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Emerging regional innovation policies for Industry 4.0: analyzing the Digital Innovation Hub program in European regions

Abstract

Industry 4.0 or digitization, from a regional innovation system and policy perspective to improve regional innovation, is overlooked. Specifically, we focus on analyzing the nascent European Commission Digital Innovation Hub (DIH) program, designed for fostering transition into Industry 4.0 in regions and facilitating new path development. Empirically, 10 Spanish Digital Innovation Hubs are explored through interviews and secondary data analysis. In doing so, this study answers a very simple and overlooked question: what are the key characteristics of emerging European-level regional innovation policies aimed at facilitating Industry 4.0 in regions? Results suggest that DIHs, despite their emerging and trial-and-error stage, are designed for promoting multi-actor collaborative platforms, including *non-local actors*, to stimulate transition into Industry 4.0 by promoting place-based collaboration alliances that respond to local/regional contextual specificities and demands. These regional-based platforms facilitate public-private partnerships that co-design policy initiatives resulting from co-participation and negotiation of spatially-bounded, oriented initiatives for digitizing.

Key words: Industry 4.0, innovation policy, RIS, place-based innovation

1- Introduction

Following Fitzgerald et al., (2014:2), *digitization or digital transformation* (of business) is the “use of new digital technologies to enable major business improvements”. Digitization, and Industry 4.0 specifically, is transforming entire businesses, companies, industries and platforms through the introduction of digital technologies and paradigms (e.g., key enabling technologies, social media, online stores, digital markets, cloud computing, Internet of Things, etc.) enticing a transformative digital disruption (e.g. Fitzgerald et al., 2014; Nambisan, 2017; Autio et al., 2018) and developing new business models (Sung, 2018).

Despite pioneering efforts on developing conceptualizations and logics of Industry 4.0 in the innovation community (e.g. Mariani and Borghi, 2019; Galati and Bigliardi, 2019; Hervas-Oliver et al., 2019; Müller et al., 2018 Ciffolilli and Muscio, 2018; Götz and Jankowska, 2018; Sung, 2018; Li, 2018), its assessment and conceptualization from a regional innovation policy perspective is overlooked, and therefore constitutes this study’s goal. Why is it important to address the regional level? Because innovation is an interactive learning process that occurs at the local/regional level (e.g. Lundvall, 1992;

Cooke and Morgan, 1994; Hassink et al., 2019; De Noni et al., 2018). Thus, we posit that regions constitute a context from which to facilitate SME transition into Industry 4.0. For this reason, in this paper we take up the challenge of analyzing emerging regionally-focused European innovation policies aimed at facilitating the introduction of Industry 4.0 in European regions. For this purpose, we review the regionally-focused European Commission RIS-3 Digital Innovation Hub (DIH) program, within the Smart Specialization platform, aimed at facilitating regional digitization. Empirically, 10 DIHs are studied through interviews and secondary data analysis. As a constituent of the *Smart Specialization* agenda, DIHs are defined by the European Commission¹ as *one-stop-shops that help companies to become more competitive with regard to their business/production processes, products or services using digital technologies*, and constitute one of the leading regionally-focused European programs to facilitate Industry 4.0 in European regions within the *Digital Single Market* package for *maximising the growth potential of the digital economy*². To the best of our knowledge, this is the first study analyzing an emerging European-level regionally-focused innovation policy for facilitating transition into Industry 4.0 and, specifically, deciphering the DIH program. In doing so, this study answers a very simple and overlooked question: what are the key characteristics of emerging European-level regional innovation policies aimed at facilitating Industry 4.0 in regions?

Our study extends knowledge on regional innovation policy-making for the development of Industry 4.0 in European regions, contributing to literature on Regional Innovation Systems (RIS, e.g. Lundavall, 1992; Cooke and Morgan, 1994; Isaksen and Trippel, 2016; Trippel, Grillitsch and Isaksen, 2018; Hassink, Isaksen and Trippel, 2019; Isaksen, Tödttling & Trippel, 2018; Asheim, Isaksen and Trippel, 2019). Besides, this study complements other similar studies performed at the national-level for facilitating Industry 4.0 transition in South Korea (Sung, 2018) and China (Li, 2018). Lastly, this study adds knowledge to the topic of Industry 4.0 from an innovation system perspective, extending thus extant literature on the topic (e.g. Mariani and Borghi, 2019; Galati and Bigliardi, 2019; Sung, 2018; Liao et al., 2017; Fitzgerald et al., 2014; Nambisan, 2017; Autio et al., 2018).

¹ <https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs>

² <https://ec.europa.eu/digital-single-market/en/news/communication-digitising-european-industry-reaping-full-benefits-digital-single-market>

The article is structured as follows. After this introduction, in Section Two, a conceptualization of Industry 4.0 is provided, along with the fundamentals of the RIS perspective. Then, in Section Three, the regionally-focused European Commission Digital Innovation Hub policy is presented and reviewed, discussing results from interviews and data analysis in the Section Four that includes empirics. Then, in Section Five, this study discusses results upon the RIS framework and in the last Section, Six, a summary of conclusions is presented.

2-Industry 4.0 and Regional Innovation Systems

2.1- Introducing Industry 4.0

Concepts such as digitalization or the internet of things, among others, are gaining momentum in business environments and also in manufacturing, known as Industry 4.0 (Liao et al., 2017). When addressing digital manufacturing, the term most used is *Industry 4.0*, although it is not the only one; some others are *smart manufacturing* or *smart industry*. As Rindfleisch et al., (2017) point out, *Industry 4.0* directly refers to manufacturing, encompassing changes in industrial and organizational activities, processes and capabilities in order to obtain opportunities from the new digital paradigm, impacting directly on existent products, services, innovation processes and business models. Industry 4.0 is also known as the *Industrial Internet of Things* and refers to a new paradigm of digital-based manufacturing and industrial inter-firm connected value (e.g., Kagermann et al., 2013). Industry 4.0 includes different technologies such as *Internet of Things*, *Cloud computing*, *Big Data*, *Artificial Intelligence*, *Block-Chain* or *Augmented Reality*, among others.

Different reviews by Piccarozzi, Aquilani and Gatti (2018) and Galati and Bigliardi (2019) find consensus with the main elements or issues encompassing the transformation started by Industry 4.0. In short, the analysis of the intellectual structure of the Industry 4.0 literature reveals that (i) Business (business models transformations, strategies to digitize), (ii) production and operations, (iii) information systems and (iv) human resources or skills are the principal topics that literature builds upon. In this present study, we focus on regional innovation policy, from the perspective of RIS, adding an extra layer and perspective to the intellectual structure of Industry 4.0.

2.2- Regional Innovation Systems: a framework for Industry 4.0 innovation policy

The RIS concept refers to actors, networks and institutions that, acting as a system of interrelated networks and interactions focused on learning and innovation, generate knowledge and drive growth in regions (e.g. Cooke et al., 2004; Cooke, 1992). Strongly rooted in the literature of *National Systems of Innovation* (Lundvall, 1992) and clusters (industrial districts, innovative milieus, etc.) that date back to the 80s³.

Following Isaksen et al., (2018), RIS explains the uneven geographic distribution of innovation in space, as well as policies to improve innovation capability across regions. Through the RIS perspective scholars explain the generation of *new path development* or the different ways of boosting development of new activities and industries in regions to create growth. In this study, we use *new path development* generically for all different ways of boosting regional growth. In this vein, Isaksen, Todtling, and Trippel (2018:223-224) distinguish different paths or changes in regions: path modernization (upgrading of existing industries based on new technologies or organizational change); branching (diversification of existing industries into new but related ones); path importation (setting up of an established industry that is new to the region); and path creation (rise of entirely new industries in a region). As regards types of RISs, distinctions are made between (1) organizationally thick and diversified RIS, (2) organizationally thick and specialized RIS and (3) thin RIS.

The RIS framework presents very interesting fundamentals that can be used to contextualize Industry 4.0 in regions (see more at Hassink, Isaksen and Trippel, 2019), starting with the fact that the DIH program is based on the smart manufacturing platform. Thus, as Asheim, Isaksen and Trippel (2019) state, *smart specialization* is built upon the concept of the Regional Innovation System (RIS). Isaksen, Todtling, and Trippel (2018) posit that RIS system-based strategies aim to improve the functioning of the RIS by targeting system failures, promoting local and non-local knowledge flows and adapting the organizational and institutional set-up of the RIS. Starting with the key importance of a systemic and comprehensive view that includes multiple actors to generate new growth

³ Late 70's with BECATTINI, G. (1979): «Dal settore industriale al distretto industriale. Alcune considerazioni sull'unità d'indagine dell'economia industriale», *Rivista di Economia e Politica Industriale*, n.° 1, pp. 7-21; and then early 80's with *innovative milieus* and other literature.

paths (see Garud and Karnoe, 2003), without focusing only on the entrepreneurial discoveries of business. In fact, this *multi-actor perspective* (e.g., Trippel et al., 2018) goes beyond firms and business to explain how knowledge circulates and is recombined in regions through a different coalition of actors such as universities, governments, technology transfer offices or clusters, among others. From this perspective, the full complexity of new path development is better explained and it is also included in the system-level agency (see Isaksen et al., 2018) that accounts comprehensively for all types of actors that can contribute to creating new knowledge, taking action to transform innovation systems or to supporting changes in regions.

Another key element of the RIS perspective for Industry 4.0 is the *multi-scalar institutional environment*, embracing different spatial scales and of nation-states for regional change (e.g. MacKinnon et al., 2018). Policies and practices of major national and supranational governments are increasingly emphasizing the relevance of digitization, especially for manufacturing (Sung, 2018; Li, 2018). All industrialized countries have started national programs aimed at developing a proper regulatory framework from which to facilitate the development of Industry 4.0. Starting with Asia, South Korea in 2014 launched its “Innovation of manufacturing 3.0” (Kang et al., 2016). Subsequently, China did the same with its “Made in China 2025” program and the “Super Smart Society” plan of Japan in 2015 (see more at Li, 2018). Other national programs across the EU are those such as *Industrie 4.0 Austria* (in Austria); *Smart Industry* (The Netherlands); *Made Different* (Belgium); *MADE* (Denmark); *Smart Industry* (Sweden); *Industria 4.0* (Portugal) or *Piano Industria 4.0* (Italy). All these national programs co-exist with the European DIH one as well as other regional initiatives launched by Regional Governments, observing a multi-scalar system of policies around the same purpose: digitizing regions.

3- The regionally-focused European Commission program for Industry 4.0: Digital Innovation Hubs

3-1 Research methodology

We focused on the European DIH program launched by the European Commission. In particular, we focused on the Spanish DIHs, developing a qualitative-based empirical

exercise to obtain evidence that complements the analysis of the secondary data of the program, available in the official DIH webpage. For this purpose, we interviewed 10 DIHs and also analyzed their secondary data at their respective webpages, as well as material sent by the interviewees. We focused on Spain because it is the country with the highest number of DIHs established throughout its national territory and because we could access to get data. Specifically, there were 68 DIHs registered by November 2019. In April, 2020 we counted 78.

We performed interviews with the managers and/or principal researchers of the hosting organization leading the different hubs in Spain, along with other members of the DIHs, such as firms, policymakers, universities or clusters. In total, 10 HUBs in Spain, listed in Table A-1 in the Appendix, agreed to participate and personal interviews were carried out from July to November 2019, lasting between 1 and 2 hours each on average. In the Appendix more details are provided. A semi-structured questionnaire was followed as a guide to conducting interviews. These are the questions that each member interviewed received in their email for the invitation to participate, before conducting the interview: *Why was the DIH created? (motivation, government's decision or bottom-up and entrepreneurial approach, etc.) What are the key objectives and technologies of Industry 4.0? Who are the key members and their role? How does the DIH select different members? How is the DIH organized (governance)? Does the DIH seek specialization or cross-sectoral diversification in its membership composition? (sector specialization, multi-sectorial focus, regional-based for specific technologies or value chains, etc.) How does the DIH diffuse, generate or develop Industry 4.0 technology? (seminars, technology demonstration events, congresses, training, newsletters, etc.).* Interviews were conducted face-to-face-, through Skype, telephone and some by email. Interviews also were complemented with additional questions depending of the specific DIH and the development of the conversation.

3-2 Introduction to the DIH program

In 2010 the European Commission (EC) launched the *Europe 2020 Strategy* with the objective of adapting the economy to the new social challenges in order to facilitate sustainable and continuous growth. As a fundamental part of this strategy, the EC established *the Digital Agenda for Europe* in the same year, intending to boost the EU

economy by promoting an efficient use of new digital technologies. The Agenda's scope was delimited by the following areas: digital single market; interoperability and standards; trust and security; fast and ultra-fast internet access; research and innovation; enhancing digital literacy, skills and inclusion, ICT-enabled benefits for EU society and international aspects (European Commission, 2010). Implementation of this agenda in subsequent years brought significant initiatives such as the *Digital Single Market*⁴, *European Open Science Cloud*, *Horizon 2020* or *REFIT*, among others. However, undoubtedly, the most important plan is the *Digital Single Market* focused on digitizing EU industry, promoting a shift to digitize products, processes and business models.

Certainly, the star initiative within the *Digital Single Market* is the *Digital Innovation Hubs*⁵ (DIHs) program, launched in 2016, *aimed at creating digital innovation ecosystems in all member nations for the purpose of facilitating digital change*. These DIHs are supported by different initiatives such as the *Innovation for Manufacturing SMEs* (I4MS) or *Smart Specialization Platform for Industrial Modernization*, among others, not receiving funding directly from the EC due to its condition of DIH. According to the European Commission, DIH⁶ are “*one-stop-shops that help companies to become more competitive with regard to their business/production processes, products or services using digital technologies*” (European Commission, 2018a). A major strength of DIH programs is that they unify regionally-embedded relevant actors (such as universities, research centers, competence centers, private companies, incubators and start-up accelerators, clusters, governmental authorities, SMEs, investors, large organizations, etc.) in order to promote multi-partner collaboration (European Commission, 2017a). DIHs focus primarily on SMEs, supporting them through the process of digitization of manufacturing.

DIHs are the front office point to boost digital technologies for companies, offering digital technology testing or pilot project experimentation, acting as nodes to connect local networks of actors (chamber of commerce, universities, trade associations, accelerators, incubators, SMEs, startups, research organizations, investors, etc.) and providing also access to external-to-the-region actors (European Commission, 2018a). Basically, they

⁴ <https://ec.europa.eu/digital-single-market/>

⁵ <http://s3platform.jrc.ec.europa.eu/digital-innovation-hubs>.

⁶ <http://s3platform.jrc.ec.europa.eu/digital-innovation-hubs>

operate as if they were digital-dedicated regional clusters or ecosystems to help regional firms to transit towards digitization, incorporating regionally-dedicated sectoral, technology and business model experts to provide the local/regional industry with digital solutions, creating sustainable digital ecosystems for local/regional support. The significance of these hubs lies in the creation of digital solutions for industry digitalization that are locally responsive. Thus, each DIH is unique and formed by a particular set of local/regional agents with different interests, embedded in existing local/regional industrial bases. Essentially, the aim consists of forming knowledge exchange platforms or collaboration-based networks that can experiment, test, create, recombine and diffuse new knowledge for transition into Industry 4.0.

The most common leading actors hosting or creating DIHs are public organizations (Research Transfer Office or University) or governmental (innovation or development) agencies. Also, other leading actors are private accelerators or public-private partnerships for research, showing organizational structures such as *joint ventures*, *network organizations* (formal or informal) and *projects* with multi-partners with formalized end time (European Commission, 2017b). The most common organizational structure is an informal one, based on a simple memorandum of understanding (not really formal, nor contract-based).

Generally, each DIH supports regional existing industries, provides services such as (i) incubators, mentoring, (ii) training and education; also, facilitating (iii) access to finance, (iv) technology brokerage, (v) and leading the development of local/regional innovation ecosystems; DIHs also provide (vi) access to competence and technology, (vii) develop and test new digital technologies, (viii) support digital experimentation and manufacture of new products and (ix) demonstrate best practices, among many others. However, it is necessary to highlight that the nature of the services and orientation of each DIH is primarily spatially-bounded, that is, dependent on the existing local/regional manufacturing activities and the diverse nature of its stakeholders, to the extent that those factors and local stakeholders do define the specific DIH features, orientations and goals. As such, depending on the local/regional industries, technologies and products embedded in each territory or location and the characteristics of the local companies/organizations involved, each DIH focuses on specific digital technologies and gives response to different regional/local demand.

In 2019, the total number of DIHs⁷ stemming from the EC initiative added up to 519, taking into account that there are countries participating in the program that have no EU membership (such as Switzerland or Serbia, among others). Thus, breaking down that figure by territory, the EU area concentrates the highest proportion with 483 hubs. In 2019, 360 of the EU hubs were fully operational as compared with 159 centers still *in preparation*. Moreover, hubs are endowed with the following digital technologies: Internet of Things (74.6%); Robotics and autonomous systems (60.6%); Data mining and big data (59.3%); Simulation and modelling (55.6); Artificial Intelligence and Cognitive Systems (55.3%); Cyber-physical Systems (49.7%); Augmented and virtual reality (48.1%); Sensors (47.9%); Interaction technologies (47.4%) and Cloud Computing (43.1%). When focusing solely on EU members, the countries with the largest number of supportive hubs are: Spain (68), Germany (55), Italy (51) and France (56) (European Commission, 2018d). Similar initiatives, based on the formation of hubs for collaboration are also replicated in national innovation policy programs, such as the UK Catapults or the German digital hubs, that are similar British and German initiatives, respectively, being inspired by, or inspirers of, the European DIHs.

4- DIH program in Spain: empirical evidence from case studies

4.1- Spanish DIHs: an introduction

We focus on the DIH program in Spain in order to obtain empirical evidence that complements the analysis of the DIH program. As above mentioned, there were 68 DIHs registered by November 2019 and 78 by April 2020.

According to their organizational structure form, there is a clear trend of setting them up as *network organizations* (usually through a *memorandum of understanding*, a very informal way of organizing the collaborative platforms), constituted by an informal collaborative-based coalition of regional innovation actors, whose principal or leading organizations are private universities or research organizations, foundations, governmental (research or development) agencies or public universities, among others (e.g. accelerators, clusters, etc.). In general, informal private-public cooperation

⁷ <https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs>; retrieved on November, 1st 2019

agreements prevail, primarily led by public organizations such as research transfer offices or public universities.

Table 1 represents 10 hubs that constitute an illustrative sample of the manifested hubs' diversity, showing their very different composition and orientation, with key distinct elements such as focal digital technologies, aims, organizational structures or principal actors hosting or leading those hubs. The HUBs or collaborative platforms are free to choose what activities to fulfil, as long as they are oriented to solving regional/local needs in Industry 4.0, especially for SMEs, facilitating thus the formation of the hub from a place-based sensitive and bottom-up perspective and promoting the emergence of *entrepreneurial discoveries* as pursued in the RIS3 program.

These hubs range from those led by accelerators, public universities, regional governments, public technology transfer organizations to others led by clusters and even SMEs. Furthermore, we can also observe hubs that are focused on one or several related technologies (e.g., *HUB4MANUVAL*, focused primarily on Robotics and automation for manufacturing) or others specialized in one single sector, covering all different digital technologies (e.g., *AgroTech*, focused on the agri-food sector; *SEK Lab* for digital technology for the education sector); also, there are others that are focused on a diverse set of sectors and technologies (*NAVARDMIHub*, in Navarra, Spain, focused on manufacturing for automotive, agri-food, health or energy, among others, covering all different digital technologies; *Basque Industry 4.0* hub, focused on advanced materials, smart industry, IoT and energy efficiency for the manufacturing industries such as automotive, equipment or energy, offering digital solutions in robotics, 3D printing or cybersecurity, among others). See Table 1.

Insert Table 1 here.

As shown in Table 1, DIHs are very diverse. For instance, one of the hubs is the *AgriTech-Big Data* in Lleida (Spain), aimed at developing Big Data for the agricultural-food sector. It is hosted and led by a public research organization (*Lleida Scientific Parc*, a public research organization) and its principal partners are the Regional Government of Catalonia, the University of Lleida and the regional Food Industry Association. Another hub is the *SEK Lab EdTech* Accelerator, hosted and led by a private university (SEK University) in Madrid, including partners such as AIR Institute, a private research transfer

organization at SEK, SKE University itself, a startup (*Bstartup*) and another international accelerator (Impact Hub). It is aimed at accelerating startups focused on education using digital technologies for e-learning and online education.

Then there is HUB4MANUVAL, a Hub 4.0 for manufacturing industries in the Valencian Region⁸, Spain. This DIH was established in 2017 at the heart of the Polytechnic University of Valencia (led by the *ai²* research group, focused on robotics and automation for manufacturing), a leading techy university in Spain that hosts the hub. The organizational form of the hub is a research-focused network organization based on a memorandum of understanding, partnering public and private organizations. The constitutive members are the Technological Platform of Traditional Manufacturing Sectors of Valencia Region (PLATECMA), which integrates all the leading traditional manufacturing industries (food, furniture, plastics, metal-mechanical, etc.); the Regional Economic and Innovation Agency (IVACE); the public network of technology transfer offices in the Valencian region named “REDIT”, through AIJU toys-plastic technology transfer organization and the ITC, the Polytechnic University of Valencia (through different research centers, such as *ai²*, *CIGIP*, *PRHLT* and *VRAIN*) and the small firm FBOX. Also, other universities (UJI, UA), technology parks (*Parque Tecnológico UMH*) and clusters (*Valmetal*, metallic manufacturers cluster from the Valencia Region) are actors of the DIH. All these actors participate in a network that performs testing, demonstration and development of applications and solutions for the existing regional industries. In particular, the hub offers i) training, ii) networking, iii) technology transfer (testing, development, etc.) and iv) mentoring (support, consulting on finance, etc.)⁹. The HUB is open to large companies and SMEs’ participation in the testing technologies demonstrations, seminars and other activities.

There are other regions like Navarra (*NAVARDMIHub*) or the Basque Country (Basque Industry 4.0 hub) that have concentrated all efforts on a single hub, led by public technology transfer organizations and regional development agencies, funded by the regional government and constituted by public-private partnerships where SMEs, large firms, universities and public research and transfer organizations meet. This approach differs remarkably from that observed in regions like Catalonia, where there are 14 hubs,

⁸ <http://hub4manuval.ai2.upv.es/es/dih-digital-innovation-hub-en-la-comunidad-valenciana/>

⁹ From interviews with the hub.

ranging from those hosted by public universities or research organizations to those hosted by clusters, local development agencies, industry associations or even accelerators. Looking at the future, the new EC research program Horizon Europe, from 2021, is going to support the former model, emphasizing the formation of hubs that aggregate most regional actors, focused on three core technologies (cybersecurity, artificial intelligence, and high-performing computing; along other digital enablers) and limited to a reduced quota of hubs in each country, as yet not established; these are named EDIH (European DIH)¹⁰.

4.2 Interviews:

DIHs are said to perform different functions, primarily oriented to facilitating networking among all different typologies of regional/local actors, focusing on their specific regional/local context and acting as collective actors. Also, hubs identify key local actors that can boost digital technologies in each given region. As NAVARDMIHub indicated¹¹:

“The DIHs not only promote networking for developing new digital technologies but identify key regional actors that can contribute and also promote cross-industry fertilization, fostering the diffusion of best practices and transferring technology horizontally”.

NEAPOLIS¹² pointed out:

“One of our core activities is to create networking, developing the local ecosystem and presenting new opportunities to digitize products, industries or activities”.

Sticking to networking or open innovation, interviews reveal that inter-firm interaction facilitating learning, experimentation and knowledge diffusion and recombination is central in DIHs. These are fulfilled at DIHs by fostering the formation of cross-function, cross-hierarchical and cross-industry *ad hoc* alliances that promote open innovation and put regional/local needs first, forging alliances that cross traditional industries’ borders and thus arranging and combining regional/local actors in very different and creative alliances for specific tasks. Hubs even perform a function to select those actors in the regions that can initiate and lead change because of their technology and capabilities. For instance, the AIJU¹³ (technology transfer organization focused on plastics and composites) representative pointed out:

¹⁰ From the interviews with HUB4MANUVAL

¹¹ Nancy Tarjenian, from AIN trade association in the NAVARDMIHub, Navarra, Spain

¹² Ester Toledo, from interviews

¹³ Ximo Villaplana, AIJU, REDIT in HUB4MANUVAL, Valencia, Spain

“This freedom of choosing partners, as is the case in the HUB4MANUVAL, is well aligned with the idea of open innovation, but in a very interesting way: different unrelated industries and firms meet here....we can learn from robotics applied to the food industry and we also transfer technologies from plastics that also contribute to the food industry.....crossing ideas and knowledge horizontally in a cross-industry approach..... We used to primarily meet with our own, vertical, value chain. The way the DIH functions allows for a different cross-industry and cross-technology orientation.... This is quite different”

DIH stakeholders pointed out that increasing awareness to change is also a principal task to perform. As such, HUB4MANUVAL pointed out that:

“DIHs are responsible for signaling the necessity to change into digital technologies and also legitimizing the new paradigm confronting policy-makers, increasing awareness and aligning interests of local industries. DIHs work in a place-based manner, being very sensitive to the regional/local needs”.

Similarly, IVACE¹⁴ indicated that:

“Hubs are also introducing new digital technologies to the regional/local industries, testing and experimenting with those that are needed in their focal regions; hubs also legitimize new digital paradigms and technologies, creating awareness and challenging existing lock-in paradigms for the purpose of forming a collective understanding of the digital change and the importance of a regional-based collective and collaborative, response”.

Public and private cooperation, among the regional/local actors involved in the DIHs do facilitate collective action, building upon existing regional capabilities and thus reinforcing the regional ecosystem. In short, interviews reveal that the main activities performed by those collaborative-based hubs are the following:

- Developing new digital technologies focused on regional/local existing demand.
- Removing institutional barriers that may constrain Industry 4.0.
- Aligning interests of local industries.
- Creating awareness on the necessity to change.
- Offering a technological support to develop new technologies to facilitate transition.
- Coordinating actors throughout local industries: cross-industry fertilization goal.
- Creating synergies among actors in the innovation and collaboration platform.
- Legitimizing new digital paradigms in their focal regions.
- Developing a collective understanding of the new digital technologies.
- Selecting leading actors, at the regional level, in order to test, experiment and develop specific digital technologies.

¹⁴ IVACE, Regional Economic and Innovation Development Agency in Valencia, related to HUB4MANUVAL

-Contributing to co-design and co-formulate policy measure for Industry 4.0

Interestingly, we found that hubs do perform different functions. For instance, while HUB4MANUVAL is primarily transferring technology, as it is hosted by a technology transfer institute at a technological university, others such as NEAPOLIS (a Local development agency), Insomnia (hosted by accelerator) or AgroHub (hosted by the regional government of Andalusia) are aimed at promoting networking, mentoring and other services (information, support for engaging in European innovation projects, etc.), without directly transferring digital technology.

As regards the place-based character of those hubs, all informants pointed out the regional/local focus or adaptation of each hub to local products, industries, technologies and actors, thus promoting the design of bottom-up, endogenous and creative initiatives by collective decisions that take into account regional/local needs.

In this sense, AgroHub points out that:

“We focus on local industries, actors and social conditions. To a certain extent, existing local networks are also important and they shape the local needs....this is our starting point”.

As NAVARDMIHub points out:

“Yes, there is a private-public partnership, but this informal understanding allows the private sector firms to make decisions, suggestions and set the agenda.....hubs are organized in a way that permits bottom-up and negotiated initiatives, instead of traditional top-down policies that consider the interests pursued by firms less”.

Moreover, DIHs connect local industries to policymakers, participating in the co-design of digital initiatives and thus performing a *liaison* function to propose and suggest innovation policies to be developed. Hubs also attempt to remove those institutional barriers that may constrain change and development of the Industry 4.0. As the manager of the HUB4MANUVAL states:

“We are in permanent contact with regional policymakers to suggest programs, funding or other ideas that are necessary for digitizing manufacturing in the region, creating an atmosphere of dialogue, ideas exchange and reciprocal feedback to stimulate the innovation debate, suggesting also potential future developments for the regional industries... Yes, in some way we participate in the design of these policies themselves, as we are front runners of change.”

In the same way, NEAPOLIS¹⁵, also manifested that:

“We connect local needs, SMEs and policymakers to call for a better dialogue about digitization and new opportunities”.

Also, AgroHub commented:

“We act as brokers of knowledge between the industry and the policymakers, favoring the alignment of initiatives”.

As regards other key function such as training and transferring, basically all interviewed hubs agree with the fact that, despite being aimed at supporting SMEs’ digitization, most frequently tech transfer and other support activities are performed in partnership with large, even multinational, companies, which are the ones with larger technological capabilities and budgets to participate in research and absorb new technologies. Therefore, these advanced firms are the ones that trigger SMEs’ digitization by interaction with less advanced firms in their respective supply chains. This transfer direction is not the one defined by the European Commission but it is the one outstanding. As NEAPOLIS Hub points out:

“Large and technologically advanced firms are the ones demanding digitization and are also the most proactive firms in engaging with the DIHs.....so, indirectly, we expect that SMEs cooperating with those large firms also learn about digitization”.

HUB4MANUVAL also indicates, in a similar way, that:

“Large firms are the ones that are really benefiting from the hub.....also the small ones, but for testing and developing new technologies the larger ones are most interested and active”.

4.3 Summary of findings

Overall, results show that the DIH policy is aimed at promoting collaborative platforms for digitizing manufacturing, encouraging place-based initiatives and promoting open innovation among all sorts of local/regional actors: accelerators, universities, trade industry associations, SMEs, large firms, startups, etc. The DIH program is built upon

¹⁵ Ester Toledo, from interviews.

inter-firm interaction, bottom-up collaboration and cluster-like functioning, trimming the formation of alliances that account for local/regional contextual specificities and demands, promoting the mobilization of resources to solve spatially-bounded problems. Thus, DIHs enable the co-design of specific initiatives that include all stakeholders, both public and private, facilitating cooperation and dialogue between local/regional stakeholders that can re-shape or adapt existing technologies and institutions for transition into Industry 4.0.

Beyond core activities, such as experimenting and developing new digital technologies or training, these new platforms for collaboration perform other activities to facilitate transition into Industry 4.0, such as removing institutional barriers that may constrain Industry 4.0, aligning interests of local/regional industries, negotiating with policymakers, selecting leading actors to test digital technologies or even co-designing new initiatives on digitization with policymakers, among many others. In addition, our results point out the heterogeneity of hubs and the different regional strategies for hub development.

From all these findings, we can summarize some interesting facts. First, it is important to notice not only the diversity of hubs, but the different approaches initiated by their respective policymakers in each region in an attempt to “adapt” the DIH program to each region. For instance, while Navarra or the Basque Country aggregate all players in a single regional hub that concentrates the regional efforts on digitization and directs them towards manufacturing, Catalonia followed the opposite path, decentralizing and promoting a rather disperse constellation of hubs with different aims and orientations. Interestingly, hubs are going beyond the established plans, developing an endogenous, flexible and dynamic set of different activities, objectives and functions under the general umbrella of digitization. Second, as regards the focus on local needs, the DIH program is built upon an innovation policy approach aimed at promoting not only open innovation among stakeholders, but enabling co-participation and public-private co-design of spatially-bounded industrial strategies. This perspective emphasizes bottom-up collaboration and open innovation, resulting from co-participation and negotiation, adjustment and learning by doing, with a strong emphasis on place-based and spatially-bounded oriented initiatives. Third, despite the fact that industry 4.0 in SMEs is said to have a very positive impact on organizational performance and networking, we notice that the introduction of new technologies is complex and risky in SMEs because of their

limited expertise and investment (Galati and Bigliardi, 2019). DIHs are targeting SMEs but also activating an indirect transfer system through large (*anchor* firms or *technology gatekeepers*) firms instead, as shown in results from case studies.

Overall, main DIH activities include: -developing new digital technologies focused on existing regional/local demand; -removing institutional barriers that may constrain Industry 4.0; -aligning interests of the local industries; -creating awareness on the necessity to change; -offering a technological support to develop new technologies to facilitate transition; -coordinating actors throughout the local industries; cross-industry fertilization goal; -creating synergies among actors in the innovation and collaboration platform; -legitimizing new digital paradigms in their focal regions; -developing a collective understanding of the new digital technologies; -selecting leading actors, at the regional level, in order to test, experiment and develop specific digital technologies.

Lastly, to conclude, it is important to indicate that all the hubs mentioned the idea that hubs, by definition, are under construction in a trail-and-error and learning-by-doing stage. Table 2 shows a brief summary of the main findings from interviews. See Table 2

Insert Table 2 here.

5: Discussion: DIH insights and the RIS perspective.

As a way to highlight some key elements of the RIS framework, we use the above data to compare two DIHs focusing on the RIS perspective: one specialized in robotics and manufacturing (*HUB4MANUVAL*) and another in digitization of services, such as *fintech* or *insurtech* (*Innsomnia*), both in the peripheral region of Valencia (Spain). The former is led by a public body, a University, and the latter by a private organization, an accelerator. Both DIHs, however, present a multiple coalition of public and private actors to organize the necessary knowledge to boost new path development. *HUB4MANUVAL* is led, on the one hand, by a University (more precisely a research institute focused on robotics and manufacturing -automation and IT manufacturing- named ai²) but it includes in its network policymakers (regional IVACE), clusters (*Valmetal*), trade associations (*FEMEVAL*), public research institutes (ITC, AIJU), scientific research parks (*Parque Científico UMH*) and other universities (UJI, UA, etc.), articulating a group of key actors

to boost Industry 4.0 for robotics manufacturing in the Valencia Region. Then, *Innsomnia*, on the other hand, which is led by a private accelerator specialized in the digitization of services and Industry 4.0 technologies (e.g. Blockchain, Big Data, IoT, Artificial Intelligence, etc.) for services industries (*fintech*, *insurtech*, etc.) and services for manufacturing (IoT), integrates a coalition of actors such as private business (large firms such as IBM or Bankia, a large Spanish bank), universities (*Universitat Politècnica de Valencia*, Spain; *Universita di Bologna*, Italy), public research institutes (*Fraunhofer Gesellschaft zur Foerderung der Forschung E.V*, Germany), policymakers (IVACE Valencian Government innovation branch; CDTI Ministry of Industry Innovation branch, Spanish Government). Interestingly, *Innsomnia* presents the same multi-actor approach as *HUB4MANUVAL* but also an additional feature: it contains a multi-scalar institutional environment, as it embraces different spatial scales for boosting regional digitization. Specifically, the Valencian Regional Government is present through its innovation office (IVACE) but also the Spanish Ministry of Industry, through its technology and innovation branch (CDTI). Also, we encounter foreign universities (*Universita di Bologna*, Italy) or even well-known public research organizations from Germany (*Fraunhofer*). Obviously, we identify in this specific case a *multi-scalar* institutional environment and an *exogenous* support from non-regional actors in the sense of (Hassink et al., 2019). DIHs, therefore, are very different from each other and main elements of the RIS perspective are evidenced.

The DIH program is built upon the RIS framework to improve innovation capability across European regions through new patch creation, specifically, it looks like *path modernization*, albeit others can be also observed. It is really interesting to identify in each DIH a coalition of multiple actors to reproduce a small scale of key regional actors to generate new path development by developing Industry 4.0 in different activities, industries or even to boost new industries (e.g. agri-tech business in the agri-food industry or Internet of Things –IoT- in an entire given region). This approach fully coincides with the RIS *multi-actor perspective* (Tippl et al., 2018; Garud and Karnoe, 2003) that includes all range of local/regional actors (universities, clusters, public research organizations, trade associations, policymakers, entrepreneurs, businesses, etc.) to create new knowledge and thus stimulate path modernization, among other different types of “paths”.

As observed in some DIHs, a *multi-scalar institutional environment* is also encountered in the DIH program, embracing different spatial scales and nation-states for regional change (e.g. Hassink et al., 2019; MacKinnon et al., 2018). Similarly, we also identified non-local actors. In fact, it is said that *exogenous support from non-regional actors and non-regional flows of knowledge* can be of support (e.g. Dawley 2014; Isaksen and Trippel, 2016), especially for those DIHs that are not in core regions, such as Valencia in this case. In the typology of *thin* RISs, following Isaksen, Todtling, and Trippel (2018:234), one key tenet of system-based policies consists of strengthening external knowledge links. So, as regards actor-based policies, the anchor firms also play a major role.

As aforementioned, we think that the type of path or regional change sought in the DIH program seems to be *path modernization*, seeking to upgrade existing industries through the development and incorporation of digital tools, albeit some *branching* or even *path creation* can be identified if we consider that Industry 4.0 itself means a reconversion of ICT industry to merge the physical and the digital world for manufacturing, like the CPS (cyber-physical systems or how the equipment includes big data, IoT, artificial intelligence and so forth). The specific type or category, however, is quite difficult to determine, due to the general aim and the diverse typology of DIHs. As regards policy approaches in the sense of Faberberg (2017) the DIH is clearly following the approach of *system-based policy* that puts the emphasis on networks and interactions, different from the *actor-based* approach to boost innovation and capabilities of single actors. The DIH program, however, does not distinguish types of RIS, nor their knowledge bases, and this is a shortcoming in the European DIH program. Also, the DIH is not always coordinated with other similar system-based or actor-based policies launched by each Regional Government for digitizing, observing a different array of non-coordinated policies in the same region, at least in the majority of hubs interviewed. Some DIHs, however, seem to have a strong relationship with regional policymakers to coordinate regional initiatives different from DIH.

Lastly, it is important to highlight that the DIH policy, however, seems a rather *one-size-fits-all policy* that has not yet addressed RIS specificities such as their knowledge bases (Asheim and Gertler, 2005; Asheim et al., 2011) or even the type of RISs (e.g. *thick* or *thin* RIS; Isaksen and Trippel 2016). This DIH policy, however, due to its character of being totally bottom-up, allowing regional actors to configure flexibly their own

collaboration platforms, might be a way to offset the lack of policy adaptation to the type of RIS or knowledge bases.

6-Conclusions

From a policymaking perspective, there is a growing interest in developing regional programs to facilitate transition into Industry 4.0. Industry 4.0 assessment and conceptualization, however, from a regional innovation system and an innovation policy perspective, is overlooked. Our purpose consists of analyzing emerging regionally-focused innovation policies aimed at facilitating the introduction of Industry 4.0 in Europe, focusing specifically on the European Commission RIS-3 Digital Innovation Hub (DIH) program, from the Smart Specialization Platform, aimed at enabling and supporting firms' transition into Industry 4.0. In order to fulfil this goal, this study analyzes the DIH program and empirically explores 10 Digital Innovation Hubs (DIHs) through interviews and secondary data analysis. In doing so, this study answers a very simple and overlooked question: what are the key characteristics of emerging European-level regional innovation policies aimed at facilitating Industry 4.0 in regions?

In short, this study's results offer a comprehensive understanding of a regionally-based European innovation policy program aimed at facilitating transition into Industry 4.0, deciphering the key elements of that digitally-focused innovation policy, fostering growth and new path development, especially path modernization. According to the results, DIHs are directly connected to fundamentals of the RIS perspective (e.g. Cooke et al., 1997; Isaksen and Trippel, 2016; Asheim, Isaksen and Trippel, 2019; Hassink et al., 2019) and the new one self-named *ecosystems of innovation* (e.g. Autio et al., 2018), although not fully embracing all the RIS theoretical features, as explained below. As shown in the results, the DIH initiative is aimed at promoting learning by interacting, facilitating the constitution of spatially-bounded and place-based collaboration platforms by regional actors, networks and their respective institutions, that is, the core elements of the RIS framework.

The following conclusions from the study of DIHs, related to the RIS perspective, are as follows:

-DIHs are run by collective decisions that take into account regional/local needs. Public and private partnerships co-design and co-formulate indications for policymaking in

Industry 4.0 similar to those reflected in other place-based policy initiatives [see Hervas-Oliver et al., (2019), Bailey et al., (2018) or Magro and Wilson (2018), Grillitsch, & Tripl (2016), among many others].

-DIHs are primarily based on *informal networks* as the most common organizational structure, based on a simple memorandum of understanding, but not contract-based.

-DIHs are very heterogeneous, showing different activities, objectives and functions, also influenced by their respective regional policymakers.

-DIHs are based on Smart Specialization, focusing on path modernization and path creation (depending on the country and region) through cross-fertilization of regional actors, industries and activities, albeit not limited to just entrepreneurial discovery through businesses or entrepreneurs.

-DIHs are based on the primary idea of RIS related to learning by interaction or open innovation, fostering primarily spatially-bounded, place-based and network-based learning and knowledge recombination through inter-actor interactions and knowledge exchange.

-DIHs are led and orchestrated by private and public organizations, built upon a coalition of actors (multi-actor perspective) that resembles the system-based policy that accounts for the entire system that contributes to creating new knowledge.

-DIHs are mostly organized around regionally-based (local-based) actors, as the primary goal consists of supporting Industry 4.0 new path development regionally or locally. Some DIHs, however, include non-local actors or external (inward) flows of knowledge to the hub and region.

-DIHs are targeting SMEs but also activating an indirect transfer system through large (*technology gatekeepers*) firms instead, as shown in results from case studies, at least in the case of *thin* RIS regions.

-DIHs are not primarily working in coordination with other existing regional initiatives that pursue the same goal of digitizing, although some of them show a strong relationship with regional policymakers to coordinate other similar regional initiatives different from DIH.

-Overall, DIHs seems to be a rather *one-size-fits-all policy* that has not yet addressed RIS specificities such as their knowledge bases (Asheim and Gertler, 2005) or even the types of RISs (Isaksen and Trippl 2016).

As has been shown, this study has presented a regionally-focused European approach to understanding innovation policy to facilitate transition into Industry 4.0. Specifically, this study is frameworked within the RIS perspective to understand new path development focused on digitizing regions, contributing to the RIS approach (e.g. Cooke et al., 1992; Hassink et al., 2019) and to the place-based innovation policy strand (e.g. Flanagan et al., 2011; Bailey et al., 2018) towards digitization (e.g. Hervas-Oliver et al., 2019; Götz and Jankowska, 2018). Overall, the DIH program mimics other modern regionally-focused innovation policy initiatives aimed at reindustrializing and boosting manufacturing, such as those reflected in Hervas-Oliver et al., (2019) or Magro and Wilson (2018) that emphasize bottom-up collaboration and regional collaboration, public-private co-design of initiatives resulting from co-participation and negotiation among (multi-actor) stakeholders and approached by place-based and spatially-bounded oriented initiatives.

As ancillary conclusions, these results complement similar studies performed in other contexts and scales (nation-level) to analyze policymaking for digitization of manufacturing, such as those focused on South Korea (Sung, 2018) or China (Li, 2018), enriching the topic of Industry 4.0 from an innovation system perspective (e.g. Galati and Bigliardi, 2019; Liao et al., 2017; Fitzgerald et al., 2014; Nambisan, 2017; Autio et al., 2018).

For policymakers, it is important to point out that the DIH program constitutes a policy template to help regional policymakers to launch initiatives for digitizing regions. The DIH program incorporates main RIS elements and guides policymakers towards articulating initiatives to foster new path development. It is also important to consider that the DIH program is a *one-size-fit-all* policy that requires adaptation to local needs, as it does not consider to the different types of settings (types of RIS, their knowledge bases, etc.). Interestingly, we noticed that practitioners (those orchestrating the hubs) were impressed by the “regional approach” followed by the European Commission, realizing that practitioners are quite alien to the RIS framework, something they need to learn.

This study also presents limitations, as the DIHs and their regions analyzed belong to a technology-follower country, Spain, and most of their regions are considered to be *thin* RISs. The type of new path creation observed, therefore, might be biased as we primarily studied those DIHs in Spain, nor the rest of Europe and those in *thick* regions. For future studies, it would be interesting to assess how effective those programs are, analyzing their performance effect and extending the analysis to a wider sample across countries and including also RIS typologies in the study in order to evaluate whether the type of RIS influences DIHs and their performance.

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APPENDIX

Table A-1 Interviews' details

DIH	Details
AgriTech BigData, (Agri Tech BigData) ¹⁶	Gabriel Anzaldi, (Manager; 2 hours)
AgroTech Hub	Judit Anda (Manager, 2 hours)
Insomnia	Francisco Estevan (Manager, 2 hours)
SEK Lab EdTech Accelerator ¹⁷	Felix Lopez (Manager, 2 hours)
NEÄPOLIS ¹⁸	Ester Toledo (Manager, 2 hours)

¹⁶ <http://agritech-bigdata.com/es/home-es/>

¹⁷ <https://seklab.es/>

¹⁸ <http://www.neapolis.cat/>

HUB4MANUVAL: Hub 4.0 of Manufacturing Sectors in Valencian Region ¹⁹	Francisco Blanes (Manager, 3 hours); Joaquin Villaplana (Technology Transfer Centre, AIJU, plastic-related technology centre of expertise, public research institute; member of the DIH; 2 hours); Valmetal (Marta Jiménez, cluster manager; metallic products cluster; member of the DIH; 2 hours); IVACE (policymaker Julia Companys, 1 hour; member of the DIH); Prof. Dr. Angel Ortiz (CIGIP member, research group on industrial organization and engineering, Universitat Politècnica de Valencia, 1 hour; member of the DIH)
CIDIHub: Canary Island Digital Innovation Hub ²⁰	Jorge Galvan (manager, 1.5 hours)
Robotics Digital Innovation Hub Hub ²¹	Dr. Anibal Ollero (manager, 2 hours)
NAVARDMIHub: Navarra Region Digital Manufacturing Innovation HUB ²²	Nancy Tarjenian (Manager, 3 hours)
IoT Catalan Alliance ²³	Rosa Paradell (Manager, 1 hour)

Tables

Table 1. A sample of Spanish DIH. An example of hub heterogeneity

AgriTech BigData, (Agri Tech BigData) ²⁴	<p>Region: Lleida, Spain</p> <p>Structural organization: public-private memorandum of agreement; hosted by a public university (University of Lleida)</p> <p>Coordinator: <i>Lleida Scientific and Technological Park</i></p>	<p>Description: AgriTech Big Data has the goals of: encouraging Big Data knowledge, incorporating the digital technologies in the agri-food sector, improving education and achieving a competitive advantage.</p> <p>Main technology: Big Data for farming</p> <p>Partners:</p> <ul style="list-style-type: none"> • <i>Government:</i> Regional Government of Catalonia • <i>Networked:</i> Cluster of Agricultural Production Mean in Catalonia and Lleida Agri-Food Science and Technology Park • <i>University:</i> University of Lleida. • <i>Industry Association:</i> Community of food production technologies.
AgroTech Hub	<p>Region: Andalucía Spain</p> <p>Structural organization: networked organization, without formal structure (informal memorandum of agreement)</p> <p>Coordinator: hosted by the Regional Government</p>	<p>The Digital Innovation Hub (DIH) Andalucía Agrotech is an ecosystem created to help companies in the digitisation process of the agri-food sector. This hub gathers the needs of the agri-food sector, technological services provided by ICT companies, the innovation capacity of knowledge agents and public programmes promoted by the public administration to provide support.</p> <p>Partners:</p> <ul style="list-style-type: none"> • INNOVASUR • IBM Spain

¹⁹ <http://hub4manuval.ai2.upv.es/es/dih-digital-innovation-hub-en-la-comunidad-valenciana/>

²⁰ http://avantalia.net/dih_canarias.html

²¹ <https://grvc.us.es/>

²² <https://www.clustercollaboration.eu/cluster-organisations/industrial-transformation-cluster-ain>

²³ <https://www.cataloniaiot.com/>

²⁴ <http://agritech-bigdata.com/es/home-es/>

	(Agriculture Department) of Andalusia, Spain.	<ul style="list-style-type: none"> • University of Cadiz • University of Seville • University of Almeria • University of Cordoba • University of Malaga • HISPATEC • Others
Insomnia	<p>Region: Valencia Spain</p> <p>Structural organization: Project (formalized end time)</p> <p>Coordinator: hosted by Insomnia, an accelerator</p>	<p>Insomnia is a Business Accelerator, Incubator and Digital Hub located in Valencia, Spain, working to improve innovation in the region of Valencia and support SMEs, and in particular industrial SMEs, to uptake the use of ICT and face the challenges of digitization.</p> <p>Main sectors: fintech, legaltech, insurtech, among others.</p> <p>Main technologies: artificial intelligence, virtual reality, augmented reality, big data, IoT, Cloud, HPC, 5G, 3D printing, robotics, blockchain, etc.</p> <p>Partners:</p> <ul style="list-style-type: none"> -IBM (Spanish subsidiary) -Fraunhofer (Germany) -Universitat Politècnica de València (Spain); Universitat di Bologna (Italy) -Bankia, a large Spanish commercial Bank -Chamber of Commerce of Barcelona (Catalonia, Spain) -<i>Regional Economic and Innovation Agency: IVACE</i> (Valencian Government, policymaker) -National policymakers: CDTI (Technology and Innovation Development Center, Ministry of Industry, Spanish Government); ICEX (Export Institute, Ministry of Industry)
SEK Lab EdTech Accelerator ²⁵	<p>Region: Madrid, Spain</p> <p>Structural Organization: hosted by a private university (SEK University)</p> <p>Coordinator: SEK University</p>	<p>Description: SEK Lab is a startups accelerator through a six months education program.</p> <p>Technologies: focused on eEducation</p> <p>Partners:</p> <ul style="list-style-type: none"> • <i>Research Transfer Organization: AIR Institute</i> • <i>Private University: SEK</i> • <i>Start-up: Bstartup</i> • Impact Hub (accelerator program)

²⁵ <https://seklab.es/>

<p>NEÀPOLIS²⁶</p>	<p>Region: Barcelona, Spain</p> <p>Structural Organization: hosted by a Public Economic Development Agency (Neàpolis)</p> <p>Coordinator: Neàpolis</p>	<p>Description: Neàpolis is a regional Governmental Agency constituted in order to boost the innovation activities in the territory, both individual and enterprise initiatives.</p> <p>Partners:</p> <ul style="list-style-type: none"> • <i>Local Regional government: Villanova i la Geltrú City Council.</i> • <i>Public Economic Development agency: Neàpolis</i> • <i>University: EPSEVG-UPC (Polytechnic University of Catalonia)</i> • <i>Start-up: Syntesa</i> • <i>Leading SME: Tetrao</i>
<p>HUB4MANUVAL: Hub 4.0 of Manufacturing Sectors in Valencian Region²⁷</p>	<p>Region: Valencia, Spain</p> <p>Structural Organization: public-private memorandum of understanding forming a new Research Network Organization</p> <p>Coordinator: hosted by Polytechnic University of Valencia (UPV), through ai² (research institute)</p>	<p>Description: HUB4MANUVAL is an innovation hub to boost the integration of robotics, CPS and IoT in the manufacturing companies of the Valencian Region. Its members are university, TTOs, SMEs and development agencies from the Regional Government. Led by the Valencia Regional Network of TTOs “REDIT” and the Polytechnic University of Valencia</p> <p>Partners:</p> <ul style="list-style-type: none"> • <i>Industry Association: Technological platform of traditional manufacturing sectors of Valencia Region (PLATECMA)</i> • <i>Regional Economic and Innovation Agency: IVACE</i> • <i>SME: The Funding Box Group</i> • <i>University: UPV</i> • <i>Institute: Centro Tecnológico del juguete (AIJU), ITC</i> • <i>Other UPV research organizations (CIGIP, PRHLT and VRAIN)</i> • <i>Other Universities (UA, UJI)</i> • <i>Clusters (Valmetal), Trade associations (FEMEVAL)</i>
<p>CIDIHub: Canary Island Digital Innovation Hub²⁸</p>	<p>Region: Tenerife, Spain</p> <p>Structural Organization: Public-Private Partnership forming a memorandum of understanding</p> <p>Coordinator: SME AVANTALIA</p>	<p>Description: The CIDIHUB aims to strengthen Canary Island digitalization, working as the connecting link between technology suppliers and companies, especially in IoT, Artificial Intelligence, Cognitive systems and Cloud Computing.</p> <p>Partners:</p> <ul style="list-style-type: none"> • <i>SME: AVANTALIA</i> • <i>Regional government: Gran Canaria Island Council, The Canary Government and Tenerife City Council.</i> • <i>Industry association: The Federation of manufacturing and New Technologies SMEs of Las Palmas</i> • <i>TTO: Institute of Technology and Renewable Energies</i> • <i>Regional government of Canary Islands</i>

²⁶ <http://www.neapolis.cat/>

²⁷ <http://hub4manuval.ai2.upv.es/es/dih-digital-innovation-hub-en-la-comunidad-valenciana/>

²⁸ http://avantalia.net/dih_canarias.html

<p>Robotics Digital Innovation Hub²⁹</p>	<p>Region: Sevilla, Spain</p> <p>Structural Organization: hosted by a university, through a public-private cooperation based on a memorandum of understanding</p> <p>Coordinator: University: University of Sevilla</p>	<p>Description: Robotics DIH was established to offer services for increasing the digital technology adoption in manufacturing enterprises, collaboration and networking activities being its core.</p> <p>Partners:</p> <ul style="list-style-type: none"> • <i>Large</i> enterprise: NAVANTIA and Ghenova Ingenieria • <i>TTO</i>: Andalusian Foundation for Aerospace Development and Research & Technology Organization. • <i>University</i>: University of Malaga and University of Sevilla • <i>Networked</i>: Technological Corporation of Andalusia. • <i>SME</i>: Droneetools
<p>NAVARDMIHub: Navarra Region Digital Manufacturing Innovation HUB³⁰</p>	<p>Region: Pamplona, Spain</p> <p>Structural Organization: public-private informal agreement.</p> <p>Coordinator: Cluster Organization: (AIN) Industrial Transformation Cluster</p>	<p>Description: The NAVARDMIHub aims to improve the manufacturing results of Navarra enterprises, through providing digital services as competence centers, funding, advice, employment boosting and innovation activities.</p> <p>Partners:</p> <ul style="list-style-type: none"> • <i>Public University</i>: Universidad Pública de Navarra • <i>Industry association and cluster</i>: Association of Industries of Navarra AIN. • <i>ADItch</i> Technology Corporation (public network of six technology transfer organizations) • <i>Cluster Organization</i>: AIN Industrial Transformation Cluster • <i>Large firm</i>: Nasertic (IT technology firm)
<p>IoT Catalan Alliance³¹</p>	<p>Region: Barcelona, Spain</p> <p>Structural Organization: Temporary Project (formalized expiration time)</p> <p>Coordinator: Public Research & Technology Organization: i2Cat</p>	<p>Description: The IoT Catalan Alliance arose as a collaborative project to motivate IoT in Catalonia, using innovation as main driver to achieve competitiveness.</p> <p>Partners:</p> <ul style="list-style-type: none"> • <i>SME</i>: TAI Smart Factory; Sensefields; Nearbysensors; The world of Thor; Nexiona; InnovalT; Accent systems; Barkeno; Zolertia and OTC Engineering • <i>Start-up</i>: Datalong16; AEInnova and Thethinks.io • <i>Large Enterprise</i>: Nokia; Cat-info; Everis, Vodafone; Simon and Cellnex • <i>University</i>: La Salle and Autonomous University of Barcelona (UAB) and Polytechnical University of Catalonia • <i>Research and Technology organization</i>: Eurecat; CTTC; BSC-CNS CIT-UPC and i2CAT

Source: Own Compilation with European Commission Data³².

Table 2. Summary of main findings from DIHs' main features.

<p>Public and private informal cooperation</p>	<p>Facilitate collective action and public and private cooperation for digitization, usually in an informal way through a memorandum of understanding, not a formal contract.</p>
<p>Hubs as new collaborative</p>	<p>Performing key activities. Removing barriers to change, coordinate efforts and act as brokers of institutional and technological processes, aligning</p>

²⁹ <https://grvc.us.es/>

³⁰ <https://www.clustercollaboration.eu/cluster-organisations/industrial-transformation-cluster-ain>

³¹ <https://www.cataloniaiot.com/>

³² <http://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool>

platforms that perform activities to digitize.	stakeholders, developing a collective understanding of the new technology and facilitating the development of an institutional framework that stimulates change, even reshaping existing institutions
Incorporating RIS and place-based features	Building upon existing regional capabilities and thus reinforcing the regional ecosystem. Regionally-focused, spatially-bounded, multi-scalar, multi-actor and including non-local sources; not distinguishing the type of RIS or the knowledge bases; performing liaison function between regional industries and policymakers, in a bottom-up approach, negotiating and promoting debate on the topic. Launching creative and collective actions that take into account local/regional social conditions and the interactions of local/regional actors in the policy Inter-firm interaction facilitating learning, experimentation and knowledge diffusion and recombination is central. Fostering the formation of cross-function, cross-hierarchical and cross-industry alliances that promote learning and open innovation and put regional/local needs first.
Services provided by hubs and type of firm participation	One-stop shops for digitizing SMEs. Training, networking, technology transfer and development and support (mentoring, finance, etc.). Main pro-active actors are large firms, not SMEs, albeit the latter are the principal target; DIH program not always coordinated with other regional initiatives for the same purpose, depending on the region.