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COLLECTIVE ACTION TOWARDS SUSTAINABLE REGIONAL INNOVATION

A qualitative study of factors that benefit and/or hinder collaboration within the innovation ecosystem of industrial transformation in North Central Sweden

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Abstract

The purpose of this study is to address the need for a better understanding of how actors in regional innovation ecosystems work collectively for sustainable regional development and innovation towards the green and digital transition of the European Green Deal. The paper contributes to existing literature about challenges in the implementation of regional innovation (smart specialisation) strategies, by examining factors that have shown to affect collaboration related to large scale problems, e.g. fossil carbon dioxide emissions. In this qualitative study eight respondents, representing the innovation ecosystem of industrial transformation in North Central Sweden (Dalarna, Gävleborg and Värmland) have been interviewed about factors that benefit or hinder (facilitators and stressors) collaboration between the participating stakeholders, i.e. the regional county councils, the universities, the business and innovation supporting organisations and civil society.

The result indicates that there are weaknesses in trust and reciprocity among actors who have *different functions* in the system and that challenges like governance, leadership, coordination and organization are related to almost all examined factors. The study shows a growing trust and reciprocity among actors within the *same function*, primarily among the business and innovation-promoting actors in North Central Sweden. Furthermore, the analysis shows a strong awareness of the importance of sustainability in all dimensions in carrying out industrial transformation. However, there is a frustration related to the implementation of equality and social inclusion due to knowledge gaps and a lack of tools, which overall risks leading to inaction.

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1. Introduction

Transition is underway to a socially, environmentally and economically sustainable society. The EU has committed via the Paris Agreement to become the first climate-neutral continent by 2050 and to reduce emissions of fossil greenhouse gases by 55% from 1990 levels by 2030 (European (EU) Commission 2021, European Council n.d., European Parliament n.d.). The EU Green Deal (EU Commission, n.d.), is the vision that aims to accelerate the transition to a green, fossil-free and inclusive economy in line with the UN's global goals (United Nations n.d.). Collaboration between stakeholders from different policy areas and levels is needed. The EU Cohesion policy (EU Commission n.d.) promote sustainable regional development and innovation and the European Structural Investment funds (EU Commission n.d) constitute the financial instruments. The political will, legislation and economic incentives are thus present. Despite this, it seems difficult to bring about the rapid changeover that is required in order to reach the climate goals.

The EU calls on European regions to develop sustainable regional innovation strategies (smart specialisation) to promote innovation and new solutions. However, previous research show challenges in the implementation of these strategies. This qualitative study is based on interviews with eight representatives from the innovation ecosystem of industrial transformation in North Central Sweden. The result indicate that Collective Action Theory to some extent can explain challenges in the collaboration among the actors in the system as all examined factors showed relevance to a certain degree. Facilitators like trust and reciprocity and communication as well as stressors like heterogeneity, anonymity and complexity seemed to be particularly relevant. In addition, financial resources emerged as an important factor, in addition to the examined theoretical framework. The findings will contribute to the existing literature and may be interesting to take into account in future policy recommendations within the field of sustainable regional innovation to improve conditions for collective action. For instance the EU Partnerships for regional innovation (PRI)-initiatives, and the further development and implementation of regional innovation strategies.

In the first section of this thesis I will introduce the research problem, motivate the chosen case of the study and express the aim and research question.

1.1 Problem discussion

Smart specialisation¹ is the EU policy approach on regional innovation. The aim is to promote regional innovation and development by focusing on a region's unique potential while promoting cooperation at the regional level. (Foray, David, Hall 2011) Smart specialisation is realized through regional innovation ecosystems (see 2.1.2) in Europe, consisting of actors from public authorities, industry, academia and civil society. An increased understanding of how to enhance collaboration between relevant actors, such as regional authorities, universities, science parks, innovation hubs and cluster organizations is needed, considering that the purpose of Smart specialisation is changing. From supporting innovation as a goal in itself with focus on competitiveness and growth, to the encouragement of environmentally, socially and economically sustainable (Eurlex n.d.) innovation as a means to solve societal challenges.

Collective Action Theory (CAT) explain collaboration problems that is likely to occur when many individuals or actors are jointly trying to overcome a collective action problem, e.g. the reducing of fossil carbon dioxide emissions (Olson 1965). This qualitative study examines if Jagers, Haring, Löfgren, Sjöstedt, Alpizar, Brülde, Langlet, Nilsson, Carnety Almroth, Dupont and Steffen (2020)

¹ <https://s3platform.jrc.ec.europa.eu/what-we-do>

approach on CAT is useful for the understanding of what factors that benefit or hinder collaboration towards green transition within a regional innovation context. It is particularly focused on the collaboration between actors involved in the implementation of regional smart specialisation strategies.

The subject for this empirical investigation is the innovation ecosystem supporting industrial transformation in North Central Sweden, i.e. Dalarna, Gävleborg and Värmland counties. Findings from a pilot project that tested new approaches to industrial transition in ten European NUTS 2-regions (Eurostat), showed that North Central Sweden has got a well-functioning innovation support system that integrate clusters in research, development and innovation. However, the investigation also revealed four major challenges to be met; “1. Improve conditions for inter-regional integration and collaboration; 2. Generate innovation (including technological and entrepreneurial) capabilities; 3. Strengthen resources and structures for clusters; and 4. Generate opportunities for North Central Sweden’s innovation ecosystem.” (Lima-Toivanen, Rilla, Zenker 2019, p 14)

The motives for choosing this region and specific field are threefold;

Firstly, manufacturing and extraction are the branches that generate the most revenue in the region and are therefore very important for the current and future regional development. North Central Sweden has traditional strengths in heavy emitting industries as steel, engineering, paper, pulp and forestry (see figure 1). Deliveries of goods from these industries consequently affect the transport emissions. The emissions per inhabitant are for example higher in Dalarna compared to the country (see figure 2).

Secondly, there are three different development levels in European regions. They divide into more developed-, less developed- and transition regions. North Central Sweden classify as the only NUTS 2-region in Sweden, as a transition region, with a GDP/inhabitant that is below the EU's average GDP/inhabitant (see figure 3). North Central Sweden was also identified as a "middle income trap" region in the European Commission's Industrial Transition pilote project (Smart Specialiation Platform). This means that you cannot compete with low wages and at the same time you have difficulties in attracting innovation capital which means that SMEs do not invest enough in research and innovation.

Thirdly, the innovation capacity is weak in North Central Sweden, e.g. due to low levels of education and weak cooperation between small and medium sized companies and the academy, but also because the larger companies moved their headquarters and research departments to metropolitan areas. (Lima-Toivanen et al. 2019) There are difficulties in measuring innovativeness and the conditions for innovation, but an innovation index can be seen as a contribution to the image of the innovation capacity in Sweden's regions, although not the whole picture (figure 4). A socio-economic analysis of North Central Sweden (2022) summarize the situation of North Central Sweden as a NUTS2 region with a large need but low capacity to carry out a major transformation.

North Central Sweden is according to the above described challenges an important context from a Green Deal-perspective. This study could bring insights to similar regions in the EU who are struggling with the green and digital transition in order to reduce fossil fuel emissions. The results could for example increase understanding of challenges in implementing the method of smart specialisation and bring knowledge into the implementation of the new EU-initiative, Partnership for Regional Innovation (PRI). In addition the study provides empirical results from the investigation of Collective Action Theory in a regional innovation context through the perceived experiences from actors who collaborate in the innovation ecosystem for industrial transformation In North Central Sweden.

1.2 Aim and research question

Based on previous research, knowledge is needed about how actors in innovation ecosystems actually come together and proceed from the smart specialisation strategy to the implementation of concrete eco-innovation measures, in order to speed up the pace of the green transition.

The aim is to contribute to better understanding of the challenges related to the collaboration between stakeholders (regional authorities, universities, business and civil society) in a regional innovation ecosystem and explore how different factors can influence collective action towards the ambitions of the EU Green Deal.

The study examines if factors that have shown to benefit or hinder collective action for solving large-scale problems are significant for cooperation towards green transition within a regional innovation ecosystem and identify possible causes to free-riding, “the heart of the collective action problem”. (Bodenstein, Faust and Furness 2017, p 446). Sverker C Jagers et als (2020) suggested analytical framework on the preconditions for large-scale collective action is suitable. They meant that facilitators like trust, reciprocity and reputation generates successful collective action and that stressors, e.g. anonymity, lack of accountability, heterogeneity, risk and uncertainty, emotional detachment and cognitive limitations have negative impact on collaboration. They argue that a third part, for example a national or regional public authority, is needed to increase the facilitators and decrease the stressors. Beyond this, the study might reveal other factors of significance for the collaboration between the actors and contribute with empirical findings to the existing theory from a regional innovation context. In order to fulfill the purpose of the study and answer the research question, semi-structured interviews were conducted with actors from public authorities, academia, business sector and civil society who are part of the innovation ecosystem for industrial transformation in North Central Sweden.

This study is guided by the following **research question**: What factors affect the prospects of achieving successful collective action towards the green transition within the innovation ecosystem of industrial transformation of North Central Sweden?

2. Background and previous research

This chapter provides an overview of the research field; the collaboration between actors in regional innovation ecosystems in Europe, specifically in North Central Sweden. The aim is to give a contextual background and explain central concepts related to collaboration towards sustainable regional innovation. The chapter is divided into two subsections where the first one gives a background to the EU approach on regional innovation, i.e. Smart specialisation and Partnership for Regional Innovation and provides some definitions of what is a regional innovation ecosystem. The second subsection discuss previous research about the implementation of Smart specialisation strategies, the progress until today and prospects for the future implementation in the light of the sustainability approach. This reveals a potential research gap that motivates this study.

2.1 Background

2.1.1 Smart specialisation and Partnership for Regional Innovation

Smart specialisation (S3) is a policy approach on regional innovation in the EU that was developed by the French economist Dominique Foray (2009) in order to enable ERA, the European Research Area. The European Commission defines Smart Specialisation as “a place-based approach characterised by the identification of strategic areas for intervention, based both on the analysis of the strengths and potential of the economy and on an Entrepreneurial Discovery Process wide stakeholder involvement”. (Smart specialisation Platform S3) Regions are expected to build a common strategic shared vision of place specific assets and strive to increase competitiveness by creating innovation and growth in the areas with the highest potential. The European Commission introduced the concept within the European Regional Development Fund (ERDF) 2014-2020 in order to increase the effectiveness of research and innovation funding. The Smart Specialisation strategy became an ex ante conditionality and thus mandatory for European regions to develop in order to access financing. In the ERDF 2021-2027 smart specialisation shall contribute to the digital and green transition. Regions are encouraged to promote projects and processes that bring innovations that respond to global environmental challenges. (Cohen 2019) S3 turns into S4: Smart Specialized, Strategic and *Sustainable*, emphasising the stakeholders’ involvement, the regional economic competitiveness and the socially, economically and environmentally sustainability dimensions of the European Green Deal. (Carayannis and Grigoroudis 2022).

Dalarna, Gävleborg and Värmland have identified seventeen prioritized knowledge areas in their regional smart specialisation strategies for sustainable innovation (Region Dalarna 2022, Region Gävleborg 2022 and Region Värmland 2022). These smart specialisations are sorted into four vertical and two horizontal domains for North Central Sweden; Sustainable bio economy, Sustainable cities and energy transition, Industrial transformation and Sustainable experience industry, Equal welfare and working life and Sustainable attractive and inclusive working life. (Tillväxtverket n.d, p 10).

This study focuses on North Central Sweden, i.e. the cross county collaboration between Dalarna, Gävleborg and Värmland towards industrial transformation, in order to identify factors that hinder or enable collective action. This work started with an European Pilot Project; Regions in Industrial Transition (OECD 2019) which resulted in a common industry strategy for North Central Sweden (Region Dalarna, Gävleborg and Värmland 2021). The changed view of smart specialisation makes it important to explore and manage goal conflicts that may arise when the three dimensions of sustainability must be achieved without coming at the expense of one another. Industrial transformation may positively affect the Agenda 2030 goals directly or indirectly while some goals may be negatively affected, see below.

Avdeitchikova, von Beckerath, Langaas, Pollak and Westerberg (2022) highlights examples of how industrial transformation in North Central Sweden can *directly* contribute to meeting goals like increased energy efficiency, reduced resource use in industry and increased sustainability in industry and infrastructure. They also show examples that can contribute *indirectly* to goals on reducing the number of illnesses and deaths due to harmful chemicals and pollution, to increased economic productivity through technological innovation and upgrading and on promoting policies for new jobs and increased entrepreneurship. Transformation efforts also risk *negative* consequences for certain goals. For instance can implementation and scaling up of new technology be very energy-intensive in it-self. Companies that succeed in implementing new sustainable ways of production strengthens its competitiveness, while other companies risk being forced out. This in turn means that jobs may be lost. The efforts can therefore have a negative effect on the goal of full employment and decent working conditions.

In 2022 the European Commission's Joint Research Center and the Committee of the Regions launched a one year pilot project within a new initiative; Partnerships for Regional Innovation (PRI). PRI is based on experiences from smart specialisation and is considered to bring the method to the next level, i.e. through a more holistic approach where a stronger sustainability dimension based in societal challenges, broader partnerships and multi-level collaboration are central parts to promote regional innovation. (Smart Specialisation Platform n.d) The aim of the pilot is to investigate the sustainability dimension in the implementation of smart specialisation in an interregional perspective. North Central Sweden participates in the project together with other European regions and national authorities in order to exchange experiences and receive tailored support from the European Commission. (Smart Specialisation Platform n.d)

2.1.2 Regional Innovation Ecosystems

Smart specialisation is implemented through the Entrepreneurial Discovery Process (EDP) including actors involved in societal change processes (Markkula and Kune 2015). Foray et al. (2011) argued that entrepreneurs in the broadest sense are those who have the best idea of which areas within a region could be best developed given the regions existing capabilities and strengths. In the last 15-20 years this kind of multi-actor collaboration towards enhanced innovation capacity and innovative entrepreneurship has been recognized as regional innovation ecosystems, followed by a flora of definitions and consequently an ambiguity about what an innovation ecosystem actually is. (Baiyere 2018). Ecosystem is a biological term originating from ecology, which is derived from the Greek *ecos*, which means household and *logos*, which means discourse. Ecology could therefore be interpreted as a discussion of household of the nature. The interactions between living organisms and the environment constitute an ecosystem. (Papaiannou, Wield and Chataway 2009) The ecosystem term was brought into social science in order to explain "the evolutionary nature of interrelations between different individuals, their innovative activities, and their environment". (Papaiannou et al. 2009, p 1) I have selected four examples of definitions that aims to bring ingredients to the overall understanding of an innovation ecosystem related to the context of smart specialisation and the topic of this study; collective action towards sustainable regional innovation.

The first example apply to the quadruple helix approach on smart specialisation. It means that an innovation ecosystem should be represented by stakeholders from policy (public national, regional or local authorities) science (academia), industry (business sector, e.g. cluster organisations, science parks, development hubs) and society (e.g. non-governmental organisations, community groups or other stakeholders) (Schüts, Heidingsfelder and Schraudner 2019). These actors are supposed to work together to promote sustainable development by bringing different perspectives on the table, for example research and expertise, financial resources, policies and regulations, market-orientated solutions, and aspects to ensure that regional development initiatives are socially responsible and inclusive and environmentally sustainable.

The second example focus on the innovation ecosystem as an “institutional infrastructure” (Romano, Passiante, Del Vecchio, and Secundo 2014, p. 284) that support the development of policies for regions and countries in the light of the knowledge economy. Furthermore, an innovation ecosystem facilitates the social interactions that take place between wide ranges of actors in the system and promotes a social and economic assessment of the knowledge shared within the network.

The third example highlights seven factors that is said to form the basis for innovation ecosystems and need to be explored in the regions; 1.actors (the cooperation between universities, industry and public administration) , 2.structures (emerging networks, research groups etc.), 3.premises (for social development etc.),4. new organisations (e.g. science parks, innovation hubs etc.), 5. knowledge and technology transfer and co-creation (the function of different innovation, invention and patent services), 6. policies (financing instruments, collaboration support, regulations etc.) and 7. Participation (the role of the knowledge base and expertise of engaged citizens). “Knowledge creation, dissemination, and use are essential for keeping regions smart. Joint learning is a corner stone of the collaboration in the ecosystem” (Markkula and Kune 2015, p 9)

The fourth and last example addresses the need for an increased consensus about the concept. Granstrand and Holgersson (2020) proposes a definition including not only collaboration between actors but also artefacts, e.g. products and services, tangible or intangible resources, technological and non-technological resources, innovations etc.: “An innovation ecosystem is the evolving set of actors, activities, and artefacts and the institutions and relations, including complementary and substitute relations, that are important for the innovative performance of an actor or a population of actors.” (Granstrand and Holgersson 2020, p 3)

In North Central Sweden the following actors, among others are included in the innovation ecosystem for industrial transformation: Region Dalarna- Gävleborg and Värmland (County Councils), Karlstad University and the University Colleges (Högskolor) of Dalarna and Gävle, innovation supporting actors like the IUCs (Industrial development centers) in each county, Sustainable Steel Region, RISE (Research and Innovation institute) Science Parks in each county and clusters, for example Paper Province in Värmland and Dalarna. Coompanion and Teknik College can be said to add a social dimension of smart specialization, regarding competence needs and supply.

2.2 Previous research

2.2.1 Implementation of Smart specialisation

Empirical studies show challenges in the realization of smart specialisation, i.e. to maintain the continuity in the EDP; “the motor of smart specialisation methodology” (Periañez Forte, Marinelli and Foray 2016, p 15). Inmaculada Periañez Forte and James Wilson (2021) identified problems in maintaining stakeholder engagement, especially when going from strategy to the implementation of the strategy. The process differs between regions depending on different contexts related to existing institutions, culture and historical course of innovation policy. EU support is usually strong in the design phase, but does not provide much guidance during the implementation. Stakeholders from the academia, industry and government are still more involved in the EDP than social actors from e.g. vocational education and training institutions and NGO: s, despite that smart specialisation presupposes participation from civil society. The change from physical to digital meetings due to the pandemic allowed, despite the lack of human touch, for more regular interactions and a more inclusive process. Furthermore the importance of establishing a coordination of the EDP that guarantee broad availability, openness and equal opportunities for all relevant actors to have a say in the process. (Periañez Forte and Wilson 2021)

Caroline Cohen (2019) discusses similar challenges related to the involvement of stakeholders in the continuous innovation process. Policy-makers (e.g. regional authorities) have largely embraced the EDP-concept as a way of understanding regional competences and needs and support the interaction between the stakeholders in the innovation ecosystems. However, to define strategic innovation priorities is still a key challenge. She meant for instance that companies that are already performing well often do not see the need to engage in smart specialisation-related activities. It can be hard to convince them of the benefits of participating in research and development projects and to share knowledge with others. The report expresses that the development of structured networks with formal and/or information communication channels, involving relevant actors, as well as the development of a shared vocabulary and a mutual understanding of the smart specialisation approach on regional innovation within the territory, seems to be success factors in unifying the different stakeholders to a common strategy.

Markku Sotarauta (2018) nuances some of the actualities that are asserted regarding the conditions for successful smart specialization by discussing five interlinked process traps towards collective action in smart specialisation; the institutional conflict trap, governance trap, mobilization trap, shared vision trap and the capability trap. The metaphor of a trap refers to a situation where “actors are misled into acting contrary to their interests or intentions and hence to an unpleasant situation that is hard to escape” (Merriam-Webster Collegiate Dictionary in Sotarauta 2018 p 194) Sotarauta argues that the implementation problem of Smart specialisation is the outcome of actors being trapped by one or more of those traps. The mobilization trap for instance, highlights difficulties in gathering relevant actors as it is less likely that they would be willing to spend time and money in a collective and public interest driven strategy. He means that it would be excessively idealistic to expect that different parties involved would be able to disregard their own motivations, reasoning, aspirations, visions and sources of funding and solely focus on what is best for the region. Furthermore, the shared vision trap, put the light on social aspects, for example weak trust, fear of losing independence and control, communication problems and differences in individual visions and interests when it comes to creating the shared vision that is expected in smart specialisation. Smart specialization is not solely a technical or economic procedure. It also encompasses social and political aspects. There is a need for a deeper understanding of how underlying forces and governance work in practice in order to realize “how various actors actually come together to work collectively for regional development and innovation” (Sotarauta 2018, p 191)

There is also a study regarding the implementation of smart specialisation in Sweden (Paulsson 2019) with the aim of mapping challenges, obstacles and best practices, including recommendations to overcome these. The following challenges were identified: The regional size and critical mass, the role of the regional authority, lack of mandate or mission and the ERDF (European Regional Development Fund) implementation. This is relevant considering the new stricter sustainability approach of Smart specialisation in the Cohesion Policy 2021-2027 which means that the innovation ecosystem shall support the green transition in order to accelerate emission reduction.

Based on previous research there seems to be gap in literature about reasons to why collaboration between actors in innovation ecosystems does not lead to collective action to the extent that should be expected, considering existing innovation strategies, shared visions, well established innovation ecosystems, ongoing Entrepreneurial Discovery Processes etc. My contribution is a better understanding by exploring collaboration challenges through the lens of Collective Action Theory. However, there are other theories and approaches that are useful as well, which will be discussed in the next section.

2.2.2 Explanatory models of regional implementation of EU-policies.

North Central Sweden is frankly speaking nothing more than a statistical construct based on the EU's NUTS-2 division. Thus it lacks what could be called a common regional identity and is not either organized to have an administrative or institutional capacity. Governance related to regional development and innovation takes place via the three regional county councils in Dalarna, Gävleborg and Värmland. Different power relations and politics as well as economic factors can affect the conditions for cooperation between actors in the regional innovation ecosystem for industrial transformation. Social Identity Theory, Institutional Capacity approaches and Multi-level governance theory capture some of the above mentioned challenges and can provide knowledge from different perspectives on the complexity of the investigated field.

Social Identity Theory explains how individuals define their identity depending on which group they think they belong to and how these groups influence their behavior and collaborations. (Turner and Tajfel 1979) Moreover, in-group favoritism and inter-group comparison have an impact on collaboration as individuals tend to favor their own group. (Turner, Brown and Tajfel 1979) Applied in a regional identity perspective this theory may help to explain how peoples sense of belonging to a region based on shared values, history and culture in a specific geographical area can influence their attitudes and behavior to other regions, for example between the three regions within North Central Sweden. Roberta Capello (2018) describes the regional identity building process as consisting of sources of similarity, i.e. shared social values and sources of solidarity, i.e. the feeling of togetherness and belonging. In addition, she argues the importance of socio-economic aspects allowing for collective and private interests to together contribute to collective action in the pursuit of social, economic and political goals.

Institutional Capacity approaches focuses on the ability of institutional structures and organizations to implement policy and decision-making and emphasizes the importance of resources, competence and organizational arrangements to support and translate European policies to regional actions. Andrés Rodríguez-Pose (2013) discuss how implementation of strategies and institutional capacity are connected by likening the relationship to a bicycle. Both wheels (strategy and capacity) must be the same size for the bike to roll nicely, but often when it comes to regional development and innovation, the strategy wheel is front-heavy, i.e. much larger than the capacity wheel, which makes the bike ride go slower than it should.

Multi-Level Governance (MLG) Theory emphasizes the importance of political commitment and willingness from different levels of governments and actors within regions to promote cooperation and political integration. Liesbet Hooghe and Gary Marks (2001 in Nelsen and Stubb 2014) discuss the movement from state-centric to multi-level governance in European integration and further in 2004 they identified two different types of MLG. The first one is characterized by a limited number of territorial jurisdictions representing international, national, regional, meso and local level. The second one is characterized by multiple different task-specific jurisdictions: “public service industries” (Hooghe and Marks 2004, p 4). The coordination and interaction between different levels of governance can have significant impact on regional innovation, which is discussed in the European Commission’s report about Multi-level Governance for Smart Specialization. (Larrea, Estensoro and Pertoldi 2019)

I am taking a different approach by the *Collective Action Theory*, which is explained in the next chapter.

3. Theory

The transition to a fossil-neutral society by 2050 in line with the EU Green Deal requires collaboration at all levels; internationally, nationally, regionally and locally. The latest IPCC report (2023) leaves no doubt about the urgency. To limit earth's warming to 1.5°C GHG emissions need to be cut by 45% by 2030, compared to 2019 levels and by 60% 2035. The innovation ecosystem of industrial transformation in North Central Sweden constitutes one of many collaborations in the collective movement towards the reduction of fossil carbon dioxide emissions. This chapter provides the theoretical framework on which my study rests; the Collective Action Theory (CAT). It is divided in two subsections: The first section defines and discuss the collective action problem related to the industrial transformation, the second one gives a brief picture of the content of CAT and Jagers et als (2020) approach linked to the topic for the thesis.

3.1 Collective Action Problem

A collective action problem occurs when individuals or groups have a shared goal or interest, but face barriers, that make it difficult to achieve the goal through collective action, i.e. a situation where "short-term self-interest of individual actors is in conflict with longer-term collective interests" (Jagers et al., 2020 p.1282). Collective action problems are sometimes social dilemmas. Robyn M. Dawes (1980) proposed a model that is based on the idea that a group of people share a common resource that they need in order to survive. Each person has the *choice* of either cooperating with others by limiting their use of the resource, or defecting by using as much of it as they want. The incentive is to choose the option that maximizes one's own interest, even if it harms the outcome for the group. If everybody cooperates the resource will be preserved and all will benefit. Consequently, if too many people defect, the resource will be depleted and all will lose.

The need for reduction of fossil fuel emissions into the atmosphere is a collective action problem that has the character of a social dilemma, arisen due to that previously measures taken have been based on short-term self-interest in conflict with long-term sustainable measures for the public good. Everybody has been free to use as much carbon dioxide they want, which led to overuse and resulted in that fossil greenhouse gases emitted into the atmosphere exceed the limit of what land, forests and water can absorb. If all actors agree to limit their fossil fuel use, all could benefit from a manageable climate situation. The problem is, that each actor may be incentivized to use more fossil fuel in order to maximize their own profit, even if it harms the group as a whole. In the end this is devastating for everyone as all actors receive a lower payment if all defect than if all cooperate. (Dawes 1980) Jagers et al. (2020) meant that collective action problems cannot be resolved unless certain individuals or groups are willing to act contrary to their own self-interest or the interests of those they represent.

North Central Sweden is, like most other European regions, responsible for the climate situation and is gathering collective forces to turn the tide by supporting industrial transformation towards a reduction of fossil fuel emissions from industry. Social dilemmas in the context of sustainable regional innovation can arise due to goal conflicts, when environmental, social and economic goals must be achieved without interfering with each other. Collective action problems and social dilemmas often require coordination and cooperation between the actors involved in the problem in order to find solutions that benefit everyone, for example through social norms, legal regulations or economic incentives. With the aim of this study in mind, that is to examine in what way Collective Action Theory can help us understand the challenges of collaboration towards the green transition of industry in North Central Sweden, we move on to the next section.

3.2 Collective Action Theory

Collective Action Theory (CAT) is based on Mancur Olson's (1965) work and explains why individuals may not act for the common good when it comes to collaboration in public goods provision, e.g. climate issues and environmental protection. He meant that individuals have a natural tendency to free-ride on the efforts of others as they can enjoy the benefits of public goods, in this example the limited carbon dioxide budget, regardless of whether they contribute to their provision or not. A classic example is Garrett Hardin's *Tragedy of the Commons* (1968) that alludes to WF Lloyds (1794-1852) reasoning of a herdsman pondering on the pros and cons for himself and for the other herdsmen of adding one more sheep to his herd or not. It shows the temptation to choose the selfish alternative and free ride on others who have an altruistic approach, instead of acting in the best interest of the group. Olson meant that individuals are more likely to participate in collective action in small groups where people know each other and can keep track of each other's behaviour. In larger groups, the incentives for free-riding increase which make collective action less likely to occur. He argued that individuals or actors must be prevented from overusing the resource and that some form of coercion is needed to encourage participation in larger scale of collective action.

I have identified three paths related to what researchers advocate bringing about collective action. *Firstly*, those who agree with Olson and argue that interventions from a third party are required to reduce uncertainty and guarantee that free riding will not occur. In addition provide information-, arenas for negotiation and sanctions in case of defection (Mansbridge 2013). *Secondly*, those who believe that large-scale voluntary collective action can be encouraged through polycentric efforts, independently of each other and without interference of third parties (Ostrom 2010). A polycentric system is based on the idea of developing norms that lead to changed behaviour, i.e. how individuals achieve results that are better than rational, by building conditions where reciprocity, reputation and trust help overcoming the strong temptations of short-run self-interest. (Ostrom 1997). She meant that reciprocity is formed through norms that individuals learn from socialization and life's experiences; that trust is about expectations individuals have about others behaviour and that reputation is about the identities that individuals create, i.e. if they are trustworthy and reciprocate. She meant that trust, reciprocity and a reputation of being trustworthy are mutually reinforcing. Reciprocity can work in a negative direction too, if participating actors does not prove to be trustworthy. Jagers et al. (2020) term factors that benefit cooperative behaviour as *facilitators* and add factors like communication and punishment of free-riders. *Thirdly*, those who believe of a combination, that polycentricism is possible but requires third party intervention that can reduce uncertainty, i.e. by increasing facilitators and by decreasing stressors, i.e. factors that hinder collective action.

According to Jagers et al. (2020) there are four characteristics that either alone or in combination defines a large scale collective action problem; a large number of actors, spatial distance, geographic territory, temporal distance (not applicable in North Central Sweden) and the complexity of the problem. These can cause a series of *stressors* that have a negative impact on the possibilities of collective action; *Anonymity*, i.e. that actors who are supposed to cooperate do not know each other is not unusual if the actors are many and spread over a large geography. *Lack of accountability*, e.g. the perception that everyone's contribution to for example the reducing of fossil fuel use is infinitesimal, so as an individual actor you may not consider your part of the responsibility to contribute so important. *Heterogeneity*, e.g. differences in identity, socio-economic status, culture, etc. can hinder collective action. Related to actors of regional innovation ecosystem, it could be about differences in governance, i.e. from where an actor gets its assignment. *Risk and uncertainty*: can relate to a lack of knowledge about the problem to be solved, an uncertainty about how others in the system should act or due to a lack of information that leads to inactivity. *Emotional detachment, and cognitive limitations* due to human beings inability to handle complex large-scale problems can also lead to inaction. Goal conflicts for instance, that can arise as industrial transformation in North Central Sweden must be sustainable in all three dimensions.

4. Method and material

This study has mainly a deductive approach, because I wanted to test if a theory, the Jager et als (2020) approach on Collective Action Theory, could help to explain the difficulties in implementation of regional sustainable smart specialisation strategies. A deductive approach gives a good start as a theory provides a structural framework for data analysis and findings can be disputed or confirmed related to the established model. Since new elements may emerge during the data collection and add new factors, the study also went partly inductive. This made it possible to capture aspects from a regional innovation context which contributed to the comprehensiveness and brought new insights to the theory. (Brinkman 2013) This chapter will outline and discuss the chosen research method, research design and material (data) for the study and provide a description of the research process.

4.1 Method

4.1.1 Case study

I chose an instrumental single case study (Yin 2009) as research method, in order to explore and analyse the challenges and opportunities of collaboration within the innovation ecosystem of industrial transformation of North Central Sweden (see motivation of case selection in section 1.1). The method offer a holistic perspective by looking at various aspects of the case and provides rich data that can contribute to theory development and practical applications. Case studies are not intended to be representative of a larger population but they can still provide insights that can be applied to other cases or situations. The chosen case is a case of the EU smart specialisation approach on regional innovation, which is implemented by many regional innovation ecosystems in Europe.

4.1.2 Qualitative research

The study was designed in order to “get a better understanding“(Brinkman 2013, p 76) of which factors are significant for actors who collaborate in an innovation ecosystem in order to bring about collective action in line with the European Green Deal. I chose semi-structured interviews for the data collection, based on a phenomenological approach (Gray 2018). The motive was to capture the interviewee’s subjective experiences, opinions and perceptions of the collaboration between actors in the innovation ecosystem and to allow follow-up questions based on the interviewees responses. The strength of choosing interviews as the source of data for a case study is that they can provide unique and enlightening information that enhance the depth and quality of the collected data. Interviews can offer valuable perspectives that may not have been considered before. (Yin 2009)

However, Yin (2009) warns of weaknesses of interviews, e.g. the risk of bias. I work with regional development in Region Dalarna County Council which gave me certain advantages in terms of an overall understanding of the theme of the study, but it also involved disadvantages due to the risk of preconceived notions that could affect my interpretation of the respondents' answers. Yin also warns of “*reflexivity*, that the interviewee gives what interviewer wants to hear”. (2009, p 102) Region Dalarna is part of the innovation ecosystem and manages regional development funds, which most actors in the innovation ecosystem depend on. Since the study is deductive, I also need to be observant of confirmation bias, i.e. the risk that I interpret what is said in the interviews in line with my expectations based on the theory. To counteract this and control my bias I used open-ended questions to encourage respondents to share their experiences in their own words. I used follow-up question to encourage respondents to expand or give more information about certain issues. I listened actively and tried to avoid interruptions or to lead answers in a certain direction. I also tried to maintain a neutral appearance by asking the main questions from the Interview guide in the same way and in the same order regardless of who I interviewed. However, the follow-up questions varied depending on which directions the responses took. (Gray 2018).

4.2 Material

4.2.1 Data collection

Preparation: I contacted the innovation strategists in Region Dalarna, Gävleborg and Värmland to discuss the theme and check the relevance for my thesis proposal, i.e. to increase understanding of how actors in a regional innovation system actually work collectively for regional development and innovation. I received positive feedback and got the advice to focus on *industrial transformation* as there are ongoing cross-county collaborations within North Central Sweden within this domain. Then I was encouraged to proceed with the planning of the interviews.

Interview guide: With the research gap, purpose and research question in mind, I started developing an interview guide (see Appendix 3) out from the theoretical framework on which I got ideas for my survey, i.e. Jagers et al. (2020) approach on CAT. The guide is divided into three parts; Facilitators, Stressors and Free-riding and give space to other factors that may be revealed from a regional innovation context, with a focus on sustainable innovation and the goal conflicts that can arise in the collaboration towards industrial transformation when the climate goals must be reached without negatively affecting social inclusion and economic sustainability. The questions are based on the respective stressor/facilitator in the theory and aims to identify various challenges for cooperation that the respondents believe exist between the actors in North Central Sweden's innovation ecosystem. Worth noting is that I wanted to investigate whether some factors that Jagers et al. (2020) defined as characteristics of a large-scale collective action problem and in that way constitute the reasons to the identified stressors, also could be seen as obstacles in themselves (e.g. the number of actors, the spatial distance and the complexity of the issue). The number of questions were adapted to a 45 minutes interview and the issue of validity was addressed by ensuring that the question content were concentrated on the research objectives (Gray 2018).

Recruitment of respondents: In order to fulfill the purpose of this study (section 1.2) I needed to talk to people who are involved in the daily practical work between actors in the ecosystem who could account for both challenges and opportunities in the collaboration. The respondents were selected purposely with help of insiders. Firstly I asked the innovation strategists of Region Gävleborg and Värmland as they act like the “spider in the net” and could provide a holistic view of the collaboration between the actors. Their organisations represent *policy* in the quadruple helix approach (Schüts et al. 2019). The innovation strategists in turn, referred me to the project manager for Fokus Industri Spets, a project in which several innovation-promoting actors are included to support industrial transformation in industrial companies, i.e. *industry*, the business perspective in the quadruple helix approach. (Schüts et al. 2019) She agreed and offered to ask if there were any additional voluntary respondents from the other participating organizations in the project, whereupon I got three more people who wanted to participate. One junior project leader from the Sustainable Steel Region, a regional innovation platform focused on advanced steel (Värmland). One project manager from the Paper Province a business cluster for pulp and paper (Värmland) and a senior project leader of RISE/Propell, a regional innovation hub (Gävleborg). Paper Province, then declined due to lack of time, but instead I got the CEO from Sustainable Steel Region (Gävleborg). After checking with Region Värmland's innovation strategist, I contacted the Head of Grants and Innovation office on Karlstad University in order to get perspectives from *science*, i.e. academia. I pondered for a while who I could talk to within *society* to get the societal perspective on industrial transformation and ended up with the regional need for skills supply to cope with the green transition. The strategist for skills supply in Region Dalarna referred to the manager of the Teknik College Dalarna, an association formed via the Industry council and based on the cooperation between the region's companies and ten certified schools in eight Dalarna municipalities, with the aim of promoting skills supply and increasing international competitiveness. Overall I got eight voluntary respondents, men and women, located in Dalarna, Gävleborg and Värmland and representing quadruple helix in the innovation ecosystem of industrial transformation in North Central Sweden. (Appendix 1)

Informed consent: I prepared e-mails to all respondents with information about the theme and purpose of the study, how the interview would be conducted, ethical aspect, etc. as a consent form, which I sent to the interviewees to sign, scan and send back to me. (Appendix 2)

Interviews: The interviews were conducted in Swedish by the author (me) digitally via Teams. Each interview resulted in a video recording and an automatic transcription, which was of great help for the further processing of the material. Immediately after the interviews, I reviewed the recorded video and corrected inaccuracies in the automatic transcription so that the interview content became readable and understandable. Validity was later secured by involving respondents into reading the transcribed interviews in order to minimize the risk of misinterpretations. The transcripts constitute the results of the data collected from the interviews which I have used as basis for the analysis.

Limitations of the interviews: In an attempt to avoid misunderstandings of the interview's rather complex questions, get an open atmosphere, and to quickly get to the core related to the purpose of the study and the research question, I chose to define the concepts based on the theoretical approach and previous research, which meant that the respondents were to a certain extent aware of what I had found in the theory. This was to make sure that the questions and thus the expected answers were placed in their right context from start, due to the limited time required for the interviews (max 45 min). Thus, the questions risked leading the answers in a certain direction which could be a source of error in the study. With more time at disposal I could have given the respondents a pre-understanding by preparing the interview in a different way, for example by sending out material in advance. As a way to still ensure reliability, the initial basic questions have been expressed in the same way for all respondents according to the interview guide and follow-up questions have been asked in order to capture different perspectives. I have also tried, as described in section 4.1.2, to be observant of my bias. The transcripts were sent out for review after the interviews to ensure validity. The different steps in the research process are documented and there are video recordings and transcripts from the interviews in order to ensure transparency and credibility. However, according to ethical aspects and GDPR transcripts and recordings will be destroyed after the approval of the thesis.

Generalizability: Qualitative interviewing seldom enables one to generalize results statistically as the sample often is too small. (Brinkman 2013). This study is no exception. The results from the sample with eight respondents from the innovation ecosystem of industrial transformation in North Central Sweden cannot be generalized to other European regions, which is a limitation. However I did my best to gather a good sample with initiated people from the academy, business, regional authorities and civil society who were eager to contribute with their experiences to the study, which is well reflected in the material. The study shows phenomena that are partially recognizable from previous research on the implementation of Smart specialization and add perspectives on regional innovation from CAT, which might be of interest to actors in similar contexts, i.e. smart specialisation and the PRI in Sweden or in Europe. The method used could be transferred in order to conduct a similar study in another regional innovation context.

4.2.2 Thematic Analysis

I chose a method of thematic analysis, which means systematically identifying and categorizing the collected data by interpreting patterns that form different themes, see table 7 in the list of figures and tables. A theme refers to a recurring pattern that emerges from the data and goes beyond isolated events to represent a broader idea. A theme becomes significant when it captures something meaningful in relation to the research question or the aim with the study. (Gray 2018)

The analysis is conducted from a combination of deductive and inductive approach. This made it possible to test the material against the factors in Jagers et als (2020) approach on CAT to find out if their theory fits collective action related to the theme of the study; regional innovation. The approach also made it possible to identify new themes, which could not directly fit into the categories in the theoretical framework. This contributed to a more exhaustive answer to the research question and

added new aspects to the theory. Miles and Huberman (1994) provide a method in three steps, or *streams*, that guided my data analysis: Data Reduction, Data Display and Conclusion Drawing and Verification. The work is conducted iteratively, i.e. you go back and adjust and refine themes and categories throughout the process as you gain a deeper understanding of the data.

Data reduction is about selecting and reducing the amount of data, focusing on the things that are relevant to the study. I started by giving each question in the Interview Guide its own document. I then sorted the answers to each question from each respondent into respective document. This gave an overview of how all respondents answered each question and a good base for the careful reading of the answers and coding. The coding was done by marking words, sentences and quotes that were connected in similar colors. This procedure also made clear information not of interest to the study.

Data display involves the organizing of data by categorizing it into themes and subcategories and to illustrate this in a way that can facilitate the interpretation of the material. As part of the analysis I designed a table (table 6) in each document where the factors from the theoretical framework made up the main categories, i.e. the stressors and facilitators. Under the main categories, themes were identified and grouped into subcategories based on the coding. The subcategories consisted mainly of different challenges related to the collaboration in the innovation ecosystem of industrial transformation in North Central Sweden. These could be sorted under the respective stressor and facilitator. The subcategories were exemplified with direct quotes from the answers of the respondents, in order to disentangle similarities and patterns between the respondents. Here I was particularly careful to take both positive and negative cases from the respondents into account in order not to risk selecting answers that confirmed my expectations or theory. (Brinkman 2013) The procedure also revealed themes that did not fit in to the existing theoretical framework, but constituted a new factor. In addition I drew attention to certain themes that belonged to other questions from the interview guide and was thus allowed to be moved to the correct document. This procedure offer transparency and secure the reliability and increase the credibility of the study.

Conclusion drawing and verification is about to interpret the data by drawing conclusions, or in this case rather discuss the themes identified and how they relate to the purpose of the study. Based on the coded, structured and systematized data from step 1 and 2 I analyzed and interpreted the data accordingly to previous research and the theoretical framework. The meanings of the interpreted data were verified by letting the respondents take part and comment the analysis, i.e. to strengthen the validity and reliability of the analysis.

5. Analysis

This chapter presents the findings from the analysed data, i.e. the transcripts from the interviews related to the analytical framework with collective action facilitators, stressors, other factors and need of external support. A summary is presented in table 7.

5.1 Collective Action Facilitators

In this chapter the analysis of the collected data of collective action facilitators will be presented and illustrated by some quotes from the interviews put in relation to Jagers et als (2020) approach on CAT and with the research question and aim of the study in mind.

Trust, Reciprocity and Reputation

The respondents' answers indicate that the levels of trust, reciprocity and reputation differ depending on whether the collaboration involves actors *within the same function* in the quadruple helix, e.g. between the innovation-promoting actors in North Central Sweden or if it concerns cooperation between actors *within different functions* in the quadruple helix, for example between innovation promoters, the universities, regions and the civil sector within North Central Sweden.

Collaboration between actors *within the same function exists* and seems to work quite well at least between some the business and innovation supporting actors and to some extent between the three regional councils of Dalarna, Gävleborg and Värmland:

"I feel that there is a desire for cooperation across county borders, but it varies how far one has come. Paper Province, the Sustainable Steel Region (SSR), the Industrial Development Centers (IUC) and the Development Innovation Hubs (DIH) are examples of collaborations across North Central Sweden" (Interview 1)

"The regional development administrations in Dalarna, Gävleborg and Värmland need to integrate more with each other. There is a structured collaboration within smart specialization and this should spread to more strategic areas." (Interview 1)

Respondents who participate in the Fokus Industri Spets project testify that trust and reciprocity was weak between the innovation-promoting actors from the start, but that it has gradually increased;

"You can see that this type of project is incredibly beneficial for cooperation within North Central Sweden, because if you meet regularly both physically and digitally for a long time, you have time to form an opinion about the credibility and ability of people and their organizations" (Interview 2)

"Trust is high. I thought it came completely automatically, so I didn't notice if someone came in with the slightest thought that it wouldn't work... which I heard afterwards... that there were many who were skeptical..." (Interview 3)

"When you have gained trust and done something together that worked well, the step is much shorter to get started the next time" (Interview 6)

This is in line with Elinor Ostrom's theory (1997) which stated that situations involving strong cooperation initially tend to contribute to more individuals adopting reciprocity as a norm and if this norm spreads then it is a good idea to create a reputation about being trustworthy. However, this works the other way too, i.e. that a not trustworthy behavior creates a bad reputation, which were also experienced of some respondents from less successful collaborations;

"You can sense... this organization does not deliver as many companies, or that they say they have so much else to do, etc. It is clear that it sticks in the memory... You are truly a representative of your organization and your behavior has a bearing on what kind of image other organizations will get of us." (Interview 2)

"You work in different ways in each organization and it can be enough that you have had a collaborative project that did not work very well, then you become less eager to enter into another collaboration with that actor. It is fragile" (Interview 2)

However, an organization's reputation for not wanting to cooperate may not be due to reluctance, but rather to the fact that it operates in different subject areas and that there is thus a lack of concrete cooperation opportunities;

"The Universities of Gävle and Dalarna are perceived to be playing in another slightly lower division and are perhaps not so interesting for Karlstad University" (Interview 1)

Collaboration between actors *within different functions* in the quadruple helix shows a lower degree of trust and reciprocity.

This seems to be the case between the academy and the business and innovation supporting actors;

"There may not be super high trust between the academy and the innovation support organizations... If trust is weak, it may not spread to the companies either. Then the companies might not get the feeling that they could get a share of that wise research." (Interview 3)

"I don't have a lot of contact with the regional universities and therefore haven't built up any trust. So there can be a skepticism – what can they really do? Trust comes from delivering, that there is a result that speaks for itself." (Interview 7)

The answers also indicate that there is a risk of a lack of trust for the business and innovation-promoting actors from the small and medium-sized enterprises;

"We have a challenge in that we don't really reach the companies. Maybe because they don't really understand what we do and what the different actors can offer. There is a risk that we are nibbling on the same company all the time" (Interview 3)

The study shows that the cooperation between all four functions of the quadruple helix is a challenge in North Central Sweden. Previous research (Perianez-Forte and Wilson, 2021) indicates that it seems to be particularly difficult to include civil society in smart specialization, which also seems to be the case in North Central Sweden. However, Coompanion Värmland has the task of being the platform for social innovation and must involve civil society, potentially also linked to industrial transition;

"I see opportunities to find models for sharing industrial resources of various kinds, e.g. competence resources, personnel resources but also physical resources" (Interview 1)

Communication

All respondents agree on the importance of physical meetings, especially at the beginning of a collaboration but also during the course of the collaboration based on which issues are to be discussed;

"It is my absolute experience that you deepen trust and collaboration much faster if you set aside time to see each other physically" (Interview 6)

"We prioritize physical meetings and have hit the ceiling in terms of conference costs, but we said early on that we have to meet physically" (Interview 3)

"In existing collaborations between actors who have worked together for a long time, you sometimes need to meet IRL to have strategy workshops and a little coffee talk" (Interview 5)

The opinions regarding digital meetings differ. One raises the problem of starting with digital meetings too early in the process, before trust has been created;

"We often think more practically than pedagogically when we talk about the type of meetings we should have" (Interview 8)

Several highlight the sustainability perspective linked to digital meetings:

"We are learning this way of working. There is a sustainability perspective as well, when we talk about the environment and reduced emissions by not having to travel around Europe" (Interview 5)

Everyone agrees that a combination of physical and digital meetings seems beneficial to the collaboration in the long run and environmentally sustainable. However, written communication via e-mail does not seem to be an option. Better to pick up the phone and make a call.

The importance of physical face-to-face meetings to promote collective action is supported by, among others, Ostrom (1997) and Dawes (1977). After the pandemic there is also scientific support that digital video meetings also promote communication between individuals. However, written digital communication does not seem to favor collaboration. (Nguyen, Gruber, Marler, Hunsaker, Fuchs and Hargittai 2021)

Punishment of free-riders

The answers indicate that free-riding occurs in the innovation ecosystem, for example in common projects. This is in accordance with the description in section 3.2 about what usually characterizes a collective action problem. However, some think that free-riding is natural in change processes. Someone is calling for better follow-up of what actors actually contribute to reduce the risk of judging actors based on a feeling.

Some respondents have experienced free-riding in common projects;

"We project owners may perceive that the project participants lean back too much... They think it is practical and nice that we have got the project through, that we do most of the work and that they get a share of the money... It can also have to do with culture, how important an organization thinks it is to create storytelling and articles." (Interview 2)

"I don't want to be prestigious, but, I am really getting my spines out when someone brings up a success and doesn't mention where it came from." (Interview 7)

The respondents explain that in change processes it is normal that actors free-ride in different stages of development. But, it shouldn't be the same free-riders all the time. You have to take turns pulling the locomotive;

"In Fokus Industri Spets, they try to help rather than free-ride." (Interview 3)

"I think you need a control over and punish those who never want to take the time to contribute. To be able to say: now you have to take the lead on something, otherwise you are not allowed to be part of the collaboration." (Interview 8)

Someone also believes that there is a risk of not noticing what actors actually contribute to the innovation ecosystem;

"We need to follow up collectively to see that things happen collectively. We don't do that, so the answer is instead based on someone's experience. The awareness of the importance of others contribution to the collaboration may not be so clear" (Interview 8)

Jagers et al. (2020) found that people tend to exhibit a willingness to accept costs in order to punish free riders and that the threat of punishment can reduce the incidence of free-riding. Judging from the answers, for example relating to the perception of the Fokus Industry Spets project it seems like carrots are better than whips to get the actors in North Central Sweden to contribute to the common.

5.2 Collective Action Stressors

In this chapter the analysis of the collected data of collective action stressors are presented and illustrated by quotes from the interviews put in relation to Jagers et als (2020) approach on CAT.

Number of actors and heterogeneity

Most respondents highlight that there is a willingness to collaborate and that collaboration often works well. However some of them also see challenges in being many actors and more important, that the differences in functions, governance, missions and culture between the actors can hinder collective action.

There seems to be an ambiguity among the business and innovation supporting actors about each one's role in the system;

"There are many actors which means that it can sometimes be difficult to distinguish who should take responsibility for what. That certain issues go into each other and so on. (Interview 6)

"We are involved in similar areas because many of the challenges are similar. Circular transformation for example. I think we are in there and pawing at very similar areas" (Interview 3)

Another challenge raised is that the actors have different governance;

"There is different power over each actor, where the operational depends on decisions in boards, steering groups, company boards, etc. who do not know about each other's work or who do not have ambitions that lead in the same direction" (Interview 8)

As well as actors having different missions:

"If excellence meets excellence, e.g. that we are similar organizations, but in completely different industries, then we get a good interaction because we understand each other's purpose. But if excellence meets breadth, it may be difficult to see the common purpose and a collective action become harder." (Interview 7)

"The university does not have a regional mission, even though our region is very important. It is a national mission to conduct research and educational activities for the good of the nation and perhaps also for the EU. (Interview 5)

Different organizational cultures are also highlighted as a challenge for collaboration;

"If organizations' basic goals and culture are fundamentally different, then much more is required, i.e. that you are rooted in a kind of pre-understanding of what it is you are supposed to do." (Interview 6)

"Sometimes there are also requirements from the regional authority that someone from the business support system must be included in the project application in order for the University to receive funding. This can be difficult because we have completely different cultures." (Interview 2)

Jagers et al. (2020) found that the number of actors involved in collaboration is the most obvious characteristic of a large-scale problem as it complicates the coordination and cooperation and generate several forms of heterogeneity, for example power asymmetries, cultures. Some respondents thought that the number of actor's complicated collaboration, but the main problem seemed to be that the innovation ecosystem for industrial transformation consists of many heterogeneous actors which makes collective action difficult and thus confirm the theory.

Anonymity and spatial distance

North Central Sweden includes actors in the large geographic area of Dalarna, Gävleborg and Värmland. The respondents believe that this affects the possibilities for collective action. Some express specifically that it is a challenge above all for Värmland in relation to Dalarna and Gävleborg, that there are no natural relations with Värmland due to the geographical distances that may have led even to a mental distance. However, Fokus Industri Spets shows that it is possible to gather around a common goal and build relationships that facilitates collective action. All respondents agree that anonymity is devastating to collaboration.

Some respondents highlights deficiencies in public transports etc. which makes physical meetings difficult:

"The best way to meet in terms of communication is Stockholm. Then you wonder what the logic is? That it is precisely in North Central Sweden that we collaborate" (Interview 1)

"This may sound banal, but there is no direct train line between Karlstad and Hudiksvall (laughter) and the roads in between are quite bumpy" (Interview 2)

Others say that it is possible to create conditions if there is interest, thanks to new ways of working and better systems as an effect of the pandemic. Fokus Industri Spets, which several of the business and innovation supporting actors participate in, is an example of this;

"The actors have known each other before, but thanks to getting to know each other through the Fokus Industri Spets project, we now have this personal relationship that makes it so much easier for us to pick up the phone. According to those in the project, the geographic distance has almost disappeared" (Interview 3)

The respondents highlight the importance of getting to know each other and creating trust, as well as supporting actors who can play an important regional role.

"I think we are where we are today because we didn't have the knowledge of each other and that is why we are pushing for the regions to cooperate" (Interview 4)

"When problems arise, you must be able to work together and trust each other, so anonymity is probably the biggest obstacle for collective action. Once you get to know each other, good things happen. It is not possible to build trust without knowing each other" (Interview 8)

Spatial distance characterize large-scale problems according to Jagers et al. (2020). For example, the fossil fuel emissions from North Central Sweden causes climate change that affect even other geographical territories. However, this study show that geographical distances can also be a stressor for cooperation between the actors who are expected to facilitate the reducing of emissions, because it

affects the possibilities of creating the trust and reciprocity which according to theory is a prerequisite for collective action.

Complexity

The respondents highlight several challenges linked to the implementation of industrial transformation each of which individually and together are complex and affect the possibilities for collective action. Actors have different views on what the purpose of smart specialization is, how to relate to the sustainability aspects in regional innovation and goal conflicts that industrial transformation can give rise to (see more examples in section 2.1.1)

Some responses indicate an ambiguity regarding the purpose of smart specialization:

"We haven't talked together clearly about what we mean by smart specialization, which means that the view of the purpose of this specialization can vary. Some think it is obvious that we work with impact and that we develop our priorities and strengths is only a contributing factor. Others think that this goes against the purpose, because that we are supposed to compete in the first place. Not with each other in Europe but with the rest of the world and that is the motivation" (Interview 8)

Regarding the sustainability aspects, some emphasize that it is clearer now than 7-8 years ago that the global goals and societal challenges are expressed in programs and calls for proposals, etc. They mean that the big companies are aware especially the environmental and climate challenges and the changes they have to make.

"There is an emotional element in the sustainability aspect that makes it a little more difficult for companies to refrain from acting" (Interview 2)

"Industrial symbiosis is a complex issue where we have to bring different industries together. If I demand something from my industry, the other industry needs to tell me how this affects them. (Interview 7)

The respondents agree that it is harder for the small enterprises who are busy with the daily operational activities and questions like competence supply for instance. The social sustainability perspectives seems to be particularly difficult to encounter.

"I think that we still have a hard time in the industry in North Central Sweden with the social sustainability perspectives, i.e. to understand how diversity and inclusion would benefit my company" (Interview 3)

"Among the companies we help, there are many who have never been in contact with the academic world and it is an art to translate... I cannot just step in there and say: Hi, now I want to talk about equality, do you have any intersectional perspectives in your vision? Then they would kick me out... it would not work. (Interview 6)

Some respondents also recognized the goal conflicts that may arise;

"There are goal conflicts. Even in the global sustainability goals, innovative power can be created at the expense of another goal. Employment for all means that we need growth, which means an impact on nature. Greener electricity causes us to encroach on nature (Interview 7)

Jagers et al. (2020) states that large-scale problems are characterized by a large degree of complexity that means that they are difficult to understand as such and what consequences they can have. They are also often interconnected. For example the emissions from industry and transport in North Central Sweden may affect the biodiversity loss and ocean acidification. These are major challenges for the

actors in the innovation ecosystem in North Central Sweden to encounter, where cooperation is required not only within the region but also with other regional innovation ecosystems, for example through the EU's initiative Partnership for Regional Innovation (PRI). So complexity give rise to other stressors, but in this context it is also a barrier in it-self that affect possibilities for collective action.

Lack of accountability, risk and uncertainty

Regarding stressors like lack of accountability and risk and uncertainty that can hamper collective action, the respondents mainly relate to challenges with governance in North Central Sweden and leadership related to the participants in the innovation ecosystem for industrial transformation. Someone also highlights the existence of competition between the actors.

Industrial transformation is expected to take place in cooperation between actors within North Central Sweden, but is complicated due to the lack of governance at that level:

"Our regional authorities have the coordinating and neutral leadership that is so important, but this formally extends only to the regional borders. It is difficult to get a leadership that is comprehensive over the whole of North Central Sweden. Nevertheless, expectations are high on the actors, that they should take this major regional leadership responsibility for their issues, but they do not always have the mandate to do so. I think the conflict is clear there" (Interview 8)

"We have an industrial strategy that is common to North Central Sweden, which is a strength. However, each regional authority has its own innovation strategy and regional development strategy, which can create uncertainty in the interpretation" (Interview 1)

The cooperation across the county borders seems to go at a slightly different pace and independently of each other, which indicates weak coordination/management of the system;

"There is uncertainty in the system. Some actors are forward working, while others are waiting. Take our IUCs (Industrial development centers) for example, which are important actors in the industrial context, they have a North Central Sweden organization in the form of the Sustainable Steel Region which stands for more innovative approaches today." (Interview 1)

"This happens when isolated larger organizations run their own race, i.e. don't put the puzzle together and relate to others" (Interview 7)

Competition between actors occurs because everyone is dependent on public financing;

"We are absolutely not competitors, because the whole reason you work in organizations like this is that you want things to go well for our regions. In general, we all have a societal interest, but at the same time we are competing for the same money when it comes to co-financing opportunities from the region, etc. So you'd be lying if you said there wasn't... competition." (Interview 2)

Jagers et al. (2020) points to the risks with the scope of the climate issue, which means that individuals, or in this case actors, may experience that each individual's effort to, for example, reduce climate emissions contributes so infinitely little to the big picture, so that it is psychologically tempting to ignore or downplay one's own role in contributing to reducing the negative effects on the climate system and gloss over the shared responsibility that most actors have in addressing the climate change. I don't think this phenomenon is reflected in the respondents' answers at all, on the contrary. They are well aware of the importance of the issue and want to contribute, but they face challenges in achieving collaboration because of factors that seems to have to do with the weak institutional capacity and governance on the level of North Central Sweden. My view is that these shortcomings should be examined further through other theories than CAT, see section 2.2.2.

Emotional detachment and cognitive limitations

The respondents did not show any emotional detachment to the increased sustainability focus in the regional innovation work. However, they demand more knowledge and tools for the implementation, especially concerning the social sustainability aspects of industrial transformation.

According to environmental sustainability, especially with a focus on the climate issue and that we must reduce carbon dioxide emissions, there is no doubt among the actors in the innovation ecosystem for industrial transition;

“Climate issues are everyone's concern” (Interview 1)

” Generally when it comes to the climate part, the energy part, other types of material, i.e. what is close to technical issues is easier. I would like to say that it reflects society at large.” (Interview 3)

“In industrial transition, the climate challenge is often talked about from a technical perspective. Fundamentally, it is a technical factory that stands there, and it is the technical tangible products we use that cause problems. So we start from that and add all the layers of behavior along the way” (Interview 7)

Nor does it seem that there is any emotional resistance among the actors regarding social sustainability. They know that it is important, but have difficulty in knowing how to bring about the changes;

“There is a strong consensus both in terms of gender equality and inclusion issues, where you link it very much to skills supply and innovation. (Interview 1)

“It was much more sensitive ten years ago. Today it is intellectually accepted and people believe that it is an important factor, because we have learned more and it has become a matter of fact instead of an emotional issue as it was before” (Interview 8)

However, some respondents express that there is a certain resistance among the companies;

“It's also about the cultural behaviors that exist in many companies, not so much about foreign-born compared to Swedes, rather that it's a bit heavy, old-fashioned and that there is a jargon. These are big challenges to tackle.”(Interview 3)

The respondents' answers expressed a need for leadership in the field of the social sustainability;

“The company itself must have a conviction that this is a board decision and we have to go in this direction. After all, we have no leader, not even in North Central Sweden, who stands on the barricade and shouts that transformation is required. We don't have a Macron who is adamant and says what is required but which people don't want to hear...” (Interview 2)

“I strongly believe in this - to absorb it, be strong and take the lead. They call it soft values and I don't know why. It's a really stupid word, because it's actually one of the most important things, this particular thing about behavior and how we relate to each other. (Interview 4)

The answers also showed a demand for knowledge and tools, in order to make social sustainability happen within industrial transformation;

” In each actor there is a great emotional uncertainty and frustration. How? How do I do then? How do we achieve the social dimension in the circular society? What is that? There is a lack of self-confidence when it comes to social sustainability, how we should integrate it in a good way. But not resistance, as it used to be” (Interview 8)

"There is a realization that we lack the competence to deal with these things, but not that we should be afraid of them. We want it to be equal, but don't have the tools to get there" (Interview 7)

"How to fill the knowledge gap? I think that is more complex than all employees taking an equality course one morning." (Interview 6)

Someone also called for guidance in programs and calls for proposals;

"The system underestimates the problem. It is agreed to work towards equality, but how to do it, how it is formulated in calls for proposals and what actually counts as doing this is a very exciting challenge. (Interview 6)

Jagers et al. (2019) found that emotions get less intense the further away something is perceived to be from one's immediate experience. They meant that even though people know and are aware of the negative consequences of climate change, it is not certain that they are prepared to act - if these changes take place far away, i.e. does not affect one directly. I perceive from the interviews that there is a great awareness in the innovation ecosystem of North Central Sweden about the importance of large-scale cooperation at all levels to take responsibility for the reduction of fossil fuel emissions and a strong will to cooperate and contribute. Perhaps because of the Green Deal and the various climate packages presented by the EU In line with Fit for 55 are beginning to have an impact on companies and organizations. However, the social sustainability goals are not as prominent in these writings which is reflected in the respondents' answers.

5.3 Other identified factors

In addition to the above-mentioned facilitators and stressors that, according to Jager et al.'s theory, benefit and hinder collective action, the respondents highlight financial resources and as a key challenge that permeates in principle all previously mentioned factors.

Financial resources

Since practically the entire innovation ecosystem in North Central Sweden is publicly financed, the financial resources related to industrial transition is an important factor to consider. My view is that financial resources is a facilitator that should supplement Jagers et als (2020) theoretical framework with in a sustainable regional innovation and development perspective.

All respondents except one raise the problem with the organizations' dependence on external project funding to be able to carry out their tasks and contribute to collective action;

"We have an abnormality in the Swedish innovation support system, that there is a preponderance of project funding in relation to operational funding" (Interview 1)

"I perceive that it makes it difficult with different types of financing. For example, when it comes to the Tillväxtverket (Swedish Agency for Growth and regional development), it is quite natural that you work across the whole of North Central Sweden, while Vinnova may not have the same view of North Central Sweden at all" (Interview 3)

"If you have your main funding from a municipality, as well as a small part in a collaborative project where you would really like to do more, for example in the form of collective action, then a conflict of interest could arise"(Interview 6)

The respondents highlight above all the importance of secure base funding for the various actors in the innovation ecosystem;

"Away with project-financed investments and in with base funding, so that we build a foundation to stand on where implementation, follow-up and governance must come from the same direction" (Interview 8)

"It is projects and project financing that limit the actors' capacity to go outside the box. Because here it's about going outside the box to build something new and build new collaborations" (Interview 1)

"The university's research grants and the individual's salary are based on having scientific publications. This means that this type of collaborative project, collective action, is not as highly meritorious as a more traditional scientific project that ends up in a publication" (Interview 5)

There is a competitive aspect related to financing that seems to hinder collective action;

"The pursuit of winning tenders... We have an old-fashioned view of winning things and competing for money and all that. I don't know how you could do it otherwise, but it's actually something that splits." (Interview 8)

One of the respondents, however, believes that *"Too much money is an obstacle. Organizations that are core can more easily define a role. Everything we do is based on cooperation with others, but if you are big you can still move on. So I think that limitation leads to cooperation" (Interview 7)*

5.4 External support

Several respondents raised that there is no clear leadership and organization at the North Central Sweden level, i.e. that there is an "administrative distance" (Interview 1) that complicates the possibilities for collective action. They meant that the regional authorities (Region Dalarna, Gävleborg and Värmland) have taken on the role of coordinating the actors in the system, but that this role will be difficult to fulfill because of the lack of mandate to govern and lead. I previously heard a person liken the situation to "herding cats", i.e. cooperation is voluntarily, and the cats do what they want.

"We haven't addressed this issue of how we actually organize ourselves nationally, regionally and with the EU to make things happen. We follow old patterns. We say we have an innovation ecosystem, but actually we don't have a system!" (Interview 8)

"There is a lack of structure in the system and I think it will get better over time" (interview 4)

External support for regional innovation often comes from the EU, national or regional level;

"The regional fund program, ERDF, is a very clear support. Without that, there would probably be very limited collaboration" (Interview 1)

"The EU's initiative Partnership for Regional Innovation is a way to support cooperation by pooling funds and getting more joint mobilization of resources for the transition work" (Interview 8)

The answers confirm Jagers et al (2020) theory that within large-scale problems it is less likely that the actors can coordinate themselves, "most important they cannot directly monitor the performance or anticipate the actions and outcomes of other actors" (2020, p 1284). Some form of external support seems to be needed and is also demanded from respondents, in order to coordinate and guide the actors towards cooperation.

5.5 Summary

The result of the analysis is summarized in table 7 in the list of figures and tables. The table shows the investigated factors in CAT and the salient themes, i.e. identified challenges and opportunities. All factors were found to be relevant for the collaboration within the innovation ecosystem for industrial transformation in North Central Sweden to a certain degree.

Factors of high relevance related to identified *challenges* are, a weak *trust and reciprocity* among actors with *different* functions in the innovation ecosystem, *heterogeneity* due to actors different governance and missions, *anonymity* because of geographical and administrative distance, *complexity* related to e.g. goal conflicts linked to industrial transformation, *lack of accountability, risk and uncertainty* due to e.g. issues like weak governance and leadership and the existence of competition between actors. Financial resources were identified in addition to the theoretical framework due to the actors dependency on external funding and a great need for base funding which are also perceived to have high relevance for the possibilities of collective action within the innovation ecosystem. Other factors that were found to be relevant but to a lower degree are *punishment of free-riders, number of actors* in the system and *emotional detachment and cognitive limitations* related to social sustainability.

Factors of high relevance related to identified *opportunities* are, a growing *trust and reciprocity* among actors with *similar* function in the innovation ecosystem, *communication* related to the combination of physical and digital meetings, decreasing *anonymity* through personal relations via e.g. common projects and no *emotional detachment and cognitive limitations* were present related to environmental sustainability, i.e. climate issues. In addition a demand for leadership, knowledge and tools was expressed related to the implementation of social sustainability goals in industrial transformation.

The results are discussed in the next and final chapter.

6. Discussion of results and conclusion

The aim of this study is to contribute to a better understanding of challenges related to collaboration between stakeholders in a regional innovation ecosystem and explore how different factors can influence collective action towards the ambitions of the EU Green Deal. The subject was approached by testing if Collective Action Theory (chapter 3) could help explain difficulties in the implementation of regional innovation strategies in the EU (section 2.2.1) The study is supposed to answer the question:” What factors affect the prospects of achieving successful collective action towards the green transition within the innovation ecosystem of industrial transformation in North Central Sweden?

An empirical investigation of challenges related to collaboration within a regional innovation ecosystem and how different factors can influence collective action towards industrial transformation has been provided. Based on the empirical results (chapter 5) all investigated factors affect collaboration to a certain degree within the examined ecosystem (table 7). This indicates that CAT captures important aspects that hinder or benefit collective action and put the light on challenges that are worth investigating more closely. Some facilitators and stressors seems to be particularly distinctive for the collaboration in the examined ecosystem:

Trust and reciprocity are noticeable among actors who have the *same function* in the ecosystem, e.g. business and innovation-promoting actors in North Central Sweden. However those facilitators appear to be rather weak among actors with *different functions* in the ecosystem, i.e. actors representing academia, business, public authorities and civil society (the quadruple helix). This might, according to CAT, hinder collective action and consequently make industrial transformation difficult. The implementation of Smart specialization presupposes collaboration among actors in the quadruple helix (section 2.1.1), so *trust and reciprocity* should be considered in the further implementation of the regional innovation strategies. This is not least important from the EU's interest in ensuring efficient use of the European Regional Development Fund (section 2.1.1.). In the light of the recognized weak trust and reciprocity within the ecosystem it is perhaps not surprising that several respondents raised challenges like *governance, leadership* and *coordination* related to the difficulties in cross-county collaboration that is expected among actors in Dalarna, Gävleborg and Värmland, i.e. North Central Sweden. These challenges appear consistently in the survey and are particularly related to **Heterogeneity, Spatial distance, Anonymity and Lack of accountability and Risk and uncertainty**. The respondents request *external support* to resolve this, which corresponds to Jagers et als (2020) approach on CAT (section 5.5). Those challenges could advantageously be examined through other theories and approaches, for example linked to regional identity, institutional capacity and multilevel governance (section 2.2.2 and the paragraph of future research). **Emotional detachment and cognitive limitations** do not seem to characterize the collaboration in the innovation ecosystem. The respondents conveyed a broad consensus and awareness among the actors in the system concerning *the importance of the climate and the social sustainability issues*, although some respondents admitted that a certain resistance can still be felt in some companies related to e.g. equality and social inclusion (section 5.3). However, there is a clear frustration among the respondents about how to implement social sustainability due to a *lack of leadership* to change the status quo, *knowledge gaps*, and a *lack of tools*. **Financial resources** is not included in the Jagers et als (2020) approach on CAT, but were perceived as crucial for collaboration and collective action within the innovation ecosystem for industrial transition in North Central Sweden. The pursuit of money creates *competition* between the actors in the system, creating split instead of unity which is devastating for collaboration. (section 5.4)

Conclusion

This study contributes to existing literature about difficulties in the implementation of EU-policies on regional level. This by shining a light on Collective Action Theory (CAT) as a useful source for increasing understanding of challenges related to large-scale collaboration in solving large-scale collective action problems. This investigation showed that factors which, according to CAT, influence the possibilities of bringing about collective action have been identified in North Central Sweden's innovation ecosystem for industrial transformation, as well as challenges linked to these factors. These aspects could be taken into account in creating better conditions for collaboration between actors in the ecosystem in order to increase the possibilities for collective action. The findings are useful especially for the continued inclusive, digital and green transition within the EU Partnership for Regional Innovation (PRI) initiative (section 2.1.1) which aims to solve societal challenges through interregional cooperation and innovation. In addition, the study may contribute to the improvement of the implementation of the regional innovation strategies in Dalarna, Gävleborg and Värmland, with focus on the sustainable industrial transformation. The empirical results from this study confirm Jagers et al (2020) approach on CAT, and add Financial Resources as an important factor to consider in a regional innovation context.

Limitations of the study are present due to my professional role and network and the study's deductive approach there is a risk of bias (section 4.1.2). Moreover, the interview questions could have appeared leading and put answers in a certain direction (section 4.2.1). Generalizability of results is not possible due to the limited sample of eight respondents (section 4.2.1). The research process in itself imply limitations as it is based entirely on my choices and assessments. However, I have been well aware of these constraints and tried to counteract them in line with usual scientific approaches for increasing the validity and reliability of a study, e.g. by asking respondents to check the transcripts from the interviews and the analysis of the collected data.

Future research could focus on increasing the understanding of the most relevant factors and challenges that appeared from this study, e.g. strengthen trust and reciprocity, facilitate governance, leadership and coordination as well as investigating methods and measures that could improve social sustainability in industrial transformation as well as counteract goal conflicts that risk to arise. Other theoretical frameworks could be used to enlighten the challenges of weak governance, leadership and coordination related to the examined innovation ecosystem (section 2.2.2). Quantitative studies would be useful by supplementing the findings from this study with statistical analysis. This could increase the relevance and credibility and make possible the generalizability of the results. Finally, comparative studies of collaboration within similar innovation ecosystems in other regions in Sweden and Europe would also be a suggestion for research.

List of figures/tables

Figure 1

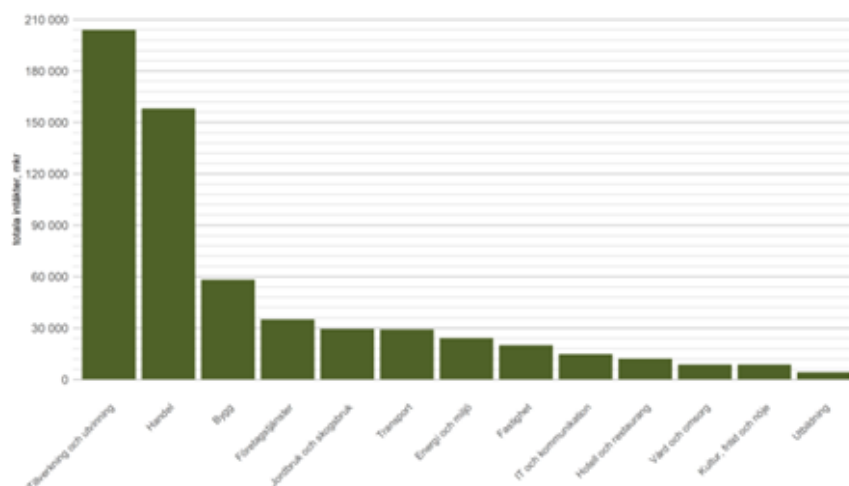
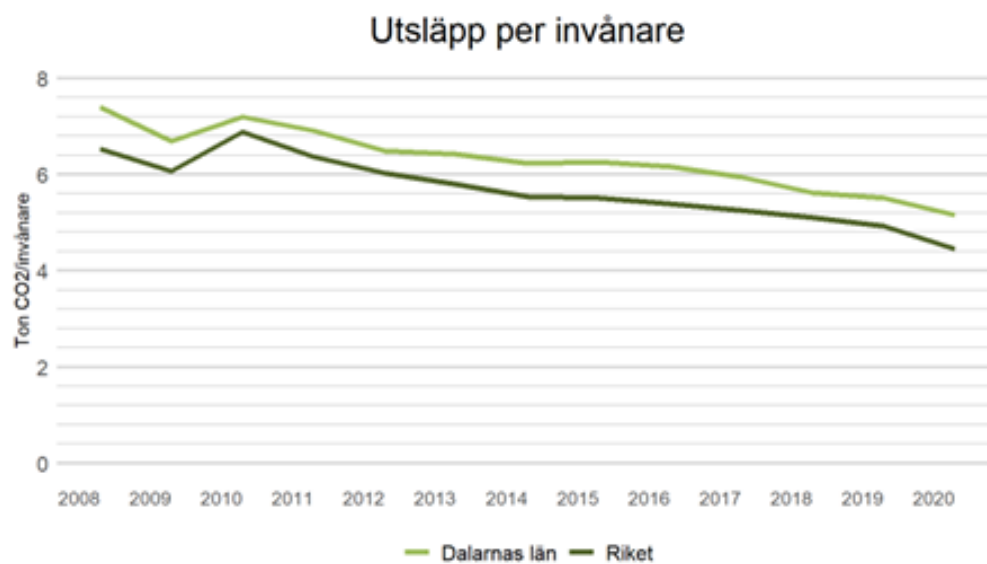


Diagram 47. Branschernas totala intäkter i mkr, 2019, Norra Mellansverige (Källa: SCB)

Figure 2



Källa: Kolada
 Bearbetning: Samhällsanalys, Region Dalarna
 Diagramförklaring: Utsläpp av växthusgaser inom det geografiska området delat med invånare i ton CO2-ekvivalenter.

Figure 3

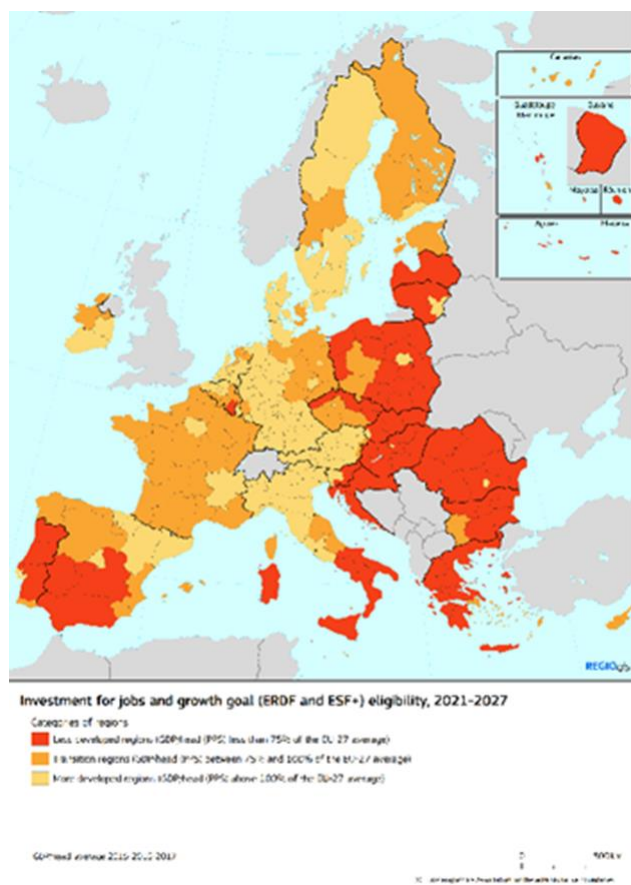


Figure 4

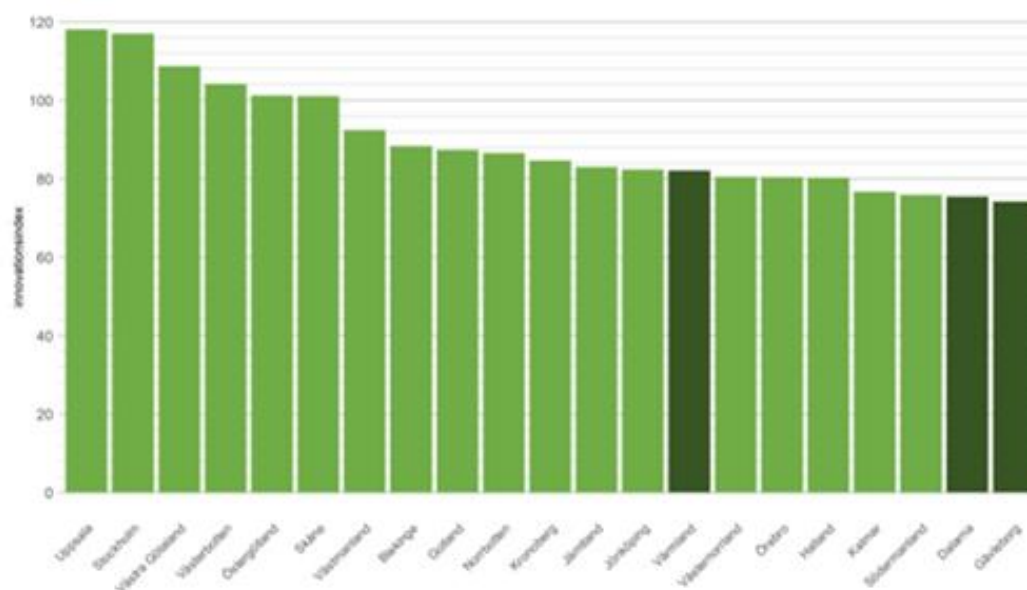


Diagram 46. Innovationsindex år 2021 (Källa: Reglob)

Figure 5

1290

Ambio 2020, 49:1282–1296

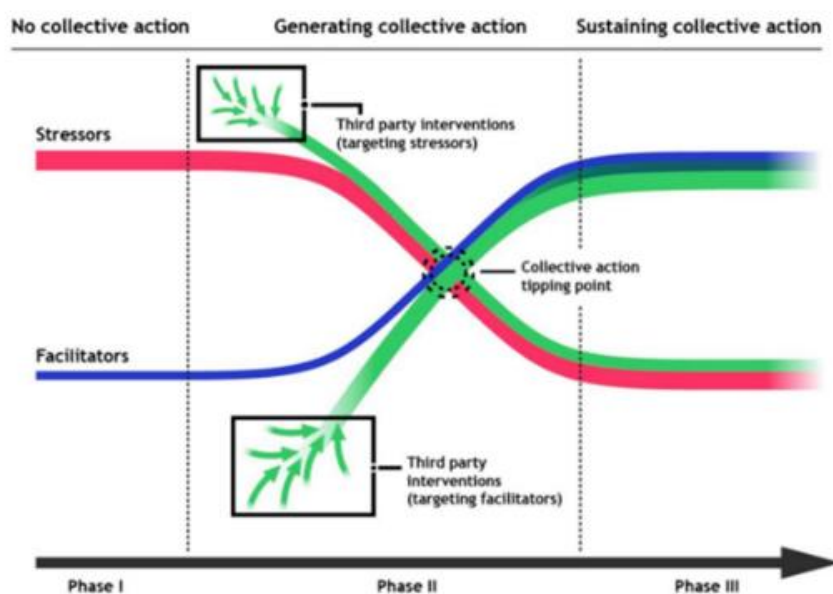


Fig. 1 Generating and sustaining large-scale collective action

Table 6

Category/subcategory (i.e. challenges related to the stressors or facilitators)	Stressor 1 (e.g. anonymity)	Stressor 2 (e.g. spatial distance)
Challenge 1	“direct quote” (Interview 1) “direct quote” (Interview 8)	
Challenge 2		“direct quote” (Interview 5) “direct quote” (Interview 2)
Challenge 3	“direct quote” (Interview 4) “direct quote” (Interview 6)	“direct quote” (Interview 7)
Challenge 4 - may be moved to another table if the theme is more related to another stressor or facilitator in the survey.	“direct quote” (Interview 4)	
Challenge 5 – may sort under a totally new stressor or facilitator that is not derived from the theoretical framework.		“direct quote” (Interview 6) “direct quote” (Interview 8) “direct quote” (Interview 3)

Table 7

This table summarizes the results from the analysis of the conducted interviews. The left column lists the examined factors (*facilitators* and *stressors*) from the Jagers et al (2020) approach on CAT plus a factor that appeared to be important in addition to the theoretical framework. The other two columns list the identified themes (*challenges* and *opportunities*) from the data analysis. The middle column list the main identified *challenges* related to the respective factor. The right column list the main identified *opportunities* related to the respective factor. Different colours indicate my assessment of the relevance of the different themes for the collaboration between the actors in the innovation ecosystem of industrial transformation according to the results of the analysis:

Red= high relevance, Green= medium relevance

Factors (Categories) from CAT	Challenges (negative)	Opportunities (positive)
Facilitators		
Trust, reciprocity and reputation	Low level of trust and reciprocity between actors within different functions in quadruple helix	Growing level of trust, reciprocity between actors within the same function in quadruple helix
Communication	Written digital communication (e-mail)	Physical face-to-face meetings
	Digital meetings (Teams, Zoom, Skype etc.)	Combo of physical and digital meetings
Punishment of free-riders	Free-riding in common projects	
	Free-riding to a certain degree is normal in change processes	
	Follow-up and evaluation of actors contributions are missing	
Stressors		
Number of actors and heterogeneity	Numerous actors with unclear roles – confusing for the target groups	
	Different governance of actors	
	Different missions of actors	
	Different organizational cultures of actors	
Anonymity and spatial distance	Large geographic area with rather poor connections	
	North Central Sweden = three regional identities; Dalarna, Gävleborg and Värmland (administrative and mental distance as a consequence of spatial distance?)	
		Personal relations, e.g in Fokus Industri Spets
Complexity	Ambiguity on the purpose of Smart specialisation	
	Sustainability in regional innovation (environmentally, socially and economically)	
	Goal conflicts that industrial transition can give rise to	
Lack of accountability, risk and uncertainty	No governance on the North Central Sweden – level (but from three regional authorities in Dalarna, Gävleborg and Värmland)	

	Leadership within the innovation ecosystem – unclear mandates	
	Competition among actors due to dependence regional development money	
Emotional detachment and cognitive limitations	Social sustainability with focus on equality and inclusion –high awareness, some resistance	Environmental sustainability with focus on climate issues – high awareness, no resistance
	Weak leadership in driving social sustainability.	Demand for knowledge and tools for social sustainability
Other identified factors		
Financial resources	Dependency of external project funding	Base funding of important functions in the innovation ecosystem
	Competition between the actors in the ecosystem divides instead of uniting.	

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Appendix 1 List of respondents organisations

Respondents in the interview survey representing Industrial Transformation in North Central Sweden

Quadruple helix/Sector	Actor	Date of interview
Policy/Public organisations	Region Gävleborg https://www.regiongavleborg.se/regional-utveckling/	April 6 2023
	Region Värmland https://www.regionvarmland.se/regionvarmland/om-regionen/om-region-varmland/organisation/regional-utveckling	April 12 2023
Science/Academy	Karlstad University, <i>Värmland</i> https://www.kau.se/samverkan/forsknings-och-innovationssamverkan/forsknings-samverkan/akademin-smart-specialisering	April 13 2023
Industry/Business	RISE, Propell, <i>Gävleborg</i> https://propell.se/om-oss/	March 29 2023
	Sustainable Steel Region (SSR), <i>Värmland</i> https://iucstalverkstad.se/om-oss/sustainable-steel-regions/	April 4 2023
	Sustainable Steel Region (SSR), <i>Gävleborg</i> https://www.sustainablesteelregion.se/en-GB	April 14 2023
	Dalarna Science Park; Industri Fokus Spets North Central Sweden https://www.dalarnasciencepark.se/vara-projekt/focus-industry-spets/	April 3 2023
Society	Teknik College <i>Dalarna</i> https://teknikcollege.se/dalarna	V.16 el 17, (tbc)

Appendix 2 Consent form

Dear Nn, My name is Åsa Ängsback and I work as an EU/international strategist at Region Dalarna. I am currently studying European Studies via the University of Gothenburg; Executive Master's Program in European Studies (EMAES). It is a program that assumes that you have worked with EU-related work for some years, and the idea is that the training should generate added value for the employer as well. In the spring, I write my master's thesis; COLLECTIVE ACTION TOWARDS SUSTAINABLE REGIONAL INNOVATION; A qualitative study of factors that benefit and/or hinder collaboration within the innovation ecosystem of industrial transformation in North Central Sweden.

The purpose of the study is to gain an increased understanding of what makes actors within an area of knowledge within smart specialization go from collaboration to collective action. The idea is to investigate to what extent factors, which within Collective Action Theory have been shown to promote and/or hinder collective action, exist within North Central Sweden's innovation ecosystem for industrial transformation. This is in view of the green transition that is now taking place in line with the ambitions of the EU's Green Deal. The study will also contribute to an increased understanding of Collective Action Theory in a regional innovation context. I am preparing a qualitative study where I intend to interview innovation promoters linked to industrial transformation in North Central Sweden. I was therefore very happy that you showed interest in participating!

Information about the interview

The interview will take place digitally via Teams (or another video link that you prefer) and take about 45 minutes. The interview will be recorded and transcribed.

Film and transcription are to be used solely for this study by me, my supervisor Georgios Xezonakis, assistant Professor in the Department of Political Science and the course supervisor, Ann-Kristin Jonasson, fil. Dr. and university lecturer at the political science department at the University of Gothenburg.

All footage and collected data will be removed/deleted once the essay is approved and completed.

Participation is completely voluntary and you have the right to refrain from answering questions or to end the interview at any time.

It will appear in the essay which organizations are participating in the study as well as the names and titles of the interviewees, but the answers will be anonymized so it will not appear who says what.

After transcribing and data analysis, I will double check with you and the other respondents that I have interpreted the answers correctly. I will also share the report with you and other participants in the study after it has been approved.

I hope you feel safe with the above information, but feel free to contact me if you have any questions or concerns, see my contact details below. If you feel you have received the information you need and are still willing and able to attend an interview, I would like to ask you to print this email, sign with your name, title and organization, scan the document and email it back to me. In this way, you give your consent to participate in the study. Then I do the corresponding procedure with my signature, scan and send back to you. The plan is to try to conduct the interviews during v. xx-xx I will return with suggestions for times for interviews if it becomes relevant.

Kind regards

Åsa Ängsback

Appendix 3 Interview guide

Introduction

Hello and welcome (and some small talk to get the respondent in a good relaxed mood)

We have 45 minutes for this interview and I will start with a brief description of the background and purpose of the interview.

Based on my literature review I have recognized that there seem to be problems in general in Europe when it comes to the actual implementation of the regions' smart specialisation/ innovation strategies. Despite being able to agree on a vision and prioritized areas of knowledge and strengths and having well-established innovation ecosystems, it has proven difficult to move from collaboration to collective action.

In this study, I take support in Collective Action Theory. It is based on problems that can arise when many people must agree on a common resource, for example natural resources such as water and air, i.e. a public good. Something that we can relate to today is the limited carbon dioxide "budget" and challenges of reducing fossil fuel emissions. This large-scale problem needs to be solved by many actors at different levels.

Collective Action Theory shows that there are factors that promote and hinder collective action. The heart of the collaboration problem is about free-riding. This means that some actors take advantage of the efforts of others, i.e. rather make short-term decisions for their own gain than decisions that in the long term will be the best for everyone.

The purpose of this interview is to try to identify which factors promote or hinder collective action within North Central Sweden's innovation ecosystem for industrial transformation and consider whether there are tendencies towards free-riding between the actors. I am also very curious to hear if there are other factors than those that I have picked from theory that affect the possibilities for collective action from your perspective.

Any questions so far?

I also want to remind you of your right to refrain from answering questions, to interrupt the interview, and that the answers will be anonymized i.e. i.e. it will not appear in the essay who says what.

Now I will start recording and then an automatic transcription should begin.

Hope that it feels ok?!

We will talk for approximately 15 minutes about factors, which in theory have shown to hinder collective action. Next 15 minutes we will talk about factors that have shown to benefit collective action. In the last 10 minutes, we will reflect on whether there are tendencies towards free-riding among the actors in the innovation ecosystem of industrial innovation in North Central Sweden.

STRESSORS

First, two short questions about you and the organization you represent:

What function do you think your organization has in the innovation ecosystem for industrial conversion in North Central Sweden? What is your role in this?

1. We start with factors that hinder collective action.

- a) Two hindering factors are, a large number of actors and heterogeneity (i.e. that the actors who cooperate are very different from each other) Do you feel that these factors affect the possibilities for collective action between the actors in the innovation ecosystem for industrial transformation? If yes, in what way?
- b) Another factor is how the complexity of the issue affects the possibilities for collective action. This case is about how smart specialization shall not only lead to increased capacity for innovation but to sustainable innovation that can reduce emissions of fossil greenhouse gases and at the same time is economically and socially sustainable. Any thoughts on this?
- c) Do you feel that anonymity, i.e. that the actors do not know each other well, and/or that the geographical distance affect the possibilities for collective action? In this case, there are actors from three counties, a quiet large territory who work together in the ecosystem. What is your experience?
- d) Do you think that actors feel a lack of responsibility to contribute to the joint work or that there is risk and uncertainty in the system, i.e. that one does not dare to invest because one is unsure of what the other intends to do, and that this may hinder the collective action? Please describe!
- e) Do you feel that there is a kind of emotional detachment among the actors, i.e. that the climate issue or social aspects such as diversity, inclusion, equality cause discomfort or that you avoid it because the task feels overwhelming?
- f) Are there other factors than those I mentioned, which you feel are an obstacle to collective action? Which one or which ones, and in what way are they hindering?
- g) Do you think that external support from the EU, national or regional level is needed to reduce stressors? Do you have any suggestions for appropriate measures?

FACILITATORS

2. Now, we will discuss factors that promote collective action.

Trust, reciprocity and reputation have been shown to facilitate collective action and these are also self-generating. Trust increases the possibilities for mutual exchange and cooperation. If you are trustworthy and a good partner, you get a good reputation, which creates a positive spiral. Correspondingly, a negative spiral is created if you do not prove to be a trustworthy partner. Good communication is also super important as is punishing free-riders.

- a) Do you feel that there is trust and mutual exchange among the actors who collaborate around industrial transformation? Are there actors who have a particularly good reputation? How is this expressed? Please describe and give examples.
- b) Face to face communication, through physical meetings has shown to promote collective action. Now many of the physical meetings are replaced with digital ones. How do you feel that this has affected the collaboration, i.e. to create trust, confidence, mutual exchange?
- c) Do you see that there are measures that could increase trust and mutual exchange in the system? I am thinking of different types of efforts from third parties, e.g. EU, national or regional initiatives. Can you give examples of desirable interventions?

d) Do you see that there are other promoting factors than the ones we have talked about so far in the NMS innovation ecosystem, which lead to collective action in the transition effort? Which? Exemplify!

FREE-RIDING

Do you feel that actors in the innovation ecosystem take advantage of the efforts of others? If so, how does it turn out? What could this be due to?

Do you have any idea how this could be countered? Is action needed from third parties, from the EU, national or regional level?

Great! Then we went through all the questions. I hope to get back with any follow-up questions and I will send over the analysis so you have a chance to check that my interpretation matches what you wanted to say. Now I turn off the recording.

Many thanks for your participation! Have a nice day and see you soon.