

Key aspects of establishing research, knowledge, and innovation-based hubs as part of the local innovation ecosystem

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The purpose of this research is to increase the understanding of the principles of forming different types of hubs as spaces for collaborative R&D and innovation. This article offers valuable new knowledge regarding the establishment of hubs as part of the local innovation ecosystem. The paper will, through a qualitative multiple case study, shed light on the research issue of the establishment of hubs through an analysis of empirical data collected from three different types of hubs: a research hub, knowledge hub, and innovation hub. As a result, we introduce new building blocks of hubs to support managers and practitioners in forming collaborative hub structures.

1. Introduction

Digital transformation, accelerated by the Covid-19 pandemic (Wade and Shan, 2020), has brought unprecedented challenges to, for example, companies of varied sizes, as many of them lack knowledge regarding modern technologies. Undoubtedly, there are major differences in the levels of digitisation within European businesses. Too often, new digital solutions remain available to a few active players only, while citizens, users and employees lack the necessary skills to adapt to the technological changes (see Casorati and Verbeek, 2020). This emerging challenge was acknowledged by the European Commission (EC) which, in 2016, initiated working groups focusing

on digitising the European industry through Digital Innovation Hubs (DIHs) as means of supporting companies in their digital transformation (EU, 2020). The EC defines DIHs as *one-stop shops that help companies make their business, products, or services more competitive using digital technologies* (Butter et al., 2020). In regards of companies' digitally mediated business and production processes, products, and services, DIHs provide access to technical expertise and experimentation, allowing companies to test their solutions before entering the markets. They also provide innovation services, financial advice, and training needed for a successful digital transformation (Kalpaka et al., 2020). Hence, DIHs focus on supporting small and medium-sized enterprises

(SMEs) in their digitalisation in different industrial sectors (Mörner et al., 2019; EU, 2020, Sassanelli and Terzi, 2022).

SMEs have an urgent need to deploy novel digital technologies, such as Artificial Intelligence (AI), data analytics, 5G, blockchain, Virtual Reality (VR), and Augmented Reality (AR) to ease the negative consequences of the Covid-19. In the post-pandemic era, the digital uptake has further expanded, making societies and economies in need of policy initiatives that will help them accelerate their digital capacities needed for overcoming the negative economic consequences brought by Covid-19. Therefore, SMEs need to introduce innovative ways of working, new business models and more innovative products. DIHs can assist SMEs to take advantage of digital technologies and skills, which are powerful tools for policymaking that seeks to find ways to support economic recovery (Casorati and Verbeek, 2020; EU, 2020; Kalpaka et al., 2020). Findings from a recent study of regional digital innovation hubs by Hervás-Oliver et al. (2021) suggest that DIHs promote place-based collaboration alliances that respond to the regional contextual specificities and demands. DIHs are widely agreed as a strategic base for supporting the digitisation of the European industry, but they still lack funding, as well as systematic, European-level framework for monitoring their support actions (EU, 2020; Sassanelli and Terzi, 2022).

To address the challenge regarding the use and deployment of new digital technologies, the network of European Digital Innovation Hubs (EDIHs), was formed as part of the EU's new Digital Europe Programme. The programme provides funding and monitoring criteria for making EDIHs more sustainable and vital (EC, 2021). EDIHs function as service points that enhance the digitalisation of SMEs. The idea of EDIHs is to involve different kinds of organisations to make the digital transformation generate a higher degree of sustainable growth. While DIHs are based on self-declarations of their organisations, EDIHs are designated by their country as candidate EDIHs, a process which involves submitting proposals to EU calls and being evaluated above threshold (EC, 2021). Finland is an important actor in the Digital Europe Programme through the four selected EDIHs (TEM, 2022a). In Finland, the level of digitalisation and competence to help others is high: Finland was ranked first in the European Union's digital performance comparison in 2022 (TEM, 2022b). Moreover, the vision of the Research and Innovation Council of Finland is that the country will be "the most competent and attractive innovation and experimental environment

in 2030." To achieve this vision, the emergence of strong world-class innovation ecosystems is supported in areas where Finland has strong expertise and abilities needed for succeeding in international competition.

According to Moore's (1993) definition, innovation ecosystem refers to a loosely interconnected network of companies and entities that coevolve capabilities around a shared set of technologies, knowledge, or skills, and in cooperation develop new products and services. The Finnish government has outlined actions, such as ecosystem agreements, to promote technological development, innovative acquisitions, and a culture of experimentation. These agreements between the government and cities aim to strengthen the construction of attractive centers of expertise and innovation environments, as well as the connection of Finnish operators to international R&D, networks, and value chains. According to the Finnish Ministry of Economic Affairs and Employment (TEM, 2020:20), the emergence of innovation ecosystems has, alongside traditional approaches, highlighted the need for new development practices that serve knowledge, the commercialisation of research outcome, and technology transfer. The establishment of hubs will play significant role in the ongoing social and healthcare reform alongside the process of updating the Finnish health technology growth strategy (2030). In the past, ministry-led programs and established competence centres have not had operational framework and tools to manage collaboration.

At the regional level, the goals and activities of innovation ecosystems are aligned with the national and regional digitalisation strategies, for example the Smart specialisation strategy, promoted by the European Commission (Rissola and Sörvik, 2018). The local innovation ecosystems where innovation hubs operate are complex and dynamic systems enabling innovation. Hoffecker (2019) defines them as "place-based communities of interacting actors engaged in producing innovation and supporting processes of innovation, along with the infrastructure, resources, and enabling environment that allow them to create, adopt, and spread more effective ways of doing things. (p. 4)" Local innovation ecosystems are characterised by an array of interacting actors, resources, relationships, and conditions that work together to either enable or impede innovation. Due to their collaborative nature, innovation ecosystems allow stakeholders to create value that no single firm could create alone (Hoffecker, 2019; Granstrand and Holgersson, 2020).

Prior research states that empirical case studies regarding innovation ecosystems are needed, and that research should focus on the key elements and

success factors of hubs to help design and manage local innovation ecosystems (see Viitanen, 2016). Therefore, the overall purpose of this research is to increase the understanding of the principles forming different types of hubs as part of the local innovation ecosystem and as spaces for collaborative R&D and innovation. The research issue will be explored through data collection from three different types of existing case hubs: a research hub, a knowledge hub, and an innovation hub. The case hubs are named after their key functions: the innovation hub provides services to accelerate innovation, the knowledge hub supports building competences of the innovation ecosystem actors, and the research hub builds scientific knowledge base for new innovations. Thus, the more specific research question is: *what are the key aspects in establishing research, knowledge, and innovation-based hubs as part of the local innovation ecosystem?* In particular, this study seeks answers to the following sub research questions: *what is the need for the hub in a certain innovation ecosystem; what is the vision of the hub, and to whom does it provide value to; what is the added value of the hub; who are the key players and strategic partners; what are the main functions of the research-based, knowledge-based, and innovation-based hubs; and how are the operations managed and facilitated in these types of hubs to foster innovation and co-creation in the innovation ecosystems?*

As this research area is rather new, empirical research conducted in the environments is needed to gain a deeper understanding of the elements, logic, and dynamics behind innovation hubs. In our study, we conducted empirical research in a local innovation ecosystem, where the three different types of hubs were established. The case hubs were at various stages of development, from early-stage hubs to fully operational hubs. This paper presents the research findings regarding the establishment of three different types of hubs to foster innovation and co-creation in a local innovation ecosystem. We further aim to show how the DIH model can

enhance the prerequisites of innovation activities in the local ecosystem.

2. Research approach

The research process showed in this paper follows the qualitative multistage case study research process originally presented by Eisenhardt (1989). The case study method enables the achievement of a deep understanding of a specific phenomenon and is particularly suitable for the exploration of a new or unique phenomenon (Eisenhardt, 1989; Yin, 2005). The case selection is guided by the principles of maximising learning (Stake, 1995) and providing rich information (Perry, 1998).

According to Viitanen (2016), the local innovation ecosystem case studies should be conducted in compliance with qualitative research approaches and multiple case study methods to address the complex nature of the investigated phenomenon. This research also entails action research and explorative elements, as it proceeds simultaneously with establishing fully functional hubs with strong networks and a clear operating model. Experimenting with the operating models and services provided by the hubs results in final, tested and verified practices, which enhance the reliability of the findings. The research process depicted in Figure 1 shows the progress of this research, which began by the identification and crystallisation of the research problem and was followed by a state-of-the-art study and literature review of the relevant themes. Data collection was conducted simultaneously with the establishment of the three case hubs, and the data were analysed within a transdisciplinary research team, which also strengthens the interpretation and reliability of the findings.

Workshops, which were the main data collection instruments, were organised for different stakeholder groups, and complemented with stakeholder interviews, as well as a desk study based on publicly available information (Table 1). First, 11 separate workshops with 109 participants were organised and

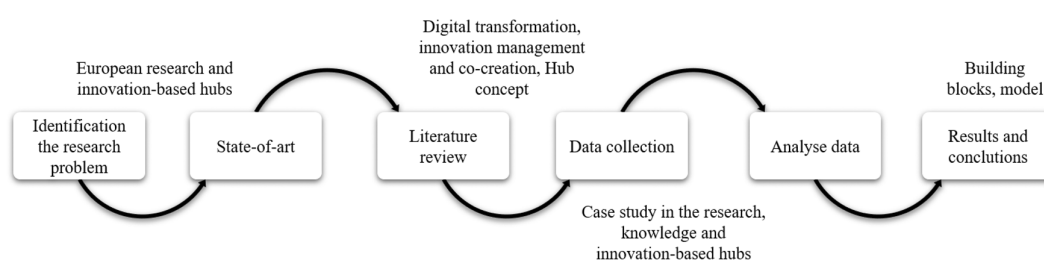


Figure 1. The research process.

Table 1. The research data

| Instrument | Type of data | Schedule | Participants (n) | Source of information |
|---|---|--|------------------|---|
| Workshops for companies (2) | Qualitative data from workshop interaction | Spring 2018 | 40 | Health tech companies: CEOs, Development directors and managers, experts |
| Workshops for researchers (5) | Qualitative workshop data (group work, notes) | Winter 2018/2019, Autumn 2019, Spring 2020 | 35 | Management, researchers |
| Workshops for health and well-being professionals (4) | Qualitative data from workshop interaction | Autumn 2019 | 34 | Health and Well-being development: Directors, Development managers and experts, researchers |
| Informal interviews | Qualitative workshop data | Spring 2019 | 9 | Health tech companies: CEO, experts Hub key personnel: Hub managers, development managers and experts |
| Group interview | Qualitative data (Written-down notes) | Autumn 2019 | 7 | Healthcare providers: Decision makers, doctors, development managers and experts |
| Semi-structured interviews | Qualitative data (Written-down notes) | Spring 2020 | 2 | Network directors |
| Desk study | Publicly available information | Autumn 2018, updated spring 2019 | 32 | Hub web pages and materials |
| Informal interview | Qualitative data (Written-down notes) | Spring 2021 | 2 | Hub manager, Ecosystem manager |
| Desk study | Reports | Autumn 2020 Spring 2021 Spring 2022 | 4 | Case knowledge hub project reports and steering group materials Region's economic growth statistics Additional funding for Hub operations |

facilitated for different stakeholder groups. The aim of the workshops was to unveil the stakeholders' needs and expectations for hub operations. Secondly, the workshop data was complemented with stakeholder interviews to gather more in-depth insights from the case hubs' key personnel and customers. Lastly, two desk studies were conducted. In the first one, 32 national and international hubs were explored to collect background information about general hub elements and operations. In the second desk study, reports from the case knowledge hub project, steering group materials and the region's economic growth statistics were studied.

The data were then analysed using thematic analysis and categorisation techniques. Triangulation (Denzin, 1973) was applied as the analysis was conducted by multiple researchers to ensure the appropriate interpretation of the data. In the end, the research data was all together complemented with information about public funding directed for hub-based operations.

Our study focused on the Oulu region in Northern Europe, where the framework for establishing research, knowledge and innovation-based hubs was enabled through the necessary strategic, political, and financial elements of the local innovation ecosystem. Already in the beginning of 2000s, the region was nationally recognised for the intensive collaboration between companies, the public sector and universities based on the Triple-Helix model introduced by Etzkowitz and Leydesdorff (1998). Triple Helix model refers to an innovation model, in which academia, the government and industry collaborate to create and discover new knowledge, technology, products, and services (Etzkowitz and Leydesdorff, 1998). Furthermore, the City of Oulu aimed to focus on the development of innovation environments to expedite the growth of businesses in the region. Consequently, innovation intermediaries were established to support the region in further utilising the existing infrastructures and networks for co-creation. The aim was to connect companies, service providers and developers as well as citizens, to innovate and develop products and services together (Haukipuro, 2019). Also, a long-term regional strategic partnership Oulu Innovation Alliance (OIA)¹ between the city, research institutes and other significant regional organisations, aimed to promote the region as an innovation hub and conduct research and development work in several innovation centers. Companies and citizens, among other actors, have been actively involved in the local innovation ecosystem activities. Hence, this research applies a multi-partner model, in which different actors are committed to the development of joint innovation

activities. As part of the local innovation ecosystem, the three explored hubs, a research hub, a knowledge hub, and an innovation hub aimed to bring together different actors to accelerate the development and commercialisation of innovations.

The case research hub builds multidisciplinary scientific knowledge base by forming a community of researchers and producing a diverse research base for new innovations. The case knowledge hub increases expertise, competences, and know-how of the local innovation ecosystem actors in rapidly evolving health and well-being digitalisation. The case innovation hub helps local health technology companies make their businesses, products, and services more competitive by providing co-creation and business development services. Although the case hubs differ from each other, together they accelerate the emergence and commercialisation of innovations in the local innovation ecosystem. Figure 2 depicts the role of the hubs and their actors (for example health and social care providers, health technology companies, research institutions and education) as parts of the local innovation ecosystem. This aligns with the local innovation ecosystem model presented by Hoffecker (2019), as similar elements can be recognised in the local innovation ecosystem, which in turn forms the operating environment for the three case hubs (Figure 2).

3. Theoretical background

The theoretical background of this research has its roots in innovation management and Open Innovation (OI) research (Chesbrough, 2003), which encompasses the perspective of the innovation ecosystem (Adner and Kapoor, 2010; Remneland Wikhamn and Styhre, 2022), collaborative innovation (Greer and Lei, 2012; Heil and Bornemann, 2018), and hubs as *spaces* that enable collaborative R&D and innovation and knowledge creation (Peschl and Fundneider, 2012; Doloreux et al., 2023). In innovation management literature, the terms "space" and "place" are often used to refer to different types of environments supporting or facilitating innovation; both provide opportunities for interaction, collaboration, resources, and knowledge. The concept of space (Tuan, 1979) is further elaborated e.g., by Liu and Grey (2018), who define space as "not static but a socially constructed and fluid entity subject to change over time". Furthermore, innovation hubs can be viewed as "built-up physical spaces" enabling innovation (see e.g., Jiménez and Zheng, 2021) but they can also be virtual spaces. This study views hubs as a collaborative innovation space (CIS) or intermediary

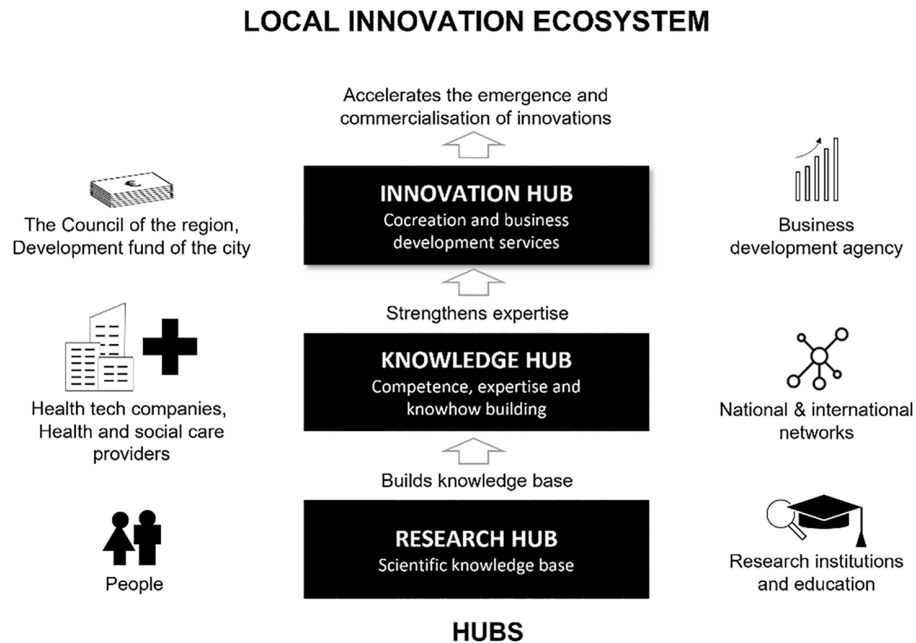


Figure 2. The case hubs as part of the local innovation ecosystem.

facilitating innovation processes between multiple stakeholders (see Leminen et al., 2020; Doloreux et al., 2023).

The main function of multi-stakeholder innovation ecosystems and innovation hubs as part of them, is to foster innovation and co-creation. Therefore, research regarding collaborative R&D and innovation stemming from the OI concept (Chesbrough, 2003) and OI in SMEs (Brunswick and Vanhaverbeke, 2015; Chesbrough and Vanhaverbeke, 2018; Vanhaverbeke et al., 2018) act as a broader background for this study. Value creation and value capture are also emphasised in the OI, as innovation-based value creation for target customers is one of the fundamental notions of the theory (Chesbrough, 2003). Moreover, innovation hubs as part of the local innovation ecosystem (Hoffecker, 2019; Remneland Wikhamn and Styhre, 2022) involve multiple actors around a certain theme, thus embracing the concept of co-creation and value co-creation (e.g., Sanders and Stappers, 2008; Vargo et al., 2008), and value creation and capture in innovation ecosystems (Adner and Kapoor, 2010; Ritala et al., 2013). The innovation hub concept, establishment, and its innovation mechanisms have raised growing interest across different fields (Youtie and Shapira, 2008; Siebert et al., 2019; Butter et al., 2020; Sassanelli et al., 2020; Hervas-Oliver et al., 2021; Remneland Wikhamn and Styhre, 2022). Innovation hubs aim to pull together public sector actors, research organisations and local industry operations to support digital transformation through multi-partner cooperation, expertise, and knowledge sharing.

Open innovation (OI) refers to innovation in which a company's outside innovation sources are taken advantage of. It also refers to the use of inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation (Chesbrough, 2003). However, OI is perceived as a broad concept with slightly varying definitions. For the past decade, the OI concept has gained popularity within scholars, practitioners, and policymakers increasingly, and prior research shows that SMEs can significantly benefit from effectively adopting OI practices (see Vanhaverbeke et al., 2018). Although OI strategies are adopted in SMEs more easily, a universal OI practice in SMEs does not exist (Vanhaverbeke et al., 2018). The innovation ecosystem concept, which refers to a network of companies and other entities (Moore, 1993), is closely related to the OI concept, as the outside innovation sources play a crucial role in the innovation ecosystems (Remneland Wikhamn and Styhre, 2022). In the OI theory, external knowledge is viewed as equal to internal knowledge (Chesbrough, 2003). Local innovation ecosystems consisting of several stakeholders working together to create value (Hoffecker, 2019; Granstrand and Holgersson, 2020), form an operating environment for the different types of innovation intermediaries, for example innovation hubs.

In general, the impact of collaborative R&D initiatives can be viewed regarding a firm's innovation performance and regional innovation ecosystem vitality, for example. However, it is often difficult to show the relationship of the variables in a complex,

multifunctional environment such as an innovation ecosystem. In this light, evaluation of an innovation hub functioning within such an ecosystem often stays at a general level. Spanos et al. (2015) found beneficial effects on projects at firm level in publicly funded collaborative R&D projects, especially when prior innovation expertise existed. According to Hottenrott and Lopes-Bento (2014), the positive impact can be seen in the increase of R&D investment of SMEs, especially in international collaborations. In terms of assessing the impact and significance of innovation ecosystems, the applicable measures are yet to develop, and the current methods lack in their ability to tap into the wider societal impacts (TEM, 2021:29).

Acknowledging the broad theoretical context, the focus of this paper is narrowed down to the hub concept and related innovation ecosystem research (Launonen and Viitanen, 2011; Viitanen, 2016; Siebert et al., 2019; Hoffecker, 2019; Crupi et al., 2020; Butter et al., 2020; Remneland Wikhamn and Styhre, 2022), through a focused viewpoint of the DIH models (EC, 2017; Casorati and Verbeek, 2020; Kalpaka et al., 2020), which, in turn, forms a framework for establishing the different types of hubs.

3.1. The DIH models

Siebert et al. (2019) define an innovation hub as a collection of physical and digital workspaces and tools in which different community members interact for the purposes of learning about and producing innovation. Digital innovation hubs, on the other hand, have a mission to help companies to better understand and experiment in regards of how digital technologies can improve efficiency and product quality, increasing competitiveness (Kalpaka et al., 2020). Recent research by Crupi et al. (2020) states that DIHs, in addition to being intermediaries, can generate knowledge themselves based on their inner characteristics. Digitising European Industry Working group 1 report (EC, 2017) defined Digital Innovation Hubs as regional one-stop-shop support facilities helping companies become more competitive by digitising their businesses. DIHs improve companies' business and production processes, products, and services by the means of digital technologies. The report (EC, 2017) outlined a guide for establishing Digital Innovation Hubs (Figure 3). The aim of the iterative process, consisting of six steps, is to enable any region to build

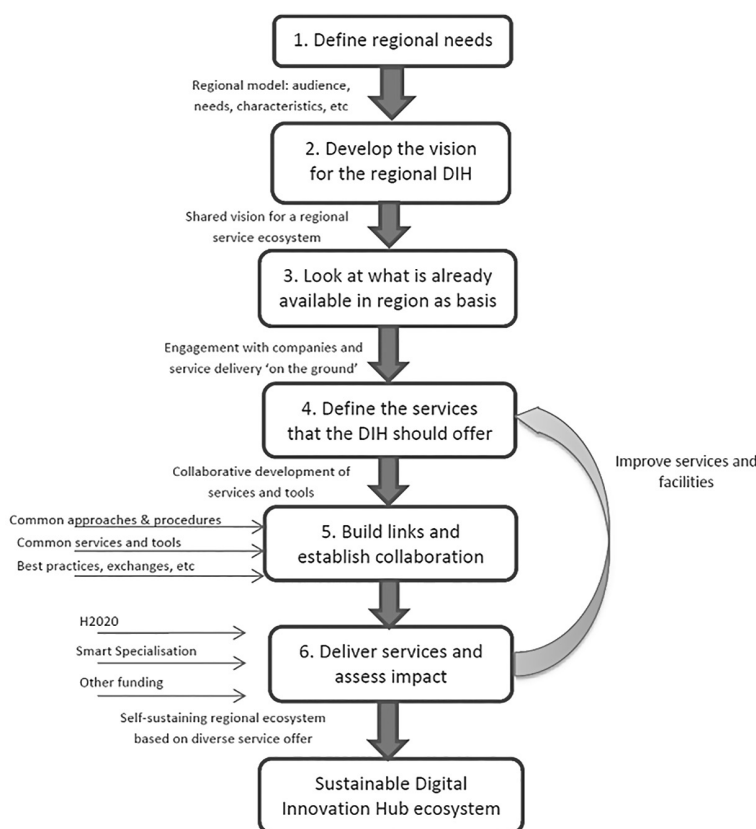


Figure 3. The initial DIH model (Source: EC, 2017).

their own sustainable DIH. The steps of this guide evolve from defining the regional needs and developing the regional vision, to identifying existing services and their gaps, all the way to building links and collaborations as well as delivering the DIH services. Furthermore, the impact assessment is included in the process to iterate and improve services and facilities.

After gaining knowledge about different regional DIHs for a period of two years, the European Commission updated the guidelines for DIHs in the JRC Science for Policy Report (Kalpaka et al., 2020). This practical handbook provides information for policy makers and DIH managers on, for example, how to establish a new DIH or reinforce existing ones. Similar to the earlier Working Group 1 report (EC, 2017), the handbook sees DIHs as one-stop-shops helping companies become more competitive using digital technologies, and as epicentres of local digital innovation ecosystems providing access to services, facilities, and expertise. The services provided by DIHs can focus on, for example, testing before investing, skills and training as well as support for finding investments, innovation ecosystem and networking. The approach for creating a new DIH or reinforcing existing ones, introduced in the handbook (Kalpaka et al., 2020), begins by defining the regional needs and assets, and then builds up through seven steps: (1) preparation phase – pre-study and pilot, (2) vision and business proposition, (3) service definitions, (4) organisational form, (5) business model and financing, (6) national and international partnerships, and (7) monitoring and assessing the impact of an innovation hub (Figure 4).

4. Findings

As a result, the research provides a comprehensive view of establishing research, knowledge, and innovation-based hubs through a practical framework. In particular, empirical evidence was sought to answer the following questions, which were introduced in the beginning of this article: *what is the need for the hub in a certain innovation ecosystem; what is the vision of the hub, and to whom does it provide value to; what is the added value of the hub; who are the key players and strategic partners; what are the main functions of the research-based, knowledge-based, and innovation-based hubs; and how are the operations managed and facilitated in these types of hubs to foster innovation and co-creation in the innovation ecosystems?*

First, we present our findings regarding the establishment of the case *innovation hub*. The region's need to strengthen innovation in the healthcare sector and to create a new partnership model among different actors led to the establishment of the regional Oulu health ecosystem in 2012. This was the driving force for the establishment of the innovation hub as part of the local innovation ecosystem. The Digital Innovation Hub concept, launched by the EC in 2017, had similar characteristics, actions, and aims as the local innovation ecosystem, and this is what guided the establishment of the case innovation hub in 2018. Beforehand, a desk study was conducted to explore the general elements and functions of different hubs for the basis of creating an innovation hub. The main shared elements found by the study were *hub services, types of customers and focus areas*. These general elements were our starting point for building the innovation hub alongside the initial

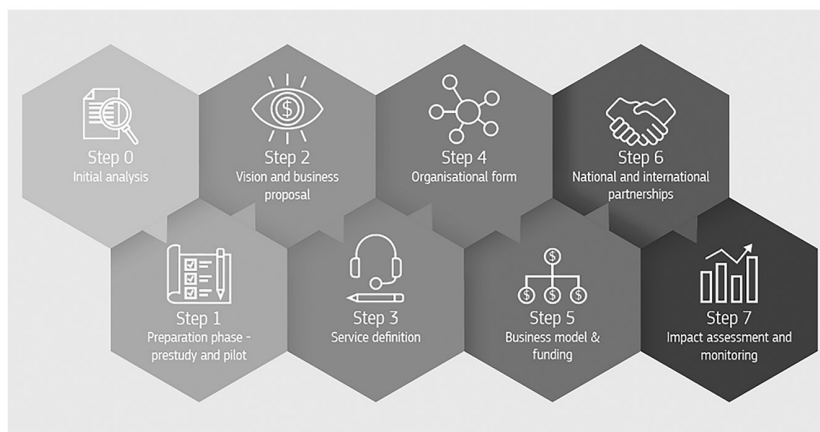


Figure 4. The updated DIH model (Source: Kalpaka et al., 2020).

DIH model as a step-by-step process. The data collected from workshops and interviews, in turn, reinforced the final formation of the case innovation hub. The established innovation hub, based on the collected needs, was designed to provide innovation, development, testing, and digitalisation services to the SMEs and public healthcare providers. For instance, the innovation hub supports companies and healthcare providers in identifying the needs of the healthcare sector and developing ideas into market-ready products and services. The principal idea of the hub is to facilitate open Public-Private-Partnership (PPP) collaboration and innovation to accelerate business growth, promote capacity building, and to foster RDI investments.

Second, we present findings regarding the case *knowledge hub*. The changing conditions of the operating environment, alongside the digital transformation, contributed to the establishment of the knowledge hub; new technologies were changing healthcare by enabling streamlining services, enhancing personal care, and restraining the continuous growth of healthcare costs. The emergence of new technologies has also created opportunities for growth and internationalisation for companies that operate in the field. To redeem the opportunities of new technologies, there was a need to increase the expertise and the capability to utilise and innovate digital technologies. According to Youtie and Shapira (2008), in addition to accumulating and producing knowledge, knowledge hubs also foster knowledge exchange, learning, and innovation through new methods and the development of boundary-spanning activities. To respond to the previously mentioned challenges and opportunities, the case knowledge hub was established during 2018–2020 to accelerate research and innovation actions on digital health and well-being.

In the beginning, the stakeholders' needs, and their expectations of the knowledge hub operations were collected in the workshops and group interviews. For instance, the healthcare providers stated that they would like a hub to provide *easy access to the latest knowledge and information of novel digital technologies and research results*. They felt that the information is currently scattered to many research groups and themes, therefore being difficult to find. The companies' needs, in turn, revolved around the *access to health and well-being data*, as means for development and innovation, and increasing competence regarding new AI and analytics technologies, regulation, assessment methods and impact of digital solutions. The challenge of accessing and using health and wellness data was also brought up by researchers, as well as dealing with upcoming and changing regulations. The workshops with health

and well-being professionals contributed to the definition of the hub focus, role of the different actors and strategic partners.

In the next phase, the hub managers were interviewed to gain in-depth insights into the ways of running a successful hub. They viewed the role of a hub as being both a *catalyst* and a *broker*. According to them, a hub should accelerate the innovation process, contain broad knowledge of the developments and actors within its focus area, and find the right expertise and partners to meet their specific needs. These findings confirmed the need for a network-like approach which brings together various actors and enables the combination of a broad range of expertise.

“A hub should act as a catalyst – like in a chemical reaction: *accelerate the process*.” (Hub Manager 1) “...to be the centre of knowledge. Also, *networker – finding and identifying suitable partners*.” (Hub Manager 2)

The established *knowledge hub*, based on the collected needs, is founded on network-like cooperation. It aims to speed up the adoption of digital innovations and the joint development of knowledge-based services and innovations. Moreover, the knowledge hub combines different kinds of know-how and shares the best practices and expertise, while creating and providing new tools, methods, and guidance to boost knowledge and innovations. It offers functional support for research and innovation in its focus areas: health data practices and competences for data-driven health and well-being innovations. It provides access to the latest knowledge, scientific expertise, easy entries to innovation ecosystems, as well as multi-partner cooperation. The knowledge hub aims to develop the national and international networks and enhance cooperation in identifying and comparing the success factors of digital change.

Lastly, we present our findings regarding the case *research hub*. The idea of the research-based hub arose within the local scientific community to tackle one challenging and prevailing aspect of digitalisation. That is, modern technologies are rapidly developing and becoming more intelligent, invisible, and ubiquitous, while contemporary approaches to technological transformation are narrow, as they take the human-being for granted. These contemporary approaches focus on the developments of ICT, new technological solutions, and applications, as well as the possibility to utilise intelligent technologies to improve business. The research regarding the establishment of the case research-based hub turns this mainstream perspective inside out, claiming that research-based knowledge about the co-evolution

of humans and intelligent technologies is needed. It offers a solution by establishing a multidisciplinary research cluster, which is the case research-based hub explored in this paper. The mission of the case research hub is to identify and describe practices, processes and strategies that fortify human capabilities, create knowledge about the features of changing work-life that are still unknown, strengthen intelligent behaviour of individuals, communities, and ecosystems, and renew research methods in human sciences to respond to the current challenges. World-class research will be at the center of the hub operations, and the research outcomes will be communicated to the stakeholders, such as companies, as these findings may steer the human-centric development of technologies, products, services, and solutions.

To clarify the aim of the research hub, the needs and expectations of the core scientific community were collected in a workshop and further discussions. The outcome of the workshop strengthened the thought that *researchers are the most important actors* of the hub. The aim of the hub was outlined as establishing new high-quality scientific knowledge, collaboration, and co-creation in the local innovation ecosystem. The building of the research hub is ongoing, starting from broadening the scientific community by targeted recruitment and activities, to identifying relevant researchers in the field. The identification of researchers is needed, because the research hub needs to engage a broad enough multidisciplinary community in order to be fully functional. These initial findings supported the importance of *building the community*.

4.1. The building blocks

Due to the varying stages of development, the empirical data was utilised in diverse ways in the establishment of the three case hubs. Overall, the feedback from stakeholders gathered in workshops and interviews proved to be critical in enforcing the focus areas of the hubs and developing services and operations to meet the actual needs. It was also found beneficial that the hub development and feedback collection were iterative, partly simultaneous processes. This cycle of defining, testing, collecting feedback and redefining of the hub operations increased the knowledge and competences of the hub actors and stakeholders, thus enabling the utilisation of the growing competences in the best way possible.

To concretise our findings, [Table 2](#) presents the main *building blocks and related examples from each hub*. The building blocks were formed based on the models developed by the European Commission

working groups (EC, 2017; Kalpaka et al., 2020). The first building block, *Need*, describes the need for a hub in the region. *Operational framework* sets the foundation that the hub builds on. *Vision* describes the aim of the hub. *Customer segments* and *value proposition* define to whom the value will be provided to, and what kind of value it is. *Service offering/key activities* refers to fee-based services or key activities which may also be offered free of charge, depending on the business model of the hub. *Resources* defines the key personnel, infrastructure, and knowhow needed to run the hub. Together with *Strategic partnerships*, the hub produces added value for the customers. *Organisational form* and *Business model* describe the operation model of the hub. Finally, *National and international networks* describe how the hubs expand their impact through visibility and awareness raising.

The building blocks of hubs were formed when building the case hubs based on both EC models (EC, 2017; Kalpaka et al., 2020). The building blocks were divided into *three categories* (why, what, and how), which help to structure the functionality of hubs. Building blocks *Need*, *Operational framework* and *Vision* belong to the category *Why*, answering the following questions: what is the need for the hub; do we need a hub; what is the foundation that the hub builds on; and what is the aim of the hub? Building blocks *Customer segment*, *Value proposition* and *Service offering/key activities* are placed under category *What*, which defines the value that the hub will provide through services and key activities, and the people or parties whom the value will be provided to. The third category, *How*, includes the building blocks *Resources*, *Strategic partnerships*, *Organisational form*, *Business model* and *National and international networks*. These building blocks form the operational model of the hub and describe how hubs expand their impact.

5. Discussion

The empirical research of this paper consists of data gathered from three different types of case hubs, offering new knowledge about the key aspects of establishing hubs in local innovation ecosystem. A model originally developed for building a digital innovation hub (DIH) (EC, 2017) was applied to all the case hubs. We found that the original DIH model (EC, 2017) as well as the updated DIH model (Kalpaka et al., 2020) can both be applied to the building of other types of hubs also. However, while simultaneously establishing hubs and collecting

Table 2. The building blocks and related examples from the case hubs

| Category | Building blocks | Innovation hub | Knowledge hub | Research hub |
|-------------------------------------|---------------------------------|---|---|--|
| WHY | Need | One-stop-shop of innovation services to accelerate digital health innovation | To build competencies of the innovation ecosystem actors in the data-driven health economy | Multidisciplinary scientific knowledge base for new innovations |
| | Operational framework | Strategic collaboration agreement between local innovation ecosystem actors | Network-like collaboration with national and international partners | Multidisciplinary research community |
| | Vision | One of the leading digital innovation hubs in health in Europe | Nationally and internationally recognised digital health knowledge hub | A world-class multidisciplinary research hub |
| WHAT | Customer segments | Health technology companies Health and social care providers | Local innovation ecosystem actors | Technology companies Researchers |
| | Value proposition | New RDI investments New business and exports | New competences and expertise | New scientific knowledge |
| | Service offering/Key activities | Business development Testing and piloting environments Facilitating co-creation | Awareness raising and competence building Broker service: connecting different actors to exchange knowhow and expertise | Awareness raising and dissemination of research results |
| | | Resources | Personnel: management, testing environment managers, innovation manager, business developers Infrastructures: Testing and piloting environments Knowhow: Collaborative innovation, business development | Personnel: management and experts Knowhow: selected focus areas of digital health, collaborative networking |
| HOW | Strategic partnerships | Local life science and health ecosystem | Local and national competence networks | Local and international research community and technology companies |
| | Organisational form | The core partners of the local innovation ecosystem | Coordinated group of experts | Local research community |
| | Business model | Hybrid business model by combining public and private financing | Public financing | Public financing |
| National and international networks | DIH network | International knowledge networks EU policy networks | International knowledge networks EU policy networks | National and international research community and policymakers |

related data, our empirical research indicates that the DIH models did not cover all the elements needed to build a fully operational research or knowledge hub, which led us to form a new practical framework for *building blocks of hubs* (Table 2). While the DIH models offer process- and step-by-step type of instructions for building a DIH, the practical building blocks provide new information and key aspects to be considered when establishing other types of hubs also, such as a research or knowledge hub.

The building blocks were categorised as *why, what, and how* sections to help structure the functionality of hubs. In terms of the *Why* category, its definition of the need, the aim and vision of the hub was found important as there are typically several stakeholders with different expectations when it comes to the hub. Thus, to set expectations on the same level, time and effort spent on crystallising the need and vision of the hub should not be underestimated. The *What* category was found to help focus on the core activities that provide value for their target groups. Regarding the *How* category, the wide network of actors was regarded as an asset when forming the operational model of hubs; we found that it is crucial to obtain the right kind and diverse know-how in the resources and strategic partnerships of hubs. The new elements we identified are the *operational framework* (*Why* category), *resources* (*How* category), and *strategic partnerships* (*How* category). The foundation for the *operational framework* element stems from the way of cooperation in different types of hubs; in the innovation hub the operational framework is the strategic collaboration agreement between local innovation ecosystem actors. In the knowledge hub, the operational framework is the network-like collaboration with national and international partners, and in the research hub the operational framework is the multi-disciplinary research community. *Resources* that generate expenses consist of, for example, personnel and infrastructure. From the sustainability point of view, the resources were regarded as an important element to be defined already in an early phase of establishing hubs. For instance, regarding the research hub, it was important to identify the necessary resources to be able to design the operational and funding model of the hub. *Strategic partnerships*, in turn, are necessary to be formed to be able to provide services for the needs of the customers, and to scale up the activities from local to national level. As the knowledge hub is strongly based on network-like operations, it provides several examples regarding the “strategic partnerships” element. The knowledge hub is also more easily scalable whereas the innovation hub focuses more on co-creation, experimentation, and testing, which are more local activities. As an example, the

knowledge hub and its strategic partnerships has played a significant role in integrating the developed tools to national ministry-led programs. Another example is the establishment of national networks around health data analytics, for which the knowledge hub gathered national key actors and experts to promote transfer and exchange of knowledge and best practices nationally (THL, 2021). This activity resulted in the development of a national network of cross regional health data ecosystems, which is funded by the Finnish Ministry of Economic Affairs and Employment.

These examples demonstrate how the development of the knowledge hub has influenced national strategies, programs, and development activities. As a result, the knowledge hub enhances the vitality of their regions and creates better environments for innovation activities. This is in line with the view of the Finnish Ministry of Economic Affairs and Employment (TEM, 2020:20) – the effectiveness of R&D at different regional levels, from local to global, depends on the binding nature of the vision and goal set by the actors together. Working together requires the facilitation of concrete cooperation processes by a reliable actor trusted by all organisations in the ecosystem. The knowledge hub has also contributed to the creation of the national health data analytics network, which is currently operational, and aims to develop broader regional-level cooperation. The development of the local innovation ecosystem, along with the establishment of the hubs, has also enabled the development of a European Digital Innovation Hub (EDIH) called HealthHub Finland² in the region as a joint effort with other regions in Finland. The EDIHs aim to make their expertise and research data available to SMEs and support the digitalisation of companies. This cooperation will create new opportunities for companies to grow and employ (TEM, 2022b).

Establishing a hub can be a complex and time-consuming process, but with careful planning, a strong network of stakeholders, and a commitment to fostering innovation and collaboration, it can be an effective tool for driving economic growth and social impact. Early-stage evidence of hubs indicates positive effects on the visibility, network and development of new knowledge, methodology and tools, to mention a few. In this way, the hub model can be seen to enhance the prerequisites of innovation activities in the local innovation ecosystem, ensuring the desirable environment for EDIHs, which focus on leading the digital transformation of healthcare through data-driven innovation and facilitation of new and emerging data-driven solutions created by SMEs in Finland and Europe.

6. Conclusions and implications

6.1. Theoretical implications

The primary purpose of this research was to increase the understanding of the establishment of the different types of hubs in the local innovation ecosystem. Hence, the study addressed the previously stated research gap and need of empirical case studies of (innovation) hubs to show how theories and models reconcile with practice (see, e.g., Viitanen, 2016). The previous models for establishing a DIH (EC, 2017; Kalpaka et al., 2020) were systematically used in our empirical study. Our main contribution to the existing literature is the identification of new elements that were missing from the previous DIH models. As a result, we presented *building blocks of hubs* based on the previous DIH models and complemented them with new knowledge from the empirical case study. The building blocks are well aligned with Remneland Wikhamn and Styhre (2022) who emphasise the need for a comprehensive and strategic approach to the development of innovation hubs, considering the various actors and stages involved in the process.

This study also contributes to the scientific discussion in the field of innovation management, from the point of view of hubs as spaces for collaborative R&D and innovation. Prior research regarding hub concepts and innovation ecosystem research (Launonen and Viitanen, 2011; Viitanen, 2016; Crupi et al., 2020) highlights the importance of innovation hubs in fostering innovation and promoting economic growth, which is in line with our findings, although we note that being able to show causal connections and robust evidence of the economic impact of hubs, requires longitudinal studies and more hub-specific data.

Moreover, the study brings new knowledge of innovation hubs as part of local innovation ecosystems. The findings are in line with Hoffecker's (2019) model of local innovation ecosystem, as there are similar elements among, for example, the resources, actors, and the enabling environment within the local innovation ecosystem that we identified as an operating environment for our case hubs (see Figure 2). The study also aligns with prior findings of DIHs playing important role in supporting startups and SMEs and in fostering innovation and growth in the European, national, and regional innovation ecosystems (Butter et al., 2020).

6.2. Managerial implications

In addition to providing new scientific knowledge, the results may help set up a functional network-like hub and, most importantly, offer guidelines for

creating hubs that provide added value for multiple stakeholders. Managers and other actors of local innovation ecosystems will gain new, partly novel viewpoints to be applied in their daily innovation management practices and in recently established digital innovation hubs in the healthcare sector, for instance.

Policymakers may also benefit from the results of this study; the establishment of hubs will play significant role in the ongoing social and health-care reform by providing an operational framework and tools for managing collaborative innovation in this context. For example, in Finland, several centers of excellence have been established over the years, but the way of interacting and exchanging knowledge within them is not well-developed. The main outcome of this article – the building blocks of hubs – highlight the importance of balancing these elements to form well-performing collaborative innovation structures that create value for all stakeholders.

In practice, policymakers, managers, and ecosystem actors may use the building blocks (Table 2) as a hands-on guide to focus the most critical aspects in the establishment of hubs. Regardless of the sector or the type of hub being built, the framework of building blocks can guide managers in setting up the hub and in deciding what type of hub is appropriate. Following the guidelines help managers focus on the right things in the right order. Especially the Why, What and How elements should be carefully considered one by one. First, managers should clarify the fundamental need for establishing a hub: *Why* is it necessary. Second, they should define *What* is the function of the hub and for whom does it create value and third, they should plan and state *How* the hub operates in practice.

6.3. Limitations and future research

We acknowledge the common limitations related to the case study method such as the possible bias in case selection, complexity of analysis, and the lack of generalisability of findings. The results should be viewed as initial findings regarding the establishment of the different types of data because the case hubs were in their early phase of development, thus offering limited data. For example, impact assessment would require long-term data. The current data available from the local innovation ecosystem, for instance, cannot be directly linked to hubs' impact. Thus, the development of hub-specific assessment tools is needed. Furthermore, further development of the DIH models to the building blocks was based on

the use of the existing DIH models in the establishment of different type of hubs. The building blocks, however, are not tested and verified in practice, which would be needed to be able to evaluate and compare to the previous models.

This study offers further research directions by identifying several key topics for future research of hubs, which are currently under great interest and development, for example in the European Commission strategy level. For instance, considering the assessment of the impact, quantitative indicators to assess general business impact of the hubs were identified in the EC report (EC, 2021). Qualitative data, such as interview data from companies and other stakeholders, should be collected to gather a more comprehensive view of the case hubs' impact. Furthermore, considering the early phase of the explored hubs, future research should focus on hubs' longer-term data-based impact assessment and value co-creation mechanisms as part of local innovation ecosystems, encompassing questions such as how hubs should operate to create most value for their stakeholders, and how innovation and co-creation should be facilitated. Moreover, as a future consideration for hubs' continuity and sustainability, the emphasis should shift from building a hub to increasing the engagement of stakeholders, and to adjusting the business model and operations.

In this study, the case hubs created new knowledge, methods, tools, and networks by bringing together different actors to innovate. The establishment of the hubs was based on a real, societal need, which made the simultaneous establishment work and data collection fruitful. Our findings show that new structures and collaboration networks are needed to support research-based partnership networks where higher education and government research institutes network with businesses and industries to enhance the societal impact of high-quality research. The building blocks presented in this study can bring new insights and support when new research and innovation based collaborative hub structures are formed. For example, research-based hubs would benefit from active interaction with business and innovation-driven hub activities and *vice versa*.

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Ethic statement

Not applicable.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Notes

¹<https://www.businessoulu.com/en/company-networks/oulu-innovation-alliance>

²<https://www.healthhub.fi/>

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