European Centre for the Development
of Vocational Training

EN

Digital skills ambitions in action

Cedefop's Skills forecast digitalisation scenario

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The **European Centre for the Development of Vocational Training** (Cedefop) is the European Union's reference centre for vocational education and training, skills and qualifications. We provide information, research, analyses and evidence on vocational education and training, skills and qualifications for policy-making in the EU Member States. Cedefop was originally established in 1975 by Council Regulation (EEC) No 337/75. This decision was repealed in 2019 by Regulation (EU) 2019/128 establishing Cedefop as a Union Agency with a renewed mandate.

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Foreword

Rooted in long-term transformative shifts spanning decades, the digital and green transitions are becoming increasingly intertwined and gaining momentum. The shifts in skill requirements the twin transition brings about extend beyond the occupations and sectors directly driving change. Accelerating up- and reskilling to equip Europeans with the means to succeed in increasingly digital and eco-friendly jobs, is a major challenge for the coming years.

Reliable and trusted skills intelligence is essential for understanding and managing the twin transition and for ensuring it is just. In the past decade, analysis mapping the labour market and skills impacts of digitalisation and automation has advanced. The focus has been on assessing and quantifying the threats posed by automation and, more recently, artificial intelligence (AI).

This report presents new analysis that considers the complex interlinkages between digitalisation, digital skills and learning and their direct and indirect impacts on employment across sectors and occupations. Cedefop has used its skills forecast to build a policy scenario that incorporates the goals and ambitions of Europe's Digital Decade Programme and the digital skills objectives outlined in the European Skills Agenda, and to evaluate the repercussions of the digitalisation and digital skills agenda on skills and employment. The scenario builds upon the 2023 Cedefop Skills forecast and its assumptions about implementation of policies under the European Green Deal; adding digitalisation and digital skills targets helps capture the impact of the twin transition more comprehensively.

Using our skills forecast framework as a tool for evaluating policy contributes to the new generation of skills intelligence to which Cedefop is actively giving shape. While the scenario approach of this report uses a macro perspective that helps the thinking about the future, the findings are not to be interpreted as the future itself. The speed of deployment of automation and IT more generally, which depends on socio-economic and other factors that are challenging to define precisely, will be a decisive factor for employment trends in the coming years. The scenario findings, therefore, are not as definitive employment predictions but do provide the background and context for shaping forward-looking vocational and education training (VET), employment, and skills policy. We hope policymakers and other stakeholders will leverage the insights this report presents for this purpose in their efforts to accelerate upskilling and reskilling for the twin transition in the coming decade.

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Contents

Figures & tables

Figures

Tables

CHAPTER 1.
Introduction

1.1. Skills forecasts in times of transition

Cedefop skills forecasts supply comprehensive and up-to-date insights into the current structure and future trajectories of the EU labour market. They use a standardised methodology and integrate data and assumptions covering several decades to capture the impact of megatrends on labour markets and education and training systems in the EU and the Member States. Cedefop's 2023 forecast (Cedefop 2023d) showcases the transition toward more service-oriented economies imprinted by the twin transitions, the impact of workforce ageing, and skills upgrading replacing the long-lasting trend of skills polarisation.

Skills forecasts play an increasingly important role in anticipating and influencing change as Europe's economies and labour markets transition towards a greener and more digital future. They offer evidence-based insight into how labour market trends are shaped by megatrends and other societal developments. Skills forecasts have relevance far beyond the traditional policy domains they were developed for in the past, such as employment and education. Decision-makers in charge of innovation and technology, environmental sustainability, digitalisation, migration, social policy and other policy areas can leverage forecasts to gain valuable insight into the links between ambitions in their policy field, labour market needs, and skills trends.

Beyond their value for policy making, skills forecasts also help employers and sectors see potential skills shortages on the horizon. Information about occupations and skill profiles where shortages are likely to emerge is instrumental for designing training programmes and human resources policies fostering skill development, activation, and matching. In the past decade, the importance of presenting forecast results in non-expert, accessible and user-friendly formats has grown. Skills forecast-powered tools support workers and learners in making informed decisions about education and training and career development opportunities.

While skills forecasts provide valuable indications about future trends, they are not to be interpreted as precise predictions. Mechanistic use of forecast information, for example attempting to determine the exact number of graduates needed to meet labour demand, is cautioned against. The accuracy of forecasts is generally higher when based on stable historical trajectories. Correctly interpreting findings can be challenging during economic shocks and economic crises, unexpected events like the COVID-19 pandemic, or changes in policies such as the Green Deal.

Nevertheless, even in times of rapid change and transition, skills forecasts remain valuable. They can provide insightful perspectives on the impact of accelerating trends or shocks and be used as a policy evaluation tool. Comparing policy scenarios based on expert assumptions with a 'business as usual' scenario helps decision-makers in employment, education, and skills development and related policy fields understand how policy aims and targets interact with the labour market, employment, and skills trends. This facilitates informed decision making in the face of evolving circumstances. Using forecasts as a policy evaluation tool contributes to monitoring and implementation of the Skills Agenda, the EU VET policy framework, the European Pillar for Social Rights, and other EU flagship initiatives.

1.2. Digital transition scenario

The digital transition is clearly visible in the 2024 Cedefop Skills forecast, which anticipates rapidly expanding employment in the telecommunications and computer programming sectors throughout

Europe. As it is rooted in historical trends, the standard forecast methodology does not fully capture the ambitious digital transition goals and targets put forward in the European Skills Agenda and Europe's Digital Decade policy programme. To capture the ambitions and the complexities and uncertainties of digital transition, Cedefop has used its skills forecast framework to develop a scenario that translates digital policy aims and targets into trends in skills and jobs.

To calibrate the assumptions, the scenario has taken into consideration all quantitative research and empirical literature on the impacts of AI and automation on skills and jobs. Most research studies find evidence for negative employment impacts because technology displaces workers in jobs that can relatively easily be automated and because increased labour productivity in some labour market segments makes labour more expensive, thereby reducing labour demand.

This report provides a different image and shows that the negative employment impact of digitalisation is quite modest and that AI also creates jobs. Nevertheless, while the scenario presents a stylised image of the future, it cannot be interpreted as a definitive prediction of it. Modeling the digital capital deepening impacts of AI and automation on future growth and employment would require more advanced analysis. Such work was out of scope of the present scenario study.

Cedefop's digital transition scenario covers three broad areas to capture policy implications and impacts: upskilling and reskilling; digitalization, automation, and AI adoption; and investment expenditure to support the first two areas. The scenario is compared with the 2024 (baseline) Skills forecast, which incorporates the assumption that the European Green Deal will be fully implemented. The analysis in this report offers a comprehensive perspective of the labour market impact of the twin transition.

CHAPTER 2.

Scenario approach and assumptions

2.1. Introduction

Building a forecast scenario requires a thorough assessment of factors and variables impacted by policy and involves adopting a set of assumptions. The Cedefop Digital transition scenario combines the European Green Deal assumptions reflected in the 2023 Skills forecast (i.e. the baseline scenario) (Cedefop 2023c) with a set of digital transition assumptions. The latter incorporate the digital skills targets set out in the European Skills Agenda and the ambitions of Europe's Digital decade policy programme (Table 1).

These assumptions encompass a wide range of variables to capture three types of impact:

(a) up- or reskilling impacts resulting from the 2020 European Skills Agenda objectives;
(b) impacts of the digital transition in terms of increasing digitalisation, automation and AI adoption;
(c) impacts of the investment required to enable (a) and (b).

Table 1. **Digital transition targets and objectives**

Europe's Digital Decade: digital targets for 2030	European Skills Agenda: objectives to be achieved by 2025
At least 80% of the population having Basic digital skills. 75% of EU companies using cloud, AI, or big data (i.e. increasing the tech uptake). More than 90% of SMEs reach at least a basic level of digital intensity (targeting late adopters). Digitalisation of public services.	70% of adults aged 16-74 having at least basic digital skills.

Source: European Commission (1) (2).

2.2. Upskilling and reskilling assumptions

The scenario assumes the successful achievement of the digital skills targets: 70% of the total population has basic digital skills by 2025 and 80% by 2030. Reaching these targets means training part of the population to reach at least a basic level of digital skills and covering the costs associated with such training. The number of people to be trained is calculated using the population forecast from the 2023 Skills forecast. Only the working-age population (i.e. aged 15-64) is considered because the focus of the scenario is on people who are likely to remain in the labour force. The digital skills level is proxied by the percentage of the working-age population having basic or above basic digital skills (3).

The digital skills target has been translated into a digital skills trajectory up to 2030 and an estimated number of people who would to be trained in every EU Member State up to 2035 (Table 2). Reaching the target is expected to lead to considerable improvement in the level of basic digital skills in Bulgaria, Italy and Romania. In Member States which have already reached the 2025 target in 2021, such as the Netherlands and Finland, the share of the population having at least basic digital skills remains at its 2021 value, and no additional digital skills training expenditure is foreseen until 2025.

(1) European Skills Agenda
(2) Europe's digital decade: digital targets 2023
(3) Based on the Eurostat DESI index, the share of individuals with basic or above basic overall digital skills for the population aged 16-74 is used instead, given that the indicator is not available for those aged 16-64. The inclusion of those aged 65 or more in the indicator is not expected to impact the scenario significantly.

Table 2. **Share of individuals with basic or above basic overall digital skills and number of people requiring training.**

	% of individuals with basic or above basic overall digital skills			No of people requiring training ('000)		
Member States	**2021**	**2025**	**2030**	**2025**	**2030**	**2035**
Belgium	54%	70%	80%	1 166	689	638
Bulgaria	31%	70%	80%	1 584	270	322
Czechia	60%	70%	80%	694	627	590
Denmark	69%	70%	80%	43	330	326
Germany	49%	70%	80%	10 487	3 604	4 266
Estonia	56%	70%	80%	108	71	71
Ireland	70%	70%	80%	-	432	55
Greece	52%	70%	80%	1 076	473	486
Spain	64%	70%	80%	2 010	2 819	2 223
France	62%	70%	80%	3 308	3 974	3 890
Croatia	63%	70%	80%	187	283	-
Italy	46%	70%	80%	8 923	2 874	2 418
Cyprus	50%	70%	80%	128	70	8
Latvia	51%	70%	80%	179	40	96
Lithuania	49%	70%	80%	313	58	134
Luxembourg	64%	70%	80%	38	54	4
Hungary	49%	70%	80%	1 253	558	484
Malta	61%	70%	80%	45	50	15
Netherlands	79%	79%	80%	-	945	910
Austria	63%	70%	80%	357	490	464
Poland	43%	70%	80%	6 216	1 967	1 914
Portugal	55%	70%	80%	860	411	452
Romania	28%	70%	80%	4 857	811	951
Slovenia	50%	70%	80%	265	114	106
Slovakia	55%	70%	80%	480	290	295
Finland	79%	79%	80%	-	3	267
Sweden	67%	70%	80%	1 166	689	638

NB: Digital skill indicator refers to the percentage of individuals with basic or above basic overall digital skills All five component DESI indicator are at basic of above basic level.

Source: Cedefop Skills forecast, Eurostat (isoc_sk_dskl_i21).

The cost of digital skills training in the Member States was obtained by multiplying the cost per participant (4) by the number of people to be trained (Annex Table A.1). To calculate the costs of digital

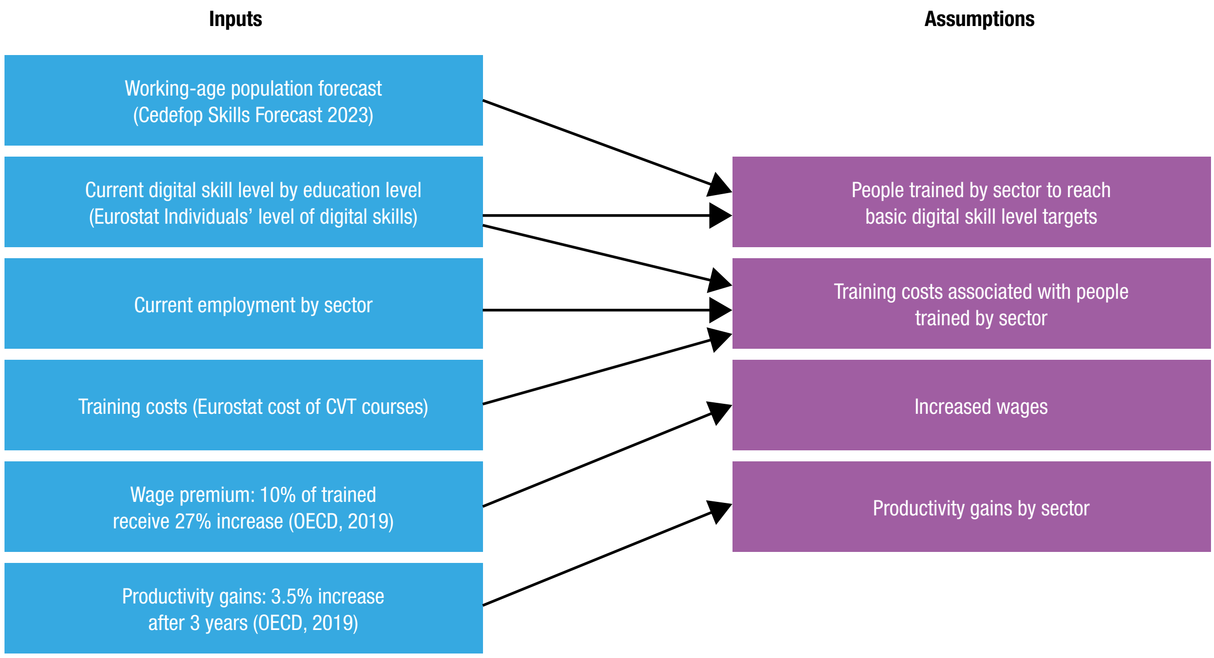
(4) Information from dataset *Cost of CVT courses by type and size class – cost per participant* was used (Annex Table A.1).

training by sector, it is assumed that workers with the same educational attainment have the same level of digital skills across sectors and that the costs of digital skills training in 2025, 2030 and 2035 are distributed equally in intermediate years (Annex Table A.2). While most training will need to happen 2024-25, some will also be required to maintain the Digital skills targets in the years up to 2035.

In the scenario, the assumption is made that the people who receive the training (Table 2) will benefit from a wage increase relative to the baseline. This assumption is aligned with the results of a study showing that workers who improve their digital skills from Level 1 or below to Level 2 or 3 earn 27% more, on average (OECD, 2019). The wage premium is expected to materialise gradually, starting from 2026 and reaching 27% by 2030.

Apart from the wage premium, the digital skill training is also expected to result in productivity gains. In line with empirical findings (OECD, 2019), it is assumed that productivity increases by 3.5% after 3 years of digital skill improvement. The productivity gains have been added by sector, using the number of people trained as weights. Figure 1 presents a summary of the assumptions and the inputs linked to them.

Figure 1. **Summary of assumptions and inputs for upskilling and retraining**



Source: Cedefop Digital transition scenario.

2.3. Digital transition assumptions

The digital transition in Europe is driven by investments in new technologies (EU companies using cloud, AI, or big data), and the speed of, and increase in, the adoption of automation technologies, i.e. robots. To build the digital transition forecast scenario, a review of recent analytical work on the labour market impact of generative AI was carried out to set assumptions that complement estimates on the automation risks by sector already reflected in the forecast model (Annex A.3).

Assessing the impact of AI on the labour market is challenging because of uncertainty about the readiness of companies to deploy it. General purpose technologies leveraging the latest advancements in AI technology radically broaden technological capabilities. The launch and rapid adoption of Chat GPT and other large language models has challenged long-held assumptions about the nature of work and types of jobs which could potentially be automated. Occupations and tasks previously assumed to be shielded from automation including a wide range of high-skilled ones, increasingly considered to be replaceable by AI. AI-driven innovation can also augment jobs because the technology widens opportunities for human-machine interaction. It is difficult to assess which jobs are at risk of being automated and in which labour market segments job augmentation dominates. At the time of writing this report, the discussions about the automation likelihood of different occupations were not conclusive. Some studies provided insights into the tasks exposed to AI, because of large language models (e.g. Eloundou et al., 2023) and into the automation potential of AI and GPT (generative pre-trained transformation) technology (Gmyrek et al., 2023). Using the task profiles of occupations, the latter analysis was leveraged to derive estimates of AI impact on employment in occupations (Table 3).

Table 3. **AI exposure (1) level by occupation**

Occupation	Medium exposure to generative AI (share of tasks)	High exposure to generative AI (share of tasks)
Managers	13%	1%
Professionals	25%	1%
Technicians	25%	2%
Clerks	58%	24%
Service workers	18%	4%
Skilled agricultural	7%	1%
Craft and related trade workers	3%	-
Plant and machine operators	6%	2%
Elementary occupations	3%	1%

(1) Exposure levels are measured at task level. Tasks with high exposure to automatability through generative AI are those which received an exposure score of above 0.75 (index scores are between 0 and 1). Medium exposure is calculated by index scores between 0.5 and 0.75.

Source: Gmyrek et al.(2023).

Research that quantifies the risk of AI impact in terms of jobs lost in in sectors is scarce. The handful of studies providing sectoral data show that – in relative terms – sectors with large net employment gains include information and communication, health and social work, professional and scientific services, and real estate (PwC, 2023). Employment is expected to decline as AI implementation progresses in transport, mining and quarrying, manufacturing, and public administration and defence (Ibid.).

Most research on AI's labour market impact focuses on job destruction, i.e. automation of tasks, and less so on its job creation potential (e.g. Albanesi, et al., 2023; Wilson, et al., 2022). Estimates show that – depending on the speed of automation adoption – global productivity could grow by 0.2%-3.3% annually between 2023 and 2040 (McKinsey, 2023b). In developed countries, the estimated productivity gains are higher: 1.3-3.9% in Germany and 0.8-3.7% in France (McKinsey, 2023b). Using experimental evidence, Dell'Acqua et al. (2023) analysed the productivity gains from generative AI on complex, knowledge-intensive tasks. They find productivity increases ranging from 12% to 25%, depending on the metric (number of tasks completed or time to complete tasks). The productivity effect of using new technology) and the development and maintenance of it can be expected to create jobs.

To capture the impacts of automation comprehensively, the assumptions used in the scenario include the automation risk by sector and the increase in productivity associated with the use of generative AI (Table 4).

Table 4. **Automation risk and generative AI exposure by sector (% of employment): assumptions used in the scenario**

Sector	Automation risk (1)	High exposure to generative AI (2)
Agriculture	12%	2%
Mining and quarrying	12%	3%
Manufacturing	12%	3%
Electricity, gas, steam and air conditioning supply	8%	4%
Water supply; sewerage; waste management and remediation activities	10%	4%
Construction	12%	2%
Wholesale and retail trade; repair of motor vehicles and motorcycles	9%	5%
Transporting and storage	10%	6%
Accommodation and food service activities	8%	4%
Information and communication	6%	3%
Financial and insurance activities	6%	7%
Real estate activities	8%	5%
Professional scientific and technical activities	7%	5%
Administrative and support service activities	9%	5%
Public administration and defence; compulsory social security	7%	5%
Education	8%	2%
Human health and social work activities	6%	3%
Arts, entertainment and recreation	7%	4%
Other services activities	9%	4%
Activities of households as employers; undifferentiated goods – and services – producing activities of households for own use	9%	4%

(1) This figure is calculated as a weighted average using the year 2023 from Cedefop Skills forecast 2023. Original figure from Automation risk for occupations | CEDEFOP (europa.eu) is by occupation.
(2) This figure is calculated as a weighted average using the year 2023 from Cedefop Skills forecast 2023. Original figure is by broad occupation and was taken from Figure 2 of Gmyrek et al.(2023)

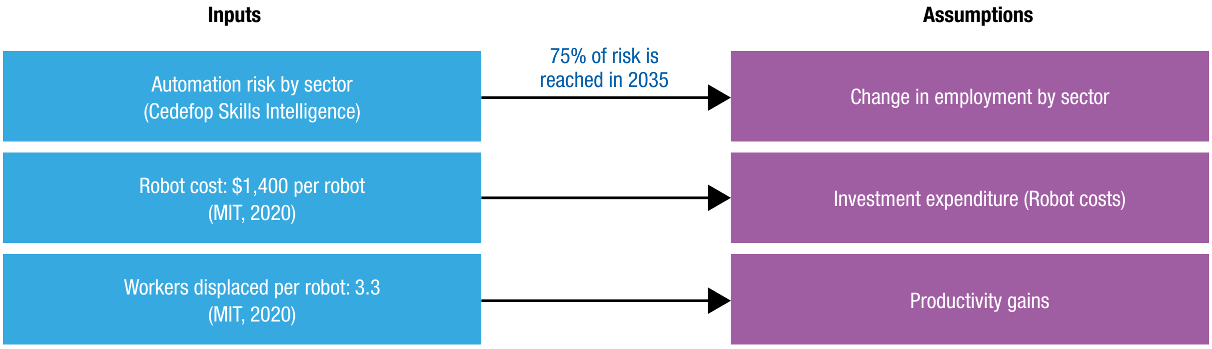
Source: Cedefop based on the literature.

Key assumptions and inputs related to automation risks are summarised in Figure 2. About 75% of the job displacement resulting from automation is expected to materialise by 2035 (5), with initial impacts appearing in 2024. While equal sectoral job displacement rates were applied across the Member States, the volume of employment displaced depends on the national sectoral distribution of employment. The

(5) The green transition will create more labour-intensive jobs and is less likely to lead to mass displacement. The interaction between digital and green technologies is expected to reduce the risk of automation of jobs deemed at high risk of automation. However, it is unclear which technologies will be deployed first. At the same time, there is considerable uncertainty around the AI deployment timeline. For this reason, this report presents two alternative scenarios to explore the impact of different speeds of automation. The first assumes at a delay of 5 years (policy aims and targets achieved in 2040 instead of 2035); the second at a delay of 15 years (policy aims and target achieved in 2050 instead of 2035).

scenario builds in the assumptions that – across sectors – the cost of a robot is around USD 1 400 ([6]), and that one robot can replace about 3.3 workers (MIT, 2020).

Figure 2. **Summary of assumptions and inputs related to automation**



Source: Cedefop Digital transition scenario.

Figure 3 presents the key assumptions and inputs related to the expected impact of AI adoption across sectors. The exposure to generative AI presented in Table 4 is used to calculate the productivity increase resulting from the adoption of AI by sector. The sectoral productivity gains are applied across all Member States and assumed to be achieved by 2035.

Additional productivity gains are expected from increased AI uptake (increased use of AI technologies) (PwC, 2018a). The elasticity of productivity with respect to AI (the % increase in labour productivity resulting from a 1% increase in AI-uptake (per worker)) is summarised in Table 5.

Table 5. **Elasticity of productivity with respect to AI**

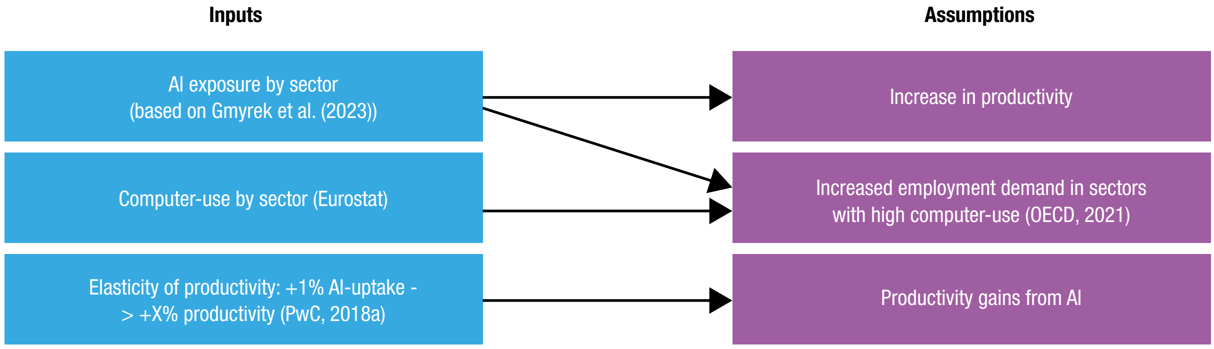
Sector	Elasticity
Energy, Utilities & mining	0.23%
Manufacturing & construction	0.37%
Transport & logistics	0.42%

Source: PwC (2018a).

Increasing AI use in the economy is also expected to lead to employment growth in some sectors. Sectors for which automation technology and AI is core business are expected to see an increase in employment demand as a result of increased AI deployment (OECD, 2021, p. 4-5). In every country, these employment gains are applied to sectors where computer use is above 80% ([7]). The OECD (2019) estimate of the productivity impact of improved e-governance (+1.079%) has been integrated into the scenario to account for the eGovernance target set by the European Commission (Table 1).

([6]) Price of service robotics per unit worldwide from 2016 to 2027, by region.
([7]) Based on the Eurostat information about the use of computers and the internet by employees by NACE Rev.2 activity (ISOC_CI_CM_PN2) (see Annex Table A).

Figure 3. **Summary of assumptions and inputs related to AI adoption**



Source: Cedefop Digital transition scenario.

2.4. Funding the digital transition

The calculation of the investment cost of the digital transition is based on the level of ambition for the different targets and strategies. Synergies exist between the European Skills Agenda and Europe's digital transition with respect to investment required for the organisation of digital skills training. Some of these investment requirements are envisaged under the Recovery and resilience facility and were incorporated into the skills forecast scenario.

Part of the EU Recovery and resilience facility grants support investment to speed up AI/automation adoption. For automation, the assumed investment requirement in the scenario is based on the degree of automation and its costs (i.e. the number of robots multiplied by cost per robot). If funds are required additional to what the grants cover, it is assumed sectors will pay, adding to their total costs. The cost increase may be passed on to consumers via higher prices and/or be absorbed, resulting in lower profits.

CHAPTER 3.

How digital transition reshapes the employment outlook

3.1. Unravelling the effects of digital transition

The 2023 Skills forecast (i.e. the baseline used in the Digital transition scenario) foresees expanding employment throughout the European Union. Between 2021 and 2035, employment is expected to increase by around 3.4%, approximately seven million jobs. Greening policies, growth in service sectors in the aftermath of COVID-19, expansion of the health and care sectors in ageing societies, and more expenditure on leisure are drivers of employment growth.

The assumptions the scenario introduces translate into a modest negative employment impact. This is the case throughout the forecast period, and the gap between scenario projections and baseline estimates widens in the years up to 2035. Employment in 2035 is projected to be 5% lower. The difference between baseline and scenario total employment estimates is about 10.5 million jobs.

The assumptions the scenario introduces have varying impacts on employment. The digital skills targets essential for the digital (and green) transition and the digitalisation of public services are expected to create over 200 000 more jobs, compared to the baseline, most of them in marketed and non-marketed services (which includes the education and training sector) and wholesale and retail trade (Figure 4). Raising the level of digital skills to basic or above-basic also has second-order negative employment effects: the positive impacts on productivity and wages will ultimately adversely affect employment as labour is becoming more expensive. Such impacts do not consider digital skills deepening and its possible positive productivity growth and employment effects, which were not captured in the scenario.

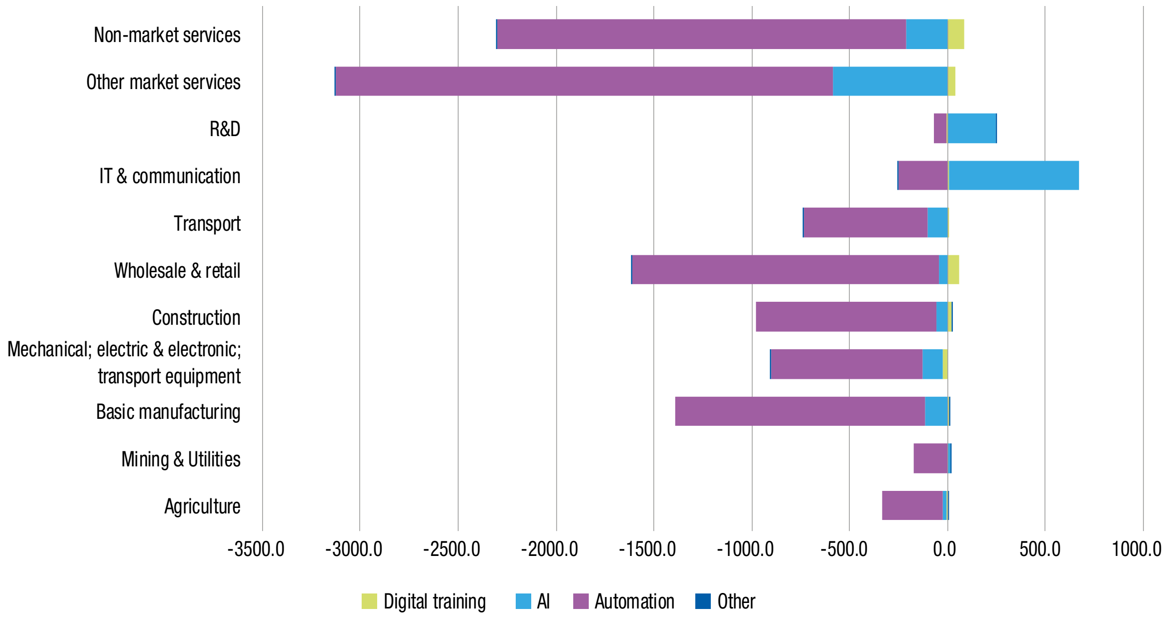
AI adoption is expected to reduce net job creation by about 300 000 jobs up until 2035. This negative overall impact is the result of negative AI-driven employment trends outweighing positive ones in particular sectors. Automation and related technologies can create jobs in the sectors that design, produce and maintain them. The scenario projects significant job creation of around 900 000 jobs in R&D and ICT, sectors that develop and deploy AI technologies.

However, AI technology is also a number one cause of shrinking employment up to 2035, with impact magnitude varying across sectors. While automation is often directly associated with job displacement, the growing demand for workers equipped with AI skills (see Cedefop 2023a), shows that adapting AI technology does not inherently lead to employment decline. In many contexts, AI adoption radically transforms the nature of work and requires investment in more advanced skill sets to stay employed. As it is commonly heard, ‘AI won’t replace humans – but humans with AI skills will replace humans without them’ ([8]).

Nevertheless, the assumption of increased labour productivity due to digital upskilling drives part of the reduction in employment: fewer workers are needed to produce the same output. Moreover, the wage premium for upskilled workers makes the cost of labour more expensive, also lowering the demand for labour. Sectors adopting AI technology will see productivity increase, leading to less job creation but better job quality (i.e. with higher wages). The total negative employment impact of the productivity effect (fewer workers needed to produce the same level of output) amounts to around one million jobs; this is concentrated in other market services, non-market services and manufacturing.

([8]) AI Won’t Replace Humans: but Humans With AI Will Replace Humans Without AI

Figure 4. **Scenario employment impact of digital transition by sector (difference in '000t from baseline), EU-27**



Source: Cedefop Digital transition scenario.

The ease of acquiring AI and related skills will determine the ultimate influence of this technology. Recent research findings show that – given the current high costs of implementing AI solutions – less than one-quarter of all vision tasks that could be replaced by AI are prioritised for automation (Svanberg et al. 2024).

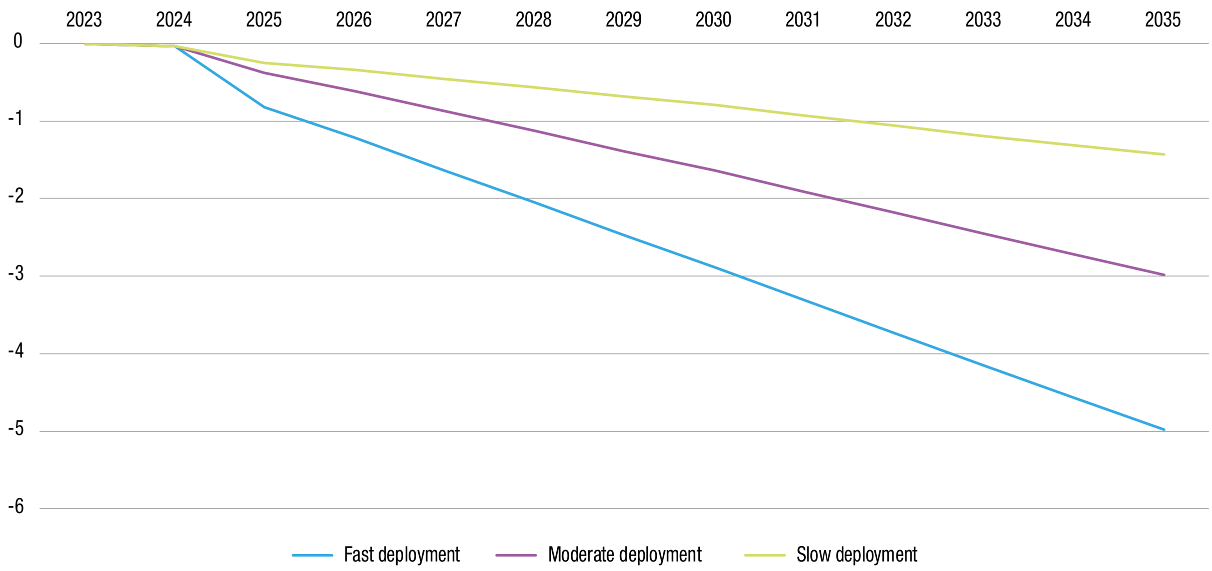
Technology has the potential to displace jobs but can create them, too, with jobs created by technology being more difficult to automate (European Parliament, 2021). While employment in some labour market segments will shrink, demand in others increases. Emerging occupations in high demand can mitigate the negative impact on total employment. AI adoption might also lead to the emergence of new sectors (Cazzaniga et al. 2024).

While machines will deal with routine and repetitive tasks, people will focus on more complex activities requiring creativity and strategic thinking. This transformation is not synonymous with job reduction but signifies a shift in work. With AI taking charge of mundane tasks, humans are entrusted with responsibilities that will demand emotional intelligence, critical thinking, and creative problem-solving; these attributes distinctly define human capabilities.

As the future of work is uncertain, caution is advised when interpreting scenario results. When and where digital transition will be most visible strongly depends on the pace of technology adoption, which is uncertain for economic and institutional reasons; these include funds available for introducing technologies, availability of energy resources to power the digital transformation, EU regulation on adoption of AI, and employer and trade union responses.

To capture the impacts of different speeds of digital transition, Cedefop ran two alternative scenarios. These differ from the main scenario in terms of timing of the deployment of automation technologies. In the main scenario, it is assumed that digitalisation and digital skills targets are met in 2035. The alternative scenarios consider moderate (targets met by 2040), and slow deployment (by 2050). When the digital transition takes longer, the reduction in employment is lower: 3% by 2035 with moderate deployment and 1.4% with slow deployment.

Figure 5. **Scenario employment impact of the digital transition by speed of deployment (% difference from baseline), EU-27**



Source(s): Cedefop Digital transition scenario.

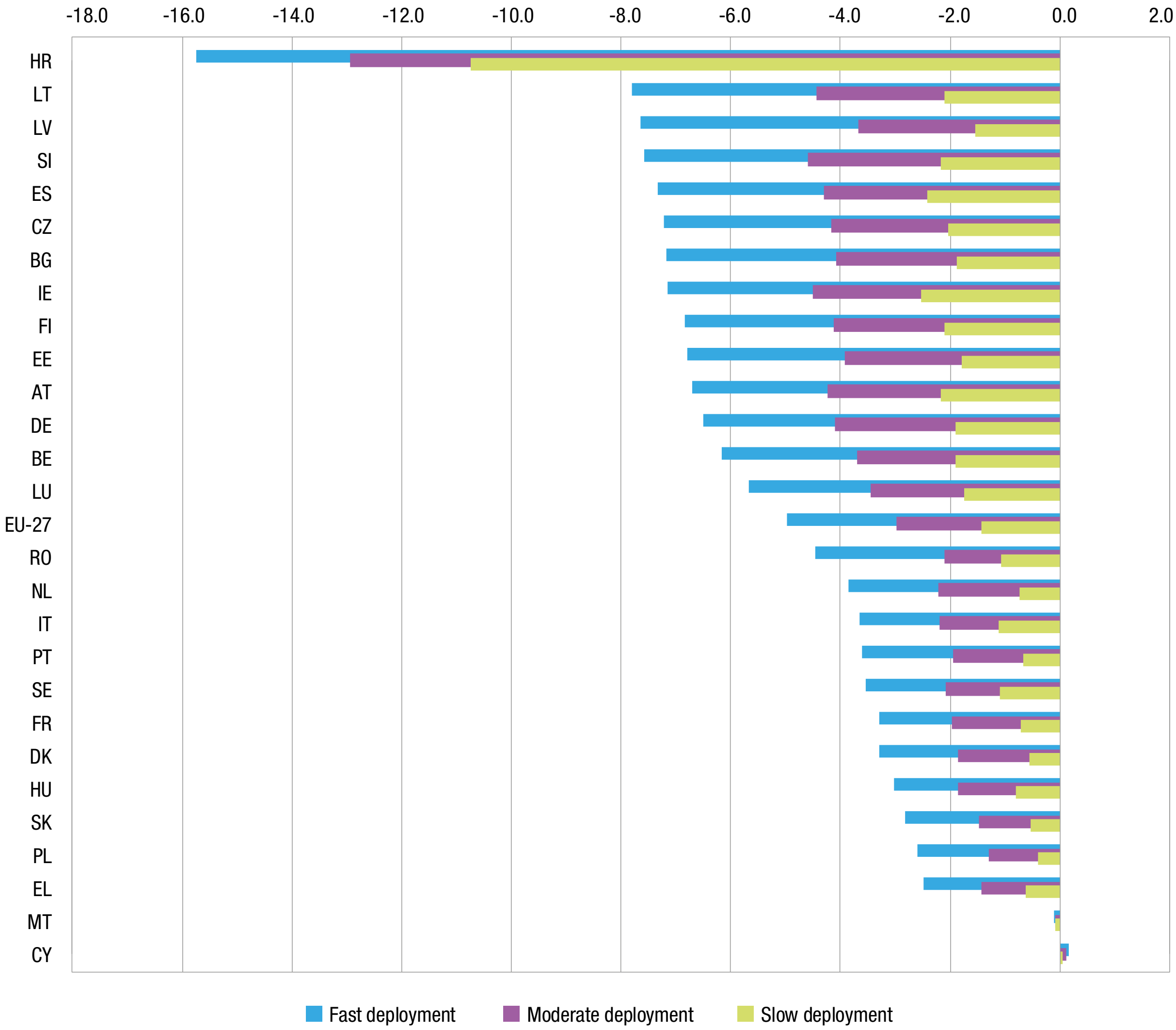
3.2. National employment trends

In the short term, upskilling and retraining policies and practices aimed at meeting the digital skills targets are expected to lead to limited change in employment, and in some cases to a slight increase. As automation and AI adoption gather pace, lower job creation is expected compared to baseline, in all Member States albeit at different rates (Figure 6). A limited employment decline is expected in small Member States (e.g. Cyprus and Malta) and in countries that are considered leaders in digitalisation and technology deployment (e.g. Denmark, Sweden).

Employment is expected to decline faster (compared to baseline) in Member States where sectors vulnerable to automation and digitalisation are important employers, than in countries where employment is concentrated in sectors that are more shielded from automation. In Croatia, where sectors with high automation potential such as manufacturing, wholesale, construction, and transport [9] account for nearly half of those employed, employment is expected to decline fastest. While these sectors are also important employers in Greece, their share in total employment is much lower, resulting in a slower forecast employment decline in the years up to 2025 compared to many other countries. In countries where the sectoral employment structure implies a moderate exposure to automation, the decline in job creation the scenario forecasts is moderated by job growth in sectors benefiting from it in terms of employment. In Romania, for example, Retail and Construction job creation is declining compared to the baseline, while the ICT sector is benefiting from AI and productivity increases.

(9) Cedefop Skills forecast, 2023.

Figure 6. **Scenario forecast employment impact of the digital transition by speed of deployment in EU Member States (% difference from baseline)**



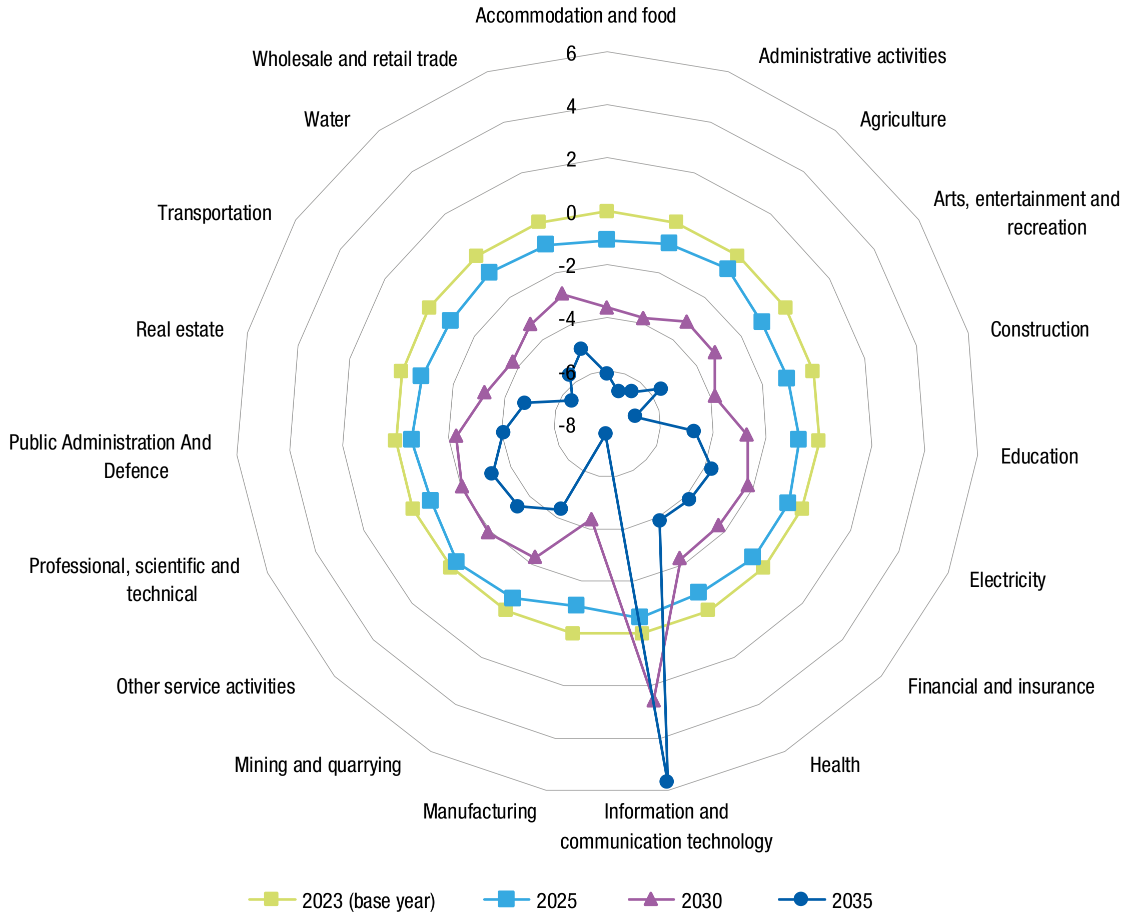
Note: The MS are listed in descending order of the % difference from baseline in 2035.
Source: Cedefop Digital transition scenario.

Member States with a declining population (e.g. Germany) or with large sectors where employment is at high risk of being automated (e.g. Spain) are expected to see the largest employment decrease. Slower deployment of automation is expected to moderate this effect somewhat, the size of impact depending on national economic structure. In small countries, such as Cyprus and Malta, there is limited scope for automation because of the limited size of some sectors. In some countries the speed of adoption of AI matters more than in others: fast adoption will have more negative impact on employment than slower. In some countries, like Denmark, the Netherlands, Portugal, Poland and Slovakia, the negative impact on the levels of employment estimated in the slow adoption scenario is at 20% of levels of fast adoption scenario, while the moderate scenario at above 50%.

3.3. Sectoral shifts: impacts and magnitude

ICT is the only sector expected to experience increased employment compared to the baseline (+6% by 2035) (Figure 7). While in the first year of the forecast period (2023), several sectors see employment increase, afterwards all sectors except ICT experience a decline, which steadily increases in the years up to 2035. Expanding deployment of AI and automation technologies across the economy is expected to lead to growing demand in ICT, as this sector implements, supports, maintains and further develops these new technologies. Sectors with a high risk of automation (Table 4), manufacturing, construction and agriculture, are expected to have the largest employment fall compared to the baseline.

Figure 7. **Forecast employment impact of the digital transition (difference from baseline in %) by broad sector, EU-27**



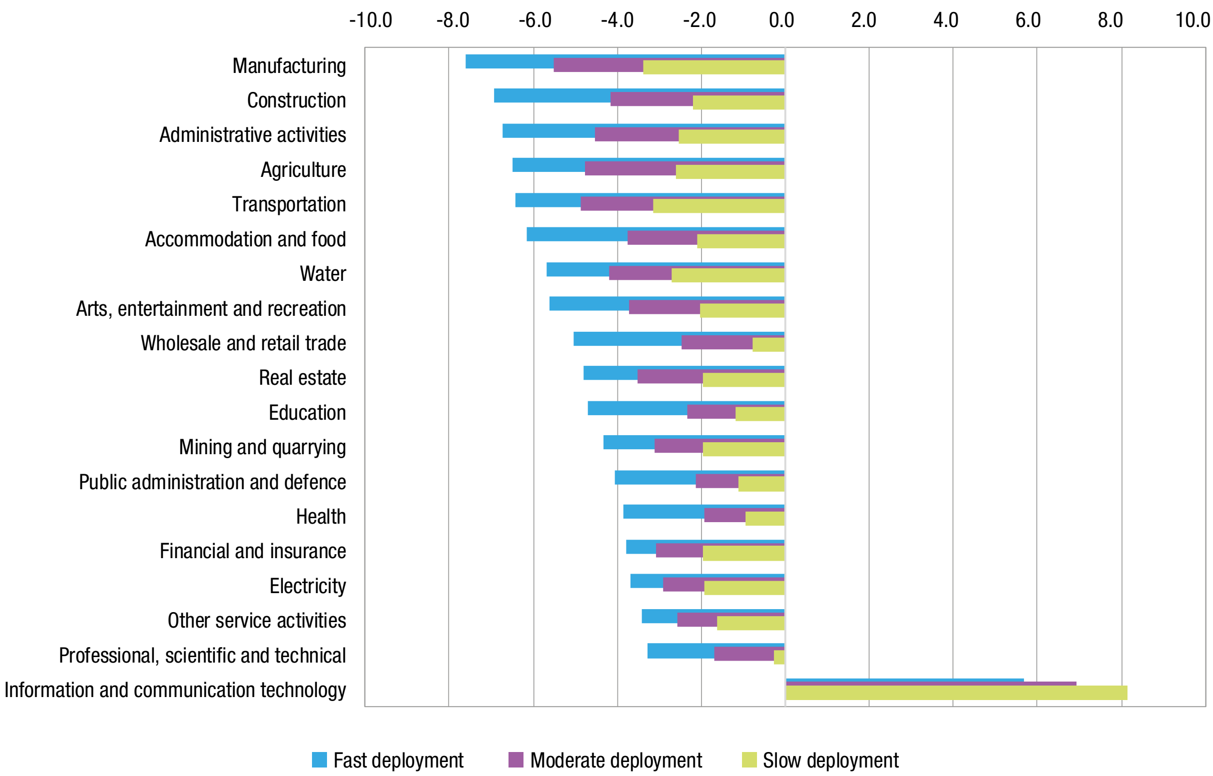
Source: Cedefop Digital transition scenario.

In several other sectors, large negative impacts on employment levels are expected. The pace of adoption, which depends on factors that may slow down implementation, determines when such impacts will materialise (Figure 8). For example, in several manufacturing sectors, AI methodologies have the potential to revolutionise the design, planning, control, management, and integration of products and processes. The affordability of these solutions, particularly for small and medium-size enterprises, is an important barrier slowing down their uptake (AIM-NET 2023). To benefit from the AI potential in this sector manufacturers must be empowered to transition from traditional production to autonomous factories, facilitating their scalability and efficiency (Ibid). AI is also expected to have a transformative effect in the construction sector, though adoption is lagging. While AI has the potential to be applied throughout construction processes alongside other digital technologies (e.g. virtual/ augmented reality, digital twins), much of it is still in the development stages or being piloted and not yet market-ready (ECSO 2021).

The primary hurdle in adopting AI in the healthcare sector is not the technology's capability. There are numerous examples of AI capability to match or surpass human performance in healthcare tasks (e.g. imaging analysis-based diagnosis in radiology) but successfully integrating these into daily clinical practice is challenging. To upscale adoption, AI systems must receive regulatory approval and medical staff needs to be trained. Without this, reaping the full potential of AI may be delayed by a decade (Davenport & Kalakota, 2019).

In the agriculture sector, AI-based technologies can take over hazardous or physically demanding tasks to protect farmers, harvest workers, and other agricultural workers. For example, autonomous agricultural vehicles and small field robots employ image recognition techniques to identify and mechanically eliminate weeds and pests or administer precise pesticide microdoses to eradicate them (Garske et al. 2021). Without adequate upskilling, most farmers will continue to use the traditional farming methods they are accustomed to and not start pilots or projects incorporating AI technology. Although AI and other digital technologies offer significant opportunities in many sectors, regulating them will be crucial to ensure their effective, fair and inclusive implementation. Education is a case in point; regulations should be applied to protect human agency and the well-being of children, and well-trained teachers should not be replaced with machines (UNESCO, 2023).

Figure 8. **Forecast employment decline by broad sector reflecting the pace of adoption of digital, automation and AI technologies (% difference from baseline)**



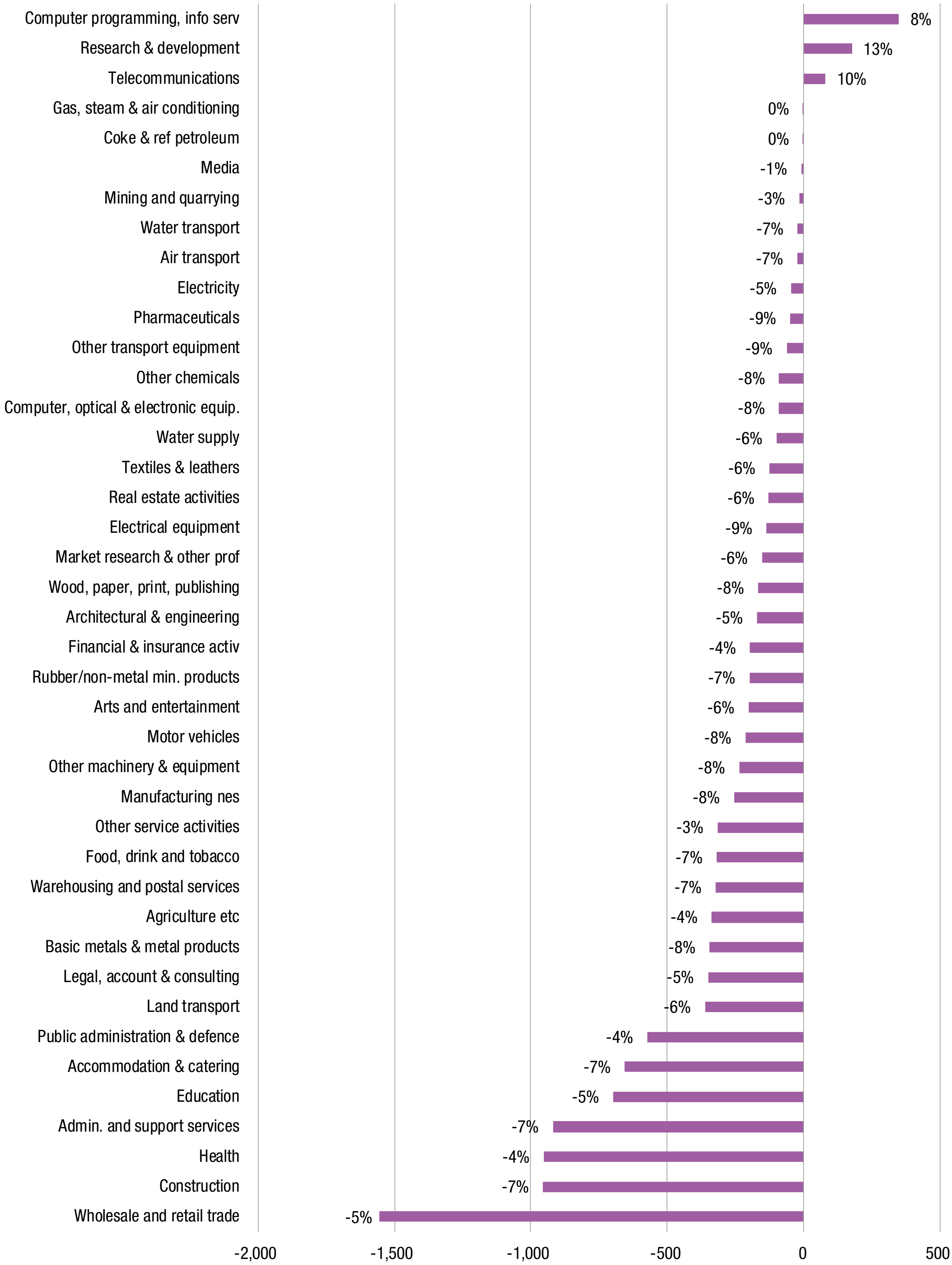
Source: Cedefop Digital transition scenario.

Comparison of the absolute and percentage difference in employment at detailed sectoral level (Figure 9) shows that nearly all are expected to have lower job creation, compared to the baseline scenario, with only tech-heavy activities seeing an expansion in demand ([10]).

The largest impact on employment in absolute terms is expected in the wholesale and retail sector, in which automation, advanced analytics, and artificial intelligence (AI) can revolutionise nearly every aspect of the value chain (Figure 9). AI can enhance supply chain management, streamline store operations, support data-driven pricing strategies, facilitate personalized promotion, and help introduce new customer interaction methods (McKinsey 2022). Increased AI-uptake leads to productivity gains, while also raising employment demand in specific sectors such as computer services, telecommunications and R&D. Occupations in sectors with a high degree of computer-use, such as computer programmers and R&D workers, will necessarily be high in demand for the digital transition to succeed. The overall increase in these sectors is largely driven by strong job creation, compared to the baseline in Germany, France, Italy, and the Netherlands, where employment is more than 10% higher in 2035. Various sectors for which the employment impact in the Digital transition scenario is strongly negative are those with a high share of occupations at significant risk of automation (Table 4).

([10]) These results corroborate previous analysis (see OECD, 2021).

Figure 9. **Employment impact of the digital transition (difference from baseline in 000s and %) by sector, EU-27**



NB: The percentages indicate the difference in forecast employment growth or decline (in %) between digital and baseline scenario.
Source: Cedefop Digital transition scenario.

In several sectors with large shares of low-skilled employment a substantial employment decline (compared to the baseline) is expected. Examples include accommodation, administration, and logistics. Research has shown that the gradual elimination of routine tasks likely leads to higher productivity in services, sales and construction, posing particular risks for workers with low skills (Frey & Osborne, 2017). Nedelkoska and Quintini (2018) found that high-risk occupations are predominantly found in manufacturing and agriculture. With the proliferation of (generative) AI, sectors with high shares of high-skilled employment, such as in education, health, and legal and accounting services, are increasingly impacted (OECD, 2023).

In the sectors where the skilling efforts are highest (Table A.2), the gap between baseline and scenario employment is largest. Sectors not needing substantial reskilling to meet the digital skills targets are expected to lose little employment or even gain some in the Digital transition scenario. The productivity gains and wage premia resulting from up- and reskilling many workers in sectors where more effort is needed to meet the targets help reduce labour demand. This is the case for the wholesale and retail and the construction sectors.

Alongside the indirect effects of training on employment demand, advances in automation also directly result in the displacement of workers in sectors with automation potential. At the same time, with AI deployment advancing, the demand for specific occupations is rising, not despite but because of AI. Sectors employing many data scientists and other AI and automation occupations will see employment increase. Ensuring sufficient supply of professionals who can meet such increase in demand is challenging, as technological advancement is not skill neutral. The difficulties companies in the EU face in recruiting ICT specialists ([11]) point towards the importance of investing in substantial IT training to overcome digital skills mismatches.

([11]) ICT specialists - statistics on hard-to-fill vacancies in enterprises – Statistics Explained (europa.eu)

CHAPTER 4.

Navigating the digital transition: implications for occupations

4.1. Exposure of occupations to digitalisation: insights from research

Realising EU digital transition aims and targets is expected to impact employment negatively across almost all sectors: employment is lower in the forecast scenario compared to the baseline. The occupational and skills level distribution of sectoral employment determines which occupational and skill levels will be most affected. In making an assessment, it is assumed that the occupational shares estimated in the skills forecast baseline remain constant.

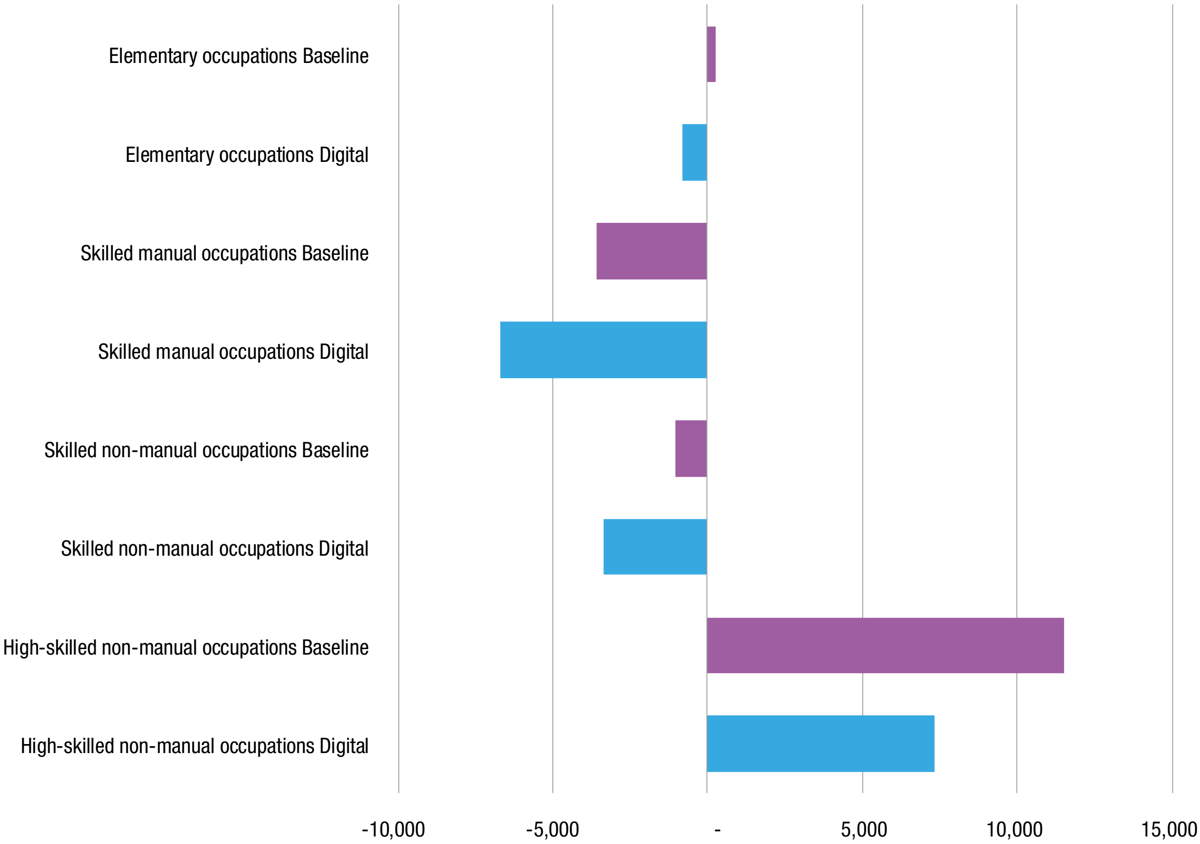
To what extent exposed occupations would be automated as opposed to augmented by AI technology is still under debate. Previous studies show that among the most exposed occupations (6-digit SOC level) are genetic counsellors, financial examiners, and actuaries, whereas the least exposed are dancers, fitness trainers, and helpers (Felten et al., 2021). The estimates indicate a larger influence of AI on occupations involving more cognitive tasks, whereas physical tasks are less influenced. The results of the analysis in which tasks were matched to capabilities and these to existing technologies (including generative AI) allowed for the assessments of potential automation of the share of hours worked that could be automated by 2030 in occupations. Occupations which were found most automatable are: office support; food services; production work; and mechanical installation and repair. Less automatable occupations include: health professionals; health aides, technicians, and wellness professionals; and property maintenance workers. By isolating the impact of generative AI on the automatability of occupations it is possible to identify the occupations most exposed to the latest technologies: STEM professionals; education and workforce training professionals; creative and arts management professionals; and business and legal professionals (McKinsey, 2023a).

4.2. Employment trends in occupations at different skills levels

The comparison of occupational employment by skill level required in 2035 under the Digital transition scenario with the 2023 Skills forecast baseline shows that while the impact varies, it is negative in most cases. High-skilled non-manual occupations absorb about 40% of the employment reduction in 2035 while for elementary occupations it is 10%. Skilled manual and skilled non-manual share the remaining 50% (29% and 22%, respectively).

However, while employment in elementary occupations is on the decline, at the same time, through 2021-35, digitalisation will further intensify skills-intensive employment. The long-standing trend of skills polarisation – simultaneous employment growth for high and low skilled occupations – is making way for rapid skills upgrading. Only high-skilled non-manual occupations will experience job growth up to 2035. Given that low-educated workers are present in various job types (e.g. as sales workers or market-oriented agricultural workers), impacted further by the digital transition, ensuring up-and reskilling opportunities will be vital.

Figure 10. **Scenario employment impact of digital transition in 2021-35 by skill level (000s), EU-27**



Source: Cedefop Digital transition scenario.

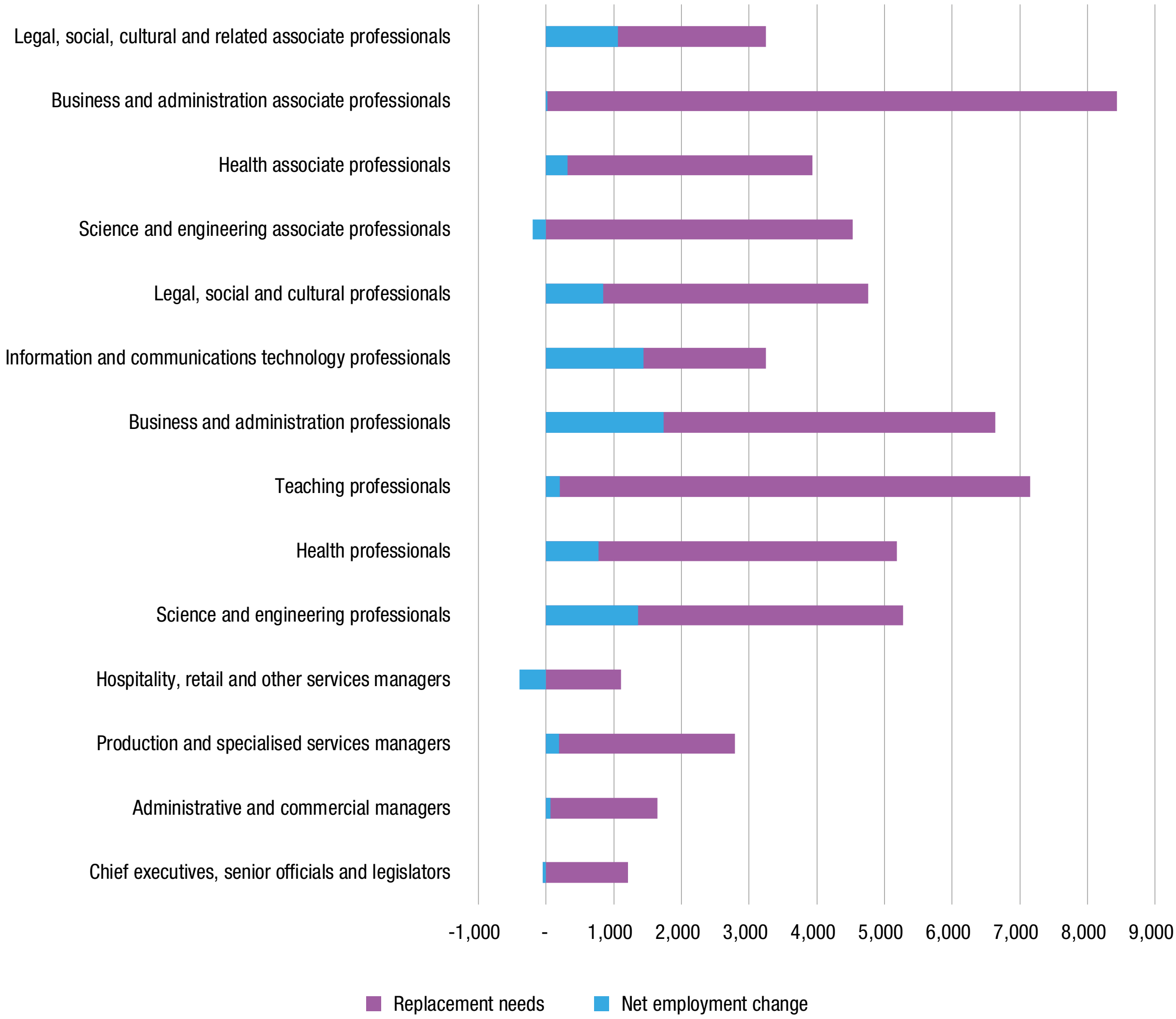
4.3. Specific occupation employment impact and replacement needs

The labour market impact of the digital transition transcends net employment effects. In the period 2021-35, alongside job openings related to the expansion of the economy, there will be many more job openings to replace workers that retire or move to another job. Depending on the magnitude of replacement demand, which is assumed equal in the Digital transition scenario and the baseline, employment decline for occupations may be outweighed by strong replacement needs. However, alongside the digital transition's impact on employment, it likely also affects replacement demand for automatable jobs, where positions are made redundant after workers retire. The impacts of digital transition on replacement demand were not included in the Digital transition scenario. Earlier forecasts (e.g. Cedefop 2021) suggest that that such impacts will be significant across all occupation levels, with replacement demand for low-skilled jobs impacted most.

For instance, even though the level of 2035 employment for science and engineering professionals is estimated to contract by about 320 000 jobs within the Digital transition scenario, the strong replacement demand (about 4 million jobs between 2021-35) will minimise the difference between scenario and baseline job openings (Figure 11): about 94% will materialise in spite of the strong impact of going digital. The negative employment impact of digital transition on employment will also be counterbalanced by replacement demand for hospitality, retail, and other service managers. Although there are many opportunities for AI adoption in the hospitality industry (Vinnakota, et al. 2023) their successful implementation necessitates employee training to facilitate a smooth transition. With the changing nature of work in the hospitality industry due to AI adoption, people that replace retirees will need to be upskilled or retrained.

Many high-skilled non-manual occupations (e.g. legal, social associate professionals, health professionals) will benefit from the digital transition in terms of employment growth. Job openings are expected to amount to 94% of the baseline level on average. Only for information and communication technology professionals will the digital transition translate into additional job creation (about 65 000 jobs on top of the baseline estimate).

Figure 11. **Job openings 2021-35 broken down by net change and replacement needs, high-skilled non-manual occupations (000s), EU-27**

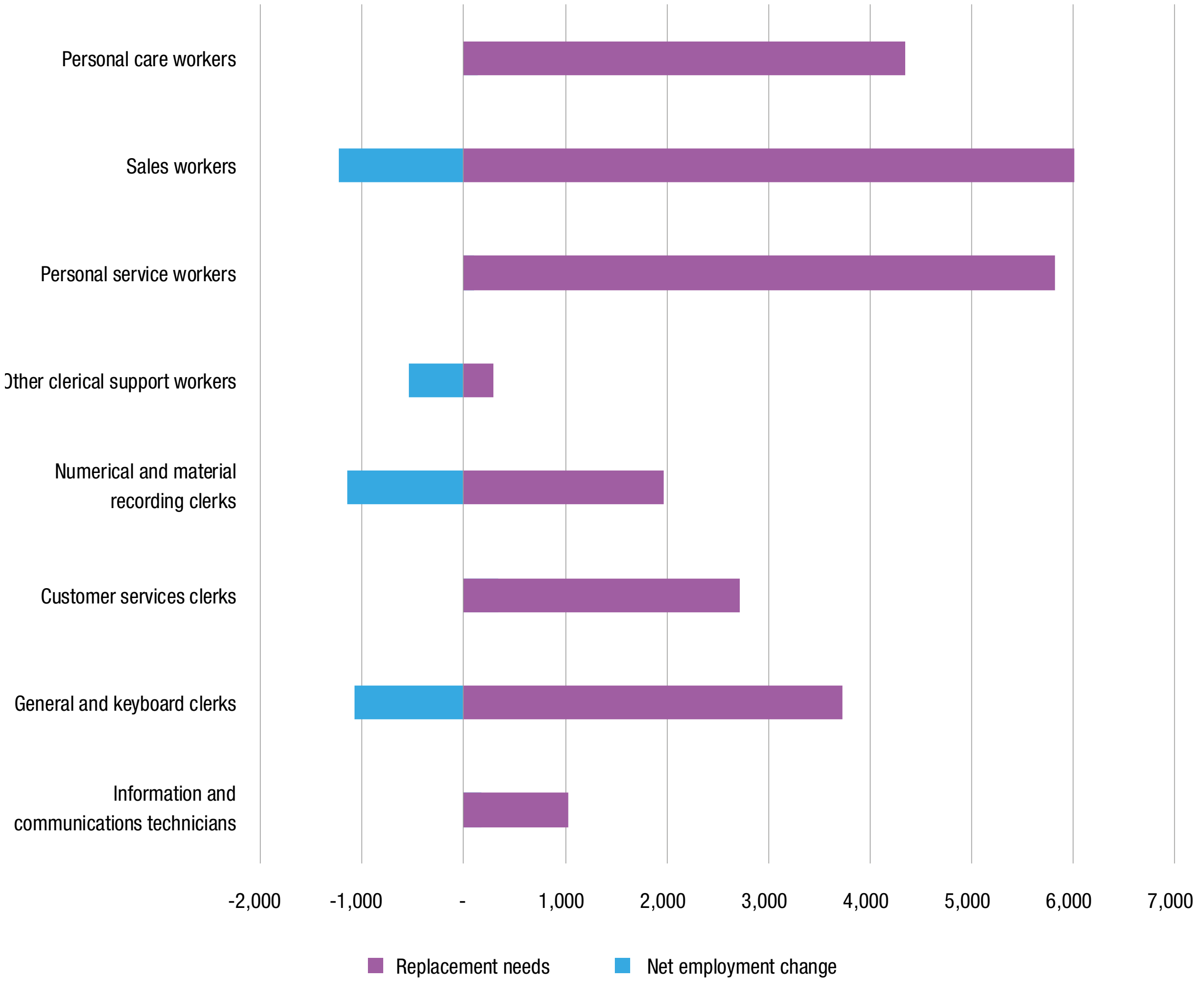


Source: Cedefop Digital transition scenario.

Exploring skilled non-manual occupations in more detail helps map the consequences of digital transition (Figure 12). More than a million fewer job positions would be available for sales workers in 2035. To stay competitive, organisations are shifting from in-person engagement with customers to hybrid or remote interaction. The AI solutions making this possible significantly reduce workload and help sales workers save time, because routine tasks such as scheduling meetings, taking notes and managing data entry are automated. The customer behaviour data that AI models generates give sales professionals the opportunity to conduct analysis of customer expectations and to design targeted marketing campaigns. To benefit from these technologies, many sales professionals need technical know-how to become more skilled (Salesloft 2023). Although the negative employment effect of digital transition is counterbalanced by significant replacement demand, digitalisation will transform many sales jobs coming to market in the coming decade. Basic digital skills will often not be enough to stay employable and upskilling will be needed to acquire AI solution knowledge and skills in the sales field.

The job displacing impact of automation will also affect clerical occupations such as numerical and material recording clerks and other clerical support workers. Of the total job openings foreseen for these two categories in the baseline, only 86% and 79% respectively, will materialise in the Digital transition scenario.

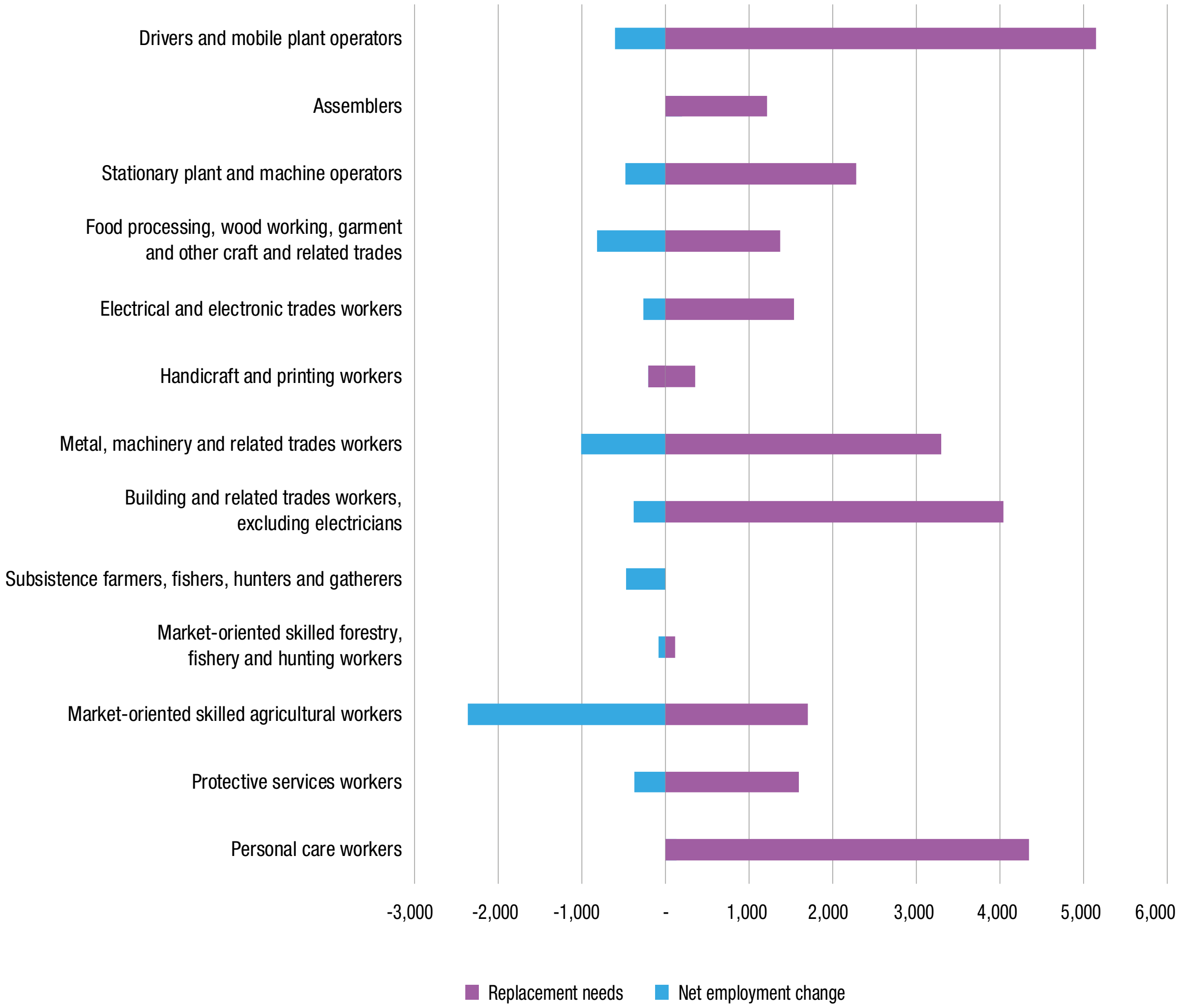
Figure 12. **Job openings 2021-35 broken down by net change and replacement needs, skilled non-manual occupations (000s), EU-27**



Source: Cedefop Digital transition scenario.

Among skilled manual occupations, employment of agriculture workers is most negatively affected by digital transition: more than two million jobs are expected to be lost (Figure 13). Demographics will help cushion the negative effect of the transition to some extent: in 2020, only one in three farm managers was 40 years old or younger (Cedefop, 2023b). Yet, similar to sales positions, benefiting from job opportunities in the coming years will require upskilling as automation, robotisation and AI will transform agriculture jobs. To fully leverage these technologies in agricultural practices, Europe needs a new generation of well-trained farmers equipped with digital skills beyond basic ones. Most farm managers in the EU primarily possess practical experience or have undergone basic agricultural training (EPRS, 2023). At the same time, digitalisation is rapidly transforming the trade. In 2022, global sales of robotics in agriculture increased by 18%, with nearly 8 000 units shipped. Of these, over 5 800 were robots taking over core agricultural tasks such as milking and barn cleaning. Labour shortages in agricultural regions and the increasing demand for sustainable farming practices make service robots pivotal technology in the evolving agriculture landscape ([12]).

Figure 13. **Job openings 2021-35 broken down by net change and replacement needs, skilled manual occupations (000s), EU-27**



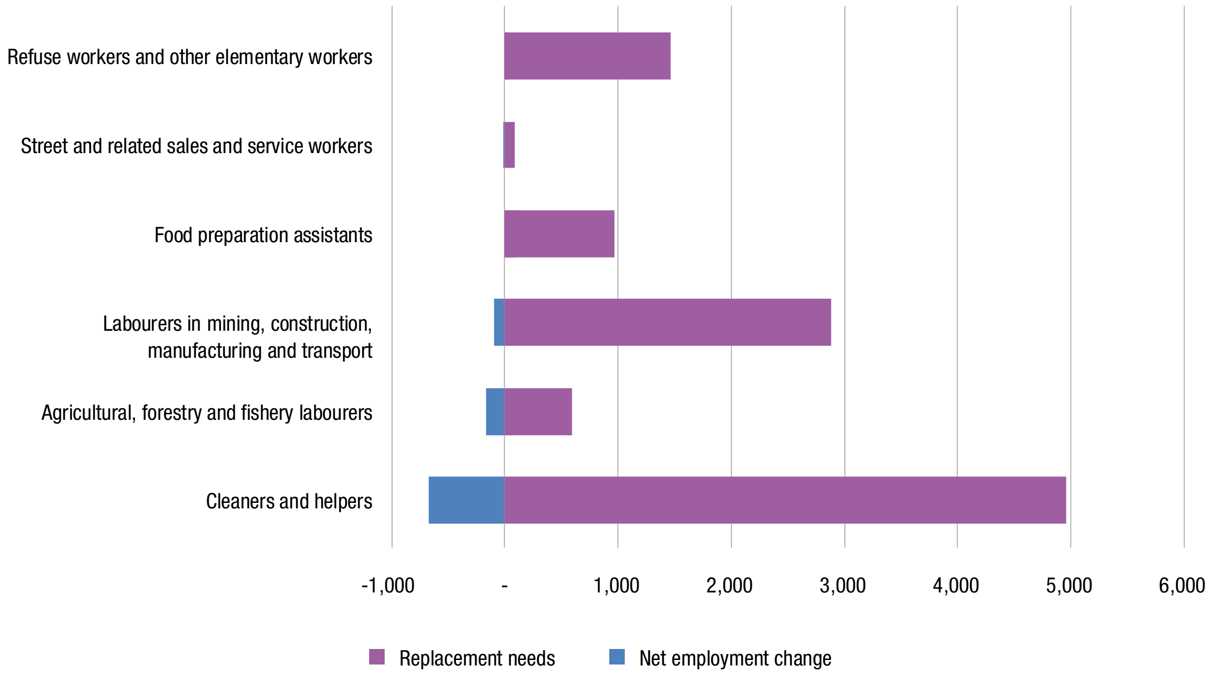
Source: Cedefop Digital transition scenario.

([12]) Staff Shortage Boosts Service Robots – Sales Up 48%.

The second most negative impact of the digital transition on skilled manual occupations is for metal, machinery and related trades jobs, for which employment is expected to drop by a million. Metallurgy and machinery production can benefit extensively from AI application and machine learning. The integration of such technologies across different stages of production and planning (including material flows, energy, and information) opens boundless opportunities to transition to intelligent production. Transformations in production imply changes in employment structure. Tasks traditionally carried out by employees in metal or machinery manufacturing enterprises are being supplanted by industrial robots. This inevitably leads to reduced demand for traditional professionals operating equipment, such as welders, turners and locksmiths. The decision-making responsibilities of first line and production managers are increasingly being supported by statistical analysis software, algorithms, and probability calculations. To operate effectively in production systems supported by cyber-physical solutions, employees must have fundamental understanding of IT and advanced manufacturing technology. Personnel tasked with servicing such systems must possess in-depth process knowledge and be proficient in using information stored in cloud computing systems (Biały et al., 2019).

Food processing, woodworking and garment workers will be the third most negatively impacted group of skilled manual occupations affected by digital transition. Compared to the baseline scenario, approximately 800 000 fewer jobs are expected. Competitiveness is a driving force behind the food processing industry's exploration and implementation of IoT sensors, artificial intelligence, robotics, and other digital technology. These technologies have potential to enhance business performance by increasing productivity and reducing costs and food waste. Particularly in food processing, robotics and other innovations can perform repetitive tasks such as cutting, sorting, and packing, with a level of accuracy and efficiency that humans may not always match. Such sectoral technological trends directly translate into worker replacement by machines. Thanks to robotic precision, safety, speed, and adaptability, similar unparalleled levels of efficiency and production are also observed in the woodworking industry ([13]).

Figure 14. **Job openings 2021-35 broken down by net change and replacement needs, Elementary occupations, EU-27**



Source: Cedefop Digital transition scenario.

([13]) The beauty of AI in the wood industry

Among elementary occupations, cleaners and helpers are most impacted by the negative employment effects of digital transition (Figure 14). The difference from the baseline scenario amounts to over 600 000 jobs. Occupations where physical activities still prevail (such as cleaners, or helpers, including painters, paper hangers, plasterers) are believed to be least exposed to AI impact (Guarascio et al. 2023). Robotics and automation, the IoT and sensor technology, which is gradually being introduced in commercial cleaning, brings great benefits to the industry. In 2022, global sales of professional cleaning robots grew by 8% and 10% more floor-cleaning robots were sold. (International Federation of Robotics, 2024). Staff shortages motivate cleaning companies to pursue automation solutions.

CHAPTER 5.

Reflection and lessons for policy

Realising EU Digital transition aims and policy targets brings about substantial job creation in computer programming, research and development, and telecommunications. The training required to fuel the transition will create jobs in other areas, including wholesale and retail, and non-market services, which includes the education and training sectors. Benefits will also be felt across areas; AI adoption will lead to increases in labour productivity, allowing people to become more versatile and dedicate time to new and more interesting activities. Employment will become more skills-intensive, with most new job openings expected at the higher level of the skills spectrum. Skills upgrading will help transform Europe into a more competitive, knowledge-driven economy.

Digital transition will reduce aggregate employment, but not dramatically. Automation and AI will take over part of the work so far typically performed by humans, reducing the demand for labour in most sectors. In absolute terms, most of the impact will be borne by wholesale and retail trade, and the construction sector. As it is linked to the sectoral structure of employment, the employment impact of digital transition varies across Member States. In analysing digital transition, it is important to consider second-order effects: labour productivity increases mean that less labour is needed. Digital skills training for the workforce translates into higher wages, which makes labour more expensive (relative to technology) and can be expected reduce employment.

The Digital transition scenario presented in this report assumes the EU digitalisation and digital skills agenda is fully implemented. How fast automation and AI deployment will progress is surrounded by uncertainty. Slower deployment means that negative employment impacts will take longer to materialise and several hurdles can slow down digital transition. Alongside the willingness to introduce new technologies and securing funds to implement them, the approaches of social partners and the regulatory framework are factors driving deployment. Given all these uncertainties, it is important to be careful when interpreting the scenario findings.

Technological change requires massive investment in human capital to let the workforce benefit from the innovative solutions and to become more productive. Achieving just the basic digital skills policy targets will not be sufficient to make and keep people employable. AI education and training programmes at all levels, from primary education to lifelong learning are an essential part of the answer to bridging the emerging skills gap.

While this study presents mildly negative employment impacts of digital transition, it is important to also be aware of AI-infused productivity and employment gains - aspects that could not be fully captured in the scenario. Policies that help leverage such gains will contribute to economic growth, stimulate demand, and can ultimately lead to job creation that possibly outweighs the negative impacts the scenario suggests.

In the digital transition, Europe must skill a workforce that knows its way around AI and other technological innovations. The organisations adopting them must encourage employees to embrace change and become proactive learners. A culture of continuous learning should be promoted in all workplaces. A mix of education and training programmes, targeted up- and reskilling, and other learning opportunities will help ensure learners will stay abreast with the latest trends and technologies in their fields. AI-powered training programmes can greatly enhance learning processes and results. Corporate wellbeing and mental health professionals can help organisations integrate stress management and resilience into training and learning, to equip the workforce with the socio-emotional and adaptation skills required to navigate the increasingly complex and dynamic worlds of work and learning.

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Annex

Table A.1. **Cost of training, per participant and total, by MS**

Member States	Cost per participant (EUR)	Total cost (mn EUR)		
		2025	2030	2035
Belgium	1 547	1 803	1 065	987
Bulgaria	318	504	86	102
Czechia	232	161	145	137
Denmark	2 168	94	717	706
Germany	1 854	19 442	6 681	7 910
Estonia	892	96	63	63
Ireland	2 776	-	1 201	153
Greece	802	863	379	390
Spain	638	1 282	1 799	1 418
France	2 090	6 913	8 306	8 131
Croatia	681	66	106	120
Italy	1 496	13 349	4 300	3 617
Cyprus	1 052	135	74	9
Latvia	297	53	12	28
Lithuania	432	135	25	58
Luxembourg	1 704	65	92	6
Hungary	840	1 053	469	407
Malta	902	40	45	13
Netherlands	2 621	-	2 476	2 384
Austria	1 369	489	671	635
Poland	376	2 337	739	720
Portugal	477	410	196	216
Romania	462	2 244	375	439
Slovenia	859	228	98	91
Slovakia	506	243	147	149
Finland	1 120	-	3	299
Sweden	1 854	1 803	1 065	987

Source: Cedefop calculation based on Eurostat (TRNG_CVT_19S).

Table A.2. **Shares of workers in need of training by sector**

Sectors	BE	DK	DE	EL	ES	FR	IE	IT	LU	NL	AT	PT	FI	SE
Agriculture etc	1%	2%	1%	16%	5%	3%	12%	3%	1%	0%	3%	15%	0%	2%
Mining and quarrying	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%
Food, drink and tobacco	3%	2%	3%	4%	3%	3%	4%	2%	3%	2%	3%	5%	0%	2%
Textiles & leathers	0%	0%	0%	1%	1%	0%	0%	2%	0%	0%	0%	9%	0%	0%
Wood, paper, print, publishing	1%	1%	1%	1%	1%	1%	1%	1%	0%	7%	2%	2%	0%	1%
Coke & ref petroleum	0%	0%	0%	0%	0%	0%	0%	0%		0%	0%	0%	0%	0%
Other chemicals	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Pharmaceuticals	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Rubber/non-metal min. products	2%	1%	2%	1%	1%	1%	2%	2%	1%	0%	2%	2%	8%	1%
Basic metals & metal products	2%	2%	3%	1%	2%	2%	1%	3%	2%	0%	4%	4%	8%	3%
Optical & electronic equip	0%	0%	1%	0%	0%	0%	1%	0%	0%	0%	1%	0%	0%	1%
Electrical equipment	0%	0%	1%	0%	0%	0%	0%	0%	1%	0%	1%	1%	0%	1%
Other machinery & equipment	1%	2%	3%	0%	0%	0%	1%	2%	0%	0%	2%	1%	0%	2%
Motor vehicles	1%	0%	2%	0%	1%	0%	0%	1%	0%	0%	1%	1%	0%	1%
Other transport equipment	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%
Manufacturing nes	1%	1%	1%	1%	1%	2%	3%	2%	0%	0%	2%	2%	1%	1%
Electricity	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Gas, steam & air conditioning	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Water supply	1%	1%	0%	1%	2%	1%	1%	1%	1%	0%	1%	2%	0%	1%
Construction	9%	10%	5%	8%	12%	13%	12%	9%	21%	0%	7%	11%	41%	14%
Wholesale and retail trade	16%	25%	15%	21%	26%	15%	23%	18%	13%	0%	20%	12%	0%	14%
Land transport	4%	5%	3%	4%	4%	4%	5%	3%	7%	0%	3%	4%	18%	4%
Water transport	0%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Air transport	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%	0%	0%	0%
Warehousing and postal services	3%	3%	3%	2%	2%	2%	2%	2%	2%	0%	2%	1%	0%	3%
Accommodation & catering	5%	7%	5%	17%	11%	6%	9%	8%	9%	91%	10%	10%	21%	9%
Media	0%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
Telecommunications	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%
Computer programming, info serv	1%	1%	2%	1%	0%	0%	0%	1%	0%	0%	1%	0%	0%	2%
Financial & insurance activ	1%	2%	2%	1%	0%	0%	0%	1%	0%	0%	1%	0%	0%	1%
Real estate activities	1%	3%	2%	1%	2%	2%	1%	1%	3%	0%	3%	2%	0%	2%
Legal, account & consulting	5%	1%	3%	1%	0%	1%	1%	2%	3%	0%	2%	0%	0%	1%
Architectural & engineering	1%	0%	2%	0%	1%	1%	1%	1%	2%	0%	1%	0%	0%	1%
Research & development	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Market research & other prof	1%	1%	1%	0%	1%	1%	1%	2%	0%	0%	1%	1%	0%	1%
Admin. and support services	9%	5%	7%	2%	8%	6%	3%	6%	7%	0%	6%	4%	0%	4%
Public administration & defence	8%	3%	5%	4%	4%	8%	3%	3%	9%	0%	10%	4%	0%	2%
Education	3%	2%	4%	0%	0%	0%	1%	4%	0%	0%	0%	0%	0%	7%
Health	12%	11%	15%	2%	1%	19%	7%	4%	8%	0%	8%	4%	0%	11%
Arts and entertainment	1%	2%	1%	1%	1%	1%	1%	1%	1%	0%	1%	0%	0%	2%
Other service activities	4%	3%	5%	5%	8%	6%	2%	10%	2%	0%	2%	5%	0%	3%

Sectors	CZ	EE	CY	LV	LT	HU	MT	PL	SI	SK	BG	RO	HR
Agriculture etc	4%	3%	5%	9%	7%	4%	2%	9%	6%	3%	11%	14%	18%
Mining and quarrying	0%	1%	0%	0%	0%	0%	0%	1%	0%	0%	1%	1%	0%
Food, drink and tobacco	3%	3%	4%	4%	3%	3%	3%	3%	2%	3%	3%	3%	3%
Textiles & leathers	1%	2%	0%	1%	2%	1%	1%	2%	1%	2%	5%	3%	1%
Wood, paper, print, publishing	2%	4%	1%	4%	3%	1%	2%	3%	2%	2%	1%	1%	3%
Coke & ref petroleum	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Other chemicals	1%	1%	0%	0%	1%	0%	0%	1%	1%	0%	0%	0%	0%
Pharmaceuticals	0%	0%	1%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%
Rubber/non-metal min. products	5%	2%	1%	1%	2%	2%	4%	3%	3%	3%	2%	1%	2%
Basic metals & metal products	4%	3%	2%	2%	2%	2%	1%	3%	5%	5%	2%	2%	5%
Optical & electronic equip	1%	1%	0%	0%	0%	2%	0%	1%	1%	1%	0%	1%	0%
Electrical equipment	3%	1%	0%	0%	0%	1%	0%	1%	3%	2%	1%	1%	2%
Other machinery & equipment	3%	0%	0%	0%	0%	2%	0%	1%	2%	2%	1%	1%	3%
Motor vehicles	5%	0%	0%	1%	1%	3%	1%	2%	2%	5%	1%	3%	0%
Other transport equipment	1%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	1%	1%
Manufacturing nes	3%	3%	2%	1%	4%	2%	4%	3%	3%	2%	2%	2%	2%
Electricity	1%	1%	1%	1%	1%	0%	0%	1%	1%	1%	1%	1%	0%
Gas, steam & air conditioning	0%	0%	0%	0%	0%	0%		0%	0%	0%	0%	0%	0%
Water supply	1%	1%	1%	1%	1%	1%	2%	1%	1%	1%	2%	1%	11%
Construction	10%	9%	11%	10%	9%	9%	16%	10%	8%	10%	8%	9%	12%
Wholesale and retail trade	15%	13%	17%	18%	18%	16%	22%	15%	13%	17%	14%	18%	20%
Land transport	5%	3%	2%	5%	6%	4%	8%	5%	5%	5%	5%	6%	2%
Water transport	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Air transport	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%
Warehousing and postal services	2%	3%	3%	3%	2%	2%	4%	2%	2%	2%	2%	1%	0%
Accommodation & catering	5%	4%	12%	5%	4%	4%	14%	3%	6%	5%	5%	4%	13%
Media	0%	1%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%
Telecommunications	0%	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	1%	0%
Computer programming, info serv	1%	4%	1%	2%	1%	1%	0%	2%	2%	1%	2%	1%	0%
Financial & insurance activ	1%	2%	2%	1%	1%	1%	0%	1%	1%	1%	1%	1%	0%
Real estate activities	2%	2%	1%	3%	1%	2%	3%	1%	1%	2%	1%	0%	1%
Legal, account & consulting	1%	3%	3%	1%	2%	3%	0%	1%	4%	2%	1%	1%	0%
Architectural & engineering	1%	1%	1%	1%	1%	1%	1%	1%	2%	1%	1%	1%	0%
Research & development	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	1%	0%	0%
Market research & other prof	1%	1%	1%	1%	1%	1%	1%	1%	2%	1%	1%	1%	0%
Admin. and support services	3%	4%	3%	3%	4%	5%	0%	3%	4%	5%	5%	2%	0%
Public administration & defence	3%	5%	4%	3%	4%	8%	1%	4%	2%	4%	5%	5%	0%
Education	1%	7%	5%	5%	8%	3%	0%	4%	2%	3%	3%	3%	0%
Health	6%	6%	3%	6%	6%	7%	7%	6%	6%	6%	5%	6%	0%
Arts and entertainment	1%	2%	2%	2%	1%	1%	1%	1%	2%	1%	1%	1%	0%
Other service activities	3%	2%	9%	2%	2%	3%	1%	3%	3%	2%	3%	2%	0%

Source: Eurostat (isoc_sk_dskl_i21), Cedefop Skills Forecast.

Table A.3. **Articles reviewed to identify automation risk estimates**

Paper
Pouliakas, K. (2018). *Determinants of automation risk in the EU labour market: a skills-needs approach*
McKinsey. (2023). *Generative AI and the future of work in America.* https://www.mckinsey.com/mgi/our-research/generative-ai-and-the-future-of-work-in-america#/
McKinsey (2023) The economic potential of generative AI: the next productivity frontier. https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/the-economic-potential-of-generative-ai-the-next-productivity-frontier
Gmyrek, P., Berg, J., & Bescond, D. (2023). *Generative AI and jobs: a global analysis of potential effects on job quantity and quality.* ILO Working Paper 96. https://doi.org/10.54394/FHEM8239
Filippi, E., Banno, M., & Trento, S. (2023). *Automation technologies and their impact on employment: A review, synthesis and future research agenda.*
PWC. (2018). *Will robots really steal our jobs? An international analysis of the potential long-term impact of automation.* https://www.pwc.co.uk/economic-services/assets/international-impact-of-automation-feb-2018.pdf
Felten, et al (2023). *Occupational heterogeneity in exposure to generative AI.*
Elondou, et al (2023). *GPTs are GPTs: an early look at the labor market impact potential of large language models.*
A visual guide to AI adoption, by industry (Visual Capitalist, 2023)
PWC. (2021). *The Potential impact of artificial intelligence on UK employment and the demand for skills.* Report for BEIS

Table A.4. **Sectors with high computer use by MS, 2019**

Detailed sectors	Belgium	Germany	Greece	Spain	France	Ireland	Italy	Luxembourg	Netherlands	Austria	Portugal	Finland	Sweden	Czechia	Estonia	Cyprus	Latvia	Lithuania	Hungary	Malta	Poland	Slovenia	Slovakia	Bulgaria	Romania	Croatia
Accommodation and food service activities																									
Activities for rental and leasing, employment, security and investigation, services to buildings and landscape, office administrative, office support and other business support																									
Administrative and support service activities																									
Computer programming, consultancy, and information service activities																									
Construction																									
Electricity, gas, steam and air conditioning supply; water supply; sewerage, waste management and remediation activities																									
Information and communication																									
Legal and accounting activities; activities of head offices; management consultancy activities; architectural and engineering activities; technical testing and analysis; scientific research and development; advertising and market research; other professional, scientific and technical activities																									
Manufacture of basic metals and fabricated metal products, except machinery and equipment																									

Detailed sectors	Belgium	Germany	Greece	Spain	France	Ireland	Italy	Luxembourg	Netherlands	Austria	Portugal	Finland	Sweden	Czechia	Estonia	Cyprus	Latvia	Lithuania	Hungary	Malta	Poland	Slovenia	Slovakia	Bulgaria	Romania	Croatia
Manufacture of coke, refined petroleum, chemical and basic pharmaceutical products, rubber and plastics, other non-metallic mineral products																										
Manufacture of computer, electronic and optical products																										
Manufacture of computers, electric and optical products, electrical equipment, machinery and equipment n.e.c, motor vehicles, other transport equipment, furniture, other manufacturing, repair and installation of machinery and equipment																										
Manufacture of electrical equipment, machinery and equipment n.e.c.																										
Manufacture of food products; beverages and tobacco products																										
Manufacture of furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment																										
Manufacture of motor vehicles, trailers, semi-trailers and of other transport equipment																										
Manufacture of products based on: food, beverages, tobacco, textile, leather, wood, pulp and paper; publishing and printing																										

Detailed sectors	Belgium	Germany	Greece	Spain	France	Ireland	Italy	Luxembourg	Netherlands	Austria	Portugal	Finland	Sweden	Czechia	Estonia	Cyprus	Latvia	Lithuania	Hungary	Malta	Poland	Slovenia	Slovakia	Bulgaria	Romania	Croatia
Manufacture of textiles, wearing apparel, leather and related products																										
Manufacture of wood, paper, printing and reproduction																										
Manufacturing, electricity, gas, steam and air conditioning; water supply, sewerage, waste management and remediation activities																										
Publishing, motion picture, video, television programme production; sound recording, programming and broadcasting activities																										
Real estate activities																										
Repair of computers and communication equipment																										
Retail trade, except of motor vehicles and motorcycles																										
Telecommunications																										
Transportation and storage																										
Travel agency, tour operator and other reservation service and related activities																										
Wholesale and retail trade and repair of motor vehicles and motorcycles																										
Wholesale and retail trade; repair of motor vehicles and motorcycles																										
Wholesale trade, except of motor vehicles and motorcycles																										

Source: Eurostat data (ISOC_CI_CM_PN2).

EN

Digital skills ambitions in action

Cedefop's Skills forecast digitalisation scenario

Achieving the EU's digital transition objectives and policy targets is expected to create significant additional employment in key sectors such as computer programming, research and development, and telecommunications. As digital transformation requires substantial training, job opportunities will also emerge in wholesale and retail trade, and in non-market services, which includes the education and training sector.
The productivity-enhancing effect of AI fosters versatility among workers and enables them to engage in more fulfilling activities. Alongside automation, AI will also replace human tasks, leading to shrinking employment, particularly in wholesale and retail trade and construction. The pace of automation and AI deployment is uncertain, as it is influenced by technological readiness, funding availability, regulatory frameworks, social partner dynamics, and other factors.
What is certain is that – to navigate the digital transition successfully – substantial investment in human capital via digital skills training is needed, including on AI at all levels.

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