



**CEDEFOP**

# Going digital means skilling for digital

Using big data to track emerging  
digital skill needs

**POLICY BRIEF**



## **POLICY BACKGROUND**

### **In this section**

**Digital technology is a cornerstone of business transformation**

**Lack of staff with solid digital skills blocks investment**

**Artificial intelligence has become a productivity and competitiveness driver**

**One in every two adults in the EU has only basic digital skills**

**Just digital transformation in the EU is impossible without investing in digital skills**



# Digital technology is a cornerstone of business transformation

The internet and digital technology have changed business paradigms and give small companies enormous opportunities for global outreach. Digital tools help organisations simplify and streamline their operations, become greener and reduce waste, and better manage their staff. Technology has also greatly expanded the possibilities to interact with customers or clients and to offer them a personalised experience. The COVID-19 pandemic forced organisations to accelerate digital transformation and many introduced digital tools to allow their staff to work remotely or to sell products or services online. Undoubtedly, digital strategies and investment are catalysts for business empowerment and transformation in today's technology-driven economy. Yet, while most organisations are well-aware of the importance of investment in digital technology, in 2022 only just over half (53%) of EU firms reported taking action to become more digital (EIB, 2023). It is obvious that digitally just transformation will not be possible without a digitally ready workforce (Cedefop, 2022).

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...**digital tools** help organisations simplify and **streamline their operations**, become **greener and reduce waste**, and better manage their staff...



...**digital strategies and investment** are **catalysts** for business empowerment and **transformation** in today's technology-driven economy...



...**digitally just transformation** will **not be possible** without a **digitally ready workforce**...

# Lack of staff with solid digital skills blocks investment

Digital skills drive innovation and help organisations adopt new digital technology and adjust their operations accordingly. As technology continues to evolve rapidly, many employers need, and are stepping up efforts to find, IT workers to keep pace with the latest developments. In an increasingly digital environment that evolves as technology progresses, organisations need employees who can identify digital transformation opportunities, leverage emerging technologies, and adapt or reshape production, service, and customer processes.

A digitally skilled workforce is critical for organisations, essential in supporting their capacity to innovate and keep up with their competitors. With 70% of EU companies reporting lack of adequate digital skills as an obstacle to investment, Europe faces a considerable skills gap (European Commission, 2021). Addressing it to increase the competitiveness of organisations and the employability of people, and to promote digital inclusion, is a cornerstone of the EU digital and skills agenda.

The EU is aiming to increase the number of IT professionals from 9 to 20 million to ease labour shortages. In 2022 4.5% of EU companies reported having difficulties when recruiting IT specialists: this challenge is particularly visible in Denmark, Ger-

many, Luxembourg, the Netherlands and Austria. Affecting more than half of the companies in the sector, it is most challenging to recruit IT specialists in firms active in computer programming, consultancy, and information service activities. One in five companies producing basic pharmaceutical products struggles to recruit IT workers and 17% of companies involved in scientific research and development reported having hard-to-fill vacancies for IT specialists.

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...with **70%** of EU companies reporting **lack of adequate digital skills** as an obstacle to investment, **Europe faces** a considerable **skills gap**...

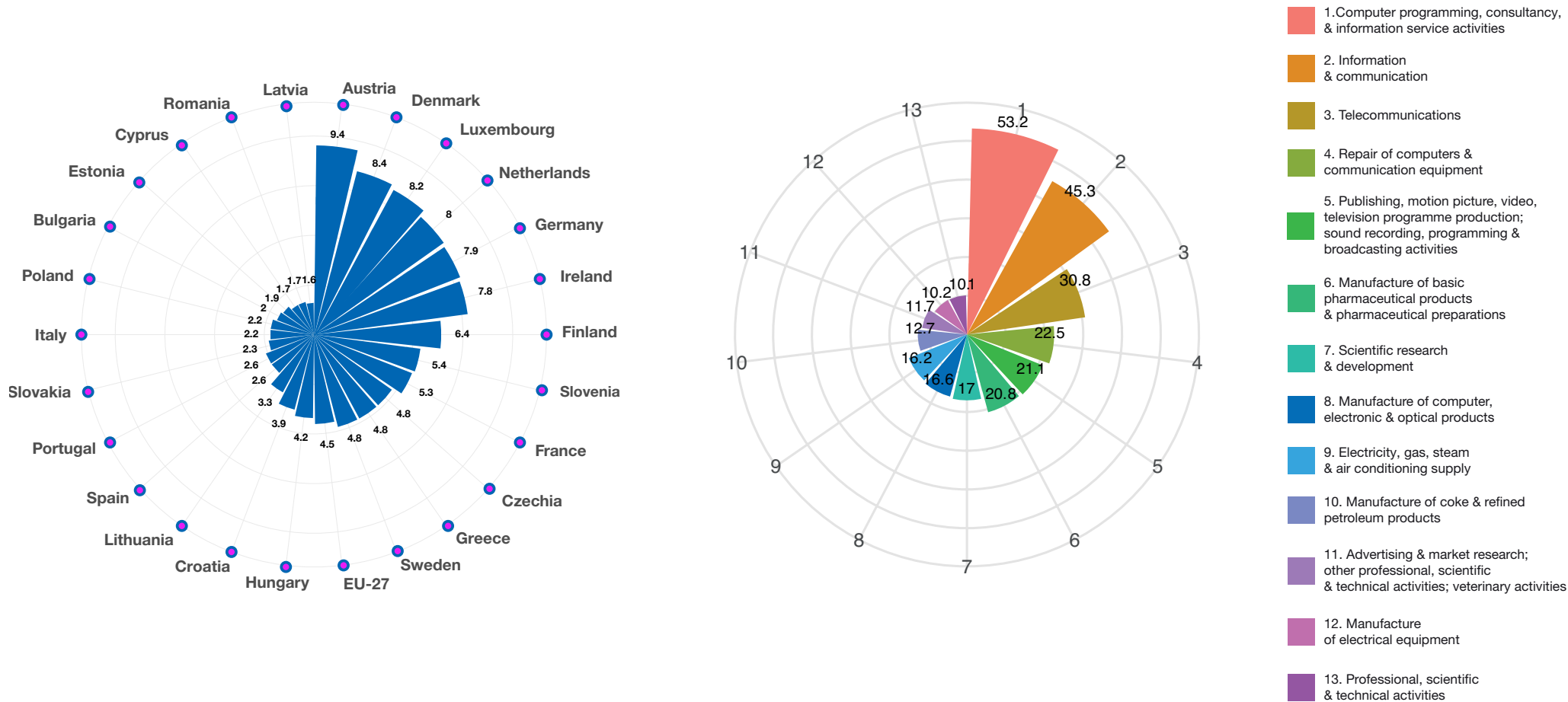


...the **EU** is aiming to **increase** the number of **IT professionals from 9 to 20 million** to ease labour shortages...



...**more than half of companies** active in computer programming, consultancy, or information service activities face **challenges to recruit IT specialists**...

**Figure 1. Enterprises (%) with hard-to-fill vacancies for jobs requiring ICT specialist skills in 2022 by country (left) and sector (right)**



NB: Data for Belgium and Malta are missing. The figure displays NACE sectors where 10% of companies or more reported recruitment difficulties in finding ICT specialists.

Source: Eurostat [SOC\_SKE\_ITRCRN2].

# Artificial intelligence has become a productivity and competitiveness driver

Putting aside the issue of necessary regulation, artificial intelligence (AI) is a foundational technology boosting organisational competitiveness and worker productivity. While it can be disruptive in particular contexts, the [Global workforce hopes and fears survey \(PwC, 2023\)](#) shows that – rather than a fear of being replaced by AI (13%) – half of the workers acknowledge the benefits of using it at work. AI is expected to contribute significantly to achieving the [sustainable development goals \(SDGs\)](#) (Vinuesa; Azizpour and Leite, 2020) and AI research and development (R&D) is crucial for national security and defence.

When it comes to the share of firms adopting AI, the EU ranks behind China and the United States. The EU has lots of AI talent, but it often fails to retain it (Castro; McLaughlin and Chivot, 2019). In the EU only 7.3% of companies employing 10 or more workers reported using at least one AI technology in 2021 (Figure 2). Alongside IT and scientific research, where 1 in every 4 companies used AI, AI implementation was highest among manufacturing companies producing coke and refined petroleum products (17.9%), computer, electronic and optical products (16.9%) or basic pharmaceutical products (15.9%).

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...a **global survey** shows that **half of the workers** acknowledge the **benefits of using AI at work...**



...when it comes to the share of firms adopting AI, **the EU ranks behind China and the United States...**

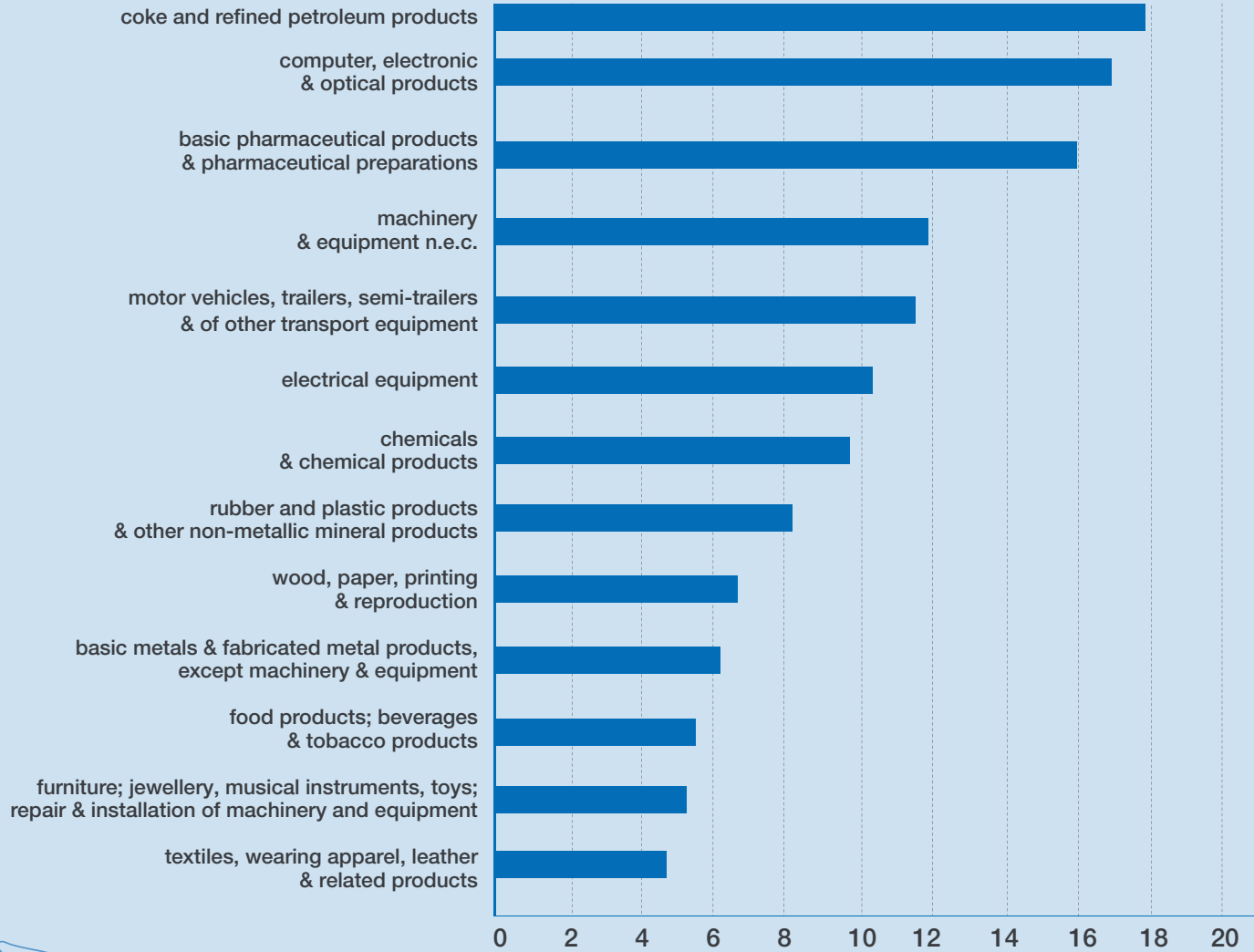


...in the EU **only 7.4% of companies** employing 10 or more workers **reported using at least one AI technology** in 2021...

Figure 2. **Enterprises using at least one AI technology (%) by sector and in the manufacturing sectors**

- 25.5%** Information & communication
- 17.6%** Professional, scientific & technical activities
- 9%** Electricity, gas, steam & air conditioning supply; water supply; sewerage, waste management & remediation activities
- 7.3%** Administrative & support service activities
- 7.3%** **Manufacturing**
- 6.4%** Wholesale & retail trade; repair of motor vehicles & motorcycles
- 5.3%** Transportation & storage
- 4.8%** Construction
- 3.6%** Accommodation & food service activities

**Manufacturing**



Source: ISOC\_EB\_AIN2.

# One in every two adults in the EU has only basic digital skills

Digital technologies and tools affect all aspects of life, including education and employment. Digital skills refer to the abilities and competences required to use digital technologies, devices, and tools effectively (Box 1). In the 21st century, digital skills are foundational skills: developing, expanding, and deepening them to contribute and be productive in the modern knowledge-based economy is important for all citizens.

Factors helping determine the digital skill level of individuals include age, education level, socio-economic status, and – because it often impacts access to technology – geographic location. Although digital skills have become increasingly important for people to thrive personally and professionally and to benefit from technological advances, in 2019 only in the Netherlands and Finland was the share of adults aged 16-74 with at least basic digital skills over 70%, the objective the [2020 European Skills Agenda](#) set for 2025 (Figure 3).

Most other EU countries need to upscale digital skills provision drastically, and in Bulgaria and Romania reaching the 2025 objective means doubling the population with at least basic digital skills. Apart from pointing towards the need to support a digital skills revolution via training and learning, the current state of play also suggests that overcoming gender inequality needs to be in focus. In almost all countries the share of female adults with at least basic digital skills is lower than the share observed for males. The gender gap in digital skills reflects gender imbalance in employment: in 2021 only 19.1% of those employed by companies in the IT sector were women.

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...in 2019 **only in the Netherlands and Finland** was the share of adults aged 16-74 **with at least basic digital skills over 70%...**

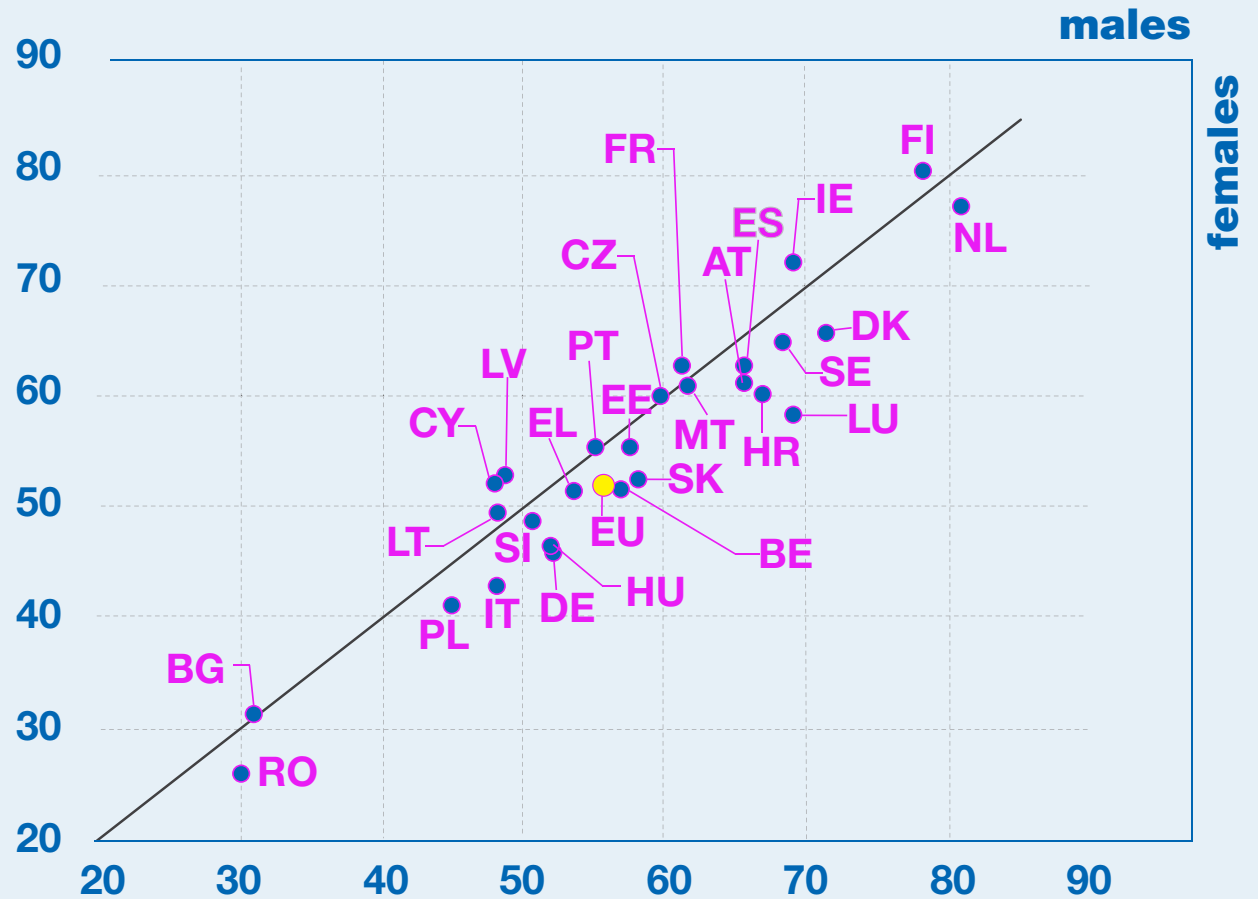


...**most other EU countries** need to **upscale digital skills** provision drastically to **reach the 2025 European Skills Agenda objective for basic digital skills...**





Figure 3. **Adults aged 16-74 with at least basic digital skills (%) by gender and country in 2020**



Source: DESI 2021.

# Just digital transformation in the EU is impossible without investing in digital skills

The European Union launched the first large-scale initiative to tackle the lack of digital skills already in 2013 with the Grand Coalition for Digital Jobs. The coalition was a European Commission-led multi-stakeholder partnership put in place to raise awareness of the need to engage national stakeholders to address the digital skills challenge.

More recently, the EU spotlighted the importance of equipping people with digital skills by signing the [European declaration on digital rights and principles](#) and by launching the [Digital decade](#), initiatives that place people centre stage in digital transformation. They are supported by substantial funding. More than EUR 4.5 billion is available through the 2023-24 Horizon Europe work programme.

The [European Social Fund Plus ESF+](#) finances the implementation of the [European Pillar for Social Rights](#), has budget of over EUR 15 billion up to 2027 to support adult learning and skills and prioritises digital skills <sup>(1)</sup>. The [Digital Europe programme](#) will provide EUR 7.5 billion of strategic funding – especially to small and medium-sized enterprises – to support supercomputing, artificial

intelligence, and cybersecurity projects, to develop advanced digital skills, and to promote widespread use of digital technologies in the economy and society. More than EUR 23 billion from the [Recovery and Resilience Facility](#) will be available for digital skills and education, for example via projects to increase the digital literacy of the population and by establishing funds to help learners finance their digital skills development.

Digital skills development is also supported by the [Erasmus+ programme](#), which enables recent graduates and students to develop digital skills and valuable work experience at businesses abroad through the [Digital opportunity traineeship scheme](#). The planned investment is expected to contribute to higher demand for IT roles across sectors in the EU economy.

<sup>(1)</sup> See also [ESF+ investments contribute to the European Year of Skills](#).



...the EU launched the first large-scale initiative to **tackle the lack of digital skills** already in 2013 with the **Grand Coalition for Digital Jobs...**



...**EU initiatives** in place today **put people centre stage in digital transformation** and are supported by **billions of funding...**



...planned **investment in digitalisation and digital skills** is expected to contribute to **higher demand for IT roles** in the EU economy...



## Box 1. **Digital skills, literacy and competence explained**

### **DIGITAL SKILLS**

refer to the ability to use digital devices and technologies effectively and confidently. These skills encompass a wide range of competences, including basic computer literacy, internet usage, online communication, information retrieval, and digital security. Such skills enable individuals to navigate and utilise various digital platforms, applications, and services.

### **DIGITAL LITERACY**

defines the ability to access, manage, understand, integrate, communicate, evaluate and create information safely and appropriately through digital devices and networked technologies for participation in economic and social life (Antoninis and Montoya, 2018)

### **DIGITAL COMPETENCE**

is one of the key competences for lifelong learning. Competences are broader than skills because they encompass knowledge, skills and attitudes. Digcomp 2.2 provides a common understanding of what digital competence is, across six areas and eight proficiency levels. It is an EU-wide tool to improve citizens' digital competence, help policy-makers formulate policies that support digital competence building, and plan education and training initiatives to improve the digital competence of specific target groups.

Source: Various: Unesco. Digital skills critical for jobs and social inclusion, Antoninis and Montoya, 2018 and Digcomp 2.2.



## EVIDENCE

### In this section

**ICT workers are still in short supply but demand growth is slowing**

**Employment for ICT workers is forecast to grow across sectors**

**The labour market for IT occupations is tight**

**Process development and business ICT roles are gaining ground**

**SQL and Javascript currently the most requested programming languages**

**Demand for AI skills remains low: few EU companies have adopted the technology**

**Blockchain skills also needed in non-IT occupations**

**Digital skill needs transcend IT occupations: several sectors are rapidly becoming more digital**



# ICT workers are still in short supply but demand growth is slowing

Recent announcements made by big tech companies about laying off workers because of revised growth strategies and restructuring processes (Eurofound, 2023) have had an immediate labour market impact. Between the first and second quarter of 2023 the number of advertisements targeting IT workers decreased by almost 100 000 (Figure 4).

This does not mean that labour market tensions are resolved: in the second quarter of 2023 there were still more than 600 000 open job advertisements for IT workers in the EU. Nevertheless, growth in demand for IT professionals is slowing and this trend has been visible since early 2022.

In the second quarter of 2023 growth in demand for IT technicians slowed for the first time since mid-2020, when the pandemic hit labour markets full force. In the past 5 years, most advertised job opportunities were for IT professionals; just 13% of online job ads for IT workers targeted IT technicians.

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...revised growth strategies and restructuring processes at big tech companies have had an immediate labour market impact...



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...in the past 5 years, most advertised jobs were for IT professionals; just 13% of online job ads for IT workers targeted IT technicians...



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Figure 4. **Trends in the number of online job ads targeting IT profiles**  
(Q1 2018=100)



Source: WIH-OJA.

# Employment for ICT workers is forecast to grow across sectors

Despite the recent slowdown, from a longer-term perspective the demand for IT workers will expand. The impact of the COVID-19 pandemic, which forced many companies to transition rapidly to remote work, appears to have had a permanent impact. It increased demand for IT professionals to manage new ways of providing services and to protect organisations against data breaches and other cyber security threats. As many organisations continue allowing their staff to work remotely, and also because of the employment impact of expected technology uptake, employment for IT professionals and technicians in the EU is projected to continue growing by 2% per year on average until 2035. The sector contributing most to employment growth is information and communication, which is the largest employer of ICT professionals. However, the impact of digitalisation will also be felt in many other sectors (Figure 5).

The increasing digitalisation of retailers transitioning to e-commerce to adapt to new realities and to stay competitive will translate into increased employment for IT professionals in the wholesale and retail trade sector. Manufacturers modernising their production processes by implementing Industry 4.0 principles will rely more on data to

improve processes, optimise supply chains and predict maintenance needs; this will create jobs for data analysts and scientists in the sector. The financial and insurance sector contributes to growing demand for IT professionals as it needs staff to implement AI technology to benefit from the opportunities big data and analytics offer for improving decision-making.

Continued development of new software, systems, or technological solutions will translate into new IT jobs in the professional, scientific and technical activities sectors. As governments aim to improve efficiency, expand e-government and improve the quality of citizen outreach and services, they will need more IT professionals to help them digitise their operations.

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**...employment for IT professionals and technicians** in the EU is projected to **continue growing by 2% per year** until 2035...



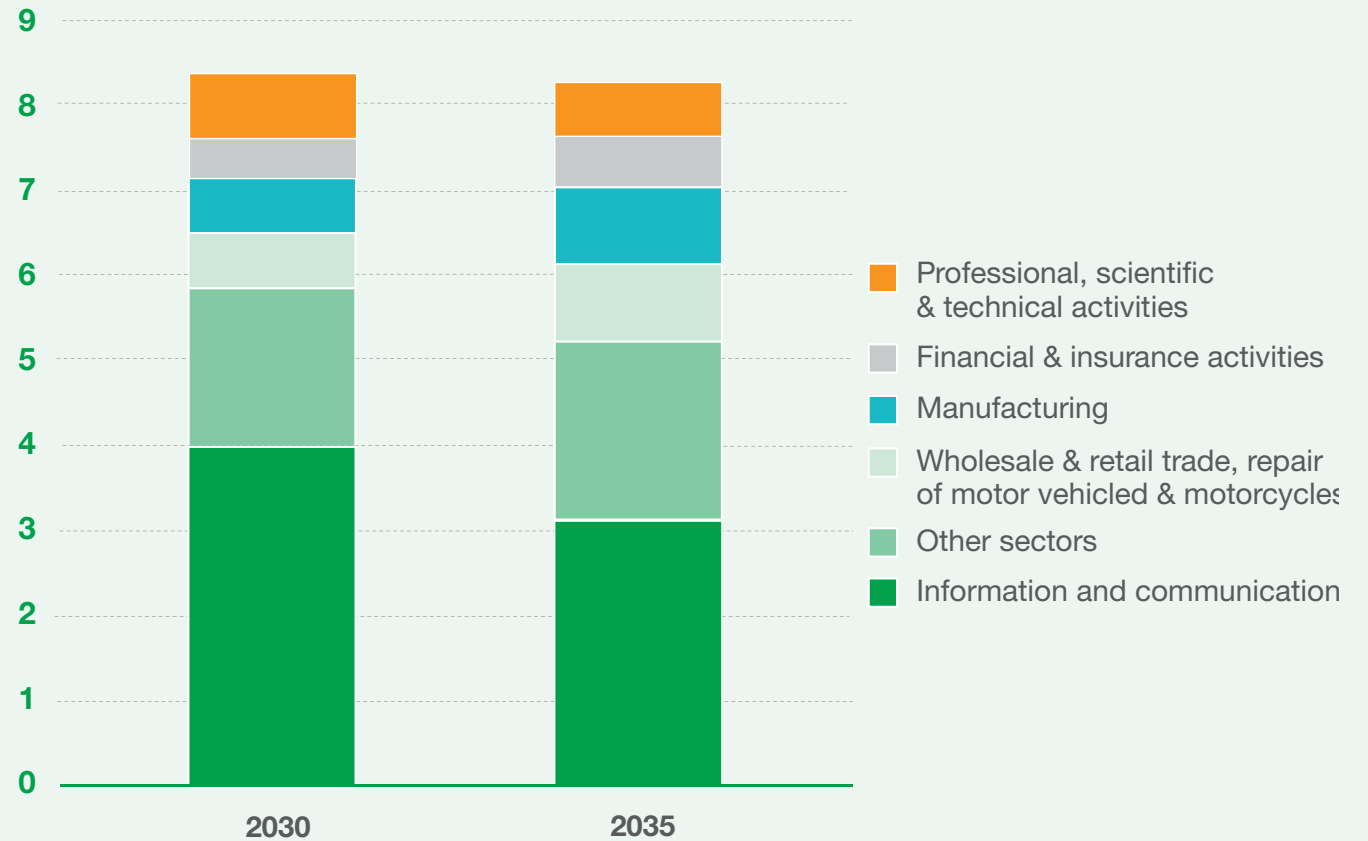
**...digitalisation of retailers** transitioning to e-commerce will **increase employment for IT professionals...**



**...new software, systems, or technological solutions** will translate into **new IT jobs** in the **professional, scientific and technical activities** sectors...



Figure 5. **Forecast contribution to employment growth of IT professionals and technicians in EU-27 by sector (in %)**



Source: Cedefop skills forecast 2023.



# The labour market for IT occupations is tight

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...while **demand for IT professionals** has been **steadily growing**, participation in **IT education and training** has **not increased sufficiently**...



...the number of **IT graduates** with an upper secondary **VET qualification** has **surpassed 100 000**, but gaps between demand and supply remain...

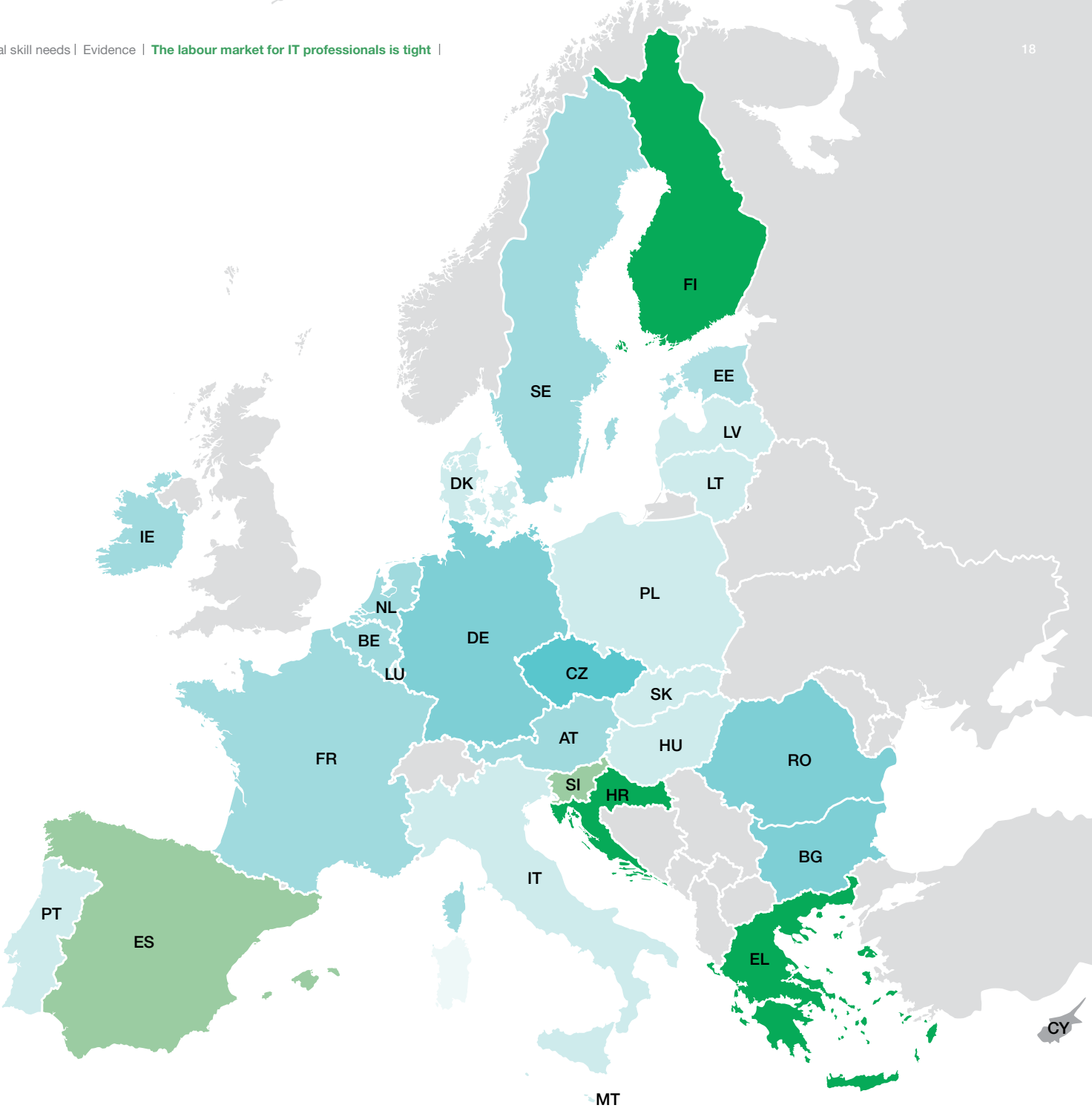
The transformative labour market impact of digitalisation, and the resulting change in skill needs that the workforce will need to adapt to in the future, are widely discussed by analysts and policy-makers (Cedefop, 2022).

While demand for IT professionals has been steadily growing for years and is expected to continue doing so over the next decade, the number of people taking part in education and training programmes in information and communication technologies has not increased sufficiently to address current skills shortages and gaps. In recent years on average only 4% of graduates had an IT qualification, irrespective of education level (Eurostat, 2023).

Recently, supply has been picking up speed, albeit at slow pace: in 2021 the number of IT graduates with an upper secondary vocational qualification surpassed 100 000 for the first time (5% of graduates at this education level). In the same year, there were 94 000 IT graduates with a bachelor degree (4% of graduates), 55 000 IT graduates with a master (4% of graduates) and 3 000 with a PhD (3% of graduates).

There is a notable gap between demand and supply in the IT sector across Europe (Figure 6). In Czechia and Germany, the number of online job advertisements per unemployed person with an IT background is highest.

Figure 6. **Labour market tightness for IT professionals in the EU**



Source: WIH-OJA and Labour force survey.

# Process development and business ICT roles are gaining ground

Between 2018 and 2022 the number of online ads for ICT professionals <sup>(2)</sup> in the EU increased for all profiles. The highest increase was registered for ICT process development roles (including DevOps experts <sup>(3)</sup>, Product owners, Digital transformation leader, Scrum master) and ICT business roles (including Business information manager, Data scientist, ICT operations manager and CIO chief information officer).

Advertised job opportunities for Product owners and DevOps experts contributed most to the growth in process development roles. Among business ICT profiles, online job ads expanded fastest for business information managers and data scientists (Figure 7).

Increasing demand for Product owners, which are essential for coordinating work across different teams and stakeholders, coincides with the uptake of agile methodologies across industrial

<sup>(3)</sup> Defined as the [European ICT Professional Role Profiles](#) by the European Committee for Standardisation (CEN).

<sup>(2)</sup> DevOps is a development methodology aimed at bridging the gap between Development (Dev) and Operations (Ops), emphasising communication and collaboration, continuous integration, quality assurance, and delivery with automated deployment utilising a set of development practices (Jabbari et al., 2016).

and service sectors. This role, which is integral to managing any agile methodology, requires software development skills and mastering agile frameworks such as Scrum or Kanban. The growing importance of collaboration between IT and operational teams and business looking for ways to reduce IT capital expenditures explains why the demand for DevOps professionals is growing. This relatively new role helps organisations deploy software and services faster by automating processes.

During the period Cedefop analysed (2018-22) the use of data analytics in organisational decision-making became more prevalent. This triggered additional demand for business information managers who can handle all business information and understand how to leverage data in strategic decisions. At the same time the demand for data scientists increased. The proliferation of AI and machine learning in organisations translates into positive career prospects for data scientists who can mix and match data analysis and business intelligence skills to drive smarter business decisions and solve complex problems.

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...**job opportunities for Product owners and DevOps experts** contributed most to the **growth in process development roles...**



...among business ICT profiles, **online job ads expanded fastest for business information managers and data scientists...**

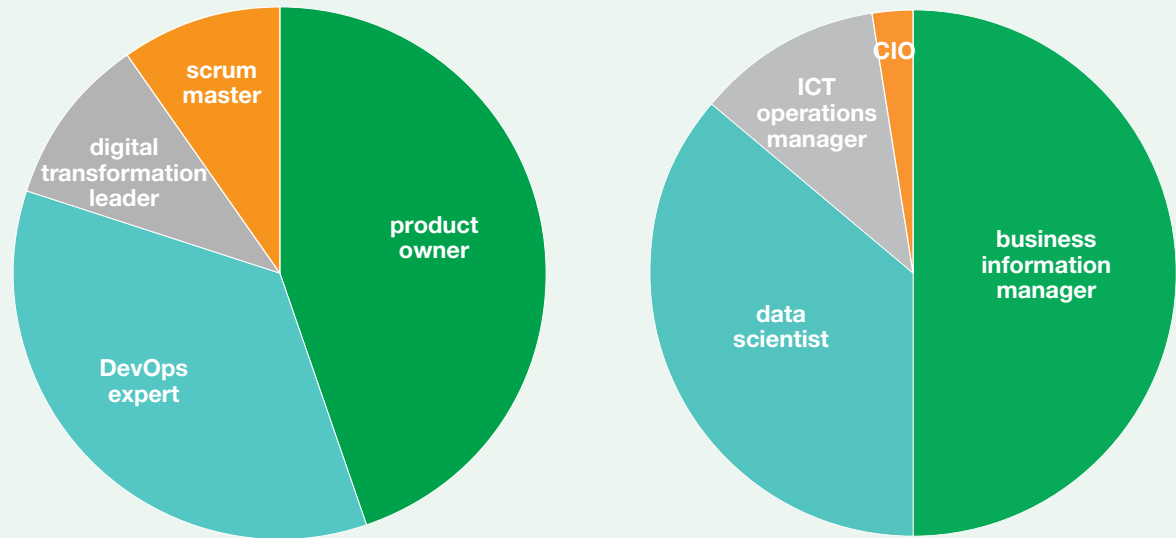


...between 2018 and 2022 the **use of data analytics** in organisational **decision-making** became **more prevalent...**



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Figure 7. **Contribution (%) of IT profiles to growth in the number of online job advertisements for process improvement (left) and business (right) IT professionals (Q3 2018 – Q4 2022)**



NB: Data classified according to the European Committee for Standardisation (CEN) ICT occupation profiles.

Source: WIH-OJA.

# SQL and Javascript currently the most requested programming languages

Rapid technological change and continuous innovation in software and tools bring about new digital skill needs. Professionals in sectors active in technology or IT development need to develop their skills and knowledge continuously to keep their expertise up to date and to stay competitive on the labour market. IT developers frequently need to learn how to work with new programming languages, as is also obvious from a [worldwide developer survey](#) which suggested that 2 in 3 have to learn a new programming language at least once per year.

The same survey also mapped the tools and technologies developers use and identified the most popular programming, scripting, and markup languages ([Box 2](#)). In 2021 and 2022 JavaScript and HTML/CSS were in the lead. Python is the third most popular language and has overtaken SQL (in fourth position) and Typescript, which was the fifth most used language (*ibidem*). Students reported using Python more often than SQL, which has typically remained the preferred language of more experienced IT professionals. Python was also the first language of choice for IT professionals who are not professional developers.

These global survey findings corroborate Cedefop evidence based on online job advertisements in the EU. In the first quarter of 2023, SQL and/or Javascript were required for the job in one quarter of online jobs ads targeting technology professionals on the EU labour market ([Figure 8](#)). The third most wanted programming language was PHP. Python is rapidly gaining ground: in the period Cedefop looked at, the number job ads mentioning knowledge of Python as required almost doubled (from around 6% in 2019 to close to 10% in Q1 2023). The popularity of Typescript is also growing but its use appears far from widespread: in the past couple of years, it was only mentioned in 1% of online job ads targeting IT professionals.

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...a **worldwide developer survey** suggested that **2 in 3** have to **learn a new programming language** at least **once per year**...

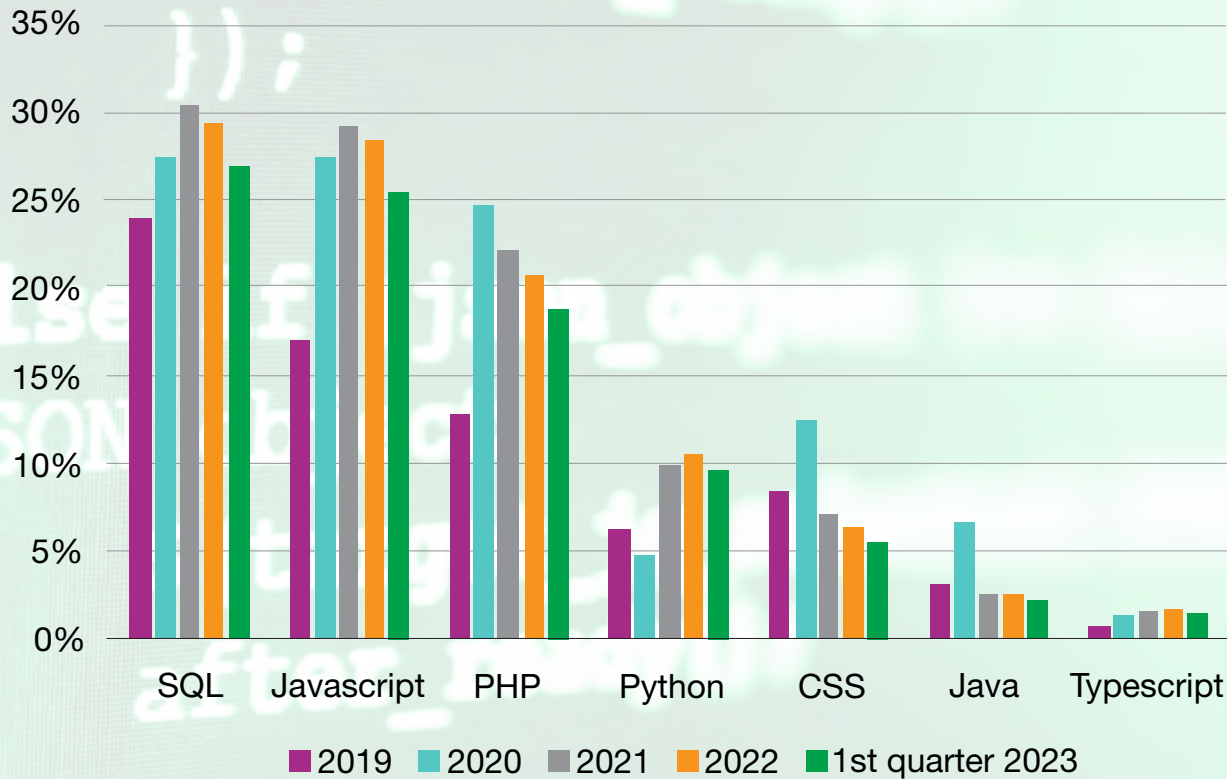


...the **most popular** programming, scripting and markup **languages** in 2021 and 2022 were **JavaScript, HTML/CSS, Python, SQL** and **Typescript**...



...in the first quarter of 2023, **SQL** and/or **Javascript** were **required in one quarter of online jobs ads** targeting technology professionals...

**Figure 8. Programming languages mentioned (%) in online job ads targeting IT professionals in the EU**



Source: WIH-OJA.

**Box 2. Programming languages explained**

Programming languages, scripting languages, and markup languages serve different purposes in computing and web development, although they often interact and complement one another.

Programming languages such as C, C++, Java, Python are used for creating standalone applications, systems software, libraries, or even simple scripts. They can be compiled or interpreted and can run independently of a webpage or user application .

Scripting languages (e.g. Javascript, PHP) support task automation and are often used for web development, data manipulation, and system administration. Markup languages (e.g. HTML) are used for defining the structure and presentation of raw text. Such languages are used to describe how elements on a page are structured and how text is formatted.

Popular programming languages include:

**SQL (Structured Query Language)**

A specialised programming language used for managing and manipulating relational databases. It is commonly used to perform tasks such as data retrieval, insertion, updating, and deletion, as well as database schema creation and modification;

**JavaScript**

A lightweight interpreted programming language primarily used for client-side web development to power interactive web pages. JavaScript is part of most web browsers and its features enable interaction with users via client-side scripts, controlling the browser, and manipulating the Document Object Model (DOM) which defines the logical structure of documents and the way a document is accessed and manipulated. JavaScript is a prototype-based, multi-paradigm, dynamic language, which supports object-oriented, imperative (explicit), and declarative (e.g. functional) programming styles. While it is most known as



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scripting language for Web pages, many other non-browser environments, such as Adobe Acrobat, also use it.

### **PHP (Hypertext Preprocessor)**

A general-purpose scripting language originally developed in 1994 that is particularly suited for server-side web development. PHP runtime is generally executed by webpage content and can be added to HTML and HTML5 webpages.

### **Python**

An interpreted (meaning that it does not use compilation into machine code before commands are executed), object-oriented, and high-level programming language first released in 1991. Used for general-purpose programming, Python is intuitive because it uses dynamic semantics, meaning that its variables are dynamic objects. Python is widely used in web development, data analysis, artificial intelligence, scientific computing, and other domains.

### **HTML/CSS**

#### **(HyperText Markup Language/Cascading Style Sheets)**

The standard markup language for creating web pages and web applications (HTML) and a stylesheet language (CSS) used to define the look and formatting of a document written in HTML. Together, they are fundamental technologies for webpage development.

### **Java**

This is a high-level, object-oriented, platform-independent programming language that is widely used for developing enterprise-level applications, mobile apps (for Android), and web services.

**TypeScript:** is a superset of JavaScript that adds optional static typing to the language to readily spot programming errors. It is designed to make it easier to write robust and maintainable code for larger projects.

Source: Cedefop.

# Demand for AI skills remains low: few EU companies have adopted the technology

Past research and discussions emphasise the negative impact of artificial intelligence on employment and several studies have provided dramatic estimates about job losses and obsolete tasks or entire occupations (see [Pouliakas, 2018](#), [Cedefop, 2023](#) and [OECD, 2023](#) for an overview). A focus on task rather than job replacement, and on human/machine complementarity, has contributed to recent research on automation showing a more positive image of the future of work. Nevertheless, the proliferation of generative AI technology is believed to open up many more possibilities to automate tasks, which could potentially reduce hours worked by 30% by 2030 ([McKinsey, 2023](#)).

Yet, AI adoption is still rather limited in Europe. Before any AI replacement effect will materialise, many more companies will need to adopt it. According to Eurostat ([Artificial intelligence by NACE Rev.2 activity](#)), in 2021 the share of companies using AI in the European Union was 7.4%. This average obscures the enormous differences in AI adoption: countries such as Denmark, Portugal and Finland lead the way in terms of AI, with over 15% reporting use of at least one AI technology. At the other side of the technology spectrum are countries such as Romania and Cyprus, where less

than 2% companies reported using any AI tools.

Lacking access to workers with advanced IT skills remains a major barrier to AI adoption ([OECD, 2023](#)). To ensure sufficient supply of workers who can develop and maintain AI systems it is vital to understand what tools they use and what skills they need to do so. AI developers reported the use of the Github Copilot, Tabnine and AWS CodeWhisperer tools <sup>(4)</sup>. At the same time, AI will require skills for workers in positions where AI is not replacing tasks or their job but is complementary. AI helps radiologists make better judgements about image-based health screenings and helps lawyers and judges easily manage enormous amounts of case law, but it does not replace them. The training needed for people employed in workplaces with AI will be about giving them the skills to use and interact efficiently with AI applications.

AI-enabled work roles require managing large amounts of data and applying machine learning techniques. Therefore, apart from programming language skills (like Python, Java), knowledge of libraries and frameworks (e.g. TensorFlow, NumPy, SciPy, Scikit-learn, PyTorch, and Apache Spark) is essential.

<sup>(3)</sup> 2023 Developer survey: AI developer tools.

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**...AI adoption is still rather limited in Europe** and before any AI replacement effect will materialise, many more companies will need to adopt it...



**...Denmark, Portugal and Finland lead the way in AI adoption (15% of companies), while less than 2% of companies in Romania and Cyprus use any AI tools...**



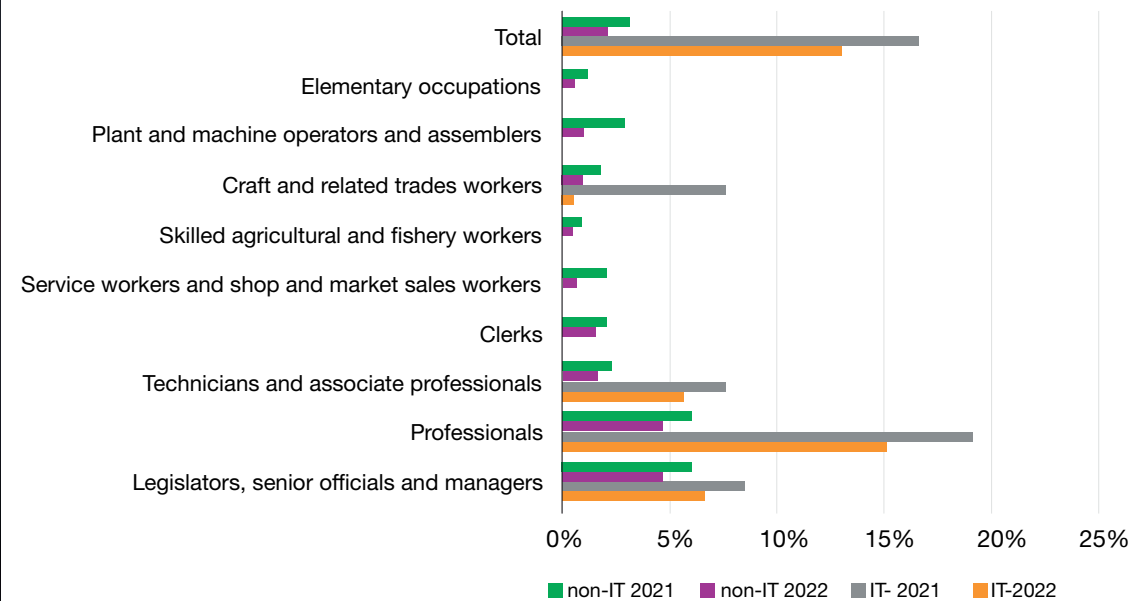
**...lacking access to workers with advanced IT skills remains a major barrier to AI adoption...**





The demand for AI skills has diffused across a large set of occupations and across sectors. AI skills requirements are much higher in IT occupations, where on average 15% of online job advertisements (OJAs) included at least one AI skill; in non-IT roles, this is the case only in 3% of online job ads (Figure 9). As expected, job ads targeting high-skilled workers on average require more AI skills than ads for low-skilled roles.

Figure 9. **Online job ads (%) mentioning at least one AI skill by broad occupation (IT versus non-IT)**



NB: The year 2022 includes data until October.

Source: WIH-OJA.

# Blockchain skills also needed in non-IT occupations

Alongside AI, blockchain technology is widely viewed to be one of the key change drivers in the following years. While it has been strongly associated with IT, blockchain technology has potential to become more widely adopted across other sectors (e.g. banking and financial services, healthcare, energy, education, and retail). Several applications of this technology (e.g. e-signature, certification of documents) have already become part and parcel of work life (CHAISE, 2021). To reap the full benefits of this technology, also in advancing sustainable economic development, the EU put forward the **Blockchain strategy**, an ambitious plan to become a leader in blockchain innovation. The bloc has acknowledged that achieving the plan's ambitions will require proper support and funding of blockchain skills development.

The **Sector Skills Alliance – CHAISE project**, financed by the Erasmus+ programme, was established to support a strategic approach to blockchain skills development and to meet the rapidly growing demand for blockchain and distributed ledger technologies (DLTs) skills in Europe. The project includes creating blockchain specialist occupational profiles to understand better the skillsets required in emerging roles and a

5-semester Blockchain VET programme to address future training needs.

Online job advertisements were among the sources used to understand the demand for skills in blockchain, which is still a labour market niche. Analysis undertaken as part of the project concluded that companies using blockchain (mostly start-ups) view roles relying on it as emerging occupations. They typically do not expect candidates to have experience in blockchain technology but require standard software development skills which they top-up with in-house blockchain training (CHAISE, 2021). With more industries and services starting to use blockchain technology, several blockchain occupations are emerging. Alongside skilled blockchain developers who can design, build, and maintain blockchain networks and applications, non-IT blockchain occupations such as Business process developer, Value chain architect, and BC consultant were identified (CHAISE, 2021).

Cedefop tracked the number of online job ads mentioning blockchain in the EU between the first quarter of 2021 and the third quarter of 2022. On average, European employers in different sectors published 5 500 such job ads every quarter (Figure 10). Occupations requiring blockchain expertise include researchers, engineers and developers, along with lawyers, game designers, marketing managers, economists, and HR recruiters.

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...while it has been strongly associated with IT, **blockchain technology** has **potential to become more widely adopted** across other sectors...



...**researchers, engineers and developers, lawyers, game designers, marketing managers, economists, and HR recruiters** are occupations for which some employers require **blockchain expertise**...

Figure 10. **OJAs mentioning blockchain in job title or description (%) by sector, 2022.**



**27%**

**Professional, scientific and technical activities**



**24%**

**Information and communication**



**15%**

**Financial and insurance activities**



**13%**

**Administrative and support service activities**



**9%**

**Other sectors**



**7%**

**Arts, entertainment and recreation**



**3%**

**Manufacturing**



**2%**

**Wholesale and retail trade**

# Digital skill needs transcend IT occupations: several sectors are rapidly becoming more digital

There are significant gaps between sectors when it comes to the share of OJAs for non-IT workers requiring at least one digital skill (Figure 11). Employers in the education, water supply, and waste management sectors demand digital skills less often in non-IT roles, with – on average – only one-third of job ads mentioning them. Sectors like electricity, gas, steam, and air conditioning supply, construction, and professional, scientific, and technical activities rely much more on them, with almost half of online ads for non-IT jobs posted in the first two quarters of 2023 requiring such skills.

The demand for digital skills in non-IT jobs is growing and some sectors that relied less on digital skills only a few years ago are now going through rapid and profound digital transformation. In the accommodation and food services sector, the demand for digital skills between 2019 and the first quarter of 2023 doubled; digital skills needs will likely keep expanding, particularly for workers involved in transforming traditional processes via AI and robotics-driven innovation (Blöcher and Alt, 2020). The growing importance of e-commerce and persistent labour shortages in the EU accelerated warehouse automation.

Before the COVID-19 pandemic, 26% of non-IT jobs advertised online by employers in the transportation and storage sector required digital skills. In 2023, the share was almost 13 percentage points higher. The role of warehouse managers has evolved and they now often need to apply predictive analytics. This means that, on top of foreseeing stock requirements, they are also expected to have the expertise to analyse data using advanced analytics techniques to optimise warehouse capacity and maximise asset utilisation (Sunol, 2023).

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...there are **significant gaps** between sectors when it comes to the **share of OJAs for non-IT workers** requiring at least one digital skill...



...the **demand for digital skills in non-IT jobs is growing** and some sectors are going through rapid and **profound digital transformation**...

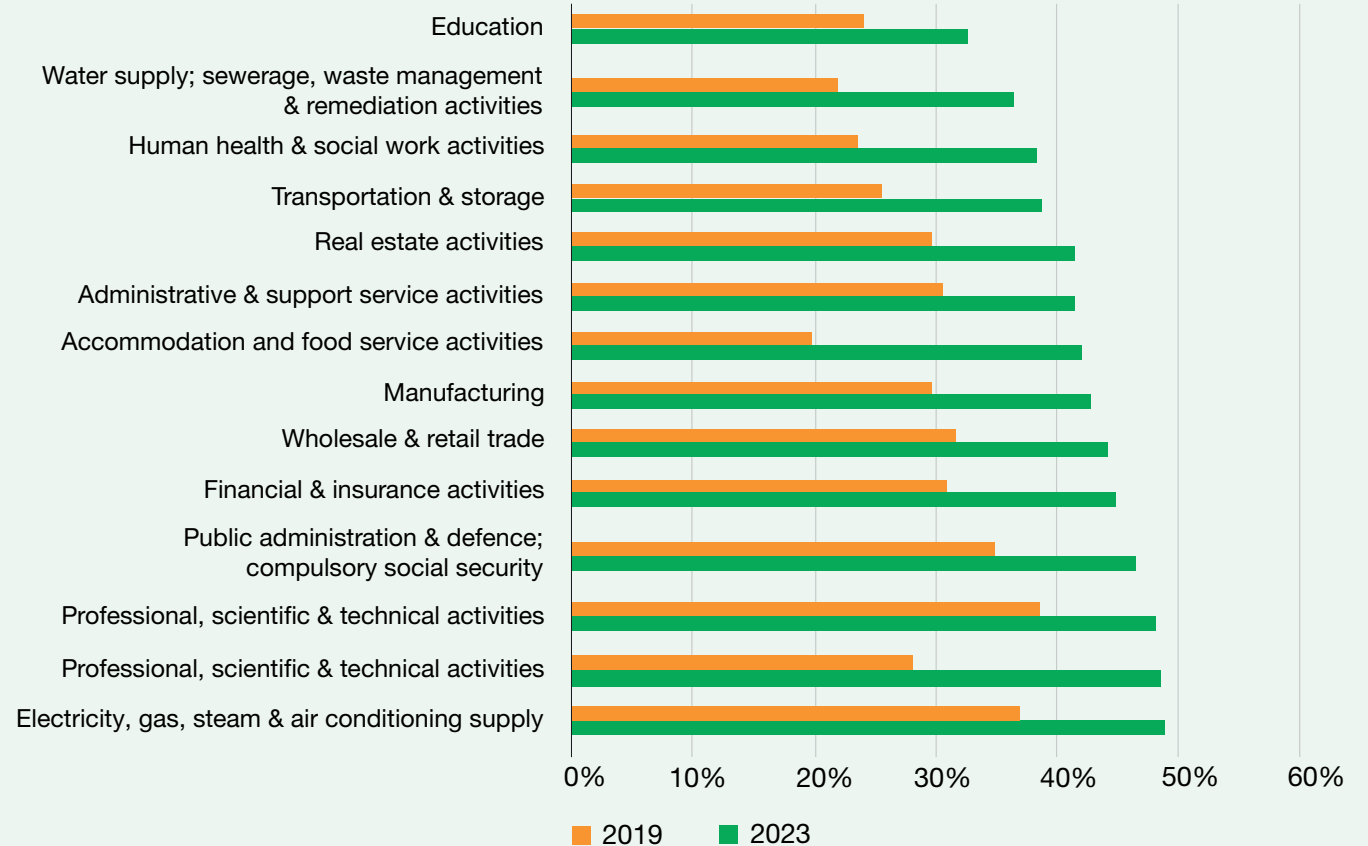


...before **COVID-19**, **26% of non-IT jobs** advertised by employers in the **transportation and storage** sector required **digital skills**. In **2023**, this was **13 percentage points** higher...



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**Figure 11. OJAs (%) including at least one mention of digital skills by sector in 2019 and 2023**



NB: Excluding advertisements targeting IT workers; only sectors with good coverage in the WIH-OJA database are shown; data for 2023 include the first two quarters.

Source: WIH-OJA.



## CONCLUSIONS

### In this section

**Teachers, trainers and skills ecosystems reinforce VET's role as digital skills supplier**

**Online job advertisement information aids education and training policy implementation**

**Big data analytics offers enormous potential for skills intelligence**



# Teachers, trainers and skills ecosystems reinforce VET's role as digital skills supplier

Digital skills are becoming essential for almost all occupations and workers, and vocational education and training (VET) institutions will play an increasingly important role in supplying them to the future workforce. To do this, VET teachers, trainers, and workplace instructors need to expand their own digital competence. This will allow them to integrate digital technology in teaching, to include the state-of-the-art technologies employers use in programmes and in teaching, and to support learners in developing their own digital skills.

Current evidence suggests not all teachers feel confident in using digital technologies. Only 1 in 2 teachers in advanced economies reported they received support when trying out new digital technology-enabled teaching (OECD, 2023). In Europe, several projects aim at bridging digital knowledge gaps to support teachers and trainers in accelerating the digital transformation of VET: the [AI-powered Next Generation of VET \(AI4VET4AI\)](#) project adds new innovative teaching content and methods to VET curricula in 11 European countries and 18 EU regions; [e-VET4AI](#) supports initial VET (IVET) in adopting AI tools; [VET teachers embracing digital disruption \(VET-TEDD\)](#) has built a database of case studies and good practice examples of innovation in engaging students via digital learning

content. The Finnish National Agency of Education's [Digitalisation in vocational education network](#) encourages collaboration and exchange of ideas among VET providers and helps them explore new digitalisation opportunities.

Skills ecosystems and the governance structures that support them can be leveraged to address the digital requirements of employers (see also [Cedefop, 2022](#)). They facilitate information exchange and help VET providers and staff make connections with sectoral employers, social partners, and regional players. Working in partnership is a basis for establishing youth and adult apprenticeships and other VET programmes with a solid work-based component. Partnership is particularly powerful in the field of rapidly evolving technology because it gives VET providers valuable first-hand knowledge about the skills employers want, including emerging digital skills needs. It also gives learners opportunities to use modern equipment and technology and to make the most of learning by seeing, doing, and trying.

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**...VET teachers, trainers, and workplace instructors** need to expand their **digital competence** to **integrate digital technology** in teaching, to **include state-of-the-art technologies** in programmes, and to **support learners...**



**...not all teachers feel confident** in using digital technologies and **only 1 in 2 received support** when trying out **new digital technology-enabled teaching...**



**...skills ecosystems** and the **governance structures** that support them can be leveraged to address the **digital requirements of employers...**

# Online job advertisement information aids education and training policy implementation

Online job ads are especially suited for analysing trends in rapidly changing technology. On top of skills and/or task descriptions, they often also specify required qualification(s) or certification(s). Analysing such information can provide valuable insights into the credentials employers are currently looking for and trend analysis can be used to by education and training providers to understand more about evolving labour market demand (Box 3).

With data protection and privacy becoming more important, and working away from employer premises becoming more common, the availability of skilled professionals who can protect business against cyber threats and attacks has become a critical factor for organisations worldwide. Cyber security specialists and professionals need continuous skilling to keep in sync with the latest digital technology and other trends impacting the way business is done in an increasingly digital marketplace. Cedefop analysis of online job ads for cyber security professionals published in the EU in 2022 shows that Certified information systems security professional (CISSP), Security information and event management (SIEM) and NIST (U.S. National Institute of Standards and Technology) cybersecurity framework were the three most requested credentials. But there were also references to at least 50 other credentials or certificates (Figure 13).

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...**online job ads** are especially suited for analysing trends in rapidly changing technology because they **specify skills, task descriptions**, and often also **qualification(s) or certification(s)**...



...**CISSP, SIEM and NIST** are the **most requested credentials** found in **online job ads** for **cyber security professionals** published in the EU in 2022...

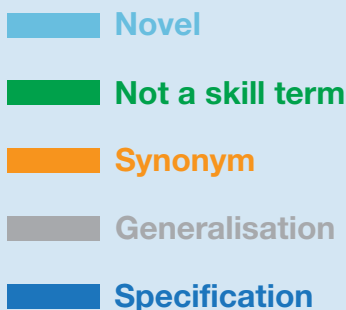
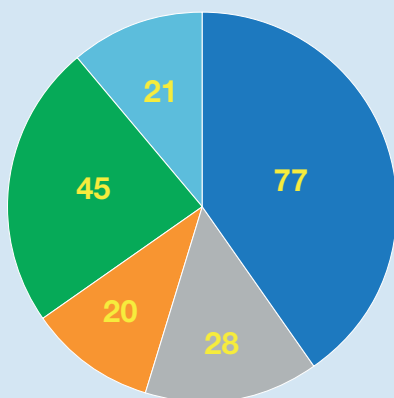


Figure 13. **Credentials and certificates mentioned by employers recruiting for cybersecurity roles in the EU in 2022**



Source: WIH-OJA NLP 2022 sample.

Figure 12. **Classification of 191 emerging skill terms found in online jobs ads posted by Italian employers**



NB: Pooled data from Q3 2018 – Q4 2019.

Source: WIH-OJA.

### Box 3. Using big data to identify emerging occupations and skills

Extracting information from millions of online job ads in different languages and analysing them comparatively across EU Member States is not an easy task. It requires data engineering, data science, statistics and labour market expertise. The WIH-OJA database applies taxonomy-based extraction using the multilingual classification of [European skills, competences, and occupations \(ESCO\)](#) to organise and categorise data about skills. Taxonomy-based extraction will result in skills information that is limited to the skills terms included in the taxonomy. Regular updates are crucial to keep the taxonomy and the skills extracted based on it up to date.

#### Identifying technologies and skills not present in taxonomies

Using ChatGPT – an advanced language model launched in November 2022 – is already requested by some employers (Lightcast, 2023) but will not feature as an extracted skill until the next ESCO update. Algorithms can be used to address the problem of taxonomies becoming quickly outdated (e.g. [Giabelli et al., 2020](#)). They assist in identifying new and emerging skills and in building complementary skills taxonomies. In the IT field, information from the [Stackoverflow platform](#) can be used to track skills terms ESCO does not yet capture (e.g. [Napierala, 2023](#)).

In identifying new skill terms, the involvement of labour market experts is crucial to confirm the validity of the terms and link them to the ESCO taxonomy, whenever possible. Analysis of Italian online job ads posted between the third quarter of 2018 and fourth quarter of 2020 confirms the importance of expertise and sound judgement (Figure 12). While the machines extracted 191 terms as potentially emerging skills, only 28 were truly novel. Many other terms were alternative formulations of existing ESCO skills and 45 terms did not refer to skills at all.

#### OJA analysis provides insight into newly emerging skills in IT and beyond

Online job ads can be leveraged as a resource when those in charge of skills taxonomies prepare updates to include missing skill terms and new occupations. The job titles they contain provide useful information for updating occupation classifications. The [International standard classification of occupations \(ISCO\)](#) currently in force was published in 2008 and does not include occupations which have emerged since then, such as Cloud architect and DevOps engineer. Such job titles in OJAs end up being flagged as occupations not elsewhere classified. In the second quarter of 2023 the share of these two occupations equalled 5% of total number of OJAs targeting technology professionals.

# Big data analytics offers enormous potential for skills intelligence

Despite the challenges inherent in analysing online job advertisements (e.g. [Cedefop](#); [European Commission](#); [ETF et al. 2021](#)) over time this source of information has increasingly been acknowledged as true added value for labour market and skills analysis. Research using such data to analyse labour market changes and to support labour market and education policies is expanding (e.g. [Napierala and Kvetan, 2023](#)). Such analysis has, for example, proved to be useful to reflect on skills needed in ICT and statistician positions ([Lovaglio et al., 2018](#)), in software engineering jobs ([Gurcan and Cagiltay, 2019](#); [Papoutsoglou et al., 2019](#)) and for computer scientist positions ([Gruger and Schneider, 2019](#)).

Online job ads also hold significant promise for understanding better the impact on skills demand of emerging technologies, such as artificial intelligence (e.g. [Alekseeva et al., 2019](#); [Manca, 2023](#)) or blockchain (e.g. [CHAISE, 2022](#)), and which skills will be replaceable by technologies based on large language models (e.g. [Eloundou et al., 2023](#)).

Combining information from OJAs with that about the characteristics of skills supply makes it possible to identify potential skills mismatches. [Persaud \(2020\)](#) used information extracted from online job ads and compared it with the content of

programmes offered by universities and colleges to identify the mismatch between skills employers are looking for in big data analytics roles and the competences students acquire in education programmes. Online job advertisements can also be leveraged to improve labour market and skills demand forecasts (e.g. [Maysa M. et al., 2022](#)) and combining such analysis with information about skills supply can open up new insights into labour market tensions. Such analysis is still in its initial stages but holds enormous promise for better matching people to jobs in tomorrow's labour market.

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...using **online job advertisements** has increasingly been acknowledged as **true added value** for **labour market** and **skills analysis**...



...**combining information** from OJAs with that about the characteristics of skills supply makes it possible to **identify potential skills mismatches**...



...**blending OJA analysis, forecasts** and **skills supply information** holds **enormous promise** for **better matching** people to **jobs in tomorrow's labour markets**...

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# POLICY BRIEF

## Going digital means skilling for digital

Using big data to track emerging digital skill needs

As the European Union navigates an era of rapid digital transformation, the demand for digital skills has never been higher, and it will keep growing in the next decade. This policy brief sheds new light on the evolving landscape of digital skill requirements in the EU-27, using Cedefop analysis of online job advertisements. The evidence in this policy brief showcases the pivotal role of digital skills in economic development and global competitiveness. It also points towards the need to accelerate the implementation of digital policy and strategy. Up- and reskilling the workforce, investing in the skills of teachers and trainers and modernising education and training systems will help ensure the digital revolution will benefit all citizens.

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