LEADS
ADVANCED DIGITAL SKILLS

D1.3 FINAL ADS DEMAND AND FORECAST REPORT

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| Abstract | This document provides the final analysis of the demand for ADS skills and forecasts for three different scenarios building on previous reports (D1.1, D1.2) and primary data from the survey and a series of workshops with experts. It provides a summary of results of a survey to European organisations related to skills planning, challenges and talent development and an updated view of demand within specific advanced digital skills. It also provides conclusions on the roles within ICT and the differences between HR and ICT perceptions. |
| Keywords | Skills, demand, forecast, roles, jobs, framework, Artificial Intelligence, Business Intelligence, Data Science, Cybersecurity, IoT, Quantum, Cloud, Edge |

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    DMP: Data management plan
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EXECUTIVE SUMMARY

Despite economic slowdown in Europe in 2022, European technology employment continued to grow 2.7% in 2021 with continued demand for ICT skills, underlining the deeper dependency on technology in all aspects of business, which accelerated during the COVID-19 pandemic. ICT employment in 2022 grew more than twice as we expected in our March 2022 forecast, following in the footsteps of the start of the Russia-Ukraine conflict.

Although most European countries have been increasing their retirement ages over the past few years, the demographics are of an ageing population, which will inevitably lead to higher attrition due to retirement. The current skills gap in technology roles and ageing IT professionals mean that supply from university programs will not be enough to support the current pace of technology development in Europe. Therefore, reskilling outside of academia has become a major source of IT professionals in the European market and a key factor for organisations to keep their skills pools up to date.

The LEADS consortium has developed a use case based methodology for predicting demand for future Advanced Digital Skills between 2020-2027. This has been expanded through a market scenario model tailored to each tech area and supported by a market survey to gain qualitative and quantitative data to contrast and complement this. The primary context for the work of LEADS is within the Digital Europe Programme; the key funding mechanism for the realisation of the ambitions set out in the Digital Decade. Amongst the key ambitions within this guiding policy is reaching 20 million employed ICT Specialists through generating more talent and striving for correcting the gender imbalance present today.

Two thirds of European organisations believe they already have sufficient Business Intelligence/Data skills, but a quarter are planning to continue to hire these skills, underlining how European businesses have embraced the notion of becoming data driven. Around 60% of European organisations currently have Cloud and Cyber skills and around 30% plan to hire more in the next two years.

In terms of hiring, salaries are not the biggest barrier to onboarding new talent, it is predominantly the lack of relevant work experience and professional qualifications. In order to meet current skills demands. 30% of companies will look to hire new staff while around 25% will look to use external staff – but 25-30% will look at upskilling internal staff to fulfil the needs. At the same time, around 1 in 5 organisations are looking at automation as a way of sourcing the skills (or indeed lessening the need for the human skill).

SMEs suffer from lower perception of digital maturity and also are more unsure of the skills that they will need to execute on a digital strategy. Only 1 in 5 SMEs have defined their skills requirements compared to 1 in 3 for large organisations.

The top 3 non-ICT roles significantly affected by ICT include operations and supply chain, customer support, and marketing. In addition, the view of HR managers compared to ICT managers and their perceptions of the importance of ADS in the future differs across the board while the challenges are closely aligned, the needs are not.

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ABBREVIATIONS

ADS	Advanced Digital Skills
AI	Artificial Intelligence
AIOTI	Alliance for the Internet of Things Innovation
BDVA	Big Data Value Association
BI	Business Intelligence
CAGR	Compound Annual Growth Rate
CATI	Computer-Assisted Telephone Interview
CISO	Chief Information Cyber Officer
EC	European Commission
ECF	e-Competence Framework
EU	European Union
GPU	Graphics Processing Units
HPC	High Performance Computing
ICT	Information and Communication Technologies
IoT	Internet of Things
IT	Information Technologies
JU	Joint Undertaking
ML	Machine Learning
MS	Member State
MSP	Managed Service Provider
NICE	National Initiative for Cybersecurity Education
NVME	Non-Volatile Memory Express
OECD	Organisation for Economic Cooperation and Development
SCM	Storage Class Memory
SDS	Software Defined Storage
SRIAs	Strategic Research and Innovation Agendas
SSDs	Solid State Driven
USD	US Dollar
WP	Work Package
5G	Fifth Generation

1 INTRODUCTION

LEADS Collaboration and Support Action (CSA), as a Digital Europe Programme (DIGITAL) funded initiative, plays a strategic role in reaching the ambitious goal of the creating 20M new ICT specialists by 2030[1]. The DIGITAL programme was set to invest €570M within the 2021-2027 period to enhance the competency of Advanced Digital Skills (ADS), one of its priority areas, by developing masters programmes, academic and vocational and education training networks, short term training course and training academy. LEADS CSA's mandate is to provide a roadmap to effectively direct that investment. The project's first mandate is to define what ADS are most needed currently and in the future, to latter address its second priority: how to best deliver such skills.

Since its recent creation LEADS has been addressing the identification of the ADS current and future shortage via two main tasks. Firstly, it has developed the first ADS taxonomy that extends on six foundational technologies areas[2] and over 30 skills pockets that allow to identify current skills classification as well as the current convergence of ADS in current and upcoming job profiles[3]. Secondly, the framework was further developed by the identification 80 skills details based on multiple data sources including IDC trackers, Bureau of Labour Statistics, Eurostat, and ILOSTAT, OECD data and other competence frameworks (such as EC-F and NICE). This has led to a more detailed level framework of coverage when compared to the EC-F and NICE, as it focuses on advanced digital skills whereas these cover a broader set of competences on a higher level. Finally, the skills details were matched to 150 market use case investment trackers that lead to the publication of the first ADS Demand and Forecast Report that presents, on a market data-based analysis, what is the current and future demand[4] of the ADS skills grouped by specific skills profiles[5].

Consequently, the current report of ADS Demand and Forecast outlines the expected growth in demand for different ADS in the next five years while incorporating the projection on three scenario forecasts to determine the expected magnitude of the future demand under baseline, optimistic and pessimistic ADS demand scenarios.

These unique insights into the future ADS scenario are of particularly relevance for policy makers at EU level, responsible for assuring the Digital Decade Target on advanced skills as well as for national-level policy makers responsible for shaping the education policies and digital agendas of their countries. Additionally, education leaders and local governing bodies can use the insights provided by the project to make informed decisions about the allocation of resources and the development of IT education programs that will meet the needs of their local communities. Ultimately, the LEADS project can help ensure that the IT education industry in the European Union is better equipped to meet the demands of the future and mitigate potential bottlenecks in the education system as well as it can provide Industry and SME's evidence-based tools in order to best interpret market shifts and changes that will allow

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[1] 2030 Digital Compass: the European way for the Digital Decade
[2] Artificial Intelligence (AI), Cybersecurity, Cloud Computing & Internet of Things (IoT), Business Intelligence/Data Science, and Quantum technologies.
[3] LEADS D1.1 Demand Assessment Framework
[4] See ADS Pockets composition future demand through interactive dashboard
[5] LEADS D1.2 First draft on ADS Demand and Forecast Report

them design their ADS acquisition strategies in order to ensure the sufficient talent-pipeline management in order to ensure business sustained growth.

2 METHODOLOGY

2.1 Summary of approach

For the demand assessment and forecasting analysis, the project team established a correlation between the framework of identified advanced digital skills with over 150 market use cases that reflect how the industry is allocating financial resources to develop the AI, IoT, Cybersecurity, Business Intelligence/Data Science, Cloud Computing and Quantum markets in software, hardware, and services. The results of these have provided a baseline prediction for the growth in demand for relevant tech areas their component skills pockets, a detailed approach to this can be found in the first version of the demand forecast.[6]

With this initial, market-led mapping of future demand, the LEADS team conducted a market survey to gain qualitative and quantitative data to contrast and complement this.

Following on from this demand mapping, a set of market adoption scenarios were developed using tailored indicators specific to each technology area and the application of existing macroeconomic and global models. The result of this is to provide a range of forecasted demand which delivers pessimistic and optimistic outcomes.
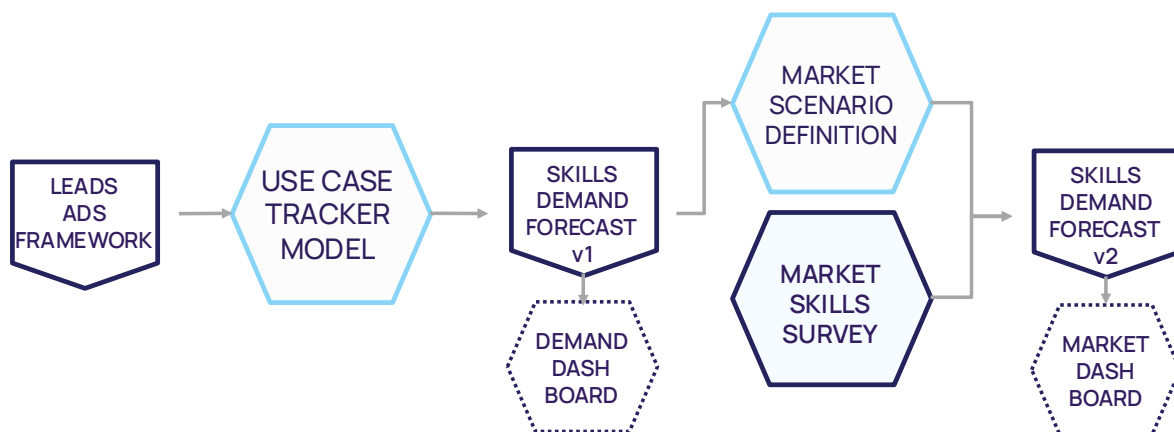
Figure 1. Overview of the approach towards the definition of the demand for advanced digital skills

2.2 Survey methodology

As part of this project, a survey of European organisations was conducted in order to get a deeper understanding of the plans, challenges and approaches that employers are taking to address the need for advanced digital skills. The survey was delivered in April 2023 with responses collected from individuals with roles in HR (12%) and IT (88%) departments in 885 European organisations using Computer Assisted Web Interviewing (CAWI) techniques. All respondents were location across 12 Member States as shown below which aimed to achieve a balanced sample across industries reflecting the business demographics of European organisations.

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[6] D1.2 first draft of ADS demand and forecast report, April 2023
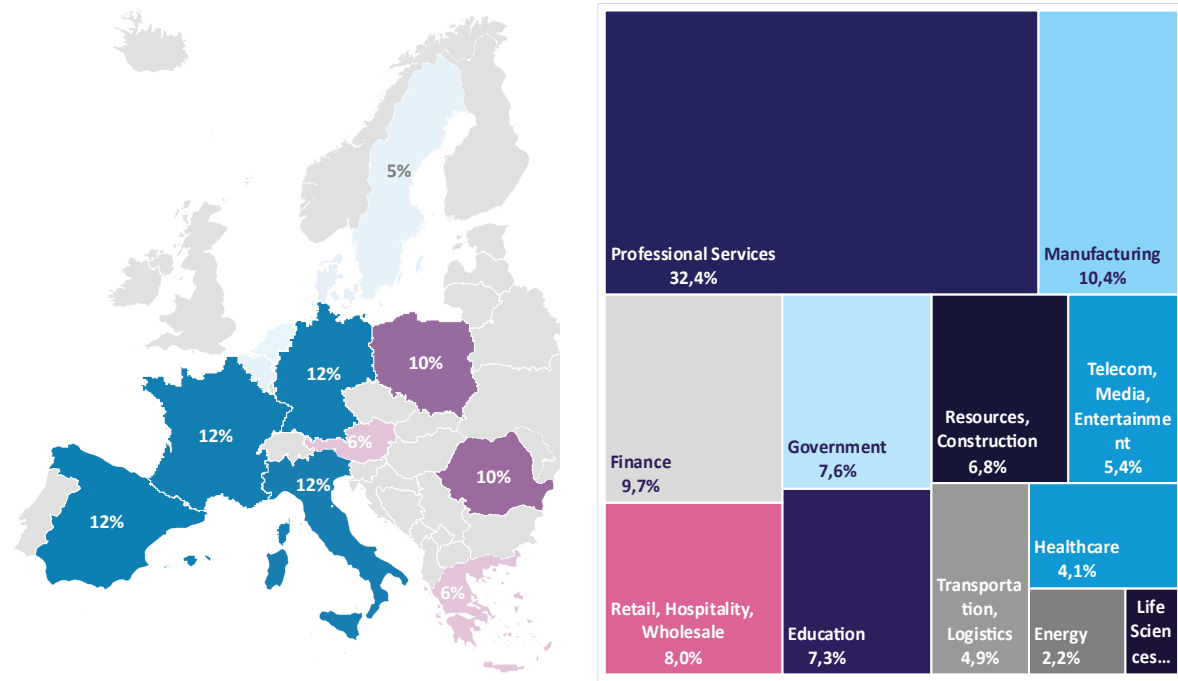
Figure 2. Summary of location of respondents across the Member States (L), and by industry (R), n=885,

Source: LEADS Digital Skills Survey April, 2023

The survey included three quarters of respondents responsible for managing staff with 60% at team supervisor level or above. An important factor to highlight is that all respondents were currently involved in sourcing or managing the demand for advanced digital skills and most (84%) also involved in evaluating the future demand for these skills in the organisation.
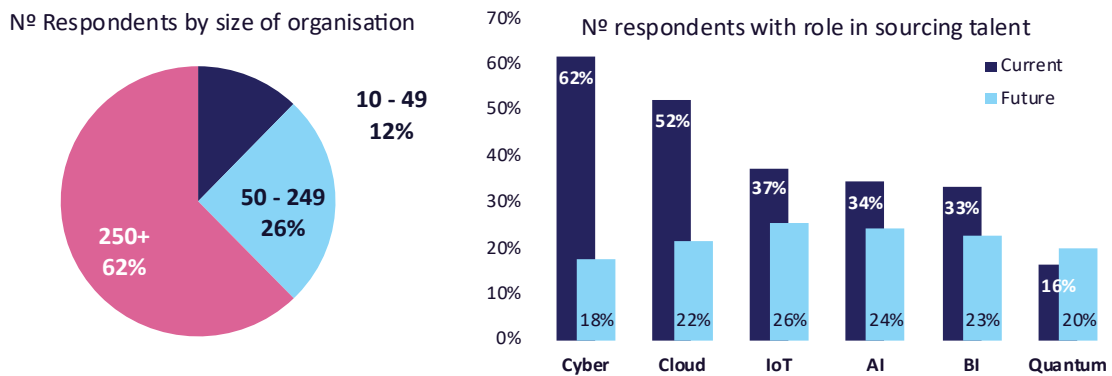
Figure 3. Survey respondents by size of organisation and by responsibility for sourcing talent by area

Source: LEADS Digital Skills Survey, April 2023

Within the completed survey, respondents provided their inputs on the following areas, among others:

- Relevance of advanced digital skills and talent for organisational strategy.
- Current talent gaps and planned recruitment.
- Methods for assessing candidate skills and competences.
- Strategies for fulfilling existing digital skills needs.

2.3 Market scenario forecasting

Through the methodology applied by the LEADS consortium, the baseline for future skills demands has been defined through the tracking and measurement of market uptake and spend on defined use cases. This relative growth prediction is, however, based on current decision making and historical activity, which does not consider potential changes in future scenarios. As we have previously mentioned and defined, both the rate of technological development and the context around its adoption is highly dynamic with many transformative and pivotal factors responsible. For this reason, we have developed a scenario-based modelling approach to provide a pessimistic and optimistic forecasting, with certain assumptions to underpin this.

These factors and assumptions can be categorised into the following areas:

- **Macroeconomic** – influence of economic and global events on ICT spend, includes GVA, inflation and significant geopolitical events like the impact of the Russian aggression.
- **Sociopolitical** – this looks, in this case, primarily at the investment in R&D at EU and MS level.
- **Technological** – novel to the LEADS approach, we have explored in detail how technical and political advances may influence tech adoption and skills of scope technologies.

As the model has been built from current data about technology adoption and, above all, spending by the industry in different categories of ICT such as (but not limited to) AI systems, IoT and automation, cybersecurity and cloud, more embryonic areas of technology such as Quantum Computing may lack the same level of insight granularity due to the smaller amount of data behind its market.

For Quantum Computing skills, public sector spending in Research & Development (R&D) was accounted for in the analysis, as well as some of the new industry efforts and discoveries to foment the area. However, the predictability of such an area may be less accurate as the market may quickly change depending on any future breakthroughs that may occur over the next few years.

2.3.1 Technological factors and the influence on advanced digital skills

Within the LEADS consortium, the team has built on the work of BluSpecs and the NGIoT Initiative which had previously performed a meta-analysis of the key themes and trends within the Strategic Research and Innovation Agendas (SRIAs) of principal tech development communities within the EU.[78] This analysis has provided the identification of factors and the generation of preliminary assumptions of how they will affect the rate of market adoption.

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7 Brendan Rowan, Martín Robles, & Sam Jones. (2023). A Federated Future: Mapping of the future directions towards the Cloud Edge IoT from Data, IoT and Edge community. Zenodo. https://doi.org/10.5281/zenodo.7919952

8 Tanya Suárez, Brendan Rowan, & Martín Robles. (2023). Shared Digital Future. Impact of key European legislation and proposals on the IoT and Edge community (v1.0). Zenodo. https://doi.org/10.5281/zenodo.7919944

In total 17 factors were identified, 16 from the trends within the R&D communities and another included, Generative AI, which is anticipated to have a significant effect on the democratisation of access to advanced digital technologies by domain experts who are not digital or ICT specialists. The full list of the factors, their description and their assumptions for influence on key technology areas is provided in Annex II.

Within the Technological Factors, three categories were formed:

- **Digital Infrastructure**: factors related to the availability and deployment of networks and computing assets both generally and within individual organisations.
- **Components:** trends in key enabling technologies like the availability of specific chips and sensors, and industrial data ecosystems.
- **Legislation:** exploration of three key proposed legislations which will have a medium-term impact on tech development and market functioning, as well as the overall direction towards greater regulation on powerful digital technologies and markets.
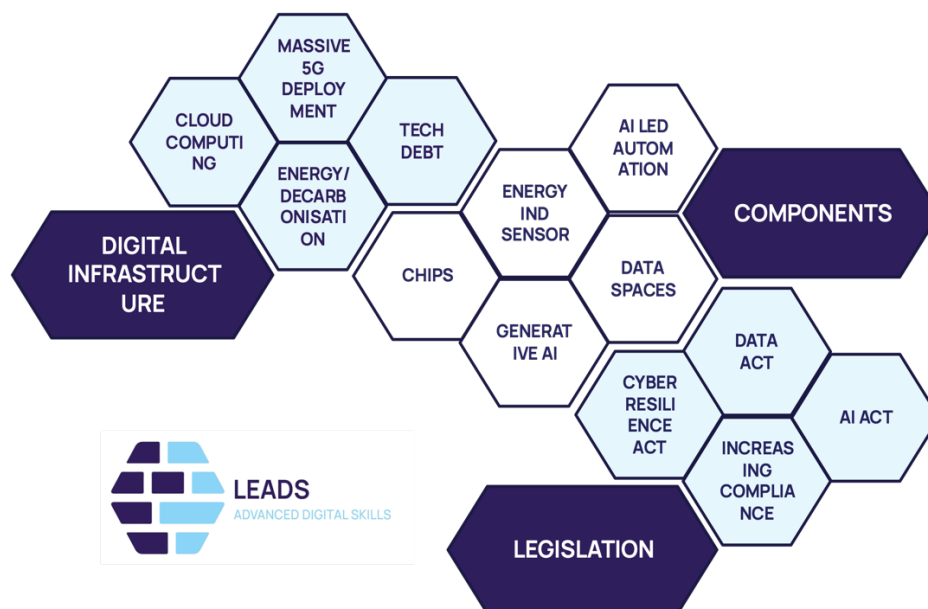
Figure 4. Overview of the influencing factors explored under the technological category

2.3.2 Expert stakeholder engagement and co-creation

The influence of these key factors require modelling for each of the main technologies and skills pockets within the LEADS framework. The initial assumptions have been defined by LEADS experts in both advanced tech development and digital skills but required validation and contributions from the expert communities of stakeholders.

This is achieved through a series of consultative workshops and expert consultations organised with the BDVA/DAIRO (Data & AI), Alliance for IoT and Edge Innovation (IoT & Cloud), Women4Cyber[9] (Cyber)and Quantum Flagship (Quantum). In total 97 experts participated in this activity and agendas are provided in the Annex I.

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[9] W4C is a non-profit organisation aimed at promoting, encouraging, and supporting the participation of women in the field of cybersecurity.

Within each of these workshops, the expert participants explored and refined the assignment of market use cases to the skills pockets and its component skills details before taking each of the technological factors in turn. Within each factor, the hypothesis or hypotheses for their scenario were validated or further developed and the descriptive impact on skills demand constructed.

Following on from this, both the relevance and scale of impact for each factor was assigned using a Likehart scale against each skills pocket to provide a common relationship between the factors and the skills demand. Relevance meant how relevant the individual factor was to each skills pocket while magnitude referred to the scale of impact the factor would have on the skills pocket demand.
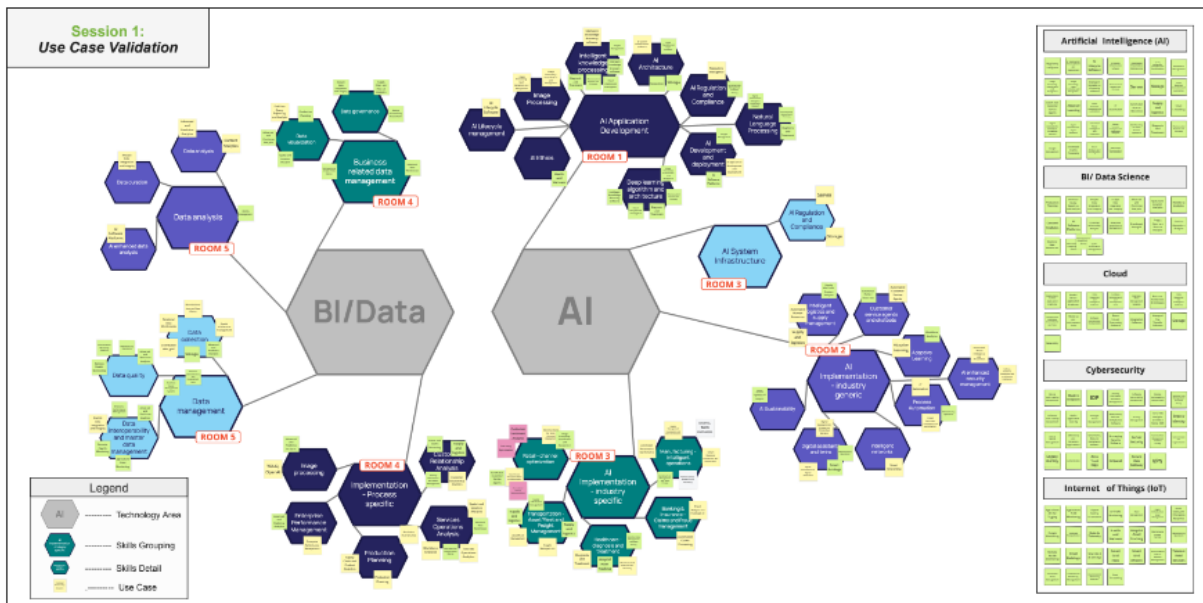
Figure 5. BDVA Quadrant Board Activity

2.3.3   Scenario Model construction

The outcomes of this were then incorporated into the modelling and scenarios constructed to provide the optimistic and pessimistic scenarios applied for the final demand analysis data contained within this report. The scenarios apply the forces that will define the rate of adoption of ICT by industry. The LEADS final model analysis combined the hypotheses and factors generated from the expert stakeholder engagement sessions with macroeconomic variables which are known to affect ICT investment and uptake such as forecast GDP growth, public investment in R&D, inflation, and conflict.

3 THE EUROPEAN LANDSCAPE OF SKILLS DEMAND

3.1 The situation of Europe in the last 5 years

The European landscape of technological skills demand has been evolving rapidly in recent years. As technology continues to advance and transform various industries, the demand for specific technological skills has increased across Europe. In the last few years, Europe has witnessed significant trends in technology adoption across various sectors. Organisations across Europe have been embracing digital transformation to stay competitive and improve operational efficiency. This includes adopting cloud computing, implementing data analytics and AI solutions, digitising processes, and enhancing online customer experiences. The main trends that have emerged are:

- **Internet of Things (IoT) Deployment:** European businesses have increasingly adopted IoT technologies to optimise operations and provide innovative services. IoT applications can be found in sectors such as manufacturing, energy management, agriculture, transportation, and smart cities. For example, smart metres for energy monitoring, connected cars, and intelligent infrastructure for urban planning.

- **Artificial Intelligence (AI) and Machine Learning (ML):** The adoption of AI and ML technologies has gained momentum in Europe. organisations are utilising these technologies for various purposes, including predictive analytics, customer personalization, fraud detection, and process automation. European countries have also been investing in AI research and development and establishing AI-focused initiatives and centres.

- **Big Data Analytics:** With the exponential growth of data, organisations are investing in technologies and tools to analyse and extract valuable insights. Big data analytics helps businesses make data-driven decisions, improve operational efficiency, understand customer behaviour, and identify market trends. It involves techniques like data mining, predictive analytics, and data visualisation.

- **Cloud Computing:** Cloud computing has revolutionised the way businesses store, manage, and process data. It offers scalability, flexibility, cost-effectiveness, and accessibility. Many organisations are migrating their data and applications to the cloud, enabling them to access resources on-demand and focus on their core competencies without significant infrastructure investments.

- **Cybersecurity:** As technology advances, the need for robust cybersecurity measures becomes increasingly critical. With the rise in cyber threats and data breaches, organisations are investing in cybersecurity technologies and practices to protect sensitive information and ensure data integrity. This includes technologies like encryption, multi-factor authentication, intrusion detection systems, and Cyber awareness training.

- **Renewable Energy and Sustainability:** European countries have been actively adopting and promoting renewable energy sources. Investments in wind, solar, and hydropower have increased, as well as the deployment of smart grid technologies for efficient energy management. Sustainability practices, such as carbon footprint reduction and circular economy initiatives, have also gained prominence.

- **5G Connectivity and Digital Infrastructure:** Europe has been investing in the deployment of 5G networks to enable faster and more reliable connectivity. The rollout of 5G infrastructure facilitates the adoption of IoT, smart city initiatives, autonomous vehicles, and augmented reality applications.
- **Data Privacy and Cyber Regulations:** The introduction of the General Data Protection Regulation (GDPR) in 2018 has had a significant impact on technology adoption in Europe. organisations have been focusing on data privacy and Cyber compliance, leading to increased investments in cybersecurity measures, data protection technologies, and privacy-enhancing tools.

These trends reflect Europe's ongoing efforts to embrace technology-driven innovation, improve sustainability, and create a digital economy that benefits businesses and citizens. However, it's important to note that technology adoption may vary among European countries due to factors such as skills shortage, regulatory frameworks, economic conditions, and technological infrastructure.

The shortage of skills in Europe has been a significant challenge in recent years. In 2019, nearly 77% of businesses faced challenges in locating individuals possessing the necessary skill sets for their workforce[10]. In 2021, a total of 28 job categories were identified as experiencing shortages. These included occupations in sectors in the fields of IT and Cyber, particularly in cybersecurity, as well as a demand for workers with backgrounds in science, technology, engineering, and mathematics (STEM). This observation indicates an increasing need for both highly skilled and less skilled workers in the labour market[11].

Several factors contribute to the skill shortage problem, including rapid technological advancements, demographic changes, and a mismatch between the skills demanded by the job market and those possessed by the workforce. The rapid development of new technologies, such as artificial intelligence, automation, and digitalization, has created a demand for new skills. However, the education and training systems have struggled to keep pace with these advancements, leading to a shortage of individuals with the necessary technical competencies. There is often a mismatch between the skills taught in educational institutions and those demanded by the job market. Many employers report difficulties in finding candidates with the right skills, particularly in emerging fields like information technology, data science, and engineering. This gap highlights the need for better collaboration between educational institutions and industries to align curriculum with market needs. In addition to that, in recent years, there has been a greater emphasis on academic education, leading to a decline in vocational training programs. Encouraging and investing in vocational training can help address the shortage of skilled workers in these fields.

On the other hand, Europe is experiencing demographic shifts, including an ageing population, and declining birth rates. This demographic change is resulting in a shrinking workforce and a potential shortage of skilled workers. As older employees retire, there is a need for younger generations to possess the required skills to fill the gaps. In addition to that, skilled workers may migrate to other countries or regions where better opportunities and working conditions

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[10] Eurofound, European Company Survey 2019.

[11] European Labour Authority, Report on labour shortages and surpluses 2021 and ENISA, Cybersecurity skills development in the EU, March 2020. The ENISA studies identify there is a gap of 291,000 professionals in cybersecurity.

are available. The scarcity of advanced technological skills reinforces the dominance of global digital leaders, as the limited pool of talent gravitates towards the most lucrative and prestigious positions. Consequently, as these technology pioneers attract a greater share of global talent, their productivity continues to increase, further solidifying their competitive edge. The concentration of highly skilled workforce to global digital leader companies outside the European region, results in the European Union (EU) facing economic and geopolitical interdependencies. This brain drain can exacerbate skill shortages in certain European countries, particularly in sectors that require highly specialised knowledge.

To tackle these challenges, European countries and the European Union should take some action. This includes investing in education and training programs that focus on emerging technologies, promoting lifelong learning and upskilling opportunities, facilitating labour mobility across borders, and encouraging public-private partnerships to bridge the gap between education and industry needs.

It's important to note that the situation may vary across different European countries and industries. Efforts to address the shortage of skills require a multi-faceted approach involving government policies, educational institutions, employers, and individuals to ensure a skilled and adaptable workforce that can meet the demands of a rapidly evolving economy.

3.2 Drivers and enablers

In the context of estimating the future demand of advanced digital skills (ADS), the terms enabling factors and driver factors are used to analyse and understand the various influences that contribute to the demand for these skills. While both factors play a role in shaping the demand for ADS, they differ in their underlying mechanisms and effects.

Driver factors are the forces or influences that directly propel the demand for advanced digital skills. These factors are often motivated by specific needs, opportunities, or challenges that arise in society, industry, or the job market. Driver factors typically emerge from shifts in technology, market dynamics, economic conditions, or societal changes. They create a demand for individuals with ADS to address emerging requirements, solve complex problems, or seize new opportunities

Enabling factors refer to the conditions or elements that create a conducive environment for the growth and adoption of advanced digital skills. These factors provide a foundation or infrastructure that facilitates the development and utilisation of ADS. Enabling factors can include technological advancements, supportive policies and regulations, educational initiatives, availability of resources, and access to relevant infrastructure. They essentially create the necessary groundwork and resources for individuals, organisations, and societies to engage with and benefit from ADS.

The key distinction between enabling factors and driver factors lies in their underlying nature and roles. Enabling factors are the foundational elements that create a favourable environment for the growth and adoption of ADS. They provide the necessary conditions, resources, and infrastructure to support the development and utilisation of these skills. On the other hand, driver factors are the specific forces that directly propel the demand for ADS. They arise from changes in technology, market dynamics, or societal needs and create the

demand for individuals with advanced digital skills to address these emerging requirements or opportunities.

Key drivers include:

- Increase of competitiveness in job roles as a result of a more global and competitive market
- Shortage in qualified labour force to cover positions
  - Lack of working experience to be compensated by upskilling courses
- Workforce interest to remain competitive and updates in a global and dynamic market
  - Remote/hybrid working as a post-pandemic new normal, reduced mobility restrictions within EU single market
- Business growth enhanced by tech adoption
  - Increase in productivity
  - Reduction in cost

Key enablers include:

- Online availability of ADS courses on a worldwide level
- Available funding for ADS skilling
  - Public sector grants and subsidised free courses
  - Private sector incentives for workers' upskilling
- Increase in maturity and application of foundational tech necessary for ADS within specific tech areas
  - E.g. Increase in processing capacity and reduction of cost in Cloud technology
- Wide-spread adoption of AI Models and NLP solutions.

3.3 Barriers towards skills and talent development

In an ideal world, as technology develops, so does the pool of human competences and technical skills to iterate, manage and operate new systems that will be implemented. However, the pace of technology adoption often surpasses the pace of Learning and Development (L&D), leaving considerable bottlenecks of knowledge/skills in organisations and delaying digital transformation projects.

Key barriers identified include:

- Limited data on skills demands and difficulties in planning for future talent pipelines.
- Limited resources within organisations for upskilling and reskilling.
- Poor visibility on future tech developments and the accelerated pace for tech demand.
- Lack of relevant knowledge and experience among graduates.
- Dominant IT ecosystems, with coupled skills and certifications limiting the transferability of skills and talent.
- Short supply of talent with STEM backgrounds who can be more readily reskilled into new roles as they emerge.
- Significant global competition for talent and the catalyst of remote work which decouples salaries from local economies.

In general, companies are aware that the adoption of new technologies must be planned strategically, with a long-term roadmap, however, recruitment, upskilling and reskilling programs must be equally planned to ensure the necessary technical skills are present when projects start. Without a proper resourcing and L&D plan in place, digital transformation projects run the risk of being delayed, less workers will develop the necessary skills to perform needed tasks and the clarity on which are the needed skills to be trained diminishes. Therefore, not identifying which skills are needed in the long term is the principal barrier for skills demand within the IT department.

Furthermore, there is a gap in collaboration and knowledge exchange within the ICT partner ecosystem. As IT vendors and service companies provide the backbone of many of the systems and tools to its customers, knowledge tends to be siloed within certain stakeholders. This concentration of knowledge and skills in a handful of players may be perceived by some companies as a competitive advantage in the first moment but also serve as a barrier for the holistic development of technology and a healthy talent market.

3.4 Policy context

Within the scope of policy, the challenge of talent and digital skills is highly complex, multifaceted, and interdependent. The acquisition of digital skills is reliant on the good functioning of the education system, the investment by companies in talent development, a pipeline of adaptable and flexible talent, an alignment of skills programmes to market needs, and access to equal opportunities and finance.

In this context, although the social and economic impact of any skills gap is immediately evident once it arises, the solution or preventative measures are not always so, especially in the case of advanced digital skills. This complexity relates to the required elasticity of the labour market, the rapid pace of digital transformation and the summative fact that advanced digital skills are the final link of a long chain of education, training, employment, and individual circumstances. It crosses social, educational, industrial, and research and innovation policies and strategies.

3.4.1 Europe's Digital Decade

The primary context for the work of LEADS is within the Digital Europe Programme; the key funding mechanism for the realisation of the ambitions set out in the Digital Decade. Amongst the key ambitions within this guiding policy is reaching 20 million employed ICT Specialists through generating more talent and striving for correcting the gender imbalance present today.
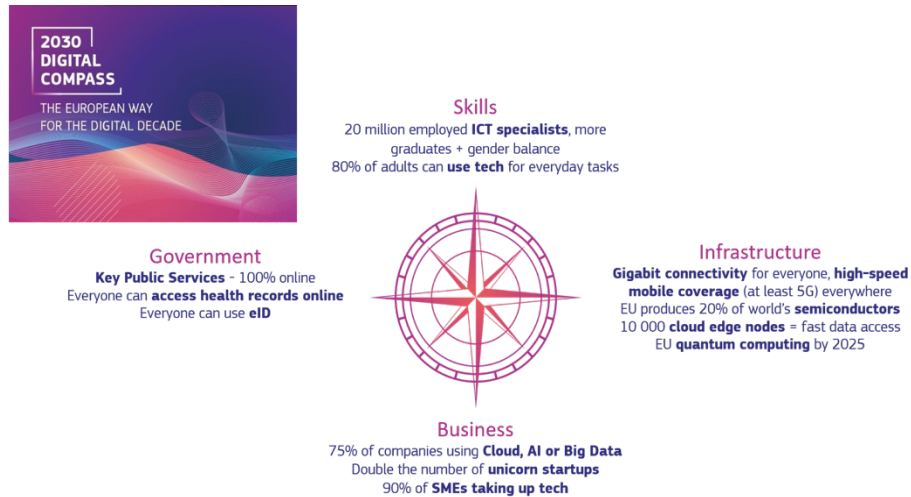
Figure 6. Summary of the Digital Compass: the guiding targets towards realisation of Europe's Digital Decade by 2030.

Source: European Commission

If the existing trend from 2010-2020 were to continue, the EU would miss out on the target by over 7.7 million. For this reason, urgent and widescale action is required at all levels.
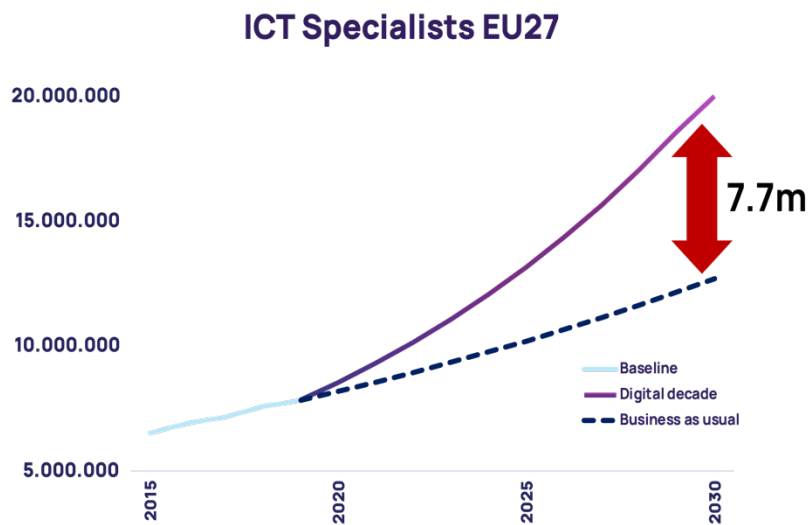
Figure 7. Projected supply of ICT Specialists from 2020 to 2030 compared to Digital Compass target

Source: European Commission

The DIGITAL programme, guided by the DIGITAL DECADE, aims to significantly increase European digital competences and secure strong and resilient digital supply chains. The 7.5bn EUR programme itself acts across 5 key areas of action; High Performance Computing, Artificial Intelligence, Cybersecurity and Trust, Deployment and Best Use of Digital Technologies and Advanced Digital Skills. Cutting across all of these areas, the DIGITAL programme is the need to provide a solid basis for which European business and society can benefit from advancement of digital technologies and innovation especially by SMEs and the individual.
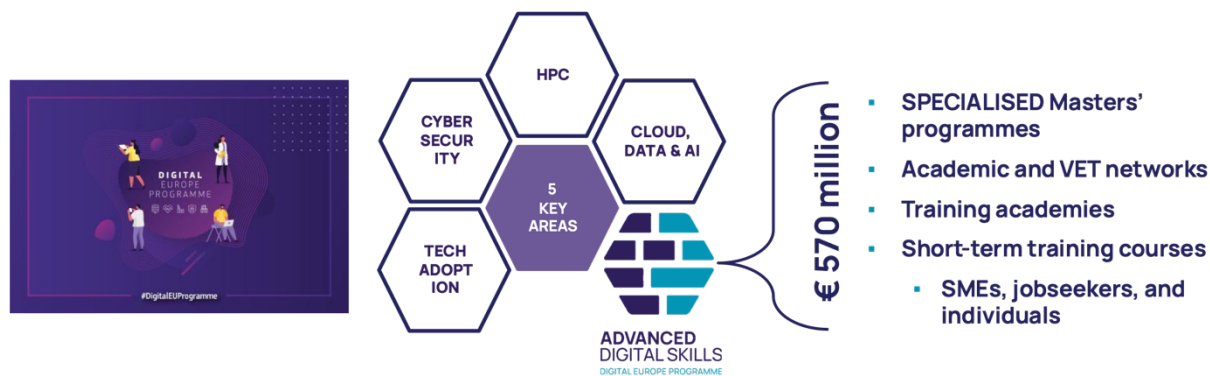
Figure 2. Overview of the DIGITAL programme and the advanced digital skills component

Within the Advanced Digital Skills, it is established to provide the workforce in both the private and public sector, in particular ICT professionals and the need to reduce the gender divide in order to secure Europe's long-term growth and sustained prosperity. Under the Specific Objective, the EU is seeking to stimulate the investment in sustainable consortia of education institutes, training providers, and industry to tackle both short-form and long-form skilling, reskilling and upskilling programmes. This includes bootcamps, alliances, master's programmes, among others.

3.4.2   Interlinked policy contexts

As previously described, the complexity of the challenge around advanced digital skills is reflected in the set of linked policies at European level which includes among others, New European Skills Agenda, The European Pillar of Social Rights, and the Recovery and Resilience Plan.
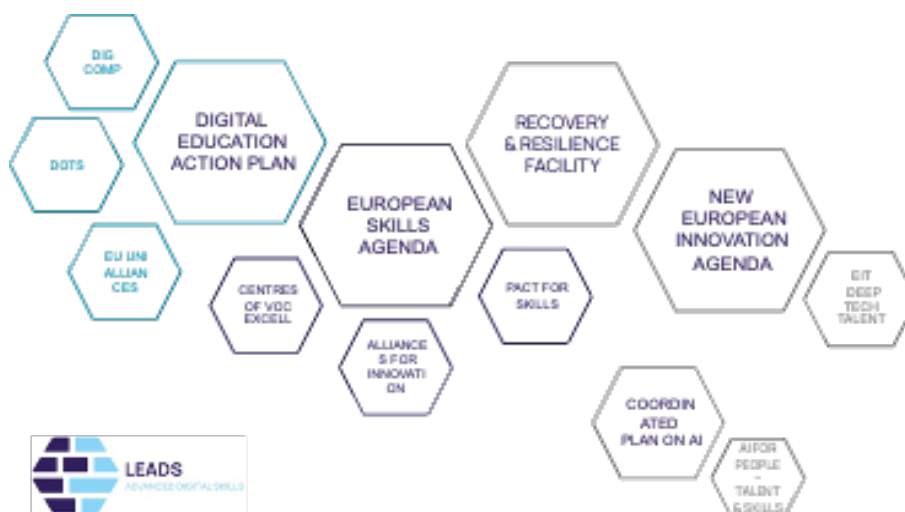
Figure 8. Non-exclusive view of the policy context for digital skills.

Under these policies there are the following plans and strategies are particularly of relevance with certain overlaps already existing between the Skills Agenda and DEAP:

- Digital Education Action Plan
  - Revision of the DigComp
  - European University Alliances
  - Digital Opportunity Traineeship

- Recovery and Resilience Facility
  - NextGenerationEU: Support to digital transition
    - IT services and applications for digital skills and digital inclusion12
    - Skills development for smart specialisation, industrial transition
    - Support for the development of digital skills13
  - REPowerEU: accelerated requalification of the workforce towards green and related digital skills
- European Skills Agenda
  - Pact for Skills
  - Centres of Vocational Excellence
- A New European Innovation Strategy
  - EIT Deep Tech Talent
- European Industrial Strategy
- Cohesion Policy
  - ESF+
  - ERDF
- Coordinated Plan on AI

  - AI for People – Skills and Talent

As can be seen below, the DIGITAL programme accounts for only 0.6% of the total EU spend on skills related actions, and the shared need for skills requires action across all areas not just within the Digital Decade.

Table 1. Summary of EU investment in skills.

PROGRAMME	EUR (BN)	PROGRAMME	EUR (BN)
European Social Fund Plus (ESF+)	61.5	European Globalisation Adjustment Fund	1.1
Erasmus	16.2	European Solidarity Corps	0.8
InvestEU	4.9	Digital Europe	0.5
		Total	85bn EUR

Source: European Commission

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[12] Measures to support the digitalisation of education and training institutions (including investments in ICT infrastructure), including for vocational education and training and adult learning

[13] Digital skills at all levels and includes: highly specialised education programmes to train digital specialists (that is technology focused programmes); training of teachers, development of digital content for education purposes and relevant organisational capabilities. This also includes measures and programmes aimed at improving basic digital skills.

4 RESULTS ON BUSINESS SURVEY

4.1 A focus on skills demand

The main focus of the survey was to obtain detailed insights into which skills European organisations currently have, which they plan to acquire in the next two years and how difficult they find it to acquire the needed skills. The survey asked respondents detailed breakdowns on the six technology areas but for this report, results are analysed on an aggregate level.

Sourcing Advanced Digital Skills in business

As shown below, two thirds of European organisations say that they already have Business Intelligence/Data skills in house, but a quarter are planning to continue to hire these skills, underlining how European businesses have embraced the notion of becoming data-driven. Around 60% of European organisations currently have Cloud skills and around 30% plan to hire more in the next few years. These numbers are similar to those for Cyber which seems a little surprising as cybersecurity technologies should be a prerequisite for any IT department.

Looking at the new advanced digital technologies, it is clear that European organisations are expecting a strong expansion – in fact almost doubling - of the related skills in the next few years, correlating well to the data generated through use case tracking.
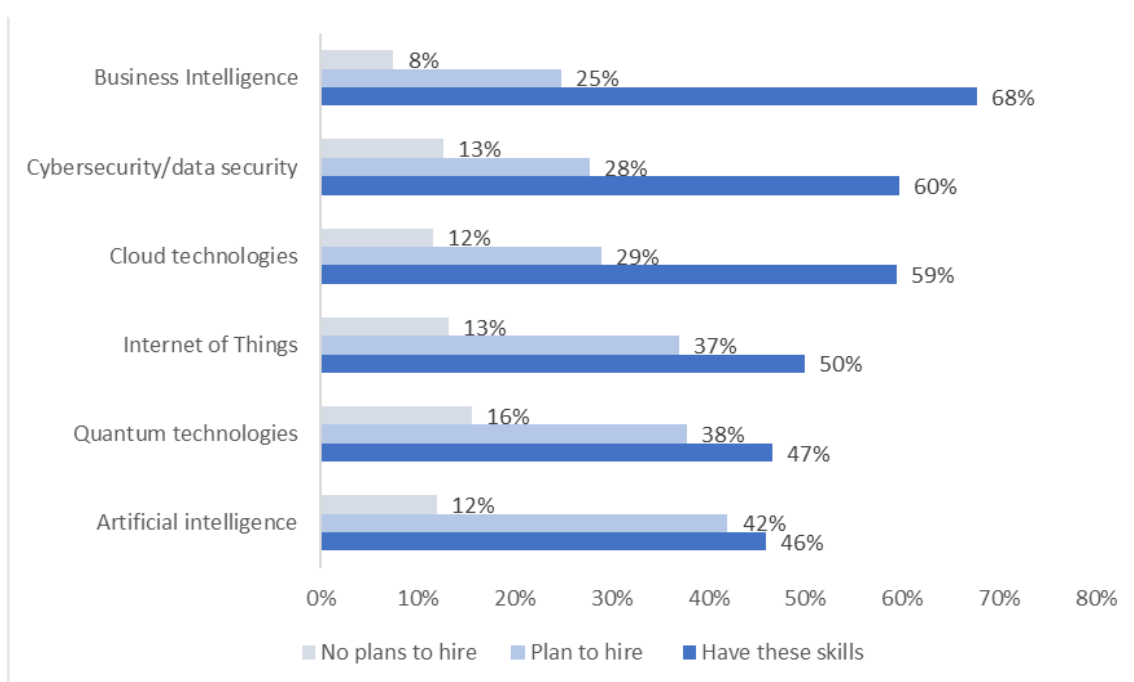
Figure 9. Current and Future Plans for Advanced Digital Skills

Source: LEADS Digital Skills Survey, April 2023

So how are European organisations planning to source the digital skills that they will need to execute on their digital strategies? When asked about their approach, they are looking at any means possible to find the skills they need – and the pattern is consistent across all six skills areas. About 30% of respondents will look to hire new staff while around 25% will look to use external staff – but 25-30% will look at upskilling internal staff to fulfil the needs. At the same

time, around 1 in 5 organisations are looking at automation as a way of sourcing the skills (or indeed lessening the need for the human skill).
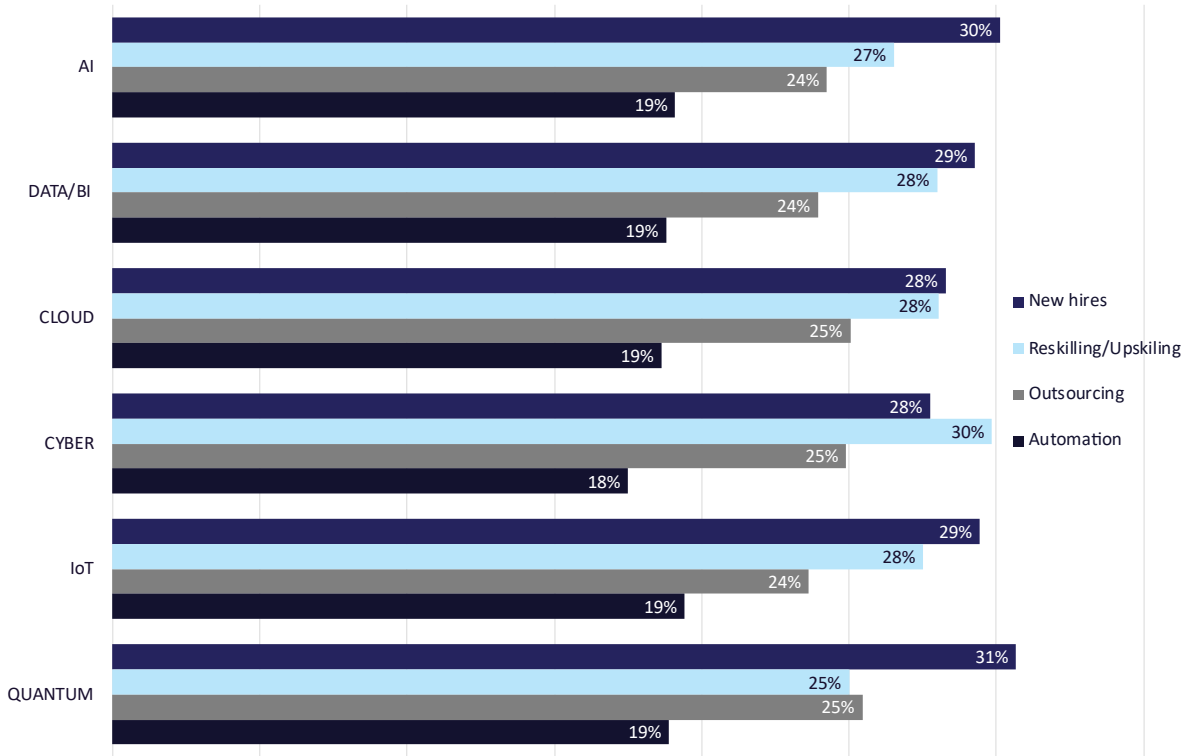
Figure 10. Distribution of strategies for sourcing skills within each tech area

The hiring situation for advanced digital skills continues to be a challenge for a large number of European organisations – both for more established skills, such as Cloud, Data and Cyber and for the newer technologies (AI, IoT and Quantum), which obviously leads to the findings above that organisations are looking at all options for fulfilling their skills needs.

Compared to the most important skills identified as contributing towards the successful execution of their digital strategies, the largest gap between importance and difficulty to hire can be seen in Data, while AI appears to have shortest distance which implies that the gap in AI talent will continue to grow at twice the rate for those with Data skills. This correlates well with the difference between the currently available skills and future hiring plans previously provided.
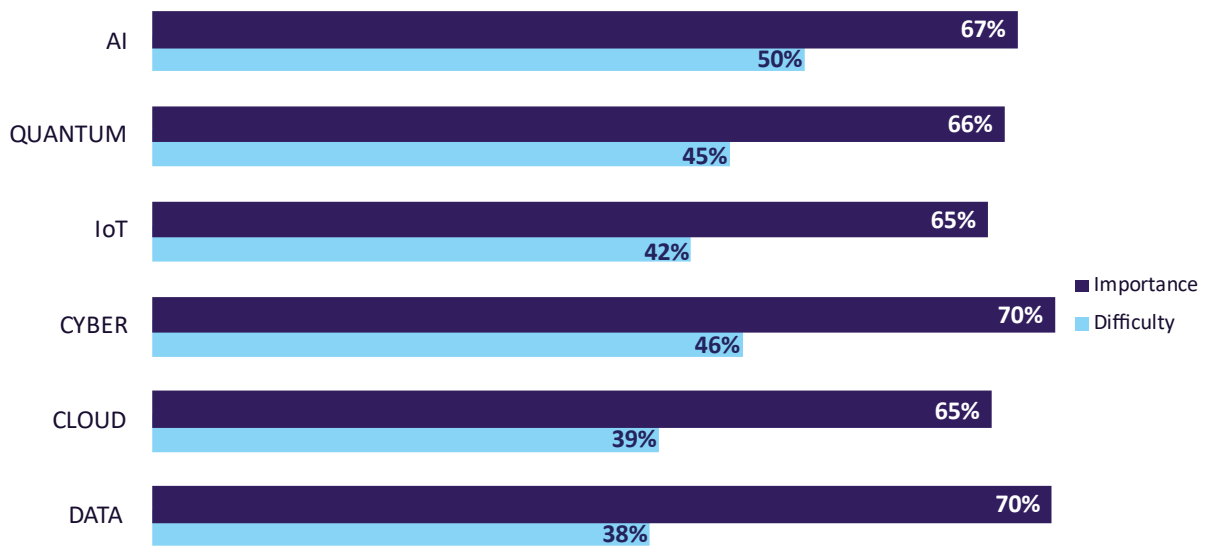
Figure 11. Difficulty in Hiring for Advanced Digital Skills

Source: LEADS Digital Skills Survey, April 2023

Barriers to sourcing talent and skills

While it has been well publicised and anecdotally confirmed that there has been significant competition for talent with leading advanced digital skills, primarily led through aggressive hiring within the tech sector and the wider proliferation of remote work which has increased salaries for tech talent. What has been surprising to note, however, is that although it remains a key concern, salaries are not the biggest barrier to onboarding new talent, it is predominantly the lack of relevant work experience and professional qualifications.
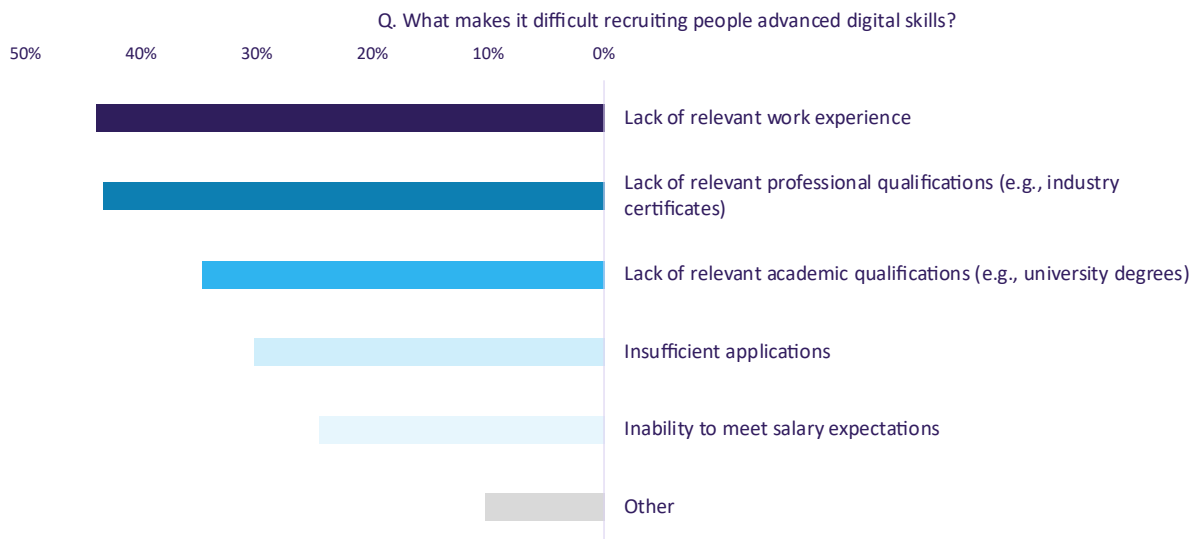
Figure 12. Principal challenges to hiring talent with necessary skills

Source: LEADS Digital Skills Survey, April 2023

The reasons given are consistent across the six technology areas with some variations, such as lack of academic qualifications being a larger factor for hiring in AI and salary expectations playing a larger role for Cyber skills, where the existing access to talent is more moderate.
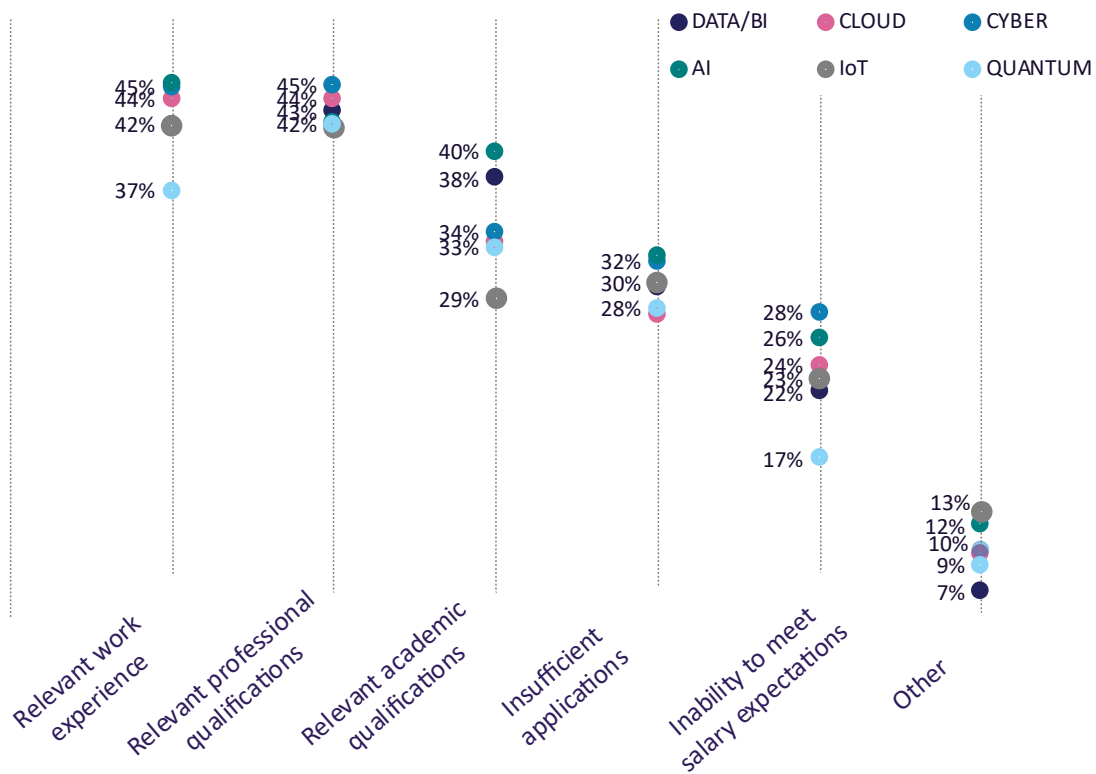
Figure 11: Challenges towards hiring talent with skills by tech area

Source: LEADS Digital Skills Survey, April 2023

Across the roles of ICT and HR, respondents agreed more closely on the challenges for Cyber while were more divergent when it came to AI and Quantum.
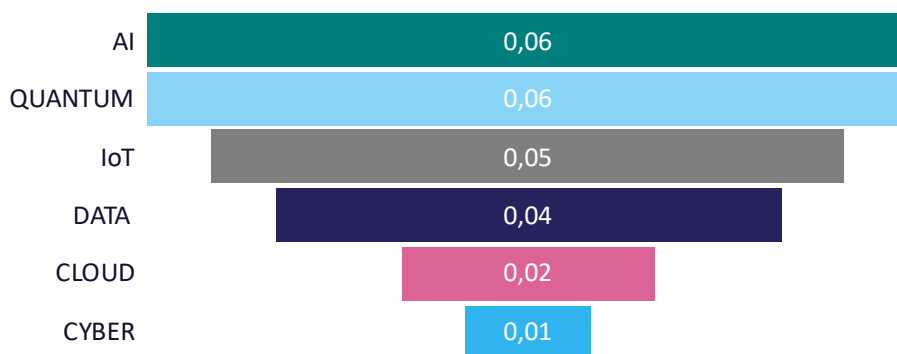
Figure 13. Standard deviation for between ICT and HR respondents on challenges for hiring within each tech area

4.2 Europe's SME's Feel the Digital Skills Challenge

The success of Europe's SMEs in embracing digital transformation will be highly important for the future competitiveness of Europe in the global market. From high-tech specialist medium organisations to more traditional organisations, SMEs must be playing a prominent and active role in the development and use of advanced digital technologies.

SMEs often view themselves as less digitally mature; results show that the smaller the organisation, the more the respondents feel they are lagging behind peers in digital maturity. Potentially generating a negative feedback loop in attracting advanced digital talent.

Digital Maturity of Organizations
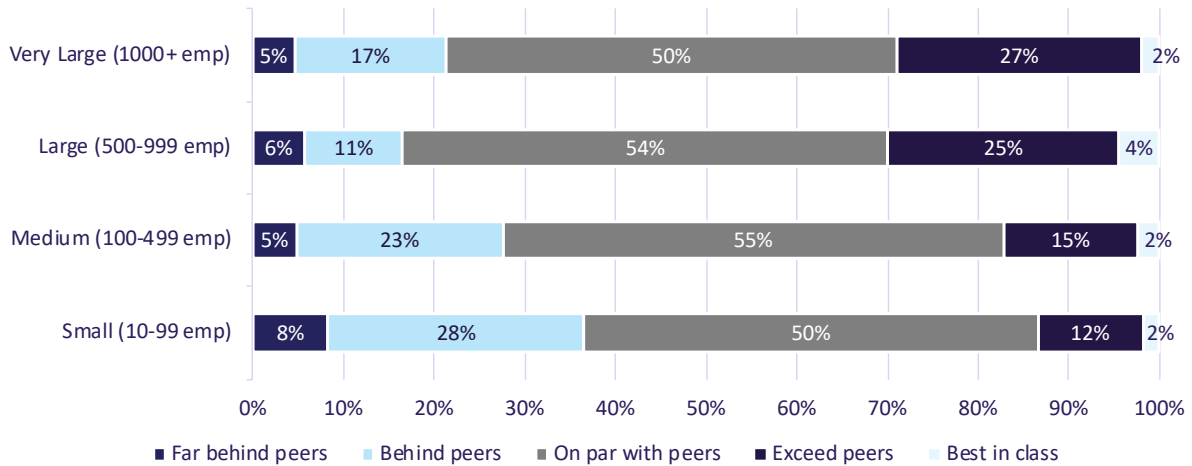
Figure 14. Digital Maturity by Company Size

Source: LEADS Digital Skills Survey, April 2023

Not only are SMEs feeling behind the digital transformation curve – they also are more unsure of the skills that they will need to execute on a digital strategy. Only 1 in 5. SMEs have defined their skills requirements compared to 1 in 3 for large organisations. In fact, close to 30% have either not identified the skills needed at all or have only done so to a little extent.

Extent in Which Organisations Have Identified the Skills Required for Success
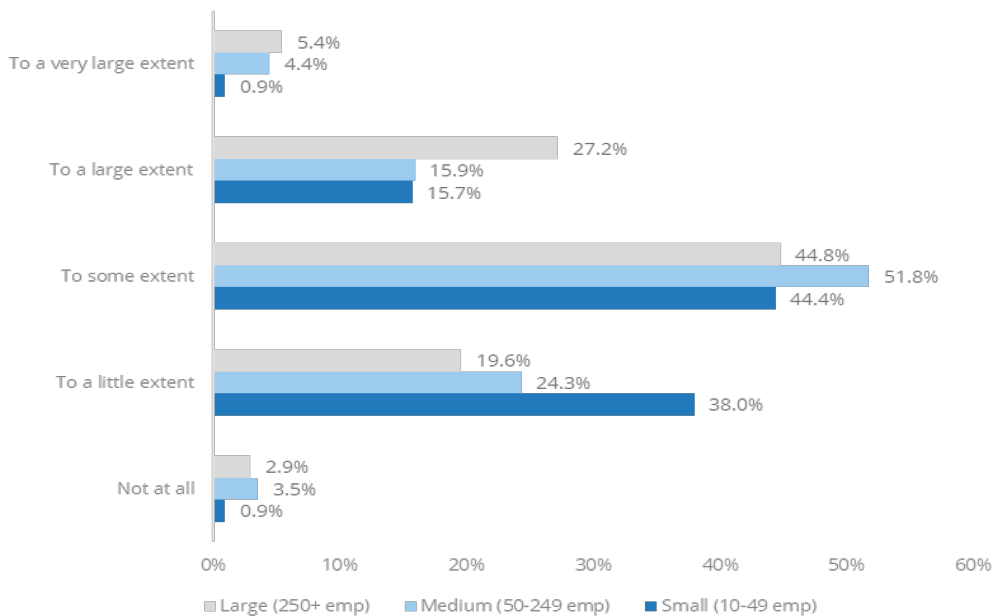
Figure 15. Skills Identification for Digital Strategy

Source: LEADS Digital Skills Survey, April 2023

These two findings indicate that Europe's SMEs are faced with some key challenges: they are not executing successfully on a digital strategy compared to peers in their industry and they do not have a clear view of which skills they will need to proceed. This is also reflected in the importance that they attach to the six advanced digital skills categories compared to large organisations as shown in the figure below. European SME's uncertainty on strategy and the skills needed are factors that spill over into their ability to hire staff with advanced digital skills over the next two years.

SMEs are expecting to find it more difficult to hire over the next two years than large organisations across most of the six skills categories, with the difference most notable in IoT and more comparable in Cloud, Cyber and AI. Of note, medium organisations are more likely to report difficulties compared to both large and small. This may be due to their demand being higher compared to smaller organisations and their capacity and reach lower compared to the larger finding themselves stuck in the middle.
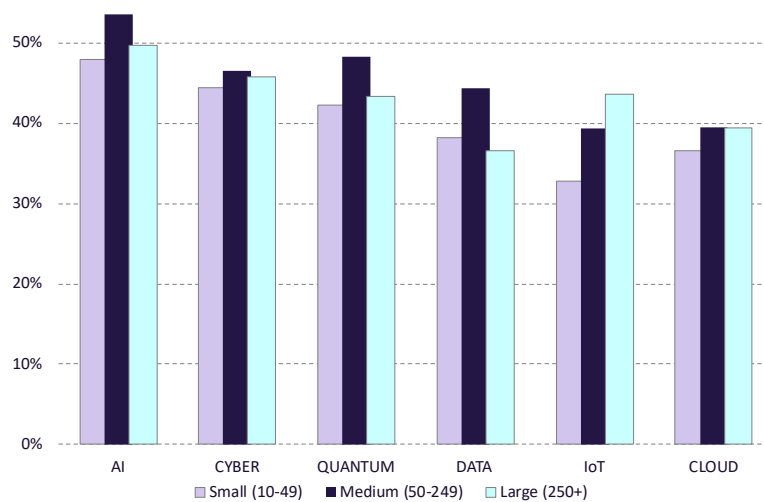
Figure 16. Comparison of the reported difficulties in hiring within each tech area by size of organisation

Reflecting on the strategies for sourcing advanced digital talent, it can be seen that there is a minimal distinction between medium and large organisations while small companies believe that automation will resolve their needs more than for the other categories.
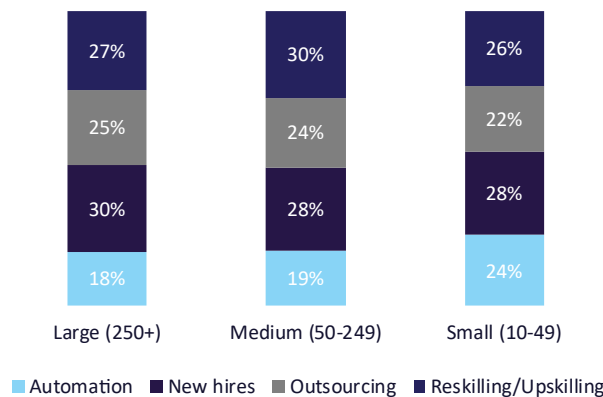
Figure 17.. Comparison of the average strategy for talent sourcing by size of organisation across all tech areas

5 AI: ADS FORECASTING RESULTS

5.1 Future demand with scenarios

Latest findings of the LEADS assessment and forecasting indicate that Artificial Intelligence (AI) is the area of highest demand growth of advanced skills within the framework, with AI application development and AI implementation (both generic and industry specific) skills expected to grow 4x over the next five years in our forecasted baseline scenario.

It is important to note that the growing demand for AI ADS skills may shape the future of different technology areas, such as IoT, cloud and cybersecurity. Below are a few examples:

- The emergence of edge nodes and edge processing driven by IoT devices and real-time decision-making necessitates AI experts who can optimise and deploy models on edge devices efficiently.
- Increased data flows and the federation of models create a critical need for cybersecurity experts to protect data privacy and AI models from attacks.
- Intelligent filtering is also crucial, requiring domain knowledge and skilled AI professionals to develop algorithms that process relevant information efficiently, enabling data-driven decision-making.

As the industry enters discovery mode with AI applications and starts to implement the use of AI models across the board, the baseline scenario already considers the current rate of technology adoption to be exceptionally high and still accelerating. In a higher growth scenario, demand for core advanced skills in AI will be further accelerated due to additional investments in the area, as well as policies to support the implementation of AI.

However, the uptick in the demand of advanced skills experienced by further growth than currently observed may be slowed down by the capacity of the industry to find enough technically capable talent to work in the area over the next five years. Therefore, the estimated high growth scenario is not much bigger than what is currently observed in baseline estimates.
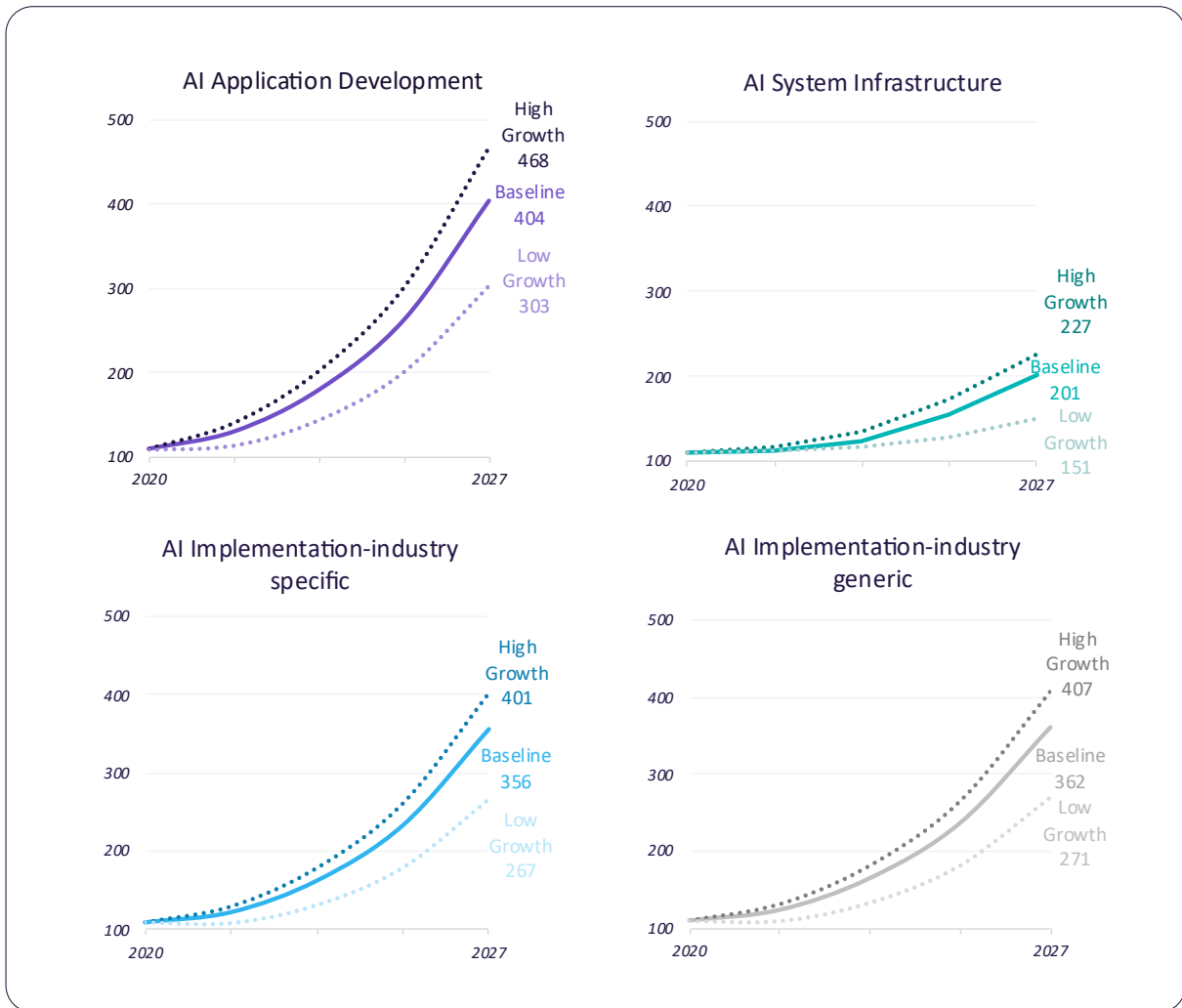
Figure 18. Projected Demand for AI Related Advanced Skills Pockets

Source: LEADS

Although the low growth scenario still shows an increase in demand for different AI advanced skills pockets, the growth is substantially slower when compared to LEADS baseline scenario. For AI, the lower demand scenario considers a more challenging macroeconomic environment and the fact that it will take a longer time for governments to draft regulations and ensure compliance of AI tools over the forecasting period.

Currently, there is a major push in Europe and across the world for the slowdown of AI adoption until a robust set of regulations come into place. In case such trends come to fruition, adoption of AI tools by the industry will have to slow down to adapt to new regulations, which will impact the demand of AI related advanced skills.

Projected demand for AI related advanced skills

AI System Infrastructure

| AI Server and Storage deployment | 147 / 223 / 196 / 105 |

AI Implementation - industry specific

Transportation - Asset/Fleet and Freight Management	352 / 529 / 470 / 100
Banking & Insurance - Claims and Fraud management	327 / 492 / 436 / 100
Healthcare - diagnosis and treatment	308 / 462 / 410 / 100
Manufacturing - intelligent operations	270 / 406 / 361 / 100
Retail - channel optimization	269 / 404 / 358 / 100

AI Implementation - industry generic

AI Sustainability	312 / 468 / 416 / 108
Digital assistants and twins	309 / 463 / 412 / 108
Customer service agents and chatbots	308 / 462 / 411 / 108
Adaptive Learning	272 / 408 / 363 / 108
AI enhanced security management	268 / 402 / 357 / 108
Intelligent logistics and supply management	241 / 361 / 321 / 108
Intelligent networks	222 / 333 / 296 / 108
Process Automation	217 / 326 / 290 / 108

AI Application Development

AI Development and deployment	323 / 500 / 431 / 110
AI Lifecycle management	313 / 483 / 417 / 110
Natural Language Processing	308 / 476 / 411 / 110
Total AI Application development	303 / 468 / 404 / 110
Image Processing	290 / 449 / 387 / 110
AI Ethics	289 / 446 / 385 / 110
AI Architecture	286 / 443 / 382 / 110
AI Regulation and Compliance	415 / 410 / 354 / 110
Deep learning algorithm and architecture	253 / 390 / 337 / 110
Intelligent knowledge processing	199 / 307 / 265 / 110

Legend: ■ 2027 - Low Growth   ▢ 2027 – High Growth   ■ 2027 - Baseline   ▢ Current demand

Figure 19. Projected Demand for AI Related Advanced Skills Details

Source: LEADS

On AI ADS skills details, Industry specific AI implementation competences such as Asset/Fleet and Freight Management, claims and fraud management and healthcare are expected to register the highest growth across industries in the high growth scenario, followed by AI Development and Deployment, AI lifecycle management, Natural Language processing, image processing and AI ethics. For some of the highest demanded skills, growth in demand means the area could see a 5x growth in certain competences which will translate into strong hiring pressure and upskilling/reskilling efforts going forward.

On the low growth scenario, several factors that may impact AI skills were considered, such as the slowdown in cloud adoption and 5G deployments, a worsening geopolitical scenario in Europe, higher cost of energy, sensors and chips which are crucial to collect vast amounts of data, and the emphasis on the regulatory aspect of AI that may slow down on the adoption of the technology.

Interestingly, while other advanced skills may see slower demand in growth in the more pessimistic scenario, the search for AI Regulation and Compliance skills is expected to grow the fastest as observed in the figure above. The push for AI regulatory skills may be not only driven by governments but also private organisations aiming to adapt AI systems to state and regional regulations to ensure compliance.

5.2 AI Specific Survey indicators

On AI Specific Survey Indicators, around 42% of all respondents said they had plans to hire staff with ADS AI skills over the next two years. The results of the survey served as further confirmation of the trends observed in the forecasting model, where there is a significantly higher expected demand for AI capabilities over the next few years. Furthermore, the survey indicates that over 45% of organisations already possess certain AI skills capabilities in-house. However, with the rapid expansion of AI tools and systems, the increase in penetration of AI skills is expected to happen across the board (Both at companies currently working with the technology and new users).
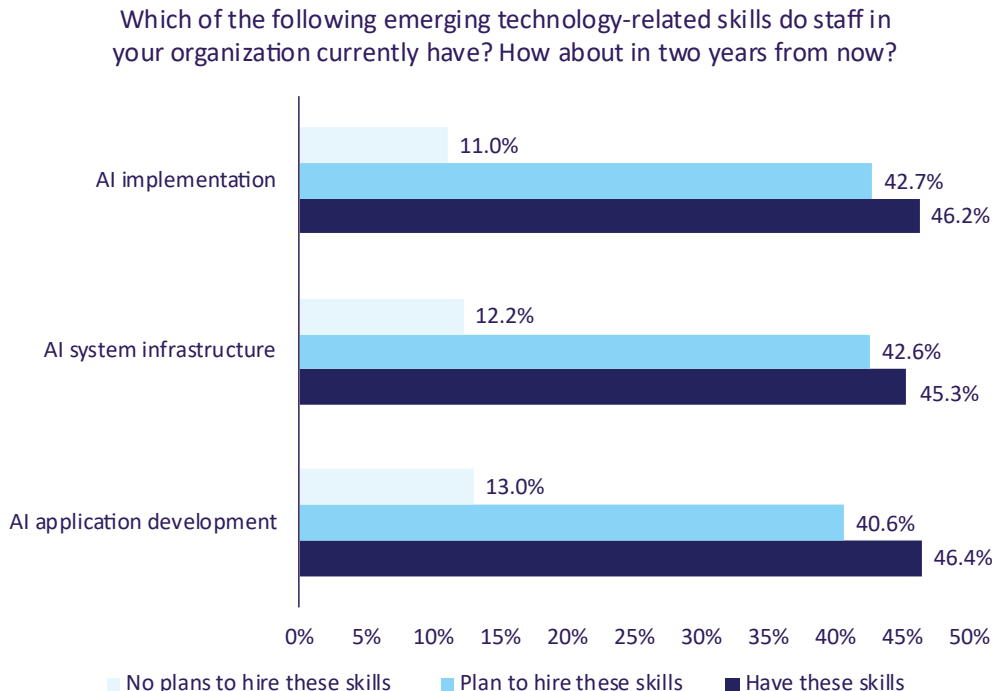
Figure 20. Current Advanced Skills Capacity and Future Intention of Hiring

Source: ADS Digital Skills Survey, April 2023

Focusing on hiring specific AI skills, respondents were asked to state to what degree they thought it would be easy or difficult to find the skills that they need. As can be seen from figure above, the hiring situation for different AI skills pockets continues to be a challenge for a large

number of European organisations – This seems to be the case across the board within AI Implementation, system infrastructure and application development skills.

Level of Difficulty in Hiring (AI)
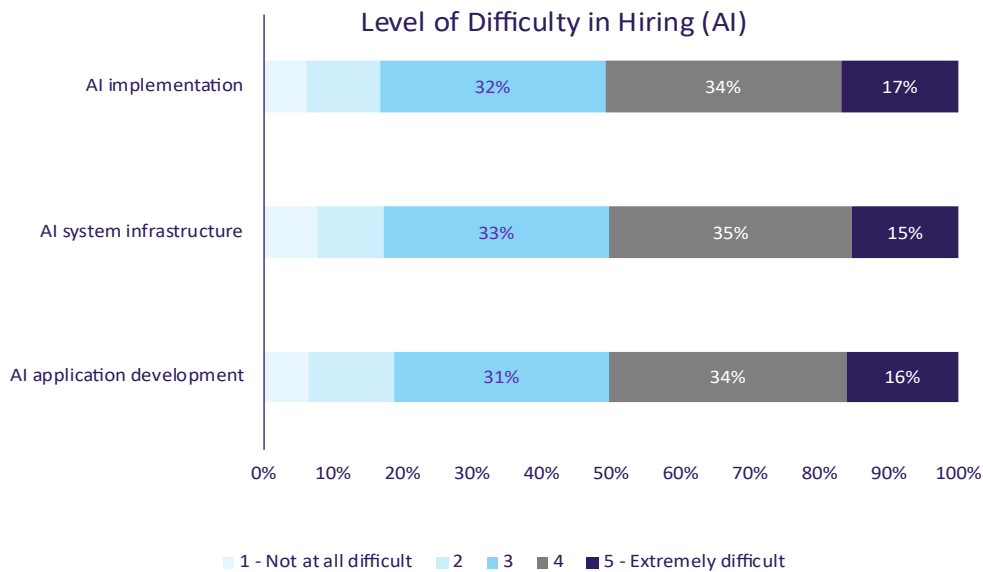
Figure 21. Level of Difficulty in Hiring AI Skills

Source: ADS Digital Skills Survey, April 2023

Focusing on hiring specific AI skills, respondents were asked to state to what degree they thought it would be easy or difficult to find the skills that they need. As can be seen from above, the hiring situation for different AI skills pockets continues to be a challenge for a large number of European organisations – This seems to be the case across the board within AI Implementation, system infrastructure and application development skills.

Why is it difficult to hire AI skills?

Figure 22. Why is it difficult to hire AI Skills

Source: ADS Digital Skills Survey, April 2023

In addition, the two biggest barriers to hiring staff with ADS AI skills in Europe are the lack of professional qualification and work experience, with academic qualifications taking only the third place in relevance. results reinforce the case that only academic skills are not enough for organisations to have a highly competent AI workforce in Europe and cannot expect that fresh out of university graduates will possess all the necessary requirements to work from day one.

5.3 Barriers and enablers for AI skills demand

The demand for AI skills is experiencing significant growth due to various factors, such as:

The widespread adoption of cloud computing has created a need for AI professionals who can develop and deploy AI models within cloud environments. Organisations rely on cloud infrastructure for storage and processing power, and AI experts are essential in optimising the performance and scalability of AI systems in the cloud.

The increasing concerns regarding cybersecurity may drive the demand for AI professionals with expertise in safeguarding sensitive data and protecting AI models from attacks. With the rise of AI technologies, organisations require cybersecurity experts who can implement robust Cyber measures, ensure secure communication, and address potential threats.

Energy-related factors may also influence the demand for AI skills. The focus on energy efficiency and sustainability has led to the development of AI-powered technologies for energy management and renewable energy systems. AI professionals with expertise in energy applications are needed to develop and implement these solutions, contributing to the overall demand for AI skills in the energy sector. Energy independence has sparked interest in energy independent sensors that can operate without external power sources. AI professionals are needed to develop AI-powered algorithms and systems that optimise the performance and energy efficiency of these sensors, contributing to the growing demand for AI skills in this domain.

Regulatory frameworks and acts also play a significant role in driving AI skills demand. The AI Act and other general legislation related to AI emphasise the importance of responsible and ethical AI practices. Organisations require AI professionals who can navigate the legal and regulatory complexities, ensuring compliance with ethical standards and promoting the responsible use of AI technologies.

The availability of cheaper sensors may increase the demand for AI skills. As sensor technology becomes more affordable and accessible, organisations can integrate sensors into AI systems to collect vast amounts of data. AI professionals are needed to process and derive valuable insights from this data, contributing to the growing demand for AI skills.

Generative AI, a subset of AI focused on content generation, has seen increased demand. AI professionals skilled in generative AI are sought after for applications such as content creation and design. Their expertise is essential in developing AI models that can generate realistic and creative outputs.

The integration of AI and automation has created a demand for AI professionals who can design and deploy AI-based automation systems. They play a crucial role in improving efficiency and productivity by integrating AI capabilities into automated processes.

The Cybersecurity Resilience Act, aimed at enhancing the resilience of critical infrastructure against cyber threats, may increase the demand for AI skills in the cybersecurity domain. AI professionals with expertise in cybersecurity and resilience are essential in developing and implementing robust AI-powered systems that can withstand cyber attacks and protect critical infrastructure.

Legacy systems and technological debt pose challenges for organisations seeking to adopt AI. AI professionals are needed to modernise and optimise these legacy systems by integrating AI capabilities. This enables organisations to leverage AI advancements without completely overhauling their existing infrastructure.

Regulatory acts, such as the Data Act, have influenced the demand for AI skills by emphasising the importance of data privacy and governance. Organisations require AI professionals who can ensure compliance with data regulations and implement robust data management practices.

The emergence of Data Spaces, which provide transparency and tracking of training sets, has contributed to the demand for AI skills. These spaces enable organisations to establish trust and transparency in AI models by tracking the training sets used. AI professionals are needed to leverage data spaces effectively and ensure the reliability and ethical use of AI solutions.

6 IOT & CLOUD: ADS FORECASTING RESULTS

6.1 Future demand with scenarios

The findings of the LEADS assessment and forecasting indicate that around 60% of European organisations already possess cloud skills internally, while 30% of them intend to hire new employees with cloud skills in the coming years. In respect to the IoT skills, around 50% of organisations currently have them internally, whereas the 37% of them intend to hire talent with this expertise in the coming years. In general, 39.2% of European organisations declared to face difficulties to find people with cloud skills, and the 41.7% of them to find people with IoT skills. Interestingly, IoT and cloud technologies skills appear to be among the less important in the successful implementation of the organisations' digital strategy.

Specifically, concerning IoT, it seems that IoT analytics skills are expected to grow 3 times over the next five years in our forecasted baseline scenario, whereas in the area of cloud-related advanced digital skills, cloud-solutions – infrastructure is expected to grow around 3 times over the next five years.

Figure 23. Projected Demand for IOT Related Advanced Skills Pockets

Indicative driving factors for the expansion of IoT that will increase the need for related skills include – but are not limited to – the proliferation of smart cities / homes / buildings and blockchain technologies, the exploitation of data gathered (IoT transforms to a "data generator") by big data analytics and advanced data processing technologies, as well as the continuous expansion of connected IoT devices. All these are supported mainly by three key technologies; Wi-Fi, Bluetooth and Cellular IoT.

In parallel, cloud technologies – that faced a serious adoption rate due to the pandemic – face similar demand rates, with their needs shifting from Cyber to their usage management; Cloud solution – infrastructure related skills (e.g. cloud storage and data centre development, as well as cloud specific network management) are expected to face significant demand the coming years, mainly due to the need to achieve cost saving, operational efficiency and greater Cyber, supporting in parallel the digital transformation of companies.
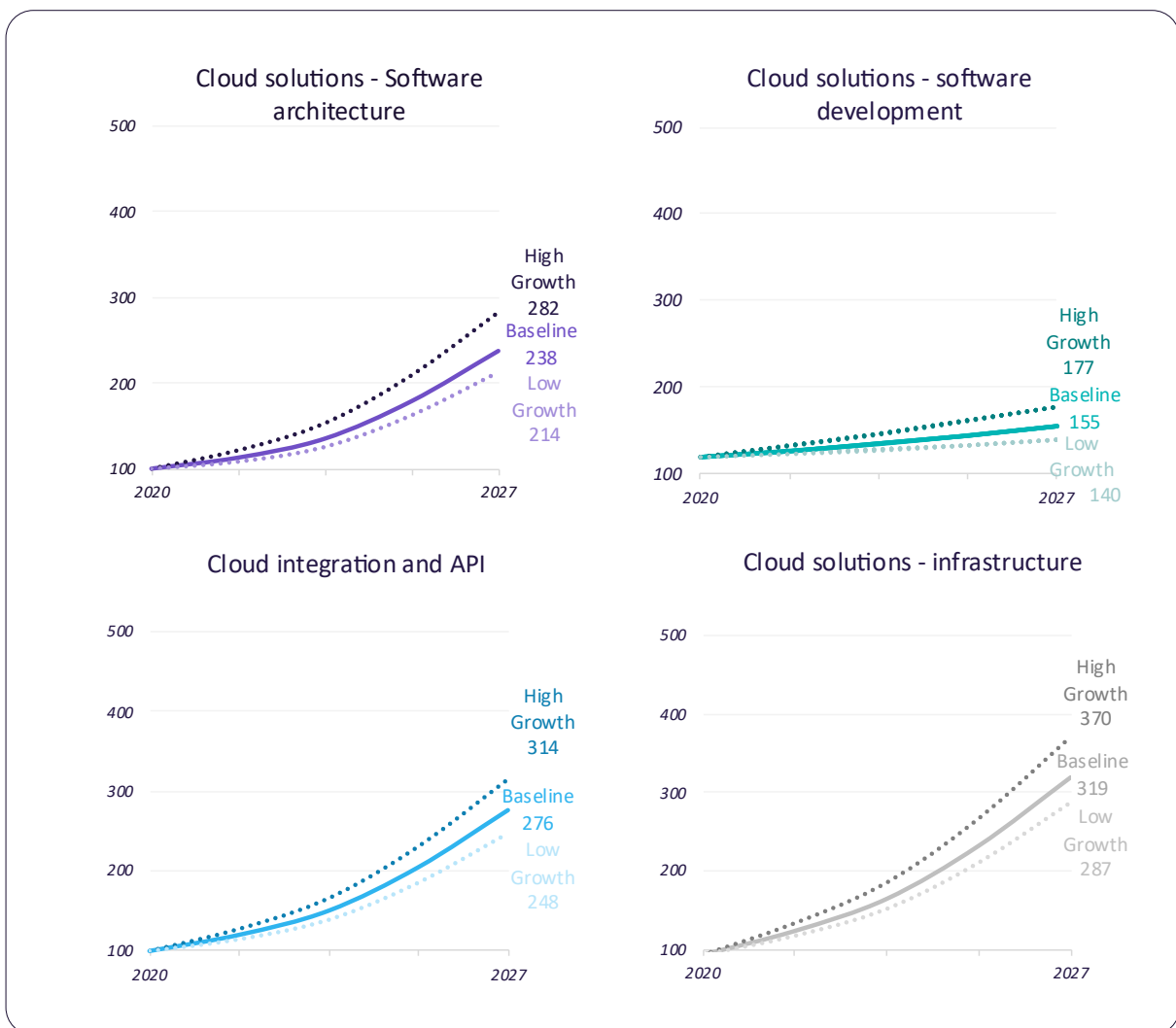
Figure 24. Projected Demand for cloud Related Advanced Skills Pockets

Source: LEADS

For both technologies it seems that all analysed scenarios will register significant growth mostly in data related usage (for IoT) and in all apart software development in the cloud area, declaring its maturity in this direction. Nevertheless, these growth rates may be affected by the lack of personnel expertise (especially technical skills, data analysis, Cyber, integration, etc.), justifying partially the low gaps between the different scenarios projected. In the cloud technologies area, the lack of expertise (skills) that may affect proliferation is identified mainly to the infrastructure (architecture, design, Cyber, development and deployment, governance and optimization).
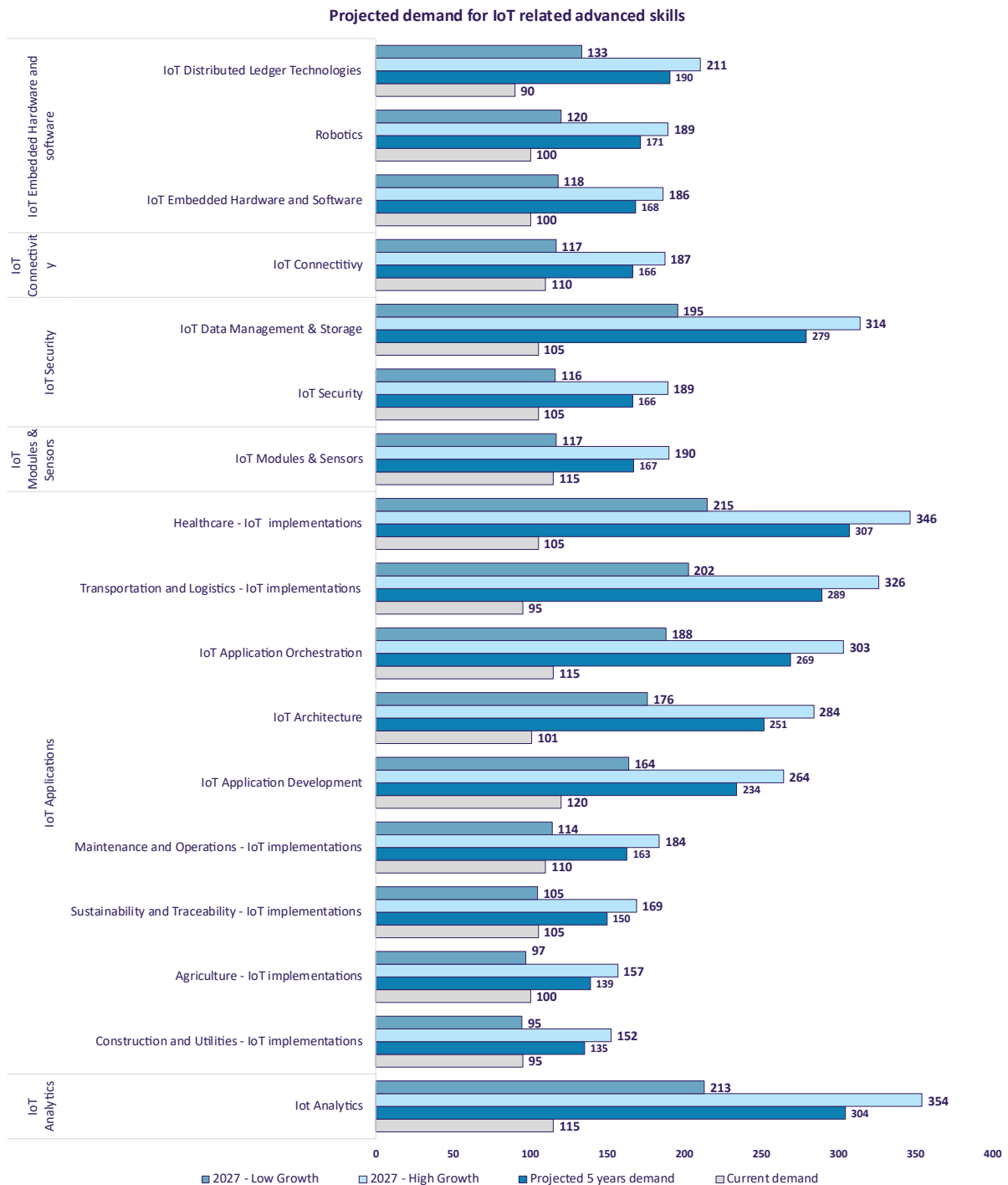
Figure 25. Projected Demand for IoT Related Advanced Skills Details

Source: ADS Digital Skills Survey, April 2023

The low growth scenario presents an expansion in the different IoT skills pockets (and almost double for the respective clout related advanced digital skills), which is around 30% lower than the baseline scenario in IoT and 10% in the cloud technologies. In the case of IoT, these differences are mainly explained by challenges unfolding in areas of security, privacy, interoperability, integration, skilled workforce, regulatory and compliance, whereas in the case of cloud technologies, they unfold from security and privacy, compliance and regulations, bandwidth and connectivity, limited personnel skills and costs.

Considering the different IoT ADS skills, IoT analytics are expected to face the highest growth across the market in the high growth scenario, followed by IoT applications. Some of the highest demand skills are expected to face even a 3X growth which will lead to increased expertise demand that will lead new hires and reskilling / upskilling. On the opposite side, i.e. the lowest growth scenario, these skills will face a 2X growth factor.
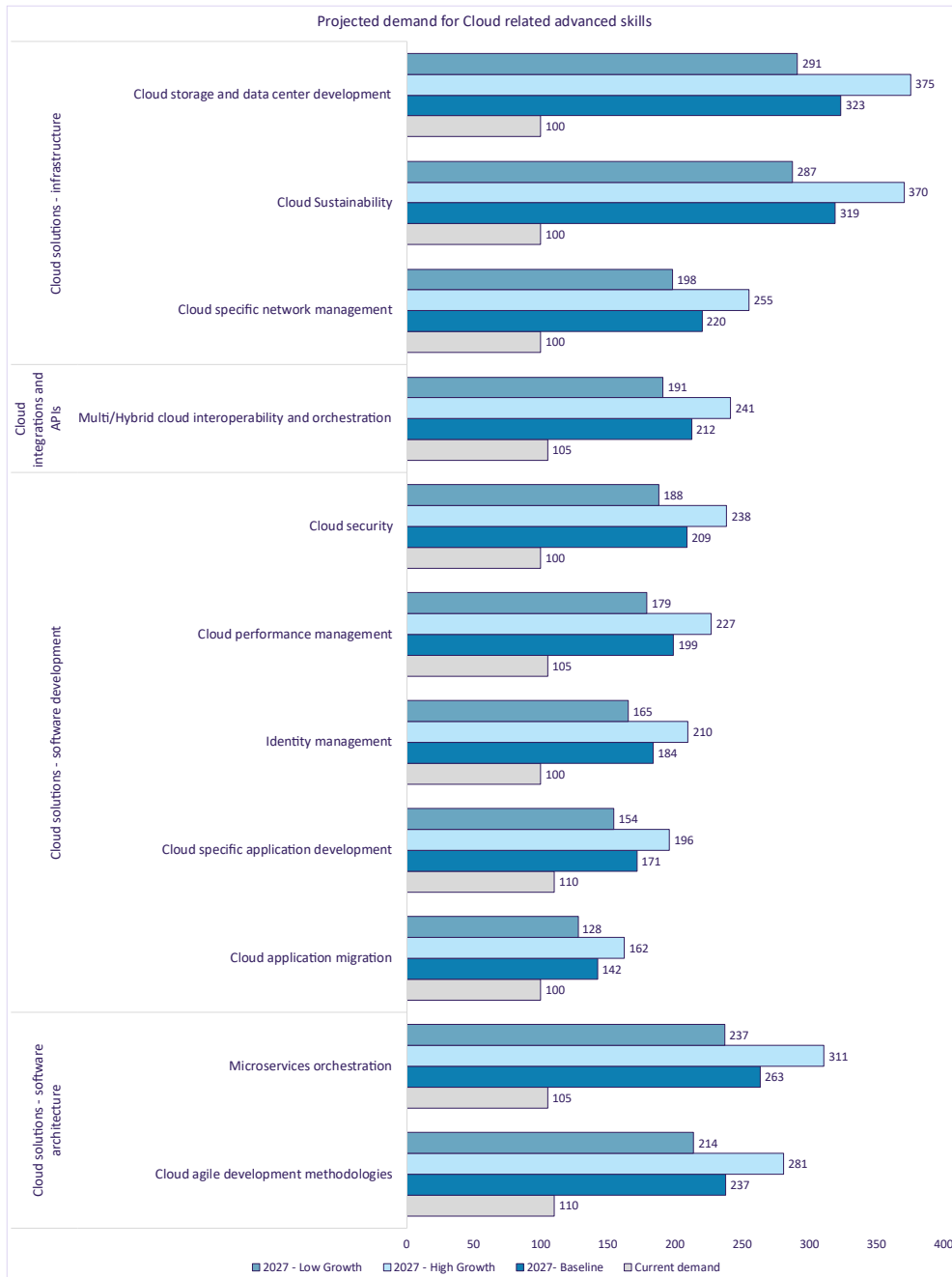
Figure 26. Projected Demand for Cloud Related Advanced Skills Details

Source: ADS Digital Skills Survey, April 2023

Considering the different cloud technologies' ADS skills, cloud solutions - infrastructures are expected to face the highest growth across the market in the high growth scenario, followed by cloud solutions – software architecture. Again, some of the highest demand skills are expected to face even a 3X growth which will lead to increased expertise demand that will lead new hires and reskilling / upskilling. On the opposite side, i.e. the lowest growth scenario, these skills will face a 2X growth factor.

6.2 IoT and Cloud Specific Survey indicators (SDU)

Which of the following emerging technology-related skills do staff in your organization currently have? How about in two years from now?
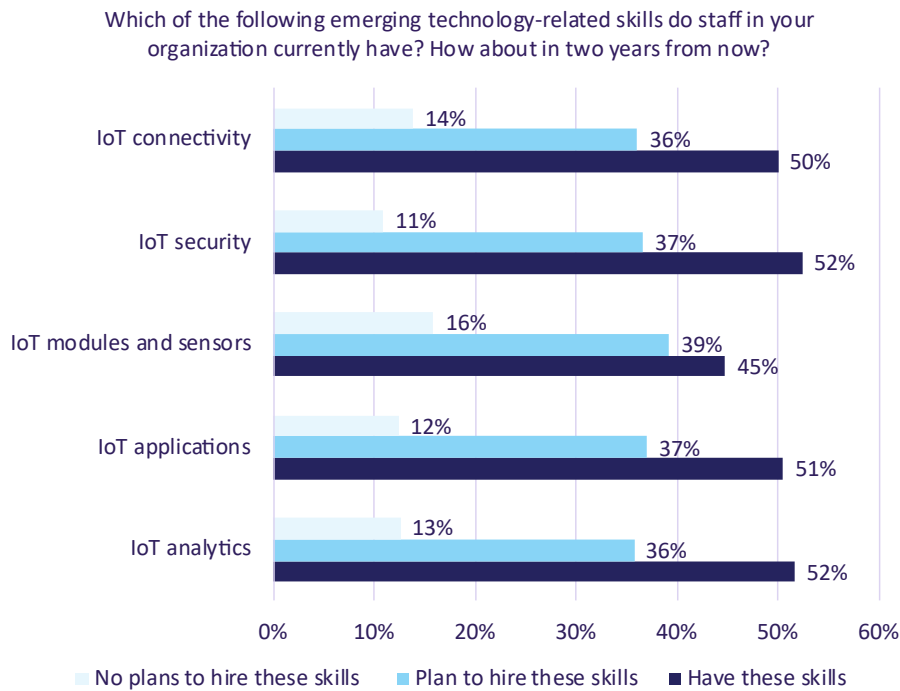
Figure 27. Current Advanced Skills Capacity and Future Intention of Hiring (IOT)

Source: ADS Digital Skills Survey, April 2023

On IoT specific survey indications, intention to hire such skills has been presented by over 36% of respondents in several of the related skills pockets, with only 10-15% of companies stating no intentions to hire/acquire IoT skills. Hiring pressure seems to be slightly stronger for talent with IoT modules and sensors and IoT applications skills. However, intention to hire seems to be happening across the board.

Which of the following technology or data-related skills do staff in your organization currently have? How about in two years from now?
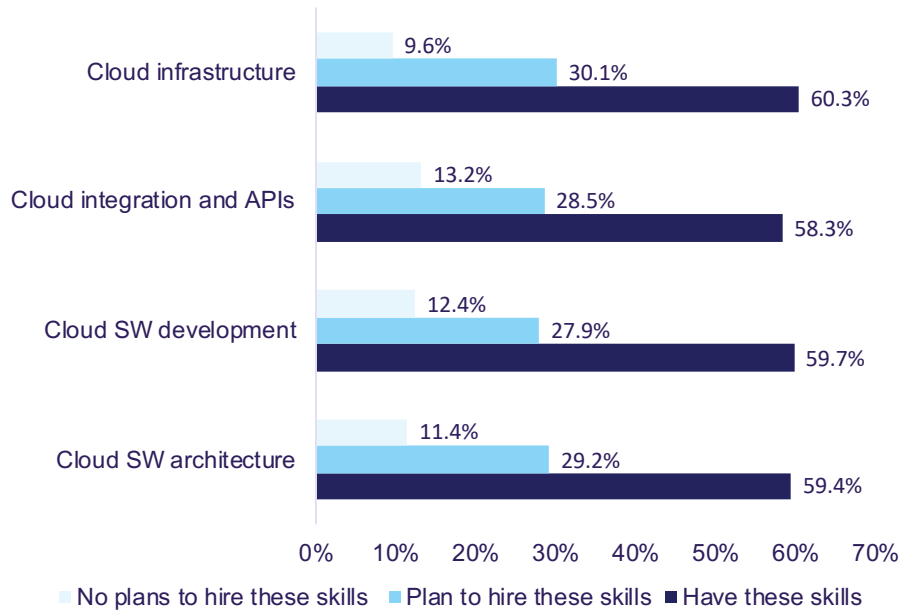
Figure 28. Current Advanced Skills Capacity and Future Intention of Hiring (Cloud)

Source: ADS Digital Skills Survey, April 2023

For cloud, most companies (around 60%) indicated to already possess such capabilities in house, with around 30% of respondents planning to hire cloud skills over the next two years in case they already do not have it within their companies. Compared to other technology skills, cloud seems to be the most popular and widespread set of competences, which corroborates the fact that the technology is already widely adopted currently.

Level of Difficulty in Hiring (Cloud)
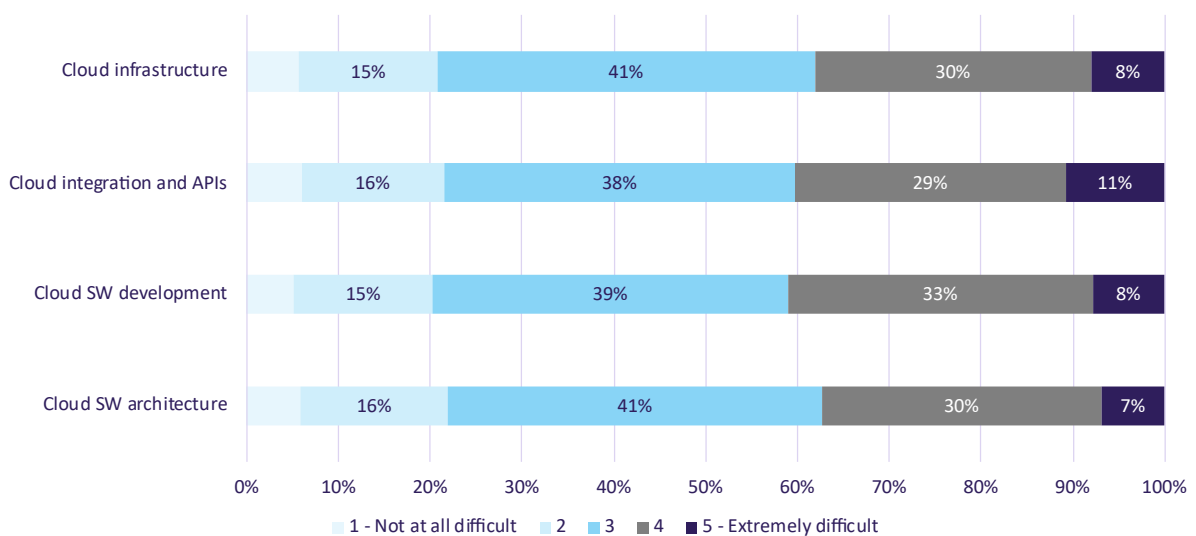
Figure 29. Difficulty to hire staff with a certain skills (Cloud)

Source: ADS Digital Skills Survey, April 2023

Despite the higher installed capacity for cloud skills across organisations, most respondents still think that recruiting staff with ADS cloud skills is not easy. Around 40% of respondents judge to be either difficult or extremely difficult to find suitable candidates with cloud skills in different areas, with a highlight for specialisations in Cloud Integrations and API and cloud-centric software development.
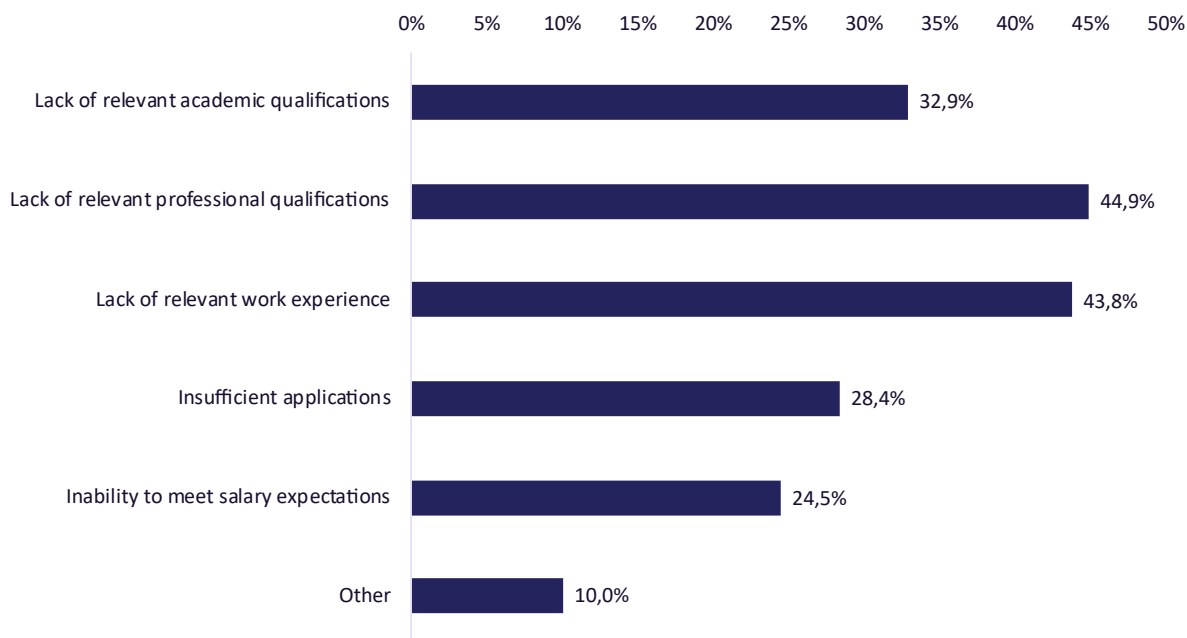
Figure 30. Challenges in hiring cloud talent

Source: ADS Digital Skills Survey, April 2023

6.3 Barriers and enablers for IoT & Cloud skills demand

The advent of the Internet of Things (IoT) and cloud computing has revolutionised the way businesses operate and interact with their environment. The combination of these technologies has led to numerous benefits, including increased efficiency, scalability, and cost-effectiveness. However, the widespread adoption of IoT and cloud technology also poses certain barriers and enablers that influence the demand for skills in these domains.

Widespread Adoption of Cloud Technology:
The widespread adoption of cloud technology has significantly contributed to the demand for IoT and cloud skills. Cloud computing provides the necessary infrastructure and platforms for storing, processing, and analysing massive amounts of data generated by IoT devices. The scalability and flexibility offered by cloud platforms have made it easier for businesses to deploy and manage IoT solutions.

As a result, organisations across various sectors, including manufacturing, healthcare, and transportation, have embraced cloud technology to unlock the full potential of their IoT initiatives. This has created a growing demand for professionals skilled in cloud technologies, development, architecture, and infrastructure, in addition to cybersecurity.

- **(Enabler) Cost-Effectiveness and Scalability:**
  Cloud technology has become increasingly affordable, with cloud service providers

offering cost-effective pricing models such as pay-as-you-go or subscription-based plans. This accessibility has empowered organisations of all sizes to leverage cloud infrastructure and services, fuelling the demand for cloud skills. Additionally, the scalability of cloud platforms enables businesses to expand their IoT deployments without significant upfront investments in infrastructure. This scalability aspect has made it easier for organisations to experiment with IoT solutions, leading to a higher demand for professionals with expertise in managing cloud-based IoT deployments.

- **(Barrier) Security and Privacy Concerns:**
  While the widespread adoption of cloud technology has accelerated IoT growth, it has also raised concerns about data security and privacy. Storing sensitive IoT data in the cloud requires robust Cyber measures to safeguard against unauthorised access and data breaches. Organisations need skilled professionals who understand cloud Cyber best practices, encryption techniques, and data privacy regulations to address these concerns effectively. The evolving threat landscape and the need for constant Cyber updates make it essential for businesses to have access to skilled cloud Cyber professionals, which can be a barrier due to the shortage of talent in this specialised field.

- **Decreased price for sensors and processing power:**
  The decreasing price of sensors and processing power has been a significant enabler for IoT adoption. In the early stages of IoT, sensors and processors were relatively expensive, limiting their widespread use. However, advancements in technology and economies of scale have significantly reduced this cost. This reduction in price has made it feasible for organisations to deploy large-scale IoT networks and collect data from a vast array of sensors. The affordability has resulted in increased demand for professionals skilled in IoT development, applications, Cyber, and analytics.

- **(Enabler) Increased Accessibility:**
  The cheaper price of sensors and processors has made IoT technology more accessible to a broader range of industries and organisations. Small and medium-sized enterprises, which previously faced budget constraints, can now adopt IoT solutions to optimise their operations, improve decision-making, and enhance customer experiences. This accessibility has fuelled the demand for professionals capable of developing IoT applications, managing sensor networks, and extracting valuable insights from sensor data.

- **(Barrier) Interoperability and Integration Challenges:**
  While the cheaper price of sensors and processors has opened up new possibilities for IoT deployments, it has also introduced challenges related to interoperability and integration. With a wide variety of sensors available in the market, ensuring compatibility and seamless integration between different sensor types and communication protocols can be complex. Organisations require skilled professionals who can navigate these challenges, ensuring smooth interoperability and integration across various IoT devices and platforms. Overcoming these barriers will be crucial in meeting the growing demand for IoT specialists who possess the skills to address interoperability and integration complexities effectively.

In conclusion, the widespread adoption of cloud technology and the decreasing price of sensors have played pivotal roles in shaping the demand for IoT and cloud skills. The affordability and scalability of cloud platforms have empowered organisations to embrace IoT initiatives, leading to a growing need for cloud and IoT professionals. Simultaneously, the decreased cost of sensors and processing power has made IoT technology more accessible, driving the demand for professionals skilled in integrating and analysing sensor data.

However, survey results show that organisations expect severe difficulties in recruiting the relevant professionals needed to overcome these barriers. Difficulties which in large part stem from the condition of the current workforce, lacking relevant academic and professional qualifications and experience.

These issues therefore need to be addressed for organisations to continue to drive innovation and maximise the benefits offered by IoT and cloud computing.

6.4 Cloud-Edge-IoT convergence

The convergence of Cloud and IoT within a computing continuum is a result of advancements in enabling technologies, such as the development of more intelligent and capable devices and federated AI architectures, as well as intelligent and programmable networks. To this end LEADS and EU Cloud-Edge-IoT initiative (through UNLOCK-CEI project) jointly worked to investigate the link between CEI use-cases and the required digital skills for the exploitation of those use- cases[14].

The rationale behind the intra-CSA collaboration was that the quantitative analysis (described in the methodological section of the present report) that involved market use-case trackers, stakeholders' consultation via surveys, and intervening factors definition and operation did not account for the convergence we are going through. For example, the integration of IoT and AI in specific sectors such as manufacturing or utilities is driving significant spending in Edge Computing (worldwide spending on edge computing is expected to be \$208 billion in 2023, an increase of 13.1% over 2022[15]). For this reason, it was necessary to explore what does this shift in paradigm from the defined IoT and Cloud environments towards the Computing Continuum and the emergence of edge computing within this, mean for future skills and talent.

For that purpose the presented a unique opportunity as it allowed for the leaders of 5 novel technologies use case applications to reflect on both which are the current tech profiles needed for use-cases deployment (and therefore which are the skills pockets that are needed) as well as which are the future profiles that are going to be needed not only for the operationalisation of successful case studies but all along the commercial and adoption chain (from manufacturers, to third parties such as network suppliers of government officials).

Main conclusions on what kind of Profiles moving to Edge demands presently and in the future:

- Edge computing demands a hybrid approach, incorporating both existing and novel skills. Yet specific requirements might vary depending on the sector and use case in question. Existing skills can indeed be leveraged for edge computing, provided they are accompanied by the integration of domain-specific knowledge.
  - An example of this would be the amalgamating Cloud DevOps and Embedded engineering skills. According to the expert's views, professionals well-versed in cloud technologies, such as Kubernetes (K8s), along with a profound understanding of

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[14] A joint outcome paper on this topic is under production at the time of this Deliverable's publication.

[15] IDC Worldwide Edge Spending Guide (2022)

Funded by Horizon Europe
Framework Programme of the European Union

embedded systems, possess formidable skill sets to effectively navigate the intricacies of edge computing tasks.

- Expertise in IoT deployment and the critical aspect of securing edge devices among other pertinent domains constitutes a new skills requirement specific to edge computing. With edge computing involving the deployment of numerous IoT devices, the ability to adeptly manage and safeguard these devices increases significantly increasing the need for Cybersecurity skills within the profiles.

On current and future demand for satisfaction and profile matching

- Validating consensus was given on the current demand and supply mismatch (presented in the previous version of this deliverable) and the ever-growing challenges associated with acquiring specialised skills for domain-specific applications.
- Specialised professionals are often more inclined towards production roles in the industry rather than engaging in research activities. This increases the difficulty of finding the needed professionals for tech development.
- Lack of standardisation impairs professional formation and profile matching. The absence of standardised frameworks and practices for edge computing can make it more difficult to find professionals who are well-versed in the specific infrastructure requirements of edge computing environments.
- There is a shortage of practical experiences with cutting-edge technologies at the university level, further highlighting the need for third level institutions to address the gap in providing hands-on training and exposure to emerging technologies[16].

In other words, the joint collaboration efforts contributed not only to validate LEAD's finding in terms of current and future demands of technologies but contributed to identify relevant intervening factors (such as standardisation requirements for effective skilling) that need to be taken into account when addressing Cloud-Edge-IoT as an evolving continuum.

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[16] Validating LEADS stakeholder's survey results that indicate lack of relevant work experience as the main constraints for ADS profiles matching.

7 DATA/BI: ADS FORECASTING RESULTS

7.1 Key contexts for demand and challenges

Preliminary findings of the forecasting conducted in the LEADS project indicates that those skills highly related to Artificial Intelligence and Data Analysis will experience a high growth. In contrast, the demand for other skills related to data management such as data governance or data curation will only slightly grow. There are several factors we must analyse that underlies the different growth of AI vs Data/BI and the requirement for more talent.

- **Sector Addressed:**

Those sectors with a long history of digitalization will be more focused on data governance explaining the growth of demand in the next few years. However, sectors that are new to digitalization will be the ones behind the high demand on AI enhanced data analysis. This can explain the low growth expected, even in the best scenario of business-related data management and data management.

- **Saturation and democratisation:**

Business Intelligence has been around for a long time and already many organisations have already established data systems and teams. While there will always be a need for data professionals the growth will not be significant. Besides data tools are now becoming more user-friendly, enabling business users to perform self-service analytics without relying heavily on dedicated Data teams.

- **Evolution and Market Dynamics:**

The data analysis field is constantly evolving, factors such as regulatory changes, industry trends, or technological advancements can impact the demand for skills. Besides, data implementation technologies are rapidly evolving. Hiring additional professionals allows organisations to stay ahead of the curve and adapt to changing market dynamics. Professionals with expertise in emerging technologies (big data platforms, data lakes, and data streaming frameworks), can contribute to driving innovation in data implementation processes. This may include data automation which will allow companies to handle data more seamlessly by reaching a higher level of accuracy, lower time, and a reduced headcount. Consequently, data management skills will not experience a high growth.

- **Data Security and Compliance:**

Data breaches and privacy concerns continue to be major challenges for organisations that may drive the need for additional professionals in data implementation who can address these critical aspects.

- **Cloud Migration and Digital Transformation:**

Hiring professionals with experience in cloud-based data integration, migration, and management can help organisations effectively transition their data to the cloud and optimize their data implementation processes.

- **Scalability and Increased Data Volume and Complexity**

With the exponential growth of data, organisations are faced with vast amounts of information that need to be processed and analysed. Enhanced data analysis skills are essential to extract meaningful insights and patterns from large and complex datasets and consequently this is behind the expected high growth in this demand. Besides, businesses today are increasingly relying on data-driven decision-making processes. They need professionals who can perform sophisticated analysis techniques to uncover actionable insights that drive strategic initiatives, optimise processes, and improve overall business performance.

- **Team diversity and specialised Roles and Expertise:**

Different roles such as data architects, data stewards, data governance managers, and data quality analysts require specific skills and expertise. While organisations may have skilled professionals in certain areas, they may still need to hire for other specialised roles to address specific data management challenges or initiatives. Building a diverse team can bring different perspectives and skills to the table helping organisations to foster a collaborative environment, promote knowledge sharing, and leverage a broader range of expertise in data management practices.

7.2 Future demand with scenarios

Business Intelligence has been focused from the beginning on descriptive and diagnostic analytics, providing historical and retrospective views of data. Today organisations are searching for predictive and prescriptive analytics to gain a competitive edge by leveraging data for forecasting, optimization, and strategic planning. This is behind the difference in growth of traditional Data in comparison with AI analysis.

On the other hand, while data curation skills are still important for maintaining data quality and integrity, the growth rate may not be as high as it has been previously mentioned due mainly to automation of tasks related such as data cleaning, transformation, and integration, which reduces the need of manual help.

It is also important to mention that Data governance and data engineering roles are often responsible for managing data pipelines, ensuring data quality, which overlaps data curation tasks. Consequently, the demand for dedicated data curation specialists may be relatively lower.

Figure 31. Market scenarios for Data skills

Source: ADS Digital Skills Survey, April 2023

If we go for a deeper analysis into skills pockets, we can observe that process specific skilled professionals such as production planning and CRM professionals continue to be valuable assets for organisations in optimising production processes, supply chain management, and enhancing customer relationships. However, they are associated with a more traditional decision-making approach that relies on established methods and practices rather than the data driven approach that is fuelling the demand of AI analysis professionals. Besides, while process specific tasks require data analysis and domain knowledge, they may not demand the same level of technical complexity and specialisation as advanced AI analysis. This difference in complexity leads to a higher demand for AI skills. This is also highly related to the level of maturity and adoption. CRM, process planning, and other process specific tasks have been around for a longer time and are more established within organisations than AI emerging cutting-edge technologies.
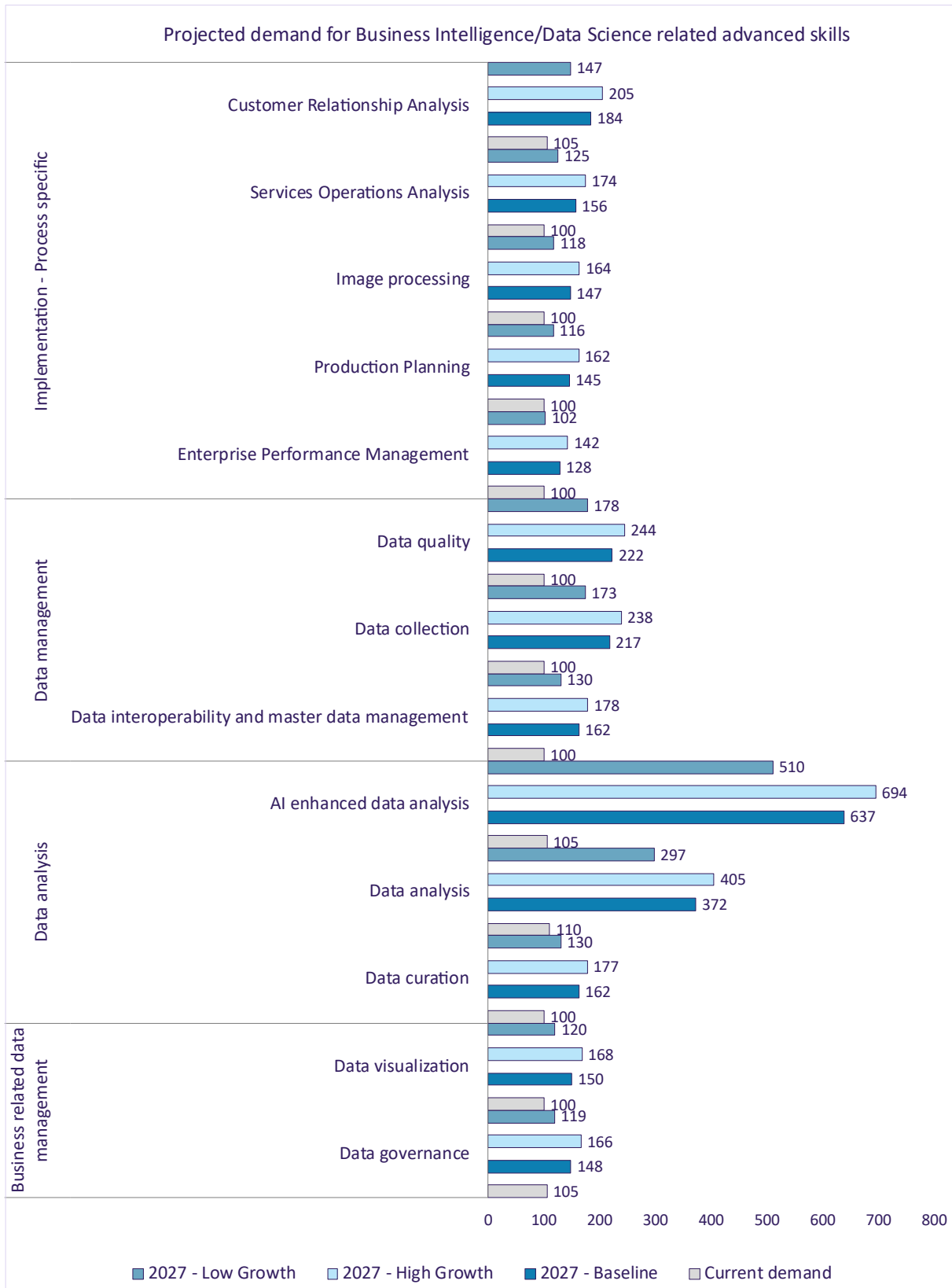
Figure 32. Market scenarios for Data skills by skills pockets

Source: ADS Digital Skills Survey, April 2023

To end with, the demand for production planning and CRM skills may be more specific to industries heavily rely on manufacturing or customer-centric operations while the demand for

AI skills is prevalent across various industries, including healthcare, finance, retail, and transportation. This can also explain the difference on demand.

The demand for image processing skills is expected to experience notable growth. However, it's important to note that the growth rate may vary across industries and applications. Augmented Reality (AR) and Virtual Reality (VR) technologies leverage image processing. These technologies have applications in gaming, education, training, to name a few but still the adoption is not immediate. As AR and VR gain wider adoption the demand for professionals with image processing skills is expected to grow.

Certain industries, such as healthcare and automation, may have a particularly high demand for image processing expertise, while other industries may have a relatively slower growth rate. The adoption of deep learning models for image processing has in some sense lowered the demand of experts in the field. However, while deep learning has automated and optimized many image processing tasks, the involvement of skilled image processing professionals remains critical for data pre-processing, model selection, annotation, evaluation, and domain-specific knowledge. Their expertise ensures the accuracy, reliability, and contextual understanding necessary for effective image processing applications. The healthcare industry, robotics, and computer vision will also increase the demand of people with skills on image processing. However, some of these applications will be deferred due to regulatory issues.

While the demand for data quality skills may not grow as quickly as data analysis skills, it is important to note that data quality remains a critical aspect of successful data analysis. organisations recognize the importance of reliable and accurate data for making informed decisions, and data quality professionals play a vital role in ensuring the integrity of the data used for analysis.

The relatively slower growth in demand for data quality skills compared to data analysis skills can be attributed to several factors being the most important ones the maturity of the sector together with the automation and advances in technology:

- Exponential growth of data but awareness and maturity of the field. Data analysis has gained more attention and recognition in recent years, leading to increased investment in data analysis skills and resources. Data quality, on the other hand, has been a long-standing concern for organisations, and they have already made significant efforts to establish data quality frameworks and processes, data quality measures are often established and implemented upfront, and organisations aim to ensure high-quality data from the beginning of the data lifecycle.
- Automation tools and technologies are being developed to address data quality challenges. These tools can automatically identify and resolve common data quality issues, reducing the manual effort required for data quality management. As automation advances, the demand for manual data quality tasks may not grow as rapidly.
- To end with it is also important to see that there is some overlap between data analysis and data quality skills. Professionals with strong data analysis skills are often expected to possess some level of data quality knowledge and experience what reduces the need for dedicated data quality professionals

While the growth in demand for skilled professionals in data interoperability may not be as high as other areas, the importance of data interoperability remains crucial for organisations aiming to achieve integrated and holistic data management. As data ecosystems continue to evolve and organisations recognize the value of interconnected data, there may be an increased need for professionals with data interoperability skills however, maybe this will come only after certain facts happen. To start with, the lack of standardized data formats, protocols, and schemas across industries and organisations can hinder the widespread adoption of data interoperability practices. Without consistent standards, the demand for skilled professionals in data interoperability may be limited. Many organisations still operate in siloed data environments; this fragmentation makes it challenging to establish seamless data interoperability. Only once siloes are removed may the field experience substantial growth. To end with as automation lowers the need of some experts in the case of interoperability it happens that as organisations adopt more advanced technologies (cloud computing) the need for specialised skills in data interoperability may be reduced, as these technologies provide more out-of-the-box interoperability capabilities.

The growth in demand for skilled professionals in data visualisation remains important although not as high as the one in data analysis as a consequence of the development of latest. Once organisations recognize the value of data-driven decision making, the need for effective data visualisation becomes essential. Skilled professionals who can create compelling and insightful visual representations of data are sought after to communicate data-driven insights effectively.

This comes as a consequence of the rise in Big Data and Analytics: Skilled professionals who can transform raw data into visually appealing and informative visualisations are in demand to help organisations make sense of their data as data visualisation goes beyond presenting numbers and charts it is about making knowledge more accessible helping to bridge the gap between data scientist and decision-makers.

As data continues to play a significant role in businesses, the demand for professionals who can transform data into visually compelling and meaningful representations will continue to be relevant.

Going deeper into business related skills, there are several elements that will affect the growth in particular, regulatory compliance will affect the rhythm to deploy solutions with special emphasis on those highly affected such as healthcare or finance. Governments and regulatory bodies worldwide are implementing stricter regulations around data privacy, Cyber, and compliance. As regulatory requirements evolve, the demand for data governance professionals will increase. Data breaches and Cyber incidents pose significant risks to organisations. Effective data governance helps mitigate these risks thus, as organisations become more conscious of data risks and the importance of safeguarding sensitive information, the need for data governance expertise will grow.

7.3 BI/Data Science Specific Survey indicators

As we have been analysing organisations with respect to Data skills, these organisations are somewhat prepared especially in what it relates to data curation, data governance, and process specific skills mainly due on the one hand to the maturity of the sector and on the

other to automation. It must be noted, however, that the definition of roles is fuzzy and professionals with skills on data analysis will also have skills on data quality, data pre-processing and management.

Which of the following technology or data-related skills do staff in your organization currently have? How about in two years from now?
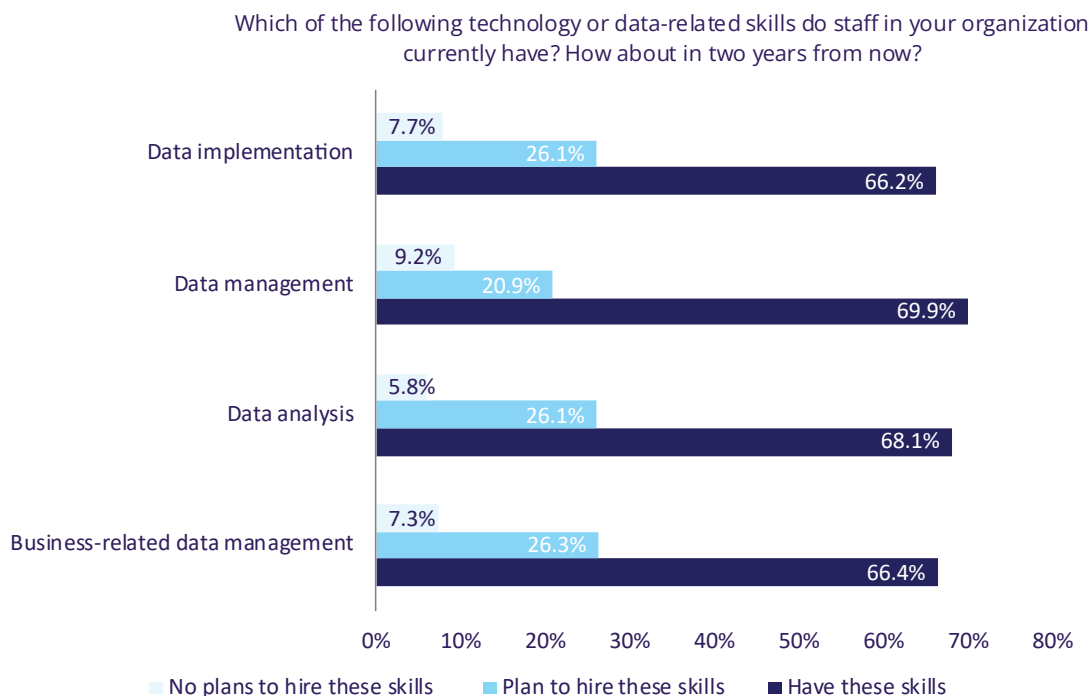
Figure 33. Data workforce in organisations

Source: ADS Digital Skills Survey, April 2023

7.4 Barriers and enablers for BI/Data Science skills demand

Hiring staff with skills in BI/Data Science can be challenging and the difficulty may vary depending on several factors being maybe the most important the global shortage of skilled professionals in the field. The demand for skills in BI/Data has been consistently high, while the supply of qualified candidates has not kept pace. As a result, organisations may face difficulties in finding and hiring individuals with the specific data management skills they require, especially in an ecosystem in which advancements in technology and industry needs are continuously evolving. Besides, finding candidates with the right combination of skills, experience, and domain knowledge can be challenging as most of the candidates may have technical skills but not always are experienced on the domain. Professionals need to collaborate and align their efforts with various stakeholders to fit within the organisational culture. Another barrier in the next two years will be that multiple sectors will compete for talent. The competition for skilled data management/data implementation professionals intensifies due the non-stop adoption of organisations to the new technologies. Traditional sectors such as technology, finance, and e-commerce active in recruiting these professionals compete with healthcare, agriculture or manufacturing.

Level of Difficulty in Hiring (BI/Data Science)
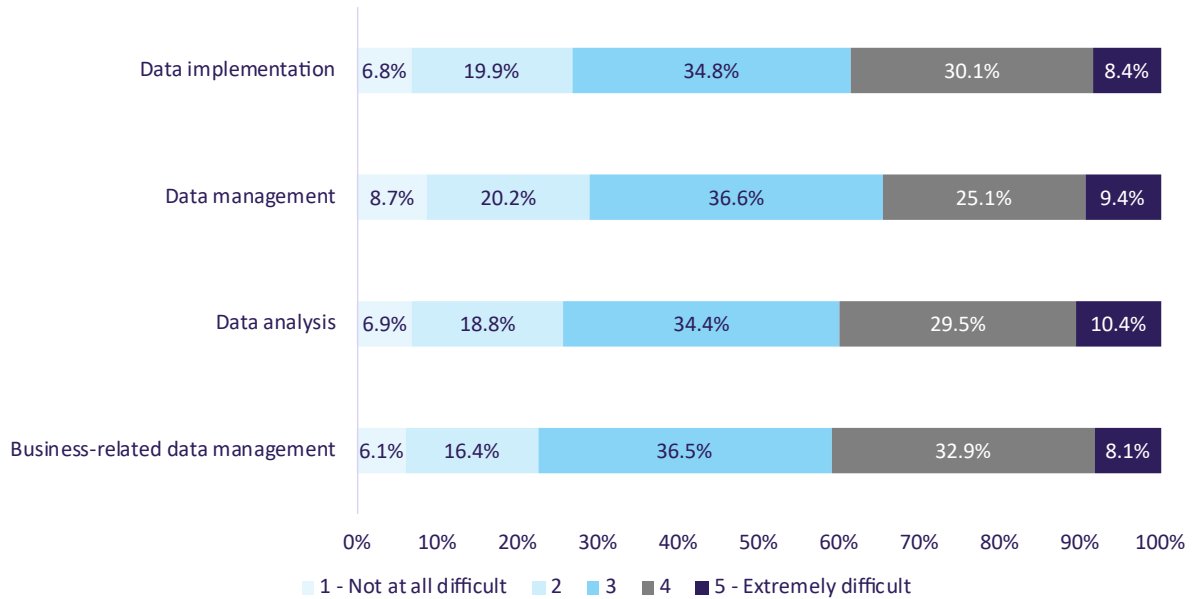
Figure 34. Barriers in hiring Data workforce

Source: ADS Digital Skills Survey, April 2023

Companies will have to develop effective recruitment and talent acquisition strategies specific to the field to significantly improve the chances of finding qualified professionals. Building relationships with universities, and training institutions can also yield potential candidates through partnerships, job fairs, or internships. Demonstrating the organisation's commitment to leveraging data and investing in advanced analytics tools and technologies can be appealing to professionals who want to work in a dynamic and innovative environment.
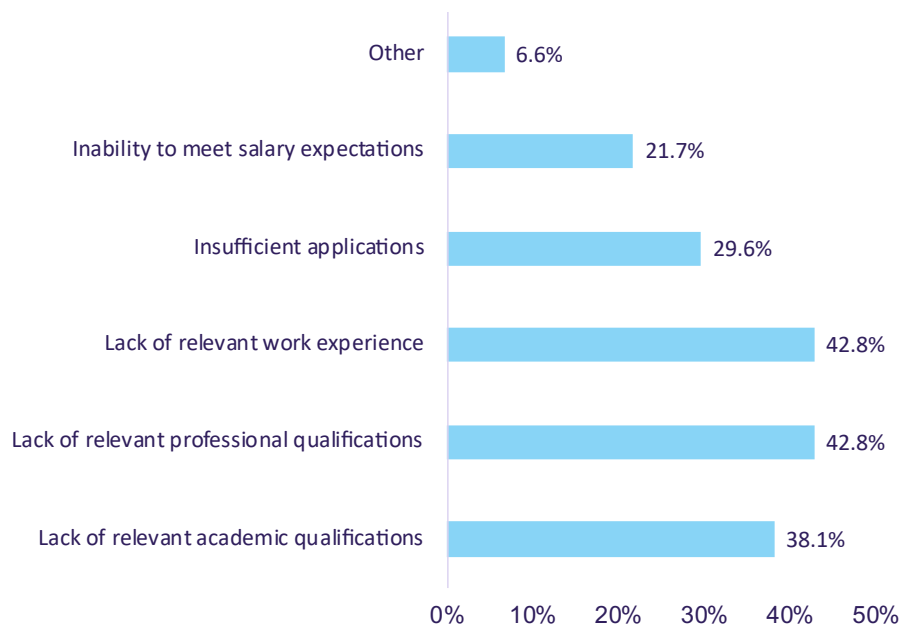
Figure 35. Difficulties in Recruiting Staff with Data Skills

Source: ADS Digital Skills Survey, April 2023

8 CYBERSECURITY: ADS FORECASTING RESULTS

8.1 Future demand with scenarios

Cybersecurity and data security have consistently been at the top of the IT agenda for European organisations for many years – also driving the demand for related skills. The past few years have also seen a strong increase in cyber attacks and with organisations increasingly being data driven, the risk of security breaches takes on an even more critical nature.

European companies are constantly looking for ways to improve their cybersecurity capabilities, and although many Cyber services are already automated, human competences to work on the development of these tools and to analyse automated searches are and will continue to be in high demand over the next years.

Looking at the different demand forecasting estimates within Cybersecurity ADS skills pockets, Identity related competences are expected to register the highest growth in all proposed scenarios (baseline, high growth and low growth), having its demand almost doubled by 2027.

Demand for identity skills is currently being driven by the increase in roll out of Zero Trust capabilities within European organisations, especially considering the uptick in hybrid work after the COVID-19 pandemic and the need for a higher level of remote Cyber to access sensitive information by employees. The trend also pushes the need for more endpoint Cyber skills, which is also expected to grow substantially over the next five years as companies have to manage Cyber for a myriad of remotely connected devices simultaneously.

Organisations across industries are becoming increasingly aware of the need to fortify their digital ecosystems, creating a surge in demand for professionals proficient in Cyber analytics. Furthermore, as technology continues to evolve, the expanding complexity of networks, cloud infrastructure, and interconnected systems necessitates a higher level of expertise in analysing and detecting potential vulnerabilities.

Moreover, compliance regulations and data privacy laws are becoming more stringent, prompting organisations to invest heavily in Cyber analytics talent to ensure adherence to these requirements. Lastly, the growing adoption of emerging technologies such as artificial intelligence and machine learning in cybersecurity further accentuates the need for skilled professionals who can harness these tools to proactively detect and mitigate threats.

In light of these factors, the demand for Cyber analytics skills is expected to soar in the coming years, nearly doubling as organisations strive to safeguard their digital assets and maintain a robust Cyber posture.

It is also important to note that even in a low growth scenario where digital transformation efforts occur slower than its current pace and less investments in technology are made, the demand for ADS cybersecurity skills will continue to grow.

Figure 36. Market Scenarios for Cyber skills Pockets

Source: LEADS

Security analytics skills are also poised to experience a remarkable surge, nearly doubling over the next five years on a high growth scenario and growing by 1.6x on the baseline scenario. This accelerated growth can be attributed to a confluence of factors driving the demand for individuals adept in this field. First and foremost, the constant rise in cyber threats and sophisticated attacks has underscored the critical importance of robust Cyber measures.
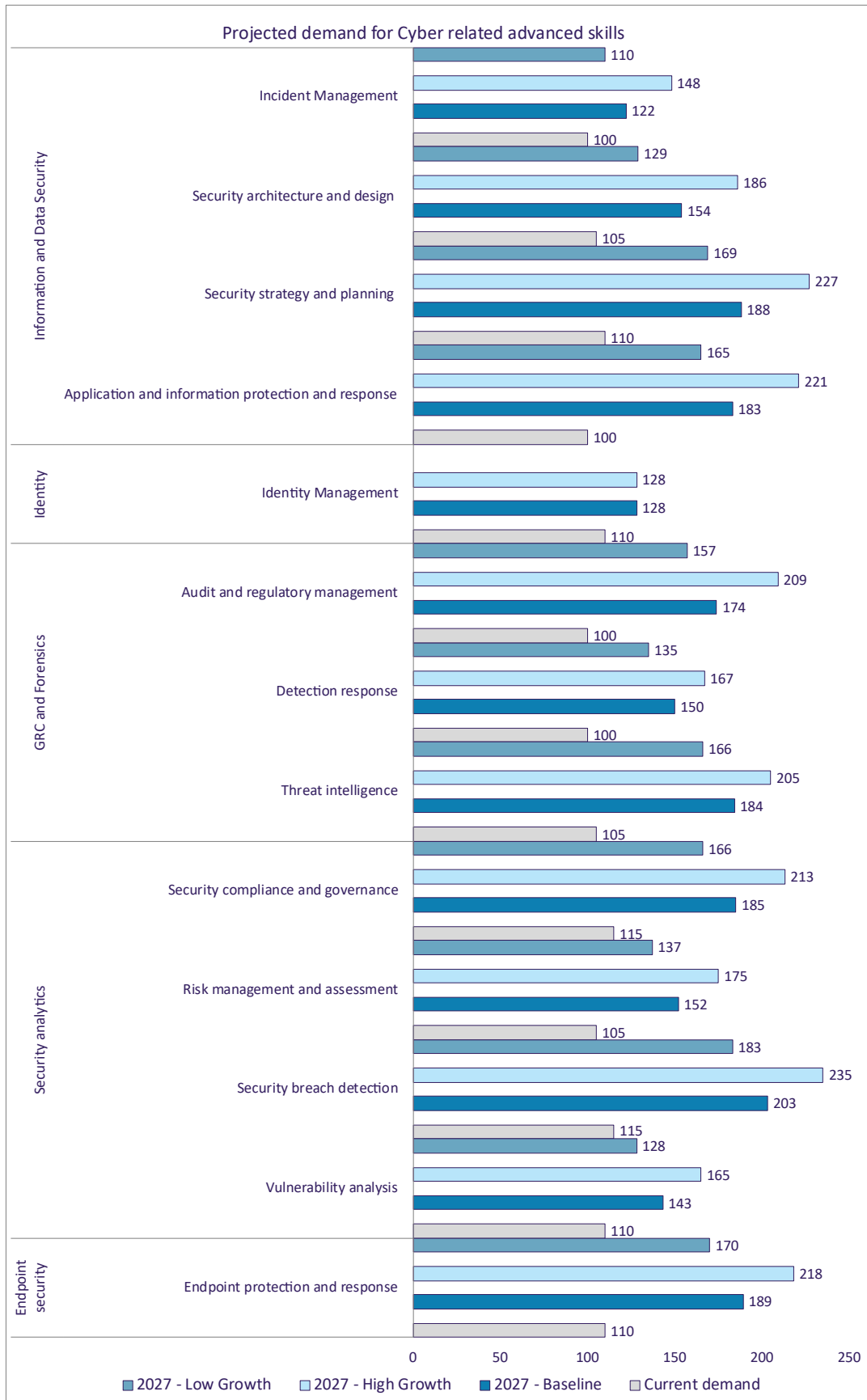
Figure 37. Market scenario demand for Cyber skills Details

Source: LEADS

On ADS skills details for cybersecurity, competences such as security breach detection, compliance and governance, audit and regulatory management and strategy and planning are expected to register a substantial growth in demand irrespectively of the scenario. The reason behind this trend is that even in a scenario of slower economic growth, European organisations will keep investing in cybersecurity improvements, especially considering the current geopolitical situation in the continent with the Russian aggression against Ukraine and constant threats to the EU.

Therefore, the need for a larger and specialised cybersecurity workforce will continue to be on top of the agenda of European institutions and organisations with more emphasis is expected to be put on hiring, upskilling and reskilling individuals into this path.

8.2 Cybersecurity Specific Survey indicators

Level of Difficulty in Hiring (Cyber skills)

Skill	1 - Not at all difficult	2	3	4	5 - Extremely difficult
Network security	10.2%	16.9%	31.4%	30.3%	11.3%
Information and data security	8.3%	14.8%	32.6%	33.5%	10.8%
Identity management	5.2%	15.2%	34.0%	34.8%	10.8%
GRC and forensics	6.1%	14.5%	30.2%	37.9%	11.3%
Security analytics	6.6%	14.3%	33.1%	32.0%	14.0%
Endpoint security	6.5%	14.6%	31.1%	35.4%	12.4%
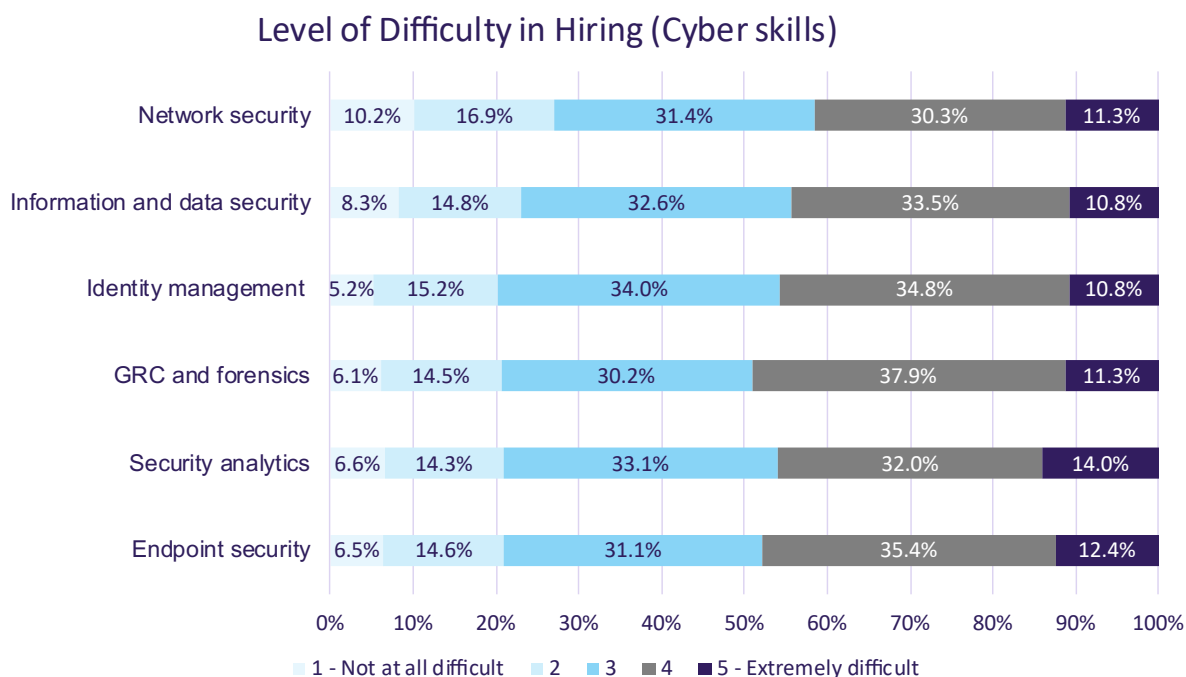
Figure 38. Difficulty to Hire Staff in Cybersecurity over the next two years

Overall, around 45% of respondents find either difficult or extremely difficult to hire staff with ADS cybersecurity skills in Europe, with competences such as Cyber analytics and GRC & Forensics being the most difficult to find.

Interestingly, according to the same survey, only 43% of respondents said that they had GRC and forensics skills in-house, despite the IDC Europe 2023 CISO Survey showing that almost half of European CISOs have "complying with Cyber regulations" as one of their top priorities. One of the main reasons is that these skills are the most difficult to hire from the market, according to the Advanced Digital Skills Survey.

In addition, the two biggest barriers to hiring staff with ADS Cyber skills in Europe are the lack of professional qualification and work experience, with academic qualifications taking only the

third place in relevance. results reinforce the case that only academic skills are not enough for organisations to have a highly competent cybersecurity workforce in Europe.

So how do IT and Cyber organisations address the issue of Cyber skills in short supply? If they cannot rely on hiring from the market, it may be time to look inside the organisation to upskill or reskill existing staff. The added benefit is that by using existing employees, these are already known entities that have been "vetted" in the organisation – and they will understand the specific business context and the organisation's culture – both very valuable qualities.

In addition, by providing development opportunities to existing IT (or line of business) staff, the organisation can establish a continuous learning culture, where recognition of achievements can be tied with more advanced assignments, increased responsibilities and promotions.

8.3 Barriers and enablers for Cybersecurity skills demand

The growth of cybersecurity skills faces several barriers that pose challenges to individuals and organisations seeking to enhance their capabilities in this field. Firstly, the rapidly evolving nature of cyber threats creates a perpetual need for upskilling and staying abreast of the latest trends. However, the shortage of accessible and affordable training programs and educational resources can hinder individuals from acquiring the necessary knowledge and skills. This scarcity of resources often results in a significant gap between the demand for cybersecurity professionals and the available talent pool, impeding the growth of cybersecurity skills.

In addition, the complexity and technical nature of cybersecurity make it a challenging field to enter and navigate. Many cybersecurity roles require advanced technical expertise, which necessitates a solid foundation in computer science, networking, and programming. The steep learning curve and the need for continuous learning can discourage individuals from pursuing careers in cybersecurity and delving into advanced competences, exacerbating the skills gap. Also, the constantly evolving threat landscape puts immense pressure on cybersecurity professionals to keep their skills updated. However, the rapid pace of technological advancements and the emergence of new attack vectors make it difficult for individuals to stay current. The sheer volume and diversity of threats can overwhelm professionals, making it challenging to develop deep expertise in specific areas and inhibiting the growth of specialised cybersecurity skills.

Lastly, the high cost associated with establishing and maintaining robust cybersecurity infrastructures can impede the growth of cybersecurity skills. Organisations often face financial constraints when investing in cutting-edge tools, technologies, and talent needed to effectively combat cyber threats. Limited budgets can restrict the allocation of resources for training programs, certifications, and professional development opportunities, hindering the growth of cybersecurity skills within organisations.

In summary, the barriers to the growth of cybersecurity skills include limited access to training programs, the technical complexity of the field, the rapid evolution of threats, and the high costs associated with cybersecurity infrastructure. Overcoming these barriers requires concerted efforts from educational institutions, governments, and organisations to provide accessible and affordable training opportunities, foster collaboration between academia and industry, and allocate adequate resources to enhance cybersecurity capabilities.

On the other hand, several enablers play a crucial role in fostering the growth of cybersecurity ADS skills. One significant enabler is the increased awareness of the importance of cybersecurity and the potential consequences of cyber threats. This awareness has led to greater investment in talent development from governments, educational institutions, and organisations. By recognizing the significance of cybersecurity and investing in skill development, these entities are creating an environment conducive to the growth of cybersecurity skills.

Additionally, the incorporation of artificial intelligence and machine learning in cybersecurity tools and solutions has automated certain tasks, enabling professionals to focus on higher-level analysis and response. This automation not only improves efficiency but also expands the possibilities for specialisation and growth in cybersecurity skills, as professionals can delve deeper into areas that require human expertise and critical thinking.

9   IMPACT ON JOB ROLES AND EMPLOYMENT

This section examines how advanced digital skills are impacting job roles and employment in both ICT roles within organisations and also roles that are non-ICT related.

9.1 ICT job roles

9.1.1   Trends in ICT Job Roles

The rapid development of technologies will continue to transform the world of work and international labour markets. Cultivating robust digital skills will be crucial to participate in the digital economy and drive growth. It has been predicted that 85% of the jobs that college leavers of 2030 will hold have not been invented yet[17]. AI and automation will be a big driver of this statistic as machines become capable of taking on more work. Rather than just automation of manual jobs, smart, artificial intelligence (AI)-powered machines will increasingly do jobs that require thought and decision-making.

The data in the **LEADS Survey** illustrates the impact on ICT job roles across industry. As illustrated in Figure 39, it is expected that there will be continued growth in advanced digital skills. This illustrates how this demand will represent itself within each of the categories: Cloud, BI/Data, AI, IoT, Cybersecurity and Quantum.

Headcount Prediction By Technology Area

Source: LEADS Digital Skills Survey, April 2023

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[17]https://www.forbes.com/sites/bernardmarr/2022/12/05/the-top-5-in-demand-tech-skills-for-jobs-in-2023/?sh=4fbc883826cc
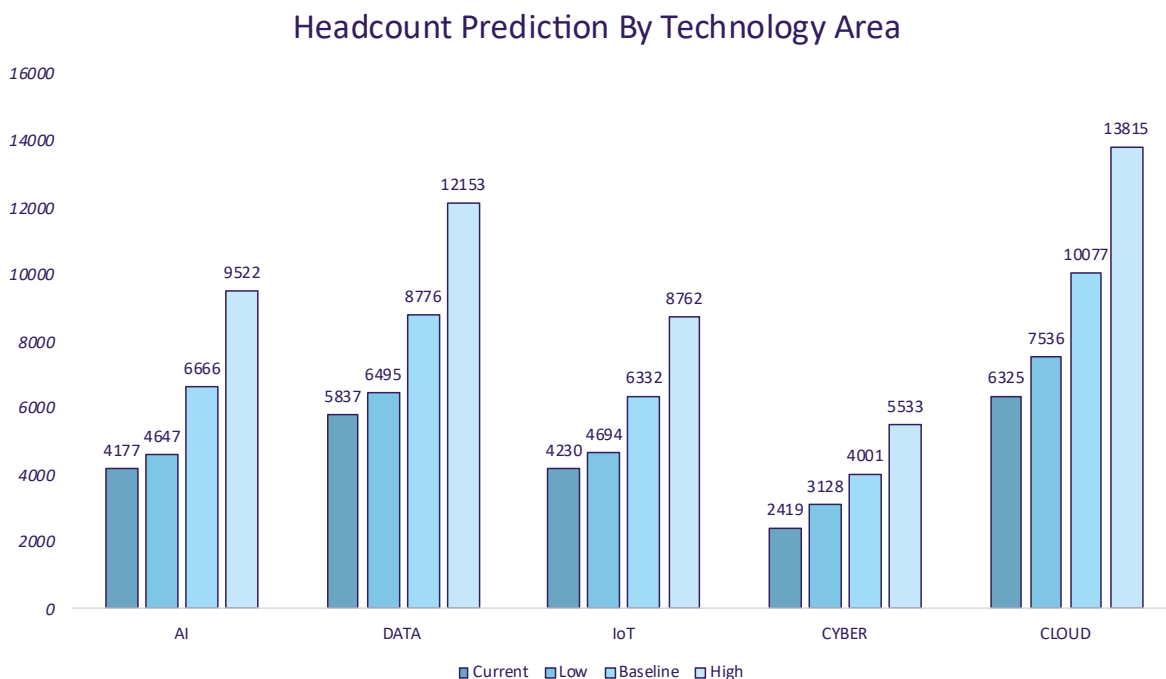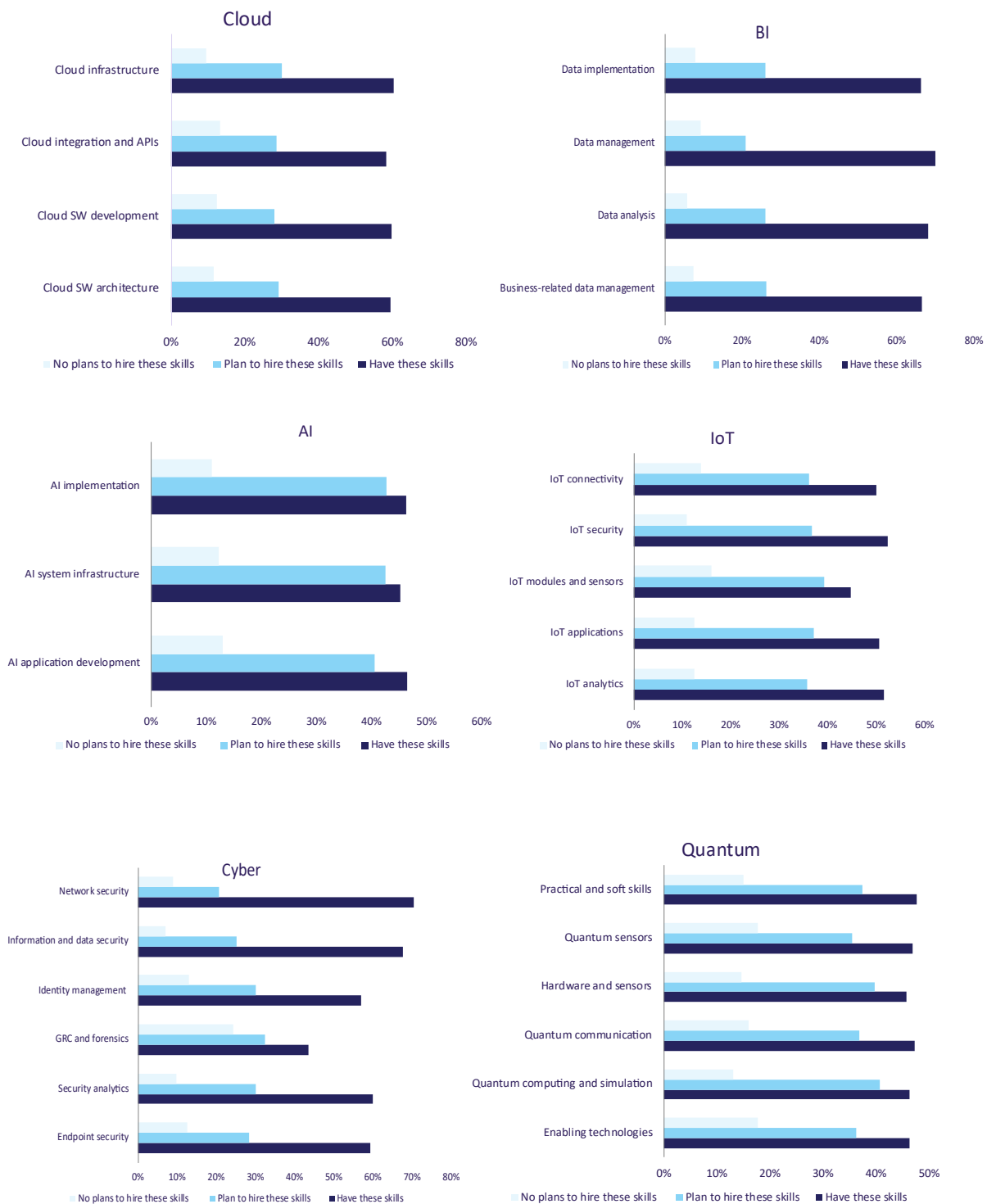
Figure 39. Staff ICT Skills - Present and Plan for the Next Two Years

Source: LEADS Digital Skills Survey, April 2023

9.1.2 Recommendations for Human Capital Management in ICT Job Roles

Creating Workforce Planning

This increasing demand illustrates the need for organisations to create detailed workforce planning forecasts and will place additional requirements on the HR functions within organisations. It will also require that sourcing strategies adopt as broad a perspective as

possible to ensure that new candidate pools are reached as effectively as possible. This is likely to be challenging as the pace of change and emergence of new roles places additional pressures on organisations as illustrated by the feedback from Workshop 2 in WP3.

The role of third-party providers in the provision of ICT services in the future is expected to play an important role in the creation of the ICT ecosystem. McKinsey predicts that by 2050, the knowledge of how core systems work will be concentrated among a small number of developers, and most of the industry will rely on third-party providers for this expertise[18]. This has the potential to change the dynamic for organisations for their resource modelling.

Education as a Key Supplier

The need for education to play its role in creating these pools has been identified by WP3 following engagement with the industry. Amongst industry representatives, there was general agreement that there is and will continue to be a critical shortage in **supplying graduates with ADS**. It was proposed by those in the workshop that the root of the problem was within the primary and secondary school systems. The industry leaders believed that the quality of primary and secondary education was a concern and an impediment to filling demand. This reinforces the requirement for industry and education providers to have more interaction to ensure an adequate pipeline is being created from an early stage.

Promoting Gender Diversity and Inclusion

The **LEADS Survey** explored the extent to which organisations placed targets on increasing representation in ADS across their workforce. Addressing disparities in the workforce is not just about doing the right thing but also addressing an economic necessity. Based on the data from the survey, Figure 9.3 reveals that gender diversity is the key area targeted by companies with 40% of companies suggesting that they have focused on this category. However, there is still a worrying low representation of women in ICT roles. It is estimated that women occupy only 22% of all tech roles across European companies[19].

Beyond that, companies have still much to do in terms of attracting and targeting broader diversity. Companies need to adjust hiring processes to take account of the needs of under-represented groups. For example, one of the first barriers to entry for someone who is neurodiverse is the interview process. Traditional interviews take into consideration things like body language and awareness of social cues that can put a neurodiverse person at a disadvantage. One way businesses can address this challenge is by partnering with community organisations to gain expert guidance, education, and best practices around talent acquisition and talent nurturing.

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[18]https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/tech-forward/overriding-macro-trends-to-unlock-performance-in-tech-enabled-organizations
[19]https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/women-in-tech-the-best-bet-to-solve-europes-talent-shortage
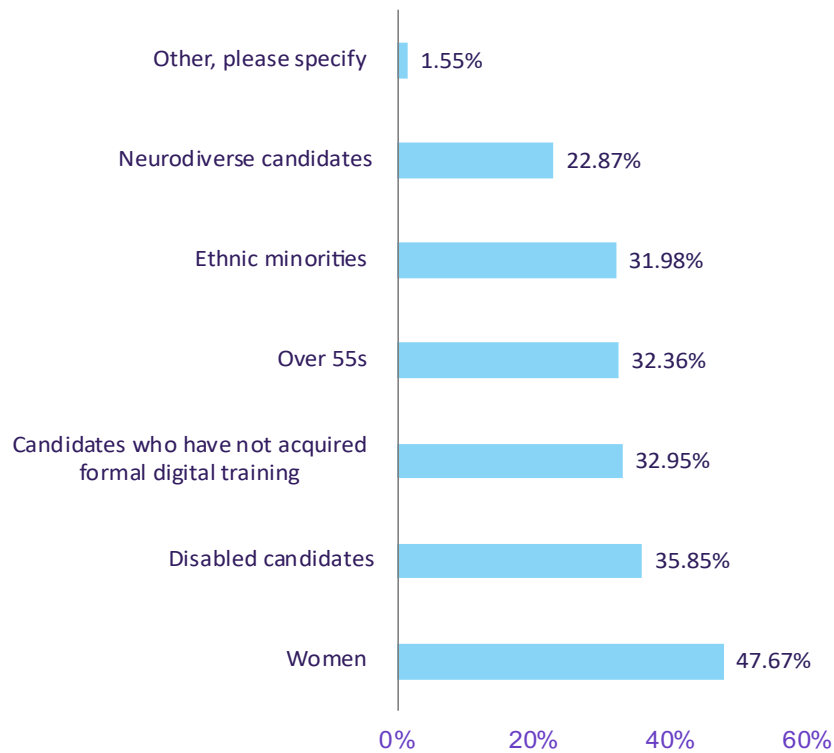
Figure 40. Organisational Targets for Diversity

Source: LEADS Digital Skills Survey, April 2023

Upskilling and Reskilling Existing Employees in ICT Roles

The survey data revealed that industries source new hires through external sourcing and internal hiring is a lower priority (see Figure 9.4). This may be due to the time and effort required to invest in upskilling and reskilling existing employees. However, new technology is rapidly changing the way work is being done. Skills that were relevant a few years back are no longer relevant today. The World Economic Forum estimates[20] that by 2025, 85 million jobs may be displaced by machines, but 97 million new roles may also emerge due to a new dynamic between people and technology. This indicates that a major shift in skills is underway at the same time as a potential shortage of those emerging skills.

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[20] https://www3.weforum.org/docs/WEF_Future_of_Jobs_2020.pdf
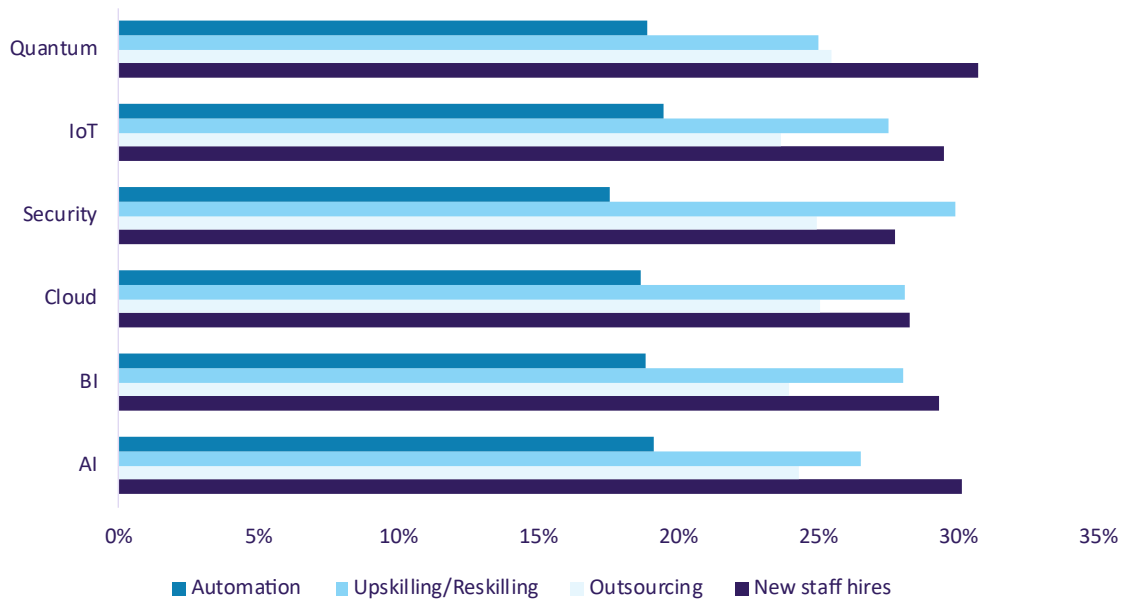
Figure 41. Skills Sourcing Strategies by Technology Area

Source: LEADS Digital Skills Survey, April 2023

Through training and development, employers can explore the internal marketplace and identify those employees who can and want to shift skill sets. Doing so will require increased investment in training. The survey reveals that the training budgets in companies will increase to address digital skills training (see Figure 9.5). However, whether this is sufficient will be context specific.
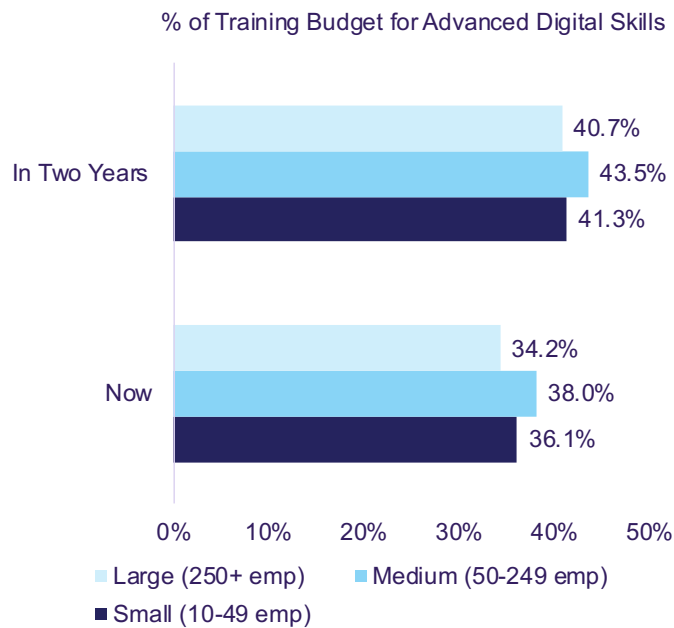
Figure 42. % of Training Budget for ADS skills

Source: LEADS Digital Skills Survey, April 2023

It is necessary for organisations to effectively use data-driven insights and the powers of these new technologies to enable them to effectively provide skills for existing employees. Enabling

personalised predictive learning can help to bridge skills gaps. Comparing employees' current skills to those required for other roles in order to create skills graphs and career path recommendations can help create new sources of talent from within existing resources.

9.1.3   Implications for Organisational Culture

As the debate continues around the return to the office, it has been received with mixed reviews and although a success for many, equally it has not been a success for all people. Many enterprises watched their entire workforce go digital and are now suffering attrition as they struggle to figure out how to hybridise a remote workforce. Everyone has felt the loss of intangible office benefits, like chance encounters and consistent, close guidance of junior talent. Now the consequences of the loss are becoming clear. Industry leaders in WP3 workshop 2 were concerned that in relation to ICT skills, without in-person engagement, companies can stand to lose mentorship, innovation, culture and inclusion. There is a need for organisations to find the right balance that can ensure knowledge generation, collaboration and support new hires and continue the development opportunities for current hires.

9.2 Non-ICT job roles

The survey revealed that not only ICT areas are affected by Advanced Digital Skills (ADS) requirements. The next section extracts interesting insights from the survey in relation to the impact of ADS on non-ICT roles in organisations.

9.2.1 The Importance of ADS for Non-ICT Roles

Data from the respondents indicate that there are other functions impacted by ICT. The data reveals in Figure 9.6 the areas where the demand for ADS will increase in future digital strategies.
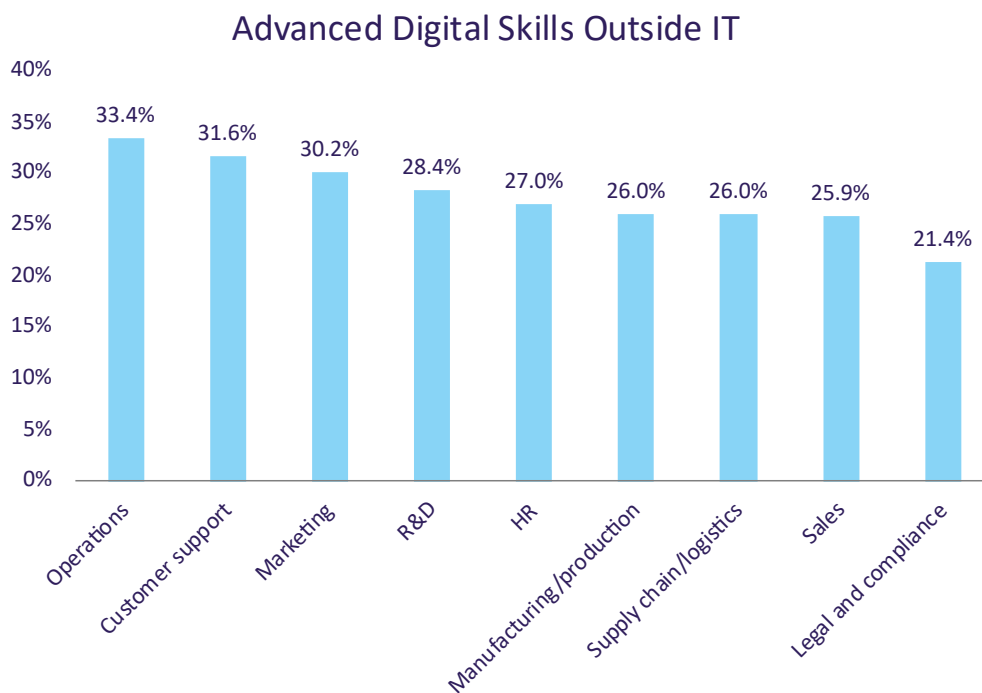
Figure 43. Impact of Advanced Digital Skills across Non-ICT Areas

Source: LEADS Digital Skills Survey, April 2023

9.2.2 The Key Functions Impacted

As shown in Figure 9.6, the top 3 functions that are significantly affected by ICT include operations and supply chain, customer support, and marketing. Below presents more information about the three functions affected by ICT.

Operations and Supply Chain

The survey shows that Operational is the most likely area to benefit from ADS. 33.45% of respondents across Europe anticipate that there will be an increased demand for ADS requirements within operational areas and 26% expect that ADS skills will be required within the supply chain areas. This may be due to the potential of ADS to significantly enhance operations functions by streamlining processes and improving efficiencies and decision-making. This is not too surprising as there are many opportunities for digitisation to support operations. Examples include:

- **Big Data Analytics** can allow companies to analyse large volumes of data collected from various sources, including customer interactions, operational processes, and supply chain activities. These insights can be leveraged to identify operational bottlenecks, optimise inventory levels, improve forecasting accuracy, and make data-driven decisions.
- **Cloud-based platforms** can provide scalability, flexibility, and accessibility to operational functions. Companies can store and process large amounts of data, collaborate with remote teams, and deploy software applications without the need for extensive hardware infrastructure.
- **Artificial Intelligence (AI) technologies** such as machine learning and natural language processing, can automate tasks, detect patterns, and provide intelligent recommendations. AI-powered chatbots, for example, can handle customer inquiries, freeing up customer service representatives for more complex issues.

Supply chain management can benefit from:

- **Advanced supply chain management software** can integrate various operational processes, such as procurement, inventory management, logistics, and demand planning.
- **Blockchain technology** can enhance transparency, traceability, and Cyber in supply chain operations. It enables secure and decentralised record-keeping, reducing fraud risks and improving trust among participants.

Customer Interaction and Marketing

Respondents also see the importance of ADS in Customer support (31.64%) and Marketing areas (30.17%). The importance of technologies such as AI in Marketing is well documented. Forbes[21] in 2022 indicated that AI would drive transformational change in marketing and referred to a McKinsey study that, along with sales, Marketing would be the single business function where AI would have the most financial impact.

9.2.3   Additional Analysis

The Perceived Role of ADS in the Future: Misalignment between HR and ICT Views

This survey compares the view of HR managers compared to ICT managers and their perceptions of the importance of ADS in the future (see Table 9.1). The overall takeaway is a different point of view due to different job roles and their perception of what is more beneficial to their organisation.

Table 2. Respondent from HR and ICT across non-ICT Areas

Non-ICT Sector	GAP	Respondent Role	
		ICT	HR
Customer support	1,97%	31,88%	29,91%
HR	9,67%	25,84%	35,51%
Legal and compliance	5,48%	20,69%	26,17%
Manufacturing/production	10,43%	27,25%	16,82%
Marketing	7,75%	31,11%	23,36%

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[21]https://www.forbes.com/sites/bernardmarr/2022/09/09/artificial-intelligence-and-the-future-of-marketing/?sh=4e10b66d697f

Operations	13,59%	35,09%	21,50%
R&D	12,06%	29,82%	17,76%
Sales	1,79%	26,09%	24,30%
Supply chain/logistics	0,86%	26,09%	25,23%
Other, please specify	1,1%	0,77%	1,87%

Source: LEADS Digital Skills Survey, April 2023

The study reveals that there is a misalignment in the perceived need for advanced digital skills for HR functions. The most revealing figure is the comparison of ICT respondents and their perception of technology with HR (25.8% vs 35.5%).

This is important as intelligent automation technologies constitute a new approach to managing employees and enhancing firm performance. However, the impact of these technologies has been identified to concentrate on HRM strategies, namely, job replacement, human-robot/AI collaboration, decision-making and learning opportunities, and HRM activities, recruiting, training and job performance (Vrontis et al., 2022[22]). Thus offering several opportunities for HRM but also considerable challenges at a technological and ethical level.

There are also differences in perception of the importance of ADS in Legal and Compliance. This may be due to more understanding by HR as they have more interaction with these areas on a daily basis and have a more inherent knowledge of the potential for ADS.

A final observation here is the lack of cohesion in ICT and HR functions' beliefs in relation to R&D, operations, marketing, and manufacturing/production. This may be due to a closer relationship and understanding of the operations by ICT.

Low Level of Recognition of ADS Needs for Legal and Compliance

The relatively low level of recognition of the need for ADS skills in Legal and Compliance (21,36%) is an interesting finding, especially as the impact of technologies such as ChatGPT raises important questions about the responsible use of AI. Accenture[23] has recently highlighted that the speed of technology evolution and adoption requires companies to pay close attention to any legal, ethical and reputational risks they may be incurring. Companies will need to answer key questions on intellectual property, data privacy and Cyber, discrimination, product liability, trust and identity.

Their research in 2022 revealed that most companies (69%) have started implementing responsible AI practices, but only 6% have operationalized their capabilities to be responsible by design. This low level of awareness suggested by this survey, of the ADS requirement within Legal and compliance ADS, is a point for action.

The Geographic Differences

There are some geographic differences across Europe in the perception of the need for ADS skills. In 2019 McKinsey Global Institute found that the most advanced Northern European countries and the Anglo-Saxon countries took the lead in Europe while a clear gap in AI

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[22] Vrontis, D., Christofi, M., Pereira, V., Tarba, S., Makrides, A., & Trichina, E. (2022). Artificial intelligence, robotics, advanced technologies and human resource management: a systematic review. The International Journal of Human Resource Management, 33(6), 1237-1266.

[23] https://www.accenture.com/bg-en/insights/technology/generative-ai

readiness existed, with Southern and Eastern Europe lagging. This current survey suggests that there is less of a differential in 2023 (see Table 9.2).

Table 3. Impact of ADS Demands from Different WE Regions

	Total	Benelux	DACH	Nordics	Southern Europe
Customer support	31,64%	29,41%	29,63%	32,18%	29,89%
HR	27,01%	20,00%	29,63%	31,03%	26,46%
Legal and compliance	21,36%	22,35%	30,25%	24,14%	16,40%
Manufacturing/production	25,99%	14,12%	25,93%	27,59%	25,93%
Marketing	30,17%	22,35%	28,40%	41,38%	25,66%
Operations	33,45%	42,35%	35,19%	40,23%	27,25%
R&D	28,36%	25,88%	17,90%	20,69%	33,60%
Sales	25,88%	20,00%	18,52%	36,78%	24,60%
Supply chain/logistics	25,99%	16,47%	27,16%	33,33%	22,75%
Other, please specify	0,90%	0,00%	1,85%	0,00%	0,26%

Source: LEADS Digital Skills Survey, April 2023

Manager versus Employee Perspectives

There is a significant misalignment between perceptions of ICT employees versus ICT managers in the future role to be played by ADS in non-ICT functions (see Table 9.3). The former believe that Customer Support and Legal and Compliance areas deserve more ADS. This could be attributed to the fact that the managers need to have a more "big picture" mindset and would therefore place a higher emphasis on cost-saving strategies such as streamlining and automating manufacturing processes or supply chains. On the other hand, the non-managerial professionals would have a clearer understanding of what is needed on a granular level to reduce liabilities and risks, therefore highlighting the importance of customer support and legal compliance due to their lack of knowledge in those areas.

Table 4. ICT Manager Roles across Non-ICT Areas

		People Manager (ICT)	
	GAP	ICT People Manager	ICT Non-managerial
Customer support	4,63%	30,66%	35,29%
HR	0,2%	25,78%	25,98%
Legal and compliance	3,84%	19,69%	23,53%
Manufacturing/production	8,36%	29,44%	21,08%
Marketing	2,96%	31,88%	28,92%
Operations	0,39%	35,19%	34,80%
R&D	3,55%	30,49%	27,94%
Sales	2,51%	26,66%	24,51%
Supply chain/logistics	5,47%	27,53%	22,06%
Other, please specify	2,28%	0,17%	2,45%

Source: LEADS Digital Skills Survey, April 2023

9.2.4 Recommendations for Human Capital Management in Non-ICT Job Roles

Education as a Key Influencer

- Education needs to introduce ADS related modules or courses to the functions influenced by ICT. There is an opportunity for providers of professional development to include ADS as a module of learning. There is a need for professional bodies (e.g. accounting institutes, marketing institutes, legal and compliance institutes) to ensure that their ongoing professional development curricula are current and to keep pace with organisations on the skills system that ADS creates. It is important to create the conversation.

- HR professional bodies and providers of HR education need to ensure that they are equipping their professionals with ADS understanding and awareness through targeted training programmes and modules.

- Providers of Executive Education in universities on non-ICT leadership programmes should ensure that the topic is integrated seamlessly as one of the challenges facing leadership.

Upskilling and Reskilling Existing Employees in Non-ICT Roles

- As a company goes through the ongoing process of developing a data-and-AI-literate culture, it is more important that it enables people who are already experts in their particular field to upskill and understand the importance of the technology. Creating communities of expertise, inhouse mentoring can all assist this process.

- There is a need to promote the use of technology in non ICT areas as an enabler. In tandem with this is the importance of people development and the creation of in-house courses aimed at equipping non ICT employees with the competence to use ICt to enhance their activities.

Aligning strategies across the business

- Within organisations, there is a need for the strategy process to be fully integrated, allowing the creation of a digital roadmap for non-ICT functions to ensure that all parts of the organisation are aligned and maximise their capabilities.

- There is a need for a close partnership between IT and the rest of the business. Some business leaders can deflect responsibility and are quick to blame IT when challenges arise. While there is often room for improvement on the IT side, business leaders must also step up and take ownership.

9.2.5   Conclusion

As can be seen by the above, both ICT and non-ICT roles are impacted by the challenges presented by the emerging gap in ICT roles. This creates a need for a more holistic approach to addressing this challenge. For ADS skills development, it is important to differentiate the approach to practitioners and core IT staff who will work on development and implementation of different systems, and the non-ICT staff who may be end-users of systems.

10 CONCLUSIONS, NEXT STEPS AND INTRODUCTION TO GAP ANALYSIS

10.1 Conclusions on Forecasting

With the conclusion of the LEADS ADS skills demand forecasting, the consortium was able to identify important trends and growth drivers of ADS digital skills across Europe reflecting different scenarios.

In summary, irrespectively of the scenario analysed (being baseline, high growth or low growth), the demand for ADS skills in Europe will increase significantly over the next five years due to the rapid pace of technology adoption observed in public and private organisations across the continent - With AI, Data Science, Cloud and Cyber skills being on the forefront of this transformation.

Again, an important reminder that the skills demand indexes portrayed in this project do not directly reflect the number of headcount/professionals related to the skills within LEADS framework as these may pertain to multiple job roles and may also be acquired through the reskilling of current ICT professionals. Instead, the project aims to showcase the appetite of the industry for certain advanced capabilities based on technology adoption and growth of investments in underlying use cases.

As the LEADS forecasting results are based primarily on the current and expected pace of technology adoption across Europe, the capacity of increasing such pace will also rely on the industry and education sector capabilities to attract, upskill and re-skill talent into ICT so the supply for ADS skills is met and future projects have the right level of resources to be deployed without major barriers.

With such mapping of the appetite of the industry for certain advanced capabilities, LEADS is able to provide a direction of travel for companies, public entities and education sector on where to focus their skilling efforts over the next years - And delving into such direction of which will also be an important component of the continuation of LEADS through the subsequent Work Packages.

10.2 Collaboration with tech communities

The collaborative work with other projects has played a fundamental role for the present delivery on various levels. On a first stage, the use-case driven approach of the workshop coordinated along with Unlock-CEI (CSA) within the EU-Cloud-Edge-IoT initiative helped validate and the skills pockets identification by reaching to the community to map which are the profiles that will be needed in future EDGE-based deployment.

The profile validation as well as the stakeholders identification has allowed to produce research and development-based evidence on which are the future profiles that will be needed for the eventual deployment of Cloud-Edge-IoT solutions in a variety of fields such as disaster management, agriculture and smart cities among others. Likewise, the ecosystem identification has provided depth and qualitative insights on the feasibility of forecasting

scenarios to occur by identifying which are the main stakeholders, such as networks supplier companies and regulation implementations bodies that need to be aligned for the deployment of these cutting-edge solutions.

On a second stage the engagement with EU-based Industry organisations and business organisations has contributed to the definition and posterior validation of the scenario forecasting that has been incorporated to produce the Final Demand's Forecast. Trough the separated engagements with the Big Data Value Association (BDVA) and the Alliance of Internet of Things and Edge Computing Innovation, the definitive ponderation of intervening factors' relevance and magnitude was validated along with the specialised communities for ADS regarding AI, Cloud, Business Intelligence and Data Analytics. Likewise the workshop carried out with EC funded initiative Women4Cyber produced validation and feedback on, though not exclusively, Cybersecurity ADS.

Finally, the active participation of EC funded initiatives such as Women4Cyber as well of ADS EU SPECIALISED projects and Unlock-CEI RIA's into the workshops has served the double purpose of helping built and validate the current report while building engagement opportunities for the ADS community and EC Funded Projects.

Based on the current advancement and following LEADS strategy of engagement and critical thinking and validation, the mentioned communities, along with project relevant EC-Funded Initiatives such as the Quantum Flagship Initiative as well as the Data Spaces Support Centre and the Euro HPC joint undertaking, will remain to work together as to increase knowledge sharing and increase the robustness of analysis of the upcoming ADS Gap Analysis Report.

10.3 Brief introduction on the GAP Analysis

The technology areas and skills identified will be used in conjunction with the advanced digital skills courses provided by the HEI and VET institutions so as to identify potential gaps, currently and in the long (5 years) term. In particular, these results will be used to assess whether and to what degree current and future skills supply is and will respectively support the market demand, accompanied with rich insights about the drivers that formulate those findings.

The analysis will take into account the current state in the demand of the advanced digital skills and will estimate the difference with the current state of the supply, the projection for the next five years, and will lead to the estimation of degree the training offer should be expanded in the next years so as to fulfil the forecasted demand. The results will be validated through a series of workshops in key technology sectors, were stakeholders by both aspects (supply - demand) will participate.

10.4 Expectations on policy recommendations

Within this current report and leading into the next "Gap Analysis" it has been identified the clear areas of growth and demand. Included within this is the mapping of which factors will be central to influencing the positive or negative demand growth over the coming years.

What remains is the clear and evident challenge facing European policy makers from regional through to European in realising the ambitions of the Digital Decade. While there has been

much advancement in supporting European R&D and the modernising of industries, including following the strategy of reindustrialisation and onshoring in the wake of the 2008 Financial Crisis, and recent geopolitical shocks which demands self-sufficiency and global competitiveness at the same time.

What cannot be put in doubt and described here in detail, is the omnipresent risk to all organisations due to the lack of not just digital skilled talent but talent with the right skills. There is not one solution to this challenge and policy makers must address the complex nature of advanced digital skills.

This firstly requires a clear distinction between the ambitions for a pool of tech development talent, i.e. the researchers and product developers of the future, and those for tech users within industry. This will influence greatly the investments to be made.

While a model has been developed and presented here, the individual factors beneath can form part of a tracker which will allow for more accurate and targeted interventions as well as enabling a more responsive approach to skills development. Opening a dialogue and providing an evidence basis for action.

Furthermore, the supply of programmes and courses is one side of the equation, with actors from education, VET, industry and government closely aligning to improve the outcomes. As can be observed through online programmes and open courses, a wide variety of options for upskilling and in some cases reskilling or transitioning. The challenge for policy makers is how to ensure the impact of such interventions, which relies on the motivation and individual context of the learner to acquire the level of skills, continuously be upskilling and applying their competences in a productive role. This will be key to addressing the jobs market imbalance currently in place.

Finally, reflected in the approach from LEADS, it requires close and coordinated action across all areas of policy and needs to be reflected across national governments, and within the European Institutions themselves. Without the diversity and breadth of actions, the ADS challenge will remain the canary in the mine.

ANNEX I - LEADS EXPERT GATHERING AGENDAS

Cloud-Edge-IoT Skills Demand for Adoption Event:

What you need to know:

LeADS and EU Cloud-Edge-IoT initiative (through UNLOCK-CEI project) joint forces to investigate the link between CEI use-cases and the required digital skills for the exploitation of these.

What you will find:

- **Novel insights** in ADVANCED DIGITAL SKILLS demands forecast for the next 5 years based on market analysis on specific technology use cases
- **Engagement opportunity** with relevant stakeholders from Digital Europe Programme CSA to facilitate RIAs outreach
- Contribute to contribute to a **white paper publication** on recommendations on for exploitation plans of both projects.
- **Unique discussion** on the required digital skills to be included in the early phases of the exploitation process to support a **successful Go to Market journey** on the following fields:

Smart Cognitive Manufacturing · Smart Ports · Precision Farming · Smart Grids Flexibility and Resilience · Disaster Management

REGISTER HERE!

BDVA Tech Adoption Scenarios Workshop:

Proposed agenda

Time	Session
14:00	**Introduction** • Overview of approach and tech pockets • Leading use cases • Market data and current forecasts 2030
14:20	**Use case exploration** • Refining selected use cases and validation of links to key tech groups
14:50	**Scenario development 1** • Discussion and selection of influencing factors
15:15	**Scenario development 2** • Assigning scale and relevance to use case clusters
15:50	**Next Steps**

Funded by the European Union

Funded by Horizon Europe
Framework Programme of the European Union

Women4Cyber Event:

Proposed agenda

Time	Session
11:00	**Welcome** Nuria de Lama, IDC
11:05	**Understanding the cyber skills of the future to ensure access and gender diversity** Nina Olesen, Women4Cyber & ECSO • Introduction to understanding changing skills needs in cybersecurity to ensure gender diversity and training of the right profiles.
11:10	**Overview of LeADS** Brendan Rowan, BluSpecs • Overview of approach and tech pockets • Leading cybersecurity use cases • Market data and current forecasts for 2030
11:30	**Session 1: Use case exploration** • Refining selected use cases and validation of links to cybersecurity
11:40	**Session 2: Influencing Factors** • Discussion and selection of influencing factors which influence the adoption rate of technologies in the cybersecurity space
12:10	**Session 3: Impact Mapping** • Assigning scale and relevance to factors for cybersecurity use case clusters
12:50	**Next Steps** Brendan Rowan, BluSpecs
13:00	**Close**

IOTI Market Demand Workshop:

Proposed agenda

Time	Session
14:00	**Introduction** • Overview of approach and tech pockets • Leading use cases • Market data and current forecasts 2030
14:20	**Use case exploration** • Refining selected use cases and validation of links to key tech groups
14:50	**Scenario development 1** • Discussion and selection of influencing factors
15:15	**Scenario development 2** • Assigning scale and relevance to use case clusters
15:50	**Next Steps**
16:00	**Close**

ANNEX II – SAMPLE FACTORS OF INFLUENCE

Factor	General Description	Hypotheses				
		Data	**AI**	**Cloud**	**IoT**	**Cyber**
Massive 5G deployments	5G deployments will reach 100% of EU	5G will result in more IoT devices deployed and more specialised devices	Increased application of federated models	MEC will reduce amount of processing done on the cloud	5G will result in more IoT devices deployed	
Cloud computing	Cloud infrastructure becomes increasing federated with orchestration across multi-cloud environment	Edge nodes and edge processing will be the dominant force	Edge nodes and edge processing will be the dominant force	Edge nodes and edge processing will be the dominant force	Edge nodes and edge processing will be the dominant force	
Energy	Cloud computing becomes more renewable, increasing availability and reducing costs.	More AI and complex/expensive processes will be used	Increasing need for energy efficiency will drive more AI system implementation	Increasing need for energy efficiency will increase need for specialists and diversify complexity of hybrid and federated cloud systems	Cloud becomes cheaper and more green inhibits edge deployment	
Cybersecurity	Increased data flows and federation of models and systems will increase need for cybersecurity experts	Increased data flows and federation of models and systems will increase need for cybersecurity experts	Increased data flows and federation of models and systems will increase need for cybersecurity experts	Increased data flows and federation of models and systems will increase need for cybersecurity experts	Increased data flows and federation of models and systems will increase need for cybersecurity experts	
General legislation	Increased need for compliance officers	Increased need for compliance specialists and certification	Increased need for ethics and compliance		More cybersecurity designers and certification will be required	

Cheaper sensors	More specialised chips and systems on chips are developed resulting in specialist and cheaper sensors	More data flows increasing will need	More training datasets become available		More edge devices and distributed intelligence systems are deployed
Energy independent sensors	More highly specialised sensors will be able to run processes on batteries and energy harvesting		More processing can be provided to the edge increasing demand for distributed intelligence	More processing can be provided to the edge	Increased virtualisation and automation of devices will compensate the increased number of devices deployed
Data Spaces	Data Spaces achieve market adoption and provide default data governance structures for specific sectors	Increased dataflows within data space actors will increase needs for skills			Reduced demand for data will reduce device deployments
		Participation in a data space drives demand for experts to ensure secure management of own data			
Generative AI	The deployment of generative AI will remove the need for digital skills and knowledge increasing the deployment of complex solutions led by domain experts	Reduces/removes coding skills requirements enabling non-ICT roles develop complex systems	Reduces/removes coding skills requirements enabling non-ICT roles develop complex systems	Reduces/removes coding removing demand for lower order tasks and basic software engineering skills	Reduces/removes coding removing demand for lower order tasks and basic software engineering skills	Reduces/removes coding removing demand for cybersecurity specialists
AI and automation	More automation of digital systems will be driven by AI applied across all aspects of DevSecOps	Reduces demand for data scientists and ETL proccesses as performed by AI	More specialism and less demand overall	Increased demand due to need for more automated and cognitive solutions	Increased demand due to need for more automated and cognitive solutions	Increased demand due to need for more automated and cognitive solutions

Policy						
Data Act		Flow of more non-personal data requires more hadling	Flow of more non-personal data	Greater portability of cloud providers will accelerate the deployment of federated systems		
				Compliance will drive the use of greater non-native app development and use of containers		
AI Act	Treating of AI solutions as products within high-risk areas will require self-certification and the submission of compliance data		Greater uptake of AI solutions through trust generation of certification			
Cybersecurity Resilience Act	Greater standards and compliance will change the current design practices and introduce common approaches and tools	Automation, standards and tools will reduce need for specialists	Automation, standards and tools will reduce need for specialists	Automation, standards and tools will reduce need for specialists	Automation, standards and tools will reduce need for specialists	Automation, standards and tools will reduce need for specialists