229120

Adler, P., S. Kwon (2002). Social capital: prospects for a new concept. *Academy of Management Review*. 27, 17-40.

European Council. (2018). *EU clears national aid linked to EU funded programmes from state aid checks*. Retrieved from: EU clears national aid linked to EU funded programmes from state aid checks - Consilium (europa.eu)

European Council. (2023). *Council conclusions on the European Court of Auditors' Special Report No 23/2022 'Synergies between Horizon 2020 and European Structural and Investment Funds - Not yet used to full potential'*. European Council. https://data.consilium.europa.eu/doc/document/ST-7258-2023-INIT/en/pdf

European Court of Auditors. (2022). *Special Report 23/2022: Synergies between Horizon 2020 and European Structural and Investment Funds.*

Florida, R. (2002). *The Rise of the Creative Class: And How it's transforming work, leisure, community and everyday life*. New York: Perseus Book Group.

Foray 2015: Foray, D. (2015). *Smart Specialisation: Opportunities and Challenges for Regional Innovation Policy.* Abingdon: Routledge.

Foray, D., David, P.A. and Hall, B.H. (2009). Smart Specialisation. The Concept. *Knowledge Economists Policy Brief No. 9.*

Foray, D., Goddard, J., Goenaga Beldarrain, X., Landabaso, M., McCann, P., Morgan, K., Nauwelaers, C., Ortega-Argilés, R. (2012). *Guide to Research and Innovation Strategies for Smart Specialisation* (RIS 3). European Commission.

Freeman, C. (1982). *The Economics of Industrial Innovation*. Pinter Publishers, London.

Freeman, C. (1995). The National System of Innovation in Historical Perspective. *Cambridge Journal of Economics*. 19(1), 5–24.

Frietsch et al. Heterogeneity of Innovation Systems in Europe and Horizon 2020 in Veugelers, R., Cincera, M., Frietsch, R., et al. *The Impact of Horizon 2020 on Innovation in Europe.* Intereconomics. 50, 4–30.

Fukuyama, F. (2000). Social Capital and Civil Society. *IMF Working Paper WP/00/74*,

Washington DC: International Monetary Fund.

Gassmann, O., Enkel, E., and Chesbrough, H. (2010). The Future of Open Innovation. *R&D Management.* 40, 213–221.

Gębalska, M; Amanatidou, E; Cox, D. (2018). Inclusiveness In European R&I Partnership Programme. *ERA Learn*. Retrieved from: era-learn_inclusiveness-in-european-r-and-i-partnership-programme.pdf

Gianelle, C., Guzzo, F., and Mieszkowski, K. (2020). Smart Specialisation: What Gets Lost in Translation from Concept to Practice? *Regional Studies*. 54, 1377–88.

González-Martinez, P., García-Pérez-De-Lema, D., Castillo-Vergara, M., & Bent Hansen, P. (2021). Systematic review of the literature on the concept of civil society in the quadruple helix framework. *Journal of technology management & innovation*. *16*(4), 85-95.

Gorzelak, G. (2017). Cohesion policy and regional development. *EU Cohesion Policy. Reassessing Performance and Direction.* (pp. 33-54). Abingdon–New York: Routledge.

Government of the Czech Republic, Department for Analysis and Coordination of Science, Research and Innovation. (2016). *National Research and Innovation Strategy for Smart Specialisation of the Czech Republic (National RIS3 Strategy).*

Goyal, S. (2007). *Connections: an introduction to the economics of networks*. Princeton University Press, Princeton and Oxford.

Grabbe, H. (2006). *The EU's Transformative Power: Europeanization through Conditionality in Central and Eastern Europe*. Basingstoke: Palgrave Macmillan.

Grillo, F., and M. Landabaso. (2011). Merits, Problems and Paradoxes of Regional Innovation Policies. *Local Economy*. 26, 544–561.

Griniece, E., A. Reid, J. Angelis. (2015). Guide to Evaluating and Monitoring Socio-Economic Impact of Investment in Research Infrastructures. *Technopolis Group.* Tallinn.

Hantrais, L. (2005). Combining methods: a key to understanding complexity in European societies?. *European Societies*. (7)3, 399-421.

Hix, S., Hoyland, B., (2011). *The Political System of the European Union 3rd edition*. Palgrave Macmillan.

Hollanders, H., Léon L. Rivera, and L. Roman. (2012). *Regional Innovation Scoreboard 2012*. European Commission.

Hollanders, H., N. Es-Sadki, B. Buligescu, Léon L. Rivera, E. Griniece and L. Roman. (2014). Regional Innovation Scoreboard 2014. Directorate-General for Enterprise and Industry European Commission.

Iacobucci, D. and Guzzini, E. (2016). Relatedness and Connectivity in Technological Domains: Missing Links in S3 Design and Implementation. *European Planning Studies*. (24)8, 1511–26.

Iammarino, s. Rodriguez-Pose, A. Storper, M. (2019). Regional inequality in Europe: evidence, theory and policy implications, *Journal of Economic Geography*. 19(2), 273–298.

Karo, E., Kattel, R., and Cepilovs, A. (2017). Can Smart Specialization and Entrepreneurial Discovery Be Organized by the Government? Lessons from Central and Eastern Europe. In: Radosevic S., Curaj A., Gheorgiu R., et al. (eds) *Advances in the Theory and Practice of Smart Specialization*. (pp. 270–93). London, San Diego, Cambridge, Oxford: Elsevier

Keszei, E., Hausz, F., Fonyó, A., & Kardon, B. (2015). Financing Research Universities in Postcommunist EHEA Countries. In: *The European Higher Education Area* (pp. 169-184). Cham: Springer.

Knill, C and Lehmkuhl, D. (2002). The national impact of European Union regulatory policy: three Europeanization mechanisms. *European Journal of Political Research*. 41(2), 255–280.

Kolodziejski, M. (2023). *Economic, Social and Territorial Cohesion.* Fact sheet of the European Union. Retrieved from: https://www.europarl.europa.eu/erpl-app-public/factsheets/pdf/en/FTU_3.1.1.pdf

Kolodziejski, M. (2023*). European Regional Development Fund (ERDF*). Fact sheet of the European Union. Retrieved from: https://www.europarl.europa.eu/erpl-app-public/factsheets/pdf/en/FTU_3.1.2.pdf

Košťálová, J. (2017). Use of Financial Instruments in the Czech Republic within the European Structural and Investment Funds in the Programming Period 2014-2020.

Kowalski, A. (2015). Commitment 5. Construct the Priority European Research Infrastructures. In: Castellacci, et al. *Investigating the Impact of the Innovation Union.*

Krammer, S. M. (2009). Drivers of national innovation in transition: Evidence from a panel of Eastern European countries. *Research Policy*. 38(5), 845-860.

Kwiek, M. (2012). Universities and knowledge production in Central Europe. *European Educational Research Journal*, 11(1), 111-126.

Landry, R, N. Amara, M. Lamari (2002). Does social capital determine innovation? To what extent?. *Canadian Journal of Policy Research*. 2, 681-701.

Leonardi, R. (2005). *Cohesion policy in the European Union: The building of Europe*, Basingstoke: Palgrave Macmillan.

Lopriore, M. (2022). *Recovery plans and structural funds: how to strengthen the link*. European Institute of Public Administration (EIPA).

Lossau, N. (2012). An Overview of Research Infrastructures in Europe – and Recommendations to LIBER. *The Journal of European Research Libraries*. 21(3/4), 313-329.

Lundvall, B.Å. (1992). *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*. Pinter Publishers, London

Lundvall, B. (1999). *Technology Policy in the Learning Economy. Innovation Policy in a Global Economy*. Cambridge: Cambridge University Press.

Lundvall, B., and S. Borras. (1997). *The Globalising Learning Economy: Implications for Innovation Policy*. Luxembourg: European Commission.

Malerba, F. (2004). *Sectoral systems of innovation: Concepts, issues and analyses of six major sectors in Europe.* Cambridge University Press, Cambridge, New York Melbourne

Marcou, G. (2002). *Regionalization for development and accession to the European Union: A comparative perspective, local government and public service reform initiative*. Budapest: Open Society Institute.

Marshall, A. (2005) Europeanization at the urban level: Local actors, institutions and the dynamics of multi-level interaction. *Journal of European Public Policy*, 12(4), 668-686.

Martens, B. (2001). The performance of the EC Phare programme as an instrument for institutional reform in the EU candidate member-states. *Journal for Institutional Innovation, Development and Transition*. 5, 35–47

Mastenbroek, E., Kaeding, M. (2006). Europeanization Beyond the Goodness of Fit: Domestic Politics in the Forefront. *Comparative European Politics*, 4(4), 331-35.

Mayring, P. (2004). Qualitative content analysis. In: *A companion to qualitative research*. *1*(2), 159-176.

McCann, P., and R. Ortega-Argilés. (2013). Smart Specialization Regional Growth and Applications to European Union Cohesion Policy. *Regional Studies*.

McNabb, D.E. (2010). *Research Methods for Political Science: Quantitative and Qualitative*

Methods (2nd ed.). Routledge.

Meier, K., Schuch, K. (2017). EU Framework Programmes for Research and Innovation. In: *Routledge Handbook of Science, Technology, and Society* (pp. 189-206). Routledge.

Mendez, C., Wishlade, F., Yuill, D. (2008). Made to Measure? Europeanization, Goodness of Fit and Adaptation Pressures in EU Competition Policy and Regional Aid. *Journal of Comparative Policy Analysis: Research and Practice*, 10(3), 279-298.

Michie J., and C. Oughton. (2001). Regional Innovation Strategies: Integrating Regional, Industrial and Innovation Policy. *New Economy.* 8(3), 164–169.

Midtkandal, I. and Sörvik, J. (2012). What is Smart Specialisation. *Nordregio News*. 5, 3–6.

Misa, T and Schot, J. (2005). Inventing Europe: technology and the hidden integration of Europe. *History and Technology*. 21(1).

Mogila, Z., Miklošovič, T., Lichner, I., Radvanský, M., & Zaleski, J. (2022). Does Cohesion Policy help to combat intra-country regional disparities? A perspective on Central European countries. *Regional Studies*, *56*(10), 1783–1795.

Monfort, P. Walsh, P. Ward, T. (2021). Chapter 9 – The Impact of Cohesion Policy. In: European Commission. Cohesion in Europe towards 2050. *Eighth report on economic, social and territorial cohesion* (pp. 267-300). Brussels: European Commission.

Moon, M. D. (2019). Triangulation: A method to increase validity, reliability, and legitimation in clinical research. *Journal of emergency nursing*. *45*(1), 103-105.

Morawska-Jancelewicz, J. (2022). The role of universities in social innovation within quadruple/quintuple helix model: Practical implications from polish experience. *Journal of the Knowledge Economy*. *13*(3), 2230-2271.

Müller, K. (1995). The Transformation of National Research System in the Countries of Central Eastern Europe. *Science & Technology Studies*, 1-12.

Naujokaitytė, G. (2022). Foresight: How the Czech Republic developed a thriving network of research infrastructures. *Science|Business*. Retrieved from: https://sciencebusiness.net/widening/news/foresight-how-czech-republic-developed-thriving-network-research-infrastructures

Oughton, C., Landabaso, M., and Morgan, K. (2002). The Regional Innovation Paradox: Innovation Policy and Industrial Policy. *The Journal of Technology Transfer.* 27, 97–110.

Pavitt K., Patel P. (1999). Global corporations and national systems of innovation: Who dominates

whom? In: D. Archibugi, J. Howells, J. Michie (eds.). *Innovation Policy in a Global Economy*. (pp. 94-199). Cambridge: Cambridge University Press.

Pelle (2015). Mind the Gap: Arguments in Favour of Judicious Constructivism in Providing Horizon for All in Veugelers, R., Cincera, M., Frietsch, R. et al. *The Impact of Horizon 2020 on Innovation in Europe*. Intereconomics. 50, 4–30.

Pelligrini, G., Terribile, F., Tarola, O., Muccigrosso, T. and Busillo, F. (2013) Measuring the effects of European regional policy on economic growth: A regression discontinuity approach. *Papers in Regional Science*, 92(1), p. 217-234.

Pero, M. (2015). The position and role of research infrastructures in the materials science network. In: D.G. Assimakopoulos, I. Oshri, K. Pandza (eds), *Managing Emerging Technologies for Socio-Economic Impact.* (pp. 186-214). Edward Elgar Publishing.

Petrariu, R. Bumbac, R. Ciobanu, R. (2013). Innovation: a path to competitiveness and economic growth. The case of CEE countries. *Theoretical and Applied Economics*. 5(582), pp. 15-26

Putnam, R. (2000). *Bowling Alone: The Collapse and Revival of American Community*. New York: Simon & Schuster.

Radosevic, S. (1999). Transformation of Science and Technology Systems into Systems of Innovation in Central and Eastern Europe: The Emerging Patterns and Determinants. *Structural Change and Economic Dynamics.* 10, 277–320.

Rauhut, D., & Humer, A. (2020). EU Cohesion Policy and spatial economic growth: Trajectories in economic thought. *European Planning Studies*, *28*(11), 2116–2133.

Reid, A., Muscio, A., and Rivera, L. (2015). An empirical test of the regional innovation paradox: can smart specialisation overcome the paradox in Central and Eastern Europe? *Journal of Economic Policy Reform.* 18(2), 153-171.

Reinert, E., Kattel, S., and Suurna, M. (2009). *Industrial restructuring and innovation policy in Central and Eastern Europe since 1990* (No. 23). TUT Ragnar Nurkse Department of Innovation and Governance.

Risse, Thomas – Cowles, Maria G. – Caporaso, James (2001): Europeanization and Domestic Change: Introduction. In: Cowles, Maria G. – Caporaso, James – Risse, Thomas (2001): *Transforming Europe: Europeanization and Domestic Change*. Ithaca, London: Cornell University Press, 1-20.

Rodriguez-Pose A., and Fratesi, U. (2002). *Unbalanced development strategies and the lack of regional convergence in the EU*. Research Papers in Environmental and Spatial Analysis. 76. London: London School of Economics.

Roman, M., Varga, H., Cvijanovic, V., et al. (2020). Quadruple Helix Models for Sustainable Regional Innovation: Engaging and Facilitating Civil Society Participation. *Economies*. 8.

Saurugger, S. (2013). *Governance. In Theoreatical Approaches to European Integration* (pp. 103–122). Macmillan Education UK.

Schott, B. (2016). *The European Union's R & D Policy. In: Research Handbook on the European Union and International Organizations* (pp. 239-250). Edward Elgar Publishing.

Schuch, K. (2005). *The Integration of Central Europe into the European System of Research.* Vienna: Guthmann-Peterson.

Schuch, K. (2014). *Participation of the 'New' EU Member States in the European Research Programmes - A Long Way to Go*. Foresight-Russia, 8(3), 6-17.

Schumpeter, J A. (1939). *Business Cycles*. New York: Macmillan.

Schumpeter, J A. (1954). *History of Economic Analysis*. London: Allen & Unwin.

Seawright, J., & Gerring, J. (2008). Case selection techniques in case study research: A menu of qualitative and quantitative options. *Political research quarterly*. *61*(2), 294-308.

Sielker, F., Rauhut, D., & Humer, A. (2021). EU Cohesion Policy and European spatial governance: An introduction to territorial, economic and social challenges. *EU Cohesion Policy and Spatial Governance*, 1–16.

Smith, K. (1997). Economic Infrastructures and Innovation Systems. In: C. Edquist (ed.), *Systems of Innovation: Technologies, Institutions and Organizations*. (pp. 86-106). Pinter, London.

Sørensen & J. Torfing (Eds.). (2007). *Theories of Democratic Network Governance* (pp. 153–166). Palgrave Macmillan UK.

Sosvilla-Rivero S, Bajo-Rubio O and Díaz-Roldán, C. (2006). Assessing the effectiveness of the EU's regional policies on real convergence: an analysis based on the HERMIN model. *European Planning Studies* 14(3), 383–396.

Stejskal, J., Kuvíková, H., Meričková, B.M. (2018). Regional Innovation Systems Analysis and

Evaluation: The Case of the Czech Republic. In: Stejskal, J., Hajek, P., Hudec, O. (eds) *Knowledge Spillovers in Regional Innovation Systems. Advances in Spatial Science.* Springer, Cham.

SIC. (n.d.). Innovation Profile of the Central Bohemia Region. *Central Bohemian Innovation Center*. Retrieved from: Innovation profile of the Central Bohemia Region – Středočeské inovační centrum (s-ic.cz)

SMR (South Moravia). (2014*). Regional Innovation Strategy for the South Moravian Region 2014-2020.*

Stevienna, S. (2015). Innovating innovation policy: the emergence of 'Responsible Research and Innovation'. *Journal of Responsible Innovation.* 2(2), 152-168.

Strauss, A., & Corbin, J. (1994). Grounded theory methodology. In: N. K. Denzin & Y. S. Lincoln (Eds.). *Handbook of qualitative research.* (pp. 273-286). Thousand Oaks, CA: Sage.

Suurna, M and Kattel, R. (2010). Europeanization of innovation policy in Central and Eastern Europe. *Science and Public Policy*. (37)9, 646–664.

The Guild. (2023). Lessons learned and way forward: The Guild's recommendations for Horizon Europe. *Position Paper The Guild.* Retrieved from: https://www.the-guild.eu/publications/position-papers/lessons-learned-and-way-forward-the-guild-s-recommendations-for-horizon-europe.pdf

Tiits, M. Kattel, R. Kalvet, T. Tamm, D. (2008). Catching up, forging ahead or falling behind? Central and Eastern European development in 1990–2005, Innovation: *The European Journal of Social Science Research*, 21(1), 65-85

Tsang, E. W. (2013). Case study methodology: Causal explanation, contextualization, and theorizing. *Journal of international management. 19*(2), 195-202.

Ulltveit-Moe KH. (2007). Regional policy design: An analysis of relocation, efficiency and equity. *European Economic Review*, 51(6), 1443–1467.

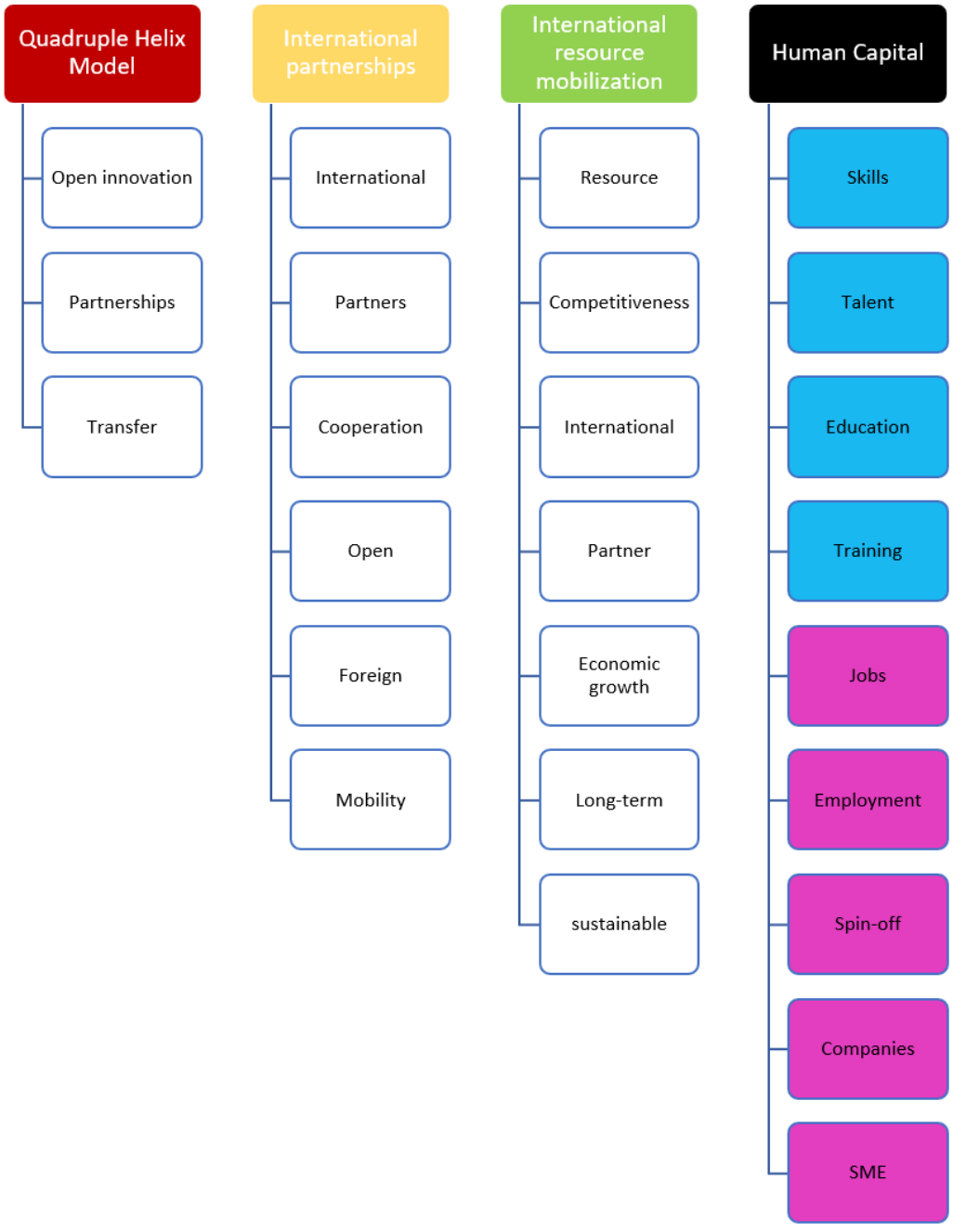
van der Lande, R. (1998). Innovation in Eastern European Countries. In J. Cobbenhagen, *Cohesion, competitiveness and RTDI: Their impact on regions* (pp. 66-75). Maastricht: Publishing House of the Town Hall.

Yin, R. K. (2009). *Case study research: Design and methods (4 ed.).* Los Angeles, CA: Sage.

Zakaria, S., Grant, J., & Luff, J. (2021). Fundamental challenges in assessing the impact of research

infrastructure. *Health Research Policy and Systems*. *19*(1), 1-9.

Appendix I – Coding Tree



Appendix II – Interview Guide

1. What is the history of the project, and were you involved in the project from the beginning?

ERDF and Teaming phases respectively:

2. How did the project receive ERDF funding?
3. How did the project receive Teaming-funding?
4. What did the ERDF-strategy of the project say about the international dimension of the project and how was this in practice? E.g., did the RI have international partners? Was it difficult to find those international partners?
    a. How did this change during the Teaming-funded phase, and how was this reflected in the strategies?
5. How did those international partnerships contribute to the enhancement of human capital during the ERDF-phase? E.g. were there a lot of foreign researchers coming to the Czech republic, did you collaborate on training opportunities, were there spin-off projects created through the international partnerships? Did it help with establishing interdisciplinary research teams?
    a. How did this change during the Teaming-funded phase, and how was this reflected in the strategies?
6. Has the establishment of international partnerships during the ERDF-phase contributed to the long term self-sustainability of the project in terms of stable resource mobilization?
    a. Has this improved during the Teaming-funded phase?
7. What did the ERDF strategy say about cooperation according to the quadruple helix model? (industry – academic – government – society) and how was this in practice?
8. What did the ERDF strategy say about the ways to enhance skills (talent attraction) training of people to use the research infrastructures and how were the different sectors involved?
9. What did the strategy say about enhancing the creation of spin-offs? Both research related as well as SME related, and thus, how do the Research Infrastructure aim to increase jobs in the region?

    a. How did the involvement of the Quadruple Helix Model change in the Teaming-funded phase and what did the strategies say about this?
10. How would you define the innovation potential of the ERDF-funded phase, and has this increased during the Teaming-funded phase?
11. If all of the innovation indicators have been better implemented during the Teaming-phase, why do you think this is?