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Drivers of the Innovation System and Role of Knowledge Application in Regional Innovation System — Case Oulu Region, Finland*

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Abstract. In the northern periphery, actions are needed to support regional economic development. According to widely shared understanding, innovations are at the core of sustainable economic growth. The regional innovation system (RIS) approach is a framework that has been developed for the design and implementation of innovation-based regional policies. This concept implicates new roles for public and private actors in the system. The role of the public sector is related to generating and diffusing knowledge to the companies and industrial networks. On the other hand, companies have increased collaboration with other actors and utilization of external knowledge for innovation and commercial purposes. The case analysis in this study is based on data from experiments in Oulu region, Finland, which has a long history in developing public-private collaboration and innovation system. The focus of the analysis is on knowledge application and exploitation, and their implications for the public driven innovation system and activities. Operational tools and activities are divided into three different categories: company collaboration, business development, and competence development. The analysis also reveals some examples of the future prospects and challenges in the region.

Keywords: *regional development, innovation, innovation system, public-private collaboration, knowledge.*

Introduction

For regional economies, innovation has become vitally important to gain and maintain competitive strength [1, Asheim B. T., Smith H. L., Oughton C., p. 1]. Socio-institutional environment from which innovations emerge is essential, and innovations are an outcome of interactive learning in localized innovation networks that are embedded in this setting [1, Asheim B.T., Smith H.L., Oughton C., p. 1–3; 2, Doloreux D., Parto S.]. Knowledge plays a central role in creating and maintaining innovation, and knowledge networks have an important role in regional success. Literature suggests that regional actors in science and technology and policies play critical roles in creating appropriate contexts for knowledge creation and transfer [e.g. 3, Huggins R., Kitagawa F.]. On the other hand, an interactive innovation system involves the users of new knowledge who are exploiting it for practical (including commercial) use [4, Cooke P., Uranga M. G., Etxebarria G., p. 478].

Innovation is recognized as being an outcome of the interaction between heterogeneous actors and resource combinations [5, Cantù C., Corsaro D., Snehota I., p. 148]. Interaction includes e.g. knowledge exchange between companies and universities. There has been pressure for the

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public sector to enhance the company collaboration and companies to utilize the external knowledge for innovation. For example, universities have been pushed closer to the industry as governments have sought to encourage these institutions to undertake more industrially relevant research, assisting competitiveness of the industry [6, Tether B.S.]. For the industry, there has been radical change in the competitive environment, and companies have incentives to, for example, increase competitiveness, shorten product life cycles and get cost savings [7, Ankrah S., Omar A. T., p. 392]. Innovation networks are enabling the use of external knowledge in the innovation actions of companies, and this is especially important for SMEs, which have fewer employees and limited resources for their own in-house R&D¹. Different variables on how and why companies are utilizing external sources of innovation on their operations are studied in multiple studies [e.g. 8, West J., Bogers M.].

The regional innovation system (RIS) involves various innovative networks with different kinds of social relationships. These relationships consist of different strong and weak ties. Strong ties mean high-level network density and norms important for innovation, but also weak ties can be fruitful for innovation as they enable breaking away from established practices and information can flow more freely [9, Granovetter M., p. 34, 45]. Innovation potential is dependent on how information is transferred between research and practice-oriented partners as well as differences in horizontal knowledge interests — potential innovating partners may have difficulties in starting the processes, as rules for communication are lacking [10, Uotila T., Harmaakorpi V., Melkas H., p. 52]. In addition, the internal capability of companies to utilize external knowledge through the learning processes of acquisition, assimilation, transformation, and exploitation (absorption capacity) is important to recognize [11, Lewin A. Y., Massini S., Peeters C.]. This capacity is easily neglected in innovation policies, especially in less favored regions [12, Tödtling F., Tripl M., p. 1203].

Moreover, in research focusing on higher education institutions (HEIs) and the public sector, attention is mostly laid on interaction and relationships between the actors within the system [e.g. 13, Scharinger D., Rammer C., Fröhlich J.]. There are some studies trying to investigate how HEIs and SMEs can work better together in the context of a RIS [14, Cooke P.], as well as trying to explain how HEI-industry-interaction works from the industry perspective [15, Cantù C., Corsaro D., Tunisini A., de Zubielqui G. C., Jones J., Seet P. S., Lindsay N.]. This paper contributes to understanding the heterogeneous roles that public actors play in facilitating knowledge application by companies and innovative system development.

The public sector has an essential role in knowledge generation and diffusion and public sector involvement in innovation development actions are needed in the northern areas. Thus, the focus of this study is on the public sector perspective on the importance of company engagement. The case area is the Oulu region, Finland, where there has been an experimental orchestration of

¹ Løkkegaard S., Lykke M. Knowledge exchange between universities and SMEs: The 'Situation' of SMEs. In University-Industry Interaction Conference, Amsterdam, Netherlands, 2016. URL: https://vbn.aau.dk/ws/files/234695585/Paper_UIIC.pdf (accessed 20 September 2020).

substantial public driven innovation activities. This focus of the public driven innovation system differs from the company sector driven innovation system, where the initiatives and guidance are private sector driven (e.g. Silicon Valley). In this study research data is not based on companies [e.g. 15, Cantù C., Corsaro D., Tunisini A., de Zubielqui G. C., Jones J., Seet P. S., Lindsay N.; 16, Santoro M.D., Gopalakrishnan S.]. The primary material consists of a massive amount of data, including, for example, meeting memos, workshop materials, and reports related to public sector innovation system activities². The material is based on engaging different stakeholders to qualitatively collect and synthesize prospects for strategies and development plans. Additional secondary material is formed by two informant interviews (one practical and one strategy orientated) to complement the synthesis based of the primary material.

This article is based on the following research questions:

- Based on the case of Oulu, what can be learned about the drivers and conditions of regional innovation system development?
- How is the connection between knowledge generation and application levels built? What incorporated services, tools and collaboration models can be initially identified?
- What kind of challenges and future prospects can be identified from the synthesis of vast data from regional decision making?

Framework of the study

The regional innovation system (RIS) approach was developed to better understand the sources of competitive advantage and to devise policies addressing regional inequalities [17, Asheim B. T., Smith H. L., Oughton C.]. An interactive innovation system involves the users and producers of new knowledge exploited for practical (including commercial) use. Interaction is a social process, involving feedback at different points in the innovation process as it involves knowledge development, diffusion and deployment [4, Cooke P., Uranga M. G., Etxebarria G.]. These interactions must be systemic and long-term in character to be qualified as an innovation system [1, Asheim B. T., Smith H. L., Oughton C., p. 8]

The two main building blocks of an RIS can be identified as the knowledge generation and diffusion subsystem, and the knowledge application and exploitation subsystem. The knowledge generation and diffusion subsystem include, among others, universities and other public and private educational and research organizations, technology transfer organizations, and workforce mediating institutions. The knowledge application and exploitation subsystem mainly consists of companies and their clients, suppliers, competitors, as well as their industrial cooperation partners, and industrial networks. In knowledge application and exploitation, there is vertical network-

² Unpublished material of the Oulu Innovation Alliance (2009-2019): innovation collaboration documents, including strategic and operative steering board documentation, agreements, special reports and metrics. The Oulu City Business Development Plan from 2019 and policy papers, UO and OUAS strategies and policy papers, some of which are publicly available. Unpublished documentation is available from corresponding author upon request.

ing between customers and contractors, and horizontal networking between collaborators and competitors — the former has more correlation to company growth and the latter has a positive impact on profitability [18, Autio E., p. 134–135]. Tödtling F. and Trippl M. also highlight the regional policy dimension, as the policy actors are playing a role in shaping the regional innovation processes [12, Tödtling F., Trippl M.]. For an RIS existence, interactive learning—engaging and connecting these two subsystems— is needed [4, Cooke P., Uranga M. G., Etxebarria G.]. It is worth noticing that the performance of a RIS does not only depend on what happens inside the system, but also on processes that take place outside the territorial boundaries of system [1, Asheim B. T., Smith H. L., Oughton C., p. 9]. In the ideal case, in this framework there are interactive relationships within and between these subsystems facilitating a continuous flow of knowledge, resources and human capital. In practice, several types of problems and failures, such as lack of relations within and between the subsystems, can occur [12, Tödtling F., Trippl M., p. 1206].

A regional innovation system includes a great number of actors, relations and activities. In this study, the focus is on BusinessOulu, a business development organization of the city of Oulu, two HEIs (University of Oulu and Oulu University of Applied Sciences) and Oulu Innovation Alliance (OIA), a strategic collaboration model, and how they are enhancing the interaction and development of knowledge application level. Therefore, it should be noted that these actors and collaboration models only partly cover the activities done overall in the regional innovation system. The framework of this study is built based on the work of Autio E. and Tödtling F., Trippl M.; it is adapted to the case of Oulu, seen in Figure 1.

As this analysis is based especially on the city development organization, BusinessOulu, and two HEIs, these organizations ought to be introduced. *BusinessOulu* is the business division of the City of Oulu, holding the responsibility for the municipality's business politics and business development, as well as services towards the business sector. The City of Oulu aggregated six different organizations together in 2011 to BusinessOulu. BusinessOulu has also been responsible for organizing and executing city branding and marketing since 2011. The key services are company services (for individual companies), company network development (e.g. incl. innovation services, job creation and entrepreneurship programs), marketing, and event planning.

Oulu University of Applied Sciences (OUAS) focuses on training professionals with emphasis on developing and implementing education in cooperation with businesses and industries. OUAS is conducting RDI activities that are closely integrated with education and projects implemented in cooperation with businesses and industries. University of Applied Sciences has a very clearly legislated objective in regional development. The strategy for 2020–2030 highlights strong networks and ecosystems in the implementation of the strategic aims. In the OUAS strategy, it is stated that the OUAS and UO form a core structure in the local ecosystem, which also comprises the City of Oulu, secondary education providers, sectoral research institutions, industries, and public-sector employers.

The University of Oulu (UO) works as part of the international science community to produce new scientific information and science-based solutions, and train future pioneers to build a more sustainable, intelligent and humane world (Strategy for the 2020s). Collaboration between the two universities is increasing; in 2018, the University of Oulu became the principal owner of Oulu University of Applied Sciences, some of the services have been merged, and both universities are located in the same campus areas starting from 2020.

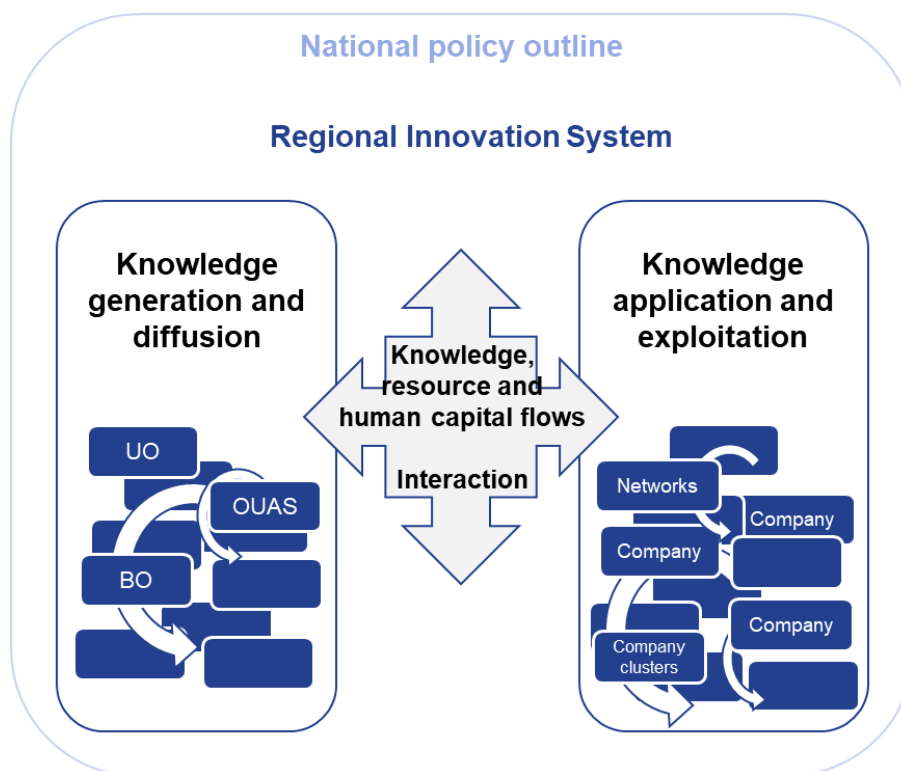


Fig. 1. Regional Innovation System framework and case Oulu.

Regional innovation system as a part of Finnish regional policy

The location of Oulu in the arctic brings some specific characteristics to the orchestration of the innovation collaboration, but there are also national and regional factors influencing the development. Therefore, it is important to highlight the effects that the Finnish regional policy development has on the development of the regional innovation system and collaboration.

As an example of an industrialized, 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 fluctuating international markets. These simultaneous development trends have indisputably affected the design of the Finnish regional development policies that otherwise can be seen to stem from the rather typical and universal desire to secure balanced development in different parts of the country.

The general outline of Finnish regional development policies has rather clearly followed a three-step process [e.g. 19, Sotarauta M.; 20, Tervo H.;³] starting from the industrialization policy in the 1960s, which was followed by a period of planned regional development policy from mid-1970s to late 1980s. The last step in this development is considered to have ignited in the late 1980s, when the manifold of program-based regional development policy was introduced and launched.

In Finland, the third step of regional development at the beginning of the 1990s defined various development programs as the cornerstones of policy. Globalization as a megatrend and Finland's membership of the EU as a major driver at national level have most certainly affected regional economic policies, along with the ongoing discussions about the competitiveness of Finland as a nation in the global economy. Program-based development aims at collecting singular development activities in larger entities and hence improving the strategic coordination of projects⁴. The nature of the role of public sector actors in development has changed from being an active—sometimes even decisive—agent, injecting and administering local economies with investments and public services, to a more supplementing actor, ensuring that there are adequate inputs to selected development activities.

Even though the program-based development per se does not indicate increasing or decreasing emphasis on the regional development, it most certainly intertwines with the thoughts on regional development introduced by Porter in his widely cited studies [e.g., 21, Porter M.E.; 22, Porter M.E.]. Local clusters, networks, or innovation ecosystems refer to a setting in which the public sector investigates economic development in regions and induces progress with appropriate means along with private sector actors. Tervo H. summarized the relation between regional policy and markets and concluded that economic growth cannot be generated by public sector activities alone [20, Tervo H.]. The public sector does not possess the means to affect the general economic development—interplay between markets and the public sector is required.

Assessing the development path of Finnish regional policy for the past decades confirms the assumption that in different contexts and situations, different policies are required. The most recent policy orientation towards innovation systems or ecosystems would not have been the most suitable choice during the post-war rebuilding period in Finland. At the moment, the grand design of Finnish regional policy is supporting rather than preventing the emergence of modern

³ Vartiainen P. Suomalaisen aluepolitiikan kehitysvaiheita. (Developmental phases of the Finnish regional policy), Sisäasianministeriö, aluekehitysosaston julkaisu, Helsinki, 6/1998.

⁴ e.g. Mäkinen M. Yhteisöaluepolitiikan periaatteiden teoreettinen erittely ja soveltaminen Suomessa. Doctoral thesis. Acta Universitatis Tamperensis 691. Tampere, Finland, 1999. URL: <https://trepo.tuni.fi/handle/10024/66509> (accessed 20 September 2020).

regional innovation systems, enabling the co-existence and networking of the public and the private RDI actors, as well as experimentation of different regional concepts ⁵.

Building the regional innovation system in Oulu

In the northern city of Oulu, first steps in the development of the regional innovation system were already taken in the early 1980s when a technology park was established to stimulate collaboration between higher education, research, and companies. The technology park or village was branded as Technopolis and it set a framework for rapidly growing the high-tech sector in Oulu. ICT and mobile phone industries quickly acquired a dominating position in local economy with, as an example, 16% of total employment linked to relevant industries [23, Herala J., Simonen J., Svento R.]. This strong dependence on one industry and even more strikingly in one company (Nokia) was identified as a risk to stable regional development. To alleviate the consequences of one-sided production structure in the region, there were growing desires to expand the collaboration between high-level research and companies to other research areas. In 2008, the key RDI actors ⁶ in the Oulu region initiated a development process to secure necessary resources for innovation activities. This development led to the strategic collaboration agreement of Oulu Innovation Alliance (OIA) ⁷, which can be identified as one form of systematic cooperation in the Oulu region.

The first stage of Oulu Innovation Alliance covered the years from 2009 to 2015. The operational model for OIA's first stage was built on the simultaneously established innovation centers. These centers focused on RDI projects and were able to obtain RDI funding as well as introduce new multi-disciplinary themes such as digital health. During the first stage of OIA, the mobile industry faced a rapid and radical downturn, which led to pervasive consequences in the development of the Oulu region, and the emerging innovation system was put to a serious test. As one of the numerous responses to the difficult situation, both universities in Oulu brought their entrepreneurship and innovation activities together and launched Business Kitchen, the universities' entrepreneurship hub. Business Kitchen acted as a platform for experimentations in start-up development and for a new entrepreneurial culture ⁸.

⁵ Niemelä S. Essays on regional economic development and innovation ecosystems in the arctic context. Doctoral thesis. Turku School of Economics, Finland, 2018. URL: <https://www.utupub.fi/handle/10024/145045> (accessed 20 September 2020).

⁶ the City of Oulu, University of Oulu (UO), Oulu University of Applied Sciences (OUAS), Oulu University Hospital, Technological Research Centre of Finland Ltd (VTT), Technopolis plc, and since 2016 Oulu Region Joint Authority for Education (OSEKK) and Natural Resources Institute Finland (Luke)

⁷ Iloranta E., Isokangas, J., Niemelä, S. Suomalaisten korkeakoulujen inkubaattoriverkosto – yhdessä kohti yritteliäämpää yhteiskuntaa. Entrepreneurship Education Conference Articles. Ed. by K. Peltonen, H. Laakso, P. Kuru, L. Oksanen. LUT Scientific and Expertise Publications – Research reports 84, 2018. URL: <https://lutpub.lut.fi/handle/10024/158942> (accessed 20 September 2020).

⁸ Isokangas J., Kosonen K., Niemelä S., Savela T. Oulun ammattikorkeakoulu yrittäjyyskasvattajana. Oulun alueen ja Pohjois-Suomen kehitystä tuetaan monipuolisella tutkimus-, kehitys- ja innovaatiotyöllä. Ed. M. Paldanius. ePooki. Oulun ammattikorkeakoulun tutkimus- ja kehitystyön julkaisut 89. Oulu, Finland, 2018. URL: <http://urn.fi/urn:nbn:fi:fe2019102534867> (accessed 20 September 2020).

Due to these significant changes in local economy, decision makers decided to renew the concept of OIA for the second stage that started in 2016. At the core of OIA's second stage are innovation ecosystems, and the main operational principle is to embed the majority of activities and, hence, the direct operational costs to member organizations as part of their normal operations. In the formulation of the strategic spearheads and goals for the second stage of OIA, the rising number of start-up companies and growing interest in entrepreneurship activities steered focus more on commercialization and business development and less on the basic research. The second stage of OIA, running until the end of 2020, is oriented towards agile experimentations aimed at improving and accelerating innovation and commercialization. These foci reflect the joint understanding of member organizations that the regional development is eventually dependent on the success of companies in markets. In practice, the second stage of OIA has generated new services and concepts. One example from HEIs actions is the University Innovation Centre. It was established in 2019 to serve both universities and RDI communities in innovations, commercialization and company collaboration, following the example of Business Kitchen in seamless cooperation. [24, Hintsala H., Niemelä S., Tervonen P. ⁹].

Company collaboration, knowledge and development services

The role of regional public sector actors continuously changes according to the prevailing regional policy. As different publicly funded projects have been dominating in applying regional policy, the public sector has been focusing on its activities accordingly. For example, the key activities have used to focus on cost-benefit analyses of proposed projects, ex ante comparisons of different alternative projects, and ex post assessment of the effectivity of executed projects. However, as concepts such as innovation ecosystems have been introduced to the practical framework of regional development, the public actors have adapted new tasks, such as the continuous updating of a complex picture of the regional system, input-output analysis on system's level and administration of composition of heterogeneous projects and activities instead of singular projects. In the Oulu region, this shift in the role of public sector is particularly evident due to the determined desire to develop the regional innovation system.

In this analysis, as the main focus is on BusinessOulu and two higher education institutions of the region and especially on their roles in generating and diffusing knowledge, a simple, yet robust classification of activities is applied. The rather exhaustive list of different procedures and activities can be summarized under three headlines: company collaboration, business development and competence development. However, it should be noted that the examples given are not exe-

⁹ Isokangas J., Kosonen K., Niemelä S., Savela T. Oulun ammattikorkeakoulu yrittäjyyskasvattajana. Oulun alueen ja Pohjois-Suomen kehitystä tuetaan monipuolisella tutkimus-, kehitys- ja innovaatiotyöllä. Ed. M. Paldanius. ePooki. Oulun ammattikorkeakoulun tutkimus- ja kehitystyön julkaisut 89. Oulu, Finland, 2018. URL: <http://urn.fi/urn:nbn:fi-fe2019102534867> (accessed 20 September 2020); Niemelä S. Essays on regional economic development and innovation ecosystems in the arctic context. Doctoral thesis. Turku School of Economics, Finland, 2018. URL: <https://www.utupub.fi/handle/10024/145045> (accessed 20 September 2020).

cuted to the same extent. Classification of services, platforms and collaboration models is shown in Table 1.

Table 1

Services, platforms and collaboration models

		Examples
Company collaboration	Mapping RDI-needs and conducting projects	Designing of and applying funding for joint RDI projects
	Themed business events and meetings	Events and meetings with public and private parties to discuss ideas, share information, peer-to-peer experiences, workshops
	Guided collaboration of business networks	Introducing, building, incubating and coordinating themed clusters/alliances
	Joint marketing and visibility measures	Collaboration with local businesses in local, national and international marketing and communication
	Strategic partnerships	Tailored strategic partnership agreements between public organization and a company
Business Development	Services for companies (commercialization process, internationalization, growth, financing)	Test labs, piloting and prototyping services, platforms and data, consulting and advisory services in business modeling, business incubators and accelerators, assistance in funding
	Assessing the idea flow	Events, competitions and services to harvest and assess emerging ideas
Competence development	Training, educational programs, continuous learning	Entrepreneurial and innovation-related training
	Human resources: talent attraction and acquisition	Identifying the needs of the companies, collaboration between educational organizations and companies, establishing hubs or centers for talent mobility in regional, national and international level

One dominant form of company collaboration in the region has been joint RDI projects, as well as organizing events based on different themes. HEIs have a more emphasized role in joint RDI projects, and BusinessOulu in other company collaboration activities. A few more recent forms of collaboration are strategic partnerships (e.g. between university and individual company) and coordination of company networks. Functional company networks are very important in the RIS — how different companies are connected and how knowledge and resources flow between them, horizontally and vertically. It cannot be clearly concluded from the documentation which level activities have been more dominant. Especially in the northern regions, the economy is usually based on natural resources¹⁰ and large industrial companies, and SMEs evolved in their value chains. Based on this, it is not surprising that a lot of emphasis in the Oulu region has been laid on generating talent, knowledge and innovation in order to enable economic growth in dominant industrial sectors. In 2018 and 2019, efforts seem to aim to increase the support of company-based ecosystems and how the public sector can support this development in the future. One activity has been the company clusters and networks enhancing the intersectoral and interdisciplinary col-

¹⁰ Middleton A., Hersinger A., Bryksenkov A., Mineev A., Dybtsyna E., Bullvåg E., Simonen J., Pesämaa O., Dahlin P., Ovesen S. Business Index North 2019: People, Business and Development conditions. URL: <https://businessindexnorth.com/reports/?Article=70> (accessed 20 September 2020).

laboration in specific themes to make sure that the most relevant knowledge can be applied and commercialized. The public sector actors see this as a collaboration model in which the companies are more involved and active. However, the role of the public sector in enhancing or coordinating these activities is not yet systematic and fully defined, and the models seem to be still developing.

Business development mainly means different services providing support for commercialization, internationalization, finding funding, and growth. BusinessOulu can be seen to be one of the key actors in this category, as it is responsible for the business development of the municipality. However, e.g. assessing the emerging ideas are many times joint actions between various public and private actors. Investigation of documentation reveals that traditional business incubators or accelerators have not been in the core activities of the public sector in the Oulu region, but for example, private companies have also been fulfilling this task (e.g. Kielo Growth Ltd).

One important development area in innovation collaboration is competence development. The most common forms are internships and the thesis work of students, entrepreneurial and innovation-related training, and joint forums for universities and companies for curricula development to better meet the needs of companies. During the past few years, for example continuous learning has been more highlighted to respond to the educational and training needs arising from changes in the working life and to better match the needs of companies and the society as a whole.

In the analyzed documentation, activities of different sized companies are not usually described in detail. In general, SMEs are seen as working with large companies and knowledge generation organizations. The so-called leading companies have international experience, bigger size and market position to enhance associated SMEs to grow and internationalize. SMEs on the other hand are more agile and open-minded, which can help large companies to boost their growth. Through collaboration, knowledge generating institutions have the opportunity to test and apply knowledge in real conditions, but also to find new areas to apply the research in. One informant described that this can be a more precise description of the process industry dynamics, where there are a few large companies and many of the small companies are dependent on them. However, in some of the new emerging sectors, there are many small companies and the logic of business operations is different.

In the OIA material from 2019, one of the main challenges in company collaboration is identified to be the passivity of the companies. By this, the actors refer to findings such as, for example, local branch offices of large companies not being active, some companies resorting to in-house RDI development, there not being defined models of co-creation between actors, and companies not being proactive to pursuit new collaboration. On the other hand, it is identified that the public organizations should be more active in marketing their services and delivering those services to companies.

According to analyzed documentation, different sectors are more highlighted in the innovation collaboration at the strategic level — and these sectors reflect the Smart Specialization

themes of the region¹¹. Different sectors are noticed and there are different collaboration models in different sectors. However, the same OIA metrics are used in all of the identified sectors and the metrics used in evaluating the success of the innovation collaboration are mainly focused on the quantity of companies participating in different activities instead of the heterogeneity of participating companies. However, new value chains and success stories have been recently added to OIA metrics. It is worth noticing, like one of the informants highlighted, that there are some sectors, such as construction, that are important in the regional economic development, but do not have great visibility in these innovation development activities.

From HEI perspective, the enhancement of cooperation between university and business has been taken forward in the form of the recently established University Innovation Centre (UIC), by the appointment and actions of the vice rector for cooperation at the University of Oulu, and by the increasing number of strategic partnerships which are developed into more systematic direction regarding the goals and actual activities. Oulu University of Applied Sciences is, by definition, more practical in its innovation activities and especially in company collaboration. The University of Oulu, on the other hand, has a long tradition in academic research and education, but is constantly focusing more on the commercialization of new ideas being developed in the academia and joint RDI projects. The business development activities of HEIs seem to be in the designing stage — clearly, there are desires to increase the role of universities in business development, but exact procedures and operational models are yet to be defined. Motivation for increasing activities in business development can be seen to differ from the more traditional university-industry collaboration [7, Ankrah S., Omar A.T., p. 392].

Identified challenges and development prospects

Collaboration has mainly involved joint RDI-project activities, but especially during the past few years the focus has been moving towards the coordination of larger and more versatile entities of activities, and it seems there is need and desire to develop this type of coordination further. Analyzing the Oulu City Business Development Plan 2019¹² reveals some of the main drivers, thematic areas, and activities related to collaboration with HEIs and companies. The synthesis of the aforementioned findings is presented in Figure 2.

As seen in Figure 2, it seems to highlight, among other, the role of digital solutions and platforms, competence development, and supporting company clusters. Overall, these elements also reflect the national policy development, for example Reform of continuous learning in HEIs¹³

¹¹ Focus areas of the Oulu Region's smart specialization: ICT and software sector, including integration with businesses in different fields, Basic industry's value chains: metal industries, refinement of timber raw material, Clean technologies, including energy, Healthcare and wellness technology.

¹² Over 150 external experts from companies, non-profit organizations, Ministry of Economic Affairs and Employment and education institutions participated for the ideation and preparation of the Oulu City Business Development Plan (2019) for the years 2019-2026.

¹³ Ministry of Education and Culture (Minedu). Reform of continuous learning. URL: <https://minedu.fi/en/project?tunnus=OKM033:00/2019> (accessed 22 May 2020).

and sustainable urban development¹⁴. These drivers and thematic areas can mainly be seen to reflect the general global and EU-level trends, and the northern regional context related themes are not emphasized.

Combining information from the Oulu City Business Development Plan with HEIs strategic perspectives, some examples of the identified challenges and development prospects in overall system development, company collaboration, business development, and competence development can be identified. These emerging challenges and development prospects can be embedded in the research framework described earlier in this article (Fig. 3).

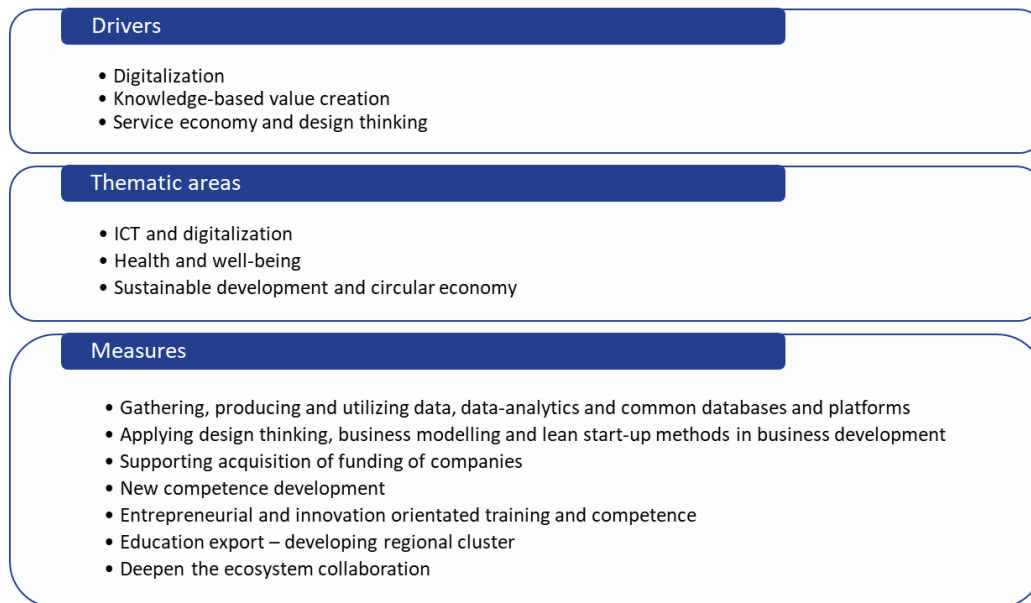


Fig. 2. Some of the main drivers, thematic areas and activities in Oulu City Business Development Plan 2019.

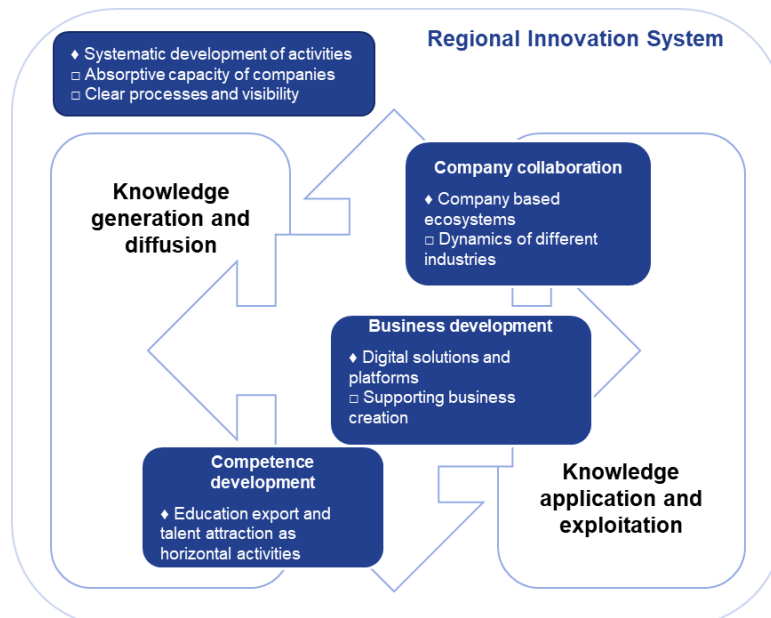


Fig. 3. Development prospects (◆) and identified challenges (□) in Oulu region innovation collaboration.

¹⁴ Ministry of Economic Affairs and Employment (TEM). Innovaatiotoimintaa vahvistavat sopimukset solmitaan kaupunkien kanssa [Agreements to boost innovation to be concluded with cities]. URL: https://tem.fi/artikkeli/-/asset_publisher/innovaatiotoimintaa-vahvistavat-sopimukset-solmitaan-kaupunkien-kanssa (accessed 25 May 2020).

Especially the main public sector actors are involved in innovation system activities, but relationships between the actors are not systematically developed. Since innovation collaboration is public sector driven, private sector actors and their variety is not considered fully in the systematic development and resourcing of the activities. In general, as one of the informants pointed out, common development aims and commitment is important, but, additionally, it is essential to have very concrete goals that can be executed in practice. The material and especially informant discussions highlighted that clear processes and actors' knowledge of them is important. For example, if a person has an idea for commercialization, there should be understanding on how to enhance this idea leading possibly to the commercialization phase. The material in general suggests that the system needs to be agile for new openings and ideas, and have piloting and testing facilities and resources for joint usage.

Based on the primary material and informant discussions, it can be interpreted that company collaboration should be based on the potential of collaboration with new partners rather than only focusing on the existing collaborative actions and partners. This means, first of all, to define the business basis of the region and its potential, and, secondly, to analyze how the horizontal competence like digitalization is related to different sectors (e.g. health, metal industry). Additionally, interaction and working models and the needs are different in different industry sectors and companies. Relevant actors should be identified according to their needs e.g. in the strategic development of the industry, piloting and commercialization. As noted before, based on the analyzed material, company-based ecosystems seem to be the future orientation of the company collaboration in the Oulu region. This can be seen as a shift from the situation where supporting start-up firms and re-training of unemployed people were the key measures of the region [25, Simonen J., Herala J., Svento R., p. 2]. In the company-based ecosystems, the role of the public sector can be a collective one, bringing the actors together, helping in configuring the joint product or service packages, and enhancing the knowledge of the services provided by the public sector.

In literature, absorptive capacity is highlighted as an important factor in defining the success of the innovation performance [26, Lau A. K., Lo W.]. In the Oulu region, more attention should be paid on networking and learning and on intensifying the utilization of knowledge in business development and innovation, especially with actors who are further away from actions and strategic decision-making. In practice, as one informant noted, a public sector actor can, with practical benchmarks and examples, concretize different collaboration models to a potential company to help the company to perceive the value of external knowledge in developing practices and innovation processes of a company. Especially from the point of view of SMEs, the practical implications are more effective than strategic, high-level statements.

A developing regional cluster for education export and putting more effort into competence development and continuous learning have been in more focus for the innovation network development for the past few years. One element is also talent attraction, to make sure that the

region is getting the best talent from abroad, and making sure that the education institutions are providing education to better match the competence sought by the employers, especially related to the high-tech industry. These activities have mainly involved HEIs, but in recent years this has been increasingly focused on the city business development (BusinessOulu). It could also be analyzed from the material that the talent attraction and education export are becoming more horizontal activities, rather than individual competence development activities.

Conclusion

This study aimed at deepening the understanding of the heterogeneous roles that public actors play in improving knowledge application by companies and in innovative system development in the Oulu region. The focus of this study was on the public sector perspective, and the material used for this paper consisted of primary material of OIA and secondary of two informants.

This study pointed out the main drivers and conditions of regional innovation system development in Oulu. National-level drivers are important in the regional level. National policy and its relation to innovations, as well as different funding mechanisms to the public and private sector activities affect regional decision-making. In the Oulu region, because of the structural changes in the regional economy, the decision has been made to invest in the innovation and network-driven development, including strategic agreement in public sector actors to unite and jointly boost the developing sectors and companies in the area. Public actors have also gone through organizational changes, partially due to these national and regional drivers, but they have also made new strategic choices in education, which have their influence on the innovation activities in the region. The northern or Arctic context is not represented clearly in the research data, even though it obviously affects the practicalities of the SME companies. Analyzing this contradiction was not a particularly essential aspect of this study, but it deserves attention in future studies.

Based on the material, the services, tools and collaboration models that are incorporated by the three public sector actors analyzed in this study can be roughly divided into three categories: company collaboration, business development and competence development. Some of the identified activities are already executed at operational level, but some are still in the early stage of development. However, it is noted that the aforementioned drivers and conditions continuously affect the strategic choices and practical activities done in the Oulu region, which seems to lead to a certain consistency in regional decision-making.

The identified challenges and future prospects of innovation system collaboration can also be analyzed through three identified categories. Some practical examples refer to the building and development of company clusters, the role of digital solutions and platforms in business development, and education export and talent attraction as horizontal activities. However, at the level of innovation system, more emphasis should be laid on themes such as the systematic development of innovation collaboration, the absorptive capacity of companies, and variety of needs for external knowledge and services depending on the industry and company-wise differences.

In the studied region, there has been a long tradition of collaboration between public and private sector in innovation to increase regional growth. There are no signs of collaboration diminishing, but there are indicators showing the changing orientation of the activities. Company-based ecosystems seem to be the future orientation of the collaboration. However, as Autio E. states, there is a difference in supporting horizontal and vertical networking at the knowledge application level [19, Autio E., p. 134], and this should be noted in policy intervention and planning future activities. What company network orientation means for joint business development activities, and for the role of the public sector in general, remains to be seen. Additionally, there seems to be desire to invest in business development instead of business creation, but this finding would require more in-depth analysis. Overall, the practical aim of this paper is to contribute to improving the future performance of RIS in Oulu.

Different RIS have different configurations and there is no all-purpose, “one-size-fits-all” RIS model to apply. Tailored innovation policies addressing specific innovation barriers in different types of regions seem to be necessary [13, Tödtling F., Trippel M., p. 1204]. The Oulu region has its own resources, capabilities, industrial contexts and innovation actions, but what could be taken into consideration in other regions as well is investigating the innovation actors, their interaction and innovation processes in the region more closely. For further research, as the number of SMEs is high and they are generating a lot of regional growth, it would be beneficial to further analyze how SMEs access knowledge and apply it, and what the roles of RIS and external elements are. Additionally, it would be beneficial to develop and test different tools aimed at measuring innovation performance at the system level instead of the traditional input-output analysis of singular projects and activities.

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