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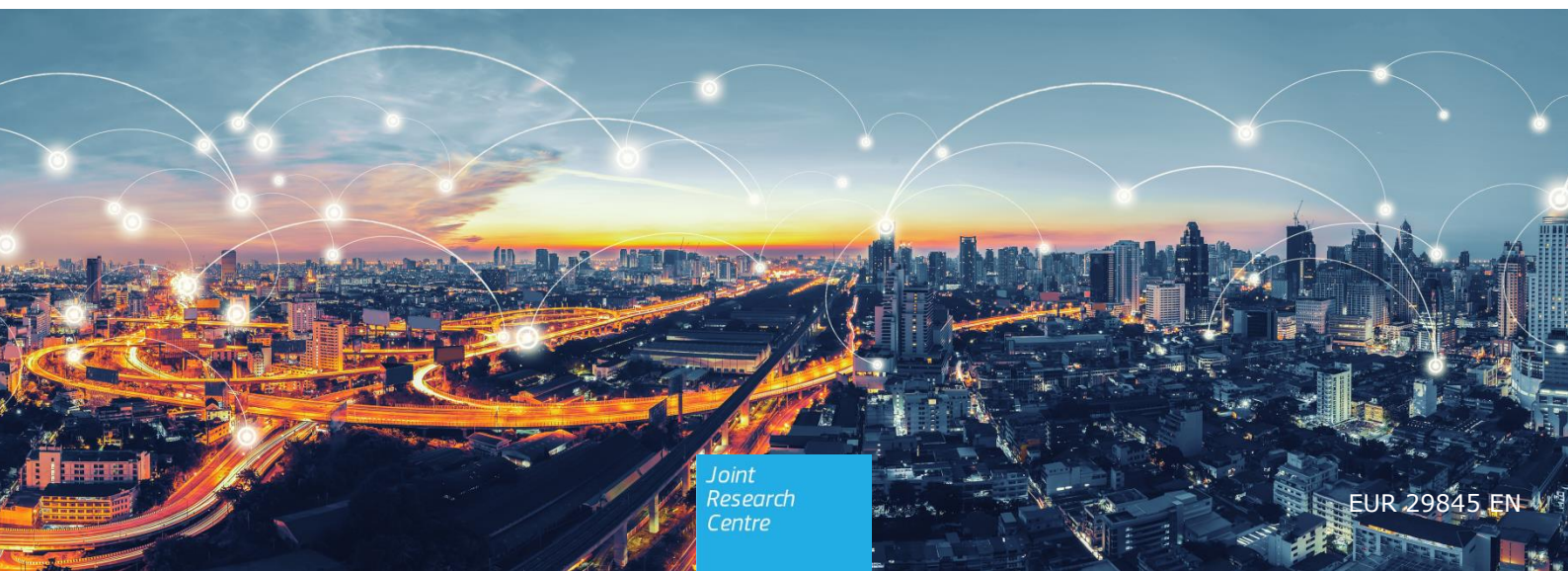
Putting Digital Innovation Hubs into Regional Context

A European survey

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Foreword

Digitisation of products and data-driven services are transforming our economy and are driving change at a pace never seen before. Digital technologies enable companies to boost their competitiveness by offering new digital products and services or enhancing their existing offer with additional digital services. Digitalised public services make administration interact better with citizens, be more transparent and deliver more user-friendly services. Our companies and public sector organisations therefore, need to integrate digital technologies into their business processes, products and services to fully benefit from the efficiency gains and innovation this may bring.

The role of Digital Innovation Hubs (DIHs) is to assure that local businesses and public authorities have access to the newest digital technologies and advanced training in digital skills. They help companies – in particular startups, small and medium-sized enterprises (SMEs) and midcaps – as well as public sector organisations better understand how digital technologies can improve their efficiency, effectiveness and product or service quality. DIHs are also place-based, often regionally embedded structures; strongly linked to local industries, geographical assets, and the available labour force and expertise. They provide services for the digitisation of the local industry and public sector and, thereby, support the development of the regional innovation ecosystem.

It is therefore important that DIHs build on the strength and specialisation of the regions, in line with their regional Smart Specialisation Strategies. The European Cohesion policy 2014-2020 required countries and regions to design and formally adopt a Smart Specialisation Strategy for research and innovation investment under the European Regional Development Fund (ERDF). The core feature of Smart Specialisation is the definition of a limited set of priority areas for public investment, corresponding to regional competitive advantages. Smart specialisation strategies also drive interregional cooperation, by exploiting complementarities in the development of products and process design, leading to new EU-wide value-chains.

Ahead of the 2021-2027 period, regions should update and refine their Smart Specialisation Strategies. It will help them identify adequate EU resources to finance innovative projects, and pair up with other regions with similar assets. Digital Innovation Hubs can serve as an intermediary for providing SMEs or public administrations with digitalisation and technology transfer services, or facilitate regions to invest together in interregional collaborations through the hubs. Engaging DIHs in developing the Smart Specialisation Strategies would help aligning regional agendas and investments with EU priorities.

This report provides interesting insight into the capabilities and nature of DIHs across the EU, including information about their position within the regional ecosystem. It highlights the main strengths and focus areas of these hubs and recognises the existing links between DIHs and regional Smart Specialisation Strategies.



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Abstract

While digitalisation is oftentimes thought of as a global megatrend and something that transcends national borders and geographical distances, it is at the same time a very tangible process exhibiting considerable regional and sectoral variation. Against this backdrop, Digital Innovation Hubs (DIHs) (a policy initiative in the context of the Digitising European Industry (DEI) strategy of the EU) constitute an important complementary and regionally anchored policy, whose impact can be boosted if combined with other EU-wide innovation supporting initiatives (i.e. regional/national innovation strategies). After three years of the launch and successful deployment of the DIHs initiative, a survey has been conducted among DIH managers and regional policy managers working with Smart Specialisation Strategies all over the EU28. The survey provided a useful insight of the digital maturity level of the regional contexts in which DIHs operate and what role they have undertaken in their respective regions, as well as the DIHs' characteristics and activities in their regional context and other important aspects such as collaboration, strategies and funding. This report consists of a thorough analysis of the collected answers. Delivered together with a case study analysis of six (6) regional DIHs in different socio-economic contexts (separate report), they aim at providing useful evidence on current strengths, weaknesses and variations of DIHs also in view of the planning for the upcoming Digital Europe Programme (DEP) and its funding priorities.

Executive Summary

While digitalisation is oftentimes thought of as a global megatrend and something that transcends national borders and geographical distances, it is at the same time a very tangible process that exhibits considerable regional and sectoral variation. Against this backdrop, Digital Innovation Hubs (DIHs) constitute an important complementary and regionally anchored policy instrument to match other EU-wide initiatives such as those associated with the Digital Europe Programme planned by the European Commission to start in 2021. Such a regional take on digitalisation also coincides with other policy instruments focused on territorial development such as Smart Specialisation Strategies (RIS3), thereby creating potential synergies and interactions between policy initiatives.

The aim and scope of this report is to provide an overview of the current state of DIHs registered in the Online Catalogue tool¹ (yellow pages of DIHs) with respect to variations in regional digitalisation as well as to other regional policy initiatives and in particular Smart Specialisation Strategies. The report is based on a survey sent out primarily to DIH managers but also to regional policy managers working with Smart Specialisation Strategies. Because of its general nature, the survey does not give causal interpretations of the DIHs impact on regional development, or of how regional variations impact the development of individual DIHs. Instead, results should first and foremost be interpreted in terms of variation and of correlation, providing a picture of what role DIHs have taken in their respective regions.

Key conclusions

According to the results of the first survey between DIHs managers and policy managers, the emphasis in the studied regions is put on digitalisation in manufacturing industries and production processes. Respondents consider that digital competitiveness is higher among larger companies than among smaller firms, while the public sector is perceived to have the lowest degree of digital maturity. There are significant variations across hardware, software and digital services, as well as concerning the technology focuses of Digital Europe programme, which provide important insights to future policy initiatives.

DIHs activities typically cover several of its expected missions (testing and experimentation, financing, skills, and ecosystem-building), targeting a wide variety of different sectors. However, most DIHs act within their usual stakeholder environment and do not seem to have the appropriate capabilities to reach out to a much larger number of (traditional) SMEs. A risk that existing testbeds are underutilised or that they only act as showrooms rather than platforms for experimentation was identified. DIHs bring together actors and funding from a wider variety of sources, signalling that it is becoming an institution in its own right.

The background role of education, training and skill development raise some concerns in terms of reaching those not engaged yet in policy initiatives stimulating the former. Finally, while DIHs do collaborate with other ecosystem players like regional authorities, universities and clusters, they still fail to perform as proper multi-sided platforms, which may undermine their expected brokerage role.

If one considers that DIHs as a policy initiative were born only three years ago, they have made great progress to define their profile and conquer their own space as digital transformation agents in their territories, but still there is room for maturing their capacities and serving more SMEs across Europe.

Main findings

1. A common denominator between the studied regions is *the emphasis on digitalisation in manufacturing industries and production processes*, followed by financial services and transport and logistics. This is consistent with the scope of strategies like the German

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

Industrie 4.0 and other similar initiatives. This is also one of the most common reported focus areas of the DIHs participating in the survey.

2. On average, *digital competitiveness appears to be higher among larger companies than among smaller firms*. This contrasts the image of small high-tech start-ups outcompeting old industrial manufacturing firms. However, the distribution of digital competitiveness within each size category deserves further investigation.
3. When digitalisation activities are divided into hardware, software and digital services, it appears that *the largest common denominators are activities aimed at Internet of Things (IoT) and smart production systems* within the hardware category. In the software category, *software development, cloud services and Artificial Intelligence (AI)* are the most common focus areas. Among digital services, *big data analytics and AI applications* are most frequent. The variation between the three categories provide important insight to future policy initiatives, namely that working with hardware, software or services within the same technology area may be very different things.
4. According to the survey results, *the digital maturity in public sector agencies is consistently perceived as low*, but a large share of the respondents also point out that there is a large unrealised potential in the digital transformation of these agencies. This constitutes both a challenge and an opportunity for policymakers. DIH managers also report working together with public sector actors, predominantly within higher education and research, education and healthcare.
5. When asked about their DIHs, DIH managers report that *access to technologies and stakeholder networks are their foremost strengths while funding and supporting scale-ups or internationalisation are their greatest weaknesses*. An important observation in this regard is that only eight to ten percent of the DIH managers claim that prototyping and testbed activities are part of the DIH's strengths, while a corresponding share of eight to nine percent report this as a weakness. Similarly, three percent report matchmaking as a strength while seven percent report it as a weakness. From a policy impact perspective, it is possible that while hubs gather large stakeholder networks, they do not manage to engage these stakeholders in tangible activities beyond networking. This merits further investigation.
6. There is a large number of *both physical and virtual testbeds among the DIHs covered in the survey but looking back at the self-reported strengths and weaknesses, these may not be utilised in an optimal way*. Especially, it may be worthwhile to investigate how testbed environments can be networked and complement each other across regions.
7. *Almost all DIHs appear to be working with the smart specialisation strategy in some manner, and about half report having been part of designing the strategy*. However, most DIHs do not appear to be directly financed by the smart specialisation strategies in their regions.
8. *DIHs report a high degree of collaboration with other actors both regionally and nationally as well as internationally within the EU*. The collaboration also spans a wide variety of activities and purposes. Furthermore, most DIHs report a desire for expanded collaboration both within and beyond their regions. This calls for further investigation to map collaborative networks and identify ways of exchanging knowledge and spreading best practices between hubs.
9. *There is a mismatch between the focus areas pointed out in the Digital Europe Programme (high-performance computing, cybersecurity, artificial intelligence and additionally digital skills) and the current focus of DIH activities across regions* - suggesting a need of provisions for a smoother alignment. Judging from the survey results, DIH activities seem to reflect and build on regional variations in digitalisation and digital competitiveness, while at least cyber security and high-performance computing lack the proper footing in regional

industries and activities needed to be a focus area of digital transformation and development. From a policy point of view this highlights the need to make two distinctions between (1) policies aimed at digital leaders and laggards which may require very different approaches, and (2) policies aimed at boosting existing development and policies aimed at steering or redirecting existing development. In the case of EU-wide priorities, it may be necessary to elaborate on and distinguish between policy initiatives aimed at cutting-edge development within a niche area and broad focus initiatives aimed at catching and boosting common denominators within the digitalised and digitalising industries across Europe. In addition, more attention should be paid to the type of problems being addressed with technologies instead of focusing on the technologies as such, e.g. by leveraging RIS3 priorities in order to identify tangible problems to address

10. *DIHs exhibit the characteristics of potential multi-sided platforms for matching together supply and demand or – more specifically – problem ownership with potential solutions.* However, this potential does not seem to be fully realised in terms of leveraging stakeholders' networks and expanding collaborations both within and across regions. The DIHs appear well-poised to facilitate the conversion of great ideas and brainstorming sessions into tangible output and digital transformation, but at the same time the survey results suggest that while hubs are strong on bringing people together, tangible project activities are more uncommon – i.e. the hubs might not be getting as much value for money as they could. This is something that merits further investigation.

Related and future JRC work

This report is the second one of a series of analytical works produced by the Territorial Development Unit of the JRC under a formal collaboration with the Directorate-General of Communication Networks, Content and Technology (DG CNECT) of the European Commission. This analytical effort is aimed to improve the evidence base for sound policies in the area of digital transformation at regional scale, by mapping two different relations: Digital Innovation Hubs (DIHs) to the regional state of digitalisation, and DIHs to Research and Innovation Strategies for Smart Specialisation (RIS3) and regional collaborations². It is strongly interconnected and complementary to the first and the third one of the series. Future planned work within the next two years includes: Practical Guidelines for Regions, Guidelines for DIHs Evaluation and a new DIH Survey.

Quick guide

After an introduction, the report is divided into four main sections. The first three correspond to the three parts of the survey. The first section covers the digital competitiveness of the studied regions. The second section reports on DIH characteristics and activities. The third section deals with collaborations, collaborative activities, strategies and funding. This is followed by a final section summarising the main findings and highlight areas of interest to policy makers.

² (Rissola and Sörvik, 2018) and (Mörner et al., 2019).

1 Introduction

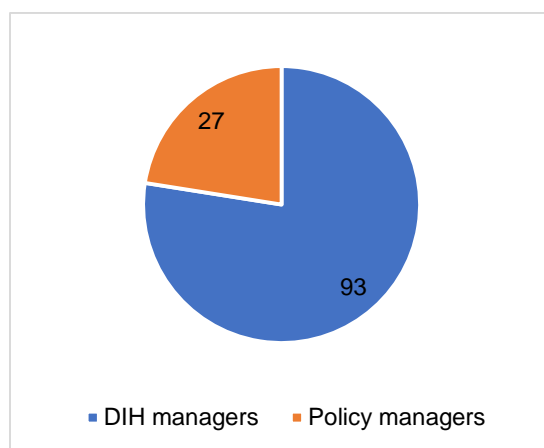
Digital Innovation Hubs (DIHs) are an emerging policy response – it has been running for three years launched by the European Commission in 2016 – to the challenges of digitalisation and digital competitiveness across European member states and regions. This report summarises a survey among (primarily) DIH managers and policy actors in European regions. The survey was distributed to all DIH managers registered in the DIH catalogue (hosted under the JRC Smart Specialisation Platform – S3P³) and to all contact persons registered in the S3 platform. In total, 1063 recipients were invited to fill out the survey and 120 responded, resulting in a response rate of approximately 11%. The respondents answered three blocks of questions. First, the respondents were asked to describe and evaluate different aspects of digitalisation and the digitalised economy within their region. This provides an important background and context to ongoing regional digitalisation initiatives. Second, the respondents were asked specifically about the Digital Innovation Hub(s) in their region, about their mission and focus as well as their specific activities. Lastly, respondents were asked to describe the DIH's funding, collaboration partners and collaborative activities. Specifically, respondents were asked about the link between DIHs and smart specialisation strategies (RIS3).

The aim of the survey was to map two different relations: *DIHs to the regional state of digitalisation*, and *DIHs to RIS3 and regional collaborations*. For this reason, the survey was addressed to both DIH managers and regional policy managers working with the RIS3 in each region, providing two perspectives on the same region. However, because the response rates differed significantly between the two groups (DIH managers by far outweigh policy managers) and because the degree of overlaps between DIH managers and policy managers from the same region is too small, the results reported here focus primarily on the DIH managers responses. The respondents consist of 93 DIH managers and 27 policy managers (Figure 1). Among the 27 policy managers (from 13 different countries) 9 report not being aware of any digital innovation hub in the region leaving a sample of only 18. The low response rate among RIS3 policy managers signals a potential lack in awareness or interest concerning digital innovation hubs, which would be an important result in and of itself, but leaves no room for scrutiny or closer interpretation. If not stated specifically, responses are reported for the whole population together to provide a maximal coverage, otherwise DIH managers are treated separately. Looking at the group of policy managers, patterns across questions appear overall similar to those of DIH managers, leaving no indication that the policy managers who have participated would be of a radically different opinion than their DIH peers. The spatial distribution of respondents is indicated on the map below. Of the total number of respondents, 86 belong to EU15 and 30 to EU13. Four respondents represent DIHs are located in non-EU countries.

Furthermore, because the number of variables (dimensions) per question is oftentimes large (>2) and the variation in alternatives is wide (often allowing multiple answers), the results are reported and interpreted on an aggregated scale. Used like this, the results provide a rich overview of the context, state and relations of DIHs across regions. In turn, this can be used to identify key questions to investigate further in future research efforts. A number of such investigations are suggested throughout the report.

³ <https://s3platform.jrc.ec.europa.eu/>

Figure 1a. Respondents distribution per category



Source: own elaboration based on survey results

Figure 1b. Spatial distribution of survey respondents



Source: own elaboration based on survey results and Google Maps

2 Regional digital competitiveness

Highlights

The studied regions share an overall pattern in digital competitiveness and maturity across sectors with emphasis on manufacturing industries and production processes (that may have been influenced by past and present policy).

Larger firms (some of which presumably in the manufacturing industry) are the most digitally competitive while medium sized enterprises (between 50-250 employees) seem to show the greatest potential for digitalisation.

The digital maturity in public sector organisations is lagging behind significantly in most areas, posing an unrealised potential as customer segment but also a sizable (policy) issue.

The reported priorities for regional digital competitiveness do not necessarily match with Digital Europe programme's advanced technologies focus (HPC, Cybersecurity and Digital Skills are indicated as priorities to a much lesser extent than AI)

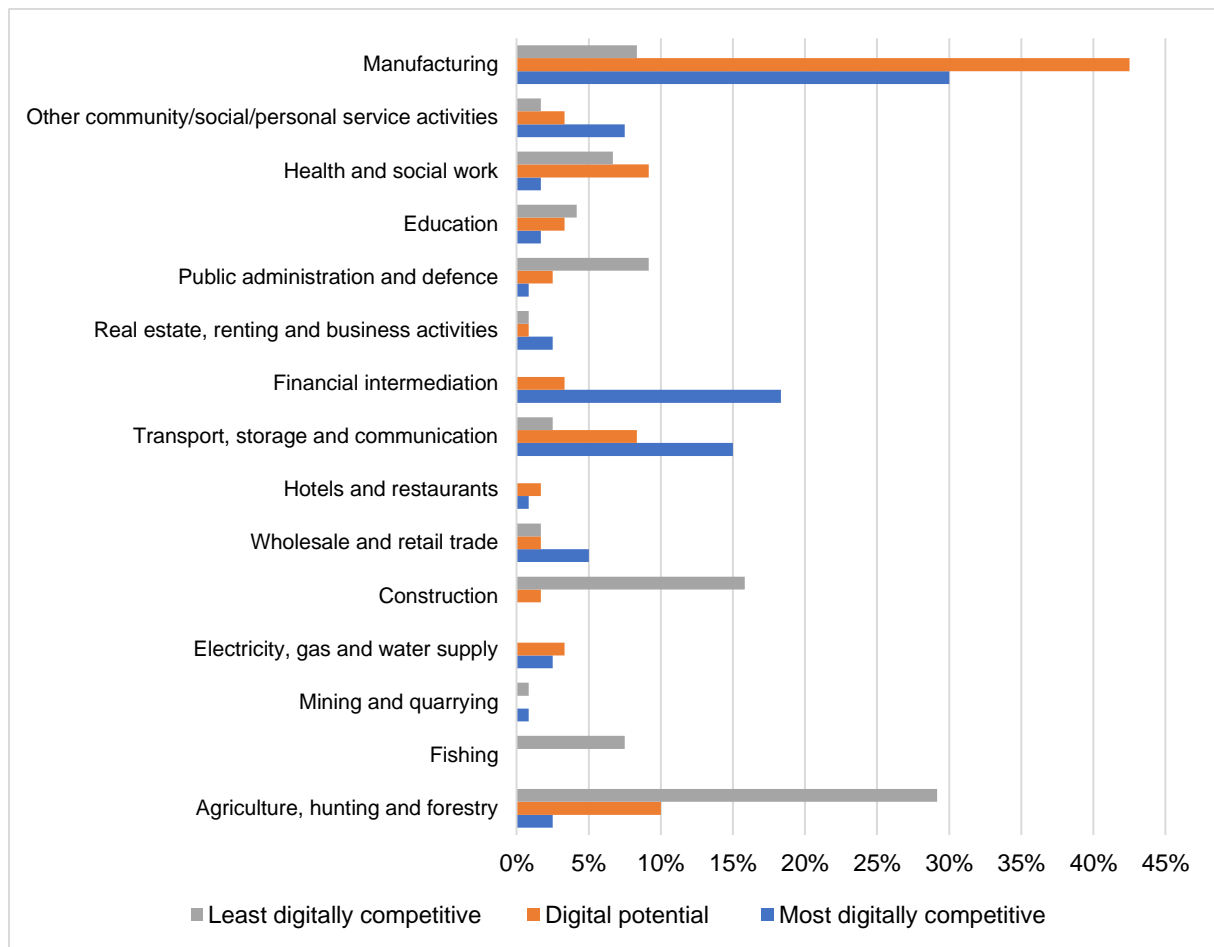
In the first part of the survey, respondents were asked to describe the regional state of digitalisation in terms of digital competitiveness (intended as the capacity to transform industrial processes, products and business models through the adoption of digital technologies) and digital maturity (intended as the gradual process of learning and adaptation to an emerging digital competitive environment). This provides an important backdrop for understanding the context in which the DIHs are operating. It also provides an overview of digitalisation that could potentially be put in relation to other digital economy indicators within the EU and other bodies in further studies.

First, respondents (both DIH managers and policy managers) were asked to identify which industries in their region have the highest digital competitiveness, the greatest unrealised digital potential, and the lowest digital competitiveness, respectively (Figure 2). The results indicate an overall skewed distribution of digital competitiveness in European regions. While manufacturing, financial intermediaries and transport, storage and communication seem to be widely considered to be the most digitally competitive, agriculture together with construction and public administration stand out as least digitally competitive. In particular, digital competitiveness in public administration appears to be considered on par with that of the fishing industry.

The respondents jointly consider the unrealised potential to be the greatest in manufacturing (over 40%), followed by agriculture, health and social work as well as transport and communication (below 10% each). These results reflect the perceptions of the respondents and might very well be somewhat biased by the attention given to concepts such as industry 4.0, but this still tells us something important about the respondents as well as the regions they are operating in. For instance, while there is certainly a great potential in digitalising healthcare, agriculture and manufacturing, there may be a significant overlooked potential (or risk of lagging behind) in areas such as electricity, gas and water supply (e.g. smart grids) or education (e.g. education technology). The common perceptions agree with the overall development in digitalisation globally.

The overall pattern of answers in Figure 2 could be argued to reflect common strategic priorities across regions. However, it could also be taken as an indication of a lack of strategic heterogeneity, i.e. not playing to each regions' most prominent comparative advantages if we believe that these are larger than indicated by the responses. How such a trade-off between regional heterogeneity and common priorities should be struck is not straightforward but relates very much to the work on smart specialisation strategies. Digitalisation efforts could for instance potentially act as an important complement (or a horizontal priority) to comparative regional advantages and priorities, boosting them further.

Figure 2: Regional digital competitiveness



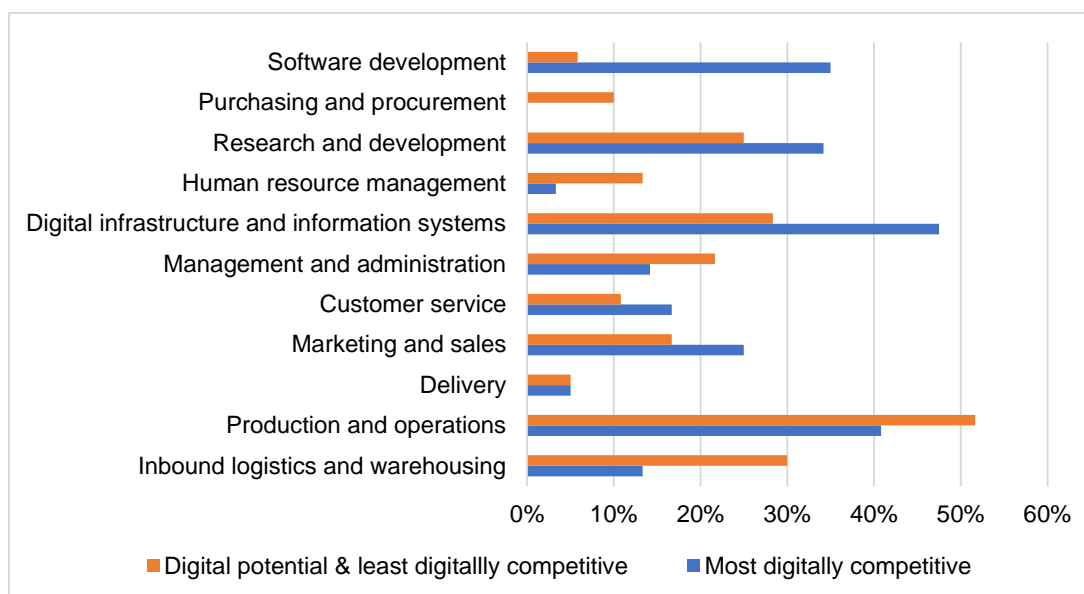
Source: own elaboration based on survey results (all respondents – 120 answers)

While digital technologies are being integrated across sectors, the effect of digitalisation varies for different part of firms' value chains (i.e. for different types of business activities). Next, respondents were asked to identify which type of business activities constitute the digital edge within the most digitalised industries in the region as well as within the remaining less digitalised industries, i.e. where their respective digital strengths lie (Figure 3). Here, the results exhibit a greater level of heterogeneity. Activities specifically related to digital technologies stand out among the most digitally competitive industries (digital infrastructure, software development and R&D), but so does production, marketing and sales.

The comparative digital strengths among the least digitalised industries give some indication of the unrealised potential in these industries and it appears to be related mainly to production and logistics, followed by digital infrastructure and R&D. Production thus stands as the focus of both current and potential competitiveness. One possible interpretation of these results is that current digital competitiveness relies heavily on technology adoption while the potential for future digital competitiveness depends more on technology adaptation, i.e. adapting traditional activities to the conditions provided by new technologies.

It should be noted that both delivery activities and human resource management appear to be considered marginal to digital competitiveness (both current and potential), although both are associated with considerable advances related for instance to artificial intelligence, data-driven processes and drone delivery systems and autonomous vehicles.

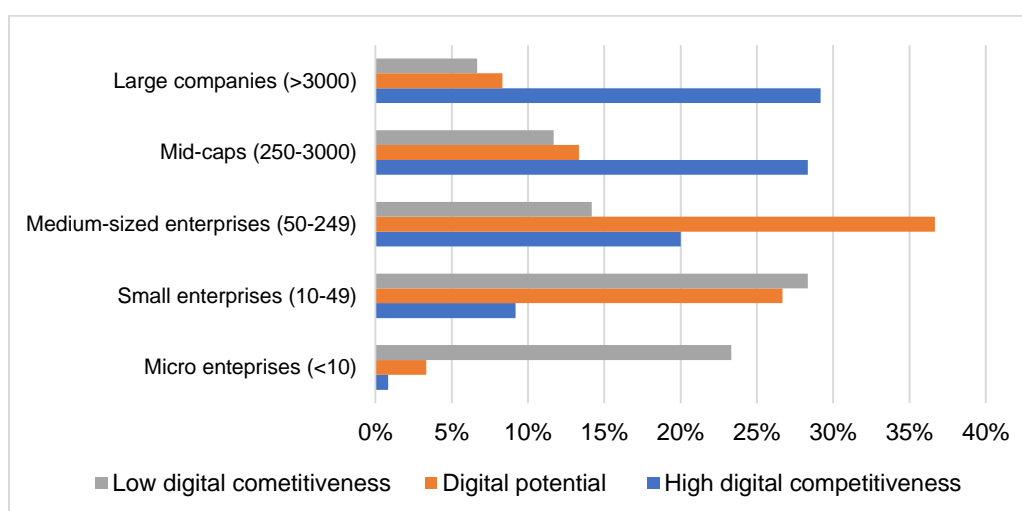
Figure 3: The edge of digital competitiveness



Source: own elaboration based on survey results (all respondents – 120 answers)

The respondents were also asked to report digital competitiveness within the region with respect to firm size. This provides an indication of perceived differences in digitalisation between firms based on their size, ranging from micro enterprises to large companies (Figure 4). The aggregated results clearly show that, according to DIH managers and policy managers, digital competitiveness is positively related with size. Put differently, there appears to be a larger share of digitally competitive companies among the largest firms and, conversely, a larger share of companies with low digital competitiveness among smaller firms.

Figure 4: Digital competitiveness and firm size



Source: own elaboration based on survey results (all respondents – 120 answers)

Turning from activities to technologies, the respondents were asked to identify the technologies most strongly associated with the most digitally competitive industries and firms in their region (Figure 5). The technologies are divided into three broad categories (A=Hardware, B=Software, and

C=Digital services) in order to differentiate between different types of business activities and business models. It is worth noting that all three categories appear to be present within the studied regions, and it may be of interest in future investigations to study how these different aspects of the digital value chain are interrelated and clustered across different regions and hubs.

Within hardware, smart production systems and internet of things (sensory systems) stand out as the technologies considered most important to the digital competitiveness in the region. This echoes the large number of respondents pointing out manufacturing as a competitive industry and production as the edge in this competitiveness. Hardware factors are also considered by far more important than software or services (>10 percentage points).

Within the software category, general software development is considered the most important technological edge among the most competitive firms, followed by cloud infrastructure, artificial intelligence and cybersecurity. Note that artificial intelligence (AI) and cybersecurity are grouped together, meaning it is not possible to differentiate between them in the results on software alone.⁴ Given the attention currently given to AI across sectors, it is clearly possible that cybersecurity on its own would not have been considered a key technology in regional digital competitiveness.

In the services category, big data analytics and applications of AI are considered key to regional digital competitiveness. Services based on these technologies provide a wide variety of possibilities and data analytics also feed into AI applications, meaning it is intuitive that they go together. In this category, it can be noted that cyber security services are only considered to be a key technology among 5% of the respondents (3% in the hardware category), suggesting that it is overvalued in the software category as well.

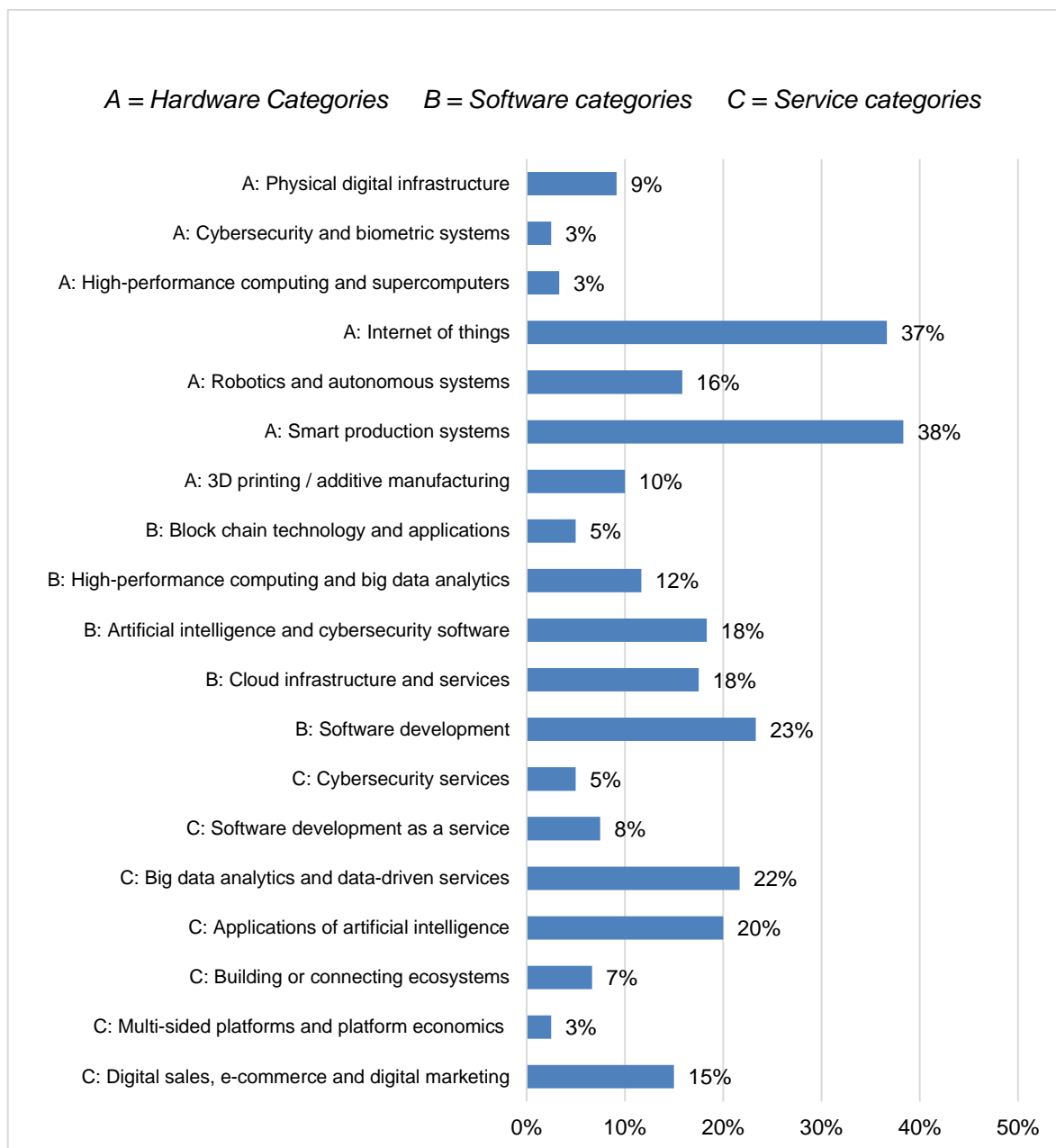
Overall, there would appear to be some clear discrepancies between the indicated focus areas suggested for the European Commission's upcoming Digital Europe programme (high-performance computing, AI, cybersecurity, and digital skills) and the perceived competitive advantages across regions. Especially high-performance computing and cybersecurity appear to lack "boots on the ground".

On a separate note, it may be cause for concern that multi-sided platform economies are considered to play such a marginal role for regional digital competitiveness.⁵ This could either be because respondents do not value or understand platform economies, or because there is a lack of firms building or leveraging platform economies. Given the new copyright directive, it is relevant from a regional and digital policy point of view to monitor the conditions for new and emerging platforms within the EU.

⁴ This was due to a technical issue in the survey tool, resulting in the grouping of two options as one.

⁵ For further discussion on digital platforms, see recent JRC report on *Digital platform innovation in European SMEs*, available at <https://ec.europa.eu/jrc/en/publication/digital-platform-innovation-european-smes>

Figure 5: Digital competitiveness and technologies



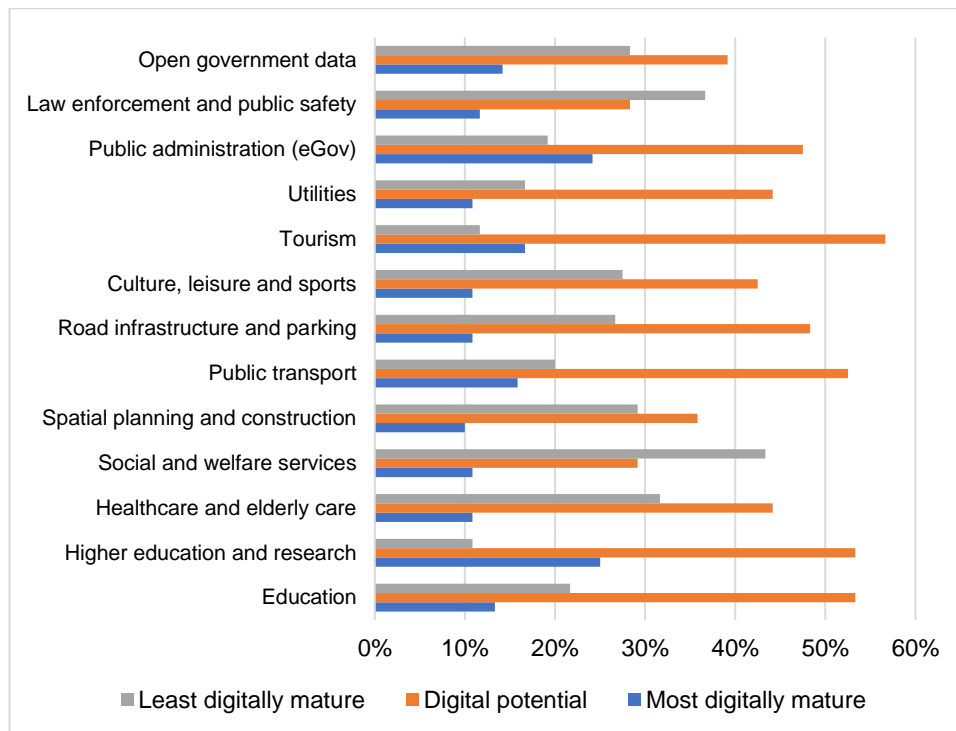
Source: own elaboration based on survey results (all respondents – 120 answers)

As a complement to the questions aimed at regional industries, the respondents were asked to estimate the digital maturity (corresponding to competitiveness in questions concerning industry) across different parts of the public sector (Figure 6). The respondents were asked to indicate for each area listed in the figure if it has a high digital maturity, if it has unrealised potential to become digitally mature, or if it has low digital maturity.

The results suggest that DIH managers and policy managers tend to consider the digital maturity of the public sector to be overall low. However, there is also a considerable number of respondents reporting a high share of unrealised potential with respect to digitalisation of public sector activities. Higher education and research together with public administration (eGov) are considered the most digitally mature, while law enforcement and social welfare services are considered by most to exhibit low digital maturity. Curiously, a larger share of respondents indicate that the digital

maturity associated with open government data is low compared to those that rank it as high. This result stands out because open government data is an inherently digital activity. The overall high share of respondents pointing to digital potential in almost all parts of the public sector suggests not only unrealised potential but also a widespread opinion that the public sector is lagging behind.

Figure 6: Digitalisation in the public sector



Source: own elaboration based on survey results (all respondents – 120 answers)

3 Digital innovation hubs, general characteristics and activities

Highlights

DIHs typically cover several of its main missions (testing and experimentation, financing, skills, and ecosystem-building). They also target a wide variety of different sectors, including public sector organisations, in their work.

However, most DIHs act within their usual stakeholder environment and do not seem to have the appropriate capabilities to reach out to a much larger number of (traditional) SMEs or to help them with access to finance, helping with business plans, etc.

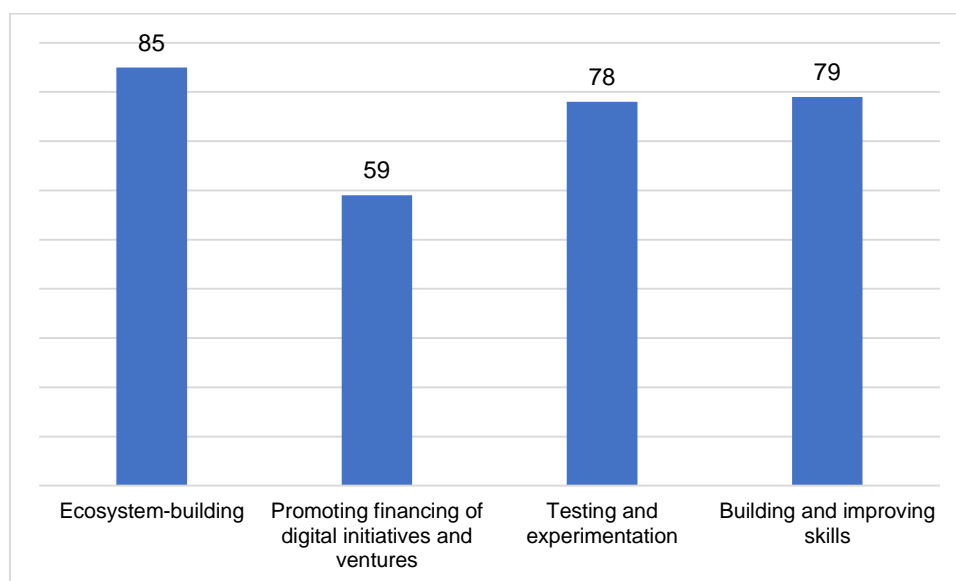
Because testbed processes are complicated, there is a risk that existing testbeds are underutilised or that they only act as showrooms rather than platforms for experimentation.

The background role of education, training and skill development raise some concerns in terms of reaching those not engaged yet.

In this section of the survey, respondents are asked questions specifically about the Digital Innovation Hub(s) in their region. Because the number of policy managers among the respondents is fairly low and (even more so) because there is a very little overlap in matching DIH managers with policy managers on a regional level, the reported results focus on DIH managers as they are first-hand informants about their DIHs.

First, respondents (DIH managers only) were asked to indicate which of the four general categories of DIH mission statements their DIH work directly with (Figure 7). The results indicate a fairly even distribution of DIH focus across the different subject areas and several respondents have indicated multiple missions for their hub. A subject for future research should be to disentangle correlations between these different goals and how they map onto hub programmes and activities.

Figure 7: DIH mission



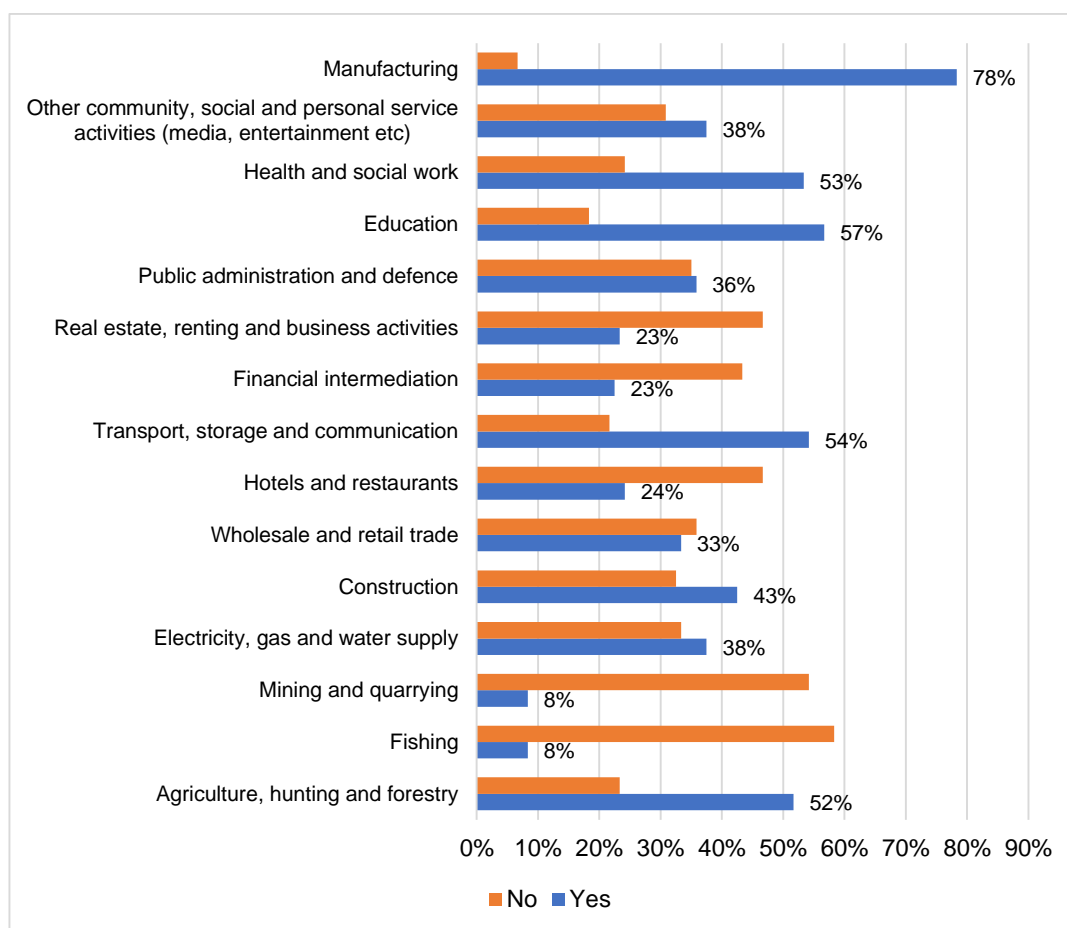
Source: own elaboration based on survey results (DIH respondents – 93 answers)

Next, the respondents (both DIH managers and policy managers) were asked to indicate which industries (based on NACE codes) they target in their activities (Figure 8). Again, manufacturing stands out as the most important across the studied regions.

Interestingly, DIH focus does not reflect the skewed distribution of (perceived) digital competitiveness. For instance, a considerable share of respondents indicates that DIHs in their region work with agriculture, electricity, gas and water supply, education and health. These sectors were either considered to have low digital competitiveness or digital potential in the first part of the survey. This suggests that DIHs position themselves not only to strengthen the most competitive industries but also to help facilitate unrealised potential and to work with digital laggards. Furthermore, several of these sectors are under public administration, meaning hubs work across both private and public sectors.

Finally, while respondents indicate a wide distribution of focus areas they also indicate a corresponding distribution of the sectors they do not target. Further analysis may suggest how priorities and demarcations vary between hubs, if some are for instance predominantly focusing on private sectors and other on public.

Figure 8: DIH focus across sectors



Source: own elaboration based on survey results (all respondents – 120 answers)

DIH managers were asked to indicate which the primary strengths and weaknesses of their hubs were (Figures 9 and 10). The overall highest rates strengths are access to technologies and stakeholder networks, followed by testbed activities. While these are important attributes for a DIH,

it is worth pointing out that these activities are primarily aimed at those who have at least some idea of what they want to achieve with digitalisation and how to do it.

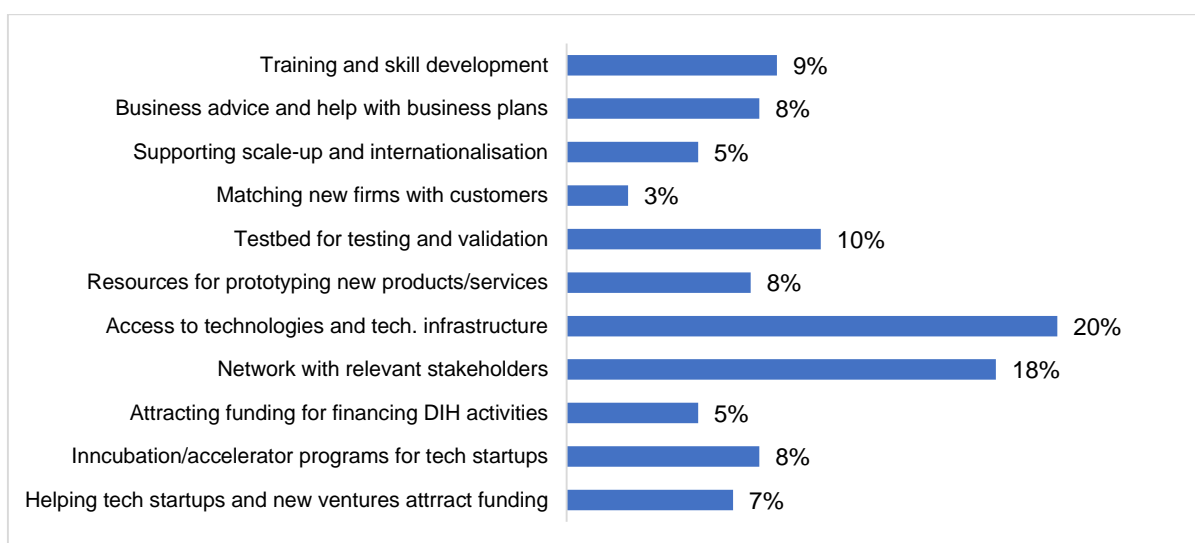
Other activities, like skill training, business advice, internationalisation and matchmaking are, overall, put forward by only a small share of DIH managers. At the same time, these aspects are – except for internationalisation – not emphasised as weaknesses either, suggesting that they may simply not be considered to be core of the hub’s activities. At any rate, these activities should be considered central, especially to hubs focused on sectors with lower digital competitiveness and thus these issues deserve further investigation.

The overall greatest weaknesses among DIHs appear to be attracting funding for the hub and helping firms with scaling up and internationalisation. The least pronounced weakness is access to stakeholder networks, suggesting that this is considered a cornerstone in many if not most DIHs as it is reported to be a strength by many and a weakness by almost no one.

The DIH managers responses also suggest that they do not consider it a primary activity for their hubs to help start-ups attracting funding, incubating or scaling up, as it is considered a strength by few and a weakness by many. While this is in line with the original intent of the DIHs, it is also significant for the hubs’ abilities to connect to, interact with and make use of the actors within these groups.

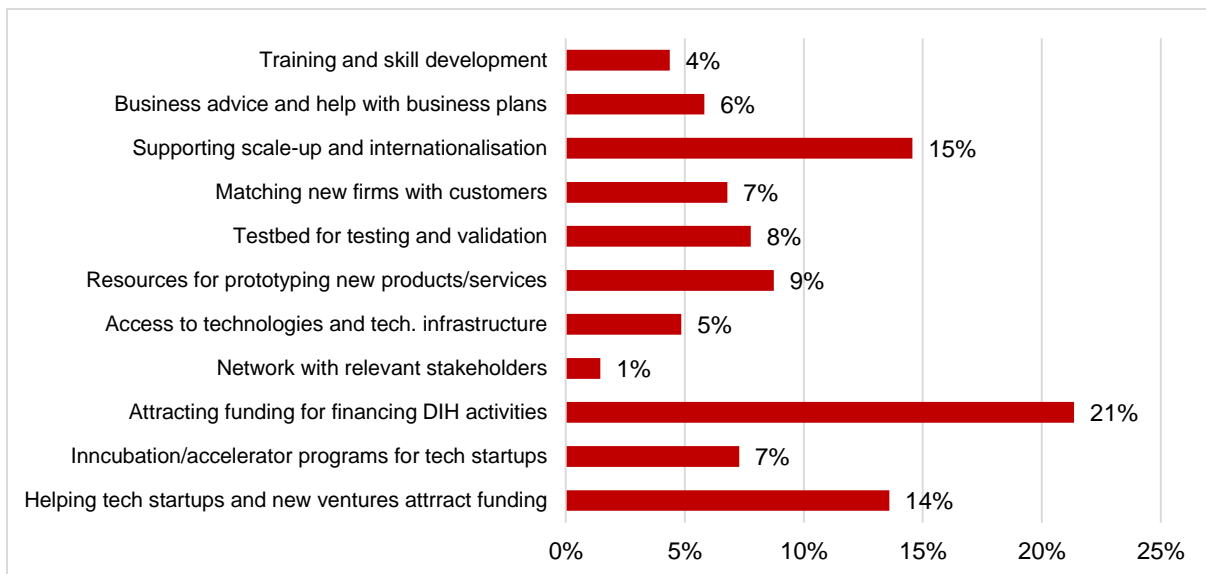
The variation in (perceived) results suggest that there is at least some scope for evaluating and learning from best practices or failures across DIHs.

Figure 9: DIH strengths



Source: own elaboration based on survey results (DIH respondents – 93 answers)

Figure 10: DIH weaknesses



Source: own elaboration based on survey results (DIH respondents – 93 answers)

A central part of digitalisation and digital transformation of SMEs is testing and prototyping and conducted in so called testbeds, yet the exact meaning of testbed and testbed activities varies widely. For that reason, DIH managers were asked to report on their testbed activities and to categorize them first as either physical (providing access to physical technologies and environments for testing for instance autonomous vehicles) or virtual (providing software and software infrastructure for testing in virtual environments) and then to relate their testbed activities to specific technologies (Figure 11 and 12). Respondents were able to choose multiple options.

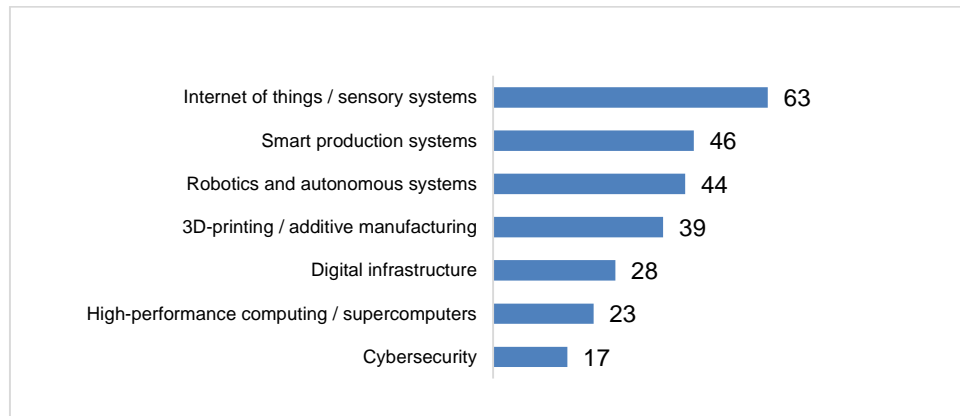
Echoing again the emphasis on manufacturing, production technologies and sensory systems, the most common physical testbed environment in the studied regions appears to be dedicated to internet of things, followed by smart production systems and robotics. The least reported physical testbed environment is that dedicated to cybersecurity and high-performance computing. Both of these areas have been targeted elsewhere in EU digital policy frameworks (Digital Europe programme), suggesting there is a potential mismatch between policy and practice.

This highlights two important issues related to digitalisation policy. First, there is a distinction between policy aimed at the most digitally advanced actors and industries and policy aimed at the least digitalised actors and industries. Even though the goal is to advance digitalisation in both groups, effective policy measures may need to look very different for each of the two groups. Second, there is an important distinction between on the one hand policy aimed at enabling or promoting existing economic activities or focus areas and, on the other hand, policy aimed at steering or redirecting focus in regional development and digitalisation across industries. More targeted studies are needed to disentangle the precise relation between regional digitalisation, Digital Innovation Hubs and the Digital Europe programme focus areas, but it would appear that there is a gap between EU-wide policy focus and the current situation in many regions that needs to be addressed.

Looking at virtual testbeds, applications of artificial intelligence and the use of digital twins come out on top, followed by big data analytics and data lakes. Digital twins, data lakes and data analytics all play into applications of AI which depends on access to relevant training data. Again, cybersecurity appears to be the least prioritised among the subject areas in virtual testbeds.

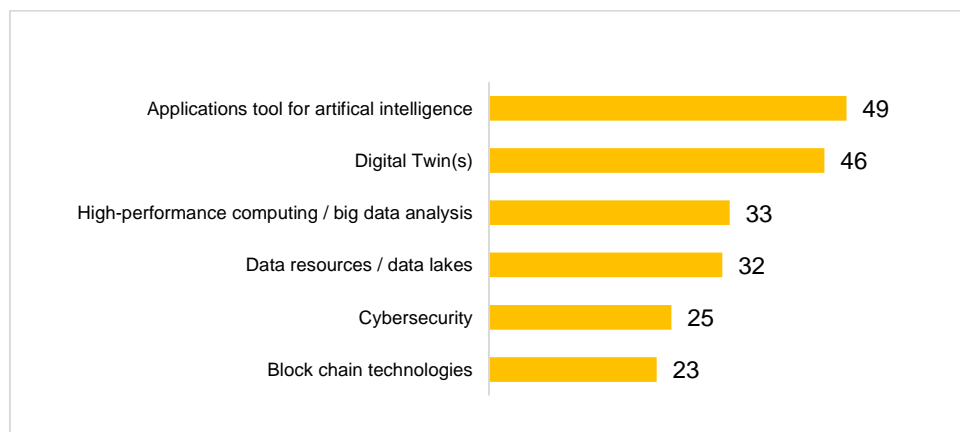
Future studies could be dedicated to clustering subject areas (because respondents oftentimes report several options for the DIH) within and between testbed environments to get a better overview of the variation between regions.

Figure 11: Physical testbeds



Source: own elaboration based on survey results (DIH respondents – 93 answers)

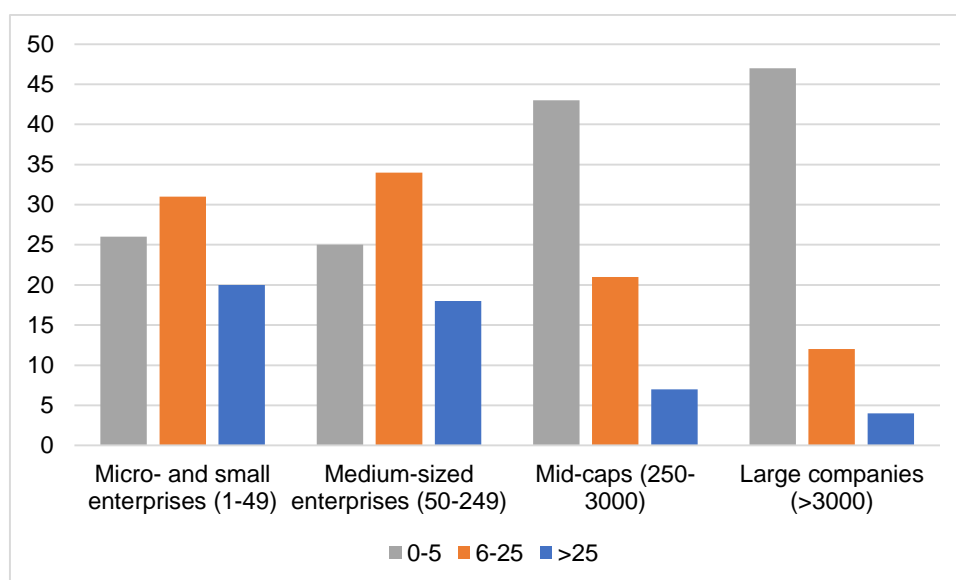
Figure 12: Virtual testbeds



Source: own elaboration based on survey results (DIH respondents – 93 answers)

Turning to the actors using the DIH and its services, DIH managers were asked to estimate how often they interact with firms of different sizes (Figure 13). Each bar in the figure indicates how many DIHs have answered that they interact with firms of a specific size 0-5, 6-25 or >25 times in a year. The results indicate that most interactions occur with small- and medium-sized enterprises (of which there are also considerably more), while interactions with the largest firms are fewer and farther between. These results also give some idea about the potential for using hubs as a platform for matching interactions between small and large firms within or between sectors.

Figure 13: DIH Customers

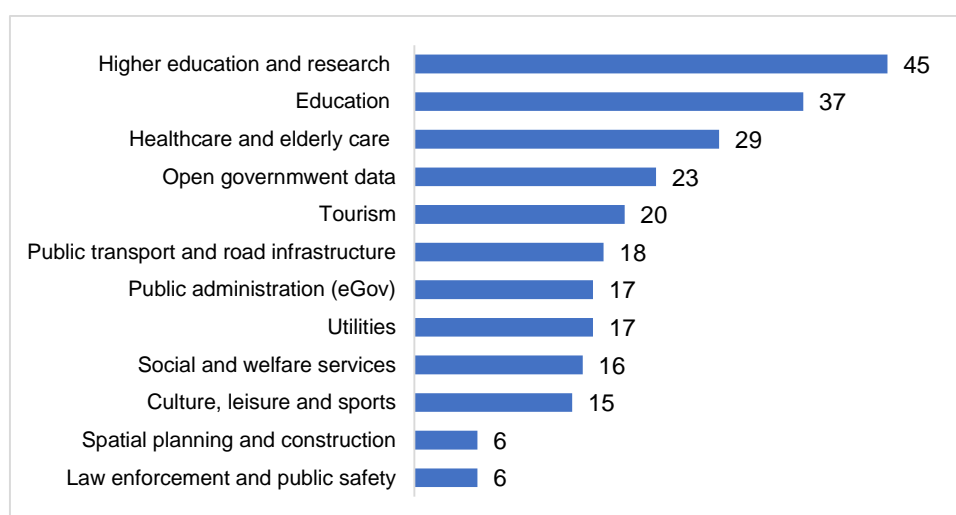


Source: own elaboration based on survey results (DIH respondents – 93 answers)

Beyond interactions with commercial actors, DIH managers were also asked about their involvement with digitalisation and digital transformation in public sector organisations (Figure 14). In the figure, each bar represents the number of DIHs reporting to have been involved with digital transformation or digitalisation projects with the corresponding public sector agencies. A large share of the hubs report working with one or several parts of the public sector, primarily higher education and research, education and healthcare. This is relevant since especially education and healthcare were identified as having low or no digital maturity in the previous part of the survey. However, law enforcement and spatial planning are both considered to have low digital maturity and lack collaboration with DIHs in the studied regions.

A relevant question for further studies is how DIHs facilitate interaction between private sector actors and public sector actors, e.g. matching a startup providing solutions for edtech or ehealth with public sector actors in education or health.

Figure 14: Digitalisation of the public sector



Source: own elaboration based on survey results (DIH respondents – 93 answers)

Although conducted for a complementary study, the opinions of key players are reported here as testimonials supporting the analysis.

Box 1. Indicative input from personal interviews with DIHs managers⁶

On DIH focus on market sectors:

"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)

On DIH's mission:

"The DIH concept was well aligned with what (name of DIH) 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 (name of DIH), but its role in the region is the same – a central node for digital activities" (Interview)

On DIH's customers (1)

"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).

On DIH's customers (2)

"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)

⁶ (Mjörner et al., 2019).

4 Digital innovation hubs, strategies and collaborations

Highlights

In terms of funding and collaborations, DIHs bring together actors and funding from a wider variety of sources, signalling that it is becoming an institution in its own right.

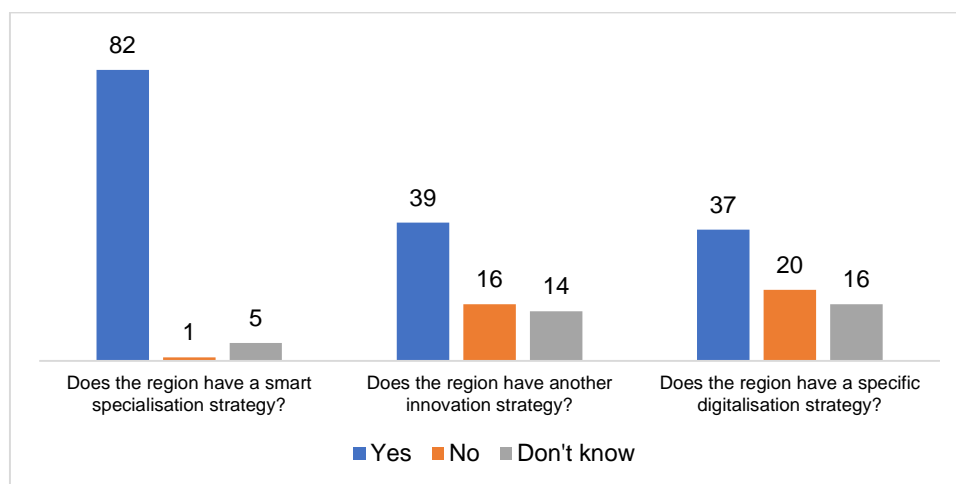
DIHs do collaborate with other ecosystem players like regional authorities, universities and clusters, but to a lesser extent with the European Enterprise Network.

Still, DIHs expected brokerage role is not as much developed yet.

In this section of the survey, respondents were asked about how Digital Innovation Hubs collaborate and interact with other actors ranging from local to international level. Respondents were also asked about the funding of the hubs. Again, because of low share of policy managers responding to the survey and the low degree of matching between DIH managers and policy managers in the same region, the results are predominantly based on DIH managers' responses.

First, DIH managers were asked about the presence of a smart specialisation strategy (RIS3) as well as other strategies related to innovation or digitalisation (Figure 15). Judging by their responses, a large share of the studied regions have a RIS3 strategy and the DIH managers are aware of it. 39 and 37 out of the total of 93 respondents also report the existence of another innovation strategy or a specific digitalisation strategy. It is worth noting that the number of uncertain respondents (who report not knowing) is very low for RIS3 but higher for other types of strategies.

Figure 15: Regional strategies



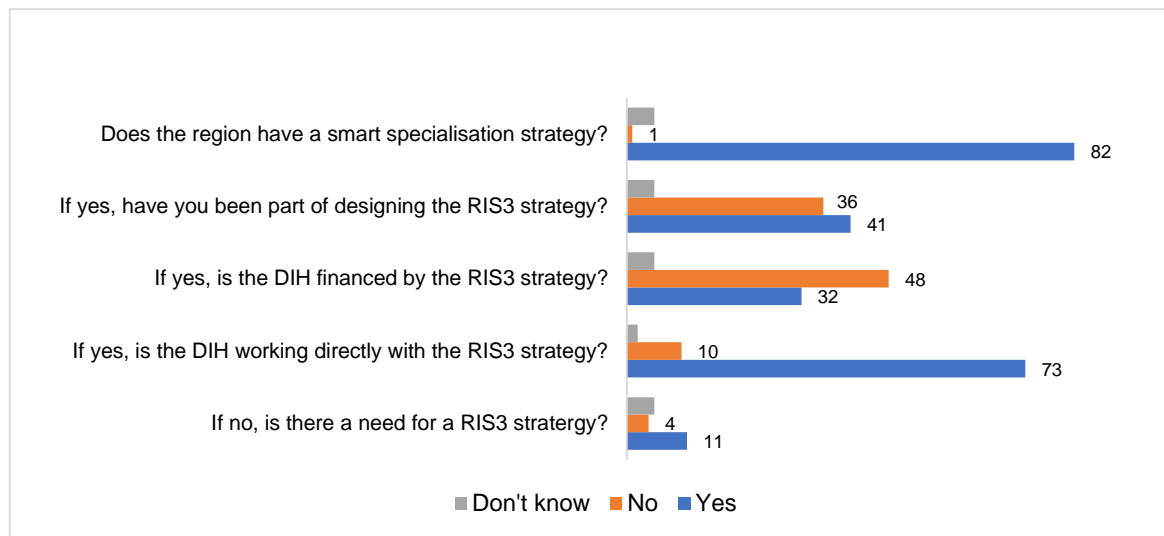
Source: own elaboration based on survey results (DIH respondents – 93 answers)

Based on this, the respondents were asked a series of questions about the RIS3 strategy in their region (Figure 16). The top question is the same result that is reported in the left-most column in Figure 15. About half the number of respondents that report having a RIS3 strategy also indicate that they were part of designing it. Somewhat fewer of the DIH managers report their hub being funded by the RIS3 strategy, but almost all of them report working directly with the RIS3 strategy.

This signals a high level of awareness from DIH managers and it would be very interesting to see how answers from policy managers in the same regions would correspond to these results. As it stands, DIH managers indicate that the hubs are well-coordinated with RIS3 actors in their region.

The responses from policy actors also echo that of the DIH managers (although they report on largely different regions) in terms of hubs working directly with RIS3 strategies.

Figure 16: About RIS3 Strategies

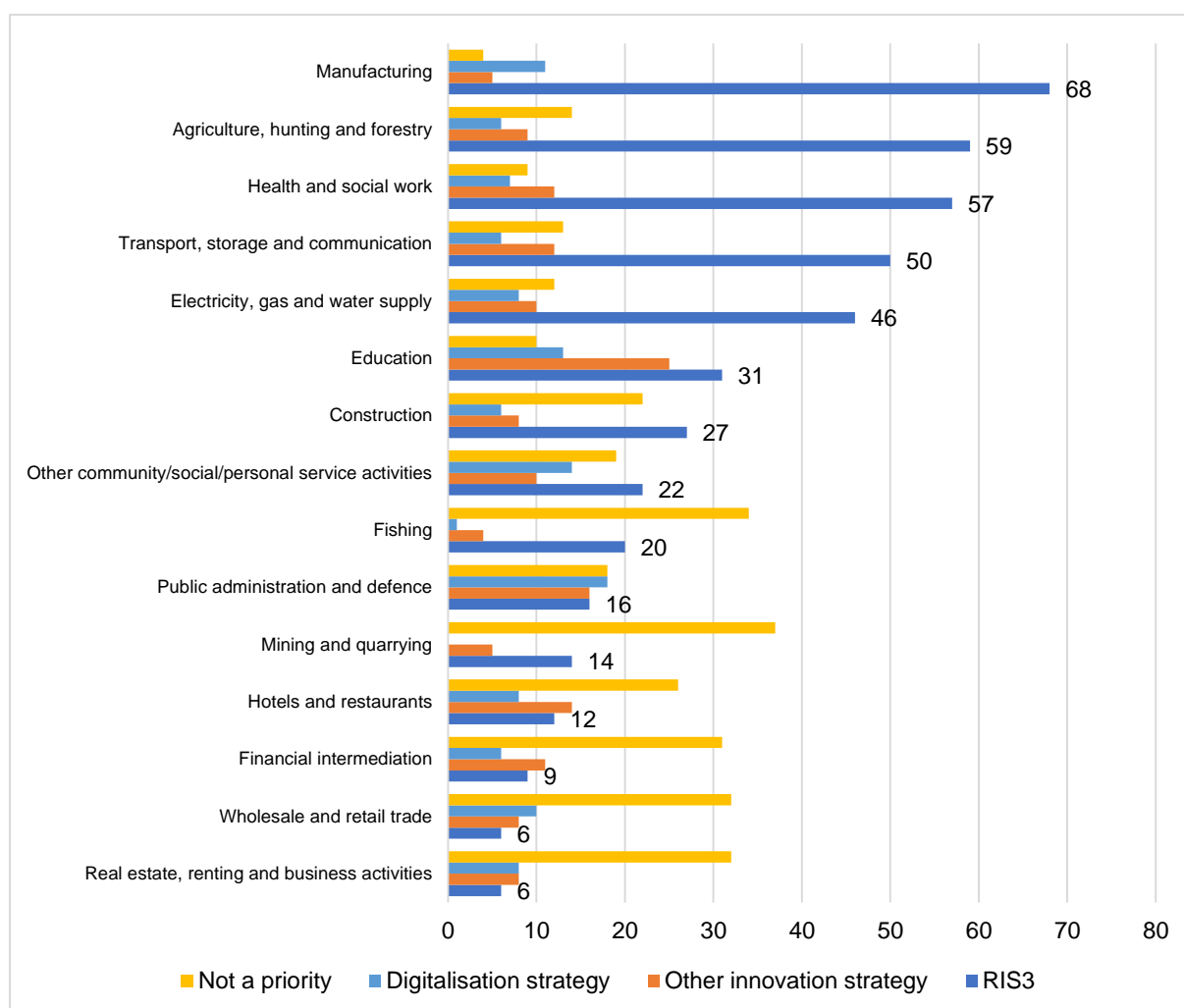


Source: own elaboration based on survey results (DIH respondents – 93 answers)

Putting different strategies in relation to each other, DIH managers were asked what sectors are targeted in different strategies (Figure 17). The results show an overall pattern emphasising manufacturing, agriculture, health and social work as well as transport and communication in RIS3 strategies. This corresponds with results from previous studies of innovation priorities in European regions⁷, with manufacturing and health and social work, ranking high. Other types of strategies exhibit more variation across the studied regions. Respondents indicating that a sector is not a strategic priority coincide well with a lower RIS3 priority. One possible interpretation, that may possibly be a bit counterintuitive, is that RIS3 strategies have more in common in terms of priority areas across regions than do other types of strategies. If that is the case, it may be of interest to study whether other local strategies in some way play into comparative advantages beyond the RIS3 framework.

⁷ (Sörvik and Kleibrink, 2015).

Figure 17: Strategic coverage



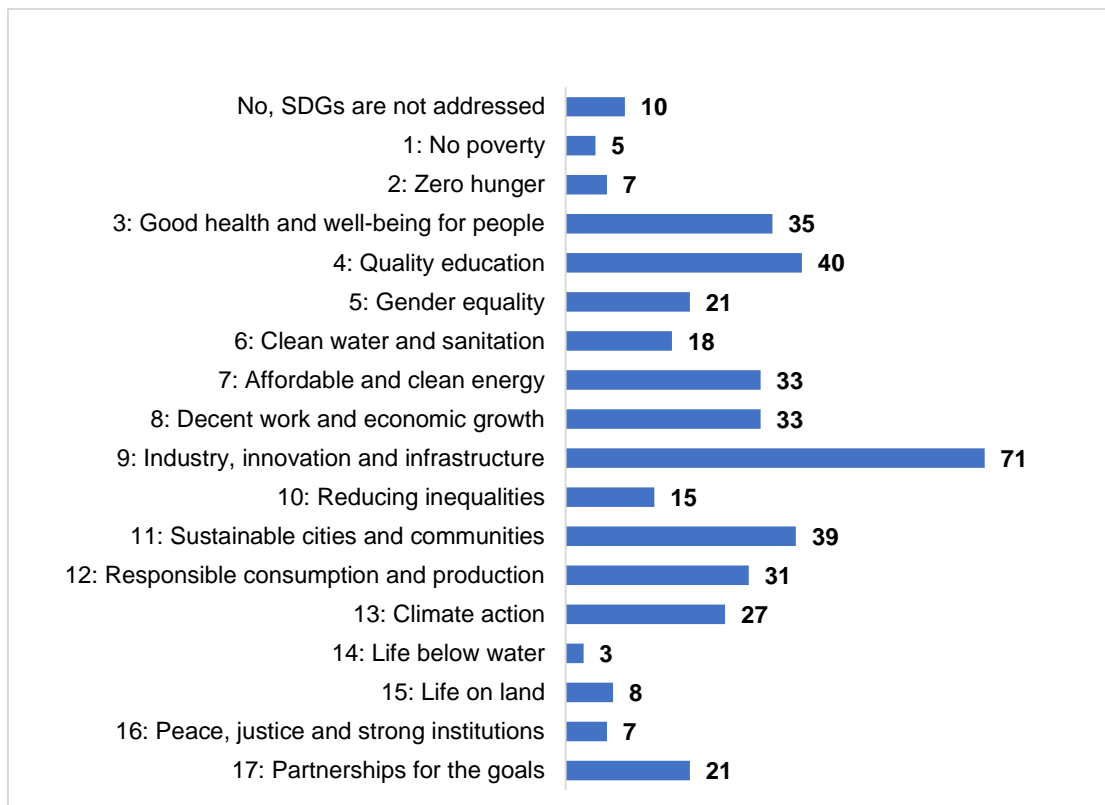
Source: own elaboration based on survey results (DIH respondents – 93 answers)

Respondents were also asked to relate the DIH's work to the UN's Sustainable Development Goals (SDGs)⁸ (Figure 18). Perhaps unsurprisingly, goal 9 (Industry, innovation and infrastructure) came out as the by far most commonly prioritised of the SDGs among DIH managers, followed by sustainable cities and education. Even though respondents were able to choose several of the SDGs, it is worth pointing out that none of them were left out. For each goal, there is at least 3 (life below water) individual DIHs considering working towards that goal. At the same time, 10 of the respondents have indicated that the SDGs are not a priority to their hubs.

While the hubs may act as matchmakers for stakeholders across different types of contexts (RIS3 and SDGs for instance) it is not necessarily a feature for a DIH to focus on too many different frameworks or too many different aspects within one framework. From the 93 DIH managers responding to the survey, there were 424 responses to this question, averaging 4,5 or 5 SDGs reported as priorities per hub. Such a wide focus can distract from actual business.

⁸ <https://sustainabledevelopment.un.org/>

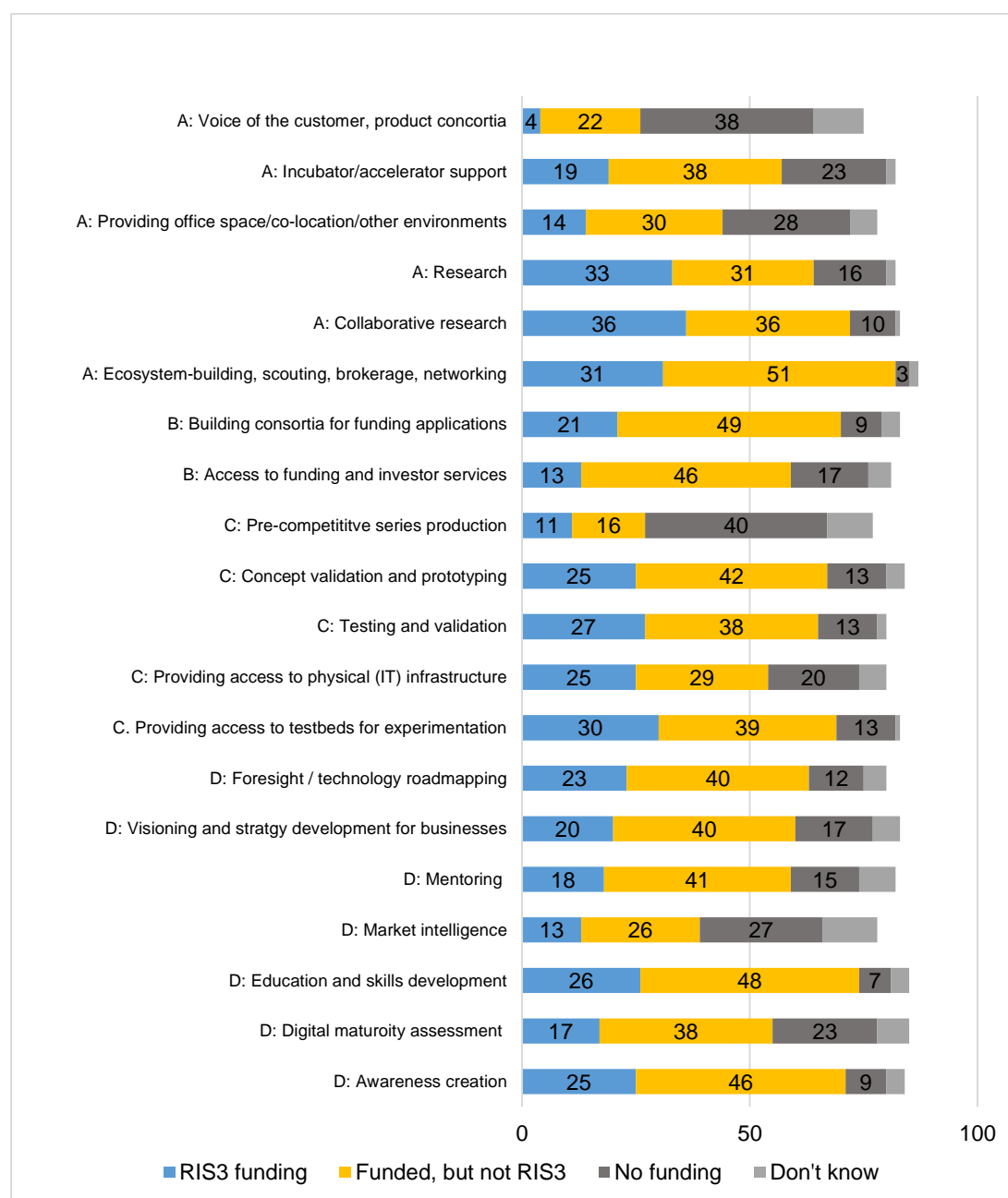
Figure 18: Sustainable Development Goals (SDG) coverage



Source: own elaboration based on survey results (DIH respondents – 93 answers)

Next, DIH managers were asked about the funding of different types of DIH activities, divided into the four principal DIH missions (A=building ecosystems, B=funding and financing, C=experiments and testing, and D=advancing digital skills). While funds connected to RIS3 are reportedly funding all types of activities across hubs (labelled in the graph), the reported funding from other sources is considerably higher in most categories (Figure 19). This indicates that while there appears to be some ties between DIHs and RIS3, DIHs dependence spans a wide variation of different funding sources and makes them a more complex entity altogether.

Figure 19: DIH funding



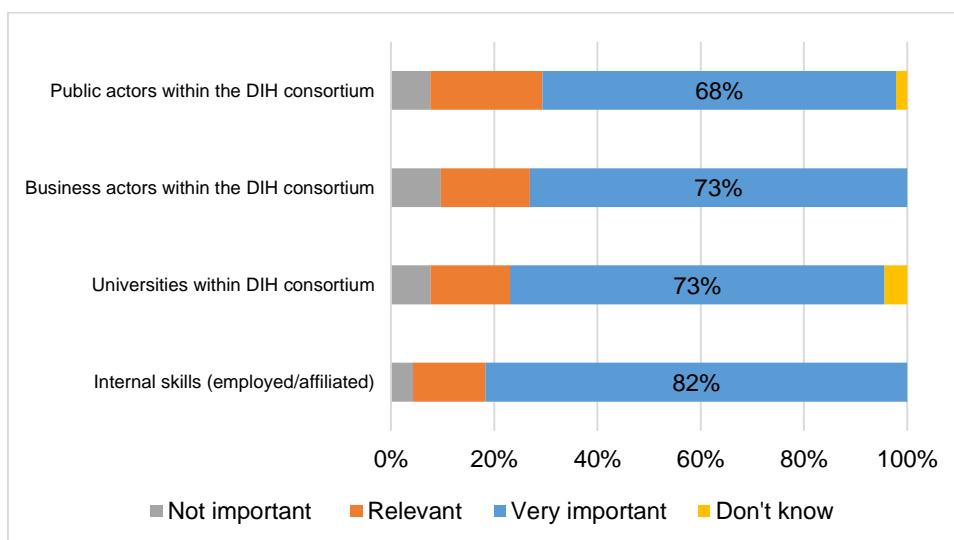
Source: own elaboration based on survey results (DIH respondents – 93 answers)

Moving on from strategy and funding, DIH managers were asked what human capital their hubs primarily draw on, internally and externally, for their activities (Figure 20 and 21). The overall results clearly indicate that the Hubs draw heavily on the skills and competencies of actors within their consortia (including employees), i.e. internalising human capital. While employees are the most important source of human capital, universities, businesses and public actors all play important parts according to the responses. This suggests that further investigation of knowledge networks within hub consortia may shed more light on how human capital can be/ is being mobilised to either build a competitive edge in leading industries or facilitate digital transformation within lagging sectors. The results here should also be put in relation to the self-reported strengths and weaknesses among hubs, where networks were reported to be a strength but skill training on the

other hand was left largely in the background. The question then becomes, how is human capital clustered and how are different types of such clusters mobilised towards specific goals?

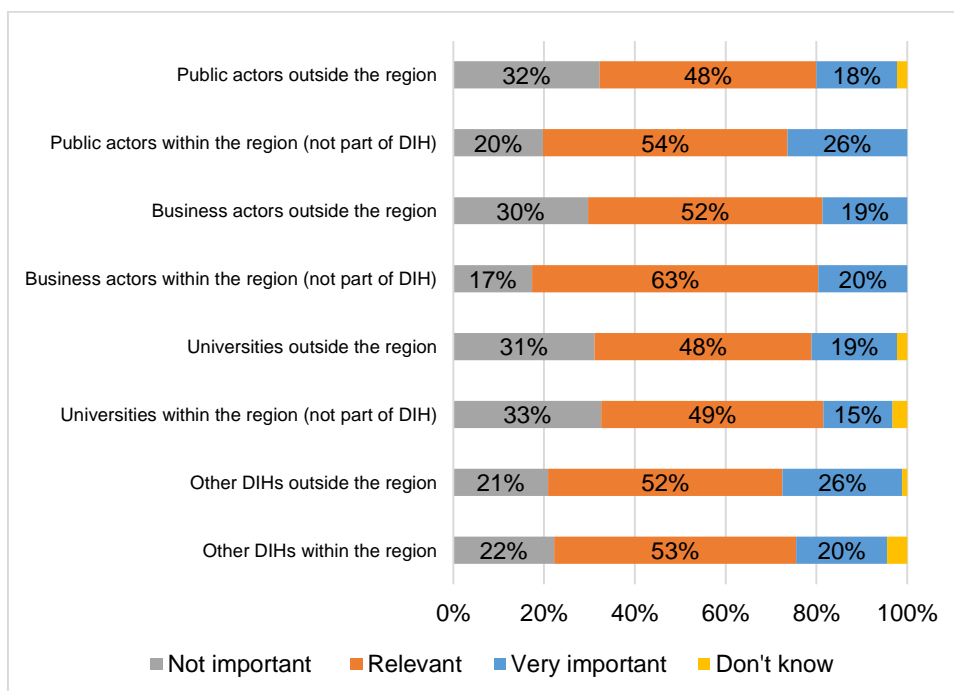
Looking to external human capital, the overall picture painted by the respondents is that external expertise may be relevant, but it less often plays a key role in DIH activities. While this indicates hubs are largely self-sustaining in human capital, it may also suggest that they are not branching out (despite emphasising their stakeholder networks). Put differently, even if hubs have the necessary human capital they need, reaching out to other actors with specific skills contribute to attracting yet other new customers and extending networks further.

Figure 20: Internal human capital



Source: own elaboration based on survey results (DIH respondents – 93 answers)

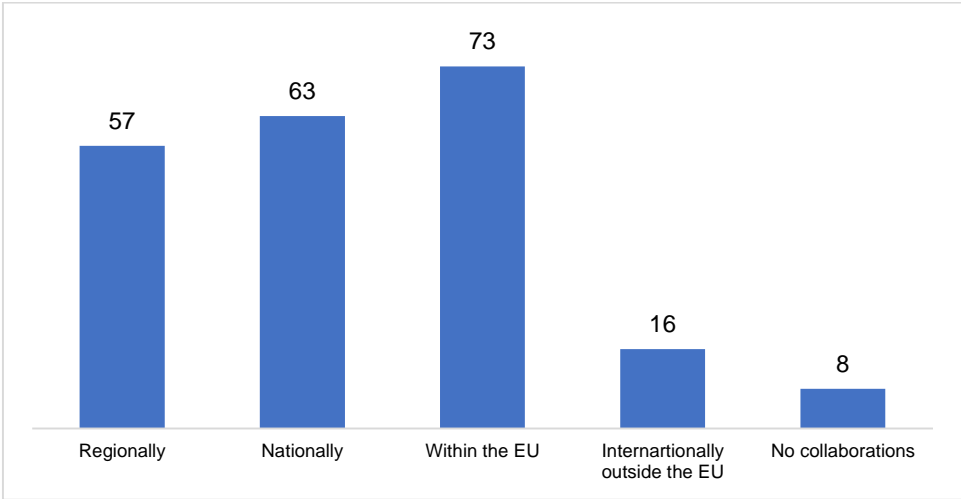
Figure 21: External human capital



Source: own elaboration based on survey results (DIH respondents – 93 answers)

DIH managers were then asked about their collaborations with other DIHs (Figure 22). The results indicate that collaboration across hubs is common on all scales within the EU. Among 93 participating DIH managers in the survey, 73 report collaborations on EU-level, 63 on a national scale and 57 on a regional scale. 16 respondents report collaboration beyond EU and 8 report not collaborating with other DIHs. These results suggest DIHs may function as a network or platform for learning and sharing mistakes or best practices across regions. Such a network may also play an important role in matching regional actors with similar needs or corresponding supply and demand related to digital transformation.

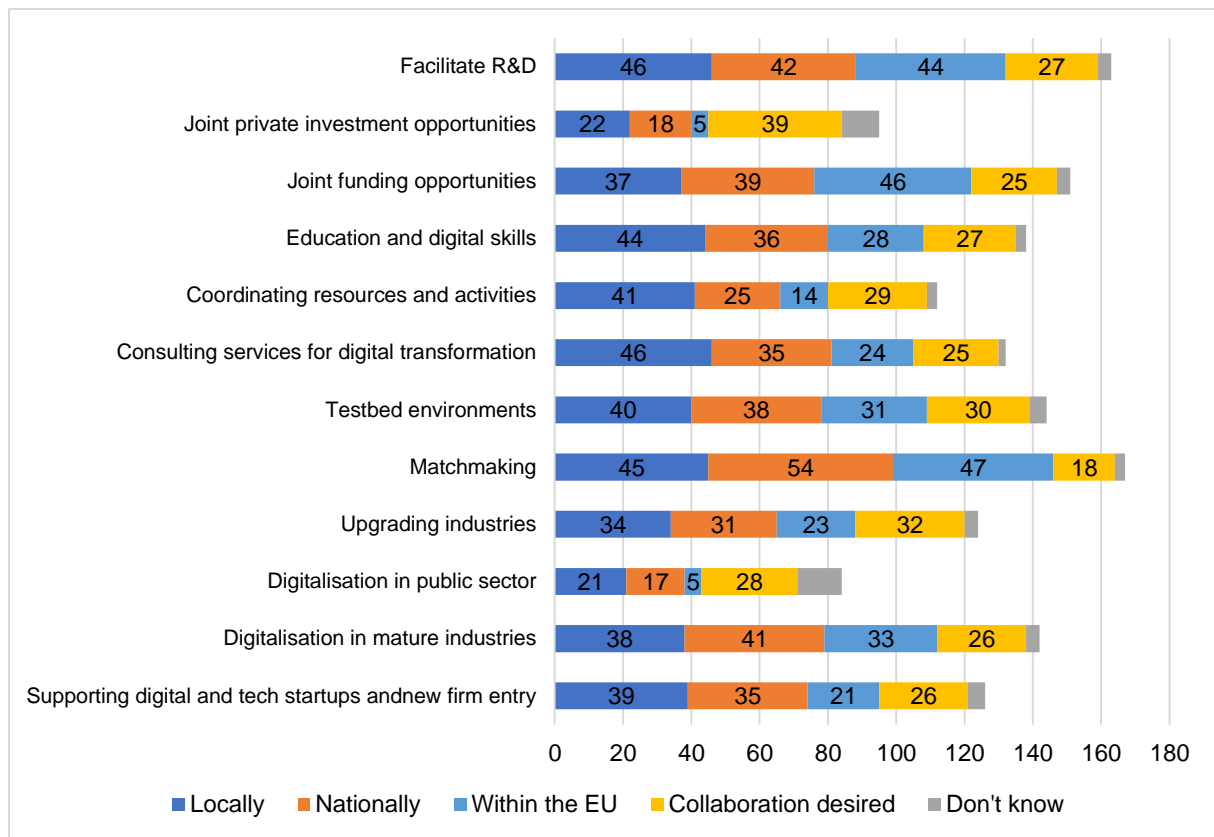
Figure 22: DIH collaborations



Source: own elaboration based on survey results (DIH respondents – 93 answers)

Looking closer at the content of the collaboration, it seems that it covers most activities on most scales (Figure 23). Especially R&D and matchmaking appear to be subjects of collaboration. Here, respondents were also able to indicate that collaboration is not present but desired. Interestingly, a considerable amount of DIH managers indicate that they want more collaboration across the spectrum of different activities.

Figure 23: The nature of collaboration

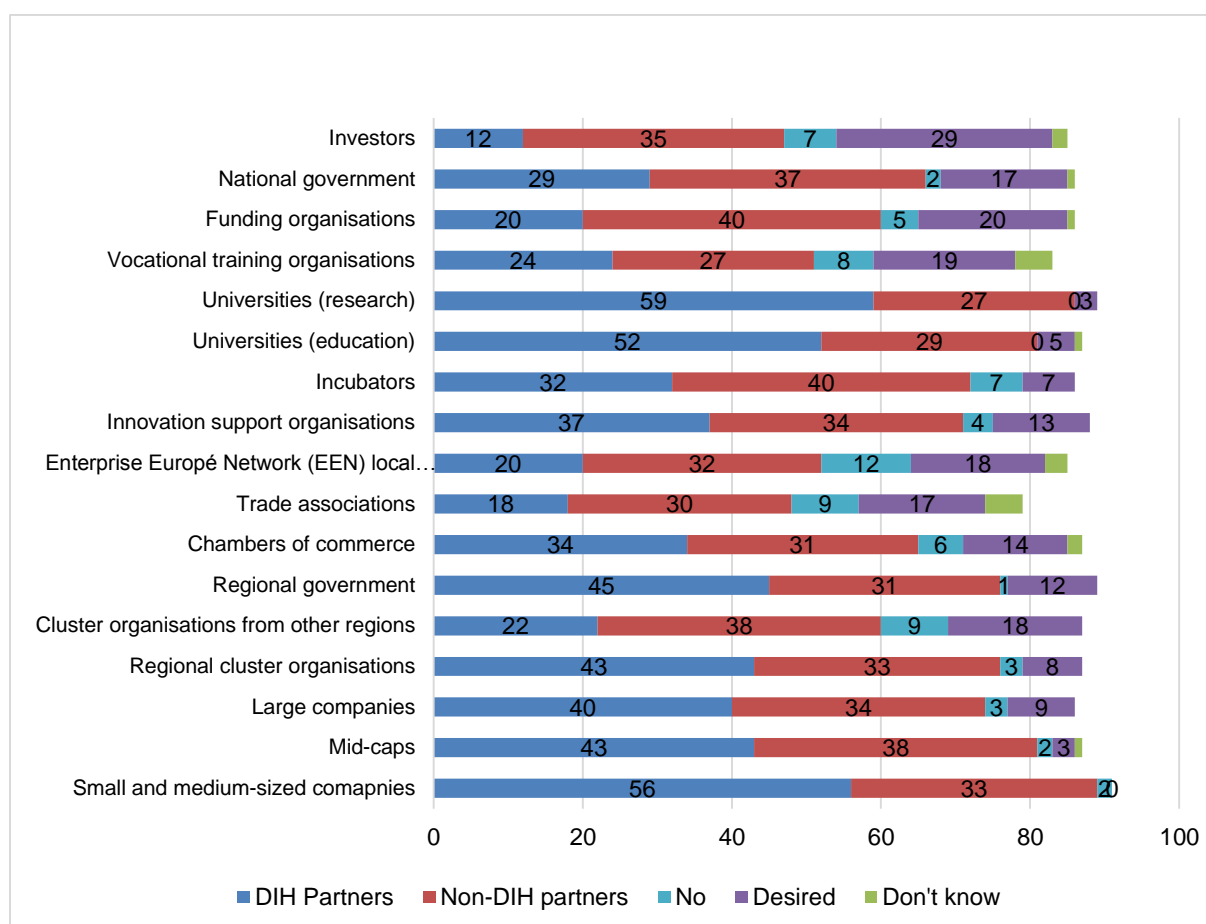


Source: own elaboration based on survey results (DIH respondents – 93 answers)

Lastly, DIH managers were asked with whom they collaborate (Figure 24). For each type of actor, the respondents were asked to clarify whether they are a part of the DIH consortium or not. The results indicate collaboration both within and outside of the DIH consortia, perhaps complementing the results from the questions about human capital earlier in this section. Again, for each category of actor, respondents were able to indicate (if no collaboration exists) that future collaboration is desired and again the results indicate a strong potential for extended collaborative networks forming around digital innovation hubs.

It is worth pointing out that investors and funding organisations are among the most sought after (desired) actors for DIHs to establish new collaborations with. This finding complements the observation that attracting funding is considered one of the most common weaknesses among hubs (see Section 3). This is not necessarily associated with attracting funding for other digital initiatives or ventures, but may also reflect an ambition to extend the funding of the hub itself.

Figure 24: Collaboration patterns



Source: own elaboration based on survey results (DIH respondents – 93 answers)

Although conducted for a complementary study, the opinions of key players are reported here as testimonials supporting the analysis.

Box 2. Indicative input from personal interviews with DIHs managers⁹

On DIH funding sources:

"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)

On DIH's collaborations (1):

"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)

On DIH's collaborations (2):

"In terms of scope and collaborations we have this motto: think globally, act locally" (Interview)

On DIH's and RIS3

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

⁹ (Mörner et al., 2019).

5 Summary and concluding remarks

Taken together, the survey results suggest that the studied regions share an overall pattern in digital competitiveness and maturity across sectors with emphasis on manufacturing and production processes. This may to some degree reflect a rising policy focus in the last years aimed at smart industry, advanced manufacturing and Industrie 4.0, to mention a few. Several Digital Innovation Hubs were set up in connection with these policy initiatives. While this result is based on perceptions, which may be affected by policy priorities past and present, the focus on manufacturing industries and production processes remains robust across different types of questions about technologies and business activities. Respondents also emphasise the digital competitiveness of larger firms, at least some of which are presumably in the manufacturing industry.

Looking at the description on regional digitalisation provided by the respondents, it seems that some of the topical areas prioritised in current policy programmes do not match the current reality on a regional level. For instance, the plan for the Digital Europe programme (DEP) is to focus on high-performance computing, cybersecurity, digital skills and artificial intelligence, while currently the first three seem to leave a very small footprint in regional digital competitiveness (a gap that DEP plans to incentivise reducing in the coming years). While AI is certainly a reported priority in the survey results, it should be pointed out that the term acts increasingly as a catch-all for a wide variety of different types of activities and applications. With this in mind, it may also prove useful to formulate policy based on the type of problems being addressed using new technologies instead of the technologies as such, i.e. treating technology as a means to an end rather than an end in its own. This would potentially make it a lot easier not only to coordinate similar developments across regions but also to engage and bring together digital leaders and laggards around problems rather than types of technologies. One way of doing this would be to leverage RIS3 priorities in order to identify tangible problems to address.

Furthermore, looking at the digital maturity in public sector organisations, the results suggest it is lagging behind significantly in most areas, posing an unrealised potential but also a sizable (policy) issue.

According to DIH managers, digital innovation hubs typically cover several of the principal missions associated with the initiative (ecosystem-building, financing, testing and experimentation, and skills). They also target a wide variety of different sectors, including public sector organisations, in their work. However, looking to their self-reported strengths, weaknesses and activities, there may be a considerable risk that their work engages or is useful only to actors who are already partially on board and that they do not manage to reach potential customers who have not themselves identified digitalisation as a priority. It appears that DIHs aim to target these groups of actors (as well as contributing to digital transformation in the public sector), but actually reaching them may prove to be easier said than done.

Formulating the goal of digitalisation and identifying relevant incentives may be one of the hardest parts for actors with low digital maturity. A lot of the activities emphasised by DIH managers are well-positioned to attract those who have at least some idea of what they want to achieve with their digital transformation. Stakeholder networks, access to technology and testbeds may be necessary to mobilise digital transformation, but there is no guarantee that it is sufficient to approach and empower actors who have not found their footing with digitalisation yet. Identifying practices for engaging these late adopters and helping them to identify their incentives and goals related to digital transformation should be a focus of further investigation.

Hence, the background role education, training and skill development seem to take in the self-reported descriptions should at least raise some concerns. There is always a risk that policy initiatives end up catering to those already engaged (preaching to the choir), and in this case, that would likely leave a whole lot of organisations behind. If, on the other hand, DIHs manage to not only engage but also enable matchmaking between more and less digital actors, this may work to

both sides' benefits. Digitally savvy tech firms could be matched with important reference customers (for instance in public sector organisations) while these in turn get access to technologies and know-how. From this perspective, DIHs could come to play an important role as multi-sided platform economies on a regional and possibly international scale.

One DIH activity that deserves further investigation and, not least, communication is the deployment of testbeds that promote experimentation in physical and virtual environments. Getting these testbeds to run efficiently is crucial to promote innovation, development and entrepreneurship related to increasingly complex and interconnected technical applications. This may for instance play a crucial role in digitalising healthcare or developing drone delivery systems and autonomous public transport. While DIH managers report offering a number of both physical and virtual testbeds, at the same time many of them report this being one of their weaknesses. Because testbed processes are complicated, there is a risk that existing testbeds are underutilised or that they only act as showrooms rather than platforms for experimentation.

Finally, DIHs appear to gather wide networks of stakeholders and collaborators both locally and internationally. This may make them a suitable platform for encouraging sharing experiences (best practices as well as failures) both between policy makers and between other types of stakeholders (firms with low digital competitiveness or tech savvy start-ups). Looking to the relationship between DIHs and RIS3, it seems clear that DIH managers are aware of and to a large extent engaged with RIS3 work. However, it is perhaps telling that the response rate from policy managers associated with RIS3 is very low, indicating that DIHs are not a top priority at the moment in the RIS3 community. The policy managers that have responded also report similar levels of DIH engagement with RIS3, but are the RIS3 policy managers overall equally engaged with DIHs? The low rate of responses to the survey from RIS3 policy managers indicates that the awareness and collaboration status are still in embryonic levels. It should at any rate be underscored that in terms of funding and collaborations DIHs bring together actors and funding from a wider variety of sources, signalling that it is becoming an institution in its own right.

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List of abbreviations

AI	Artificial Intelligence
DEI	Digitising 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
SDG	Sustainable Development Goal
SME	Small Medium Enterprise

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