FUTURES BY DESIGN

DRIVERS AND BARRIERS FOR DATA DRIVEN INNOVATION AMONGST SMALL TO MEDIUM SIZED FIRMS

Interreg North Sea Region
FBD
European Regional Development Fund

EUROPEAN UNION

www.futuresbydesign.eu

ABOUT FUTURES BY DESIGN

Futures By Design helps SMEs in rural areas of the North Sea region to use data analyses to innovate, grow and increase productivity.

Futures By Design (FBD) aims to enable small and medium-sized enterprises (SMEs) in regions of lower economic success to innovate, grow and increase productivity. SMEs are critical to regional economies and contribute considerably to regional employment. However, their capacity for success can be limited by insufficient access to data and the inability to analyse data to drive innovation and obtain improved results.

The six project regions are: Cambridgeshire (UK), Antwerp (B), Groningen (NL), Osterholz and North-West Germany (DE), Halland (SE) and Fryslan (NL). Each has a sub-region of lower economic success. Futures By Design will mainly address the industry sectors health technology, light engineering and agri-technology, which are represented in each region and all have a clear SME demand for supporting growth through better data - e.g. data about finance, legal changes, markets and technologies. This will help SMEs to develop strategies how to respond to technology shifts, data analytics and disruptive change.

We will work with 50+ SMEs in each partner region, sharing knowledge, ideas and regional experiences to support SMEs to become more data-driven and better informed about the economic, technological, policy and supply chain changes that will shape their futures.

We will create a virtual transnational horizon-scanning and knowledge transfer (HSKT) hub connecting 6 real hubs (one in each region) to support sustainable SME growth, innovation and productivity. Amongst our target 300+ SMEs we expect to enable 150 to grow, innovate, increase productivity and 150 (many the same SMEs, but not all) to make a major step to being better equipped for the digital age, and for future success.

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This report was coordinated by Emanuele Giovannetti, William Davies, Lewis Walsh, Robert Willis and Jemma Little from Anglia Ruskin University. Our thanks go also to our project partners for preparingthe sections on theregional contributions: Aleid Brouwer, NHL, Netherlands, Caroline Mair, Sirris, Belgium, Maren Meyer, Atene KOM, Germany, and Micha Björck, Alexanderson Institute, Sweden. Our thanks also go to Elisabet Klingenstierna for the production of this version and to Andrew Thomson fro providing invaluable feedback and guidance. The report remains work in progress, as it is prepared topreparethe conceptual framework for our ongoing empirical analysis with the SMEs.

INTRODUCTION

The project Futures By Design aims to help small and medium-sized enterprises (SMEs) across the North Sea region to achieve data driven innovation. The project works with SMEs to improve their data readiness and to use data management and digital tools to enhance their innovative capacity and competitiveness. This is done via the establishment of Horizon Scanning and Knowledge Transfer (HSKT) Hubs in each region.

This paper builds on the Desk Study for the project which examines the project's background, the HSKT Hub concept, scope and evaluation strategy (Koster and Bay 2020)[1] and reports on the drivers of and barriers to the development of the capacity and capabilities amongst SMEs for the adoption and exploitation of data and digital data analytics tools. It also examines the specific issues and barriers facing SME's that operate in more rural hinterland areas in the North Sea regions and the support that is in place to facilitate these firms increased data management capacities. The report is compiled using academic research, major consultancy and government reports on the subject of digital technology and the use of data driven solutions by firms. It will be used by the project's partner teams to inform the establishment of the Futures By Design HSKT Hubs as they become operational and to help identify strategies for SME engagement. The work is structured into three major sections, the first considers the emergence of data driven innovation and its relationship to digital innovation. The second highlights some of the generic barriers and drivers impacting SMEs ability to achieve data driven innovation regardless of country or region. The third provides a set of national examples of barriers impacting each of the regions involved within Futures by Design. Thus, providing a clear overview of both the generic and country specific barriers which are impacting SMEs ability to implement data driven innovation across the region.

SECTION 1 – THE EMERGENCE OF DATA DRIVEN INNOVATION (DDI) VIA DIGITAL INNOVATION

The OECD (2015) defines Data Driven Innovation (DDI) as the significant improvement of existing/ development of new products, organisational methods and markets emerging from analysis of data, including real-time analysis of big data and digital technology. (OECD 2015 Data Driven Innovation)[2]. We use the term "digital technology" not only to describe a type of technology but also to refer to the platforms, processes, and range of technologies that underpin modern information and communications technologies (ICT), including the Internet and mobile-phone platforms, as well as advanced data infrastructure and analytic approaches" (USAID 2020 Digital Strategy, 2020).

The principal driver of DDI is that more and more organisations are using digital technologies to leverage large volumes of (digital) data which is generated from a myriad of transactions and production of commercial processes; commonly referred to as 'Big Data' (OECD, 2015). Big Data is generated through ICT's including the Internet and mobile-phone platforms, as well as advanced data infrastructure and analytic approaches" (USAID 2020 Digital Strategy, 2020). While the measurement of the total real data generated is up for debate, the OECD (2015) suggest that by then a body of 2.5 exabytes (EB a Billion Gigabytes) of data was generated every

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1. https://northsearegion.eu/media/12066/202002_desk-study-and-evaluation.pdf
2. https://www.oecd.org/sti/data-driven-innovation-9789264229358-en.htm

single day, leading to an estimated total data storage of some 8 zettabytes (ZB, a trillion gigabytes). However, DDI does not always require large amounts of data. For small businesses DDI innovation might, indeed, consist of the meaningful interpretation, and usage for forecasting, of small internal datasets based, for example, on customer's bookings, suppliers' transactions and tax reports. Interestingly, moving along the ladder of sophistication in DDI, new emerging techniques allow smaller datasets to be analysed in more detail, through the utilisation of deep learning and connected techniques (Medium, 2018). These techniques provide avenues to implement DDI, without however, substituting the value of simpler and predominant forms of DDIs, based on data visualisation, extrapolation, and relevant summary statistics coupled with elementary forecasting and regression methods. Furthermore, one key aspect of the evolving data revolution is the increasing availability of open data, whereby each smaller firm can utilise existing regional data (Kitchin, 2014). Thus, allowing SMEs to achieve DDI through use of their own data matched with access to external datasets. One of the major types of innovation leading to the generation of data and their usage for innovation purposes in the framework of DDI is digital innovation. Broadly defined, digital innovation can be defined as 'a previously non-adopted digital modality to satisfy a specific need in a given context' (Giovannetti, 2017). This definition includes more traditional classifications e.g. process, product or organisational innovations, or those between radical and incremental innovations, and includes the diffusion and adoption of digital innovations in new contexts.

This broad definition is essential in the framework of digital technologies due to their intrinsic relation with converging technologies that may span across all these traditional classifications. As an example, digital product innovations may satisfy the need for an intermediate product or service within a production chain in a business-to-business (B2B) framework while, contextually, the same digital platform might be used to improve service variety for the end users in a business-to-consumer (B2C) setting . For example, due to the new Covid-19 related restrictions, a farm might need to bypass retailers and reach directly consumers though digital e-commerce platforms to sell its products, while using the same platform to procure essential intermediate products. Thus, the farmers adoption of digital platforms serves both organisational, and processes innovations, both in relation to upstream, intermediate inputs, and downstream relations, final customers. Our broad definition also encompasses digital processes and organisational innovations associated with structuring and managing resources and outputs within SMEs, as in the case of digital connected sensors that are used to collect data related to production, processing, and distribution of AgriFood products. Software applications with machine learning are required to collect, analyse, and integrate data, connect devices and guide decision making within the AgriFood supply chain. Data can help farmers to optimise inputs and adjust crops and land management regimes depending on many variable conditions between the fields, crop varieties, and climatic conditions. Data can also help suppliers of crop protection products to produce more accurate recommendations, or to gather evidence on their efficacy with more precision, reducing their use and environmental impact (FAO, 2017)[3].

This definition of digital innovation also includes the adoption and adaptation of techniques that may be well-established in other contexts, a process Edgerton (2007)[4] defined as one of creole

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3. http://www.fao.org/e-agriculture/events/turning-data-decisions-agrifood

4. David Edgerton, "Creole Technologies and Global Histories: Rethinking How Things Travel in Space and Time," Journal of History of Science and Technology, no. 1 (Summer 2007)

technologies "which finds a distinctive set of uses outside the time and place where it was first used", as they may find new applications in a different contexts. Thus, digital technology adoptions and adaptations, often through recombination, are also critically included as digital innovations.

SECTION 2 – GENERIC DRIVERS AND BARRIERS FOR THE ADOPTION OF DIGITAL TECHNOLOGY AMONG SMEs

This section considers the generic barriers to the adoption of digital technology which can be applied regardless of region.

2.1 GENERIC BARRIERS FOR DATA DRIVEN INNOVATIONS AMONG SME's

Data Driven Innovations, in SMEs, critically depend on the SMEs drivers and internal characteristics encouraging SMEs to adopt and adapt digital innovations. Amongst these, the literature has identified some key factors, discussed below.

Absorptive Capacity

Considers the ability of a firm to recognise the value of newly acquired external information, internalise it and apply it to its work processes (Cohen and Levinthal, 1990). This is seen as a precondition for adoption of innovations in general (Leahy et al. 2007)[5] and digital innovation in the specific, that would require certain digital absorptive abilities. Among these, we have:

Data readiness

In the context of FBD and the field of data science and digital innovation - Data Readiness captures the Capability to collect, store and, crucially, to make use of data as part of a firm's regular business process with the goal to increase efficiency and innovative potential (Bay and Koster 2020)[6].

Organisational capability

This considers the capacity of an organisation to adapt to and cultivate opportunities which are occurring within the digital environment, which may require fundamental new forms of organisational structure (Quinton et al, 2018). While this is a well identified problem in larger organisations this might also occur for SMEs (Garengo and Bernardi 2007)[7] as the small number of employees means that any reorganisation necessary to create resources linked to opportunities within the digital environment are less complex in organisational terms, but more challenging given the smaller diversity of human resources available.

The workforce

There is a shortage or lack of proper access to people with the right skills and in the level of systematic engagement with the skills education/training to support SME's. Related to this is a lack of business support and best practice guidance for adopting new technologies. A key tool for a better understanding of the digital skills shortage in the current workforce is provided by the Programme for the International Assessment of Adult Competencies (PIAAC) organised by the OECD, that includes a Survey of Adult Skills.

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5. Leahy, D. and Neary, J.P., 2007. Absorptive capacity, R&D spillovers, and public policy. International Journal of Industrial Organization, 25(5), pp.1089-1108.

6. https://northsearegion.eu/media/12066/202002_desk-study-and-evaluation.pdf

7. Garengo, P. and Bernardi, G., 2007. Organizational capability in SMEs: Performance measurement as a key system in supporting company development. International Journal of Productivity and Performance Management, 56(5-6), pp.518-532.

The OECD's skills outlook survey (OECD 2019)[8] was conducted in over 40 countries and measures the key cognitive and workplace skills needed for individuals to participate in society and for economies to prosper. The unique value of the OECD survey is in its scope, as it is used to assess the distribution of ICT-literacy skills for a large group of member countries and their distribution across the workforce. The OECD survey, reports that the "PIAAC reveals that 15% of adults lack basic digital skills, and 13% lack basic digital, numeracy and problem-solving skills." Stressing the associated risks for citizens, being left behind by the digital transformation. Moreover, the findings also showed that "holding a tertiary degree does not always guarantee a high level of skills. Additionally, the different countries analysed were unequally prepared to seize the benefits of digital transformation. The ITU Digital Skills Toolkit (ITU, 2018)[9] identifies other relevant resources on developing strategies for digital skills for the workforce:

- The Report on "Digital Skills for Life and Work" (Working Group on Education of the Broadband Commission for Sustainable Development, 2017)[10] providing the tools to assess the state of digital skills, and the relevant policy recommendations.

- The Digital Skills & Jobs Coalition initiatives repository. (European Commission, 2020)[11] a searchable web-repository of Europe's best digital skills projects.

The key approach of these contributions is that "digital skills develop across a continuum, and they are constantly being updated in line with changes in technology, highlighting the relevance of policy frameworks such as the Digital Competence Framework for Citizens (DigComp)[12], developed by European Commission (EC) to improve digital competence, and providing a common language on how to identify and describe the key areas of digital competence and thus offers a common reference at European level.

The EU publishes an annual report, including the "Digital Economy and Society Index" (DESI) to monitor Europe's overall digital performance and tracks the progress of EU countries in their digital competitiveness. The DESI is also an essential tool used by the Commission to monitor progress on the digitisation of SMEs, according to the guidelines of the recently published "SME strategy for a sustainable and digital Europe" (COM, 2020)[13].

The Index, has five dimensions, capturing: connectivity, human capital, use of internet, integration of digital technology, and digital public services. On human capital, the report focuses on the role of digital skills seen as the backbone of the digital society. The report discussed how the COVID-19 crisis has shown the critical nature of digital skills to empower citizens access to information and services. The report found that "In the past year, there was an improvement both in internet user skills (at least basic digital skills) and in advanced skills (ICT graduates and ICT specialists)" (COM 2020, page 12). In 2019, the percentage of people having at least basic digital skills reached 58% (up from 55% in 2015). A large part of the EU population, however, still lacks basic digital skills, even though most jobs require such skills. In 2018, some 9.1 million

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8. OECD Skills Outlook 2019, Thriving In A Digital World, https://www.oecd-ilibrary.org/docserver/df80bc12-en.pdf?expires=1593607669&id=id&accname=guest&checksum=3d7ecb7e9be3d196bd01ae1b9d19d6e8

9. https://academy.itu.int/main-activities/research-publications/digital-skills-insights/digital-skills-assessment-guidebook

10. https://broadbandcommission.org/documents/publications/wg-education-report2017.pdf

11. https://ec.europa.eu/digital-single-market/en/digital-skills-jobs-coalition-initiatives

12. Vuorikari, R., Punie, Y., Carretero Gomez S., Van den Brande, G. (2016). DigComp 2.0: The Digital Competence Framework for Citizens. Update Phase 1: The Conceptual Reference Model. Luxembourg Publication Office of the European Union. EUR 27948 EN. doi: 10. 2791/ 11517

13. https://eur-lex.europa.eu/legal-content/en/txt/?uri=com%3a2020%3a103%3afin

people worked as ICT specialists across the EU, 1.6 million more than 4 years earlier. Nevertheless, there remains a shortage of ICT specialists in the labour market: 64% of large enterprises and 56% of SMEs that recruited ICT specialists during 2018, reported hard to fill vacancies for ICT specialists: "... There is also a gender balance issue as only one-in-six ICT specialists are female." (COM 2020, page 12).

The report also indicates that company size played a relevant role in the degree of integration of digital technologies into business activities with 38.5% of large companies relying on advanced cloud services and 32.7% using big data analytics, while, only 17% of SMEs were using cloud services and only 12% big data analytics. A similar divide was found in e-commerce activities where 17.5% of SMEs sold online in 2019, against 39% of large enterprises (COM 2020).

Security

Concerns over, and confidence around, the management of cyber security is an issue for many firms (UK Industrial Digitisation 2017)[14], (McKinsey Digital 2015)[15]. The findings of these reports point out that data security is a big issue when it comes to things like implementing 4.0 technology in manufacturing firms. SMEs in particular perceive significant barriers to digital technology adoption that stem from the risks around cyber security (UK Industrial Digitisation, 2017).

Digital connectivity

Digital connectivity is clearly a precondition for digital innovation, and it is considered a social right[16] in the EU. Following the recent COVID-19 pandemic there is an increased awareness of how essential digital connectivity is for the European economy, by allowing some forms of economic activities to continue, by relying on widespread adoption, whenever possible, of new working from home practices with both SMEs suppliers and customers along newly digitised value chains.

The The Digital Economy and Society Index (DESI)[17] includes both the demand and the supply side of fixed and mobile broadband. For fixed broadband, it differentiates among ultra-fast broadband (at least 100 Mbps), fast broadband (next generation access (NGA) providing at least 30 Mbps) and fixed very high capacity networks (VHCNs). For mobile broadband the DESI includes 4G coverage, the take-up of mobile broadband (3G and 4G) and the indicator on 5G readiness.

According to the DESI report "Overall connectivity has improved, both as far as demand and supply are concerned. In 2019, NGA coverage increased to 86% of households compared to 83% a year ago, while fixed very high capacity networks (VHCNs) are available to 44% of households. VHCNs are provided either on FTTP (Fibre to the Premises) or DOCSIS 3.1 (Data Over Cable Service Interface Specification) cable networks.... across Europe 78% of households had a fixed broadband subscription in 2019, up from 70% 5 years ago. Over a period of 5 years we note that more and more people are taking up broadband services of at least 100 Mbps: penetration reached 26% of households, five times higher than 5 years ago. 4G networks cover almost the

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14. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/655570/20171027_madesmarter_final_digital.pdf

15. https://www.mckinsey.com/~/media/mckinsey/business%20functions/operations/our%20insights/industry%2040%20how%20to%20navigate%20digitization%20of%20the%20manufacturing%20sector/industry-40-how-to-navigate-digitization-of-the-manufacturing-sector.ashx

16. https://composite-indicators.jrc.ec.europa.eu/social-scoreboard/

17. https://ec.europa.eu/digital-single-market/en/digital-economy-and-society-index-desi

entire European population, but little progress has been registered on 5G spectrum assignments." (DESI 2020, page 11)[18].

From a rural SMEs' perspective what matters is the geographic distribution of connectivity. At European level, these is still a noticeable disparity, as shown in below. This depicts a situation whereby overall very high capacity network (VHCN) increased between 2011 and 2019 in the EU as a whole went from 10% to 44%, however in rural areas, coverage grew from 2% to 20%. This gap in growth shows the continuing regional disparities in digital opportunities and confirms that more investment is needed in rural areas.

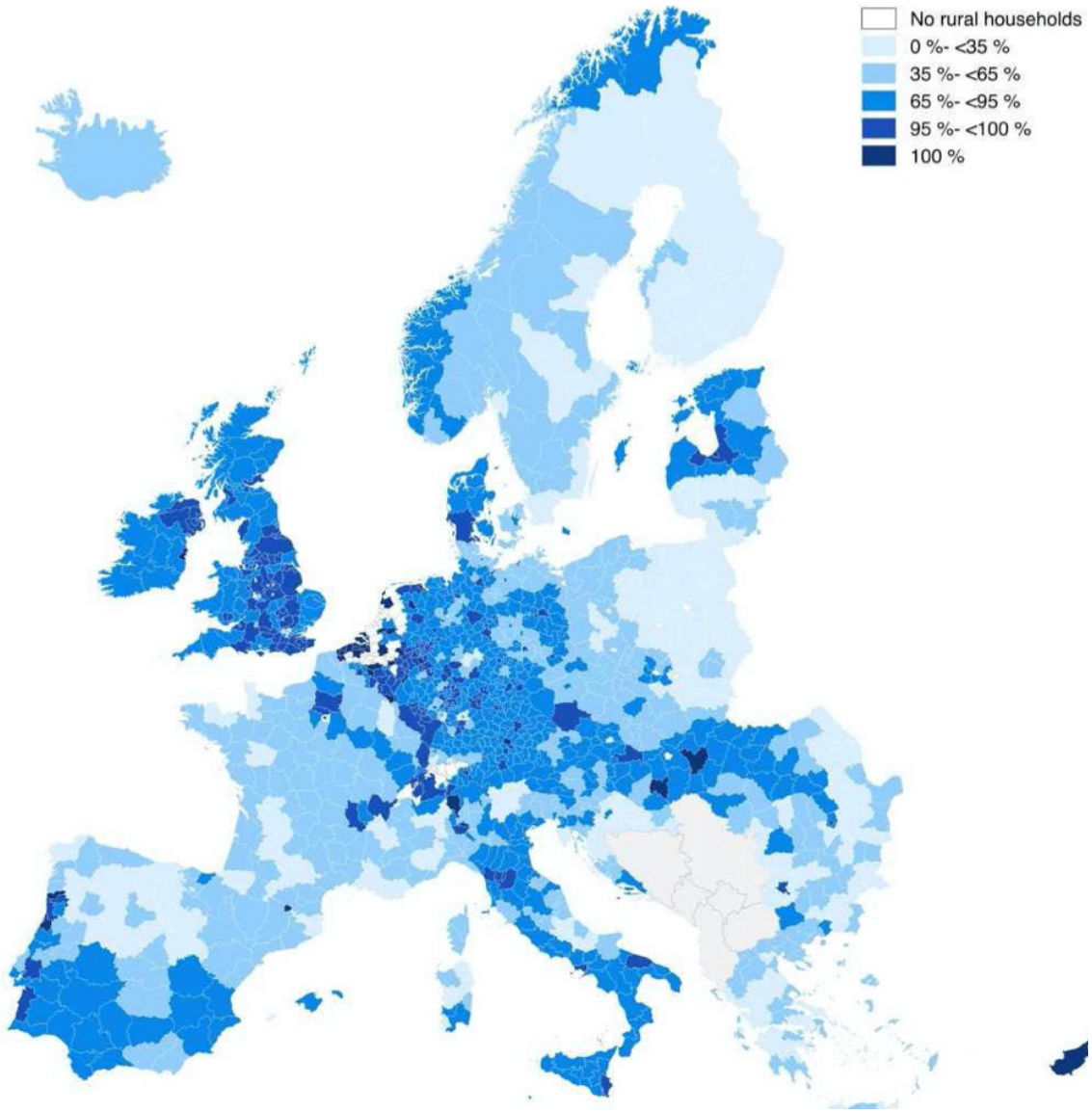

Figure 1. Digital economy and society index 2020: rural next generation access (nga) broadband coverage in the EU (% of households). Source: Broadband coverage in Europe 2019, a study by IHS Markit, Omdia and Point Topic.

18. https://ec.europa.eu/digital-single-market/en/digital-economy-and-society-index-desi

Digital affordability

The International Telecommunications Union (ITU), discusses in depth the problem of international comparisons of the affordability of the Internet access (ITU, 2020)[19]. Clearly, the price of Internet is one of the major barriers to internet access and usage. However, monitoring prices is very difficult, as prices depend on: type of service (fixed versus mobile); bundling of different services; different operators (within the same market); data, voice and text allowances; and whether national or international comparisons are made " (ITU, 2020).

In the recurrent publication, Measuring Digital Development: ICT Price Trends (ITU, 2019), the ITU "monitors the affordability of ICT services by analysing and comparing price data for mobile-voice services, mobile data and fixed broadband ... The report provides analysis in terms of dollar price, exchange-rate adjusted prices and affordability for mobile-voice, mobile and fixed broadband according to internationally agreed baskets for services, including bundled services." There are many problems in defining the 'affordability' of telecom services as at the national level, different operators in a single country, or the same operator over time, can have vastly different and varying prices. The prices tend to be based upon contract length; volume of minutes; texts and data allowances; and whether a handset is included. Moving to the international level, comparisons necessitate adjustments for exchange rates and purchasing power parity between different countries. Hence, standardised price baskets can be used to compare prices between operators and/or countries. While the price of telecom/ICT services is often cited as a barrier to using telecom services, the ITU focuses on the affordability or ease of purchasing a service, relative to consumer income. Prices can be expressed as a percentage of Gross National Income (GNI) per capita to show prices relative to the size of the economy of each country, however, it remain true that national averages may not be good at indicating that ICT services are affordable for poorer social groups, or smaller business, but they still give insights into whether telecom services are affordable. The latest analysis of affordability at international level is published in"Measuring digital development ICT Price Trends 2019" (ITU, 2020).

Mindset/culture

This considers the degree to which a business is proactive or resistant to change, which impacts significantly on the likelihood of successfully adopting new technology. This is culturally driven and is dependent upon whether the company has a growth or sustaining mindset, which stems from the attitudes of key decision makers and the length of time they have been in post (BEIS, 2019)[20].

Innovation Ecosystems

The factors discussed above are relevant in discussing internal drivers for SMEs, however, digital innovations do not take place in a vacuum, but are only possible, and more likely to be successful, for SMEs that are part of a conducive environment; of which the digital connectivity is only one aspect. This notion of a conductive environment is captured by the idea of an Innovation Ecosystem in which an SME is operating, that plays a critical role on all the different phases of SME's digital innovation process, from influencing their absorptive capacity, to affecting their mindsets and culture.

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19. https://www.itu.int/en/mediacentre/backgrounders/Pages/affordability.aspx

20. https://www.gov.uk/government/publications/small-and-medium-sized-business-sme-attitudes-towards-adopting-best-practice

The adoption of innovations, of which digital innovations are a progressively more relevant component, was seen as an organisational learning processes (Nelson and Winter, 1982; Dosi, 1982) leading to the concept of national innovation systems (Lundvall, 1992) focusing on the complex set of interactions among multiple actors engaged in producing, distributing and applying different kinds of knowledge. Accordingly, "the innovative performance of a country depends to a large extent on how these actors relate to each other as elements of a collective system of knowledge creation and use, as well as the technologies they use." (OECD, 1997, page 9)[21].
When moving from the macro to the micro level, Chesbrough (2003) introduced the notion of Open innovation networks whereby multiple stakeholders are linked through a set of explicit cooperative interactions. In this framework, a detailed analysis of a firm's collaborations is used to understand how a firm forms the intangible assets (Corrado et al., 2006) and capacity for absorbing knowledge (Cohen and Levinthal, 1990). Innovation ecosystems (Giovannetti, 2017) extend Open innovation networks by also considering the relevance for digital innovation of the indirect benefits arising from the positive innovation spill-overs and network externalities due to the innovative activities of a wider set of stakeholders that form the innovation-relevant elements of a business ecosystem. Following this approach, we can see that an appropriate analysis of the barriers and drivers to adoption of digital technologies also needs to focus on the role played by possible bottlenecks appearing in the set of explicit and implicit network of relations among the different stakeholders of the innovation ecosystem under study.

Digital innovation ecosystems are data driven innovation ecosystems, as they are based on the digital technologies to provide the modalities for forming their networked relations and interactions among different stakeholders, which jointly contribute to the development of innovations. The Community Innovation Surveys, operationalises these relational activities by focusing on cooperation with 1) Other businesses within the same enterprise group; 2) Suppliers of equipment, materials, services or software; 3) Clients, customers or end users; 4) Competitors or other businesses in the same industry; 5) Consultants, commercial laboratories, or private R&D institutes; 6) Universities or other institutions of higher education, and 7) Government or public research institutes. The data from the CIS have been used, see for example (Giovannetti and Piga, 2017) to empirically explore the key drivers and barriers to adoption in the UK Innovation Ecosystem. The analysis of the localised digital innovation ecosystems, based on the study of the set of relationship between an SME and the relevant players forming its operating environment, is therefore an additional element for understanding drivers and barriers towards data driven innovations in a specific local area.

2.2 GENERIC DRIVERS FOR DATA DRIVEN INNOVATIONS AMONG SMEs

Firm Internal Drivers

The drivers are linked to the internal incentives for an SME to adopt digital technology to achieve internally identified benefits from adoption. The identification of these drivers is often the mirror image of the dimensions discussed in the section on barriers to data driven innovations. Any progress on the reduction of the barriers, in terms of connectivity, human capital, digital skills etc, facilitate the participation of SMEs in the digital economy, and opens innovation opportunities through digital participation.

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21. OECD (1997), National innovation systems. https://www.oecd.org/science/inno/2101733.pdf

Additional drivers, based on profit motivation, can be found in both the regulatory environment and in the market competitive pressure that might drive the need, especially for SMEs, to implement the actions needed to survive in changed, more integrated, digital competitive environments.

Regulatory intervention

Public policy, including regulation and sector policies can act both as a barrier to data driven innovation as well as a driver of said innovation. Whereby regulatory intervention can provide clear incentives to firms, such as tax incentives, training schemes and access to capital. While regulation can also act as an obstacle, especially when there are demanding regulatory requirements, such as with GDPR. As Regulatory intervention is often geographically restricted, based on the specific regional policies, such issues should be considered, region by region. Examples of such intervention are considered in section 3 of this report.

Changing market needs

The market structure in which SMEs operate is what drives their constraints and opportunities in relation to data driven innovation. The adoption of data driven innovations may be due to increased competitive pressure, that allows digitally enabled competitors, to reduce costs, improve services, reach new markets, customers and or suppliers. These aspects can be self-reinforcing due to specific features of the relevant market structure. Of particular relevance, for data driven innovation, are the markets mediated through digital platforms. These platforms, by digitally linking buyers and sellers, are prone to create different effects that distort market conditions. In particular, these platforms give rise to direct network externalities, indirect network externalities, cross platform network externalities and switching costs (Rochet and Tirole (2003)[22] , Katz and Shapiro (1994)[23] , Siciliani and Giovannetti (2019)[24]). These externalities' driven processes, that can be kick-started by digital advantage, might lead to markets dominated by the digital leaders, progressively sending digital laggards out of business. Such competitive dynamics are heightened by the presence of lock-in effects, that create monetary and cognitive costs for customers to switch among competing market players.

Technology

Technology is neither a driver nor an obstacle to the adoption of digital technologies. Technology breaks existing equilibria disrupting production and service relations routines. Technology, by reducing the costs of digital applications and often facilitating user interfaces can reduce monetary barriers, however, by setting new cognitive standards, requiring parallel acculturation processes, also raises new barriers for the SMEs that are unable to keep the minimum required learning pace to be digitally functional with the latest technologies and successfully compete in markets.
Customer and Suppliers drivers and obstacles in adoption

The adoption of digital technologies can often be a customer or suppliers driven process. This is as producers are engaged in constantly changing learning process along their supply chains and do need to adapt/ react or be proactive when digital interfacing standards within their value chain change. These relations are again captured by the notion of ecosystems. Also, for the drivers, as for the barriers discussed above, the innovation ecosystems, often forming around digital

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22. Rochet, J.C. and Tirole, J., 2003. Platform competition in two-sided markets. Journal of the European economic association, 1(4), pp.990-1029.

23. Katz, M.L. and Shapiro, C., 1994. Systems competition and network effects. Journal of economic perspectives, 8(2), pp.93-115.

24. Siciliani, P. and Giovannetti, E. (2019). Platform competition and incumbency advantage under heterogeneous switching cost — exploring the impact of data portability, Bank of England Staff Working Paper No. 839

platforms, create the effective environment where SMEs face the key incentives to adopt digital innovations. These encompass all the previous dimensions, but also include indirect relations, not only those taking place between customers, suppliers, competitors, public institutions. Indirect relations also provide incentives through positive spillovers hence, being embedded in a highly digital ecosystem provides clear indirect digital benefits. However, the degree of advancement of such digital ecosystems might generate new forms of digital exclusion, something often observed when SMEs operate in the digital peripheries surrounding technological hotspots.

SECTION 3 – REGIONAL EXAMPLES OF BARRIERS TO DATA DRIVEN INNOVATION

This section considers the barriers to data driven innovation for each of the regions involved in the future by design. Providing examples of such barriers across the five regions addressed by the Futures by Design project in the UK, Netherlands, Germany, Sweden and Belgium.

UK barriers to data driven innovation

Geographic areas of low internet connectivity

In its Connected Nations Report, (2019)[25] The Office of Communications (Ofcom) provides the latest update on the connectivity of the UK. The overall situation is encouraging since "Over the last few years, the availability and take-up of superfast and ultrafast broadband, and the coverage and take-up of 4G mobile services have dramatically increased... the UK leads other large European countries for the highest availability of superfast services. The UK also holds a leading position on current 4G mobile network coverage. The findings show that homes and businesses that have access to full-fibre broadband connections have doubled from 1.5 to 3 million premises in the last year. These connections can deliver much higher download speeds, of up to 1 Gbit/s and are also much more reliable than older, copper-based broadband. Also, the deployment of wireless home broadband from mobile networks further reduces the number of premises that cannot get a decent broadband service. They now estimate that as few as 189,000 homes should be unable to access a decent fixed broadband service. In terms of mobile connectivity, 5G services are now operating in over 40 towns and cities across the UK. 91% of the UK has access to good 4G outdoor mobile coverage from at least one of the operators. This leaves 9% of the UK that does not have good outdoor 4G coverage from any operator, predominantly in rural areas. One in five premises, homes and businesses, remain unable to get good 4G indoor coverage or circa 53,000 premises cannot access either a decent fixed broadband service or get good 4G coverage indoors (from any operator).

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25. https://www.ofcom.org.uk/__data/assets/pdf_file/0023/186413/Connected-Nations-2019-UK-final.pdf

A decomposition across the country different nations is provided in Figure 2, below

Nations	All	Rural	Urban
England	2% (412,000)	8% (273,000)	1% (138,000)
Northern Ireland	6% (50,000)	19% (44,000)	1% (6,000)
Scotland	4% (98,000)	19% (89,000)	0% (9,000)
Wales	3% (50,000)	12% (42,000)	1% (8,000)
Total	2% (610,000)	10% (449,000)	1% (161,000)

Figure 2. Premises unable to receive decent broadband from a fixed line, Source: OFCOM analysis of operator data

Mobile broadband in increasingly relevant to access data for both households and businesses. A visualisation of its geographic distribution is provided in Figure 3 below:

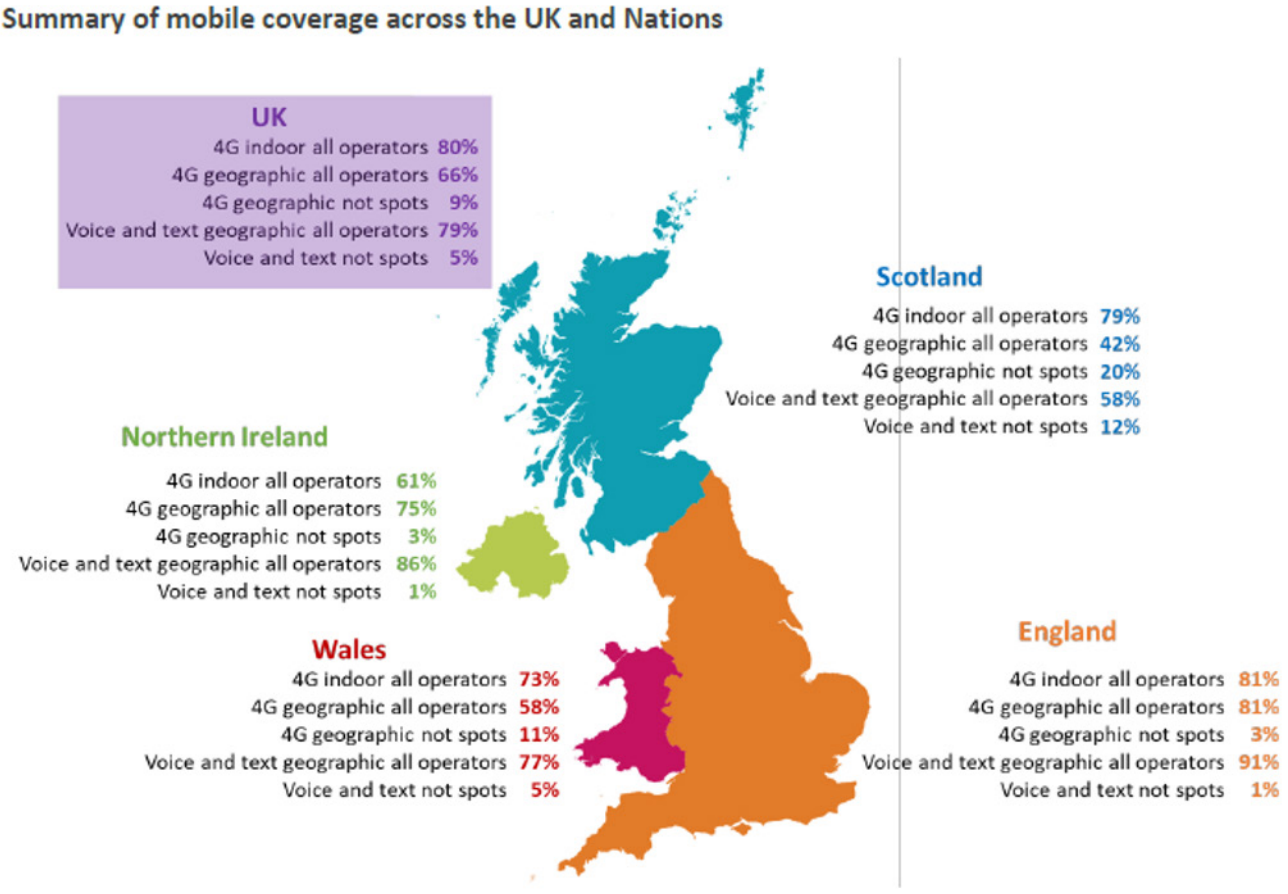

Figure 3. Summary of mobile coverage across the UK and nations. Source: OFCOM (2019) connected nations report.

In order to address the problems of rural mobile connectivity, in October 2019, the UK Government had reached an in-principle agreement with industry to fund a shared rural network whereby mobile operators will be sharing existing and new infrastructure to provide significantly improved and extended coverage in rural areas.

The most problematic issues with connectivity arise when SMEs are located in the not-spots. The map below, Figure 4, allows the visualisation of the areas of the UK that have outdoor 4G coverage from all operators, the areas that have coverage from some operators (partial not spots) and the areas that have no coverage at all (not spots).

Figure 4. 4g Coverage across the UK. Source: Ofcom, 2019.

Concerning ICT readiness, Ofcom data includes:

1. UK's fixed broadband coverage, mobile and WIFI network coverage, digital television, digital radio and internet infrastructure, and
2. UK home broadband performance, capturing the average performance of ADSL, cable and fibre broadband packages.

Ofcom's (2019) Broadband performance Report[26] allows a clear visualisation of both the improvements in connectivity at country level and the persisting asymmetry in the quality of access between rural and urban areas in the UK. This can be visualised in the figure below:

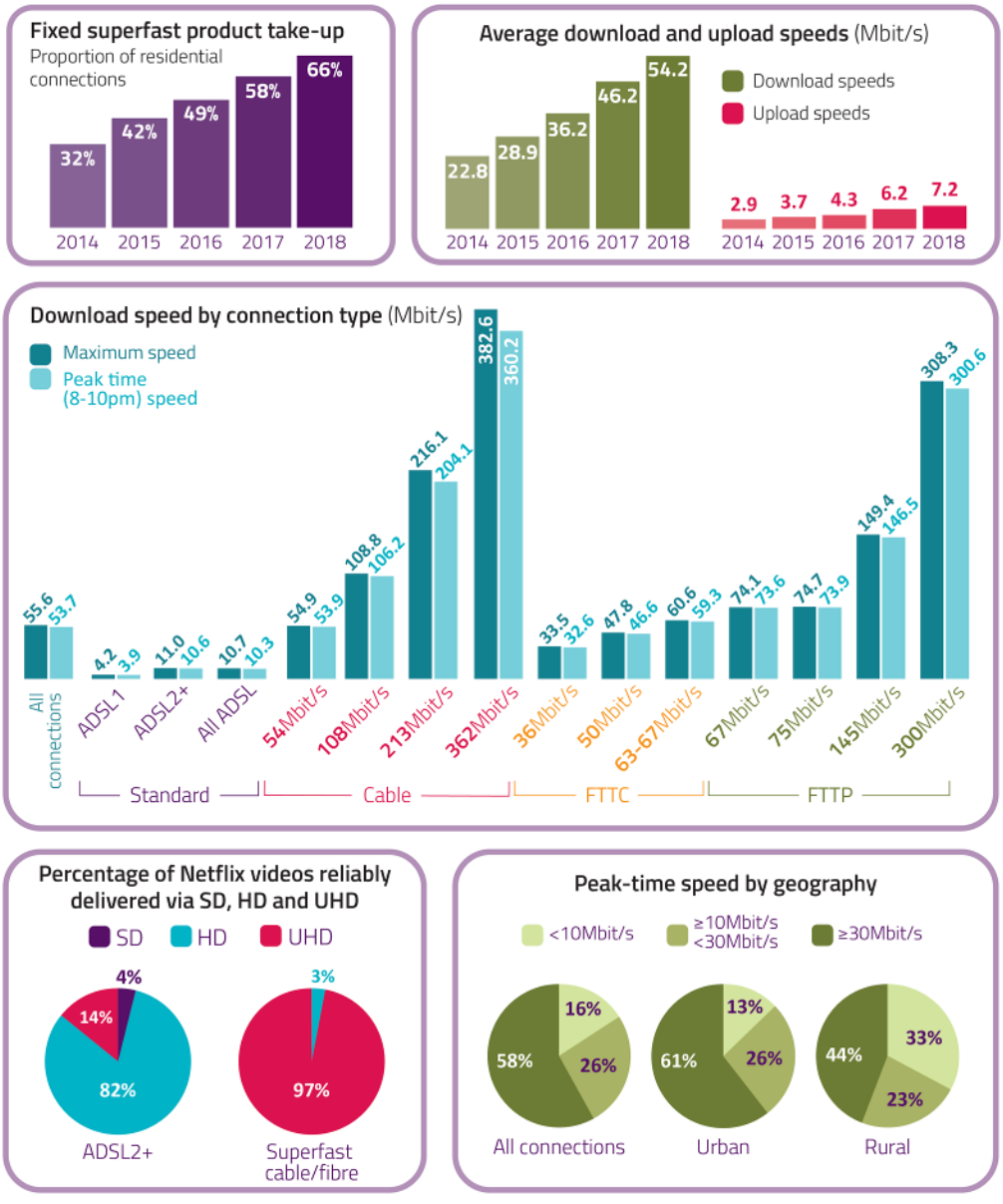

Figure 5. Source: Ofcom, 2019.

26. *https://www.ofcom.org.uk/__data/assets/pdf_file/0020/147332/home-broadband-report-2018.pdf*

The key findings of the report are that "There are significant differences in performance between urban and rural areas. Overall, 58% of lines had an average 8-10pm peak-time speed of 30 Mbit/s or above in 2018. The proportion of lines receiving an average peak-time download speed greater than 30 Mbit/s was lower in rural areas of the UK (44%) than in urban areas (61%), and while 13% of urban lines had a peak-time speed of under 10 Mbit/s, the proportion was 33% in rural areas." (Ofcom 2019, page 3)

What mattes for SMEs, and particularly those in rural areas, is, however, the geographic distribution of connectivity. There is no point of being one mile away from very good mobile coverage, if it does not reach a farm. On this topic, Rural England (2018; 42), indicated that there are a number of issues relating to digital connectivity as a precursor for technology adoption, with a third of their respondents highlighting difficulty in finding external or outsourced digital connectivity support for their business.

Digital exclusion in the UK

If a community is digitally excluded, its SMEs will not be able to benefit from data driven innovation. The key components of digital exclusion, as identified by the ITU, the UN specialised agency for the Information and Communication Technologies, [ITU, IDI 2019] are captured by an area's level network infrastructure and access to ICTs, (ICT readiness), the level of usage of ICTs in the relevant communities (ICT intensity) and levels of capabilities and digital skills. Low levels of ICT development as captured by the ICT Development Index (IDI), can be driven by access, a poor interconnection infrastructure, and the lack of appropriate digital skills required to implement digital adoption. Affordability, while not included directly into the IDI index, is also a crucial component in determining the costs barriers accessing infrastructure, and calculated separately by the ITU.

In the UK, Ofcom publishes key data that covers these dimensions. All the data releases can be seen in Ofcom's open data portal[27], which contains the following information on ICTs usage and skills dimensions:

1. Media literacy open data, providing evidence on media use, attitudes and understanding among children and young people;
2. Technology tracker data measuring awareness, access, use of and attitudes towards fixed and mobile telecoms, internet, multi-channel TV, and radio, among UK adults;
3. Adults' media literacy, on adults' media use and attitudes across TV, radio, games, mobile and the internet, with a particular focus on online use and attitudes. Additional education outcomes from schools are available from Ofsted.

Affordability in the UK

In the UK," Ofcom states that "a price threshold no higher than £45 per month should be sufficient to ensure broadband is affordable."

The Point Topic's website.[28] provides a national geo-mapping service that compares how much consumers have to pay to get the entry level (cheapest) broadband available where they live and how this entry level cost relates to the average household income in that area. This is an essential step in order to assess broadband affordability, how it varies across different areas of the country

27. https://www.ofcom.org.uk/research-and-data/data/opendata

28. http://point-topic.com/free-analysis/broadband-affordability-england-wales/

and how it is affected by local income and deprivation. Point Topic 's mapping, discussed in detail in the section on our regional analysis (See Figure 9 below), identifies 'broadband deprivation' areas where broadband access costs are relatively higher and the choice of broadband providers is often lower compared to the other parts of the country (Point Topic , 2020) .Their detailed analysis is fine-grained at the level of Lower Layer Super Output Area (LSOA) . Each LSOA contains between 400 and 1,200 households, so it is a small enough unit at the right level of granularity to reflect the differences even within the same cities, towns and rural areas.

UK Regional Analysis: Cambridgeshire and Peterborough

The digital sector is a significant part of the Cambridgeshire and Peterborough regional economy and has more than twice the employment in digitally intensive sectors compared to the rest of the country (CPCA 2019). In detail, Cambridgeshire and Peterborough's digital sector represents 8.84% of the region's total business turnover and 8.22% of employment, compared to a national share of 3.5%. But, more than this, digital is an enabling sector whose products and services offer increased productivity to all other industries – including two of the region's most important: agriculture (centred on the rich land of the Fenlands) and manufacturing (the largest sector in the region totalling 23% of business turnover).

The Digital Connectivity Review 2018-2019[29], elaborated by the Connecting Cambridgeshire Digital Connectivity Strategy for Cambridgeshire and Peterborough, provides a relevant reference point about the state of connectivity for our region. In detail, this strategy, "plans to improve the region's digital connectivity building upon funding from Cambridgeshire County Council and Peterborough City Council, £5.6million investment from Cambridgeshire & Peterborough Combined Authority, together with more than £14m in Government and EU grants. With Combined Authority investment, the innovative Connecting Cambridgeshire digital programme, led by Cambridgeshire County Council, has been expanded to: 1) Stimulate increased commercial investment and facilitate faster telecoms infrastructure deployment, 2) Improve mobile coverage, including preparing for forthcoming 5G services, 3) Increase the full fibre footprint and support digital infrastructure innovation, 4) Increase the provision of public access Wifi, particularly in market towns and village halls" (Connecting Cambridgeshire, 2018).

One of the initiatives targeting business access to connectivity, taken within this strategy, is the Connecting Businesses. More than 100 Cambridgeshire and Peterborough businesses have successfully applied to install full fibre gigabit capable connections through the Government's Gigabit Broadband Voucher Scheme and neighbouring businesses are being encouraged to pool their vouchers together with nearby residents to share the installation costs using local full fibre broadband suppliers. A new Rural Gigabit Voucher Scheme was also launched in May 2019 with additional funding for rural residents to install gigabit-capable broadband as part of a group project. (Connecting Cambridgeshire, 2018)

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29. https://www.connectingcambridgeshire.co.uk/wp-content/uploads/2019/09/CCC625-Digital-Connectivity-Review-18-19.pdf

When focussing on regional barriers to adoption, the geographic distribution of connectivity in the UK is now well mapped and understood. For example, the project Thinkbroadband[30], provides a wealth of geo-mapping tools to visualise fine-grained localised connectivity. This enables users, to easily identify the postcodes/areas where SMEs premises are facing the higher connectivity barriers within the UK:

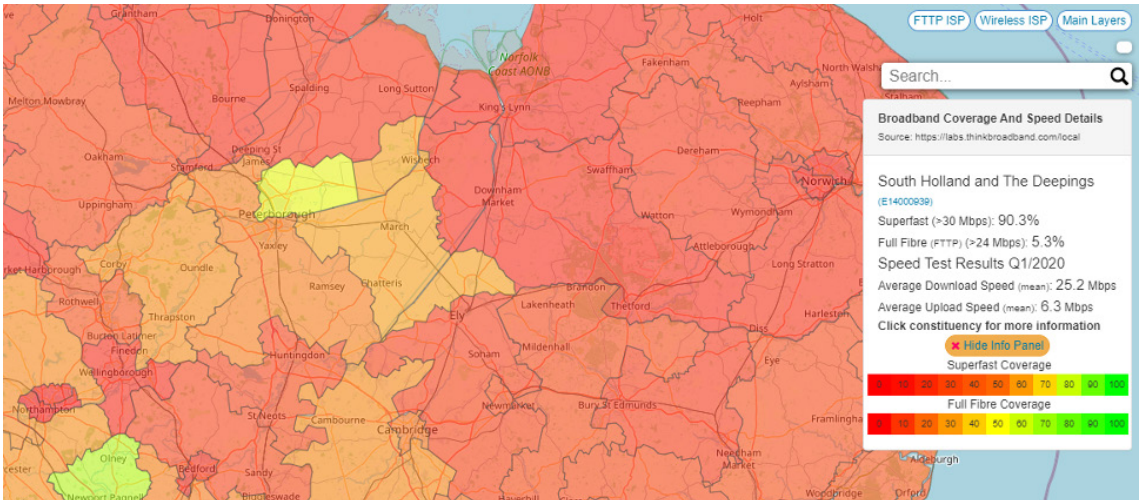

Figure 6, broadband coverage in the east of England, Source: https://labs.thinkbroadband.com/local/broadband-map#5/56.993/-5.010/

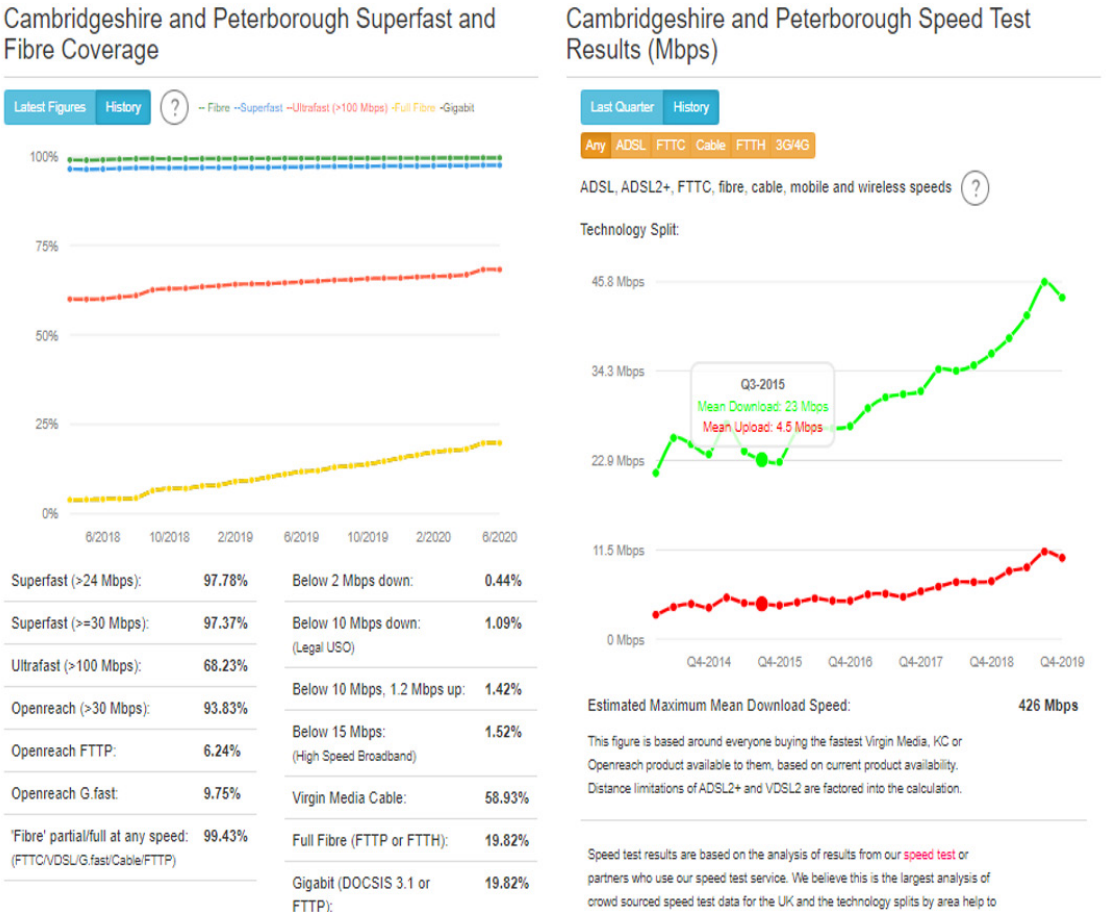

Figure 7. Broadband coverage across time in the east of England.

30. *https://labs.thinkbroadband.com/local/cambridgeshire-and-peterborough*

From the same data sources, it is also possible to follow the temporal evolution of connectivity, to capture the possible trends. Coverage Notes: Coverage is represented as the percentage of premises able to get a certain speed[31] .

The information in Figure 7 is of key relevance when addressing the problem of identifying underserved areas of connectivity as for example the postcode areas in the region where broadband speed is Under 2 or 10 Mbps using fixed line as in figure here below:

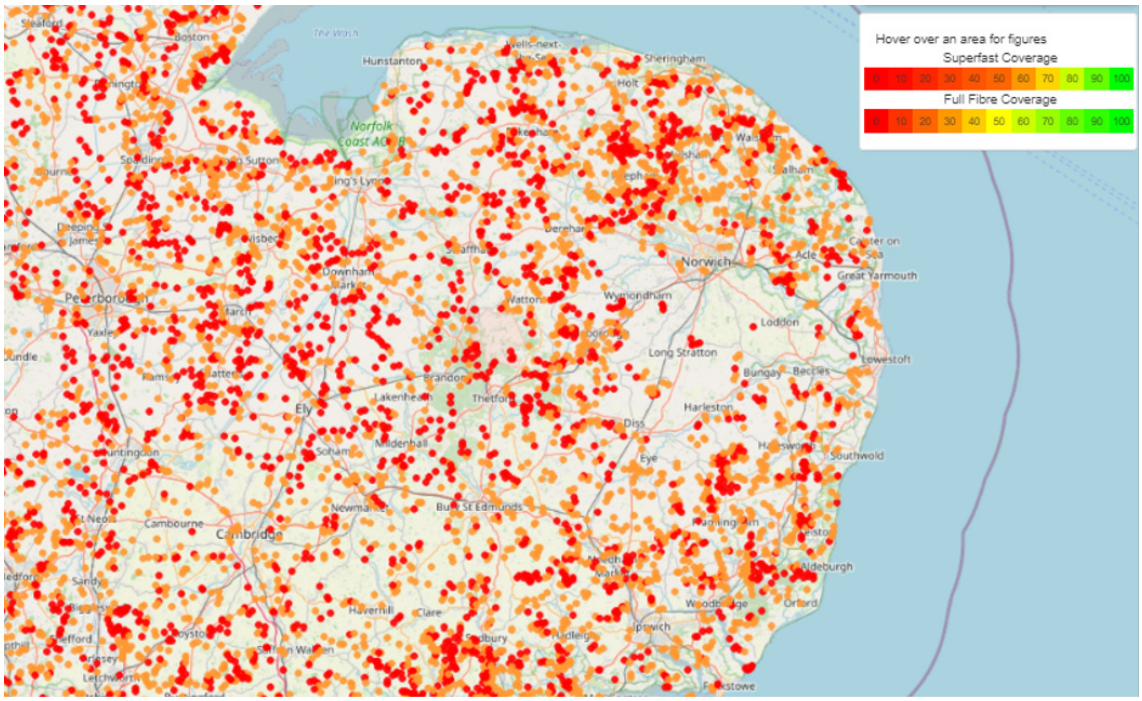

Figure 8. Superfast and full fibre coverage source: https://labs.Thinkbroadband.Com/local/uso-map#9/52.5713/1.3733/

Moving to the affordability dimension for our region both the ITU [2019] and the OECD [2019] provide a key set of representative prices of data bundles at country level, both via fixed and mobile access, as discussed in section 1. In particular, the ITU measures affordability of standard pricing baskets normalised by Gross National Income. Specific affordability data for the UK, and for our region, as discussed in section 2 at country level, are available via Point Topic (2020) [32]that provides geo-mapping of affordability in the UK. By restricting the focus on our region, the first map below shows the geography and variations of the minimum cost of Broadband, in our region, in May 2020.

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31. Fibre generally refers to a range of fibre based services including FTTC, FTTN, Cable broadband, FTTH and FTTB and includes VDSL2+ lines getting any speed.

32. http://point-topic.com/free-analysis/broadband-affordability-england-wales/

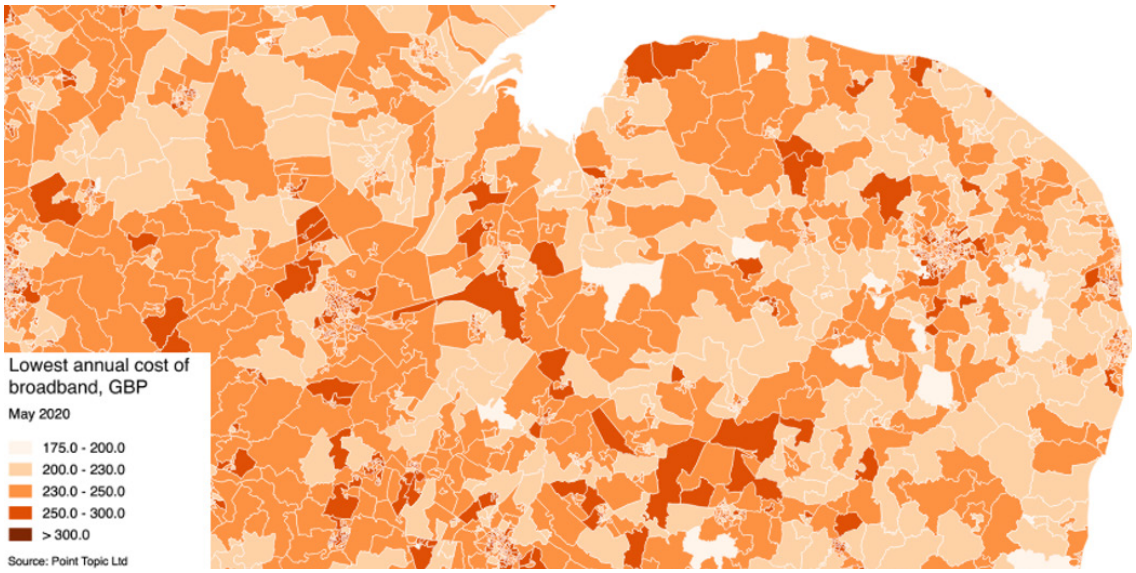


Figure 9 Broadband cost Map, East of England, source: http://point-topic.com/wp-content/uploads/2020/06/Lowest-Annual-Cost-v 4.png

However, as previously discussed, to understand local affordability, these costs need to be reported in relation to local incomes. Figure 10 below accomplishes this task and allows the visualisation of asymmetric affordability across different localities in our region.

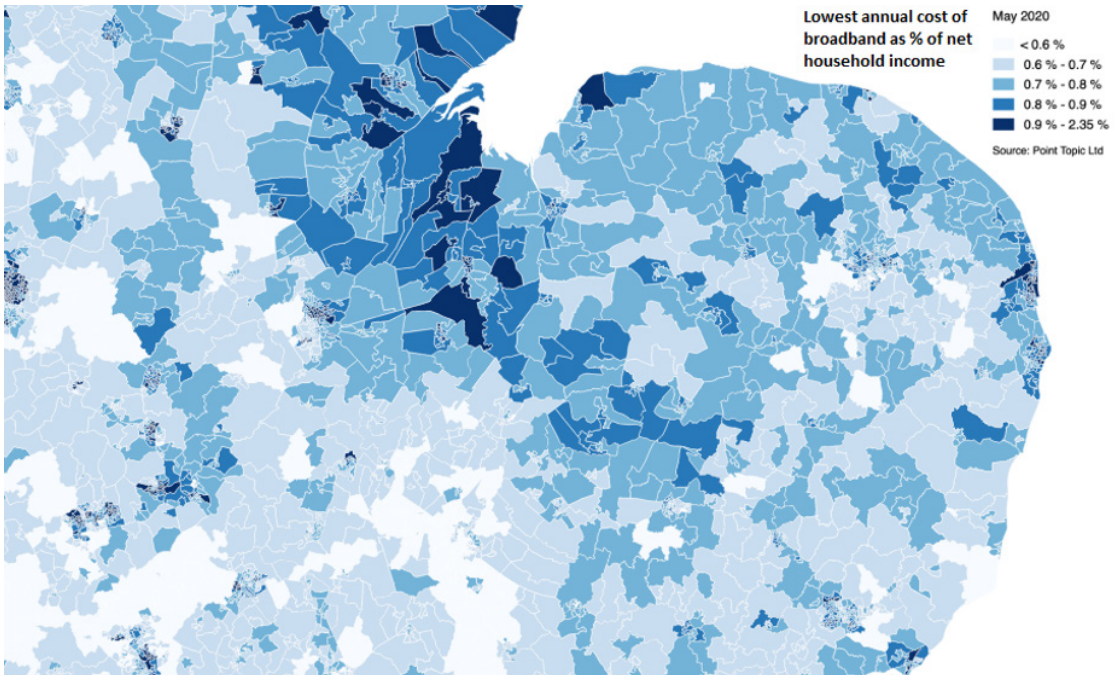


Figure 10. Affordability map, East of England. Source: http://point-topic.Com/wp-content/uploads/2020/06/lowest-annual-cost-as-of-net-income-v3.png

Policy Case study: CPCA digital sector strategy

Anglia Ruskin University has been working with Cambridge Wireless developing the Cambridge and Peterborough Combined Authority Digital Sector Strategy, (CPCA 2019)[33]. This work is based on secondary and primary data collected through a survey of local firms to understand the key barriers faced within the local digital economy. In order to examine the digital sector barriers to data driven innovation within our region, some of the key recommendations of this regional policy document are discussed in the following sections.

Digital skills

One of the key barriers that emerged from the research underpinning the CPCA Digital Sector Strategy was identified in the supply of a sufficiently skilled workforce across all levels of the digital sector, the retention of existing talent, and the upskilling of the adult population to enable all citizens to thrive in a digital world.

A set of hypotheses were explored in the Digital Sector Strategy Business Survey with their relative perceived importance varying across districts as discussed below. In detail, the key priorities were identified in: encouraging more local young people to enter the technology sector and this was particularly relevant in Fenlands, Hunts, South Cambridgeshire and Peterborough areas. Also, clearly identified was the need for more regional support to up-skill the existing labour force, again, specifically in the most marginal areas (Fenlands, Hunts, and Peterborough).

The need for more education to support digital literacy / knowledge of digital best practice, was also a relevant issue raised almost everywhere in the region as well as the necessity to delineate more entry routes for young people wanting to enter the technology sector. From the supply side, the lack of enough digitally skilled staff for the technology sector was also highlighted as being of relevance to every region including Cambridge that clearly perceives this bottleneck.

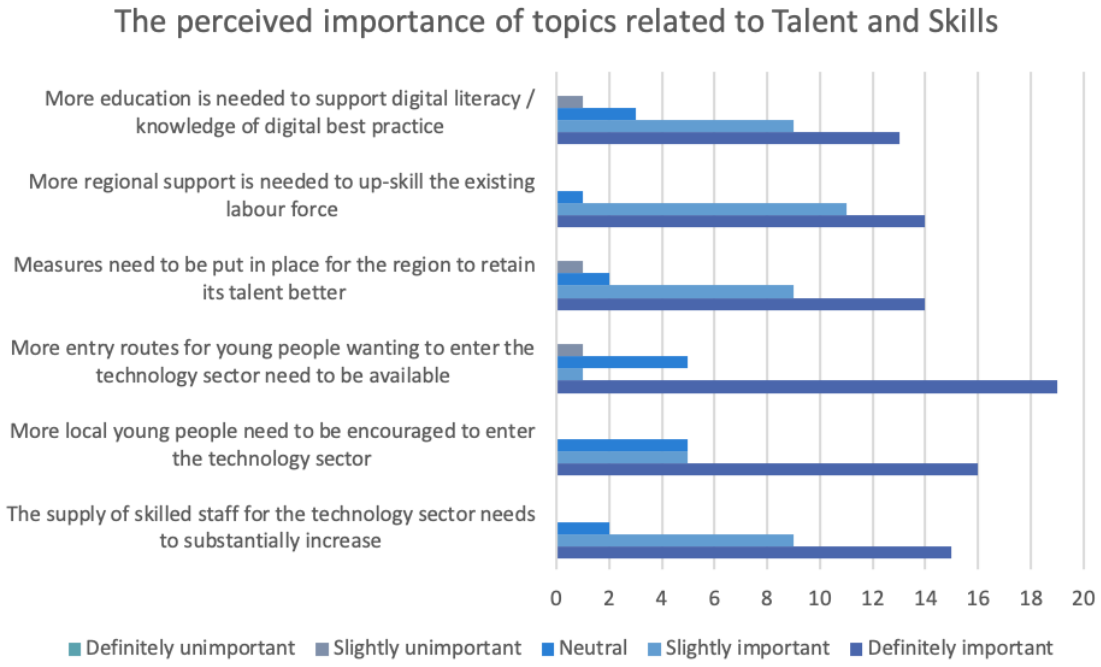


Figure 11. Survey results from business in the digital sector strategy report. Source: https://www.cambridgewireless.co.uk/media/uploads/files/digital_sector_stategy_for_cpca.pdf

33. *https://www.cambridgewireless.co.uk/media/uploads/files/Digital_Sector_Stategy_for_CPCA.pdf*

The business community supported these views in the (CBI 2016) Survey, stating:

"Businesses that are furthest along their digital journey tend to have the right people in leadership with a range of digital know-how in the workforce. This know-how could be coding, data science or digital marketing, but there needs to be an appreciation and understanding in the boardroom, and not just at the front line, that these are the skills that are needed. This will require businesses to diversify their talent pipeline and government to ensure that their approach to in-work skills and digital education in schools supports building this pipeline".

Technology infrastructure

The Digital Sector Strategy's vision is that the CPCA region becomes a region where telecommunications and digital infrastructure is understood to be an absolutely vital underpinning of the economy, and where local government acts as a catalyst to accelerate demand, encouraging the entry of private sector supply side solution providers. The following hypotheses were explored in the Digital Sector Strategy Business Survey and their relative perceived importance is outlined below:

	Importance perception score (/5)
Higher quality mobile and broadband coverage is needed across the region	4.42
Trials should be undertaken to understand the potential of an advanced digital infrastructure	4.04
Local businesses should be contracted to develop CPCA as a "smart region"	4.02
Better education is needed for businesses to make use of faster broadband	3.72

Table 1. Hypothesis explored in the digital sector strategy busienss survey, Source: CPCA, Digital Sector Strategy 2019

The survey provides interesting evidence on how the different areas perceive the priorities and Technology infrastructure needs. "Higher quality broadband and mobile coverage is needed across the entire region", was a top priority for all areas apart from East Cambridgeshire, "Local businesses should be contracted to develop CPCA as a "smart" region" is particularly relevant for the Fenland, Peterborough and Greater Cambridge. "Better education is needed for businesses to understand how to make use of higher quality broadband (e.g. video marketing)", was a priority for respondents in Fenland, Huntingdonshire and Peterborough, while "Trials should be undertaken to understand the cross-sector potential of an advanced digital infrastructure", seems to be critically relevant for Fenland, Huntingdonshire and Peterborough.

The business community supported these views in the (CBI 2016) Survey, stating: "There is no shortage of good ideas, technology inventions or ways to utilize technology, but what is often missing is the business case to spend the money. Whether it's the right finance mix to turn

start-ups into scale-ups, the right level of investment in innovation or simply the know-how to make sure a business can ensure return on investment, it is clear that money matters. Adopting digital technology is an investment for a business, not a cost, and making the right business case to invest in a new technology is an absolute must".

Digital sector supply chain

The Digital Sector Strategy's vision is that the CPCA region becomes a region where more local firms complement the supply and demand needs of the local technology community. The following hypotheses were explored in the Digital Sector Strategy Business Survey:

	Importance perception score (/5)
Better information is needed about the supply needs of the local technology sector	3.95
Better infrastructure is needed to improve the efficiency of organisations supplying into the technology sector	3.85
Better incentives are needed for technology firms to purchase from local business	3.80
Better information is needed about what local supply options are available	3.76
More local businesses are needed that can supply into the technology sector	3.56

Table 2. Hypothesis to meet supply and demand in the local technology sector. Source CPCA, digital sector strategy 2019

In detail, Peterborough, Fenland, and Huntingdonshire set as key priorities can be summed as follows: "Better information is needed about what local supply options are available", and "better information is needed about the supply needs of the technology sector". This identifies the need for bridging an information gap in these districts concerning local and technology sectors' supply chains. Greater Cambridge identifies the need to respond to an infrastructural need, captured in the priority: "Better infrastructure is needed to improve the efficiency of organisations supplying into the technology sector". Meanwhile operational improvements were considered of key relevance by Peterborough and Fenland, emphasizing the two statements "Better incentives are needed for technology firms to purchase from local businesses" and "more local businesses are needed that can supply into the technology sector".

The business community supported these views in the (CBI 2016) Survey, stating: "From fast and reliable internet connections, to online platforms to take their product to market, and the right cyber security products, tools and processes, what businesses need to become digital are the basic building blocks needed to get started. For businesses, understanding and taking advantage of these tools is critical".

Networking

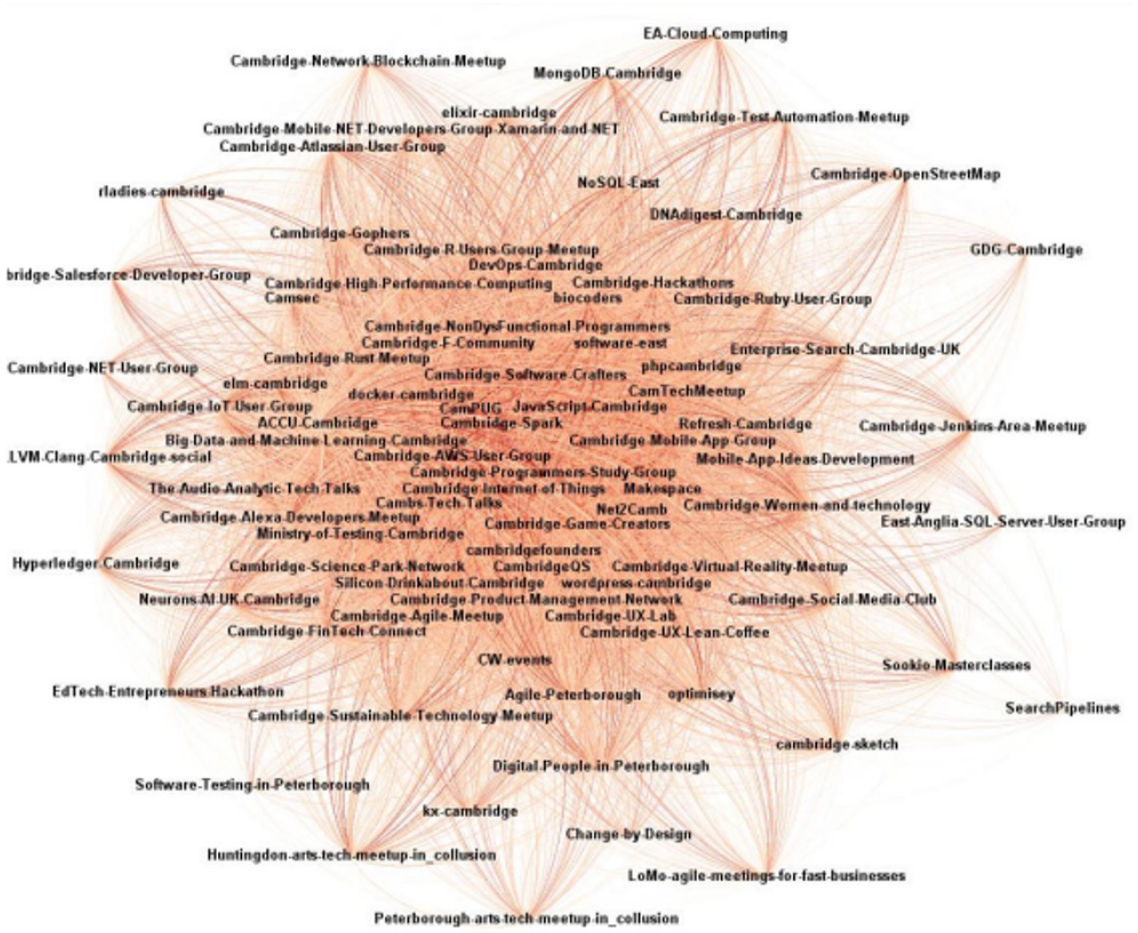
The Digital Sector Strategy's vision is that the entire region becomes a highly networked environment where organisations help bring the communities together and support them as they make the right connections. The following hypotheses were explored in the Digital Sector Strategy Business Survey and their relative perceived importance is outlined below:

	Importance perception score (/5)
More inte-sector networking opportunities need to be available	4.33
High quality business networking opportunities need to be more available across the entire region	4.20
Different formats of networking need to be deployed	4.11
More networking opportunities between CPCA and other districts need to be available	4.11

Table 3. Hypothesis to bring digital business communities together within the East of England. Source: CPCA, digital sector strategy 2019

In more detail, networking has barriers that needs to be overcome: Fenland identifies two priorities as critically relevant: "High quality business networking opportunities need to be more available across the entire region", and "more inter-sector networking opportunities need to be available (e.g. agriculture meets sensors)" This last priority is also seen as critically important for Huntingdonshire.

The Strategy reports that there are around 60 dedicated networking organisations in the Greater Cambridge area offering formal opportunities for high quality networking in general business areas, technology, energy efficiency, health-technology, and agrotechnology. These networking organisations work alongside organic, community-driven networking opportunities highlighted successfully in Tech Nation 2018 through Meet-Up data. The Strategy team analysed the relationships between the Meet-Up networks in Cambridgeshire and Peterborough. The results, visualised in the image below, demonstrate how individuals participate in multiple networking activities.



Connection map showing member-based links between meet-ups in the CPCA Area. If a member of one meet-up is also a member of another meet-up, a "bridge" is formed and mapped. Meet-ups with the most bridges are towards the centre.

Figure 12. Source: CPCA, digital sector strategy 2019

BELGIUM BARRIERS TO DATA DRIVEN INNOVATION

There are three main barriers to data-driven innovation in Belgium:

THE COST OF ADOPTION - (INTERNAL BARRIER)

The digitalisation and the transition towards using data science and artificial intelligence technologies within a company require resources and investments. Personnel needs to be trained, machines need to be adapted, changed or equipped with sensors, a data storage system needs to be put into place, the IT infrastructure within the company needs to be made compatible with those technologies.

In Belgium, those investments are considered as an important constraint for data-driven innovation within companies. This is confirmed by the recent "European enterprise survey on the use of technologies based on artificial intelligence" by Ipsos and the International Centre for

Innovation, Technology and Education[34] conducted for the EC from 2020, where 53% of the participating Belgian companies expressed that "the cost of adoption" is an internal barrier to the use of AI within their company (Figure 26).

SHORTAGE OF ICT SPECIALISTS, GRADUATES IN SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS (STEM)

New technologies such as data science change the traditional ways of working within SMEs. New skills and expertise are needed to help them identify the opportunities related to those technologies, but also to apply them to the specific company context.

In Belgium however, companies have difficulties recruiting qualified ICT experts that have the required skills (Figure 27). Additionally, the number of STEM graduates is quite low (Figure 28), whereas the number of required profiles in this domain will only growth (cf. study "Be the Change" by Agoria, the federation of the Belgian Technology industry)[35]. Therefore, to thrive the adoption of AI and Data Science within Belgian SMEs the lack of qualified personnel will need to be addressed.

LACK OF PUBLIC SUPPORT

Data-driven innovation offers new opportunities to improve internal processes and offer new services. However, this will require financial investments (infrastructure, qualified personnel...), but also changes at operational and business level for companies. This can be quite challenging, especially for SMEs.

In a recent "European enterprise survey on the use of technologies based on artificial intelligence" by Ipsos and the International Centre for Innovation, Technology and Education[36] conducted for the EC from 2020, 44% of the interviewed Belgian companies mentioned as a barrier to the adoption of AI the lack of public or external funding (Figure 26).

Additionally in a previous report from the July 2018 "The transition towards a digital society: policy recommendations and actions"[37], the Social and Economic Council of Flanders recommends to "sensitise SMEs and make them aware of the importance of digitalisation for future-proofing both internal and external business and organisational processes" and highlights the importance of the government/regional authorities in this task. Even though new initiatives like the Flemish Programme on Artificial Intelligence (a short summary on the Flemish Programme on Artificial Intelligence[38] can be found in the Annexes below) have since then been initiated, this statement is still valid (Figure 26) and the support from the government is more than ever necessary.

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34. https://ec.europa.eu/digital-single-market/en/news/european-enterprise-survey-use-technologies-based-artificial-intelligence

35. https://www.agoria.be/en/Agoria-Without-a-suitable-policy-there-will-be-584-000-unfilled-vacancies-in-2030

36. https://ec.europa.eu/digital-single-market/en/news/european-enterprise-survey-use-technologies-based-artificial-intelligence

37. https://www.serv.be/sites/default/files/documenten/20180710 Digitalisation - policy recommendations and actions.pdf

38. https://www.vlaio.be/nl/andere-doelgroepen/vlaams-beleidsplan-artificiele-intelligentie/vlaams-beleidsplan-artificiele-0

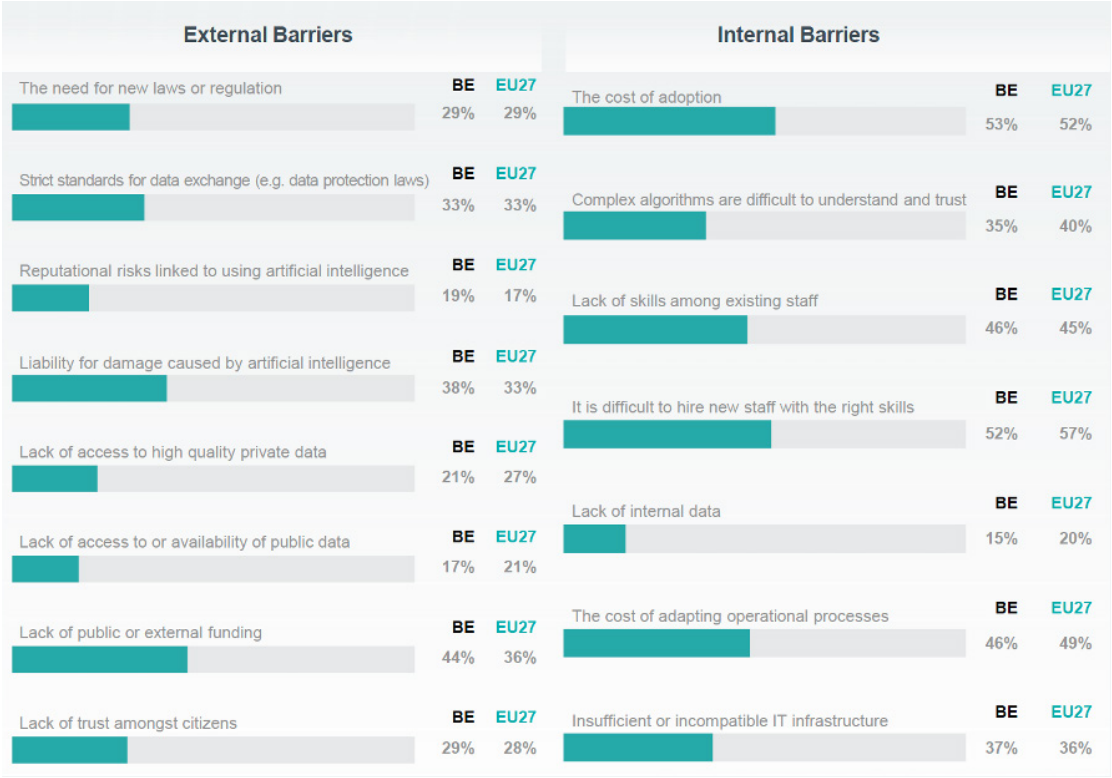


Figure 13. External and internal barriers for the use of technologies based on artificial intelligence within Belgian companies. Studies available in Belgium mainly refer to barriers for digitalising smes. This process includes data-driven innovation. Source: Graph taken from the European enterprise survey on the use of technologies based on artificial intelligence by Ipsos and the International Centre for Innovation, Technology and Education conducted for the European Commission from 2020.

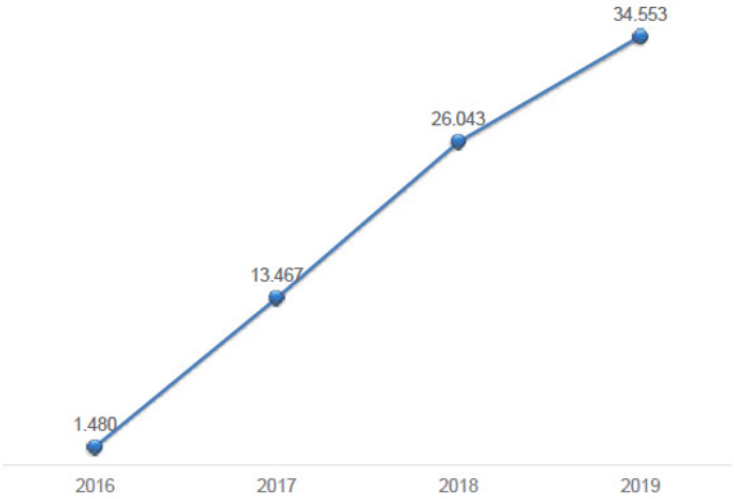


Figure 14. Number of job vacancies for ict experts in Belgium (numbers in the graph below correspond to the jobs offers in may of each year from 2016 to 2019, source: Baromètre de la société de l'imformation (2019), SPF Economie, P.M.E, Classes moyennes et Energie/ Barometer van de informatiemaatschappij (2019), FOD Economie, K.M.O, Middenstand en Energie published on 4 December 2019.

	Belgium			EU
	DESI 2018 value	DESI 2019 value	DESI 2020 value	DESI 2020 value
2a1 At least basic digital skills % individuals	61% 2017	61% 2017	61% 2019	58% 2019
2a2 Above basic digital skills % individuals	31% 2017	31% 2017	34% 2019	33% 2019
2a3 At least basic software skills % individuals	63% 2017	63% 2017	62% 2019	61% 2019
2b1 ICT specialists % total employment	4.2% 2016	4.6% 2017	4.8% 2018	3.9% 2018
2b2 Female ICT specialists % female employment	1.3% 2016	1.8% 2017	1.6% 2018	1.4% 2018
2b3 ICT graduates % graduates	1.1% 2015	1.6% 2016	1.9% 2017	3.6% 2017

Figure 15. Percentage of ICT graduates in Belgium compared to total number of graduates. Source: digital economy and society index (desi) 2020

GERMAN BARRIERS TO DATA DRIVEN INNOVATION

CONNECTIVITY – ACCESS TO BROADBAND INTERNET

Access to fast internet, which is essential for SMEs in order to be competitive, is not evenly distributed across Germany. The official broadband atlas ("Breitbandatlas") provides an overview of broadband availability in different parts of the country, down to the level of street sections. Availability is indicated in the share of household having access to particular data rates. The share of households for which broad bandwidths are available is illustrated in Table 4. Overall, there is a difference between urban and rural areas. While for 98 % of households in urban areas download rates of 30 Mbit/s are available, this only applies to 77.7 % of households in rural areas. This divide is even larger at higher data rates. Just 12.2 % of households in rural areas have access to gigabit internet. This constitutes a particular problem for business users as it depends on large data rates, e.g. to use cloud services. In order to promote SMEs' data use, as the project Futures By Design aims to do, it is important to first install the infrastructure needed – especially in the rural areas.

Area type	≥ 30 Mbit/s	≥ 50 Mbit/s	≥ 100 Mbit/s	≥ 200 Mbit/s	≥ 400 Mbit/s	≥ 1000 Mbit/s
Urban	98.0%	97.4%	93.8%	89.8%	84.2%	60.5%
Semi-urban	91.1%	88.7%	76.6%	64.3%	50.5%	24.1%
Rural	77.7%	72.8%	53.4%	33.3%	19.6%	12.2%
Total	**93.6%**	**91.9%**	**83.8%**	**75.3%**	**66.2%**	**43.2%**

Table 4. Broadband availability in percent of households. Source: : atene KOM GmbH / BMVI (status: end 2019)

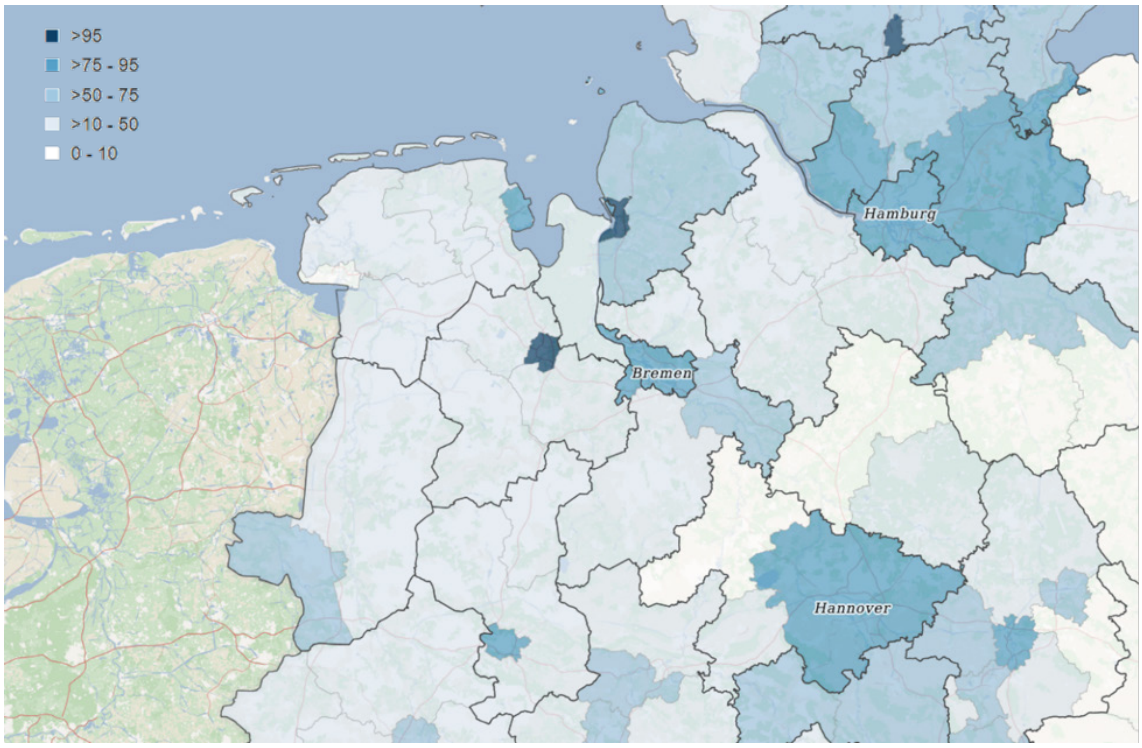


Figure 20. Broadband availability in North West Germany in % of households (1 gbit/s) source: https://www.bmvi.de/de/themen/digitales/breitbandausbau/breitbandatlas-karte/start.html

Figure 20 maps the broadband availability in North-West Germany, including the project region Osterholz (in the north of Bremen). For 10-50 % of households gigabit data rates are available there. However, it is especially important to have a look at broadband access of businesses in the context of the FBD project. At 28.6 % of business locations in Germany gigabit access is available (Figure 21).

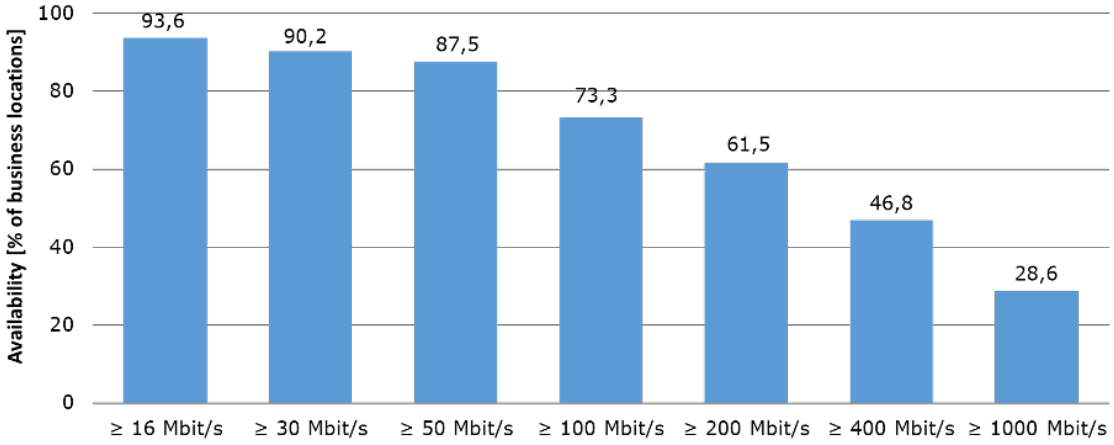


Figure 21 Broadband availability in Germany at business locations. Source: atene KOM GmbH / BMVI (status: end 2019)

Mobile coverage also varies widely throughout the country. Figure 22 shows a map of parts of Lower Saxony, including the project region of Osterholz and the surrounding. Here, only a few areas are dead zones concerning 2G or 4G coverage.

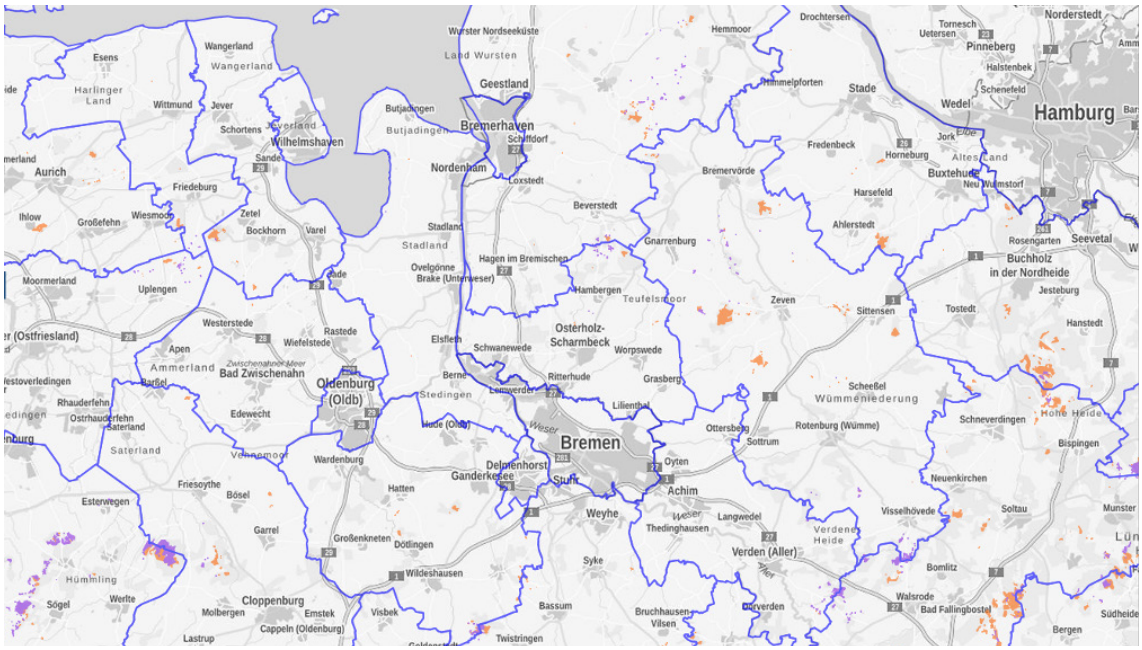


Figure 22. Mobile coverage in the project area of Osterholz and the surrounding (purple: 4g dead zones, orange: 2 g dead zones). Source: BZNB 2020, mobilfunkatlas niedersachsen

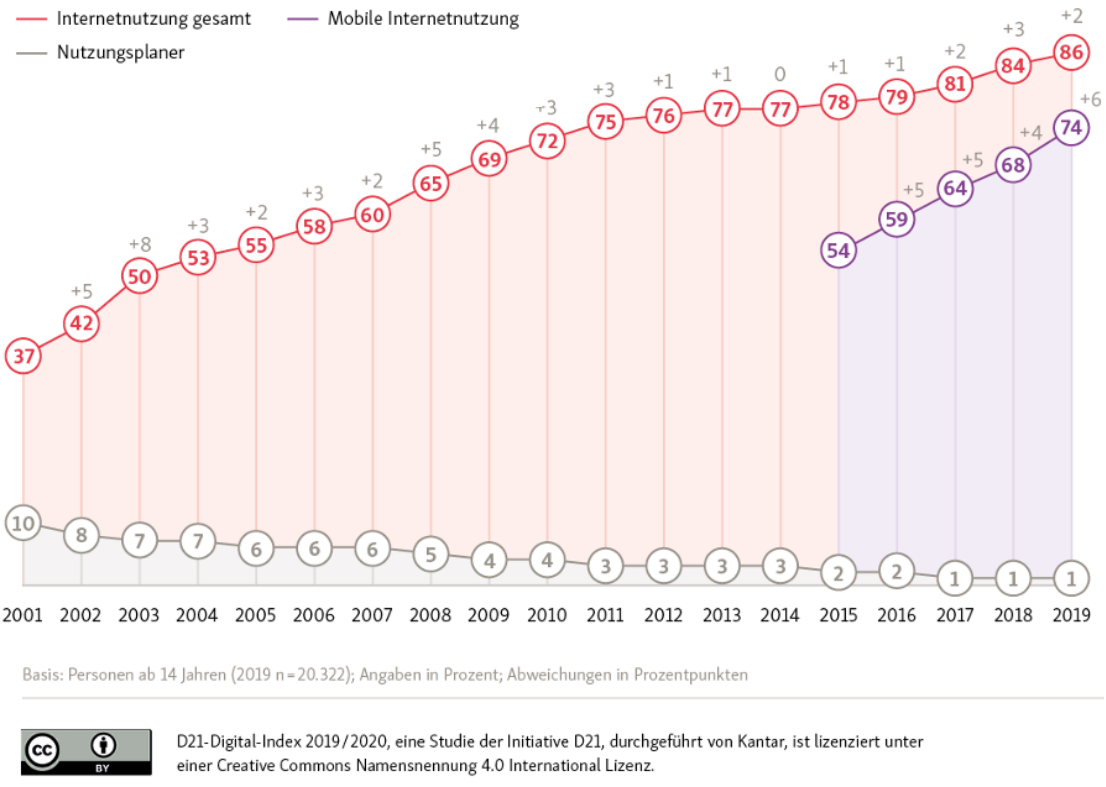
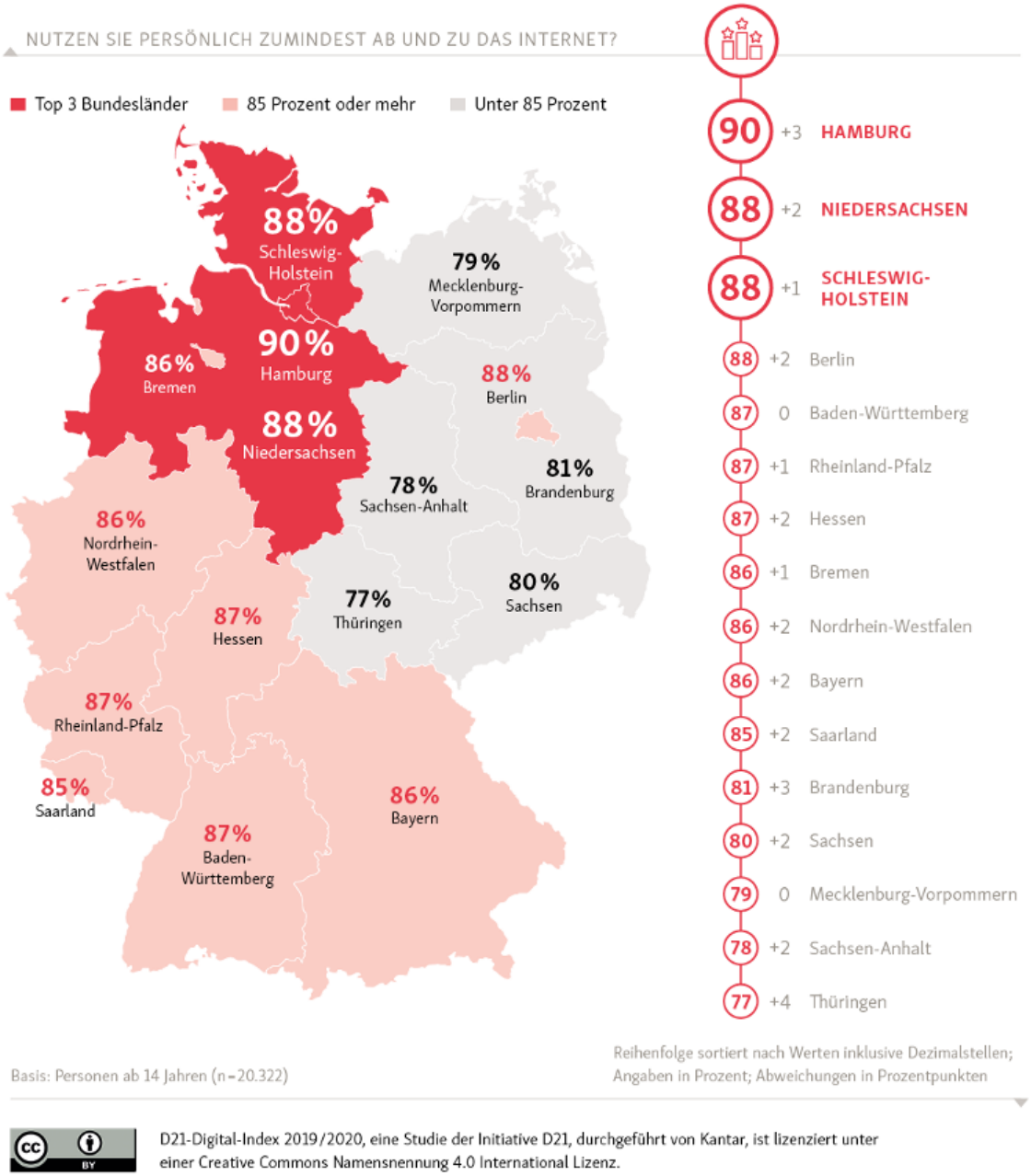


Figure 23. Internet use in Germany (red: total, purple: mobile)

DIGITAL EXCLUSION – DIGITAL SKILLS

To assess the degree of digital exclusion, it is important to consider both internet use and digital skills. In Germany, 86 % of the population aged 14 or more used the internet at least from time to time in 2019, 74 % used mobile internet services (Initiative D21 e.V., 2020) (Figure 23). The older a person is, the less likely he or she uses the internet. Gender and education also have an impact on internet use with women and lower educated people being less likely to go online. Furthermore, internet use also varies regionally (Figure 24). People in the western and especially the north western federal states – where the project region of Osterholz is located – are more likely to use the internet.



D21-Digital-Index 2019/2020, eine Studie der Initiative D21, durchgeführt von Kantar, ist lizenziert unter einer Creative Commons Namensnennung 4.0 International Lizenz.

Figure 24. Regional share of internet users in Germany (2019).
Source: https://initiatived21.De/app/uploads/2020/02/d21_index2019_2020.Pdf, p. 16

According to the European Digital Economy and Society Index (DESI)[39], Germany ranks 10th out of 28 EU countries regarding digital skills. In all human capital categories (Table 5), Germany reaches at least the mean value of EU countries, while some categories are well above EU average. 70 % of the population have at least basic digital skills. This means that 30 % do not have basic digital skills, which is a high share if one considers that without digital skills it is not easy to get around nowadays. So, there is still a need for improvement. On the OECD Skills Outlook Scoreboard, Germany is also positioned in the upper part of the ranking (Figure 25). However, 9.8 % of German students and 9.9 % of older people are low performing and have low cognitive and digital skills, respectively. As education mostly lies in the responsibility of the federal states, regional differences might exist.

	Germany			EU
	DESI 2018 value	DESI 2019 value	DESI 2020 value	DESI 2020 Value
2a1 At least basic digital skills % individuals	68% 2017	68% 2017	70% 2019	58% 2019
2a2 Above basic digital skills % individuals	37% 2017	37% 2017	39% 2019	33% 2019
2a3 At least basic software skills % individuals	70% 2017	70% 2017	72% 2019	61% 2019
2b1 ICT specialists % total employment	3.7% 2016	3.8% 2017	3.9% 2018	3.9% 2018
2b2 Female ICT specialists % female employment	1.3% 2016	1.3% 2017	1.4% 2018	1.4% 2018
2b3 ICT graduates % graduates	4.5% 2015	4.5% 2016	4.7% 2017	3.6% 2017

Table 5. Human capital in Germany according to the digital economy and society index. Source: DESI 2019, https://ec.Europa.Eu/digital-single-market/en/scoreboard/germany, p. 7

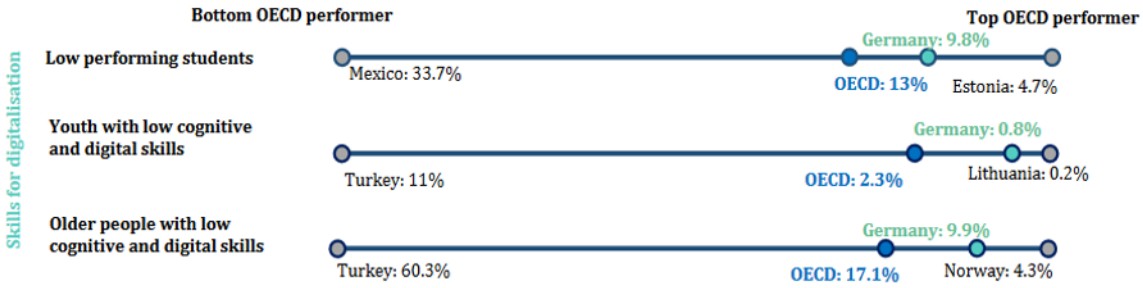


Figure 25. Skills for digitalisation according to oecd skills outlook scoreboard. Source: https://www.Oecd.Org/germany/skills-outlook-germany-en.Pdf, p. 1

39. https://ec.europa.eu/digital-single-market/en/scoreboard/germany

According to the D21 digital index, digital competences of the young generation (aged 14-29) are in general larger than those of the average population. The same applies to people who are active in working life. In contrast, to about half of the people with a low formal education basic tasks such as an internet research using several sources or sending messages by smartphone are not a matter of course. Competence differences are also large concerning data transfer, office applications, the identification of fake news or the competent handling of data protection properties (Initiative D21 e.V., 2020).

AFFORDABILITY IN GERMANY

According to the Inclusive Internet Index 2020[40], Germany ranks 20th of the compared 100 countries regarding affordability [41]. Unfortunately, there is no official comparison of customers' broadband prices in Germany. However, the German Federal Statistical Office provides data on the expenditures of German households for certain goods and services. In 2018, households spent on average 71 Euros on postal services and telecommunication (Statistisches Bundesamt, 2020a). This constitutes 1.93 % of the net average household income of 3661 euros (Statistisches Bundesamt, 2020b). Overall, costs of telecommunication has reduced from 2015 to 2019 (Statistisches Bundesamt 2020c).

NATIONAL POLICIES TO IMPROVE CONNECTIVITY AND DIGITIZATION

Regarding the connectivity, broadband expansion and digitization, Germany has set up several national and regional policies in order to promote and improve these fields. Nationally, there is the "Digital strategy of the federal government" (Die Bundesregierung 2020) with five fields of action:

1. Digital competence
2. Infrastructure and equipment
3. Innovation and digital transformation
4. Society and digital change
5. Modern state

This strategy demonstrates why digitization is important for everyone and shows actions developed for improving life quality in the digital age and unfolding economic and ecological potentials.

In order to ensure connectivity especially in the rural areas of Germany the Federal Ministry of Transport and Digital Infrastructure set up a "Funding program for the expansion of Gigabit Internet" (Bundesministerium für Verkehr und digitale Infrastruktur 2020) that aims to achieve fast broadband connections especially in the rural areas with an internet speed of less than 30 Mbit/s. The funding amount on that program is about 11 billion Euros.

Regionally regarding Northwest Germany, the state Lower Saxony has created the "Masterplan digitization" (Niedersächsisches Ministerium für Wirtschaft, Arbeit, Verkehr und Digitalisierung 2020) that sets the framework of the state government for the process of digital transformation in all political fields. The state Lower Saxony will fund more than one billion Euros for the success of digitization.

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40. https://theinclusiveinternet.eiu.com/explore/countries/performance?category=affordability

41. This category examines the cost of access relative to income and the level of competition in the Internet marketplace. Source: https://theinclusiveinternet.eiu.com/explore/countries/performance?category=affordability

NETHERLANDS BARRIERS TO DATA DRIVEN INNOVATION

CONNECTIVITY: RURAL PERIPHERY LAGS BEHIND

The most obvious barrier to data driven innovation in the Netherlands is the access to broadband internet. There are rural areas that not only have very poor connectivity in terms of glass-fibre connections, but also have limited 4G and 5G coverage. Figure 13 below shows the distribution of glass fibre connections.

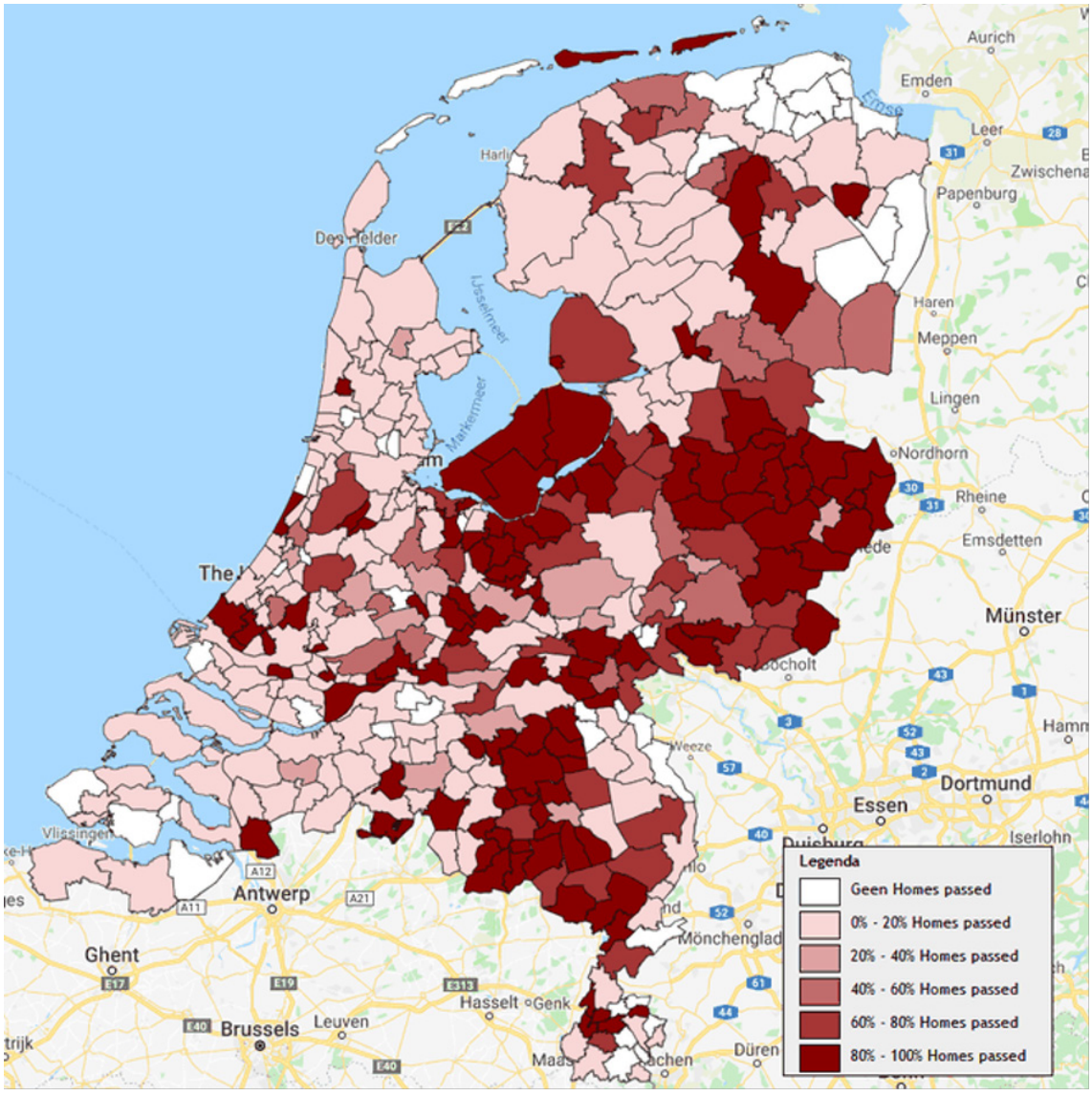


Figure 13. Glass fibre cable connections in the netherlands. Source: Strarix (2020).

In terms of 4G and 5G coverage in the Netherlands, again, rural areas have the lowest internet connectivity which can be seen below in Figure 14. Of particular interest, is that 4G and 5G coverage in the peripheral areas adjoining the North Sea Region (NSR) suffer poorer connectivity than more inland areas.

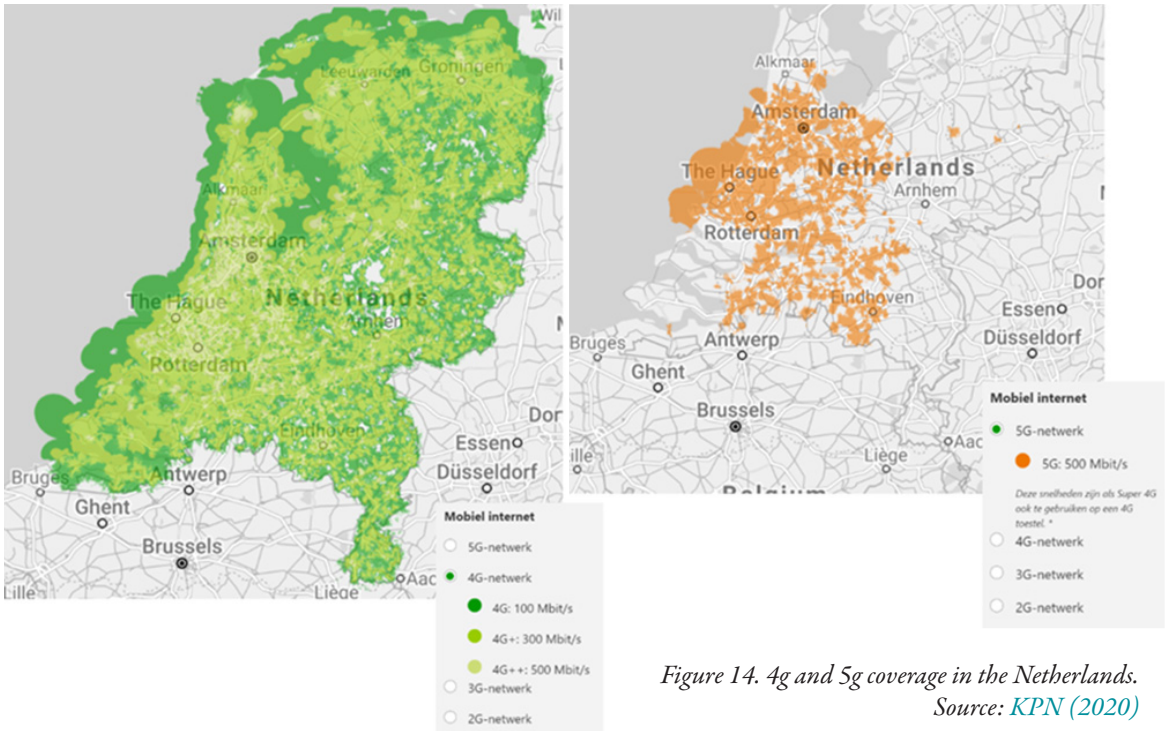


Figure 14. 4g and 5g coverage in the Netherlands. Source: KPN (2020)

In Figure 15 it can be seen that the number of mobile broadband subscriptions in the Netherlands has grown significantly in the last 10 years, while the fixed broadband subscriptions have remained relatively stable. As such, while connectivity in the Netherlands is increasing, there are still challenges around connectivity to overcome - particularly in the more rural areas. One respondent of the FBD pilot studies in the Leisure sector (March 2019) noted that in order to see his new bookings he had to take his smartphone to the garden, since he could not access the internet from inside the premises.

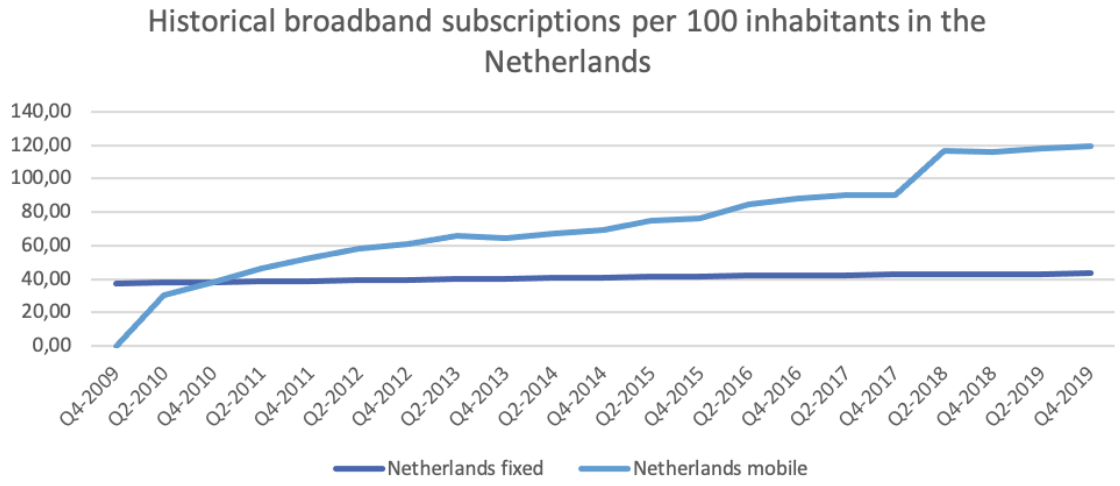


Figure 15. Historical broadband subscriptions per 100 inhabitants in the Netherlands. Source: OECD (2020)

DIGITAL EXCLUSION: DIGITAL SKILLS AND EDUCATION

The Netherlands is one of the EU countries with the largest share of inhabitants that has digital skills concerning internet use, computer and software skills. In 2019, the age group 16-75 years old, more than 50% had more than basic digital skills, compared to the average 33% in Europe. In 2015, this percentage in the Netherlands was 43%.. Figure 16 below indicated that the group 16-25 years old are the most digital skilled, followed by the age group 25-35 years old.

When we divide the basic skills into 4 fields of knowledge, it is clear that especially in the field of 'information' the Dutch score high, with 89%. This field includes finding information, but also accessing and storing data in the cloud. Similar, the Dutch score high in the field of communication (83%) and services (81%) and are well equipped to e-mail, use internet phone possibilities and social networks, even as online shopping and education. The fourth field of software is the field where the Dutch are lagging a bit, only 54% has more than basic skills in this field. This field contains the use of spreadsheet and word processing software and programming within existing computer programs. Figure 17 indicates the Dutch scores compared to the EU average.

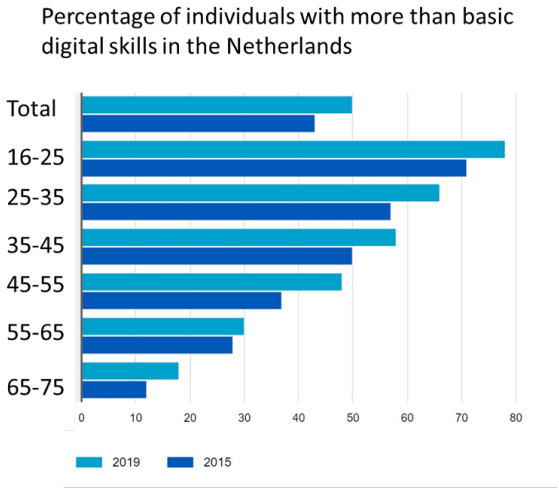
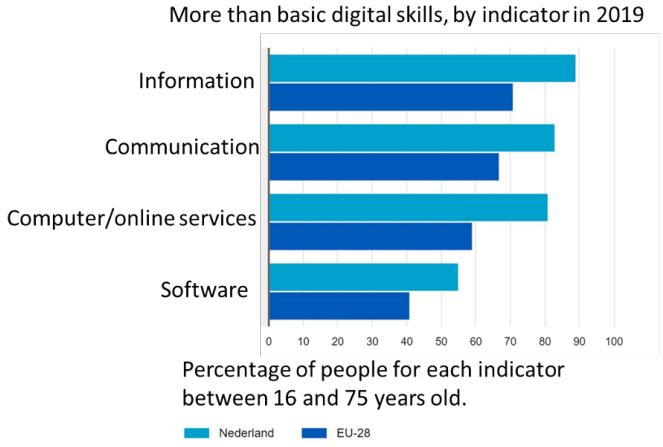


Figure 16, above. Percentage of basic digital skills 2015 and 2019 in the Netherlands. Figure 17, below. Scores on more than basic skills in 4 fields, the Netherlands and EU average. Source: CBS (2020)



Considering the goals of FBD we can conclude that the Dutch population in the Netherlands skill wise should be up to the task, however, in practice we see that especially age indicates differences in level of confidence.

When we look at the commercial internet use, we see a steady increase in the use of faster internet connections by companies (Figure 18). Furthermore, we can also indicate that almost all Dutch companies have a website. The use of the websites varies by company (See Figure 19). This is something useful for the FBD project, since much data, especially for small companies is available by the use of the website by (prospect) customers. In the data base.

Affordability

Internet in the Netherlands is not cheap. To afford the cheapest broadband connection an average Dutchman needs to work 50 minutes. In comparison, an average Canadian would only have to work 7 minutes for a similar connection. Furthermore, in the Netherlands a mobile connection is on average 5 times as expensive as on Denmark, which has the cheapest online

connections (Surfshark, 2020)[42]. According to the Alliance for Affordable Internet, which assesses how well the country scores across digital infrastructure and internet access. High ADI scores correlate with reduced broadband costs on both the industry side and for consumers. As Figure 1 shows, there is a negative and statistically significant correlation between a country's ADI score and the affordability of a 1GB mobile prepaid broadband plan. The Netherlands has an average score, which is below an expected score for this country (A4ai, 2019)[43].

POLICY

Since 2018 there is a new Dutch digitization strategy. The nationwide strategy first focusses on questions such as privacy related issues, and the possible loss of jobs with industry 4.0. Second on opportunities that come forward from block chain, technological and societal opportunities od digitization. Policies regarding protection of privacy, cybersecurity and digital skills are strengthened. The main concern of the Dutch government is that everybody should be part of the digital transformation and has a focus on strategies that decrease the digital divide, both for the labour market as well as for all civilians. The main challenge is to speed up and support the digital transition for the Dutch industries. The governments want to generate a dynamic digital economy with the focus on a data driven economy where the ambition is free data sharing within the Netherlands (EZK, 2018)[44] . This gives ample opportunity to be a good breeding ground for the FBD project and instruments.

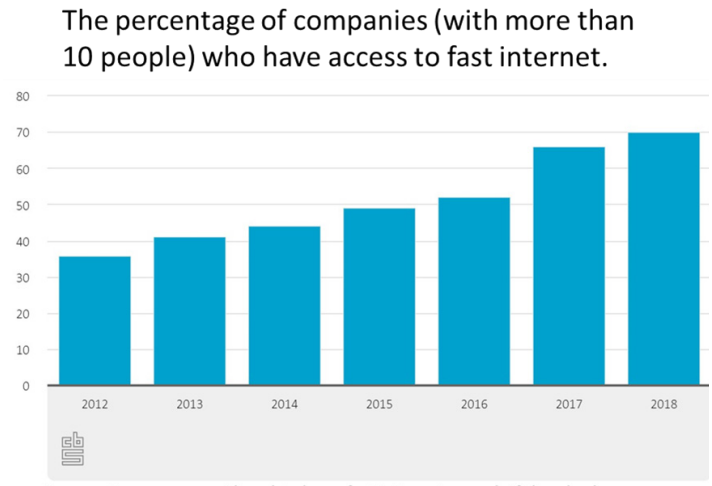
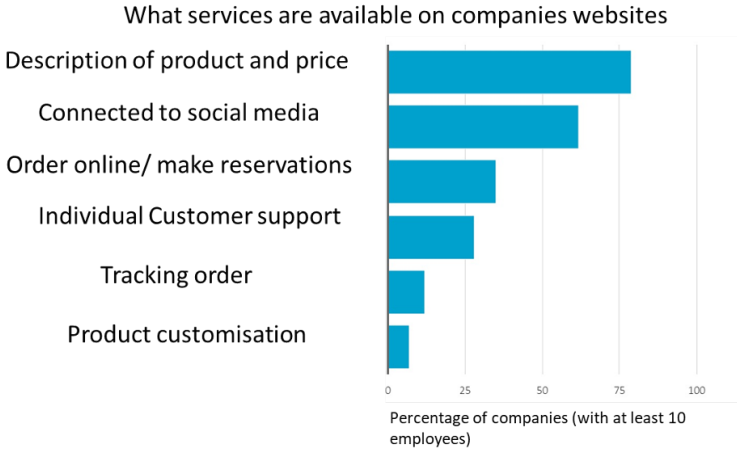


Figure 18, above. Fast commercial internet connection.
Figure 19, below: Type of website and possibilities
Source: CBS (2019)



42. https://surfshark.com/dql2020
43. https://a4ai.org/affordability-report/report/2019/
44. Ministerie van Economische Zaken en Klimaat (2018) Nederlandse digitaliseringsstrategie. Den Haag, Netherlands

SWEDISH BARRIERS TO DATA DRIVEN INNOVATION

MAIN BARRIERS TO DATA-DRIVEN INNOVATION IN SWEDEN/HALLAND

Several international reports show that Sweden is at the forefront of digitalisation, but that Swedish companies use large amounts of data to a lesser extent than companies in comparable countries. In its review of Sweden's transformation, the OECD presents a number of recommendations, and writes, among other things, that Sweden should invest in: "Promoting widespread diffusion of advanced digital technologies, in particular among SMEs, with a focus on the diffusion of Big Data Analysis (BDA) possibly through a national big data strategy. In addition to the existing measures supporting data analytics in selected flagship projects, a wider approach is needed that incentives firms to use BDA and foster complementary investments by firms in different sectors and firms of different sizes and particular SMEs " OECD (2018), OECD Review of Digital Transformation: Going Digital in Sweden, s.101.

Reports from the European Commission give the same picture. In terms of digitalisation, Sweden is often at the top among comparable countries, but lags behind in areas related to the use of large amounts of data. Sweden and Swedish companies are below the EU average when it comes to using geodata and on average when it comes to data generated from sensors. In an average EU country, 12 percent of companies use data in their operations. In Sweden, just under 10 percent of companies do so. (Digital Economy and Society Index [DESI] 2019 and 2018).

The DESI (2019) report consist of two parts. Firstly, we present the Swedish companies in relation to EU average by the study "European enterprise survey on the use of technologies based on artificial intelligence". Secondly, we present the Swedish study "Data as a strategic resource in small and medium-sized enterprises: Mapping and analysis of thirteen industries"

According to the report produced by "European enterprise survey on the use of technologies based on artificial intelligence" by Ipsos and the International Centre for Innovation, Technology and Education[45] conducted for the EC from 2020, these are the internal and external barriers for Swedish SME:s adoption to AI:

Internal barrier for Swedish SMEs

- Cost of adoption
- Complex algorithms are difficult to understand and trust
- Lack of skills among existing staff

External Barriers for Swedish SMEs

- The need for new laws or regulation
- Strict standards for data exchange (e.g. data protection laws)
- Reputational risks linked to using artificial intelligence

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45. https://ec.europa.eu/digital-single-market/en/news/european-enterprise-survey-use-technologies-based-artificial-intelligence

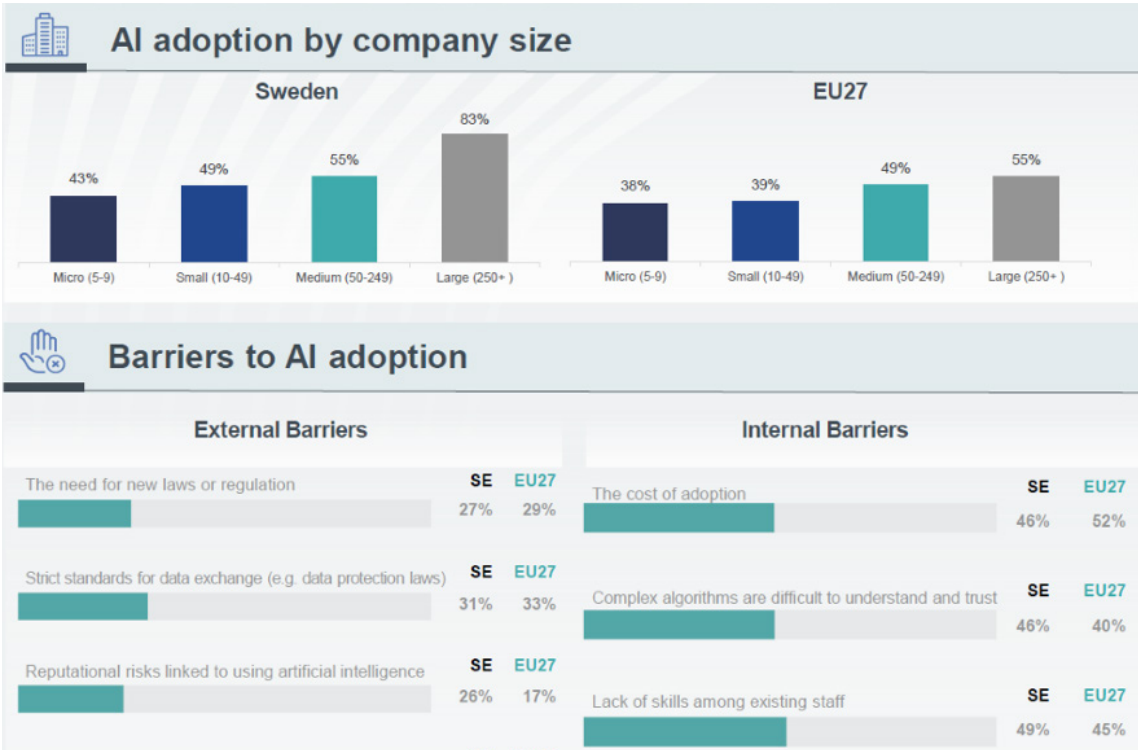

Figure 29. AI adoptions and barriers to AI adoption.

BARRIERS FROM A SWEDISH PERSPECTIVES

The Swedish Agency for Economic and Regional Growth has commissioned the company Swedish Consultants (Sweco) to map the ability of small and medium-sized enterprises (SMEs) to use data as a strategic resource. Here are the barriers from the study[46].

- Lack of insight into the possibilities with data: not least at management level Representatives of certain industries and companies have difficulties reasoning about the use of large amounts of data and instead tended to reason about digitisation in general, a sign of understanding that data is a strategic resource but lacks insight into how it can handled.
- Lack of time to familiarize themselves with the issues
- Data is often locked into systems, licenses and tied to certain suppliers, and that it varies in quality and in transferability between different systems. This means that data usually needs to be processed before it can be used, which requires resources.
- The need for additional resources to store real-time data. For many SMEs, these may appear as pure cost items rather than investments. For companies with a weak innovation culture, this can appear as pure cost items rather than investments that open up new opportunities.
- Digitisation strategies not integrated with the overall business development strategies, and it is not uncommon for IT experts to communicate poorly with business developers or operations technician
- A shortage of independent advisers with up-to-date skills that can help companies.
- Ignorance of information and cyber security and companies' low prioritisation of these issues also pose a threat.

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46. https://publector.org/embed/publication/Data-som-strategisk-resurs-i-sma-och-medelstora-foretag

INDUSTRIES SUITABLE FOR PILOT PROJECTS

Based on the analysis conducted by Sweco the following industries, or parts of industries, are best suited for public sector initiatives to help SMEs to become more data driven[47]:

Transport sector

The companies are part of a major revolution with new types of mobility solutions, and there is an interest in working with data both to streamline and develop business and the business model. Road transport of goods is a relevant sub-industry, and within it transport hauliers are judged to have sufficient readiness and capacity to participate in a pilot / announcement.

Green industries agriculture and fisheries and aquaculture / aquaculture

There is an increasing digital maturity, large amounts of data, a strong support structure and the opportunity to both streamline and develop business models.

Industrial segment

There is an opportunity for developed business and business models. The industrial companies that today have an infrastructure for centrally collecting and obtaining data for analysis should participate in a pilot. To increase the strategic benefit, industrial companies can collect more data, and data of better quality for analysis, without it negatively affecting daily production.

Connectivity and affordability

The connectivity issue within Sweden can be examined through looking at the specific connectivity issues with specific regions. In this section, we will consider the region of Halland. Halland is over 5 570 km squared with 149 306 households and 38 453 workplaces. The connectivity problems in Halland can be summarised in the following table:

Technical	Access
Fiber	82%
Kabel-TV (Cable-TV)	10%
xDSL	86%
VDSL	22%
3G	100%*
4G (LTE)	100%*
Fast Radio	0%*
Access to, including broad band close by	
Fiber (fiber connection)	92%

Table 1. Connectivity in Halland

47. *https://publector.org/embed/publication/Data-som-strategisk-resurs-i-sma-och-medelstora-foretag*

To further increase the connectivity within Sweden, the Swedish government is utilising the broadband strategy. Whereby the Swedish government wants to encourage rapid expansion of broadband and, or at least, see an improvement for the users who live in rural/peripheral areas. The Government will therefore work to ensure that the positive development in broadband development continues. In the new broadband strategy, the starting point is continued market-driven development supplemented by public initiatives[48].

POLICY CASE STUDY: THE HALLAND REGIONAL BROADBAND STRATEGY, "WHOLE OF HALLAND – A PART OF THE WORLD"

Fast and secure broadband contributes to increasing the entire region's attractiveness, it enables housing and businesses anywhere to use broadband the outside world. To be able to live and work in the countryside, especially for year-round living, new establishment and development of entrepreneurship, to get part-time residents to extend their stay and for future service, an expanded broadband will be one of the basic preconditions. Broadband helps us to be close to everything - everywhere.

The cost of establishing a connection increases with distance (the physical length of the connection) and the expected revenue increases with the number of end users. This makes it is more profitable to cater for more densely populated areas. There is shorter connections that can connect a larger number of end users compared to more sparsely populated areas. In rural areas, the population density is lower than in urban areas the geographical distance between houses, villages and communities greater, which means that few people have to share the infrastructure costs, which in turn results in high investment costs per household. For the operators, this ratio results in high investment costs in relation to the number of potential customers and revenue.

If Halland is to be able to retain and attract new companies and residents, the county must offer good development opportunities with good access to fast, accessible and robust (secure) web. Broadband interest in the Halland municipalities is very large. An expanded broadband will support the municipalities' core activities and make it easier for the business community to conduct business everywhere and for the inhabitants to live, work and study anywhere. An expanded and accessible broadband network is seen as an important growth engine for the county, municipalities and not least companies and residents, in particular in rural areas.

The Region Halland's overall vision is for Halland to be "Best place to live". The growth strategy for Halland aims to be Halland should be "a more attractive, inclusive and competitive region 2020" compared to today. To succeed in this, we, all together, need to create good basic conditions where access to broadband is one[49].

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48. "Sverige helt uppkopplat 2025 - en bredbandsstrategi" English translation: "Sweden fully connected 2025 – a broadband strategy" provided by the Swedish government. https://www.regeringen.se/informationsmaterial/2016/12/sverige-helt-uppkopplat-2025---en-bredbandsstrategi/

49. The region of Halland broadband strategy for the region. https://regionhalland.se/app/uploads/2019/03/337_Bredbandsstrategi_v4.pdf

CONCLUSIONS

This report provides an initial desk-based analysis on the barriers and incentives to adoption of data driven digital technologies. It provides an overview of some relevant key insights, and the current state of the critical barriers to Digital adoption faced by SMEs. An analysis of relevant material and data sources on connectivity affordability and digital skills for our project regions in the UK, Netherlands, Belgium, German and Sweden is also discussed. Regional policy examples are discussed, showcasing how regional authorities are dealing with the problem of SMEs digital exclusions in some of the peripheral areas included in our report.

The full conclusions and lesson learned will be developed when the second part of the paper, based on our Futures by Design data analysis will be completed. This will allow us to compare existing work and strategies with the new empirical evidence drawn from our project direct intervention with SMEs, in our project regions.

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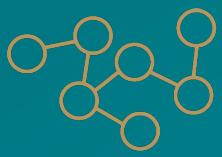

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