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Exploring heterogeneous Digital Innovation Hubs in their context

A comparative case study of six (6) DIHs with links to S3, innovation systems and digitalisation on a regional scale

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Foreword

Digital Innovation Hubs are a key pillar in the European Commission's Digitising European Industry (DEI) strategy. They help companies, esp. SMEs and midcaps, and public sector organisations to better understand how to improve their processes, products and services through digital technologies. Thereby they support organisations in their digital transformation, by offering them services such as:

- *Test before invest*: experimentation with new digital technologies – software and hardware – to understand new opportunities and return on investments
- *Skills and training to make the most of digital innovations*: train-the-trainer programmes, boot-camps, traineeships, exchange of curricula and training material
- *Support to find investments*: develop business plans, matching with investors
- *Creation of an innovation ecosystem and networking opportunities* through marketplaces and brokerage activities

The EU proposes to scale up its commitment towards Digital Innovation Hubs from 2021 on through:

- **Horizon Europe** programme: Supporting experiments where highly innovative companies work together with Digital Innovation Hubs to develop novel digital solutions to improve their businesses.
- **Digital Europe** programme: Investing in capacity building of hubs in all regions of Europe ensuring appropriate uptake of Artificial Intelligence, High Performance Computing and Cybersecurity by all industry and public sector organisations in Europe. All hubs will be networked to ensure transfer of expertise enabling specialisation and excellence, and avoiding a digital divide.

This report with its view on six (6) different Digital Innovation Hubs, provides important lessons learned for the design of the Digital Europe Programme. Especially the recommendations on how hubs can improve their brokerage role by acting as a multi-sided platform are important. Such brokering should happen at the regional, as well as European scale in order to successfully manage the transformation into the digital age, and improve the competitiveness of the European economy. We will target this aspect in the new Digital Europe Programme.



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They also wish to express their gratitude to the colleagues Anne-Marie Sassen and Andrea Halmos from DG CNECT Unit A.2 *Technologies and Systems for Digitising Industry*, for their support and feedback.

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Abstract

This report explores the regional variation in organisation and implementation of DIHs across six (6) different EU regions: Saxony-Anhalt (Germany), Wielkopolska (Poland), Northern Ostrobothnia (Finland), Tallinn (Estonia), Andalusia (Spain) and Central Macedonia (Greece). The case studies were conducted in conjunction with a wider survey among DIH managers and regional policy managers (RIS3) whose results are presented in a separate JRC Technical Report. While the survey covers a wider scope of questions, this report follows a comparative approach in order to identify common denominators, strengths and challenges concerning 1) how the DIHs are set-up; 2) how DIHs are fitted to the regional policy- and economic context, with particular attention given to the connection between DIHs and the regional/national smart specialisation strategy (RIS3); 3) how regions could better benefit by DIHs; 4) what are the funding sources and how they are coordinated.

The report aims to contribute to our understanding of different models of DIHs registered in the DIH Catalogue (yellow pages) across regions and their respective interactions with the regional/national innovation ecosystems and specifically the smart specialisation strategies. The selected approach has also helped to highlight current good practices and suggest alternative ideas on how to set up future DIHs (e.g. multi-sided platforms model) also in view of the upcoming Digital Europe Programme (DEP).

Executive summary

Digital Innovation Hubs (DIHs) is a fairly recent policy initiative which aims to support the digital transformation of industry, especially SMEs, and/or the public sector in the EU. Since its' launch (2016) an increasing number of organisations from all over the EU with different profiles have been actively participating. There is an identified need to explore the regional variation in organisation and implementation of DIHs and this report is focusing on DIHs across six (6) different regions: *Saxony-Anhalt* (Germany), *Wielkopolska* (Poland), *Northern Ostrobothnia* (Finland), *Tallinn* (Estonia), *Andalusia* (Spain) and *Central Macedonia* (Greece). The report employs a comparative approach and provides value by highlighting the regional/national connections between RIS3 and DIHs. The 6 DIHs are compared under different angles such as: how they are set-up; how they interact with their innovation ecosystem and in particular the regional/national smart specialisation strategy (S3); how regions could better benefit by DIHs; what are the funding sources and how they are coordinated. The case studies were conducted in conjunction with a wider survey among DIH managers and regional policy managers (RIS3) that covers a wider scope of questions (results are presented in a separate JRC Technical Report).

Policy context

The aim of the report is to strengthen the knowledge base around synergies and interactions between two current EC initiatives DIHs and Smart Specialisation Strategies (RIS3) with a view to contribute to better alignment. It is the result of a formal collaboration between the European Commission's Directorate-General of Communication Networks, Content and Technology (DG CNECT) and the Territorial Development Unit of the European Commission's Joint Research Centre (DG JRC) initiated in 2017. A DIH catalogue tool was developed as part of this collaboration, serving both the purpose of gathering data on the DIHs that exist in Europe and advancing DIH interconnection and interactions across regions. Today, it is a repository serving as yellow pages with more than 280 DIHs, including information on the technology and application specialisation, geographical coverage, market focus and digitalisation support available. Both the survey study and the case studies are based on samples from the DIH catalogue and the two (2) resulting reports are complementary and interconnected.

The report aspires to provide valuable evidence on the variations of DIHs in different socio-economic contexts and their interrelations with RIS3 as an input for better planning support measures also in view of the upcoming Digital Europe Programme (DEP).

Key conclusions

Existing DIHs seem to fall into one of the following three (3) categories with respect to how they fit into their regional context: a) They are existing actors guided by a previous agenda but using the DIH label to rebrand themselves, b) They are existing actors working with a new agenda to refocus their efforts (towards or within the scope of digitalisation) or c) They are new actors bringing a new focus and agenda to the region.

While the first category is already integrated into the region with respect to all four analytical dimensions – namely (i) Organisational setup, ii) Funding, iii) Geographical scope and collaboration and iv) Digital maturity –, the second requires some change and adaptation to fit into the regional digitisation agenda, and the third requires even more adaptation along all four dimensions.

There is no one size fits all as regards the four (4) aspects examined during the case study. However, important identified factors that contribute to a successful fit-for-purpose DIH in a regional context are (for the DIH) to:

- be well anchored in the regional innovation or digitalisation policy setting,
- clearly identify and respond to industry needs, and
- be well fitted and interrelated with the regional innovation ecosystem including RIS3.

Funding for DIHs is usually coming from different sources and sometimes it gets challenging to manage. In view of the upcoming Digital Europe programme (DEP) and the role of DIHs in it, it is advisable that DIHs that demonstrate a good connection with the regional/national smart specialisation strategies and innovation ecosystem in general would be further supported.

Regarding geographical coverage and collaboration, DIHs and regional policy stakeholders should participate to national and EU wide collaboration networks (as opposed to only regional collaborations). DEP and/or other EU wide initiatives could further emphasise the importance of international networks and support the funding of initiatives that cut across different geographical scales.

Given the expected key role of DIHs as matchmaker of digitisations demands and offers, a potential and alternative model for future DIHs could be to evolve towards a *multi-sided platform economy* approach, where the DIH is able to effectively match first-hand stakeholders directly and with respect to the DIH core priorities, but also with the opportunities brought by regional development policy or even national policy initiatives. This could address the important issue of bridging a fragmented system with many parallel support organisations and frameworks. In other words, the proposed model could be scaled and adjusted to fit a wider policy approach (which merits further investigation).

Main findings

The comparative study of six (6) regional DIHs in various geographical and socio-economic context showed that the scope and characteristics of digital innovation hubs appear to vary considerably across at least four different dimensions: i) Organisational setup, ii) Funding, iii) Geographical scope and collaboration and iv) Digital maturity.

- The *organizational form* is usually adapted to regional conditions and contexts and it doesn't seem that there is a form which is best for every region. Hubs can be formed from existing organisations taking on the title and/or rebranding themselves, from existing projects under H2020, by bringing together several existing actors in a (new) virtual organisation or by creating an entirely new organisation from scratch.
- As regards *funding sources* the evidence shows that DIHs most probably rely on funding by multiple sources which in some cases leads to a funding system that may be quite complex to navigate. DIHs studied under the six cases were all involved in different extents with the regional/national smart specialisation strategies (RIS3) and ERDF funding was one and in some cases the most important source of funding for them. Other important sources of funding are H2020 and national research funding.
- The *geographical scale of their focus* is also a varying factor. Most DIHs are clearly regional in their original scope but recognise the need to attract expertise and experience from outside the region. A successful implementation of the DIH concept could lead in some cases to the DIH playing a prominent role for digitalisation at a national level. Exceptionally there are cases where the high level of competences allows internationalisation and success in a global scale but the impact in the regional scale remains limited.
- Hubs also vary in their approach to *digital maturity* and the need to strike the balance between supporting basic and general forms of digitalisation efforts aimed at existing industries, and at the same time promoting the development of cutting-edge technological solutions in a niche of the market. This is a trade-off not only between leaders and laggards in digital competitiveness but also between general and specific focus on digitalisation, as well as between established firms and new start-ups. How this balance is struck may have a significant impact on the role the hub takes in the region. While for most of the studied hubs is challenging to strike this balance, some have decided to focus explicitly more on one than the other.

Related and future JRC work

This report is the third one of a series of analytical works produced by the Territorial Development Unit B3 of the JRC within the context of its formal collaboration with DG CNECT Unit A2 of the European Commission. The aim of this analytical effort is to improve the evidence base for sound policies in the area of digital regional growth by exploring with a comparative approach the dynamics between six (6) DIHs in a variety of regions and regional innovation ecosystems. It is strongly interconnected and complementary to the first and the second one of the series¹. Future planned work within the next two years includes: Practical DIH Guidelines for Regions, Guidelines for DIHs Evaluation and a new DIH Survey.

Quick guide

The report starts by introducing the context and the objectives of the case studies and the content is divided into five chapters. Chapter 2 briefly summarises the method and data collection. Chapter 3 collects backgrounds descriptions to provide some regional context for each of the cases. Chapter 4 summarises the findings from the interviews and compares differences and similarities across cases, Chapter 5 presents a potentially interesting model for future digital innovation hubs and Chapter 6 draws conclusions.

1 (Rissola and Sörvik, 2018) and (Mörner et al., 2019).

1 Introduction

“The future is already here – it’s just not very evenly distributed”

William Gibson²

As digitalisation has become a general purpose technology (Bresnahan and Trajtenberg 1995, McAfee and Brynjolfsson, 2017) its impact on the economy and society at large is moving beyond straight-forward technology uptake and increasingly depends on how well actors in both the private and public sector manage to adapt institutionally and organisationally to leverage the new technology. Consequently, it is becoming gradually more evident that the progress of digitalisation is uneven across parts of the economy, across regions and across individual organisations.

While small start-ups organised around the new technologies may be well-positioned to introduce new services, products and business models in otherwise homogenous sectors of the economy, a medium-sized manufacturing or retail firm may face very different obstacles in trying to digitalise their business. At the same time, digitalisation is both substantially local and immediately global in its infrastructure. Local firms are exposed to global competition through e-commerce – both business-to-business and business-to-customer – whether they have engaged in digital sales channels themselves or not. On the other hand, in a region with strong overall digital competitiveness and access to people with the necessary skill sets to digitalise, the same local firms can build an international competitive edge. Against this background, the Digital Innovation Hubs (DIHs) initiative provides an important complement both to other EU-wide initiatives aimed at a Digital Single Market (DSM) as well as to national and regional digital agendas and strategies.

Policy context

The European Commission launched its first industry-related initiative within the Digital Single Market package in April 2016 (EC, 2016a) with the aim to promote further investments in the digitalisation of traditional industry – building on and adding to a wide variety of existing national initiatives. In a longer run, these policy initiatives are meant to support the emergence of better framework conditions for the ongoing structural change advanced by digitalisation. One of the more prominent parts of the Digitise European Industry (DEI) initiative was to develop a network of Digital Innovation Hubs (DIHs) with the purpose of advancing digitalisation regionally and promote networking between hubs across regions, for instance to facilitate the diffusion of knowledge and transfer of expertise within the EU³. Most hubs do not have all necessary or relevant knowledge available within their respective regions and therefore need to connect to DIHs from different regions to access a wider spectrum of expertise and support.

For the next long-term EU budget period 2021-2027, the European Commission has proposed a Digital Europe programme (EC, 2018), which is set to invest €9.2 billion aimed specifically at digital challenges of the future. Within this programme, DIHs are expected to stimulate the adoption and development of targeted groups of technologies, i.e. artificial intelligence (AI), high-performance computing (HPC) and Cybersecurity, and advanced Digital Skills.

Digital innovation hubs are one-stop-shops that help companies to become more competitive regarding their business models and processes using digital technologies. The specific setup of DIHs varies significantly between countries and regions. On a conceptual level, a DIH can be a non-profit (or with non-profit goal) organisation, part of a research institute or a type of network or virtual organisation that combines competences from different stakeholders and provide access to knowledge, contact networks and new technologies. Digital innovation hubs support firms in their

² Cite attributed to the science-fiction writer in the article *Why has broadband Internet access taken off in some countries but not in others?* published by The Economist, Business edition, 21/06/2001.

³ See <https://ec.europa.eu/digital-single-market/en/digital-innovation-hubs>

digitalisation efforts through activities such as (1) training, (2) experimentation and testbed activities, (3) assisting ventures or initiatives seeking funding, and (4) ecosystem-building.

Because of their regional orientation, DIHs act as a first regional point of contact for digitalisation efforts, but also to strengthen the link between digitalisation and the regional innovation system (Goetheer and Butter, 2017). Many DIHs act as network organisations bringing together different types of actors, including organizations like universities, companies, industry associations, chambers of commerce, incubator and accelerators, regional development agencies and even governmental organisations. DIHs resemble to some extent with cluster organisations, and in many regions cluster organisations have rebranded themselves as DIHs. However, there is a significant difference: While cluster organisations are primarily aimed at promoting regional growth from a supply-side approach, a DIH's main purpose is to promote digitalisation efforts within existing industries from a demand-side approach.

Synergies with Smart Specialisation Strategies

Because DIHs have a strong regional dimension, there is a strong potential connection to other policy initiatives, and especially Smart Specialisation Strategies (S3) (Rissola and Sörvik, 2018). Smart specialisation is a place-based approach centred around regional policymakers and stakeholders jointly identifying adjacent opportunities to existing economic activities and formulating the efforts needed to expand the regional economy to these new areas (European Commission, 2012; Foray, 2015; Gianelle et al., 2016). Smart specialisation strategies consist both of horizontal measures, such as supporting digitalisation efforts across industries, and targeted efforts aimed at a limited number of priority domains identified through a multi-stakeholder entrepreneurial discovery process (EDP), where stakeholders jointly identify and develop innovation agendas for the prioritised areas. It often consists of engaging and supporting the development of the innovation ecosystem around these priority areas. In comparison, a DIH is a policy instrument aimed primarily at digitalisation of industries in general, but also specifically at the uptake and implementation of specific key technologies, such as artificial intelligence or eHealth. Furthermore, many DIHs have expressed that they have a role in ecosystem development. This suggests there should be considerable overlap between DIHs and S3, at least at face value: [...] *every DIH will have its own specialisation, in line with the smart specialisation priorities of a region. Through the networking of DIHs, competences not available within the regional DIH may be found in another DIH* [...] (European Commission, 2017).

DIHs can play several roles in Smart Specialisation processes; they can function as co-designers of smart specialisation, both as a reference point providing information on market issues and digitalisation issues and taking the lead role for development of priority areas in developing road maps, and as an implementation tool for policy objectives in providing digitalisation services (Sörvik, 2019).

Dominique Foray, one of the founding fathers of the smart specialisation concept, famously exclaimed in his 2011 paper that “policy is running ahead of theory”; the application of smart specialisation as a policy concept across European regions were driven by hopes about its effectiveness rather than by solid empirical evidence (Foray D, David PA and Hall BH., 2011). Over time, our understanding of the underlying theory as well as of best practice among regional policymakers has been greatly improved and the smart specialisation concept has matured considerably since Foray's original statement. The DIH programme and initiative appears to be following a similar trajectory. Actors across European regions are wholeheartedly adopting the DIH concept and it is possible to observe a high level of engagement among public and private actors alike. However, the rationale behind their activities is not resting on a common operationalisation of the DIH concept, but rather on individual interpretations of the idea shaped by regional context conditions. In other words, the application of the DIH concept across European regions have been running ahead of theory and a lot of work remains in terms of identifying best practice examples, common challenges and to increase our understanding of the ideas underpinning the DIH concept.

The report provides insights for six (6) regional cases of DIHs in the following regions: Saxony-Anhalt in Germany, Wielkopolska in Poland, Northern Ostrobothnia in Finland, Tallinn in Estonia, Andalusia in Spain and Central Macedonia, Greece. The DIHs selected operate in different socio-economic contexts and in regions where smart specialisation strategies exist and are being implemented. These case studies focus on identifying the organisation set-up and funding of the individual DIH, how it is fitted into a regional innovation context, and what its networks and partnerships look like. The comparative approach used highlights the variety of models and that these different models of operation, funding and collaboration can be employed in order to cover different regional needs of digitalisation, but also provides some common denominators for how to set up future DIHs.

The remainder of the report is divided into five chapters. Chapter 2 briefly summarises the method and data collection. Chapter 3 collects background descriptions to provide some regional context for each of the cases. Chapter 4 summarises the findings from the interviews and compares differences and similarities across cases. Chapter 5 suggests an alternative model for the setup of future digital innovation hubs and Chapter 6 draws conclusions.

2 Scope of the case studies

This report aims at identifying common denominators, strengths and challenges along four analytical dimensions – namely (i) Organisational setup, ii) Funding, iii) Geographical scope and collaboration and iv) Digital maturity.

Six (6) cases of regions and DIHs were selected based on their diversity in terms of regional context conditions and background. The selection is supposed to reflect a fairly balanced geographic and socio-economic distribution of cases across the EU. For comparability reasons, the selected cases are not capital regions, but rather 2nd to 3th tier cities in their respective national urban hierarchies. Also, these regions are oftentimes industrial transition regions.

All the selected hubs are registered in the DIH Catalogue tool⁴ as fully operational and focus at least to some degree on technologies related to artificial intelligence, meaning they should also be roughly comparable in terms of domain-specific factors. In addition, all selected hubs are at least partially funded through the European Regional Development Fund (ERDF), which ensures a connection between the DIH and the regional smart specialisation strategy. Table 1 provides a list of the selected DIHs and regions and figure 1 shows the geographical distribution of cases. In the case of SmartIC in Estonia, the relevant spatial scale is not regional but national, since the smart specialisation strategy is defined at the national level in Estonia.

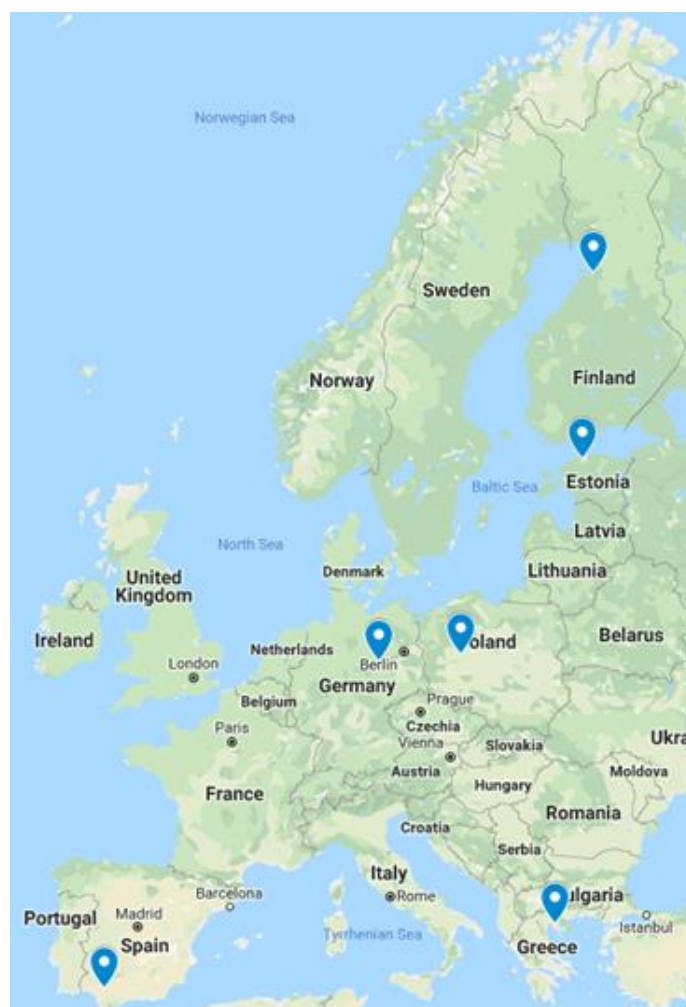
Table 1: List of selected case DIHs and regions

DIH	Location (region in bold)	Regional level
VDTC of the Fraunhofer IFF	Magdeburg, Saxony-Anhalt , Germany	NUTS2
HPC4Poland	Poznan, Wielkopolska , Poland	NUTS2
OuluHealth	Oulu, Northern Ostrobothnia , Finland	NUTS3
SmartIC	Tallinn, Estonia	NUTS1
Andalucia Agrotech	Sevilla, Andalusia , Spain	NUTS2
CERTH	Thessaloniki, Central Macedonia , Greece	NUTS2

Source: own elaboration

⁴ <https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool>

Figure 1: DIH six (6) cases location in Europe



Source: Google Maps

Data for the case background descriptions was collected through a systematic mapping of secondary material, primarily from the Regional Innovation Monitor (RIM),⁵ European Innovation Scoreboard⁶, Regional Innovation Scoreboard (RIS)⁷, the Digital Innovation Hubs catalogue,⁸ Eye@RIS3,⁹ ESIF viewer digital¹⁰ and a wide range of policy documents, such as smart specialisation strategies, RIO-reports, Digital Innovation Scoreboard, Digital Economy and Societal Index, and European Regional Development funds operational programs. The analysis of secondary data has provided the backdrop for the case studies presented in chapter 3.

For each of these cases, primary data was been collected through interviews with DIH managers, which have been complemented by interviews with regional policy actors and representatives from the private sector (see Interviews section). Interviews were semi-structured; respondents were asked to answer questions related to the themes laid out above and follow-up questions were asked in order to allow for a deeper exploration of certain topics. Interviewees were both asked for descriptions and personal reflections in terms of positive and negative examples (strengths and weaknesses) in relation to the topic under consideration.

⁵ <https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/>
⁶ https://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards_en
⁷ https://ec.europa.eu/growth/industry/innovation/facts-figures/regional_en
⁸ <http://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool>
⁹ <http://s3platform.jrc.ec.europa.eu/eye-ris3>
¹⁰ <http://s3platform.jrc.ec.europa.eu/ict-monitoring>

3 Background: Case descriptions

This chapter provides background information for the six (6) selected case studies. The presented regional backgrounds are based on secondary data sources and include principal information concerning the DIH's organisation, funding, regional context and relation to smart specialisation strategies.

3.1 Magdeburg, Saxony-Anhalt – VDT of the Fraunhofer IFF

Regional socio-economic context and innovation dynamics

Saxony-Anhalt is one of Germany's 16 federal states, located in the central-eastern part of Germany. It has a population of 2.24 million inhabitants (2017), of which the capital Magdeburg has approximately 232,000 inhabitants. The region was formed in the German reunification. The state has experienced a declining population, mainly due to out migration and has been struggling with high numbers of unemployment, with rates above 20%, but as the transformation process has progressed, industry structure has evolved and unemployment fallen. In 2017, the unemployment rate was 6.9% (Eurostat). The economy is improving but the region is lagging behind other German regions.

The regional GDP per capita (PPS) reached 25,600 euro in 2017, significantly below the German average of 37,100 euro, but getting closer to the European average of 30,000 euro. Most people are employed in the service sector (69.6%), while 28.4% work in manufacturing and construction. However, only 2.3% work in high-technology manufacturing and knowledge-intensive services, versus 4.1% at the national level and 4.0% at the European level (Eurostat). The Regional Innovation Scoreboard also points out that the region has a weakness in the share of adult population that has completed tertiary education (53% of the German average and 42% of the European average).

Figure 2: Location of VDT of the Fraunhofer IFF and Saxony-Anhalt in Europe



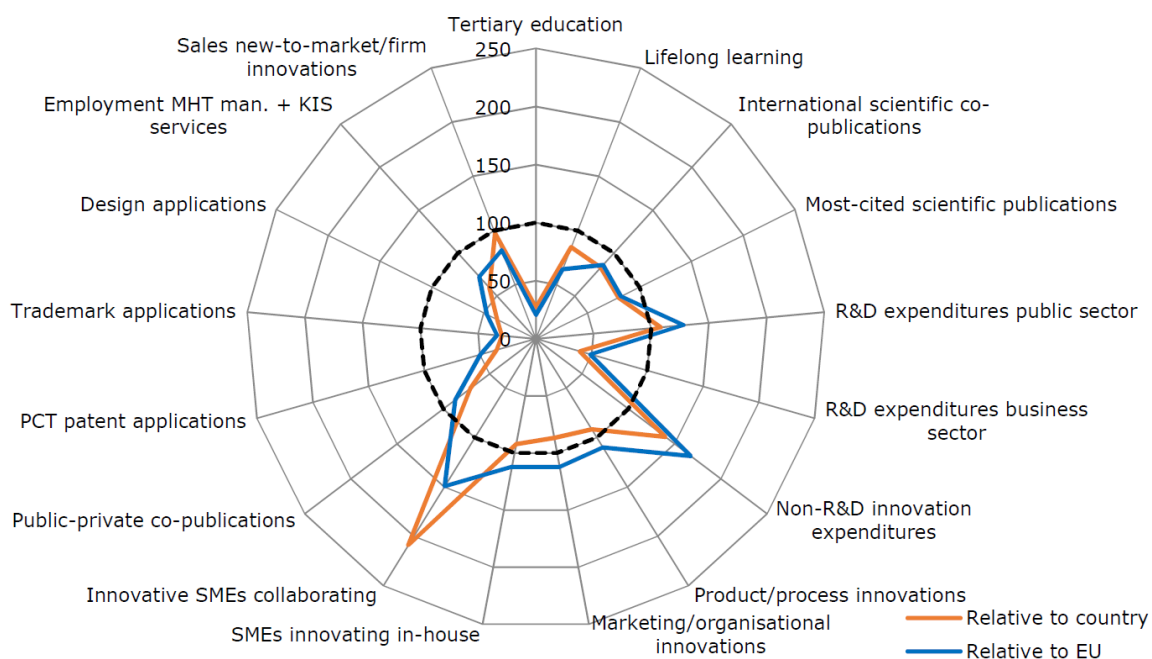
Source: Google Maps

The industrial structure is very diverse and key industrial sectors in the region are logistics, renewable energy, and the chemical industries. The region is sometimes referred to as the “Chemical Triangle”, since it has a strong concentration of chemical and oil refining industries. The region’s economic structure is dominated by very small and small enterprises with moderate research, development and innovation activities, and a few large companies with production sites located in the region rather than R&D sites. This is reflected in that the gross domestic expenditure on R&D (GERD) in the region stood at only 1.35%, of which the business enterprise sector carried out 26.3%, considerably lower than the national average of 68.6% (Eurostat).

Saxony-Anhalt has quite a broad set-up of academic and research actors. There are two universities with technical and scientific orientation. In addition to this, there are five public and three private universities of applied sciences and art academies. The region is also home to five institutes of the Leibniz Association, three Max Planck institutes, six institutes and centres of the Fraunhofer Gesellschaft, the Helmholtz Centres for Environmental Research (UFZ) as well as the Magdeburg site of the German Centre for Neurodegenerative Diseases (DZNE), which makes significant scientific and technological contributions. There are also several clusters and networks in the region working with innovation and business development including: Cluster Biotechnology in Sachsen-Anhalt; Cluster Chemistry/Plastics Central Germany; Cluster IT Central Germany; Cluster MAHREG Automotive; Cluster Medicine- and Health-Technology Saxony-Anhalt; Cluster special machines and plant construction in Saxony-Anhalt (SMAB); Polykum e.V. – Polymer development and plastics technology in Central Germany; and Cluster BioEconomy.

The Regional Innovation Scoreboard 2019 classifies Saxony-Anhalt as a “strong - innovator”. However, its innovation performance has decreased over time (-2.4%). The radar graph shows relative strengths compared to Germany (orange line) and the EU (blue line), showing relative strengths (e.g. Innovative SMEs collaborating and Non-R&D innovation expenditures) and weaknesses (e.g. Tertiary education and R&D expenditure in the business sector).

Figure 3: Regional Innovation Scoreboard 2019 values for Saxony-Anhalt



Source: Regional Innovation Scoreboard 2019¹¹

¹¹ https://ec.europa.eu/growth/industry/innovation/facts-figures/regional_en

When it comes to digital maturity, the region is relatively mature but not a front runner in Europe. In terms of frequency of Internet use, 82 % of the population in 2017 used the internet at least once per week, up with 3% from 2014. 91% of households had access to broadband in 2017 up from 79% in 2014 it was 84%. On a national level, 59% of Germans used internet banks in 2018 and 71% of Germans ordered goods or services over the internet for private use on an individual basis (Eurostat, 2019). Germans are a bit more Internet savvy than the rest of Europe, and 62% of Germans have basic skills and usage, compared to 57% for Europe; it is similar when it comes to advanced skills with 26% of Germans compared to 24 % for the rest of Europe. However, when it comes to use of eGovernment services and online health services, Germany is lagging behind Europe with 7% versus EU average of 18 % for use of online Health services, and 39% use eGovernment services versus 58 % of EU average (Digital Economy and Society Index)¹².

In terms of ERDF funds available to the region and planned investments in ICT for the region, Saxony-Anhalt was allocated approximately 2.1 billion euro, which is around the 50th greatest sum in Europe, and of this around 150 million euro is planned for ICT related investments. The region has been planning to use around 7% in ICT related investments, which is above the EU average of 6%¹³.

As regards the region's RIS3, there are three important challenges highlighted: i) the R&D expenditure is modest, and that the private sector expenditure is low, ii) the economic structure is dominated by SMEs, and then some large companies but these mainly have production sites, and then that iii) the population is ageing fast and shrinking. Through the RIS3 the region wants to strengthen start-ups and entrepreneurial culture, and also attract companies to locate to the region. For this they have been experimenting with new instruments such as platforms and co-working spaces. They have been using new forms of communication trying to match small and large companies. The region has also pointed out that digitalisation offers special opportunities to support companies to explore new business models and innovation. The regional smart specialisation strategy has five priority areas: Mobility and Logistics; Energy, Engineering and Plant Construction, Resource Efficiency; Chemistry and Bioeconomy; Food and Agriculture and Health and Medicine.

Under the heading of "Industrie 4.0", advanced manufacturing activities are targeted in Saxony-Anhalt, both on the level of strategy-building and in distinct projects. Industrie 4.0 is targeted in particular in relation to energy aspects, mechanical and plant engineering, resource efficiency, and in mobility and logistics.

The selected regional DIH – VDTC of the Fraunhofer IFF



The DIH - VDTC of the Fraunhofer IFF¹⁴ was envisaged as a beacon for digitalisation in the region when it was planned in 2001. The vision was a highly connected and data-oriented production and manufacturing environment. This was especially important to support the ongoing structural change and modernization of the

economy after the German reunification.

¹² <https://ec.europa.eu/digital-single-market/en/desi>

¹³ These data comes from the ESIF viewer Digital (<http://s3platform.jrc.ec.europa.eu/ict-monitoring>). This tool has gathered data on how European regions planned to use European Structural Funds for ICT investments in their Operational programmes for their European Regional Development Funds (ERDF) investments and European Social Fund (ESF) investments. The amounts in this tool are presented at regional level and include data from regional OPS, but also shares of national and transnational cooperation programmes. The shares have been estimated by taking into account the population size of the regions. Data depicted here are thus estimations of potential investments and do not reflect final investment figures.

¹⁴ <https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool/-/dih/1363/view>

VDTC acts as a hub in a regional network of companies, industrial associations, academic and research actors as well as the policy level. It promotes digitalisation of SME through applied research cooperation. It works with awareness raising around different digitalisation topics, within a partnership network, which it hosts. The DIH helps SMEs with expert knowledge, demonstration centres, networks for the exchange of experience and practical examples, and informs SMEs about the opportunities and challenges of digitization. They also have a range of activities focusing in particular on the construction sector.

The VDTC is part of Fraunhofer, a public research organisation. It has more than 100 employees and serves more than 50 customers annually, ranging from SMEs, Midcaps to large multinationals. It is financed by different funding sources that finance different ranges of activities. The principal sources are National basic research funding, the European Regional Development Fund, Regional funding, Private funding and Partner resources.

Figure 4: Summarising overview of the VDTC of the Fraunhofer IFF DIH

Funding sources									
European Regional Development Fund	European Social Fund	Horizon 2020	COSME	National basic research funding	National specific innovation funding	Regional funding	Private funding	Partner resources	Membership
Geographical scope									
Global		European			National		Regional		
TRL Focus									
TRL 1	TRL 2	TRL 3	TRL 4	TRL 5	TRL 6	TRL 7	TRL 8	TRL 9	
Organisational form									
Networked organization, without formal structure		Public Private Partnership		Foundation	Private organisation		Public organization (part of RTO, or university)		Joint venture
Partners									
University	Government and agencies	Private firms	Cluster organisations and business networks	User community	Research institutes / RTOs	Industry associations	Chamber of commerce	Incubators and accelerators	Science and technology parks

Note: selected boxes (in grey) indicate the properties of the DIH

Source: the Digital Innovation Hubs catalogue¹⁵

¹⁵ <http://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool>

3.2 Poznan, Wielkopolska – HPC4Poland

Regional socio-economic context and innovation dynamics

The Wielkopolska voivodship is one of the biggest regions in Poland with a population of 3.5 million inhabitants in 2017 (Eurostat). Poznań is the regional capital and largest city. Wielkopolska is one of the Polish leading regions in terms of innovation investments and one of the most important industrial centres in Poland. The share of industry in the region's gross value added (GVA) was 30.2% in 2015. Particularly, there are many large investors in the automotive sector, such as Volkswagen AG, MAN, Solaris Bus and Coach. The region is also known for its business process outsourcing and logistics sectors. The GDP per capita (PPS) was 22,800 in 2017, one of the highest in Poland and above the national average of 20,900. Furthermore, the unemployment rate of the region was 3.1% in 2017, which is also one of the lowest in Poland, where the national average is 4.9% (Eurostat).

Figure 5: Location of HPC4Poland and Wielkopolska in Europe



Source: Google Maps

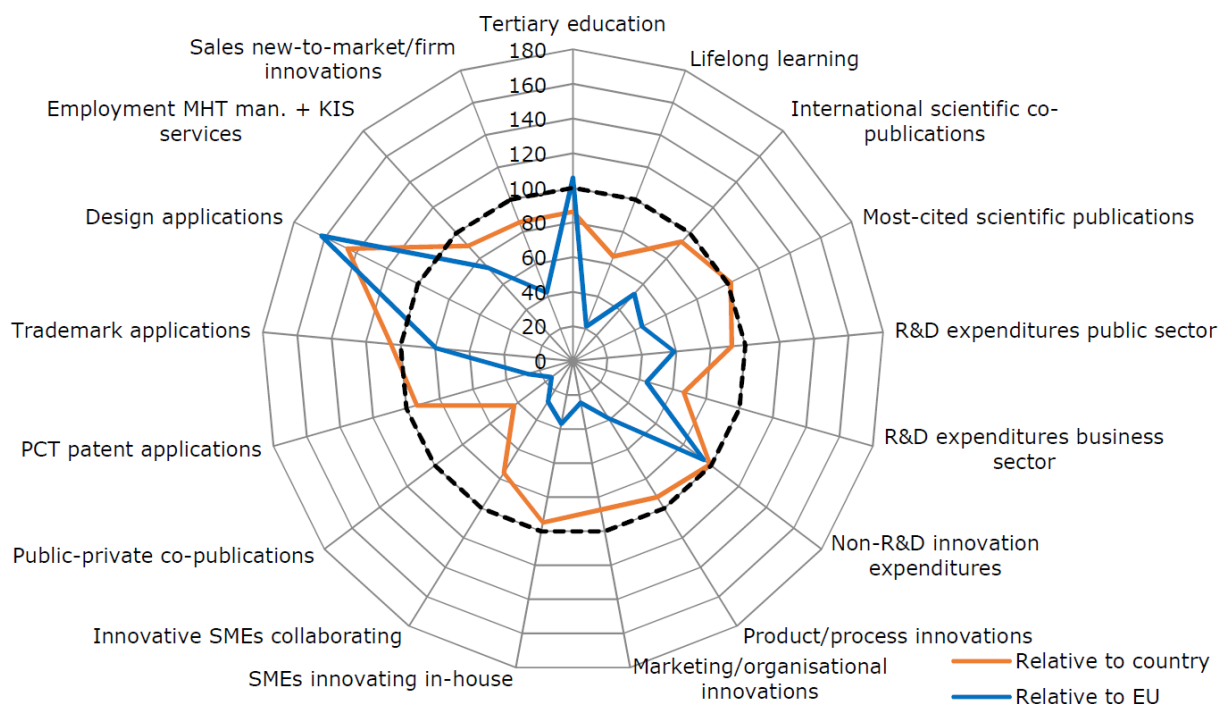
Wielkopolska's research infrastructure is characterised by the presence of more than 30 higher education institutions with different education profiles. Notable institutions include the Adam Mickiewicz University in Poznań, the Poznań University of Technology, the Poznań University of Medical Sciences, the Poznań University of Economics and Business. In Poznań is also located the Poznań Science and Technology Park, the first one in Poland, founded in 1995, with a focus on chemistry, physics and biotechnology and IT. It hosts 80 innovative companies and 60 research labs.

According to the Regional Innovation Scoreboard 2019, the Wielkopolska region is ranked as a "moderate – innovator" with an innovation performance below the EU average. The innovation performance has improved somewhat in recent years. Nonetheless, the progress on catching up with the EU average is limited.

The radar graph shows relative strengths compared to Poland (orange line) and the EU (blue line), showing relative strengths (e.g. Design applications) and Tertiary education in an EU perspective and Non R&D Innovation on a national and EU average. The region lags behind Poland as a whole on key indicators such as lifelong learning, R&D expenditures both in business and public sector, public-private co-publications, patent applications and tertiary education. Regarding the latter, it did

perform better than the EU average as most Polish regions do. Research and development (R&D) expenditures (GERD) account at 0.74 % of regional GDP. While there is a growing trend, it is still far below the country and EU average estimated at 1.0 % and 2.04 % in 2015 (Eurostat). Business expenditure on R&D (BERD) in 2015 was 0.27 % of GDP for the region, which means the region lags behind other Polish regions such as Pomorskie, Malopolskie and Mazowieckie that have spent three and four times more as a proportion of GDP.

Figure 6: Regional Innovation Scoreboard 2019 values for Wielkopolska



Source: Regional Innovation Scoreboard 2019¹⁶

The digital maturity of the region is below EU average, e.g. when it comes to frequency of internet use, 72% of the population in 2017 used it at least once per week, it has however grown with 10% units from 2014. 78% of households had access to broadband in 2017, up from 70% in 2014. On a national level 44% of Poles used internet banks in 2018 and 71% of Poles on an individual basis ordered goods or services over the internet for private use (Eurostat, 2019). Poles have on average lower Internet skills than the rest of Europe, and 49% of Poles have basic skills and usage, compared to 57% for Europe; it is similar when it comes to advanced skills and development where 22% of Poles have this compared to 24% for the rest of Europe. Also, when it comes to use of eGovernment services and online health services, Poland's use of online Health services is 14% vs the EU average of 18%, and 43% of poles use eGovernment services versus 58% of EU average – slightly better than Germany though (Digital Economy and Society Index)¹⁷.

Wielkopolska, was allocated approximately 6.4 billion euros from ERDF, which is around the 10th greatest sum in Europe, and of this around 300 million euro the region has planned for ICT related investments. This means that the region has planned for around 5% in ICT related investments, which is slightly below the EU average of 6%¹⁸.

The region's RIS3 focus is on increasing demand for innovation in public sector, raising innovation and competitiveness of enterprises, adaptation of business environment institutions services to

¹⁶ https://ec.europa.eu/growth/industry/innovation/facts-figures/regional_en

¹⁷ <https://ec.europa.eu/digital-single-market/en/desi>

¹⁸ These data comes from the ESIF viewer Digital (<http://s3platform.jrc.ec.europa.eu/ict-monitoring>)

needs of enterprises, improving innovative competences in the cycle of education and lifelong learning, stimulating innovation by local self-governments and digitalisation of enterprises and public sector entities. The priority areas of the region include Bio-based raw materials, food for informed consumers; Interiors of the future; Industry of tomorrow; Specialized logistics processes; ICT-based development; Modern medical technologies and manufacturing of the Future.

The selected regional DIH – HPC4Poland Digital Innovation Hub (DIH)



The HPC4Poland Digital Innovation Hub¹⁹ (DIH) was launched in 2016 as an outcome of a project under the European Commission's Digital innovation Hub programme: Innovation for Manufacturing SMEs (I4MS). The DIH and its partners are engaged in digital innovation related activities on regional, national and international levels. The DIH participates in the

development of National and Regional Smart Specialisation strategies and support the government in the creation of strategic documents. On the European level, the DIH coordinator is a delegate to the European Commission's Future Internet Forum and acts as national contact point for NGI. On a national level, the DIH co-creates the vision and strategy for the Polish Industry 4.0 Platform. On a regional level, they co-create the RIS3 of the Wielkopolska region and the development strategy Poznan 2030 and they provide services for regional and national smart specialisation areas.

The DIH is a network organization without a formal structure and more than 100 employees. The mission is to co-create and provide High Performance Computing (HPC) tools for manufacturing enterprises. They provide access to comprehensive digital simulation services. In addition, the partners provide support, such as IoT services, interaction technologies, artificial intelligence and cognitive systems, augmented and virtual reality, visualization, and on broadband and other communication networks (e.g. 5G). They also provide a range of business development services, such as training and mentoring services in the area of digital technologies and Industry 4.0 transformation, innovation scouting, strategy development, access to specialist expertise and infrastructure, and access to funding.

The main sources of funding for the DIH comes from Horizon 2020, the European Social Fund, the European Regional Development Fund, regional funding, private funding and partner resources.

¹⁹ <https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool/-/dih/1240/view>

Figure 7: Summarising overview of the HPC4Poland

Funding sources									
European Regional Development Fund	European Social Fund	Horizon 2020	COSME	National basic research funding	National specific innovation funding	Regional funding	Private funding	Partner resources	Membership
Geographical scope									
Global			European		National		Regional		
TRL Focus									
TRL 1	TRL 2	TRL 3	TRL 4	TRL 5	TRL 6	TRL 7	TRL 8	TRL 9	
Organisational form									
Networked organization, without formal structure		Public Private Partnership		Foundation	Private organisation		Public organization (part of RTO, or university)		Joint venture
Partners									
University	Government and agencies	Private firms	Cluster organisations and business networks	User community	Research institutes / RTOs	Industry associations	Chamber of commerce	Incubators and accelerators	Science and technology parks

Note: selected boxes (in grey) indicate the properties of the DIH

Source: the Digital Innovation Hubs catalogue²⁰

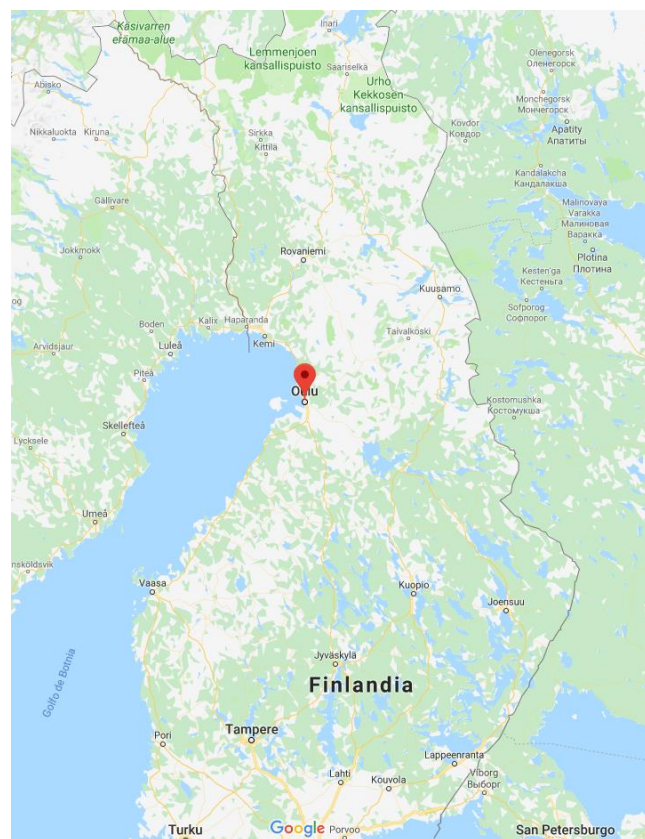
²⁰ <http://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool>

3.3 Oulu, North Ostrobothnia, North & Eastern Finland – OuluHealth

Regional socio-economic context and innovation dynamics

Oulu with 203,750 inhabitants is the capital of the region of North Ostrobothnia, with approximately 403,000 inhabitants and it is the most populous city in Northern Finland. North Ostrobothnia together with six other NUTS3 regions form the North and Eastern NUTS2 region of Finland (Pohjois- ja Itä-Suomi), which accounts for 67% of the national territory surface compared with only 23.5% of the country's total population (approximately 1,296,000 inhabitants in 2017, Eurostat). Out migration has been a severe problem, especially in the eastern parts of the region. This has been balanced by migration to the sub-region of North Ostrobothnia (especially to the city of Oulu). There is an imbalance between large rural areas lagging behind in innovation activities and a few cities with high economic and innovation activity (such as Oulu, Joensuu and Kuopio).

Figure 8: Location of OuluHealth and North Ostrobothnia in Europe



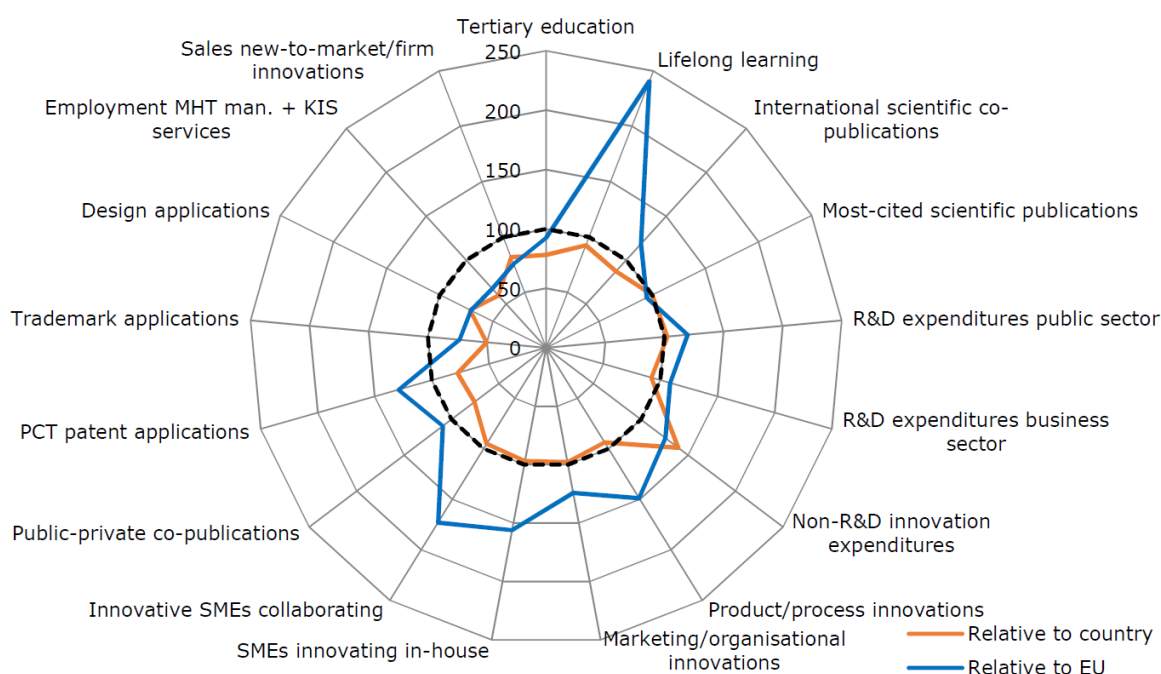
Source: Google Maps

In 2017 the GDP per capita (PPS) was 27,200, clearly below the Finnish average of 32,700. Compared to the EU average, it has also been decreasing, from 95% in 2011 to 90% in 2016. Unemployment is 9.6% (Eurostat), clearly above the national (8.6%) and the EU average (7.6%). North Finland has struggled with the swift change of the information and communication technologies (ICT) sector, where Nokia has reduced its presence in the region. Since 2011, the high-tech sector employment in the region has been decreasing. In 2017, it had 21,300 employees, which represent 15.2% of the national employment in the sector and 3.9% of the total employment (against the EU28 average of 4.0% and the national average of 5.7%) (Eurostat). On the other hand, tourism, stone and mining as well as retail industries have become increasingly important sources of jobs as well as income for the region. It also seems that both forestry and ICT are recovering, but it takes time before this is shown in the employment statistics.

Research, development and innovation (RDI) activities in the region is focused to the ICT sector (especially around the Oulu city-region), and in new emerging sectors such as health. The region is struggling though to get more mature industries, such as machinery, forest and paper to engage more in RDI. North and Eastern Finland has in a European comparison got a relatively high expenditure on research and development (GERD) as a percentage of regional GDP, 2.5% compared to the EU28 average of 2%, however slightly below the national level of 2.9%. The R&D activity is heavily concentrated to the North Ostrobothnia region which contributes with 14% of total investment on a national level and nearly 79% of the GERD of the whole region in 2016. BERD was 61.4% in 2015, below the national average (66.7%).

According to the Regional Innovation Scoreboard 2019, the region is considered to be a “Strong + Innovator”, and innovation performance has increased over time (10.7%). The radar graph shows relative strengths compared to Finland (orange line) and the EU (blue line), showing relative strengths (e.g. Lifelong learning, innovative SMEs collaborating, SMEs innovating in-house and non R&D innovation expenditures) and weaknesses (e.g. trademark applications and Employment in medium high tech + knowledge intensive services).

Figure 9: Regional Innovation Scoreboard 2019 values for North and Eastern Finland



Source: Regional Innovation Scoreboard 2019²¹

The digital maturity of the region is above EU average. Frequency of internet has been reported to 91% of the population in 2017 used it at least once per week, up with 3% units from 2014. 91% of households had access to broadband in 2017 up from 88% in 2014, which is a good number taking into account that the region to large extents is a sparsely populated area. On a national level, 89% of Finns used internet banks in 2018 and 68% of Finns ordered goods or services over the internet for private use (Eurostat, 2019). Finns have on average much higher internet skills than the rest of Europe; 89% of Finns have basic skills and usage, compared to 57 % for Europe. It is similar when it comes to advanced skills and development where 38% of Finns have this compared to 24 % for the rest of Europe. In terms of the use of eGovernment services and online health services, Finland is running ahead the rest of Europe. In Finland, the use of online Health services is 49% vs the EU

²¹ https://ec.europa.eu/growth/industry/innovation/facts-figures/regional_en

average of 18%, and 91% of Finns use eGovernment services versus 58 % of EU average (Digital Economy and Society Index)

Regarding ERDF funds available to the region and planned investments in ICT for the region, North and Eastern Finland was allocated approximately 336 million euros. This is around the 140th greatest sum in Europe, and of this the region has planned for ICT related investments for around 13 million euros, which is around 4 % of total sums, below the EU average of 6%²².

The Oulu city region focus on ICT and digitalisation of other sectors; wellbeing technology and clean technologies are also of focus. Recently a range of specific centres (Centre for Internet Excellence, Centre for Health Technology, Centre for Energy and the Environment) have been established by Oulu Innovation Alliance (OIA) to boost R&D activities and to build up innovation ecosystems. Oulu Innovation Alliance (OIA) is a strategic agreement between the City of Oulu, University of Oulu, Oulu University of Applied Sciences, VTT Technical Research Centre of Finland, Technopolis Plc, The Oulu Region Joint Authority for Education (Osekk), Natural Resources Institute Finland (Luke) and Oulu University Hospital (OYS). OIAs focus has shifted from initially more on R&D to emphasizing more on facilitating SME growth and new business opportunities.

The regional Smart specialisation strategy has several focus areas: Clean Technologies, including Energy; Mining, Steel and Processing Industries, and Wood Processing; Health and Wellness Technology; and ICT and Software Applications for Industry. The RIS3 is strongly linked to the OIA ecosystems.

This concept of Ecosystems is similar to Digital Innovation Hubs and Oulu Health is listed in the DIH online catalogue as a fully operational DIH. OuluHealth is one of the leading digital health innovation ecosystems in Europe. Members of the OuluHealth ecosystem represent the whole spectrum of health and social care, including specialised medical care, primary health and social care, health and wellbeing industry and commerce, health technology research and education, and citizens. The main stakeholders of OuluHealth are Oulu University Hospital (OYS), University of Oulu, Oulu University of Applied Sciences, VTT Technical Research Centre of Finland, and BusinessOulu and the Department of Healthcare and Social Welfare of the City of Oulu. The OuluHealth ecosystem also encompasses more than 600 health and life science companies, at least 240 of which are high-tech companies. The ecosystem approach enables the combination of a broad range of expertise, from wireless information technologies and the life sciences to smart information and communication technology (ICT) solutions for delivering advanced, personalised, connected health service solutions.

When Nokia reduced their presence strongly in Oulu in the beginning of the 2010s, there was a specific focus in the region so that through a concerted effort to stimulate the competences in wireless technologies to grow into innovative companies in health tech and in particular with relation to wireless technologies.



The selected regional DIH – OuluHealth Digital Innovation Hub (DIH)

OuluHealth²³ plays an important role in the implementation of the healthcare and wellness technology focus area. The goals and activities of OuluHealth are aligned with and financed through a wide range of different funding sources. Oulu health also contributes to the development of these strategies, being a long-term actor in the area

²² These data comes from the ESIF viewer Digital (<http://s3platform.jrc.ec.europa.eu/ict-monitoring>).

²³ <https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool/-/dih/6365/view>

of Health tech. These include the Finnish national (Digital Finland Framework) and regional digitalisation strategies (smart specialisation strategy) for Finland's regional government, health and social service reform (Ministry of Social Affairs and Health). On the regional level, OuluHealth has strong collaborations with Allied ICT Finland, which brings together several domain specific DIHs. Through the national Innovative cities programme, INKA Future health, innovation platforms and cooperative R&D projects between major cities in Finland were established. Moreover, OuluHealth is an active player in the implementation of the Health Sector Growth Strategy. On the EU level, OuluHealth is a member of the European Connected Health Alliance, EU COST-Action network: European Network for the Joint Evaluation of Connected Health Technologies (ENJECT) and Digital Health Society Task Forces, which are building EU-level strategies and proposing actions (Action plan 2018) in digital health. The City of Oulu has been granted EIP-AHA reference site status. It is also active in the Thematic Smart Specialisation platforms on Personalised Medicine and Medical Technologies.

OuluHealth supports companies in developing their ideas into market-ready products and services by providing support in activities such as identifying opportunities for digitalisation, bringing together relevant stakeholders, providing testing and piloting platforms and environments, offering services for growth, business development, innovation and internationalisation, and hands-on training.

Figure 10: Summarising overview of OuluHealth

Funding sources									
European Regional Development Fund	European Social Fund	Horizon 2020	COSME	National basic research funding	National specific innovation funding	Regional funding	Private funding	Partner resources	Membership
Geographical scope									
Global		European			National		Regional		
TRL Focus									
TRL 1	TRL 2	TRL 3	TRL 4	TRL 5	TRL 6	TRL 7	TRL 8	TRL 9	
Organisational form									
Networked organization, without formal structure		Public Private Partnership		Foundation	Private organisation		Public organization (part of RTO, or university)		Joint venture
Partners									
University	Government and agencies	Private firms	Cluster organisations and business networks	User community	Research institutes / RTOs	Industry associations	Chamber of commerce	Incubators and accelerators	Science and technology parks

Note: selected boxes (in grey) indicate the properties of the DIH

Source: the Digital Innovation Hubs catalogue²⁴

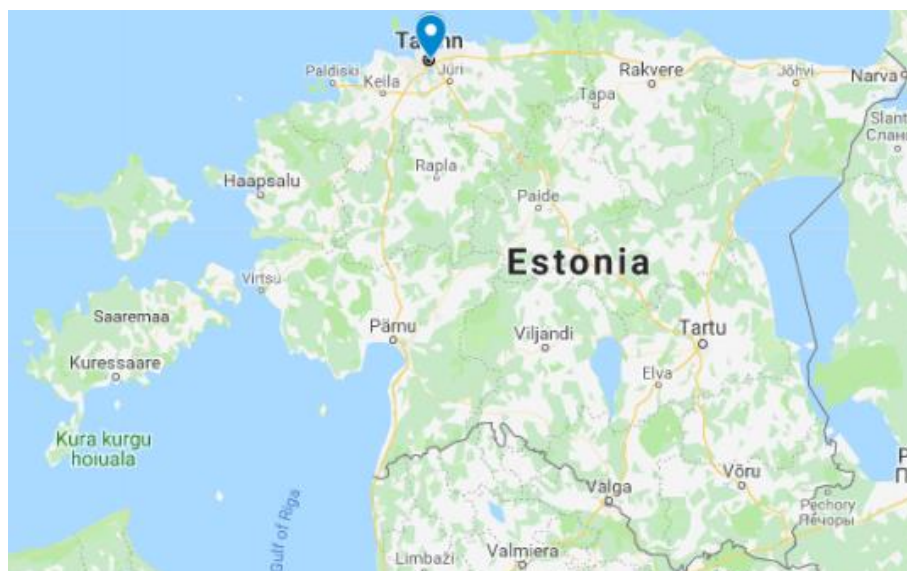
²⁴ <http://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool>

3.4 Tallinn, Estonia - SmartIC

Regional socio-economic context and innovation dynamics

Estonia is a country with a population of 1.3 million people. The capital and the biggest city of Estonia is Tallinn with a population of approximately 413,000 inhabitants.

Figure 11: Location of SmartIC and Estonia in Europe



Source: Google Maps

Industrial production is an important segment of the Estonian economy and is the largest sector in terms of jobs. Industrial production is growing steadily but has fallen behind of the European average in effectiveness and added value rates. Estonia's major exports are machinery and equipment, wood products, agricultural products and food preparations, miscellaneous manufactured articles and mineral products. The Estonian economy is dominated by SMEs in traditional sectors with fairly limited needs for R&D. Investment in R&D is concentrated in a few large companies. Business innovation is concentrated in a limited number of high-technology sectors, such as ICT, biotech, financial and telecom services. At the same time Estonia produces the biggest number of start-ups and seed stage investments per capita in Europe. Estonia continues to have a very favourable business environment, but it is faced with a short supply of highly qualified human resources. Lack of skilled labour has been one of Estonia's greatest challenges for a long time, due to an ageing population, outward migration and low attractiveness of research careers.

Unemployment has been decreasing steadily and was 6.5% in 2018, lowest of the Baltic countries and below EU's average. Furthermore, the average salary has been steadily increasing, with the yearly growth rate adding up to 6.4% in 2018.

In 2016, the R&D intensity was 1.28% of GDP (which was a fall from 1.5 % the preceding year) and business enterprise expenditure in R&D (BERD) also diminished to 0.66 % from 0.69% in 2015. The Estonian R&D system relies largely on competitive project-based policy measures, which funds public universities and as support to private companies. The public sector finances and supports mostly curiosity-driven basic research. Probably the most ambitious policy initiative to connect public research and companies has been support for applied research in the areas of smart specialisation, a measure that supports companies to collaborate with research institutions (the main applicant has to be a company). Around 50% of government spending on research comes from European structural funds. There have been ambitions to try to reduce dependence on these funds, but so far there are no great changes.

Estonia is a "strong innovator" according to the European Innovation Scoreboard 2019. Over time, performance has increased relative to that of the EU in 2011. The strong increase is related to improved performance in the categories of Intellectual assets, linkages and Human resources. Estonia scores high on Innovative SMEs collaborating with others, Trademark applications, and Non-R&D innovation expenditures. Sales impact and employment impacts are the weakest innovation dimensions. Low-scoring indicators include PCT patent applications, SMEs with marketing or organizational innovations, and R&D expenditures in the business sector.

Table 2: European Innovation Scoreboard 2019 values for Estonia²⁵

Estonia	Relative to EU 2018 in 2018		Performance relative to EU 2011 in 2018	
SUMMARY INNOVATION INDEX	95.3		87.2	103.7
Human resources	109.7		94.9	134.2
New doctorate graduates	59.0		53.8	85.7
Population with tertiary education	124.4		125.4	148.5
Lifelong learning	164.3		103.1	167.7
Attractive research systems	94.4		60.8	106.3
International scientific co-publications	141.7		106.4	206.1
Most cited publications	85.2		61.6	93.3
Foreign doctorate students	63.0		29.2	60.2
Innovation-friendly environment	87.9		92.6	138.9
Broadband penetration	88.9		77.8	177.8
Opportunity-driven entrepreneurship	86.9		102.7	112.5
Finance and support	88.5		92.7	96.8
R&D expenditure in the public sector	96.0		109.3	88.8
Venture capital expenditures	82.1		73.0	106.2
Firm investments	90.6		107.3	108.0
R&D expenditure in the business sector	43.8		65.7	50.2
Non-R&D innovation expenditures	176.1		195.1	205.6
Enterprises providing ICT training	47.4		53.3	60.0
Innovators	107.6		109.7	97.7
SMEs product/process innovations	126.5		132.1	122.8
SMEs marketing/organizational innovations	39.3		80.2	33.5
SMEs innovating in-house	152.4		117.0	137.2
Linkages	121.2		111.1	125.9
Innovative SMEs collaborating with others	203.6		211.5	217.4
Public-private co-publications	63.8		40.8	74.8
Private co-funding of public R&D exp.	84.2		67.8	80.8
Intellectual assets	127.8		84.7	124.3
PCT patent applications	36.6		62.5	33.3
Trademark applications	196.2		129.6	218.6
Design applications	153.0		71.0	141.1
Employment impacts	66.4		51.9	69.3
Employment in knowledge-intensive activities	91.8		52.6	100.0
Employment fast-growing enterprises	46.6		51.4	47.1
Sales impacts	65.6		64.2	67.6
Medium and high-tech product exports	55.3		60.5	59.6
Knowledge-intensive services exports	63.7		62.9	65.8
Sales of new-to-market/firm innovations	81.6		70.0	79.2

Source: European Innovation Scoreboard 2019²⁶

When it comes to digital maturity, Estonia is above average. In terms of Frequency of Internet use, 86% of the population in 2017 used the internet at least once per week, up with 4% units from

²⁵ Estonia is not divided in regions therefore the Regional Innovation Scoreboard used is the one in National level in contrary with the regional level RIS used in the other 5 cases of the report.

²⁶ https://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards_en

2014. 87% of households had access to broadband in 2017, up from 81% in 2014. On a national level 80% of Estonians used Internet banks in 2018 and 58% of Estonians ordered goods or services over the internet for private use (Eurostat, 2019). Estonians have on average higher Internet skills than the rest of Europe and 61% of Estonians have Basic skills and usage, compared to 57 % for Europe; it is similar when it comes to advanced skills and development where 28% of Estonians have this compared to 24 % for the rest of Europe. Estonia is a European leader when it comes to the proportion of e-government users, at 95 %, far higher than the EU average of 58%. It is similar when it comes to use of online Health services is 49% vs the EU average of 18%. On the other hand, there is a challenge with the private sector and the digitalisation of companies is trailing. Despite the well-known Estonian start-ups that are dynamic, traditional economic sectors are not digitalised to the same extent. One of the most important reasons is the challenge associated with recruiting skilled people.

When it comes to ERDF funds available to Estonia and planned investments in ICT for the country Estonia was allocated approximately 3.6 billion euros, which is around the 30th greatest sum in Europe, and of this around 223 million euros the region has planned for ICT related investments. The region has been planning to use around 6% in ICT related investments, which is on par with the EU average²⁷.

Estonia is one of the most advanced countries in Europe when it comes to widespread and free Wi-Fi connections, and digital public services and e-government, e.g. the proportion of e-government users, 78% is more than double the EU average (European Commission, 2019). However, in the private sector, digitalisation is a key challenge. There are dynamic start-ups, but the large traditional economic sectors are lagging behind.

Estonia being a relatively small country has opted to govern the Smart specialisation strategy from the national level and embedded in two national strategies, the Estonian Research and Development and Innovation Strategy 2014-2020 and the Estonian Entrepreneurship Growth Strategy 2014-2020. As part of RIS3 processes, a number of priorities have been selected: e-Health; Biotechnology; Industry 4.0, robotics and embedded systems; Cyber security; e-Government and data science; Materials technologies and Enhancement of resources.

Estonia is of the perception that they should no longer try to compete by using a low cost industry strategy, but needs to develop R&D capabilities, interacting more with universities, to become more capable partner in R&D to the industry aiming to modernise technology and preparing the industry's professionals. The DIH - SmartIC is developed according to the strategy of the Estonian smart specialisation growth area of Industry 4.0, robotics and embedded systems and receives European Regional Development Funds for this. The goal is to raise productivity of Estonian companies and employment. The DIH has also been part of the European Commission's I4MS (ICT Innovation for Manufacturing SMEs) programme. The DIH has also received national basic research funding.

The selected regional DIH – SmartIC Digital Innovation Hub (DIH)



SmartIC²⁸ aims to strengthen the ecosystem consisting of different partners from research, development centres and SMEs to collaborate on digitalisation of manufacturing SMEs in Estonia and that both SMEs and large companies can benefit from robotisation and new ICT solutions. SmartIC establishes a new digital research

infrastructure, related to distributed infrastructure at Tallinn University of Technology and Estonian University of Life Sciences in mechanical and industrial engineering, automation, mechatronics,

²⁷ These data comes from the ESIF viewer Digital (<http://s3platform.jrc.ec.europa.eu/ict-monitoring>)

²⁸ <https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool/-/dih/1083/view>

materials science and engineering, and ICT, in order to enhance smart industry research, cross-usage of research infrastructures in Estonia, as well as internationally.

The services the DIH provides include awareness creation; ecosystem building, scouting, brokerage, networking; collaborative research; concept validation and prototyping; testing and validation; pre-competitive series production; commercial infrastructure; and education and skills development.

Figure 12: Summarising overview of SmartIC

Funding sources									
European Regional Development Fund	European Social Fund	Horizon 2020	COSME	National basic research funding	National specific innovation funding	Regional funding	Private funding	Partner resources	Membership
Geographical scope									
Global			European		National		Regional		
TRL Focus									
TRL 1	TRL 2	TRL 3	TRL 4	TRL 5	TRL 6	TRL 7	TRL 8	TRL 9	
Organisational form									
Networked organization, without formal structure		Public Private Partnership		Foundation	Private organisation		Public organization (part of RTO, or university)		Joint venture
Partners									
University	Government and agencies	Private firms	Cluster organisations and business networks	User community	Research institutes / RTOs	Industry associations	Chamber of commerce	Incubators and accelerators	Science and technology parks

Note: selected boxes (in grey) indicate the properties of the DIH

Source: the Digital Innovation Hubs catalogue²⁹

²⁹ <http://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool>

3.5 Seville, Andalusia - Andalucía Agrotech

Regional socio-economic context and innovation dynamics

Andalusia is the most populated Spanish region with 8.4 million inhabitants and Seville is the capital with 1.4 million inhabitants in the greater urban area (Eurostat).

Figure 13: Location of Andalucía Agrotech and Andalusia in Europe



Source: Google Maps

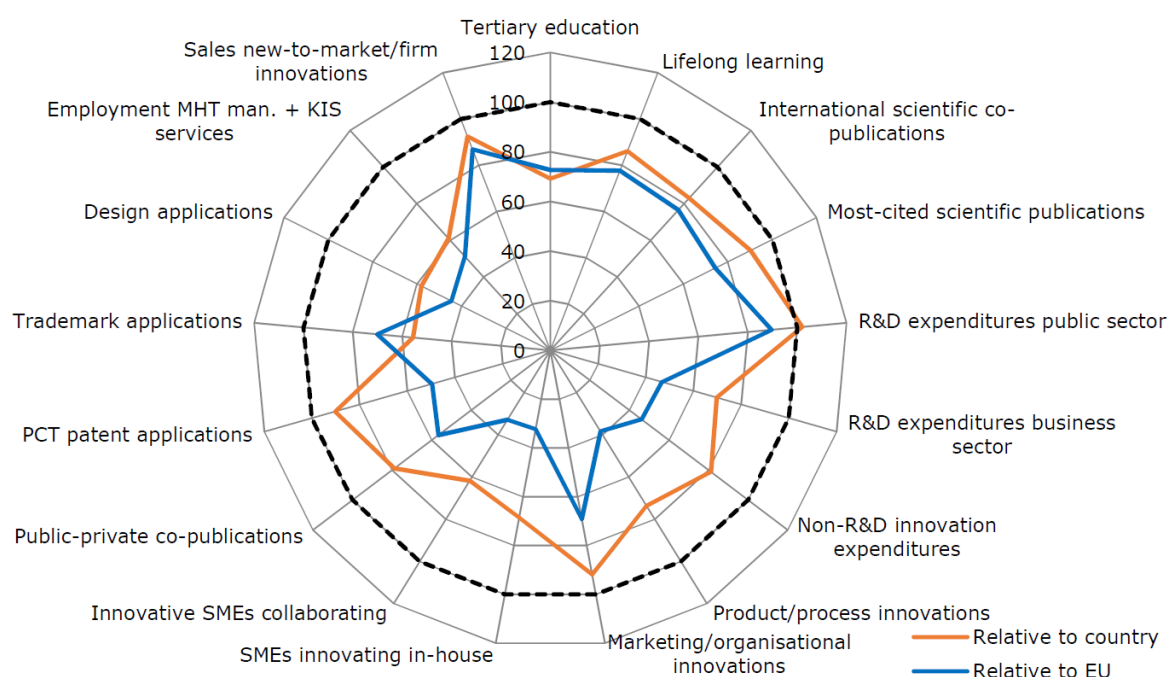
The region of Andalusia is of tradition a strong agricultural area, but the services sector (tourism, retail sales, and transportation) now dominates. The construction sector was very important for the region's economy but was hit hard by the 2009 recession. The industrial sector is less developed than most other regions in Spain and is also to a large extent connected to manufacturing of food, to some extent automotive and aeronautics. The Andalusian high technology sectors employ 73,200 people, which is 10.4% of the Spanish employment in the sector. This number represents 2.5% of the total employment in the region, below the Spanish (3.8%) and EU-28 averages (4.0%) (Eurostat).

GDP per capita (PPS) was 20,400 euro in 2017, which is below both the national (27,600) and EU-28 averages (30,000). The unemployment rate has reached its lowest since 2010, now 25.5%. This is still above the national average, 17.2% and far above the EU-28 average (7.6%).

The Andalusian expenditure on R&D was 1.5 billion euros in 2015, representing 1.0% of the regional GDP. This is below the national average (1.2%) and below the EU-28 average (2.0%) (Eurostat). Furthermore, the share of private R&D is also relatively low. Private companies accounted for 34.2% of the Andalusian R&D expenditures, which is much below the national average of 52.5%;

According to the Regional Innovation Scoreboard 2017, Andalusia is a “Moderate - Innovator”, with innovation performance increasing over time (2% since 2011). The radar graph in Figure 9, shows relative strengths compared to Spain (orange line) and the EU (blue line), showing relative strengths (e.g. R&D expenditures public sector) and weaknesses (e.g. SMEs innovating in-house, innovative SMEs collaborating and patent and design applications).

Figure 14: Regional Innovation Scoreboard 2019 values for Andalusia



Source: Regional Innovation Scoreboard 2019³⁰

With regards to digital maturity, the region is below EU average. The frequency of Internet use is 78% of the population in 2017 use it at least once per week, it has however grown with 11% units from 2014. 71% of households had access to broadband in 2017, up from 70% in 2014. On a national level, 49% of Spaniards used Internet banks in 2018 and 45% of Spaniards ordered goods or services over the internet for private use (Eurostat, 2019). Spaniards have on average lower Internet skills than the rest of Europe, 55% of Spaniards have basic skills and usage, compared to 57% for Europe; it is similar when it comes to advanced skills and development where 23% of Spaniards have this compared to 24% for the rest of Europe. However, when it comes to use of eGovernment services and online health services Spain performs better, where in Spain the use of online Health services is 29% vs the EU average of 18%, and 67 % of Spaniards use eGovernment services versus 58% at EU level (Digital Economy and Society Index).

ERDF funds available to the region and planned investments in ICT for the region are high. Andalusia, was allocated approximately 6.6 billion euro, which is around the 5th greatest sum in Europe, and of this the region has planned for ICT related investments for around 565 million euro. The region has been planning to use around 9% in ICT related investments, which is above the EU average of 6% making ICT an important area for the region³¹.

The vision for the region's smart specialisation strategy is that the region's competitiveness has to be based on a model of Andalusia that is entrepreneurial; advanced in education and training; open; healthy and attractive to live while sustainable and social. To achieve its goals it has identified a number of priority areas, based on where the region currently has its strengths and where it sees a future potential. These are the areas where the region will focus its efforts and investments. The prioritised areas are mobility and logistics; transport industry; sustainable management of natural resources; tourism innovation; the health and well-being systems; R&D in agroindustry and nutrition; renewable energies, efficiency and sustainable construction; and ICT and digital economy.

³⁰ https://ec.europa.eu/growth/industry/innovation/facts-figures/regional_en

³¹ These data comes from the ESIF viewer Digital (<http://s3platform.jrc.ec.europa.eu/ict-monitoring>)

The Regional Ministry of Agriculture, Fisheries and Rural Development of the Junta de Andalucía played a key role in the establishment of the DIH Andalucía Agrotech that supports the digital transformation of the agro food sector in Andalusia. The DIH is connected to the regional smart specialisation strategy, but also to other policy initiatives, at local, regional, national and EU level, such as national innovation and research policies, such as Connected Industry 4.0 in Spain and the EU Digitising European Industry Initiative. The DIH is also active in the Thematic Smart Specialisation Platforms and in particular is leading the specific Partnership on Traceability and Big Data in the agro food value chain.

The selected regional DIH – Andalucía Agrotech Digital Innovation Hub (DIH)



The DIH Andalucía Agrotech³² is an ecosystem, with a non-profit character, created to help companies of the agro food sector in their digitalisation process. The hub gathers the needs of the agro food sector, ICT technological services providers, knowledge agents and public support programmes. It aims to be the contact point for all actors related to the agro food sector and to the implementation of digital technologies in this sector. It is based on different competence centres that offer technological infrastructures, access to knowledge, support to piloting,

testing or experimental projects using digital technologies.

DIH Andalucía Agrotech is part of the H2020 project SmartAgriHubs Project 2020, where it leads the Iberian Regional Cluster. This cluster is an initiative to bring together actors to stimulate a profound digital change of the agro-food sector in Spain and Portugal. The idea is that these partners shall create a joint ecosystem, where the participating actors can better anticipate the sector's need. The project brings together 20 DIHs from Spain and Portugal, including 60 competence centres, ICT companies and start-ups. The project serves as a platform for cooperation and learning. This is a public-private network with a strong focus on reinforcing digitisation in the agro-food sector and is integrated with the Smart Specialisation Strategy (S3P).

The objective of the SmartAgriHubs project is to build a broad European network of regional and national networks, such as the one for the Iberian Peninsula. These networks shall facilitate the transition of the agro-food sector to the digital economy, by exchanging and developing ideas, concepts and prototypes and introducing novelties to the market.

³² <https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool/-/dih/1020/view>

Figure 15: Summarising overview of Andalucía Agrotech.

Funding sources									
European Regional Development Fund	European Social Fund	Horizon 2020	COSME	National basic research funding	National specific innovation funding	Regional funding	Private funding	Partner resources	Membership
Geographical scope									
Global			European		National			Regional	
TRL Focus									
TRL 1	TRL 2	TRL 3	TRL 4	TRL 5	TRL 6	TRL 7	TRL 8	TRL 9	
Organisational form									
Networked organization, without formal structure		Public Private Partnership		Foundation	Private organisation		Public organization (part of RTO, or university)		Joint venture
Partners									
University	Government and agencies	Private firms	Cluster organisations and business networks	User community	Research institutes / RTOs	Industry associations	Chamber of commerce	Incubators and accelerators	Science and technology parks

Note: selected boxes (in grey) indicate the properties of the DIH

Source: the Digital Innovation Hubs catalogue³³

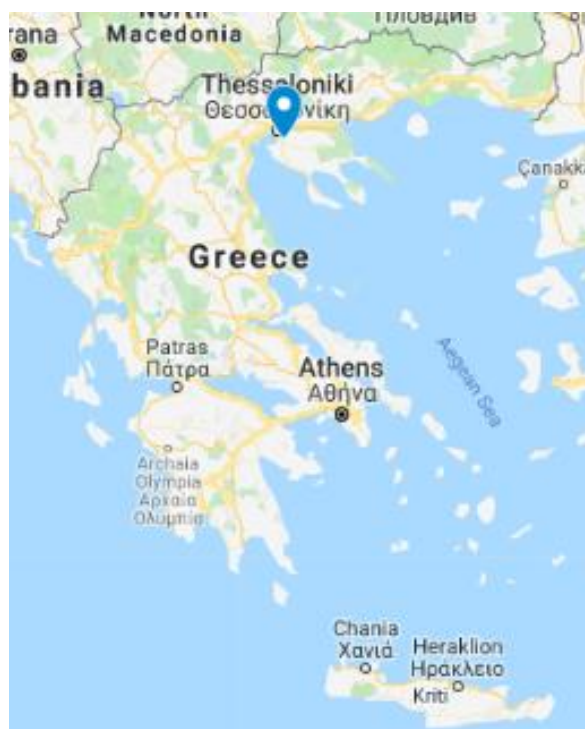
³³ <http://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool>

3.6 Thessaloniki, Central Macedonia - CERTH

Regional socio-economic context and innovation dynamics

The Region of Central Macedonia (RCM) is the largest one in Greece (19,147 km²) and the second largest in terms of population and economic activity. The region has a population of 1.9 million inhabitants (2018) representing 17% of the country's total population and its capital Thessaloniki is the second largest city in Greece with population of around 1.0 million (Eurostat).

Figure 16: Location of CERTH and Central Macedonia in Europe



Source: Google Maps

The economic activity in RCM is concentrated in a limited number of traditional manufacturing sectors and in agriculture mostly in capital and labour intensive activities. The services sector is large but not specialising in dynamic business support services or export services (with the exceptions of tourism and transport). In the area of Research & Innovation the region has a satisfactory and acknowledged level of higher education organisations, research centres, pole of excellence, technological park and highly educated human capital. However the links between the new knowledge production of regional R&I actors with the regional economy remain weak. In the area of Information and Communication Technologies there is a critical mass of businesses and the creation of start-ups in innovative areas shows signs of dynamism of this sector. As regards agriculture and fisheries (agri-food) the region is exporting heavily to big European and other markets. However there is a lot of space for improving quality and introducing technological or non-technological innovations to achieve better competitiveness and reach new value chains. Tourism is also a very important and successful economic activity of RCM that also needs to benefit by introducing innovations in order to attract more quality tourism and become more sustainable. Current sectoral share of employment shows 15% in Agriculture and Mining, 11.2% in Manufacturing, 4.5% in Utilities and Construction and 62% in Services (Eurostat, 2017). Share of employment in manufacture has been in constant decrease during the last two decades.

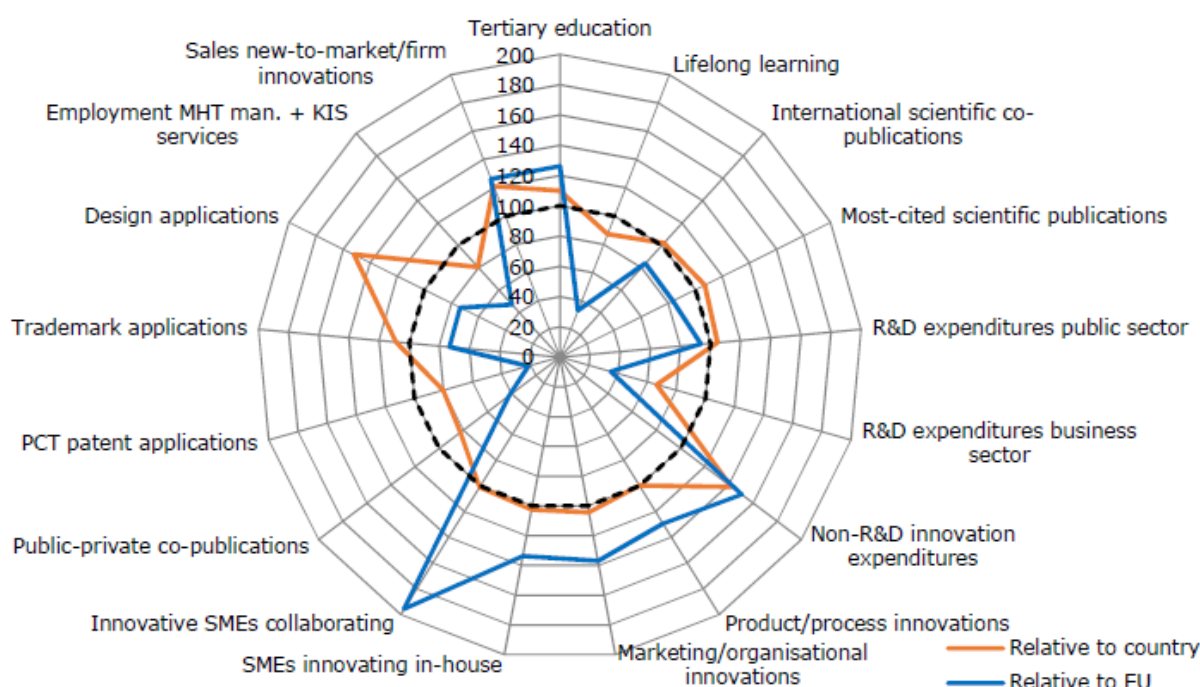
GDP per capita is 16,000 (Eurostat, 2017) which is below the national 20,200 and EU28 30,000 averages. Since 2011 and due to the prolonged economic crisis the region has seen a strong divergence in economic development both with the average in Greece and the EU and in 2017 the

GDP per inhabitant has dropped to 53% of the EU28 average. The unemployment rate is now 22.9 % (2017) but still above the national average of 21.5 % and far above the EU-28 average, 7.6 %. For the purposes of the EU Cohesion policy RCM is classified as a "less developed" region.

According to the Regional Innovation Scoreboard 2019 (RIS 2019) the Region of Central Macedonia is classified as a "Moderate + Innovator" with significant increase of the regional innovation performance over time (21.3% between 2011 and 2019). Relative strengths are noticed in areas such as: percentage of population aged 30-34 with tertiary education, SMEs introducing marketing or organisational innovations as a percentage of SMEs, design applications. Areas that face challenges are among others: percentage of population participating in lifelong learning, R&D expenditure in the business sector, patent applications, and employment in medium-high/high-tech manufacturing and knowledge intensive services. R&D expenditure in the public sector as percentage of the GDP (GERD) is 0.62 while in the business sector (BERD) is only 0.21.

The radar graph below shows relative strengths of RCM compared to average in Greece (orange line) and the EU (blue line).

Figure 17: Regional Innovation Scoreboard 2019 values for Central Macedonia



Source: Regional Innovation Scoreboard 2019³⁴

ERDF funds available to the region and planned investments in ICT for the region are quite high. The Region of Central Macedonia was allocated approximately 2.69 billion euro, and of this the region has planned for ICT related investments of around 196 million euro. This means that the region has planned for around 7% in ICT related investments, which is slightly above the EU average of 6%³⁵.

With regards to digital maturity, the wider region of Northern Greece (EL5)³⁶ is below EU average. The frequency of Internet use is 59 % of the population in 2018 use it daily, 65% of all private households had access to broadband in 2018 while the use of internet banking was at 24% of

³⁴ https://ec.europa.eu/growth/industry/innovation/facts-figures/regional_en

³⁵ These data comes from the ESIF viewer Digital (<http://s3platform.jrc.ec.europa.eu/ict-monitoring>).

³⁶ These data are in NUTS1 level as there is no relevant data available in NUTS2 level for Greece.

people aged 16-74 and the use of eCommerce was 32% in the same age range (Eurostat, 2018). In national level Greece's overall performance is among the lowest in the EU28 with signs of improvement. Areas of weaknesses are fast and ultrafast connectivity infrastructures and 5G readiness while the number of internet users is constantly growing. In human capital dimension, performance remains below the EU average with only 46% of individuals between 16 and 74 having at least basic digital skills (57% on the EU). The use of internet services is well below the EU average however a large percentage of internet users – above the EU average – are keen to engage in a variety of online activities. The use of digital public services is very low with a score 46.9 well below the EU average score of 62.9 (Digital Economy and Society Index Country Report 2019)³⁷.

As regards the RIS3 the Region of Central Macedonia has seen the precondition of ERDF 2014-2020 to put in place a Smart Specialisation Strategy (RIS3), as an opportunity to elaborate for the first time a regional innovation strategy. The vision of RCM expressed in the RIS3 is *to become by 2025 a hub for innovation for South-East Europe, empowering the human capital and enhancing collaboration between knowledge creation actors and entrepreneurship to move forward towards a more innovative economic and social model*. The high priority sectors defined, designated as “Champion Sectors”, are Agri-food, Construction Materials, Textile & Clothing, and Tourism while another four (4) sectors have been identified as technological support sectors: ICT, Energy technologies, Environmental technologies and Transport & Logistics technologies. Implementation of the RIS3 in the region faces challenges and delays like in any other region in Greece (partly due to the unfavourable economic context) but it has gained strong political support. In order to take up implementation, ensure sustainability of the Entrepreneurial Discovery Process (EDP), which is a fundamental element of RIS3, and prepare better for the post 2020 period the RCM has put in place a supporting governance mechanism called One Stop Liaison Office, with three main axes: (1) Monitoring and Evaluating RIS3 strategy and results, (2) Continuous EDP and (3) Facilitating intra and interregional links and collaborations.

In particular one of their top priorities is to use the RIS3 approach to facilitate the digitalisation in the Agri-Food sector in order to improve competitiveness and quality of their products and reach new Global Value Chains. They actively joined since the beginning the interregional innovation ecosystem created by the thematic S3 platform in Agri-Food. Their continuous commitment in the S3P Agri-Food led in active participation and contribution in 3 out of 5 partnerships of the S3P:

- 1) “High Tech Farming”, leader: Tuscany Region, Italy
- 2) “Traceability and Big Data”, leader: Region of Andalusia, Spain
- 3) “Nutritional Ingredients”, leader: Wagralim, Walloon Region, Belgium

The selected regional DIH – CERTH Digital Innovation Hub (DIH)



The DIH CERTH³⁸ (Centre of Research and Technology Hellas) –a non-profit organisation– is one of the largest applied research centres in Greece (700 people with the majority being scientists and turnover ~25 million euro) and the only one in Northern Greece. It is based in Thessaloniki and was founded in 2000. Areas of

its scientific excellence include Energy, Environment, Industry, Mechatronics, ICT, Transportation & Sustainable Mobility, Health, Agro-biotechnology, Smart farming, Safety & Security sectors as well as several cross-disciplinary areas. CERTH operates also as a DIH. Its highly qualified technical and scientific personnel is organised in five (5) specialised institutes and their mission is to transform

³⁷ <https://ec.europa.eu/digital-single-market/en/scoreboard/greece>

³⁸ <https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool/-/dih/3085/view>

scientific knowledge into innovative technological applications. CERTH disposes state of the art research infrastructure and testbeds such as nZEB smart house (listed also as a separate DIH) for exploring smart IoT-based technologies in the fields of energy, health, security, big data, robotics and AI; unique pilot plans for exploring new chemical processes and energy carriers potential enhancement; VR units and simulators for rapid prototyping of intelligent and secure transportation services; analytical equipment and computation power for big data analysis across all domains in Life Sciences. Apart from its very successful participation in competitive research grants (FP7, H2020), CERTH has developed a growing network of collaborations with industries, large companies, SMEs and organisations in national and international level addressing profitable synergies through its scientific expertise on key priority areas.

CERTH has been involved since the beginning in the smart specialisation strategy of RCM as a policy advisor and partner of the regional authority and it is a member of the Regional Innovation Council. Researchers from CERTH have actively contributed with their scientific knowledge in all EDP events organised by the regional authorities for entrepreneurial discovery in the regional RIS3 priorities. They have also provided advice as regards the Monitoring and Evaluation of RIS3 in the region within the context of an OECD report. ERDF and regional RIS3 has been a funding source for CERTH while its main sources of financing are competitive grants from FP7 and H2020 projects (60%) and industrial bilateral contracts with leading industries from USA, Japan and Europe (30%).

There is a wide range of services available to provide to SMEs including: ecosystem building/scouting/brokerage/networking, collaborative research, incubator/accelerator support, access to testbed environments for experimentation, testing and validation, concept validation and prototyping, digital maturity assessment, mentoring and more. CERTH is planning to enhance its role in exchange of know-how and its experience on transferring know-how and linking research with industry in regional/national level and this is the objective of an MOU under discussion with the Greek Ministry of Economy and Development.

Currently its contribution to the digitalisation process of regional SMEs and the public sector is still limited however there are some good examples of collaboration like: a) the collaborative projects (SMEs & CERTH) in the framework of the national RIS3 funded initiative Research>Create-Innovate action for smart farming and the circular agriculture, b) the pilot project of development of a smart sensors system to improve logistics schedule (costs) and timely servicing of customers to ELDIA (largest regional waste management SME), c) the creation of 15 spin-offs that deliver innovative production technologies materializing the 4th Industrial revolution (examples: Infalia (Smart City solutions) and Farextra (staff training in industrial operations)), and d) the Transport Observatory and Data Management portal that provides transport data for the public and private sectors in Greece.

Figure 18: Summarizing overview of CERTH.

Funding sources									
European Regional Development Fund	European Social Fund	Horizon 2020	COSME	National basic research funding	National specific innovation funding	Regional funding	Private funding	Partner resources	Membership
Geographical scope									
Global		European			National		Regional		
TRL Focus									
TRL 1	TRL 2	TRL 3	TRL 4	TRL 5	TRL 6	TRL 7	TRL 8	TRL 9	
Organisational form									
Networked organization, without formal structure		Public Private Partnership		Foundation	Private organisation		Public organization (part of RTO, or university)		Joint venture
Partners									
University	Government and agencies	Private firms	Cluster organisations and business networks	User Community	Research institutes / RTOs	Industry associations	Chamber of commerce	Incubators and accelerators	Science and technology parks

Note: selected boxes (in grey) indicate the properties of the DIH

Source: the Digital Innovation Hubs catalogue³⁹

³⁹ <http://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool>

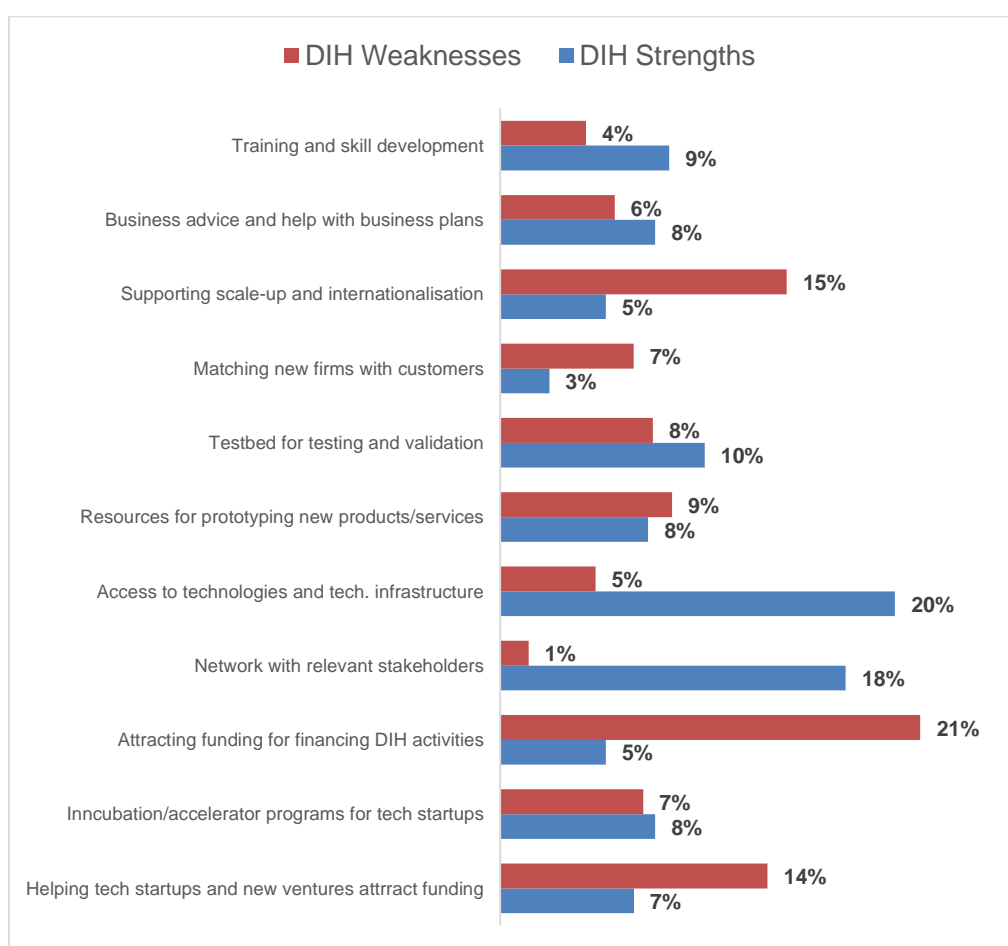
4 Comparing Cases

4.1 The heterogeneity of digital innovation hubs

Against the backdrop of the case descriptions summarised in chapter 3 and the survey conducted among DIH managers and regional policy managers in conjunction with this report, semi-structured interviews were conducted with DIH managers, regional policy managers and business leaders in each of the six selected regions. This chapter summarises the interviews using a comparative approach with respect to common denominators across hubs and regions, both strengths and challenges.

The results from the survey study suggest some common patterns but also considerable variation in perceived strengths and weaknesses reported by DIH managers (Miörner et al., 2019). While networking and access to technologies count as strengths among many of the respondents, funding as well as scaling up and internationalisation clearly come out as weaknesses. Other aspects, such as testbed activities, incubation or accelerator programs and business advice come out evenly as both strength and weakness.

Figure 19: DIH Strengths & Weaknesses



Source: (Miörner et al., 2019)

At first glance, it is tempting to think of the DIH managers as peers working with comparable organisations but because of the inclusive definition for DIHs from the DIH policy initiative there is a considerable variation between hubs which comes into light when exploring individual case studies. A better understanding of this variation is crucial to enable closer comparisons between hubs, to promote the spread of best practices, and to be able to provide some form of general advice on

setting up future DIHs. Specifically, the scope and characteristics of digital innovation hubs appear to vary across at least four different dimensions:

1. Organisational setup
2. Funding
3. Geographical scope and collaboration
4. Digital maturity

4.2 Organising the hub

Highlight

The organizational setup of a hub is not prescribed by the DIH policy initiative, which may be both a blessing and a curse – a blessing because the organizational form can be adapted to regional conditions and contexts but a curse because it may be hard to predict which form is best for which region. Hubs can be formed:

- i) from existing organisations taking on the title and/or rebranding themselves
- ii) by bringing together several existing actors in a (new) virtual organisation
- iii) by creating an entirely new organisation from scratch.

In the case of the **VDTC of the Fraunhofer IFF in Saxony-Anhalt**, the initiation of the DIH was motivated by the establishment of two Mittelstand 4.0 competence centres⁴⁰ at VDTC, but also by the existence of already established research infrastructure focused on digitalisation of the regional industry, ranging back to 2006. Thus, the VDTC represents a case of re-branding an existing regional support organisation as a DIH. One interviewee stated that:

“The DIH concept was well aligned with what VDTC already was doing – to promote digitalisation in the region. It is different from a DIH in terms of its structure, as there are no underlying external stakeholders being part of VDTC, but its role in the region is the same – a central node for digital activities”

(Interview)

A similar case can be observed in **Northern Ostrobothnia**, where **OuluHealth** was established as an organisation already in 2011 and where becoming a DIH has implied only minor changes to an existing business model and organisational set-up while it represented a way to bring together a large number of actors that were already working to solve common issues. In both these cases, the DIHs have relied on an existing physical and virtual infrastructure and ways of working, including established relationships between the organisations and existing strategies.

As regards **CERTH in Central Macedonia** a well-established and internationalised applied research centre/pole of excellence with industrial partners/customers among leading ones in the world sees the DIH branding as an opportunity to enhance its regional/national contribution to transfer of know-how including digitalisation of industrial SMEs. Recognising that their links with regional/interregional industry are not yet very strong they take concrete measures to reinforce them via activities focusing on extroversion and strategic agreements with the national authorities. This case represents a DIH pattern, presumably present in other regions/countries, where an internationally competitive Competence Centre is called to play an important role in the digital transformation of local industry. These DIHs face their specific challenges that should be addressed

⁴⁰ Mittelstand 4.0 is a national program initiated by the Federal Ministry of Economic and Energy in Germany, concerned with the establishment of competence centres with the task of support digital transformation of SMEs.

by the DIH initiative in order to fully explore the potential of these hubs in the regional/national levels.

Another type of hub is based on existing actors and strategic frameworks (for instance smart specialisation strategies) but introduces a new priority (digitalisation) to the work. For example, in Andalusia the DIH was established with direct support from the RIS3-strategy. Interviewees expressed that the DIH started as a 'node' in which different areas of the smart specialisation strategy were combined, and funding was directed through RIS3 to establish a technical office for the hub. In other words, the DIH can be understood as a form of extension or a central one-stop-shop of an existing ecosystem, building on partnerships that were developed in the context of RIS3. One DIH manager expressed that:

"We began as a part of the smart specialisation strategy, it was very important, because we came directly from it" (Interview)

A similar mechanism can be discerned in the case of **SmartIC** in **Estonia**, where a virtual organisation was created in order to exploit the opportunities provided through the DIH initiative and build laboratories that catered to the needs of the industry.

The third category of hubs is one that is initiated from scratch, based on stated or revealed demand from regional industries, specifically to address digitalisation issues. For instance, the **HPC4Poland DIH** in **Wielkopolska** was established to address a market need identified through extensive road mapping efforts. There was a critical mass of firms demanding advanced ICT services but no existing actors to meet this need. Thus, the hub was established to bring together resources and actors to supply regional industries with digitalisation support.

A clear advantage for this type of hub is that it departs from a 'market pull' rather than 'policy push' approach, meaning it becomes self-evident what services it should provide and on what basis. For example, one interviewee from Wielkopolska expressed it as follows:

"We designed services to meet the demand from our region, and it is mainly about satisfying market needs. All activities should be targeted at fulfilling our strategic goals. If a single entity can provide a service on its own, it should not be an activity for the hub." (Interview)

In the Estonian case, **SmartIC** connected to the concrete needs of the industry through partners that were providing links with customers. The DIH is operating on a demand-driven logic, responding to the needs of industry by setting up tailored teams of DIH partners and facilitating access to infrastructure available among its members.

Yet, even if the hub clearly aims to fill an empty niche in the region, it does not have a given place in relation to other regional actors, networks and support systems to start with. One interviewee expressed that there is a risk that introducing the DIH concept creates confusion among actors in the industry, in particular when it comes to support for digitalisation in SMEs. The introduction of additional policy concepts might create problems with 'noise' in the support system for digitalisation already existing in the region, consisting of a number of aligned policies and initiatives. In particular, some of the interviewees from the private sector expressed that the vast number of initiatives that were put in place to support digitalisation and SMEs created a complex system which is hard for smaller firms to survey and navigate. While the DIHs have the potential and an excellent position to enhance the coordination among actors and initiatives in the regional support system, the interview results indicate this potential may be largely unrealised in several regions. For example, one interviewee from the private sector expressed that:

"I think that the public sector is doing an excellent job in managing the hubs, but you end up with very complicated structures with complex targets, and it is hard to know how to realise the potential." (Interview)

One particular need identified through the interviews is related to defining a common view of what types of services DIHs in the region should provide, in order to better focus regional efforts. Interviewees also highlighted the need to make strategic decisions within the DIH, to avoid fragmentation and to use the DIH as a tool for coordination rather than to increase complexity in the support system:

“Don’t lose focus, when you work in this networked world, there are so many requests and opportunities to engage with other actors. Try to avoid jumping on everything, focus on the important.” (Interview)

Indirectly, this speaks to the value of coordinating DIHs with other strategies, such as smart specialisation strategies.

Links with Smart Specialisation Strategies

In terms of smart specialisation, all DIH managers expressed that they were part of discussions regarding smart specialisation in the next programming period. In **Northern Ostrobothnia**, the DIH is part of a wider ‘innovation alliance’ which plays an important role in the entrepreneurial discovery process of smart specialisation in the region. The interviews also show that policy actors are planning to establish a direct engagement with the regional DIHs in connection with their work to develop the next strategy.

Similar examples can be found also in the other cases as well; in **Saxony-Anhalt** the DIH management is taking part in meetings about the smart specialisation strategy, and managers of **HPC4Poland** is representing both the DIH and the regional cluster in discussion with policy actors. In the Region of **Central Macedonia**, while the regional authorities acknowledge the active participation of CERTH in the development of RIS3 and the EDP activities they highlight the importance of CERTH becoming a closer partner in the regional innovation ecosystem they are trying to build around RIS3 top priorities. One example they mentioned was to establish a more permanent collaboration as regards the digital transformation of the Agri-Food sector – one of the top priority smart specialisation sectors of the region.

4.3 Funding for the hub

Highlight

The second dimension across which DIHs vary is funding. While the DIH label opens up additional opportunities for funding, this also contributes to further fragmentation of a funding system that in some cases may already be quite complex to navigate. In addition, hubs must strike a balance between relying on a small number of financiers and potentially run low on funds or relying on a wide variety of different financiers and potentially be torn between different or conflicting commitments.

Funding is a very important area of consideration for all six (6) cases studied and different schemes have been identified. As expressed by one of the hubs in this question:

“We are struggling with navigating funding sources – we sometimes take money from the partners own pockets to invest in projects that are not funded through the traditional channels. In the beginning, this was manageable, but now it is not clear who should pay for what.” (Interview)

The results from the survey presented in Figure 19 show that a large share of respondents (21%) consider the attraction of funding as a weakness, whilst only 5% consider it to be a strength of the

DIH. To some extent, the analysis of interview material illustrates factors that could contribute to the challenges associated with attracting funding.

When it comes to hubs initiated in close connection to existing strategies, such as the smart specialisation strategy, one of the main advantages is that it is easier to avoid such fragmented funding situations, since the DIH receives funding from one or a few sources rather than a large number of smaller ones. This type of arrangement is most likely to be found in a region where local or regional policymakers have the mandate to steer funding and/or regions relying on funding from ERDF.

Funding associated with ERDF was shown to play a pivotal role in all cases under investigation in this study, but especially so in the case of Andalusia where funding for the creation of a DIH organisation and a technical office was directly connected to the smart specialisation strategy, channelling money from ERDF. Of course, this doesn't mean other sources of funding are unimportant, but having one main financier for the establishment of the hub also affects its organisational setup and scope of activities compared to, for instance, a hub established from a series of funded projects from different financiers.

4.4 Geographical scope and collaboration

Highlight

The third dimension along which hubs vary is the geographical scale of their focus, which also has implications for funding. While most DIHs are clearly regional in their original scope, digitalisation is by definition transcending geographical distances. It may prove important to attract expertise and experience from outside the region but also to build digital competitiveness within the region that reaches beyond it.

More precisely, in **Estonia**, **SmartIC** has been established as a part of the national research roadmap, giving the hub a strong position in the national system. The DIH management expressed that they are working on showing proof of a successful implementation of the DIH concept in order to become the 'main forum' for digitalisation at a national level.

Actors in **Northern Ostrobothnia** explicitly stated that they are investigating the possibility for the DIHs to have a coordinating role in national networks. This takes place in parallel with activities at the national level, where the Ministry of Economy and Employment has formed a group to investigate the possibility for a national structure for DIHs in Finland. The **OuluHealth DIH** is thinking about the possibility to establish a corresponding group at the regional level. One interviewee argued that they have a desire to collaborate around certain issues with other DIHs at both national and European level, and they have engaged in building up a national network for dealing with issues concerning artificial intelligence. This would be a network with shared functionalities and competences, where different regional hubs take on different tasks in a network of specialised Hubs. One suggestion is to build networks of regional centres, in a similar fashion on an EU-level.

Departing from a regional perspective, actors in **Wielkopolska** quickly realised that in order to cover the needs of the regional industry, it was necessary to link up to extra-regional partners. In the beginning, the involvement of actors from other regions were limited to partners that provided competences needed in order to provide high quality services, but over time the services started to be adapted to fit the needs also of non-regional customers. From the interviews, it seems that regional focus may even be perceived as an inhibitor to developing the hub:

"We designed the first services for the demand of our own region then we took into account also national needs. We can't disregard reality. It doesn't make sense to limit ourselves to serve only regional customers and work only with regional partners." (Interview)

Other hubs who have started out with a strictly regional focus, have also realised that internationalisation activities might serve as an important next step to further regional digitalisation efforts. For example, one DIH manager expressed that:

"Our current vision is to establish alliances with regional actors, to connect regional actors to solve regional problems. But in a next step, we will need technologies and competences that are not available regionally" (Interview)

Exactly the opposite was the case of **CERTH** in **Central Macedonia** where internationalisation is already their strength since the beginning of their operation under the DIH branding while their engagement in regional digitalisation is still limited. Their motto *"Act locally, think Globally"* has helped them not only to survive but to thrive in terms of turnover and reverse brain-drain effects in a period of severe economic crisis (and lack of national funding available) in Greece that lasted almost ten years. It is an example of reaching out successfully to the global research and innovation ecosystems in much more competitive terms than the regional/national ones in Greece. Their success has led to secure funding mainly from the highly competitive research & innovation programmes (FP7 & H2020) and from collaboration agreements with global industrial players. Nonetheless, they are involved in regional/national R&I and RIS3 and they have been funded from ERDF and RIS3 related measures as well.

It was expressed by other interviewees that it is hard to maintain a clear distinction between on the one hand regional and national funding sources for activities on those scales, and on the other hand EU funding for EU activities. DIH managers perceive a structural divide between different spatial scales and express concern that it was hard to make cross-scale activities, participation in international activities and cross-regional DIH contacts work in practice. One interviewee representing a DIH expressed that it would have been beneficial to have some leeway in terms of funding internationalisation efforts, for instance engaging with customers located in other regions, using regional development funds and ERDF money. Some of the DIHs included in the study have been struggling to engage in collaborations with partners from other European regions. For example, one interviewee indicated that the hub had an interest in presenting examples or import services from other regions but that they had no funding and were thus restricted by the current funding system and the DIH model.

Managers of **SmartIC** in **Estonia** perceive their hub to be situated at the periphery of the EU, with limited interactions with other European countries. The universities, which are dominant actors in the hub, have also pointed out that it has become a significant barrier to hub activities that non-EU students cannot easily participate.

On the other side of the spectrum, internationalisation may also prove to be a challenge in its own right, not least because of language barriers. Both in **Estonia** and **Saxony-Anhalt**, it was expressed by DIH managers that local companies want to interact with people that speak their native tongue:

"Estonian companies want to have people who can speak Estonian" (Interview)

"All our services are in German, it is often hard to find proficient English speakers to work with in the companies." (Interview)

The **VDTC** in **Saxony-Anhalt** and **OuluHealth** in **Northern Ostrobothnia** have both expressed an interest in taking on the role as intermediaries between local firms in their own region and DIHs in other regions, as well as to develop joint service offerings between different DIHs. This would target

the language barrier, but also potentially create new opportunities to navigate the funding system in a way that would make it possible to pool funding across participating DIHs. Representatives from both hubs express the advantages of DIH-to-DIH collaboration at the international level. In **Northern Ostrobothnia**, one interviewee went even further and argued for the establishment of EU-wide DIHs with sectoral focus areas, possibly identified and selected through open calls:

“Instead of regions doing it by themselves maybe there should be EU-wide competition around sectorial specialisations, [...] to identify the best centres in different sectors” (Interview)

The geographical scope of the DIH is also reflected in a need for coordinating policy across scales. Both DIH managers and regional policy managers report having gone to great length in trying to align the DIH and its activities with existing regional, national and European strategies. In three of the cases under investigation, the alignment between the DIH and strategies set at different spatial scales was argued to be one of the main strengths of the approach adopted in the respective region. However, challenges related to policy coordination and embeddedness in the regional economic context were also among the main issues that were highlighted, in particular by regional policy actors. Illustrating this, one interviewee expressed that:

“If the DIH is a mix of all regional strategies then we will lose focus. There are already so many initiatives, and we need to fit the DIH into these.” (Interview)

4.5 Digital maturity

Highlight

In addition to organisational setup, funding and geographical scope, digital innovation hubs also vary in their approach to digital maturity. One recurring theme in the interviews is the balance between supporting basic and general forms of digitalisation efforts aimed at existing industries, and at the same time promoting the development of cutting-edge technological solutions in a niche of the market. This is a trade-off not only between leaders and laggards in digital competitiveness but also between general and specific focus on digitalisation, as well as between established firms and new start-ups.

While digitalising (non-digital) existing industries is one of the main motivations for the DIH programme, it is quite possible that separating the laggards completely from the leaders may only make things worse. A firm that aims to catch up on its digitalisation should have access to leading technologies and tools from start. On the other hand, how this balance is struck may have a significant impact on the role the hub takes in the region.

While several of the interviewed hubs struggle with striking this balance, others have decided to focus explicitly more on one than the other. For example, interviewees in **Northern Ostrobothnia** expressed that even though both are necessary; the focus is on the development and commercialisation of new technologies rather than digitalising ‘non-digital’ industries. It was also mentioned that funding from different sources are used in different ways; For the support of non-digital firms they use ERDF funding, while R&D activities are primarily funded through national grants.

In **Andalusia**, on the other hand, interviewees expressed that the ambiguity that has emerged between broad support and new technology development is a challenge for both the DIH and regional policy actors:

“We are not sure if the DIH should cover both basic digitalisation needs and advanced innovation services, maybe they should not cover everything as it might result in us losing our strength.” (Interview)

In the **Region of Central Macedonia** there is an identified gap between the level of digital maturity of the regional industry, which is mostly traditional, and the pace of introduction of cutting edge digital technologies, which is rather slow, and on the other hand the advanced level of technological innovations and know-how that the **DIH CERTH** can provide. The DIH is not focusing in mainstreaming digital technologies but in transforming latest scientific advancements to technological innovations in areas wider than the regional areas of interest. On the other hand, there is a critical mass of competitive regional/interregional industry including in the Agri-Food sector that could take advantage of the competences that CERTH has to offer. As regards the national level there is really an unexplored potential for CERTH to contribute to the digitalisation of relevant national priority sectors that could highly benefit from its services. According to the regional authorities:

“We would like to see the regional DIH(s) to be closer partner(s) in the policy efforts concerning digitalisation of the local industry and more specifically of the Agri-Food sector.” (Interview)

The **SmartIC Robotics** hub in **Estonia** also underscores the need to balance broad digitalisation support with advanced innovation services. They have organised the hub to function as a bridge between university research and established firms as well as start-ups. This is done through the establishment of committees involving both university and industry representatives, but also through the employment of entrepreneurship specialists that work closely with the DIH management and the regional start-up community.

In terms of embeddedness in regional economic context, the DIHs under investigation all have a strong anchoring and knowledge about their regional industrial context conditions. As already discussed above, this knowledge has been gained through different modes, ranging from feasibility studies to prior knowledge held by actors in existing regional networks. One of the DIHs, taking a stringent approach to mapping the regional context, expressed a need for better methods for performing market analyses and evaluating new potential application areas. The interviewees argued that it would be beneficial for them to get external support for both market analysis and awareness creation activities, as they both lacked internal competences and funding to perform them in-house. As expressed by one interviewee:

“When focusing on building services, we focus on companies that already know what they need. There is an even bigger market out there that we don’t know yet. We don’t have the resources to go around and define their needs with them.” (Interview)

The range of services provided by the DIH may also be subject to conflicts of interest between the partners or stakeholders making up the hub. For the DIH in **Wielkopolska**, it is a strict criterion that any service the hub provides should be refined enough so that it could not have been supplied by any single partner on his own.

5 Multi-sided platforms: A proposed model for future DIHs

Beyond the heterogeneity among digital innovation hubs, there are some common denominators standing out jointly from the statistical survey (Miörner et al., 2019) among DIH managers and the case interviews presented in this report. Specifically, DIHs appear to be well-positioned to establish and grow networks within and potentially also between regions, coordinate actors and activities and gather stakeholders around issues related to digitalisation. Yet, at the same time DIH managers reported having a harder time facilitating matchmaking and testbed activities (despite reporting a wide variety of different physical and virtual testbeds).

Against this background, future hubs may benefit from structuring their business model according to logics similar to the idea of multi-sided platform economies. While current debate relates platform economies primarily to companies like Google or Facebook, multi-sided platforms have been along for a long time; newspapers and magazines (matching ads with readers), television channels (matching ads with viewers), video game consoles (matching game developers with gamers) and shopping malls (matching stores with shoppers) are all examples of multi-sided platform economies. This implies growing by improving the matching between sides and adding new sides to the platform (Rochet and Tirole 2003, Evans 2003, Evans and Schmalensee 2016, Wernberg 2018).

A multi-sided platform economy is essentially a matchmaker. Its main purpose is to grow the population of different sides that stand to benefit from being matched with each other. Digital innovation hubs are already, as we have seen in this report, well-positioned between academic research, policymakers, support system actors, established non-digital firms and innovative, digital start-ups. All of these sides stand to benefit from being matched against some of the other sides, but in order for that matchmaking to generate any real value it has to go beyond networking.

While most DIH managers in the statistical survey (Miörner et al., 2019) point to the hub's network as a strength, most also indicate the hub's inability to facilitate matchmaking within these networks, and that is an unrealized potential. A DIH could for instance, match academic research with start-ups or established firms, established (non-digital) firms with innovative start-ups, start-ups with support system actors, or support system actors with researchers. The trick, however, is not to bring all of these actors into one room or one project meeting, but to identify their respective incentives and to match them with each other individually. Our case comparison provides several examples of how this can be done, from organising open innovation workshops where firms or public actors present problems to local technology suppliers, to being a platform through which actors with needs and solutions are connected.

This has also been illustrated in previous studies (Rissola and Sörvik, 2018). Taking on the role of an intermediary and matchmaker also provides an important additional role for the DIHs in the regional support system, patching together rather than fragmenting support efforts aimed at digitalisation. The case comparison indicates that the particularities of this role should reflect the type of region and DIH under consideration, and general advice can be derived with regards to how to approach the process of identifying such particularities and setting up a DIH.

Platform economies depend on growing corresponding sides gradually, so that an increase on one side promotes growth on the other side in a positive spiral. Working with a platform economy model may also allow DIHs to scale their activities even with limited funding and manpower.

The following five steps provide a brief sketch to how a DIH could pursue if they chose to follow a multi-sided platform model.

1. Map needs and incentives

Identify (actor) groups with corresponding incentives related to digitalisation (so that one side's demand is the other side's supply). In addition, the DIH management need to identify the missing pieces required to realise the potential of the intended matchmaking. These missing pieces make up the mechanisms the hub is set to provide.

2. Design matching mechanisms

Design mechanisms to facilitate matching between two groups, for instance by supplying access to testbeds, technologies or skills and training. The matching mechanism is the focal point for the hub's own activities, i.e. every activity should be related to matching at least two groups together. It is crucial that the mechanisms lower thresholds for collaboration and exchange as much as possible in order for the matched parties to engage with each other.

3. Grow gradually

Start by growing two corresponding sides and matching them with each other. Rather than trying to match all types of actors together at once, focus on capturing the incentives of two groups and bring them together.

4. Data-driven analysis and experimentation

Gather data and feedback on previous matchings in order to evaluate and improve matching mechanisms.

5. Grow through expansion

Add new sides that can be matched to the existing ones, so that the platform can grow both in number of sides and population per side. Adding a new side may include adding another type of regional actor or expanding DIH-to-DIH collaboration to facilitate matching across regions.

Developing a multi-sided platform economy approach to digital innovation hubs – or more generally to regional development policy or even national policy initiatives – addresses an important issue of bridging a fragmented system with many parallel support organisations and frameworks. In other words, the proposed model could be scaled and adjusted to fit a wider policy approach which merits further investigation. However, focusing on DIHs, the point is to move beyond policy actors and be able to match first-hand stakeholders directly and with respect to the DIH core priorities.

For instance, a hub could match innovative start-ups in need of testbeds and experimentation for validation not only with their testbed environments but also with potential customers in the form of public organisations, non-digitalised firms looking for digital solutions or large firms looking to expand their business. Similarly, testbed environments and access to technology could be used to match academic researchers with business representatives. In each of these examples, getting one actor involved with the hub is only half of the solution.

Furthermore, by focusing on matchmaking, the hub can separate problem formulation and problem ownership from solution or innovation and, even more importantly, does not need to be fully responsible for either of them. One side can formulate a problem that needs solution, which can attract innovators and entrepreneurs from the other side, or vice versa. This way, a platform model is scalable in a way that a business model in which the hub needs to own problem or solution can never be. It can also be scaled to cover larger geographies, as long as matching efforts for either side is kept to a minimum.

Matchmaking can also be applied to training and skill-development, as well as to funding issues and it is essentially core to ecosystem-building. In other words, it fits well into the boundaries of DIH focus areas.

6 Concluding remarks

This report explores in more detail different types of DIHs in various geographical and socio-economic contexts and how they participate in the regional innovation ecosystems. Via the comparative approach used it aims to highlight comparative advantages and challenges faced and to provide evidence also in view of the upcoming Digital Europe Programme and the new 2021-2027 programming period. The six (6) case studies presented in this report illustrate four different aspects contributing to a better knowledge of the current variation between different hubs: (1) organisational setup, (2) funding distribution, (3) geographical scope, and (4) focus across degrees of digital maturity. Taking these different dimensions into consideration should significantly improve comparisons between hubs by helping to identify comparable peers or to demarcate the basis for comparison.

In this section we highlight some important conclusions.

The inherent flexibility of the definition of a DIH within the EC DEI initiative has both advantages and disadvantages. If digital innovation hubs are not embedded into their regional context and balanced against other policy initiatives, they could possibly end up further fragmenting and complicate the support system they are supposed to be part of. On the other hand, it is this same flexibility that allows new hubs to adapt continuously to the development within their region, as well as inter-connecting regions through DIH-to-DIH cooperation. Even though there seem to be some common patterns in institutional settings and factors among regions coming from macro regions such as northern and southern Europe or new and old member states, these factors seem to matter less for DIH organisation and management than the importance for a DIH to:

- be well anchored in the regional innovation or digitalisation policy setting,
- clearly identify and respond to industry needs, and
- be well fitted and interrelated with the regional innovation eco system.

Building on the information obtained through the six different (6) cases hubs could be sorted into one of three categories with respect to how they fit into their regional context.

1. They are existing actors maintaining an existing agenda but using the DIH label to rebrand themselves.
2. They are existing actors working with a new agenda to refocus their efforts (towards or within the scope of digitalisation).
3. They are new actors bringing a new focus and agenda to the region.

The first is already integrated into the region with respect to all four factors mentioned above, while the second requires some change and adaptation and the third requires even more adaptation along all four dimensions of variation.

While the success of individual hubs is determined by its ability to harness its flexible form in collaboration with other regional actors and stakeholders, the success of the DIH policy initiative additionally depends on how efficiently it can be evaluated. Because of the resulting heterogeneity among hubs, it may be hard to compare cases and identify best practices or to propose an optimal geographical distribution. Also, with this considerable variation between hubs, it becomes crucial to identify non-functioning or failing hubs in order to propose solutions or eliminating them from the list.

Depending on the hubs funding sources, the influence of policy makers differs substantially. Steering a hub funded through only one funding source is easier for a policymaker, than in the case of a DIH which operates with several different funding sources. In some cases a Hub or similar types of policy initiatives can become successful in securing funding from different sources while not delivering on the overall strategic goals for its setup. There may also be several actors that compete for the funding and creating confusion in the system.

In view of the upcoming Digital Europe programme (DEP) and the role of DIHs in it, it is advisable that DIHs that demonstrate a good connection with the regional/national smart specialisation strategies would be further supported. Consequently, RIS3 managers should proactively identify industry needs and fit their support to DIHs accordingly and work for that the DIH contributes to integrating different parts of the regional innovation ecosystem.

Exploring the heterogeneity of DIHs leads also to suggestions for further improvements on the Catalogue which provides an important baseline for analysis, adding more characteristics aimed at distinguishing different types of hubs (based on the different dimensions discussed above) from each other. Examples of new functionality could be in particular, being able to sort the catalogue with respect to hubs that are for instance virtual network organisations, pre-existing rebranded organisations or new organisations would help to compare cases more easily. Similarly, differences in focus on digital maturity or geographical scope may also help to improve networks and interactions between hubs

The overall quality of the DIHs also matters to the potential for DIH-to-DIH collaboration and cooperation, which stands to become an important future development of the initiative. Ideally, DIHs should not be limited to their own region but be able to access other hubs through exchanges and networking. DIHs will increasingly face the challenge to balance regional, national and global collaborations. An important finding of this study was that DIHs don't want to limit themselves on a regional perimeter imposed by an organisational set-up. DIHs and regional policy stakeholders could benefit more by participating in national and EU wide collaboration networks, and DEP and/or other EU wide initiatives could further emphasise the importance of international networks and support the funding of initiatives that cut across different geographical scales.

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Interviews

Adam Olszewski, Coordinator, HPC4Poland [Interview]

Athanasios Konstandopoulos (and his team), Chairman of the Board and Managing Director of CERTH [Interview; Survey]

Carmen Sillero Illanes, Head of Division for Strategy and Programmes, Agencia de Innovación y Desarrollo de Andalucía [Interview]

Christian Blobner, Head of International Research Networks, VDTC of the Fraunhofer IFF / Fraunhofer Institute for Factory Operation and Automation IFF [Interview; Survey]

Dimitrios Gortzis, Managing Director ELDIA S.A., (SME in Region of Central Macedonia) [Interview]

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Magdalena Bielazik, Marshall Office of the Wielkopolska Region [Survey]

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List of abbreviations

AI	Artificial Intelligence
DEI	Digitizing European Industry
DEP	Digital Europe Program
DIH	Digital Innovation Hub
EC	European Commission
EDP	Entrepreneurial Discovery Process
ERDF	European Regional Development Fund
EU	European Union
HPC	High Performance Computing
ICT	Information Communication Technologies
IoT	Internet of Things
RIS3	Regional Innovation Strategy (S3)
S3	Smart Specialisation Strategy
S3P	Smart Specialisation Platform
SME	Small Medium Enterprise

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