Bridging the Innovation System and Industry Development: Experiments from Northern Finland

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Abstract: As technological change has been identified as a one important driver of economic growth, the interest towards research, development, and innovation (RDI) has increased in academia and also in policy practices. However, a systemic analysis of innovation activities easily overlooks the role of the companies as key actors building the bridge between innovations and economic growth. Combining the analyses of innovation systems and entrepreneurial activities is important in ensuring the recognition of public and private stakeholders in regional development. This paper discusses the interplay of public and private sectors and concentrates on the companies and industry development in innovation systems. The case study in this article comes from the Oulu region in northern Finland. This paper aims at describing and analysing public-funded projects as links between RDI and business development.

Keywords: regional innovation system; RIS; industry development; company engagement; RDI projects; regional development; regional policy.

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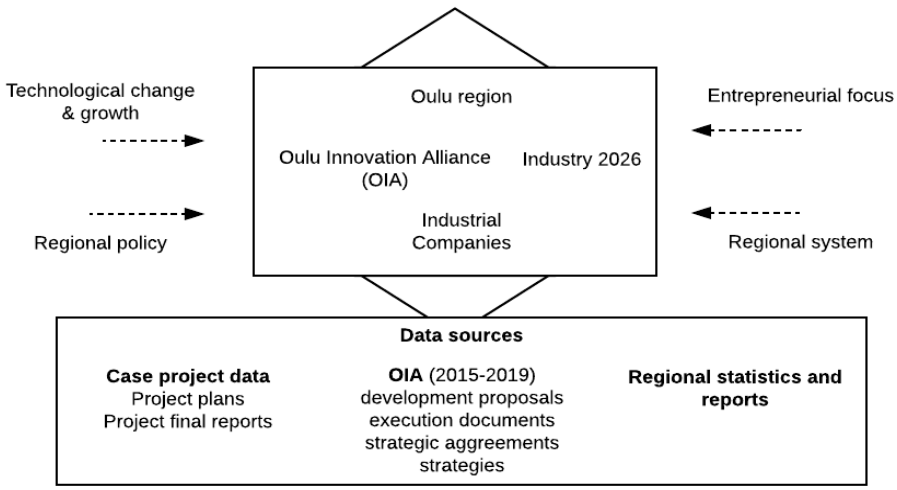
1 Introduction

As technological change has been identified as one of the main drivers of economic growth, the interest towards phenomena such as research, development, and innovation (RDI) has increased substantially. In terms of policy practices, RDI has been highlighted as an almost universal response to any challenge societies face. Whereas there are numerous examples and cases of active innovation policies, the research on innovations has remained somewhat dispersed. The latest development in the study of technological change and innovations is to focus more on people, competences, institutions, and networks. Innovation systems (ISs) are identified as an important concept for deepening the understanding of the complex nature of innovation processes. However, systemic analysis of innovation activities and especially innovation policies and practices easily overlooks the role of the entrepreneurs as key actors in innovation and economic growth (Acs et al., 2014). Therefore, in recent years the literature has aimed at bridging the IS approach and entrepreneurial perspective. IS is a policy approach emphasising that a long-term relationship between stakeholders can play a strategic role on the promotion of innovation and competitiveness (Asheim et al., 2019). The concept of entrepreneurial ecosystem (EE) stems from the IS perspective (Stam and Spigel, 2016) aiming to look at the entrepreneurial process in its broader social and economic environment (Spigel, 2017). Companies have a central role in identifying regional economic challenges and helping to create structures to overcome common problems. Companies seldom pursue innovation in isolation, instead, knowledge-intensive economy requires close cooperation between companies and other organisations (Sandström and Ylinenpää, 2012). Innovations are also connected to the development of regional policies since ISs have strong spatial dependencies. Urbanisation as a global megatrend has prompted decision makers to act on the increasing imbalance in regional economic development and thus increasing the emphasis on the functional ISs. This paper discusses the interplay of public and private sectors and concentrates on the companies and industry development in ISs. Moreover, this paper aims at describing the functionality of RDI projects as a vehicle converting research and development into innovations.

The core of this article is based on multi-disciplinary research activities that combine relevant elements from economics, geography, and industrial management. This approach is able to provide a comprehensive view of the challenges and opportunities of building a regional innovation system (RIS), which links research institutions, public actors, and companies. The case study in this article comes from the Oulu region in northern Finland. Overall, Oulu can be seen almost as an anomaly because of its continued growth and significant outcomes in terms of RDI despite the remote location, challenging conditions, and radical changes in regional production patterns over the past decades. The case study analysis is based on public-funded projects as a tool linking the IS to industrial economic development and is supplemented with the analysis of innovation collaboration documents, strategies, policy papers, statistics, and selected RDI projects (Figure 1). European Union (EU) funding of the analysed projects ensures the precise documentation and hence offers a detailed view of the role of the companies in innovation activities. The main research questions in this research paper are related to the real nature of widely applied RDI projects: to what extent is it possible to make interpretations about the relation between IS and EE by analysing joint RDI projects, what roles could RDI projects play, and what roles they actually do have in linking RDI and economic growth? Figure 1 describes the framework of the paper and shows the practical implication of regional economic drivers.

The first section offers a literature-based background for the case study. It briefly covers concepts such as technological change and economic growth, RIS, entrepreneurial perspective, and company engagement. After that, the regional context of the Oulu region and the case study analysis are presented, followed by a closer look at selected RDI projects, company engagement, and industry development. Finally, the main conclusions of the study are presented.

Figure 1 The case Oulu – framework, drivers and data sources of the study



2 Background – key concepts and definitions

2.1 Technological change and economic growth

Technological change and innovations have become a constant and pervasive theme, demonstrating the common understanding of the importance of new inventions and ideas – whether aimed at solving shared concerns such as undesired changes in the environment, or aimed at finding new competitive advantages in global competition. In economics, the endogenous growth theory states that economic growth is an outcome of endogenous activities instead of external factors (e.g., see Romer, 1990). In terms of economic policy, a lot of emphasis has been laid on the capability of economic actors to create new products and services, or to increase the efficiency of existing processes – especially in industrialised economies. As is summarised by Baccianti and Löschel (2014), technological change becomes visible in the form of product or process innovation. Evidently, economic growth is a narrower concept than economic development (e.g., see UNDP's human development index) and policy programs and other public sector activities usually aim at broader development than just (short-term) growth. Since technological change is strongly linked to issues such as education and knowledge, it can be said that analysing innovations and their effect on growth is bringing the concepts of economic growth and development closer to each other.

Despite the heterogeneity, complexity, and contingency of the phenomenon itself, when investigating technological change as a process, it is possible to observe certain systematics and repetition. In terms of the inputs required for technological change, some important specifications are to be noted. First, RDI activities accrue costs, which can be funded by both public and private parties, and, secondly, technological change involves human capital (Pike et al., 2006).

Another complication in the operationalisation of the concept of technological change is the nature of the results from the process. As already defined by Romer (1990), knowledge is characterised by non-rivalry and only partial appropriability or excludability. Therefore, it is possible for one company to enjoy part of the benefits created by the activities and investments of other companies. These spillover effects may be restricted to certain industries (intra-industry spillovers) or they may be applicable throughout the production sector (inter-industry spillovers), but altogether these spillovers magnify the effects of the technological change and in some modelling experiments are the main causes for economic growth (Gillingham et al., 2008).

The role of institutions and policy is important to capture since it shapes what kind of tools are applied to influence the regional growth. This means that inducing technological change effectively through economic policy should de facto mean focusing on innovation activities, actors, and arenas (Niemelä, 2018). Technological change is forcing organisations to enlarge their boundaries to access knowledge, and in implementing new changes to their innovation processes, they need to go forward from a traditional to a more system-centred approach (Morrar, 2015).

2.2 RISs and entrepreneurial perspective

In the 1980s and 1990s, the need to better understand the sources of competitive advantage and to devise policies addressing regional inequalities (Asheim et al., 2011) stimulated interest in the regional innovation. The concept of the RIS was developed based on the idea of the systematic network relationships' centrality for innovation at the regional level (Uyarra, 2010). The RIS can be seen as a set of interacting private and public interests and actors that function according to organisational and institutional arrangements, which lead to the generation, usage and dissemination of knowledge (Cooke et al., 1997; Doloreux and Parto, 2005). The cooperative innovation activities between actors and the innovation-supportive culture enable both firms and systems to evolve over time (Doloreux and Parto, 2005). At the core of the ISs approach are organisations' various types of actors and their interactions in the production of knowledge, but the role of entrepreneurs remains a 'black box' in the concept (Stam, 2015)

The triple helix is focusing on university-industry-government collaboration that is the key in fostering the conditions for innovation in a knowledge-based society (Etzkowitz, 2003). It is a policy-orientated approach, which views that these three spheres should cooperate closely, whereas the RIS approach can be viewed as a device to conduct research on how cooperation between actors actually takes place and can be used to inform policy [Asheim et al., (2019), pp.29–31]. Ranga and Etzkowitz (2013) further developed the concept of 'triple helix systems' as an analytical construct that provides an explicit framework for the systemic interaction between triple helix actors. However, Asheim et al. (2019) are pointing out that one weakness of the triple helix approach in general is that it does not give much guidance on how a triple-helix-based collaboration could be functional and implemented in concrete policy settings. The innovation ecosystem term is also used, where the prefix eco implies a specifically ecological aspect. This originates mainly from Moore's (1993) concept of business ecosystem management studies, where ecological aspects relates to the interdependency among different actors and the co-evolution that binds them together. However, for example, Oh et al. (2016) are noting that the term is not yet well defined and the concept can be unusable in practise.

A more recent concept, the EE, aims to bridge the IS approach and entrepreneurial research. The EE approach has emerged to explain and capture the contextual setting in promoting or restricting entrepreneurship and in framing and developing entrepreneurial activity (Ahokangas et al., 2018; Stam, 2015). A common feature with terms like the IS is that they all focus on the external business environment (Stam, 2015) and how regions can support entrepreneurship through knowledge sharing, policies, and innovation structures (Spigel and Harrison, 2018). What differentiates the EE literature from the IS literature is the special focus on entrepreneurship and innovative growth companies. For fostering innovation, there is not only a need for the capability to access new knowledge, but also for the capability to absorb and combine innovations (Huggins and Thompson, 2017). According to Isenberg (2010) there are nine principles when building an EE, which include shaping the ecosystem around local conditions, already working models, emphasising ambitious entrepreneurship, and engaging the private sector from the start. In EE literature, entrepreneurs are also central in identifying challenges and helping to create structures to overcome common problems, and hence the role of the public sector should be to facilitate and provide necessary resources (Spigel and Harrison, 2018). The main two elements of

the EE that can be distinguished are framework conditions and systemic conditions. The framework conditions include the social (informal and formal institutions), physical infrastructure and demand for new goods and services. The systemic conditions lead to entrepreneurial activity, including networks of entrepreneurs, leadership, finance, talent, knowledge, and support services (Stam, 2015).

In general, the RIS has both top-down and bottom-up characteristics, whereas the triple helix represents a top-down perspective. On the one hand, there is a strong institutional framework involving public sector and public policy, and on the other hand, there are localised patterns of interacting, knowledge sharing and innovation capabilities, and performance (Howells, 1999). Companies can push forward changes in the RIS to ultimately enhance firms' innovation activity and competitiveness in the region, and system-level actors can better support new initiatives. On the other hand, system-level actors can develop and adapt RIS to better fit new potential needs in the industrial setting, and companies then react to these system-level changes [Asheim et al., (2019), pp.59–60]. In this discussion, entrepreneurship can be stimulated within regional innovation policy through system-based or actor-based programmes. In improving the performance of the RIS, the former approach is oriented to network building, system development, cooperation, and mobility, while the latter deals with access to human and financial capital (Huggins and Thompson, 2017; Isaksen et al., 2018).

The concrete activities in innovation creation are a starting point for private sector regional engagement. Based on a literature review, Lawton-Smith (2017) found three interlinked resources in supporting entrepreneurs: networks and the associated ideas of an innovation and entrepreneurial culture, human capital, and the importance of universities for technology transfer. When describing the IS functions by fostering R&D to enhance the competencies and performances of companies, there are different collaboration types, both formal (including joint R&D projects) and informal (including use of published scientific knowledge) (Cimoli and Della Giusta, 1998). The outcomes of an IS can be measured by a variety of methods. Patent data has been traditionally used to illustrate the correlation between network properties and the performance of the system, but this particular metric seems unsatisfactory since smaller companies are less active in patenting, and moreover, organisational innovations, as well as innovative services, are missing fromthe patent statistics (Huggins and Thompson, 2015). It is important to understand the various motivations of different companies and industry sectors to collaborate in innovation networks and to utilise external knowledge. Whereas the activities in the RIS that are driven by the public sector are related to infrastructure, education, and the RDI activities, the private sector, where the need for rapid solutions for the real customers is high, is interested in innovation activities closer to the market (Viitanen, 2016). Pirinen (2013) is using the concept of value concertation to describe an individual partner's interest and motivation – how they share and co-create value – to maximise the possible contribution to the region and regional development.

The IS needs dynamic anchor companies, which are the key partners in commercialisation, as they have adequate decision-making power and access to global networks (Viitanen, 2016). However, although multinational companies bring new knowledge, employment, and investments to the system, they can easily withdraw in times of crisis (Østergaard and Park, 2015). SMEs and start-ups, another group of private actors, bring their ideas to the IS, utilise the knowledge in developing new products and services, and are active users of business services in the IS (Viitanen, 2016). Especially interesting from a regional economic point of view are innovation-driven enterprises (IDEs), as they

are capable of generating more new jobs and exports than SMEs (Aulet and Murray, 2013). The new firms and overall entrepreneurship are central to the ability of the overall economic system to adjust because of their high ability to reorganise when facing disruptions (Østergaard and Park, 2015).

The analysis of innovation activities and systems as the source of economic growth and development requires operationalisation of the most central concepts, such as IS and EE. RIS literature is moving in the direction of a more dynamic perspective and interest is increasing towards system-level actors, such as the entrepreneurs.

3 Case study

When analysing any regional context, it is necessary to embed the studied region into a national regional policy framework and to understand the development of policies. As an example of an industrialised, modern economy, Finland has rapidly transformed from an agrarian society into an economy built increasingly on the service sector. Alongside this general development during the post-war period, the Finnish economy has become a part of the global economy and of the fluctuating international markets. These simultaneous development trends have indisputably affected the design of the regional development policies. In Finland, regional policy tools have evolved in three stages (e.g., see Sotarauta, 2015; Tervo, 2005; Vartiainen, 1998). These stages consisted of the industrialisation policy of 1960s, the planned regional development policy in 1970s and 1980s, and, eventually, as a third stage, the policy of regional development programmes in 1990s. The current regional policy is focusing on gathering development activities into larger entities and strategic coordination (e.g., see Mäkinen, 1999). The most recent development in Finnish regional policy has been focused on innovations as sources of development. The role played by the public sector in economic development has changed from being an active – sometimes even decisive – agent to being a more enabling actor, ensuring sufficient inputs to selected development activities. This current policy framework urges regional actors to develop different models to accelerate innovation-driven economic growth as demonstrated in the Oulu region's experiments in building local ISs.

3.1 Oulu region and the OIA

Oulu is located in the region of Northern Ostrobothnia, Finland. It is the most populous city in northern Finland and the fifth most populous city in Finland (Statistics Finland, 2018). Oulu is a medium-sized city of over 200,000 inhabitants that is located outside of large metropolitan areas. The Oulu region was a stagnant industrial region in the early 1980s, but developed to be a high-technology centre with global recognition. Since the early 2000s, the region has increased efforts in high tech and in cooperation between education and research institutes, companies, and the public sector, as the triple helix collaboration model suggest. The region is well-educated and young, with 35% of the adult population having a university-level degree and the average age being one of the youngest in Europe at 38 years (City of Oulu, 2019). Oulu has been named as having the highest level of innovation spirit among medium-sized cities in Europe (see Giffinger et al., 2014).

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In 2008, the key RDI actors in the Oulu region initiated a development process to ensure favourable conditions for more efficient innovation activities. The process led to the Oulu Innovation Alliance (OIA), a somewhat unique collaboration arrangement. The original OIA agreement was signed by member organisations to cover the years 2009 to 2015 and was renewed for the years 2016 to 2020 for the second phase. The current form of the OIA embeds the majority of activities and direct costs to member organisations[1] as part of their normal operations. From the operational point of view, the OIA consists of five cross-sectional innovation ecosystems. The focus of the OIA is now more oriented towards agile experimentations aimed at improving and accelerating innovation and commercialisation processes, as compared to the main aim of the first phase was to attract RDI funding and intellectual capital to the area. The members of the OIA have committed to promote the commercialisation of innovations, hence reflecting the joint understanding that the regional economic development is dependent on the private economy's success in markets (Hintsala et al., 2015; Niemelä, 2018).

More closely examined in this study is one of the OIA ecosystems, the Industry 2026, which has three main focus areas: a strong value chain in the metal and machinery industries, high value creating bioeconomy products, and resource efficiency in environment and energy. The University of Oulu is the coordinating organisation of Industry 2026. The aim of the ecosystem is to act as an innovation ecosystem, tackling the concrete needs of the industry by matching the cutting-edge research of the region in joint RDI projects.

3.2 Cases – data and methods

In this article, the RDI projects are considered as links between the IS and industry development. The case analysis looks at what type of companies have participated and engaged in the projects – and if so, what has been their role – and what has been the overall context and development of the industry during these projects. The primary data source consists of project documents: official project plans (done before the start of the project) and project reports[2] (done at the end of the project) that were collected from the project coordinators. In addition, OIA documents, strategies, regional statistics and reports on industrial development, are used as secondary materials (Figure 1). The data analysis followed Eisenhardt's (1989) process of case study research.

There were five RDI projects selected for the case analysis. The criteria of the case selection were to have at least one project for every spearhead of the Industry 2026 ecosystem and to have projects including at least two OIA strategic partners. The selected projects are also important in terms of collaboration in the Oulu region and IS development in selected focus areas. Four projects are funded by the EU/European Regional Development Fund (ERDF) and one is nationally funded. Publicly funded projects have an official documentation and offer a good overall view of the project activities and results.

It is important to acknowledge that these funding mechanisms only allow the projects to focus more on the overall development of a specific industry sector or cluster, meaning that the main tasks cannot be focused on the development of single company. The ERDF is a fund allocated by the EU and the aim is to increase employment and strengthen the competitiveness and vitality of regions. In Finland, there have been four programme periods, two of which are included in this analysis. In Finland, the Council of Oulu region is distributing the most ERDF funding in Finland, as EU has allocated funding close to 130 million euro to the region for 2014–2020. Financing is directed to, for example, promoting

innovation and networking, developing new environmental technologies, and promoting the growth of SMEs and strengthening their competitiveness. The Finnish Funding Agency for Innovation (Tekes) was the most important public funding agency for research and development funding in Finland.[3] The Green Growth Programme finances companies and joint ventures with growth potential in the area of resource efficiency and a durable economy.

Usually the overall budgets of these type of projects in the region are around 0.5 million euros. EU and national funding are between 70–90% of the total budget of the project, the project participants and other forms of public and private funding (usually companies) sources provide the rest. Some projects do not receive any private funding, as many times companies do not have enough resources to participate in the project funding. Of the five projects, three have received private funding from companies varying anything between 3–20% of the total funding and from 4–7 companies per project. Table 1 shows an overview of the projects selected for analysis and includes the budget, participants, and the main aim of the projects.

4 Results

4.1 Company engagement in RDI projects

According to the project plans, there are different company sizes in the focus of the actions of the projects. Two of the projects do not specify the company size in the target group even though project tasks can be seen to mainly benefit SMEs. One project indicates that its focus is on micro-sized companies and SMEs, and two projects are aiming to improve the competitiveness of SMEs. Anchor companies and their role in the regional economy are identified in almost all of the project descriptions, and collaboration with large companies is seen essential in innovation networks as an activity enabling industry development. Even though most of the projects are aimed towards growth, competitiveness, and enhancing innovativeness, project documentation does not mention IDEs per se, which are the type of companies that can benefit from innovation- based projects.

Private funding provided to the projects is mainly from small companies in two of the projects and in one project the companies are mainly large companies. Overall, OIA evaluation reports show that the private funding is dominated by the large companies and they are quite passive in the collaboration and knowledge exchange. There are different motivations for a company to participate in funding public RDI projects. Mainly, the advantages to companies are that, as they usually have a steering board seat, they can influence project objectives and tasks, making sure that issues important to them are present, and they can access the knowledge and latest results first-hand. Companies can also get into the innovation networks and get to collaborate with other companies in order to speed up their own innovation processes.

Table 1 An overview of the selected projects

Project (years)	*Innovative Metallurgical Cooperation for Environmental Efficiency, SME IMCEE (2014–2017)*	*Northern Renewable Metal and Engineering Industry (2015–2018)*	*Northern Ostrobothnia Industrial Symbiosis System, NOISS (2017–2019)*	*LuovaOteKeskus " Innovation hub for natural resources" (2011–2013)*	*Life City (2014–2016)*
Strategic spearhead	A strong value chain in the metal and machinery industries	A strong value chain in the metal and machinery industries	Resource efficiency in environment and energy	High value–creating bioeconomy products	Resource efficiency in environment and energy
Budget (euro)	975 000	1 880 000	528 278	398 600	379 614
Funding source	Tekes The Green Growth Programme	ERDF 2014–2020	ERDF 2014–2020	ERDF 2007–2013	ERDF 2014–2020
Participants*	UO and 7 SMEs	City of Raahe, UO, Centria, Lapin AMK, NIHAK, BO, YSK	OAMK, UO, OSEKK, Luke	OAMK, UO, MTT, Metla, SYKE, ProAgria, Finnish Forest Centre, MTK	VTT, UO
The main aim of the project	To create a value chain of SMEs, research facilities, and the industry in the Oulu area; also, to improve the competiveness of all participants through shared research projects	To promote innovation, competence and internationalization within the metal and engineering industries and the SMEs in the Meripohjola region	To promote the establishment of circular economy–related industrial symbioses in the Northern Ostrobothnia region	To produce an operation model in North Ostrobothnia in order to carry out practical innovation activity and to design a service centre to coordinate and facilitate the activity	The improvement of the operational preconditions and export opportunities of northern Finland wood industry with the developed concept

* Centria University of Applied Sciences, Lapland University Of Applied Sciences (Lapin AMK), Nivala-Haapajärvi region (NIHAK), BusinessOulu (BO), Ylivieska sub-region (YSK), Natural Resources Institute (MTT, now Luke), Finnish Forest Research Institute (Metla, now Luke), Finnish Environmental Institute (SYKE), Central Union of Agricultural Producers and Forest Owners (MTK) Northern Finland.

In the projects selected for this analysis, company engagement included mainly knowledge sharing and collaboration. Two of the projects can be interpreted as having co-creation as one of the main characteristics of the project, so they can be seen as having higher involvement and creativity and leading to shared value (Scandelius and Cohen, 2016). In practise, these two projects focused on building joint specific concepts (like exporting a concept of wooden house and a common product portfolio for companies), how to develop the value chain of the industry, and how to enhance the growth and internationalisation of the companies. This means that the focus of the project is on a small number of companies (7–8). The three other projects have actions focusing more on the general innovation endorsement (facilitating and networking), meaning that the aim is to engage a greater number of companies (20–110) in the innovation networks through, e.g., events, workshops, and platform development. These projects also have a strong emphasis on involving research institutes, higher education, and the public sector in developing the whole sector and not concentrating on specific topics for development. Overall, it can be stated that entrepreneurship in the projects is seen as system-based (e.g., see Isaksen et al., 2018), meaning that there is an orientation to networking, system development, cooperation, and knowledge flow.

All of the projects involve information gathering and reporting, as well as the identification of the company/industry needs as the basis of the work in information and knowledge sharing. When looking at the feedback of the target groups of the projects from the project reports, they recognise company-related industrial challenges that the projects are tackling and see the importance of sharing this knowledge, and are content with versatile activities. Also sharing peer-to-peer experiences with other companies is considered important. Only in two of the project reports, more negative feedback is also stated; in it, they discuss that it is challenging to set the objectives for the projects at the beginning, the project to answer the company's ad-hoc needs, and collaboration with the companies could have been more concrete and target-driven. This has similarities to the analysis of Vehmas and Saarela (2018), which stated that micro-enterprises emphasise the interaction between other project participants through concrete meetings, shared practices, and various forms of peer support, but they saw that companies want more flexibility regarding the objectives and plans of the projects. This reflects the observation that companies are searching for rapid and short-term returns from the cooperation, and are also looking more on the tacit mode of implementation (Sandström and Ylinenpää, 2012).

In the spearhead of metal and machinery industries, it can be easier to have more concentrated actions and to reach the companies as the network of the actors is well defined and established. In the other projects, the overall success is influenced by having too broad project aim and too broad a range of stakeholders, as stated in the project reports. These projects involve themes such as industrial side streams or natural resources. In the project reports, it is indicated how the project activities are continued and how the results and experiences are utilised after the project has ended. The project reports mainly are highlighting new RDI projects, joint initiatives and network activities. Some of the projects indicate that the project will be resulting in new investments, teaching and training, internal company development, public development, research, platform development and usage.

It is important to acknowledge that knowledge sharing actors involved in the projects have different expectations and contribution in the projects. In addition, the funding mechanisms seem to have inflexible elements in incorporating the aims of industry development and supporting regional economic growth, and the entrepreneurial needs.

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Regional policy cannot be about maximising a certain indicator of entrepreneurship, but about creating a system, a context, in which productive entrepreneurship can flourish (Stam, 2015). Based on the data, some systemic condition elements (Stam, 2015) that the projects have an influence on:

- knowledge flow
- research actors in playing the key role in innovation processes
- support and mentoring, networks of entrepreneurial peers
- help access to finance and markets
- access to talented workforce
- the capabilities of the current workforce
- enhancing supporting policies for entrepreneurs
- events and platforms enabling entrepreneurs and community to connect

4.2 Industry development

When looking at the overall development of the regional economy of Oulu region during recent years, it is seen that Oulu has recently become the number one in Finland in RDI expenses per capita for 2015–2017 (BusinessOulu, 2018). However, the millions invested in RDI have not fully yielded the anticipated results, namely new business and more employment in the Oulu region. The industry sector in Oulu consisted of roughly 850 companies in 2017 that employed in total over 11,000 people. Of those companies, 250 were exporting goods and services, and 2.9 billion of the sector's net revenue of 4.9 billion came from exports in 2017. Of those companies, 349 were founded during the years 2010–2018 (BusinessOulu, 2018). However, according to the OIA documents, the booming era of new start-ups has now passed and new companies are created at a far slower pace than at the beginning of the current decade.

The cleantech sector[4] developed in the Oulu region during 2010–2018. Its overall growth of revenue was 30% between 2010 and 2017 and revenue was €462.8 million in 2017. The sector involves 125 companies and employment for 1900 employees (2017). The growth has been steady in companies focusing on emission control and resource efficiency. As most of the companies and overall revenue come from renewable energy companies, revenue in the years 2014 and 2015 decreased within the energy companies, meaning that the overall development and export numbers are not growing at a very steady pace in the cleantech sector as a whole (BusinessOulu, 2018). Some of the developed areas of expertise are smart lighting solutions, online monitoring, energy-efficient solutions for housing and industries, and water management.

The OIA was formed to promote the well-known public-private partnership practices to enhance the diversity of RDI activities of the region. Additionally, the OIA has worked as a framework for collaboration at the strategic and operational level. It is obviously difficult to reliably measure the straightforward effect of OIA activities on regional development and recovering from a local economic crisis. However, as Herala et al. (2017) stated, the OIA has improved the resilience of the regional economy, and hence the current economic structure has developed in a healthier and more stable direction. The OIA is, as an innovation framework or platform, a factor that can ensure the competitiveness of the region and the ability of the region to cope with fluctuating markets. The OIA has had an important role in acquiring funding for supporting actions of the ex-Nokia workforce, and in executing different RDI projects that have supported the development of new start-ups

in the region (Herala et al., 2017). The OIA has enabled RDI actors to identify the spearheads for specialisation, and, simultaneously, it has brought the advantage of having multiple areas of interests in innovation development. Project activities are focusing on the identified spearheads, and needs of the local economy, and the role of knowledge institutions in regional development are emphasised, as also highlighted by Kinnunen et al. (2018) in their analysis of the first phase of the OIA. Even though the second phase aims at business creation and development, activities are still dominated by public RDI organisations and RDI projects are seen as a main form of the collaboration method. Focus has also been shifting more towards international RDI projects (for example EU Horizon 2020 funding 23.5 million euro granted to the Oulu region[5]). However, other new perspectives are emphasised, for example, in the industry and employment policy of the city (City of Oulu, 2019) including customer orientation and knowledge-based value creation. As Sandström and Ylinenpää (2012) are stating that, the actors involved in regional collaboration must bridge different organisation logic and find functional solutions to enhance successful collaboration.

Identifying the needs of the industry requires close interaction and discussions between private sector companies and research organisations. This is why the company engagement in RDI projects is needed in improving and accelerating innovation and commercialisation processes, as stated to be one of the main aims of the OIA. Project documentation shows, however, that there is some emphasis on commercialisation especially in the projects started earlier. In the OIA documents, entrepreneurship and commercialisation are themes that are seen to need more emphasis in the future RDI projects. There is insufficient information on how successful the projects have been from the companies' perspectives and how IS level collaboration should be developed to meet the needs of different actors.

5 Conclusions

Economic growth cannot be generated by the public sector alone, so the interplay between markets and the public sector is needed. On the other hand, economic growth is strongly depending on R&D and innovations. The evolution of the Finnish regional policy has been fast and developing towards the recognition of the RIS and the networking between public and private sector. The case of Oulu illustrates the essence of these changes and fits well in the current programme-based regional policy.

In the Oulu region, the regional policy model of the OIA and its ecosystems seem to stem from an IS perspective, but also combine some elements from the EE approach. In its development, the OIA has been evolving in its consideration of entrepreneurial perspectives in the public IS in order to ensure industry development. This intensified emphasis on entrepreneurship seems to have enhanced the resilience of the regional economy. The northerly and remote location of the Oulu region highlights the importance of the ability of the region to withstand, recover from and reorganise in the cases of various disruptions.

In this study, different regional RDI projects were analysed as practical tools in linking IS and EE. These five projects highlight the networking, cooperation and innovation processes as key elements in bridging innovations and entrepreneurial actions. The role of companies in these projects varies and companies have different motivations to participate or to be targeted in actions of the projects. However, some of the biggest advantages to

companies are, for instance, knowledge sharing and joint initiatives. On the other hand, RDI projects seem to be too inflexible in defining the focus and readjusting it during the project. In addition, defining the target groups of the projects and considering the appropriate means to engage companies in projects are reflected as the critical factors of success. The analysed material is assembled by project coordinators and therefore, a deeper understanding of the company engagement in IS could benefit from some additional data. The correlation between the OIA, RDI projects, and industry development cannot be fully identified – the projects are indicators of the direction of the change in the industry and participating companies have been involved in knowledge sharing. The participating companies have been involved in knowledge sharing. The companies have also obtained solutions and networking models that can enable spillovers to other companies and the whole industry.

To conclude, it can be seen that regional policy is the bigger framework in which an IS is concretised through activities like regional RDI projects. The projects influence the companies, the whole industry, and ultimately the IS itself. Moreover, RDI projects are one form of IS activity that can generate benefits also for companies not directly participating in projects, and, thus enhance the overall industry development. This can be regarded as the spillover effect of knowledge transfer. In the analysis of the Oulu region, it can be seen that development is not only the traditional top-down approach of IS and regional policy, but also the other way round – from bottom to top. In addition, it is important to conclude that RDI projects are an insufficient means to build a bridge between RDI activities and actual business development – RIS should be a composition of different intentional operations aimed specifically at converting the progresses in research and development into economic growth. As this analysis has shown, publicly funded RDI projects are essential part of a functional RIS, but focusing solely on these projects may lead to underestimating the significance of other forms of collaboration between research and business sectors. RIS should not be translated as a collection of RDI projects.

For further research, the perspective of the company in IS deserves more attention. Research questions such as how innovation mechanisms like the OIA are influencing companies' growth and development, and what the importance of innovation collaboration and networks for companies is could be addressed by analysing a sufficient number of case companies.

6 References

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[2] Project reports include the project results and stakeholder feedback. Report is approved and altered by the steering group of the project (involving both public and private actors).

[3] Business Finland was created on 1st of January 2018 by the merger of two organisations: Tekes, which offered funding for innovation activities, and Finpro, which offered services for internationalisation, investments, and tourism promotion.

[4] Cleantech in the Oulu region includes renewable energy, emission control, and resource efficiency.

[5] European Commission Horizon 2020 funding decisions 2019 involving Oulu region-based organisations and companies 17.5 million euro and expected national organisation influence 6 million euros – altogether 23.5 million euro.