ON THE EDGE: MARKING THE IMPACT OF THE CEI CONTINUUM ON SKILLS DEMANDS

Uncovering tomorrow's market challenges through cutting-edge use cases

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BluSpecs

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CONTENT

INTRODUCTION

Europe faces difficulties in generating the required skills for different sectors of its economy.

As Digital Technologies play a vital role in the growth and functioning of society, addressing skills challenges is crucial for supporting the adoption of use cases developed by teams working on advanced technologies.

In order to explore the relationship between CEI use cases and the necessary digital skills, LEADS and the EU Cloud-Edge-IoT Initiative have collaborated through the UNLOCK-CEI program.

LEADS has analysed the demand for Advanced Digital Skills and forecasted its growth over the next five years.

The resulting findings highlighted the critical need for investment in skills development to meet the demand for advanced digital skills, particularly in the areas of AI and Data Science.
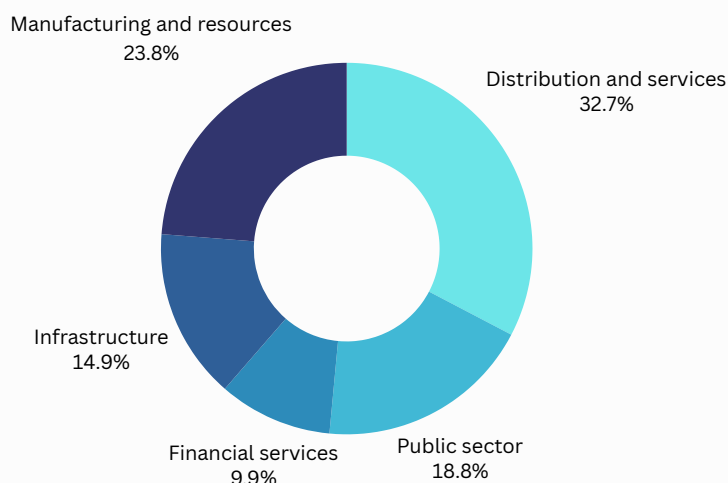
SKILLS REQUIREMENTS IN REAL-WORLD SCENARIOS

THE CLOUD EDGE IOT CONTINUUM

As our computing and processing needs continue to increase, Edge Computing is becoming just as important as Cloud Computing in our digital infrastructures. The combination of Cloud and Edge will play a crucial role in shaping future developments.

The demand for Edge Computing solutions and the creation of CEI networks is clearly demonstrated by the projected increase in spending. It is estimated that between 2020 and 2025, the investment in enterprise Edge will be more than double, going from €18 bn to €39.6 bn, outpacing the average growth rate in the overall ICT market.

Percentage of Edge computing spending by sector

Manufacturing and resources
23.8%

Distribution and services
32.7%

Infrastructure
14.9%

Financial services
9.9%

Public sector
18.8%

WORLDWIDE EDGE SPENDING GUIDE (2021) IDC

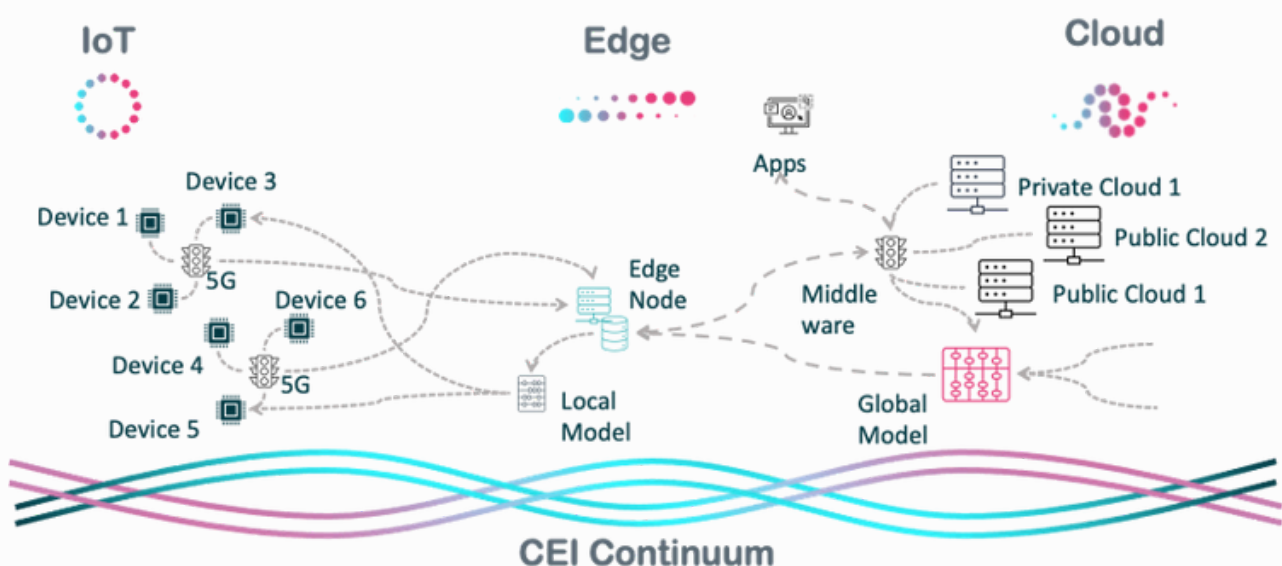# SKILLS REQUIREMENTS IN REAL-WORLD SCENARIOS

SKILLS LANDSCAPE IN EUROPE

In Europe, an annual growth rate of 26.5% in Edge Computing is expected, rising from €815m in 2020 to €2.6 bn in 2025.

Edge Computing is being adopted by various industries because it offers several benefits, such as simplifying production processes, automating equipment, improving safety and reliability, and enabling the full integration of resources through IoT advancements.

This trend is a result of the evolving technological landscape, which includes the development of more intelligent devices capable of on-device processing and the creation of federated AI architectures.

Additionally, the advancement of intelligent and programmable networks, cognitive Cloud systems, and orchestration across different Cloud environments has led to the convergence of devices and the Cloud.

SKILLS REQUIREMENTS IN REAL-WORLD SCENARIOS

THE USE CASES

The EU CEI initiative is about supporting the development of technology that brings together Cloud, Edge, and Internet of Things (IoT). This initiative, has a project cluster called MetaOS focusing on creating advanced meta operating systems.

These operating systems will connect smart IoT devices and Edge-Level systems, an integral part of the computing continuum. This will help in building smarter systems that can link up all these different devices and technologies. The 5 use cases are:

PRECISION FARMING

SMART EDGE SERVICES FOR THE PORT CONTINUUM

SMART GRIDS - FLEXIBILITY AND RESILIENCE

SMART COGNITIVE MANUFACTURING

DISASTER MANAGEMENT
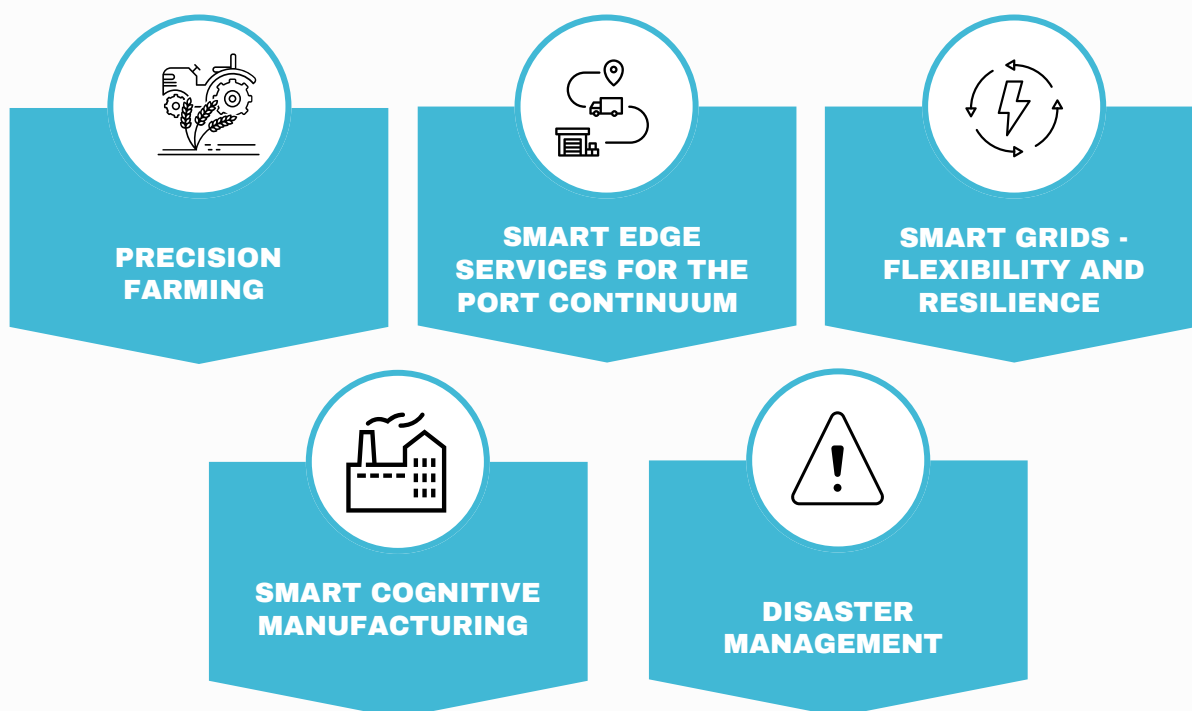
INSIGHTS INTO EDGE SKILLS

THE SOURCE OF EDGE SKILLS

In CEI, edge computing skills blend IoT and Cloud expertise, shifting toward roles from cloud experts (76%). A hybrid approach integrates existing skills with domain-specific knowledge, especially for professionals in Cloud DevOps and Embedded engineering.

A CROSS-DISCIPLINARY ENGAGEMENT

Roles executing applications require interdisciplinary skills in Cyber, Data, and AI, prevalent over direct Cloud or IoT skills. Collaborative development involves diverse actors ensuring fit-for-purpose solutions, with role combinations varying by domain. E.g., less Cloud in manufacturing, more IoT and Cyber; Crisis management as focus.

SHIFTING ROLES

As orchestration becomes more cognitive, the role of application developers centralises, with back-office functions likely becoming redundant. In response to the nature of research activities, there's a growing demand for engineers and developers to be proficient in a mix of skills, including Data, AI, and Cyber.

INSIGHTS INTO EDGE SKILLS

CHALLENGES FOR DEMAND AND SUPPLY

Sourcing talent for Cloud Edge IoT (CEI) research faces challenges as specialised professionals prefer industry production roles, limiting their return to research. Large organizations manage diverse CEI skills at a team level, while smaller tech companies rely on individuals until there's a business case for specialization or hiring.

IMPACT ON MARKET ADOPTION

Lack of standardisation in edge computing infrastructure poses challenges in finding skilled professionals. Across sectors, a high risk to market adoption exists due to a shortage of advanced skills, emphasizing the need for hands-on training in universities.

THE FUSION OF EXISTING ROLES AND SKILLS

CURRENT ROLES IDENTIFIED ACROSS USE CASES

The LEADS project established a taxonomy of different ICT-related job roles that are likely to have advanced digital skills as part of their capabilities.
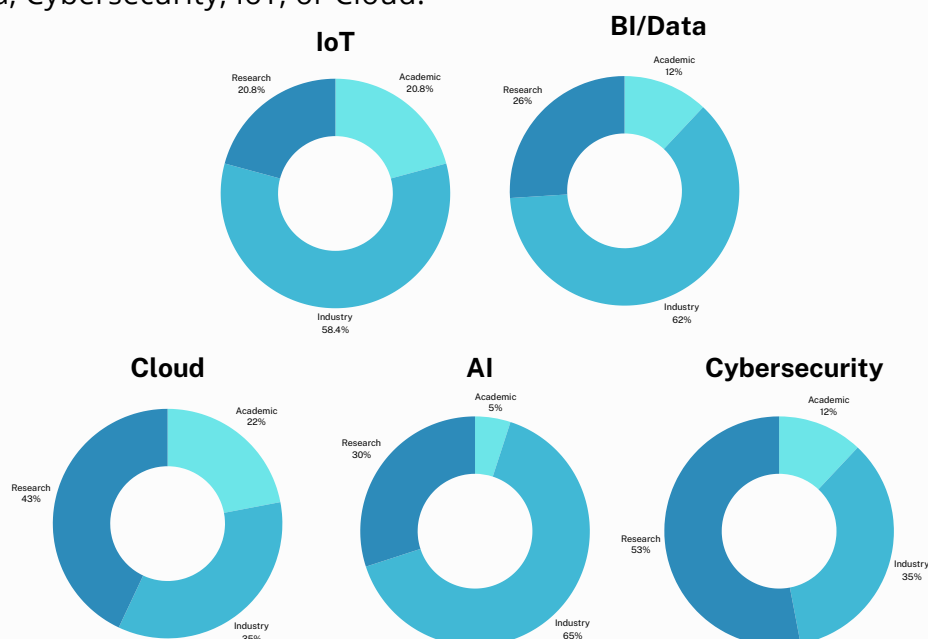
Roles: Are job positions widely used and that are reasonably common in the labour market.
Tasks: Refer to the day-to-day activities carried out by a person in each of the respective roles.
Skills: A specific ability, expertise, or proficiency that an individual possesses and can apply to perform tasks or duties related to that job. In the framework of this workshop, every task comprises 3-4 skills, with each skill originating from the domains of AI, BI/Data, Cybersecurity, IoT, or Cloud.

In Precision Farming, engineering skills prevailed, featuring Software, Technical, and Integration Engineers, along with an AI Research Engineer. Conversely, in the Smart Grids use case, multiple profiles centred on foundational skills like IoT, Edge, and Cloud, in contrast to AI, Data, and Cybersecurity.

Notably, profiles in Precision Farming and Smart Grids mentioned Cybersecurity, seemingly low for a crucial, foundational skills area. However, considering the wide skill range in some roles, the 17 named roles encompassed 34 cybersecurity skills in their day-to-day tasks.

IoT

Research 20.8%
Academic 20.8%
Industry 58.4%

BI/Data

Academic 12%
Research 26%
Industry 62%

Cloud

Academic 22%
Research 43%
Industry 35%

AI

Academic 5%
Research 30%
Industry 65%

Cybersecurity

Academic 12%
Research 53%
Industry 35%

RECOGNISING ROLES

EXPLORING SKILLS ACROSS CURRENT ROLES

The skills across roles vary in type, quantity, and combination, as shown in the figure. Profiles differ, with some featuring skills from all 5 areas, while others draw from only 1 or 2 areas, indicating more specialised or niche roles.
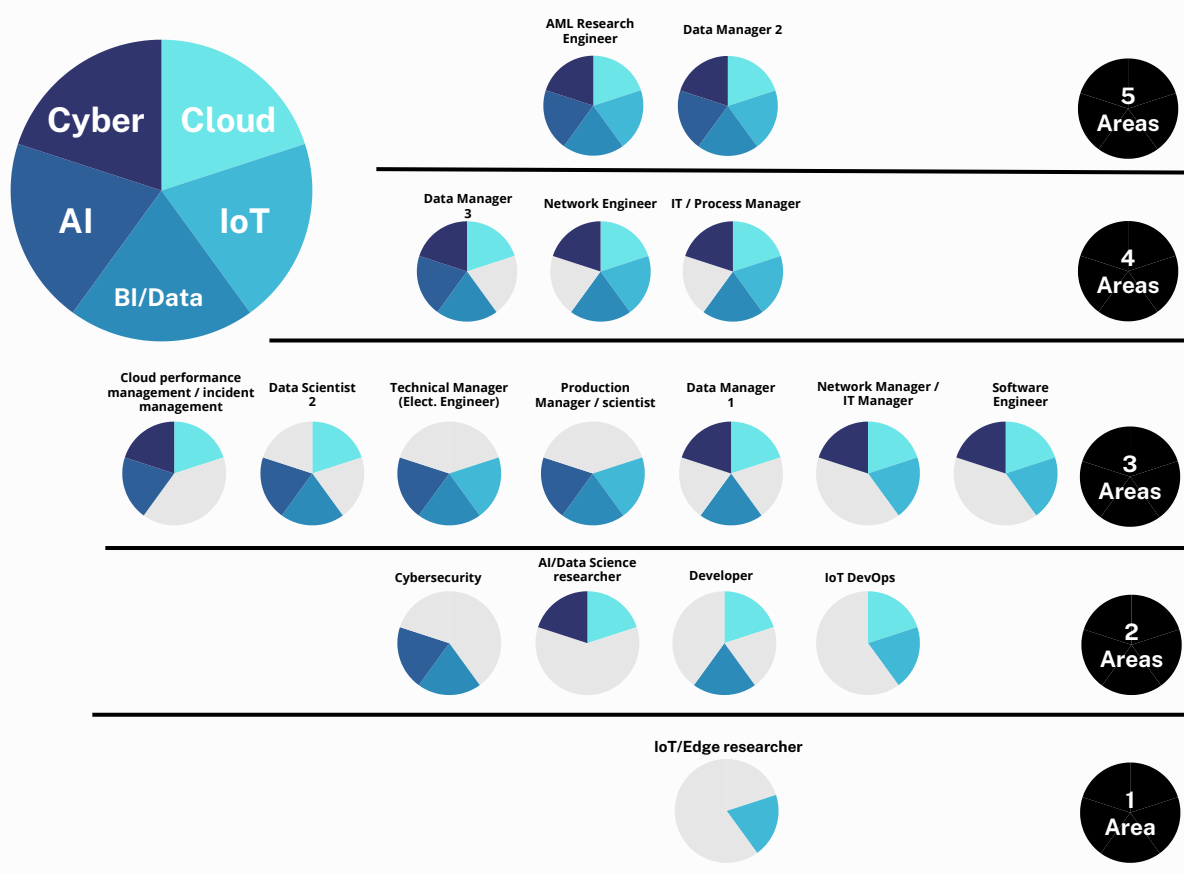
The 'AI/ML Research Engineer' role spans five tech areas, involving integrating AI with IoT, analysing data for BI, using cloud resources for AI, and contributing to cybersecurity - a testament to its broad and impactful scope.

The 'IoT/Edge Researcher' profile, focusing solely on IoT, showcases a niche expertise with a specific and narrow scope, in contrast to the broader foundational skills required for the 'AI/ML Research Engineer.'

CLOUD MEETS IOT

NAVIGATING THE EVOLUTION OF SKILLS DEMAND

The exercise aimed to identify the emergence of edge skills from IoT or Cloud. Results and practitioner observations show Cloud skills as dominant, making IoT more niche. **Among the 19 roles, 37% combine IoT and Cloud skills**, reflecting the growing importance of both.

Overlap of Cloud / IT skills across roles
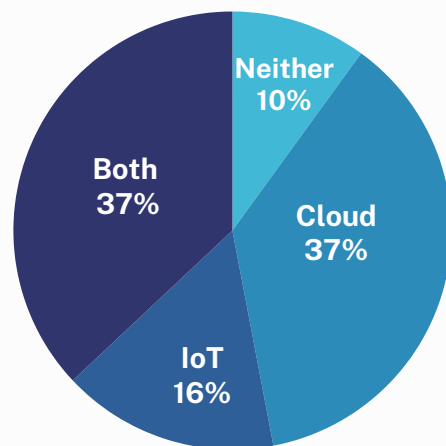
While overall tasks combining both skills are at 7%, individual roles highlight the essential connection between IoT and Cloud skills. These findings underscore the demand for professionals with a blend of IoT and Cloud skills, emphasizing the need to enhance competencies in these domains for relevance in technology-driven industries.

CLOUD MEETS IOT

ENVISIONING FUTURE ROLES

In terms of the forecasted future roles, i.e., the roles foreseen to be part of the implementation of the use case on a wider scale in future, there was a variance from the existing roles and skills necessary.

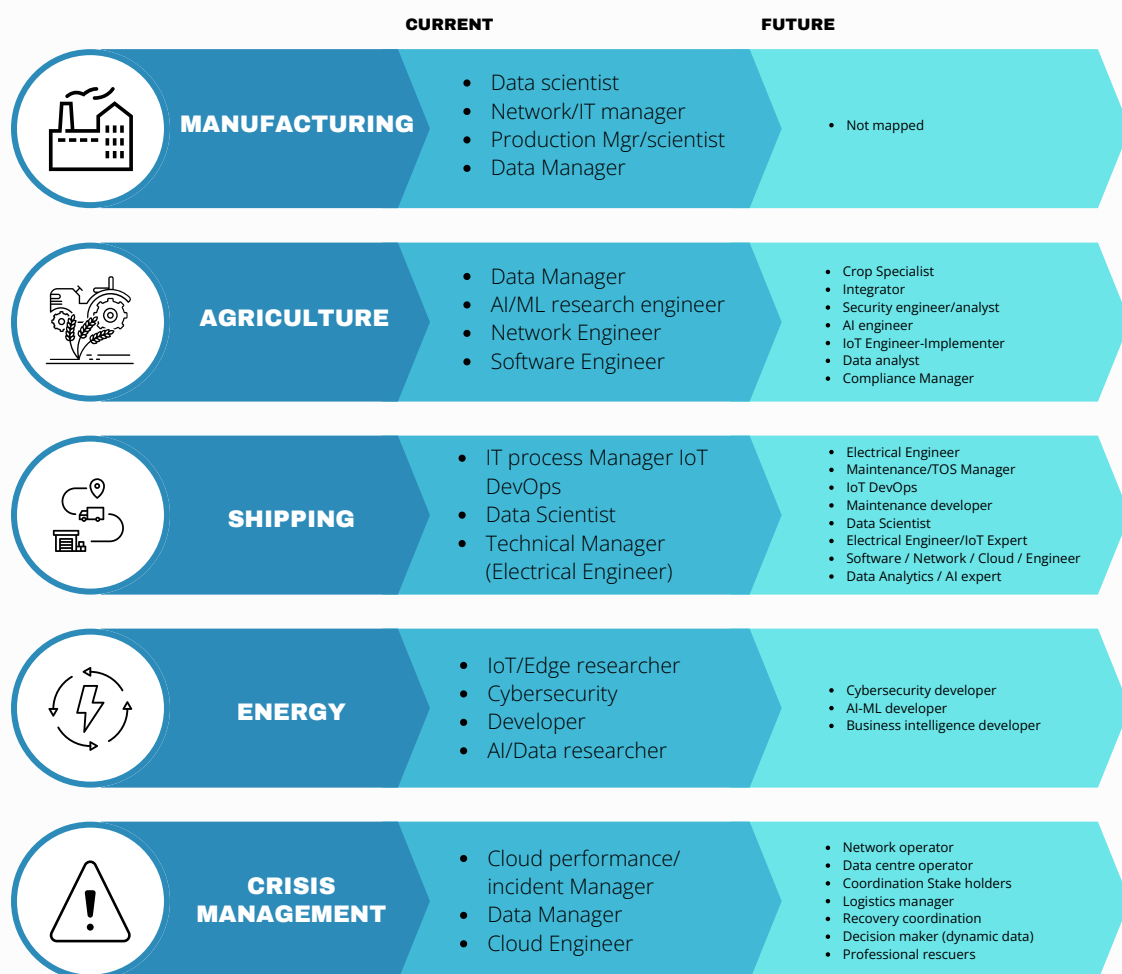Future roles in crop specialists, AI engineers, and compliance managers reflect a focus on

industry-specific domains like agriculture and energy.

Emphasis on data analytics, AI, and cybersecurity signals the increasing importance of technology integration and robust security for optimising operations in specific sectors.

	CURRENT	FUTURE
MANUFACTURING	• Data scientist • Network/IT manager • Production Mgr/scientist • Data Manager	• Not mapped
AGRICULTURE	• Data Manager • AI/ML research engineer • Network Engineer • Software Engineer	• Crop Specialist • Integrator • Security engineer/analyst • AI engineer • IoT Engineer-Implementer • Data analyst • Compliance Manager
SHIPPING	• IT process Manager IoT DevOps • Data Scientist • Technical Manager (Electrical Engineer)	• Electrical Engineer • Maintenance/TOS Manager • IoT DevOps • Maintenance developer • Data Scientist • Electrical Engineer/IoT Expert • Software / Network / Cloud / Engineer • Data Analytics / AI expert
ENERGY	• IoT/Edge researcher • Cybersecurity • Developer • AI/Data researcher	• Cybersecurity developer • AI-ML developer • Business intelligence developer
CRISIS MANAGEMENT	• Cloud performance/ incident Manager • Data Manager • Cloud Engineer	• Network operator • Data centre operator • Coordination Stake holders • Logistics manager • Recovery coordination • Decision maker (dynamic data) • Professional rescuers

NAVIGATING TOMORROW'S TALENT TERRAIN

THE CONVERGENCE OF SKILL MIX

The definition of the skills mix whereby AI, Data and Cyber are horizontal skills requirements is evident when we look at the interdependence of the 5 skills areas across the 19 roles, as displayed in the figure showing below. The table denotes the percentage of total tasks of each skills group which contain the other skill, **i.e., for all tasks that contain IoT skills, 9.5% of those contain BI/Data skills.**

From this analysis, we can see that AI and Cybersecurity, at 25.7%, have the highest average overlap of all the skills, indicating that they are the most applicable to all profiles, closely followed by BI/Data at 23.2%. In contrast, Cloud and IoT only score around 15% for the same metric.

		Skills				
		IoT	BI / Data	AI	Cyber	Cloud
Tasks	IoT		9,5%	10,8%	11,8%	14,3%
	BI / Data	17,9%		59,5%	8,8%	18,4%
	AI	15,4%	64,3%		8,8%	8,2%
	Cyber	7,7%	9,5%	16,2%		20,4%
	Cloud	17,9%	9,5%	16,2%	73,5%	
	Average	**14,7%**	**23,2%**	**25,7%**	**25,7%**	**15,3%**

The technology framework, based on extensive data sources, identifies key areas such as Cloud, Business Intelligence/Data Science, Security, AI, and IoT.

Skills identification follow a consensus-driven approach, focusing on technology-driven skills within each domain. Job roles, defined in layers, link advanced digital skills to common roles in the labor market, emphasizing non-overlapping definitions for clarity and applicability.

NAVIGATING TOMORROW'S TALENT TERRAIN

THE FIVE KEY TECHNOLOGIES

Cloud
Cloud solutions are internet-accessed servers hosting software and databases in global data centres.

Business Intelligence/Data
Business intelligence/data facilitates various analytics (descriptive, diagnostic, predictive, and prescriptive) primarily for information consumers, business analysts, and data scientists, not professional programmers.

Cybersecurity
Security technologies and services involve a holistic view of all activities necessary to plan, design, build, and manage information security across the enterprise information technology infrastructure.

Artificial Intelligence (AI)
AI is the emulation of human processing through software and hardware. It comprises AI Hardware (server, storage), AI Software (platforms, applications), and AI Services (business and IT services).

Internet of Things (IoT)
IoT is a network of identifiable endpoints connecting bidirectionally via IP. The ecosystem includes modules, connectivity, platforms, storage, servers, security, analytics, and IT services. Within each area, 10-20 skills (layer b) exist, with roughly equal distribution, ranging from 34 in Cybersecurity to 49 in Cloud.

Prevalence of skills area across tasks

15
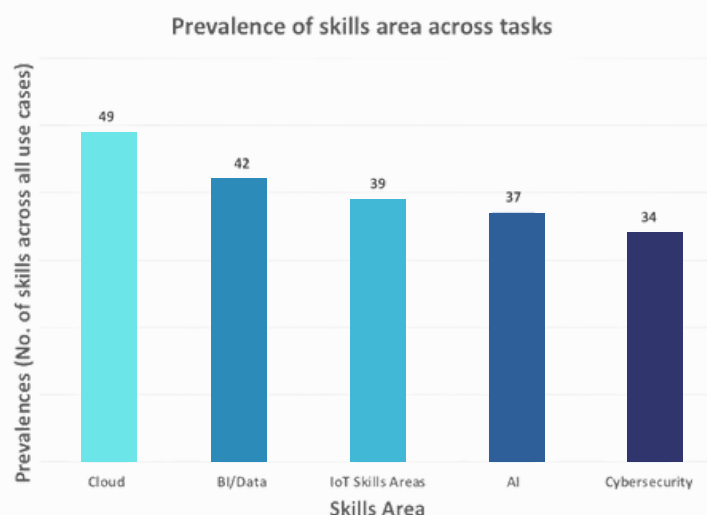
DECODING MARKET ENTRY

RISKS TOWARDS MARKET ADOPTION OF USE CASES

1. **Skill Challenges and Demand:**
Evolving difficulties in finding skills, especially in edge computing, signal the need for better education and understanding. Data-centric roles and cybersecurity are critical, with high growth rates reflecting their importance.

2. **Risk Profiles and Growth:**
Cybersecurity Managers and Data roles face the highest risks, emphasising their indispensable nature. IoT-related roles show moderate risk, while Software Engineers have low overall risk due to skill accessibility.

3. **Skill Demand and Risk Levels:**
About 20% of profiles face high risk, 10% are at low risk, and the majority fall in medium to high-risk categories. Disaster Management emerges as the most vulnerable use case, with consistent risk levels across other cases.

Profile	Avg Risk	Risk By Constituent Skills													
Cybersecurity Manager	307%	352%	347%	347%	338%	331%	331%	306%	306%	274%	274%	241%	241%		
Cloud Engineer	302%	607%	323%	323%	250%	220%	202%	189%							
Data Scientist 2	299%	607%	392%	392%	379%	379%	338%	323%	268%	217%	216%	187%	175%	162%	150%
AI/ML research engineer	288%	607%	607%	268%	266%	222%	222%	216%	162%	162%	147%				
Data scientist 1	245%	392%	338%	336%	322%	306%	222%	217%	217%	162%	162%	156%	110%		
Production Manager/scientist	241%	470%	361%	304%	304%	274%	268%	171%	168%	150%	148%	145%	128%		
Data Manager 3	238%	607%	352%	352%	217%	209%	177%	162%	162%	150%	122%	110%			
Technical Manager	229%	607%	336%	268%	266%	241%	222%	217%	168%	158%	151%	150%	145%	145%	128%
Cloud Performance Manager	227%	361%	336%	209%	202%	142%	110%								
Data Manager 2	223%	382%	352%	338%	241%	217%	209%	183%	172%	161%	145%	141%	139%		
IoT DevOps	206%	323%	266%	250%	216%	202%	195%	189%	168%	158%	151%	145%			
IT / Process Manager	201%	323%	304%	217%	209%	189%	184%	177%	172%	161%	150%	122%			
Network Engineer	197%	323%	250%	217%	209%	176%	158%	151%	147%	145%					
Network manager/IT manager	195%	266%	250%	234%	189%	172%	171%	150%	130%						
Developer	187%	250%	250%	216%	216%	209%	184%	184%	156%	156%	156%	142%	128%		
Software Engineer	182%	250%	216%	209%	195%	156%	147%	142%	139%						
IoT/edge researcher	180%	266%	266%	266%	158%	158%	158%	151%	151%	151%	145%	145%	145%		
Data Manager 1	152%	184%	184%	161%	145%	141%	141%	110%							
AI/Data Science researcher	152%	184%	184%	184%	183%	172%	161%	150%	147%	130%	110%	110%	110%		

Skills shortage risk by job role

KEY TAKEAWAYS THAT ILLUMINATE THE PATH FORWARD

LARGE ORGANISATIONS VS SMES

- **Organisational Dynamics**
Large companies often maintain separate teams for specific skills, fostering deep expertise. SMEs, constrained by budget and smaller teams, rely on versatile individuals with a broad skill set.

- **Utilisation of Resources**
Abundant resources in large companies allow for dedicated roles and efficient handling of complex projects. SMEs, despite resource limitations, navigate diverse challenges leveraging individuals with broad digital skills.

- **Skill Development Challenges**
Both SMEs and larger organisations recognise the need for continuous development for operational effectiveness. Challenges arise in finding personnel with both commercial acumen and expertise in emerging technologies like IoT/Edge.

FROM RESEARCH TO APPLICATIONS

- **The Challenge of the "European Paradox"**
Navigating the European transition from research to practical solutions in advanced digital technologies presents challenges, notably due to a lack of agile deployment practices in certain projects, requiring enhanced efficiency for successful commercial implementation.

- **Initiatives as Commercial Precursors**
Certain project teams see their initiatives as commercial precursors, highlighting the necessity for skill refinement to meet evolving demands. Recognising the importance of additional profiles, like commercial specialists, during the operational phase underscores the need for organisational adaptability to address diverse needs.

- **Continuous Development for Effective Outcomes**
The diversity in skill sets underscores the need for ongoing development beyond the initial deployment. Participants recognise the imperative of continuous skill adaptation during extended operational periods, emphasising the demand for individuals with both commercial acumen and IoT/Edge technology knowledge.

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