Competency: Digital Skills

5

KEY MESSAGES

- The demand for artificial intelligence (AI) and generative AI (GenAI) skills has surged since 2021. Although primarily concentrated among information and communication technology (ICT) professionals, GenAI skills are increasingly sought in roles related to content creation, marketing, and research.
  - From 2021 to 2024, job postings requiring AI skills grew by 2 percent in high-income countries (HICs), 16 percent in upper-middle-income countries (UMICs), and 11 percent in lower-middle-income countries (LMICs). Still, only 1.5 percent of all online vacancies globally required AI skills during this period. In 2024, more than 70 percent of these postings were based in HICs.
  - Vacancies specifically requiring GenAI skills rose ninefold from 2021 to 2024, reaching 0.2 percent of all online job postings in 2024. Although demand remains concentrated in ICT professions, it is rapidly permeating into content creation, design, marketing, research and development, education, and health care.
- Significant gaps in the supply of digital and AI skills exist in lower-income countries (LICs), creating barriers to AI adoption, inclusive growth, and economic convergence across geographies.
  - Less than 5 percent of the population in LICs possess basic digital skills, compared with 21 percent in LMICs, 38 percent in UMICs, and 66 percent in HICs. Similarly, less than 15 percent of the population in LMICs have intermediate digital skills, compared with around 26 percent in UMICs and 57 percent in HICs.
  - China, India, and the United States together account for 57 percent of ICT specialists globally. Of these specialists, 53 percent reside in HICs, 29 percent in UMICs, 17 percent in LMICs, and less than 1 percent in LICs. Women represent only 24 percent of ICT specialists worldwide.
  - The supply of AI and GenAI skills largely aligns with demand, with more than one-quarter of GenAI talent concentrated among ICT professionals, along with significant shares in business, marketing, research, engineering, and teaching roles as of June 2025.
  - The number of tertiary graduates in ICT programs has expanded globally since 2000, but it remains insufficient to meet current demand. The expansion of technical and vocational education and training programs, coding bootcamps, and online courses has been notable, with GenAI course enrollments on platforms such as Coursera increasing 12-fold from 2023 to 2025. However, women make up only 30 percent of GenAI learners.

- Migration and brain drain further complicate AI development in LICs and middle-income countries.
  - Countries such as Bangladesh, Lebanon, Nigeria, and Ukraine experience outflows of digital talent that are 3–4 times higher than their inflows.
  - The brain drain challenge is especially acute for top-tier AI researchers. In 2022, 28 percent of the world's most-elite AI researchers originated from the United States, followed by 26 percent from China and 7 percent from India. However, 57 percent of these top AI researchers eventually worked in the United States.
- Governments play a crucial role in building and retaining digital talent to unlock AI's full potential.
  - Externalities and coordination failures result in underinvestment in digital skills; education systems often lag behind industry needs, firms hesitate to invest in training because of fears of poaching by competitors, and brain drain pulls top talents abroad.
  - To address these barriers, governments can integrate digital skills into formal education curricula, collaborate with educational technology providers to expand access, align training programs with labor market demands, subsidize training for underserved populations and small and medium enterprises, and implement policies to attract and retain digital talent, including streamlined visa processes.

Introduction

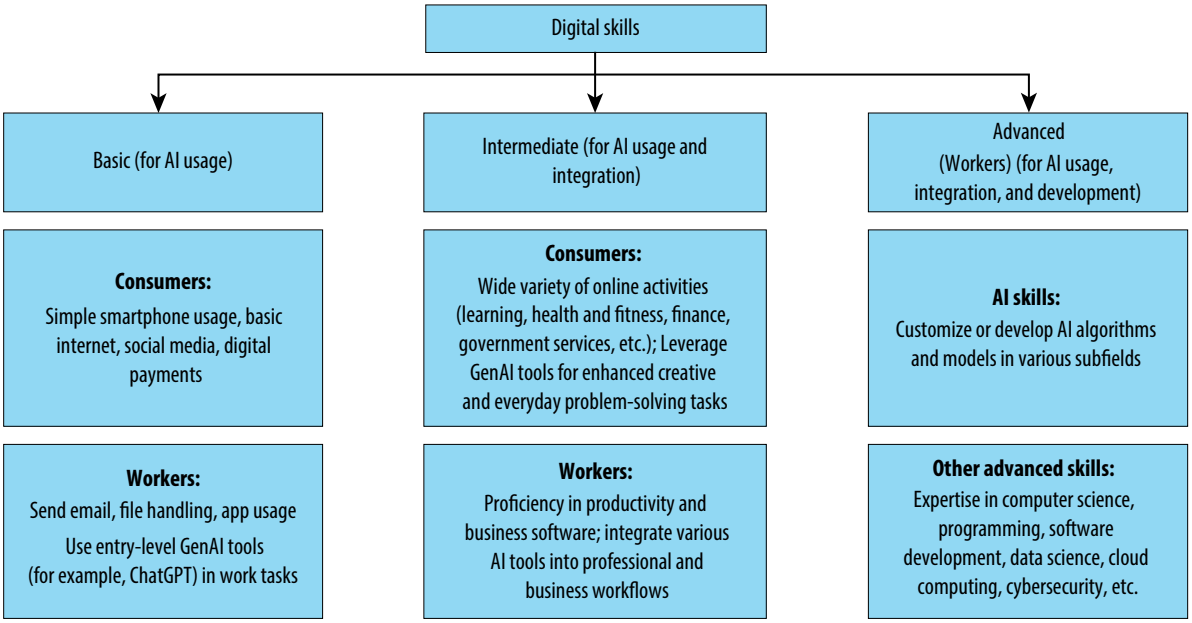
The rapid advancements in artificial intelligence (AI) are reshaping labor markets and raising demand for diverse digital skills related to AI usage, integration, and development. Digital transformation has already increased the demand for digital skills across economies, industries, and occupations. Now, with the rise of generative AI (GenAI), intuitive human-machine interactions are accelerating widespread AI adoption.

Consequently, digital and AI skills are no longer confined to specialized roles; they are becoming essential across three key dimensions. AI adoption demands basic digital and AI literacy to use consumer-facing tools such as ChatGPT. AI adaptation necessitates intermediate to advanced digital skills for embedding AI into business workflows. AI innovation requires highly specialized expertise in creating and refining AI models.

This chapter develops a taxonomy of digital skills to assess the supply-demand dynamics in the context of labor market transformations driven by AI, particularly with the rise of GenAI. In this chapter, digital skills are categorized into three levels: basic, intermediate, and advanced (refer to figure 5.1):

- *Basic digital skills* are essential for accessing information and services, participating in the modern workforce, and using AI-powered tools. These skills are often assumed rather than explicitly mentioned in current online job postings, reflecting their ubiquity across roles (Sostero and Tolan 2022).
- *Intermediate digital skills* are often required for most white-collar and professional jobs and are essential for integrating digital and AI tools into professional and business functions.
- *Advanced digital skills* are divided into AI skills and other advanced digital skills. *AI skills* involve developing and customizing AI algorithms and models. *Other advanced digital skills* mainly involve programming, software development, data science, cybersecurity, and so forth.

FIGURE 5.1 Classification of digital skills



Source: Original figure for this publication.
Note: AI = artificial intelligence; GenAI = generative artificial intelligence.

Although digital transformation and AI advances fuel demand for digital skills, a stark global imbalance exists, posing barriers to inclusive growth and economic convergence across geographies. Many economies struggle to train a sufficiently digitally savvy workforce, particularly in developing countries, where even basic digital skills are scarce, limiting AI adoption and its potential benefits. Existing digital divides—characterized by inadequate infrastructure, limited access to digital devices, and weak educational systems—exacerbate these challenges, particularly in small communities and vulnerable populations. A few countries dominate the global demand for advanced digital skills, leading to a brain drain of digital talents in many other economies. This chapter explores the digital skills gap from both demand and supply perspectives.

The chapter is structured as follows: The "Digitalization of Occupations" section examines the growing digital transformation across occupations and the complementary skills required along with digital expertise. The "Demand for Digital Skills" section analyzes digital skills demand using job vacancy data, with a focus on AI-related skills. The "Supply of Digital Skills" section examines the supply of digital skills, and the "Policy Insights to Bridge the Digital Skills Gap" section identifies key barriers for individuals to acquire digital skills and for firms to retain digital talents in developing countries and summarizes policy trends and insights to help bridge the digital skills gap.

Digitalization of occupations

Almost all occupations have become more digitalized over the past decade, with an especially rapid increase in the previously least-digitalized roles. As digitalization transforms how people work, digital skills have become a prerequisite in most occupations.

O*NET offers comprehensive insights into the tools and technologies used across various occupations, serving as an umbrella for all available digital resources. In addition, the growing

integration of AI technology into these tools has simplified complex tasks and broadened their scope of application, further transforming day-to-day workflows.

Figure 5.2 shows the usage of digital technology (refer to panel a) and digital tools (refer to panel b) across International Standard Classification of Occupations 1-digit occupations in 2015 and 2024 using O*NET data. High-skilled occupations consistently report greater usage of digital technologies and tools than medium- and low-skilled occupations.[1] Professionals hold the most-digitalized occupations, making use of more than 60 percent of all the available digital tools and 90 percent of digital technologies in 2024. However, middle- and low-skilled occupations have seen the largest increases, with their roles now requiring greater integration of digital tools and technologies in the workplace.

Digital skills are essential in the AI era, but their role is amplified by strong soft skills such as critical thinking, intellectual curiosity, communication, and teamwork, which remain fundamental across occupations. The fast pace of technological change makes specialized technical skills vulnerable to obsolescence, whereas transversal soft skills—such as the ability to learn, critical thinking, problem-solving, and adaptability—are durable and transferable across roles.[2] Postsecondary graduates who lack strong foundational and transversal skills often struggle to adapt to new job demands despite having technical expertise (World Bank 2025).

FIGURE 5.2 Exposure to digitization through the use of technologies and IT tools, by occupation, 2015 and 2024

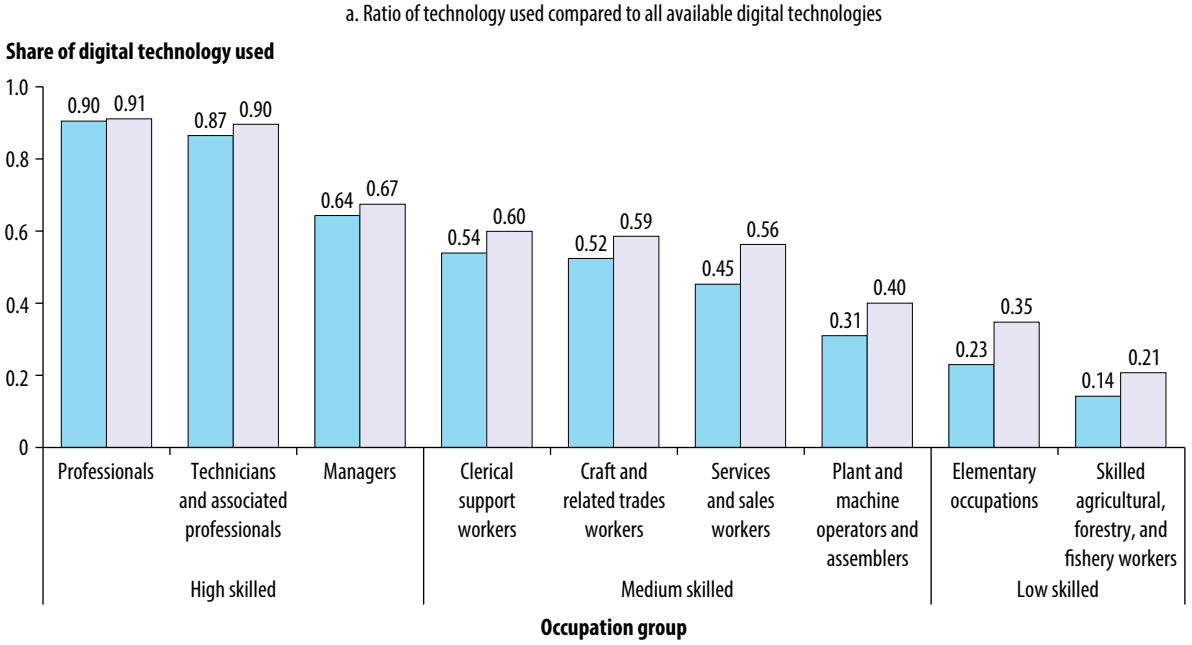


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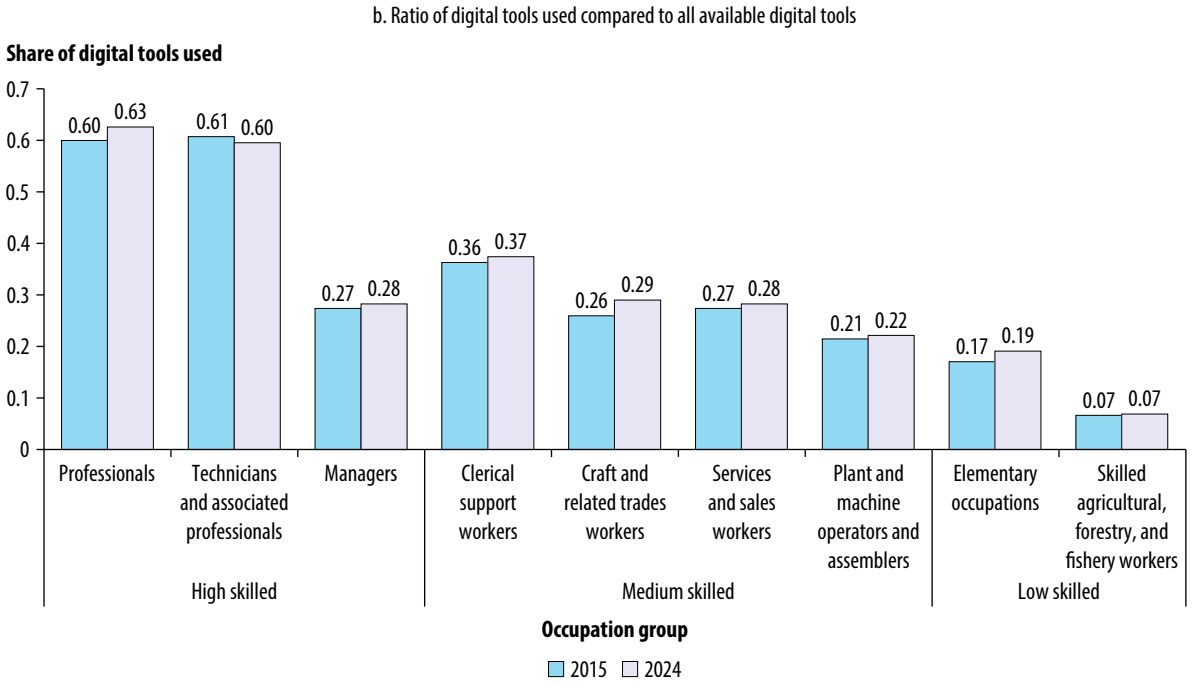
FIGURE 5.2 Exposure to digitization through the use of technologies and IT tools, by occupation, 2015 and 2024 (*Continued*)



Source: Original figures for this publication using calculations based on O*NET data (https://www.onetonline.org/).
Note: IT = information technology.

Demand for digital skills

This section uses online job posting data from Lightcast to analyze the demand for digital skills, with a focus on advanced digital skills and AI skills. Lightcast searches major job posting websites such as Glassdoor, Indeed, and LinkedIn across economies and provides real-time information on labor demand, including company names, industry affiliations, locations, job titles, job descriptions, qualifications, and other relevant details. Specifically for digital skills, the data offer detailed information on the software, programming languages, and technical competencies sought by employers, providing a level of granularity far beyond traditional labor force surveys.

However, these data have some limitations. Biases arise because of the nature of online job postings, because many roles—particularly in occupations or regions reliant on traditional hiring practices—are not advertised online. For example, nearly half of mining, shipping, and machinery manufacturing candidates in the United States still rely on local newspapers (Resources for Employers 2023; Zojceska 2019), making such roles underrepresented. Consequently, the coverage of online job postings tends to be skewed toward big cities, high-skilled industries, and white-collar occupations, reducing representativeness, especially in developing countries and for non-white-collar roles.

The reliance on English and European language-searching results in a severely incomplete picture of the job market in non-Western-language countries such as China, Japan, the Republic of Korea, and Viet Nam. In addition, the data reflect only active job openings, excluding the broader employment stock, informal sector, and freelance or gig work. Despite these limitations, Lightcast data provide timely and nuanced insights into global digital skills demand. Because low-skilled occupations are often not well-represented in Lightcast data, this chapter focuses on demand in middle- and high-skilled occupations.

Basic digital skills now serve as a minimum requirement across a broad spectrum of occupations.[3] Employers increasingly expect candidates to be proficient in operating digital devices, managing email, entering data, and leveraging social media for marketing or customer engagement. These competencies are also essential in the gig economy, where tasks such as data labeling and content moderation require platform proficiency, and location-based gig workers rely on digital tools for job matching, scheduling, and payment processing.

Intermediate and advanced digital skills are pivotal in driving productivity and fostering innovation. Intermediate digital skills, particularly proficiency in Microsoft Office and various business software applications, are highly valued in roles spanning marketing, project management, finance, professional services, and scientific research.

Demand for intermediate and advanced digital skills is concentrated in high-skilled occupations, especially in information technology (IT), professional services, finance, and insurance industries, and among information and communication technology (ICT) and business professionals, technicians, scientists, and engineers. Globally, around 27 percent and 21 percent of job postings for high-skilled occupations in 2024 required intermediate or advanced digital skills, respectively, compared with 14 percent of job postings for medium-skilled occupations.

The IT services industry is most likely to require advanced digital skills, with 60 percent of job postings requiring such skills, followed by 53 percent in professional services and 44 percent in finance and insurance. Nearly 90 percent of job postings for ICT professionals require advanced digital skills, followed by 62 percent of those for ICT technicians, 60 percent of those for science and engineering professionals, and 45 percent of those for business and administration professionals. The same pattern holds across country income groups and over time.

Global demand for advanced digital skills has fallen since mid-2022, attributed to macroeconomic headwinds, pandemic-era overhiring, and the potential influence of GenAI, with high-income countries (HICs) experiencing the steepest decline. Between 2021 and 2022, HICs witnessed a 40 percent growth in job vacancies requiring advanced digital skills, propelled by the expansion of online services in response to the coronavirus disease 2019 pandemic. Big technology firms such as Alphabet, Amazon, Apple, Meta, and Microsoft nearly doubled their head counts during this period, collectively adding around 1 million employees.

However, in HICs this rapid expansion has reversed since mid-2022. As lockdowns eased and offline activities resumed, demand for digital services slowed (Symon 2024). At the same time, the US Federal Reserve's interest rate hikes between March 2022 and July 2023 pushed borrowing costs above 5 percent, dampening overall hiring activity in the United States with knock-on effects globally (US Bureau of Labor Statistics 2024).

In addition, GenAI is changing the hiring calculus for companies. Companies are increasingly delaying or reducing hiring, opting to experiment with GenAI tools to do more with fewer employees. Increased AI spending is also diverting funds from hiring budgets (Bousquette 2024, 2025). In 2024, vacancies dropped back to nearly 2021 levels in HICs. This contraction in demand for advanced digital skills has also spilled over into other regions, underscoring the interconnectedness of the global labor market.

Demand for advanced digital skills in upper-middle-income countries (UMICs) peaked in 2023 and declined in 2024 but remained well above the 2021 level, whereas demand in lower-middle-income countries (LMICs) remained stable except for an uptick in 2023. UMICs saw a significant surge, with advanced digital skills vacancies doubling between 2021 and 2023, outpacing overall vacancy growth. Although a slight decline occurred in 2024, demand remained 66 percent above 2021 levels. Notably, Brazil and Indonesia experienced a tripling of demand from 2021 to 2024, and Colombia, Malaysia, Mexico, and Serbia nearly doubled their demand.

In LMICs, demand for advanced digital skills rose in 2023 but returned to 2021 levels in 2024, whereas other vacancies grew faster. This trend was largely driven by India, where demand contracted by 30 percent in 2024 after a 2023 increase. Conversely, Kenya, Nigeria, and the Philippines saw a tripling of vacancies by mid-2023, maintaining levels above those of early 2021 despite recent moderate declines.

These demand fluctuations reflect a complex interplay of factors. Initial increases likely resulted from enhanced online labor market data coverage, capturing previously underreported positions. The 2024 decline may indicate spillover effects from weakening demand in HICs and the nascent impact of GenAI.

A notable trend across all income groups is the accelerated demand for advanced digital skills in medium-skilled occupations, outpacing growth in high-skilled occupations. This suggests that digitalization is increasingly transforming the nature of work for previously less-digitalized roles. In HICs, the most-pronounced increase in demand for advanced digital skills was observed among personal service workers, drivers and mobile plant operators, and sales workers. In middle-income countries (MICs), sales workers, customer service clerks, and numerical and material recording clerks experienced the fastest growth in demand for advanced digital skills, reflecting the upskilling trends within the business process outsourcing sector.

HICs consistently drive the global demand for AI skills, excluding GenAI, accounting for roughly 70 percent of all AI vacancies from 2021 to 2024. Global demand has held steady at about 1.7 million annual vacancies, consistently representing around 1.5 percent of total vacancies. HICs, particularly the United States, led a notable surge in 2022. However, AI vacancies have declined since late 2022, following a trend similar to that for advanced digital skills (refer to figure 5.3, panel a). Despite this, the United States still represents 40 percent of all AI vacancies in HICs in 2024. Interestingly, although US AI vacancies decreased by 9 percent between 2021 and 2024, they nearly doubled in Canada, France, Italy, and Japan.

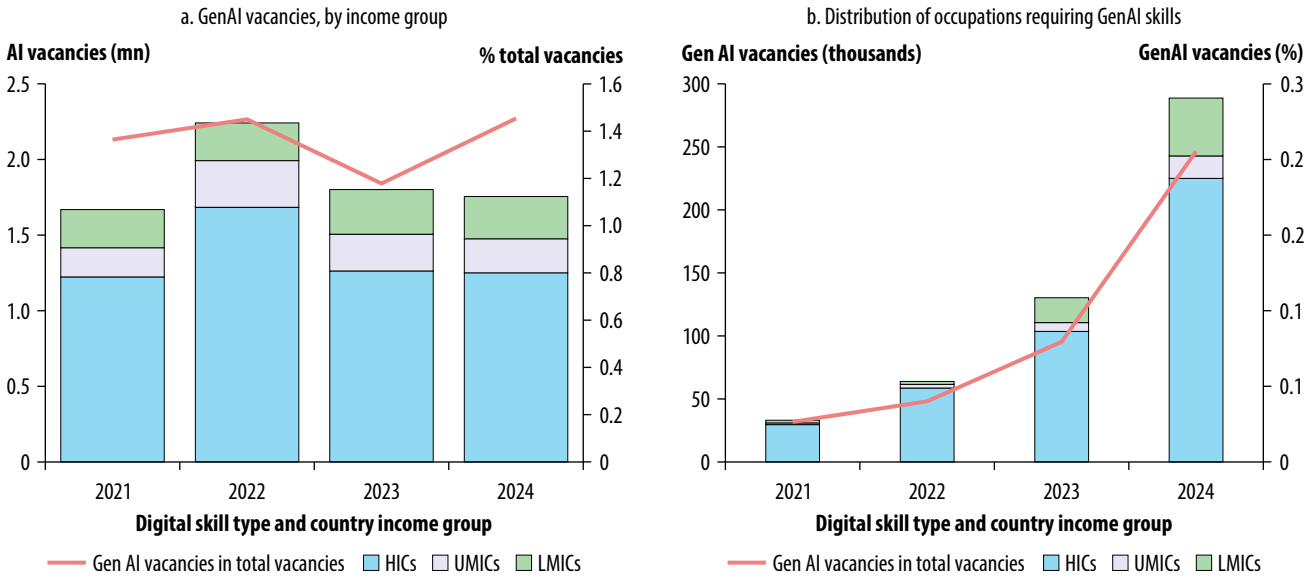
Demand for AI skills, excluding GenAI, in UMICs and LMICs also saw a cool down after 2022 and 2023, although 2024 demand remained above 2021 levels. Brazil, China, Colombia, Malaysia, and Mexico all recorded brisk growth. In UMICs, AI vacancies grew by 16 percent from 2021 to 2024,

reaching 225,000 in 2024. In China, vacancies for natural language processing surged by 111 percent in the first half of 2024 compared with the same period in 2023, followed by a 76-percent growth in AI for robotics, a 61-percent growth in deep learning, and a 49-percent growth in autonomous driving (*China Youth Daily* 2024). Brazil recorded around 56,000 AI vacancies in 2024, nearly tripling its 2021 level. Demand also tripled in Indonesia and doubled in Colombia, Malaysia, and Mexico.

Among LMICs, India maintained a stable AI skills demand, consistently hovering around 230,000 vacancies every year. From 2021 to 2024, AI vacancies doubled in the Arab Republic of Egypt, Pakistan, and the Philippines. Demand grew fourfold in Kenya, albeit from a very low base.

The IT industry is most likely to require AI skills across countries, followed by professional services and finance. The IT industry demonstrates the highest probability of AI skills demand across most countries, with around 8 percent of IT industry job postings requiring AI skills globally in 2024. Professional services and finance are the other top industries that require AI skills, with about 4–5 percent of job postings requiring such competencies. Managers and professionals in manufacturing are also increasingly expected to possess AI skills. AI skills are less required in the agriculture industry. In occupations, software developers, database designers and administrators, mathematicians, and physicists are most likely to require AI skills, with more than 10 percent of vacancies requiring them.

FIGURE 5.3 Trends in AI and GenAI skills demand across country income groups, 2021–24



Source: Original figures for this publication using computations based on Lightcast data (https://lightcast.io/).
Note: Data for UMICs is severely underestimated due to extremely limited coverage in China. GenAI = generative artificial intelligence; HICs = high-income countries; ICT = information and communication technology; IT = information technology; LMICs = lower-middle-income countries; UMICs = upper-middle-income countries.

AI vacancies stand out for their significantly higher demand for advanced degrees compared with other advanced digital skills roles. In 2024, 51 percent of global AI vacancies required at least a master's degree, a stark contrast to the 27 percent of vacancies demanding advanced digital skills without an AI component. This clearly indicates a higher skill threshold and greater technical specialization for AI roles. The gap is even more pronounced at the doctoral level, with more than 7 percent of AI vacancies requiring a PhD, compared with just 1 percent for other advanced digital skills positions.

Vacancies requiring GenAI skills surged ninefold globally from 2021 to 2024 as companies raced to develop and deploy GenAI solutions (refer to figure 5.3, panel b).[4] Before the release of Chat GPT, GenAI vacancies almost exclusively stemmed from HICs, with a focus on developing GenAI models. After GenAI tools became publicly available, demand shifted toward skills to integrate and use GenAI. GenAI skills also command substantial wage premiums. GenAI development skills are associated with a 7–9 percent wage increase in technical roles, while GenAI literacy skills yield a 25–36 percent premium in nontechnical white-collar roles (Martins Neto et al. 2025).

France and the United States accounted for nearly half of global GenAI vacancies in 2024, excluding China. The United States recorded nearly 84,000 vacancies requiring GenAI skills in 2024, up from 3,000 in 2021, representing 30 percent of global GenAI vacancies. France posted around 53,000 GenAI vacancies in 2024, accounting for another 18 percent of global vacancies, far ahead of other HICs. French start-up Mistral AI has quickly ascended as a notable player in the global GenAI arena and stimulated demand for local GenAI vacancies. Germany and the United Kingdom recorded about 16,000 and 12,000 GenAI vacancies in 2024, respectively.

Among MICs, Brazil, China, India, Malaysia, Mexico, and the Philippines have been leading the surge in GenAI vacancies. Before the release of ChatGPT, UMICs registered fewer than 3,000 GenAI vacancies, but by 2024, vacancies had soared sixfold to nearly 18,000, largely excluding China.

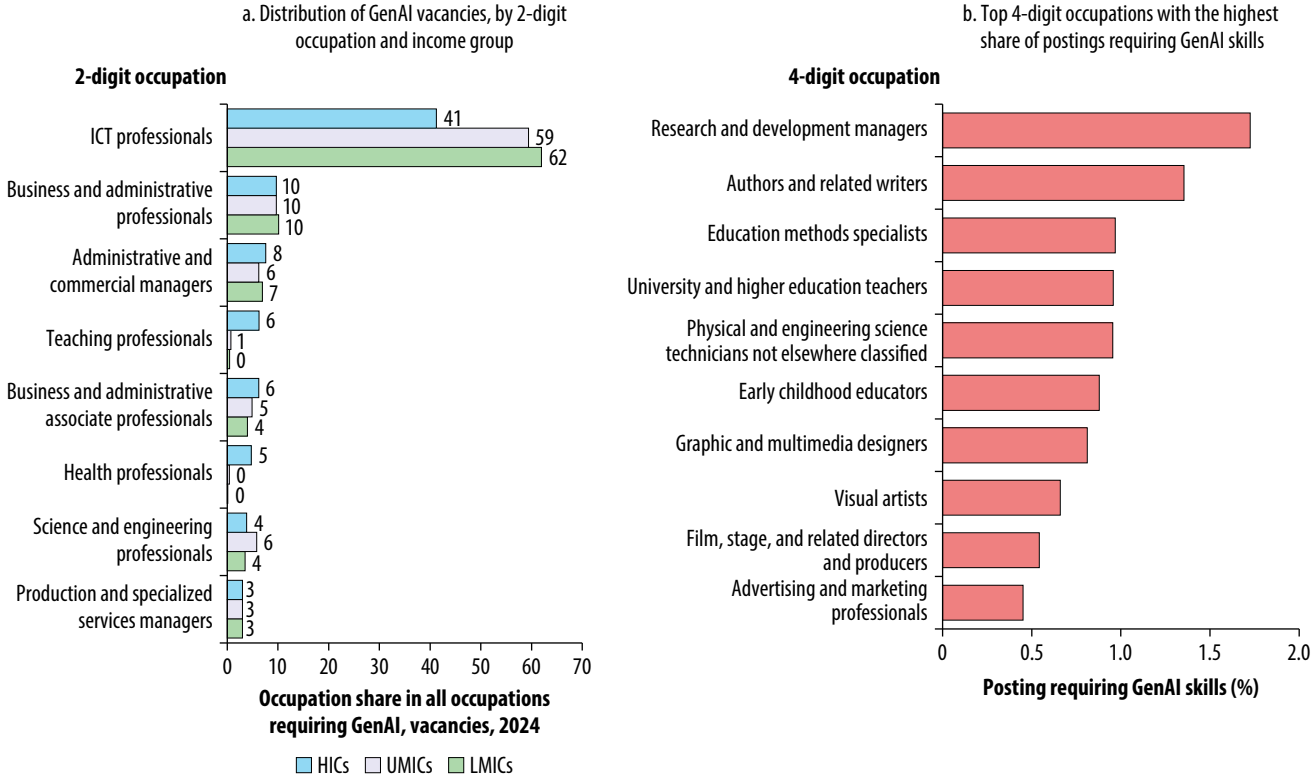
LMICs experienced a 23-fold increase, reaching around 46,000 vacancies by 2024 (refer to figure 5.3, panel b). India experienced a near 22-fold growth in GenAI vacancies between 2021 and 2024, contributing 80 percent of all GenAI vacancies among LMICs. Notably, Brazil and the Philippines saw the most-remarkable expansion, with 82-fold and 115-fold increases, respectively, from 2021 to 2024, significantly propelling growth in East Asia and Pacific (EAP) and Latin America and the Caribbean. Beyond the leading nations, Colombia, Malaysia, Mexico, Pakistan, and South Africa all recorded more than 1,000 GenAI vacancies in 2024, indicating rapid global diffusion of GenAI across major emerging markets.

The data for UMICs and EAP are grossly underestimated because of incomplete data for China. Various GenAI-related vacancies have surged in China, ranging from large language model (LLM) engineers and prompt engineers to GenAI application developers and users across industries. It is estimated that vacancies requiring GenAI skills will exceed 1 million in China by the end of 2025 ("AI Large Language Model-Driven Career Change" 2025).

GenAI vacancies primarily target ICT professionals, particularly in MICs. HICs exhibit a broader occupational distribution, including a notable presence of teaching and health professionals. In HICs, ICT professionals made up 41 percent of all GenAI vacancies in 2024 (refer to figure 5.4, panel a), suggesting that firms are hiring ICT professionals to develop and customize GenAI solutions across industries. In MICs, ICT professionals dominate, accounting for around 60 percent of all GenAI vacancies.

Software developers and systems analysts are most likely to require GenAI skills, with 2–3 percent of global vacancies requiring GenAI skills in 2024. The more even occupational distribution in HICs reflects their rapid adoption and broader integration of GenAI. Business and administrative professionals and administrative and commercial managers are the other two top occupations among GenAI vacancies across income groups, accounting for 10 percent and 7 percent of GenAI vacancies, respectively. Notably, teaching professionals and health professionals each constitute 5–6 percent of GenAI vacancies in HICs but are nearly absent in UMICs and LMICs. This disparity suggests limited integration of GenAI in education and health care in MICs.

FIGURE 5.4 Top occupations requiring GenAI skills, 2024



Source: Original figures for this publication using computations based on Lightcast data (https://lightcast.io/).
Note: Data for UMICs is severely underestimated due to extremely limited coverage in China. GenAI = generative artificial intelligence; HICs = high-income countries; ICT = information and communication technology; IT = information technology; LMICs = lower-middle-income countries; UMICs = upper-middle-income countries.

The demand for GenAI skills is rapidly extending beyond ICT occupations, permeating research and development (R&D), content creation, design, marketing, and education. Occupations in these areas increasingly require GenAI skills. Globally, R&D managers, authors and writers, education methods specialists, university teachers, graphic and multimedia designers, visual artists, film directors, and advertising and marketing professionals are among the top non-ICT occupations that were most likely to require GenAI skills in 2024, with around 0.5–2 percent of job postings requiring these skills (refer to figure 5.4, panel b). The actual demand is likely much higher because such skills are assumed rather than explicitly listed in job postings.

Despite the rapid expansion, GenAI is still in the early stages of affecting the labor market. It has created new occupations, such as prompt engineers and LLM engineers, but these jobs total only a few thousand globally and have a limited effect on overall job creation. Despite the rapid increase in GenAI vacancies, they accounted for only 0.2 percent of all job postings globally in 2024. Furthermore, GenAI has shown no discernible impact on worker earnings or recorded hours across any occupation, even among those most highly exposed, suggesting its overall labor market effects remain minimal so far (Humlum and Vestergaard 2025).

Supply of digital skills

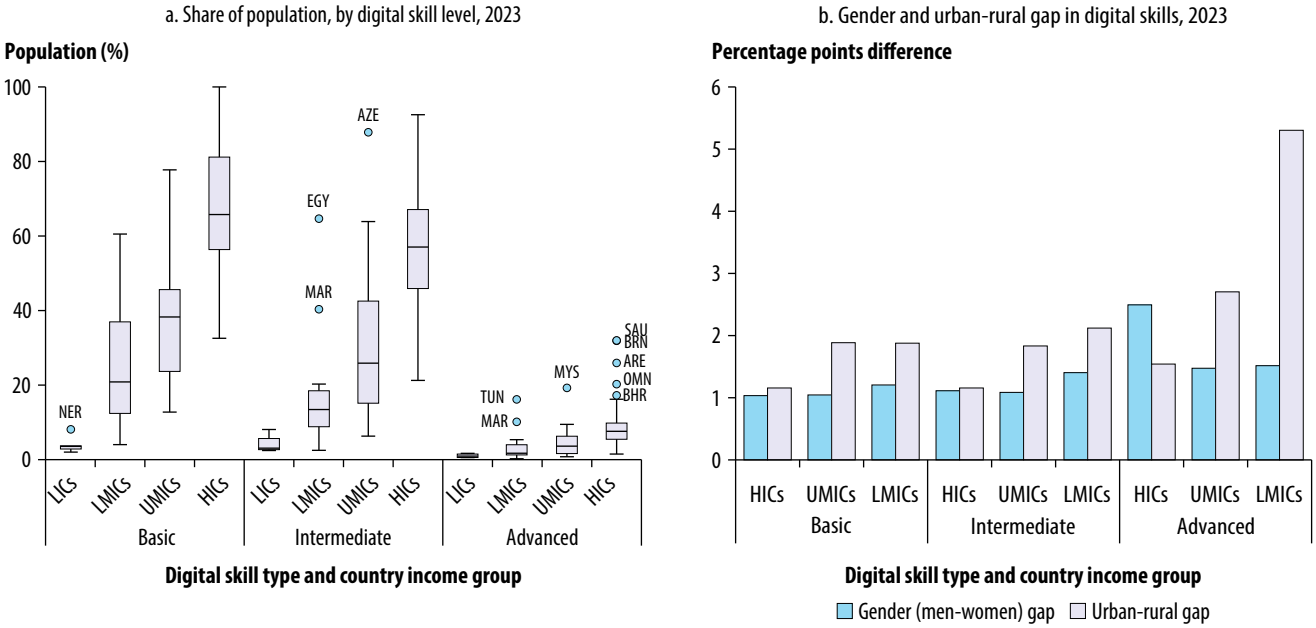
Although surging demand for digital and AI skills has driven rapid expansion in supply, gaps remain because of rapid technological advances, specialized and evolving skills requirements, outdated curricula, competition for talent and brain drain, infrastructure, and access disparities. This section analyzes the availability of digital skills across countries and examines supply through both formal education and alternative learning pathways.

A significant digital skills gap persists between rich and poor countries across all proficiency levels. Even basic digital skills are notably scarce in low-income countries (LICs), with less than 5 percent of the population possessing them, compared with 21 percent in LMICs, 38 percent in UMICs, and 66 percent in HICs (refer to figure 5.5, panel a). Less than 15 percent of the population of LMICs have intermediate digital skills, compared with around 26 percent in UMICs and 57 percent in HICs.

Advanced digital skills are limited globally, with approximately 1 in 10 people in HICs proficient in them. In LICs, this figure falls below 1 percent. Gender and urban-rural gaps deepen for more advanced digital skills, especially in LICs, where the share of individuals with advanced digital skills is 5 times higher in urban areas than in rural areas. In HICs, gender disparities are modest for basic and intermediate digital skills but widen for advanced digital skills. Urban-rural gaps in HICs also grow with skill levels. In LMICs, the median gender gap begins at 1.21 for basic skills and reaches 1.52 for advanced skills. Urban-rural gaps are more pronounced, soaring to 5.30 for advanced digital skills, indicating a significant concentration of advanced digital skills in urban areas.

UMICs show moderate disparities, with gender gaps rising from 1.05 males per female for basic skills to 1.47 males per female for advanced digital skills, and urban-rural gaps increase from 1.88 to 2.70 urban residents per rural resident for advanced skills (refer to figure 5.5, panel b). These findings highlight the need for targeted interventions to improve digital skills among women and rural populations, particularly in developing countries, to address these persistent inequalities.

FIGURE 5.5 Supply of digital skills, 2023



Source: Original figures for this publication using data from the International Telecommunication Union (https://www.itu.int/en/ITU-D/Statistics/Documents/intlcoop/sdgs/2025%20SDG%204.4.1_REV.xlsx).

Note: For panel a, data include 5 countries in LICs, 16 in LMICs, 31 in UMICs, and 49 in HICs. For panel b, gender gap data include 11 countries for LMICs, 27 for UMICs, and 46 for HICs; for the urban-rural gap, data include 11 countries for LMICs, 20 for UMICs, and 23 for HICs. Bars indicate minimum and maximum of distribution; dots are outliers. For a list of country codes, refer to https://www.iso.org/obp/ui/#search. HICs = high-income countries; LICs = low-income countries; LMICs = lower-middle-income countries; UMICs = upper-middle-income countries.

The availability of ICT specialists is heavily concentrated in a few countries, with China (21 percent), the United States (21 percent), and India (15 percent) leading, followed by the United Kingdom (5 percent), the Russian Federation (5 percent), and Germany (4 percent) as of 2023. LICs account for less than 1 percent of ICT specialists. ICT specialists also are predominantly male. Switzerland has the highest gender disparity, with a male-to-female ratio of 5.84, followed by Belgium, the Netherlands, Russia, Germany, and Italy, all of which have a ratio above 4.5. Several MICs have a more gender-balanced ICT specialist workforce. The male-to-female ratio among ICT specialists is 1.9 in the Philippines, 2.3 in China, and 2.8 in India.

Responding to rising demand, the proportion of graduates in ICT programs has consistently increased across all income groups since 2010. Despite the rapid expansion of ICT programs, universities struggle to meet the growing demand because of faculty recruitment difficulties, capacity constraints, and curriculum gaps. In Canada and the United States, the number of computer science graduates has tripled, rising from approximately 18,000 in 2010 to 52,000 in 2022. Bachelor's-degree graduates quadrupled from 9,000 to 36,000, master's-degree graduates doubled from 7,000 to 14,000, and PhD graduates saw only marginal growth, increasing from 1,800 to 2,100 (Thormundsson 2025). However, these numbers have fallen short of surging demand.

Universities face several challenges in scaling up ICT programs rapidly. Recruiting qualified faculty is a major challenge, because top-tier professionals often find industry roles far more financially rewarding than academic positions. Expanding ICT programs also requires substantial investment in infrastructure, such as dormitories, classrooms, computer labs, and campus facilities,

which cannot be scaled up quickly. Universities also face challenges in staying current with rapid technological advancements. For example, a survey of universities in Africa found that 40 percent have not updated their ICT curricula in more than 5 years, and 3 percent have never done so (World Bank forthcoming). These issues have resulted in a mismatch between the skills graduates possess and the skills employers require.

These challenges are even more acute in LICs, where infrastructure and device access gaps further compound the problem. Limited availability of reliable internet, computers, and AI labs significantly hinders the development of digital skills. Although general computer labs are common in African universities, fewer than 30 percent of institutions have specialized facilities for AI, data science, or computer-aided design (World Bank forthcoming). Moreover, many computer science students in LICs cannot afford personal computers, severely restricting their ability to practice programming and deepen their technical expertise.

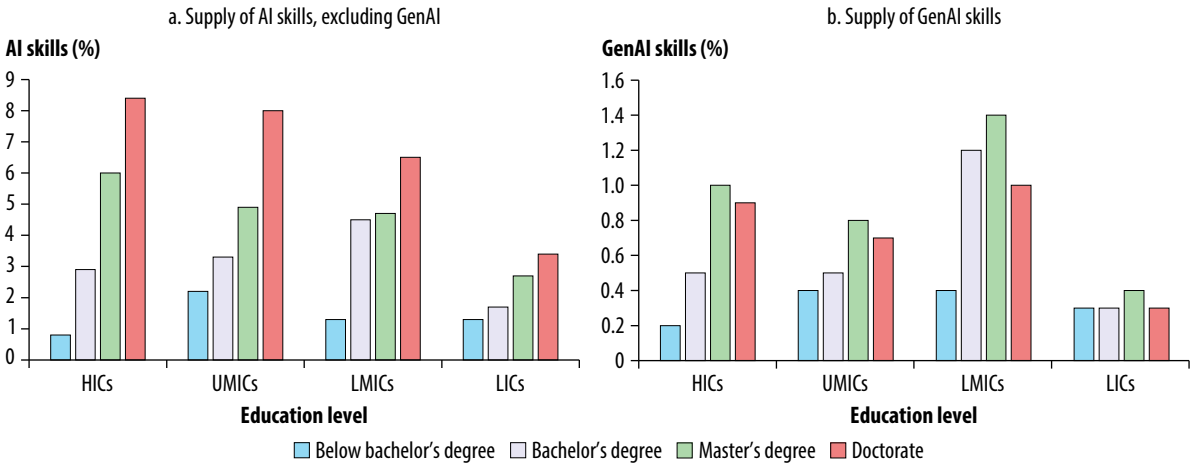
Online education has emerged as a critical avenue for acquiring digital skills, driven by its accessibility, affordability, and flexibility compared with traditional university education. These platforms offer high-quality courses from top institutions and industry leaders, often at a fraction of the cost of a university degree. Learners can acquire in-demand skills such as programming, data science, and AI on their own schedules, making online education appealing to working professionals and those in regions with limited access to quality universities. Unlike traditional degrees, which may take years to complete and often lag behind industry trends, online courses are frequently updated to reflect the latest technological advancements. Many platforms also provide hands-on projects, industry-recognized certifications, and pathways to employment, making them a more practical and responsive alternative for acquiring digital skills in today's fast-evolving job market.

A growing share of workers now enroll in online courses, but online learning remains underused by women, especially in science, technology, engineering, and mathematics (STEM) and GenAI courses. As of April 2025, global Coursera learners exceeded 170 million, representing 5 percent of the global workforce. The number of female learners has grown rapidly, reaching 46 percent of users in 2024, up from 43 percent in 2023 (Coursera Global Skills Report 2024). However, the share of female learners in STEM (34 percent) and GenAI (30 percent) courses significantly trails the overall share of female learners.

GenAI courses have seen explosive growth, with enrollments on Coursera skyrocketing 12-fold since the launch of ChatGPT in late 2022 (Coursera 2024, 2025). By April 2025, Coursera had recorded more than 8 million GenAI enrollments across its catalogue of nearly 700 GenAI courses. This surge reflects a global race toward AI literacy and adoption. According to Coursera's 2025 survey, 75 percent of employers prefer hiring less experienced candidates with GenAI skills over more experienced ones without such capabilities.

Workers in richer countries are more likely to report AI and GenAI skills, although interesting patterns emerge across educational attainment. As of June 2025, AI skill availability generally increases with education: Around 1 percent of workers without a bachelor's degree report AI skills, rising to 3 percent for those with a bachelor's degree, 6 percent for those with a master's degree, and 8 percent for those with a doctorate (refer to figure 5.6, panel a). Although PhD holders are most likely to possess AI skills across all income groups, those with master's degrees are most likely to report GenAI skills (0.4–1.4 percent across income groups; refer to figure 5.6, panel b), suggesting that GenAI has lowered the barrier to AI adoption and is increasingly being used by professionals.

FIGURE 5.6 Share of workers with AI and GenAI skills, by educational attainment, 2024



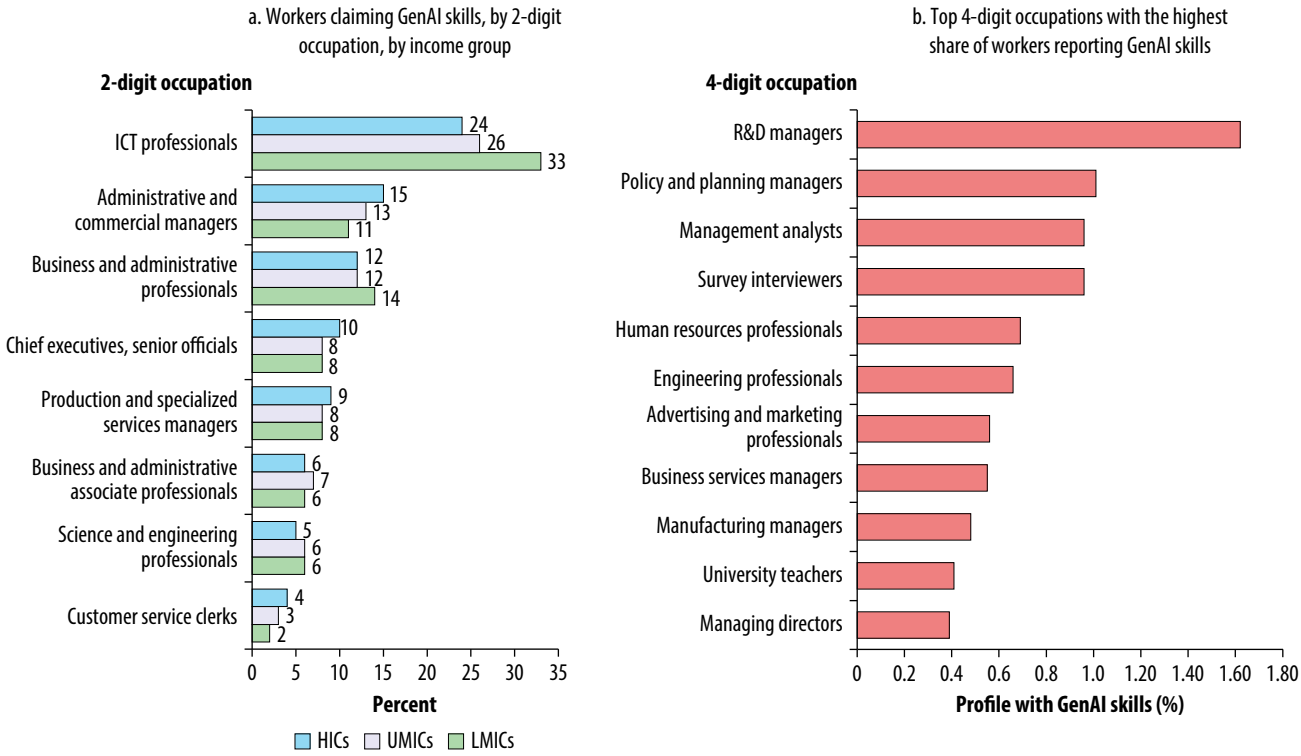
Source: Original figures for this publication using calculations based on data from Lightcast (https://lightcast.io/).
Note: AI = artificial intelligence; GenAI = generative artificial intelligence; HICs = high-income countries; LICs = low-income countries; LMICs = lower-middle-income countries; UMICs = upper-middle-income countries.

However, workers are significantly less likely to claim GenAI skills overall. Notably, workers in LMICs report GenAI skills more frequently than those in UMICs and HICs; this is largely attributable to sample bias, because a more elite segment of the workforce in poorer countries typically uses LinkedIn.

The supply of GenAI skills largely mirrors demand, being concentrated among ICT professionals, followed by administrative and commercial managers and business and administrative professionals across all country income groups. As of June 2025, an analysis of nearly 400 million individual career profiles globally revealed that one-quarter of all users claiming GenAI skills in HICs are ICT professionals. This share rises to one-third in LMICs (refer to figure 5.7, panel a).

The top five broad occupations in which GenAI skills are concentrated include administrative and commercial managers, business and administrative professionals, chief executives, and production and specialized services managers, dovetailing with demand patterns. Among non-ICT occupations, GenAI skills are most likely claimed by R&D managers, policy and planning managers, management and organizational analysts, survey and market research interviewers, human resources professionals, engineers, and advertising and marketing professionals (refer to figure 5.7, panel b). However, GenAI skill penetration in these roles remains low, typically ranging from 0.5 percent to 1.5 percent of all profiles. This limited uptake, even among highly exposed occupations, corroborates earlier findings that GenAI adoption is still in its nascent stages and has had minimal impact on skills demand and supply to date.

FIGURE 5.7 Top occupations in which workers are most likely to have GenAI skills, 2024

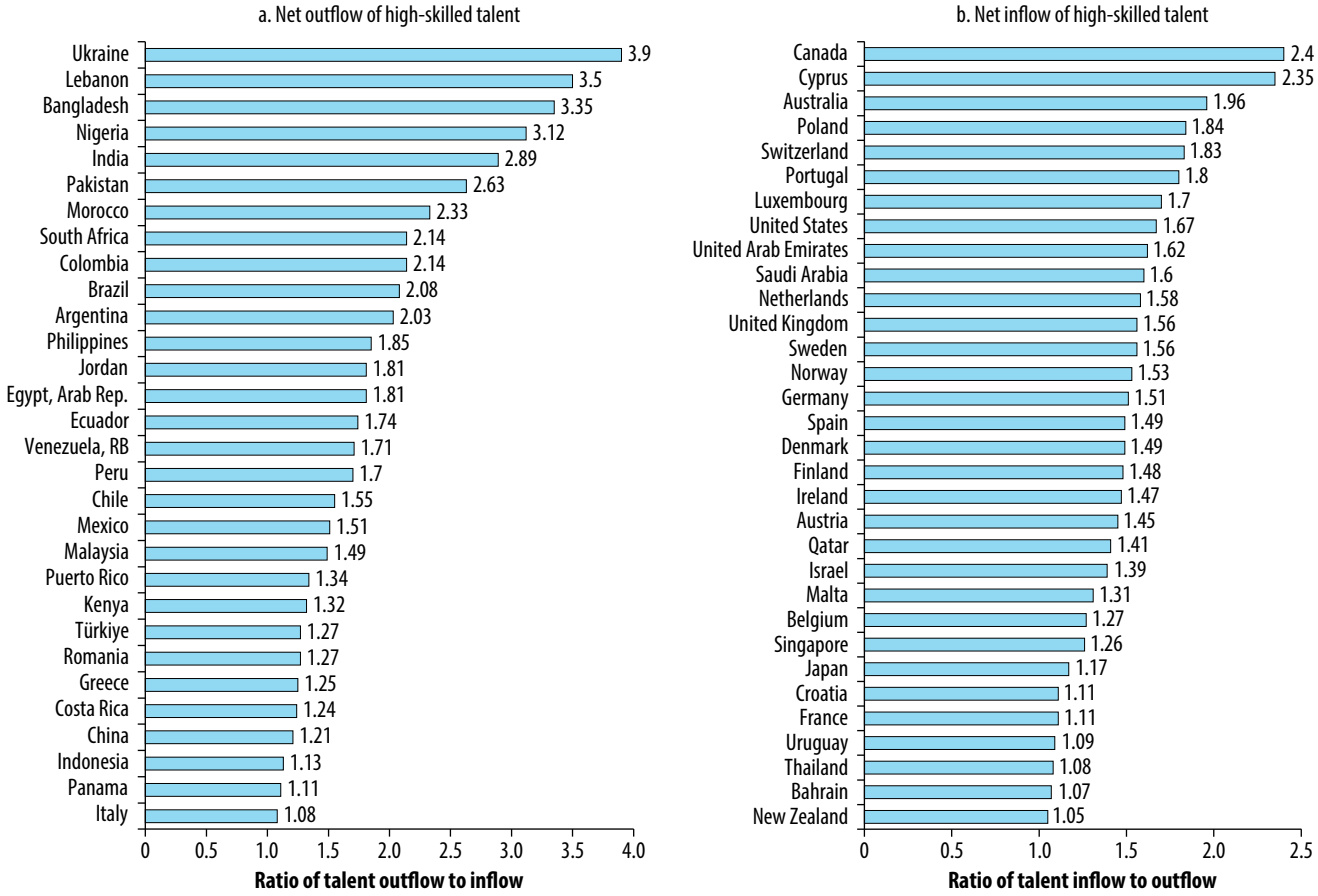


Source: Original figures for this publication using calculations based on data from Lightcast (https://lightcast.io/).
Note: AI = artificial intelligence; GenAI = generative artificial intelligence; HICs = high-income countries; ICT = information and communication technology; LMICs = lower-middle-income countries; R&D = research and development; UMICs = upper-middle-income countries.

Highly skilled digital talents enjoy global mobility and often move across borders to seek better job opportunities. This has advantaged HICs while accelerating brain drain in developing countries. LinkedIn data show that in Bangladesh, Lebanon, Nigeria, and Ukraine, talent outflows are 3–4 times higher than inflows. Argentina, Brazil, Colombia, India, Morocco, Pakistan, and South Africa follow with a ratio of outflow to inflow between 2 and 3 times (refer to figure 5.8, panel a). In contrast, countries such as Australia, Canada, and Cyprus attract high-skilled workers at least twice the rate of those leaving. Poland, Portugal, and Switzerland also attract a substantial share of skilled professionals (refer to figure 5.8, panel b).

The United States remains the world's premier destination for AI talents, benefiting from a significant brain gain, particularly from China and India. On the basis of Macro Polo's Global AI Talent Tracker, 28 percent of the most-elite AI researchers globally in 2022 originated from the United States, followed by 26 percent from China and 7 percent from India. However, 57 percent of the top AI researchers eventually work in the United States, followed by 12 percent in China and almost none in India. The pattern highlights both the strength of US academic and research institutions in cultivating AI expertise and the country's ability to offer attractive career opportunities in both academia and industry, underlining the inherent winner-takes-all dynamic of the technology sector. This sustained ability to attract and retain top global AI talent has been instrumental in maintaining US technological leadership and economic competitiveness in the rapidly evolving field.

FIGURE 5.8 Cross-border migration of high-skilled talent, 2022



Source: Original figures for this publication using data from LinkedIn (data development partnership, https://datapartnership.org/about/).

In contrast, Europe tends to have a weaker draw on top AI talents and to lose its most-elite AI talents to the United States (Pal 2024). Most of the top-tier AI talents in Europe end up working for US companies with a major presence in Europe (Macro Polo n.d.). Nonetheless, China, India, and several European countries have improved the attraction and retention of their domestic AI talents in recent years.

Policy insights to bridge the digital skills gap

Developing countries face significant market failures and barriers in cultivating and retaining digital talent, limiting their ability to participate in the digital economy and benefit from AI. Limited access to high-speed internet, modern computing infrastructure, and AI labs restricts hands-on learning opportunities. Another challenge is the lack of quality education and training programs aligned with industry needs, often resulting from weak coordination between universities and the private sector. In addition, high training costs and credit constraints prevent many individuals from acquiring digital skills, and firms underinvest in employee training because of fears of poaching by competitors.

Financial constraints, lower education levels, and sociocultural norms restrict women's access to technology and training, reinforcing gender inequality in digital skills development. Even when talent is developed, brain drain remains a persistent issue, as skilled professionals seek higher wages and better career opportunities abroad. These barriers create a vicious cycle in which a shortage of skilled workers discourages investment in the digital sector, further limiting opportunities for talent development and retention.

Governments in developing countries could consider the following actions to address the digital skills gap. Countries with low AI readiness can target interventions to improve device access and ownership. Governments can reduce taxes on digital devices, introduce targeted subsidies, and partner with device manufacturers and internet services providers to explore innovative financing schemes to promote device access and ownership.

Governments can enhance digital literacy and basic skills for AI use by doing the following:

- *Embedding basic digital skills content into compulsory education.*
- *Encouraging online content generators to teach basic digital skills,* especially for marginalized populations.
- *Tailoring initiatives to local contexts.* For example, the Saya Digital initiative in Malaysia uses native languages and addresses local challenges, enhancing its accessibility and impact.
- *Incorporating critical thinking and communication skills into education.* Overreliance on AI-generated responses may reduce cognitive engagement, leading to intellectual laziness. Digital literacy programs should integrate training on effective questioning, evaluating AI-generated content, and fostering independent problem-solving.

Countries with medium AI readiness can strengthen intermediate and advanced digital skills training and workforce readiness by doing the following:

- *Make digital training more affordable for small and medium enterprises (SMEs).* SMEs often lack the resources to train employees in digital skills, affecting their productivity and competitiveness. Public investment, complemented by industry association support, can fund upskilling programs, ensuring that SME workers gain essential competencies.
- *Address the shortage of digital skills instructors.* Expanding faculty training and incentivizing careers in digital education can improve instruction quality.
- *Promote industry-specific training to address sectoral skills shortages.* Partnerships between industry and educational institutions can help ensure that the training provided aligns with ever-changing market needs. Models such as Korea's Meister schools, which focus on aligning vocational training with labor market requirements, offer valuable lessons for replication.
- *Introduce a framework for regular curriculum updates across education systems.* In a rapidly evolving technological landscape, periodic assessments of digital skills demand and supply are essential. These diagnostics enable policy makers to identify skills gaps, project future needs, and design responsive education and training programs. Such initiatives can improve labor market matching efficiency, reducing unemployment and underemployment by equipping workers with relevant competencies. For example, Singapore's SkillsFuture program leverages big data analytics and industry consultations to update training frameworks swiftly, avoiding delays associated with long-term studies.

- *Ensure quality assurance for AI tools used in education.* Many AI-powered learning platforms operate with proprietary models, raising concerns over accuracy, biases, and long-term skills development. Public oversight and transparent certification processes can ensure AI tools align with educational best practices.

Countries with high AI readiness can support access to AI infrastructure and training data for universities, researchers, and AI start-ups for AI research, innovation, and commercialization. AI research is increasingly dominated by industry instead of academia because state-of-the-art AI models increasingly require vast compute and extensive data sets that universities lack. Empowering universities to remain at the forefront of AI research will be key to realizing AI's long-term potential. Similarly, AI start-ups may also lack access to compute and training data to effectively compete with established giants. Governments can provide targeted subsidies to facilitate access to high-performing computing resources for domestic AI researchers and start-ups.

Investment in cutting-edge AI skills and research capabilities can generate significant positive spillovers. The positive externality of such investments justifies government intervention. Governments can partner with leading technology companies and prestigious universities to offer highly specialized AI courses and training programs in university curricula, especially in PhD programs. Governments can also provide scholarships for AI-related degrees.

To retain and attract digital talent, countries with high AI readiness can do the following:

- *Enhance retention strategies to address brain drain.* Offering competitive salaries in public research institutions, research grants, tax incentives, and career development opportunities could incentivize skilled workers to stay. For instance, China's Thousand Talents Plan has successfully brought back Chinese researchers by offering high salaries, research funding, and leadership roles in AI and semiconductor research, strengthening its innovation ecosystem.
- *Streamline work visas and issue digital nomad visas to help attract foreign digital talents.* Governments can offer streamlined visas, research grants, and tax incentives for AI experts and entrepreneurs, as well as foster international collaborations and AI hubs that position the country as a competitive AI destination.

Addressing the skills gap and safeguarding workers in the age of AI is a complex challenge that requires a multifaceted policy approach. By implementing regular skills assessments; investing in digital infrastructure; enhancing critical thinking, communication, and self-learning skills; and supporting continuous, lifelong learning and reskilling initiatives, countries can create an environment in which both businesses and workers thrive. These strategies not only improve market matching efficiency and empower low-skilled workers but also bolster SMEs and promote inclusive economic growth.

Notes

1. The chapter classifies the 9 broad ISCO occupations into 3 skill levels: (1) *high-skilled occupations* include managers, professionals, technicians, and associate professionals; (2) *middle-skilled occupations* include clerical support workers, services and sales workers, plant and machine operators and assemblers, and craft and related trade workers; and (3) *low-skilled occupations* include skilled agricultural, forestry, and fishery workers and other elementary occupations such as cleaners and domestic helpers.

2. *Transversal soft skills* refer to core competencies that apply across various industries and functions, enabling workers to adapt, collaborate, and resolve challenges effectively.
3. Each job posting in the data set lists the required skills, totaling more than 40,000 unique skills, including around 13,000 digital skills. These digital skills are categorized as basic, intermediate, or advanced. Each job posting's dominant digital skills category is determined by the most-frequent classification.
4. This chapter used the following keywords and their derivatives to identify GenAI skills: *ChatGPT, generative adversarial networks, generative artificial intelligence, Transformer (machine learning model), large language modeling, natural language generation, prompt engineering, variational autoencoders, AWS Bedrock, stable diffusion, Azure OpenAI, AI copywriting, Google Bard/Gemini, Azure AI Studio,* and *DALL-E Image Generator*.

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