GALLUP | aws

AWS Global Digital Skills Study

THE ECONOMIC BENEFITS OF A TECH-SAVVY WORKFORCE

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Executive Summary

The world is increasingly going digital — from the way we work to the way we live. Information technology is driving significant transformation across the world at the individual, organizational and macroeconomic levels.

To study these dynamics in a global context, Gallup collaborated with Amazon Web Services (AWS) to conduct one of the largest international surveys on digital skills to date.[1] Gallup surveyed more than 30,000 workers with access to the internet across 19 countries — which account for 67% of global GDP — and surveyed more than 9,000 employers. Among the 19 countries included were the United States, Canada, China, the United Kingdom, Germany, France, Italy, India, Indonesia and Brazil.[2]

Furthermore, Gallup analyzed data on all advertised job vacancies across 33 countries — totaling more than 100 million openings — from June 2021 to May 2022 to further assess demand for digital skills and how much employers are willing to pay for them.

The results consistently show that digital skills provide immense economic value to businesses and workers worldwide, raising gross domestic product (GDP), revenue growth, innovation, wages, job security and job satisfaction for businesses that integrate these technologies and the workers who acquire the needed skill sets. While both workers and organizations cite strong interest in digital skills training, companies around the world are struggling to fill vacant jobs that require these skills.

Gallup also found a number of practical obstacles to hiring digital workers, including a notable disconnect between how much employers say they value non-degree credentials, such as industry certifications, and their actions when evaluating candidate resumes. Specifically, the study found a self-imposed skills gap in technology job requirements, wherein employers are slightly more likely to prefer or require a bachelor's degree than they are to prefer or require digital skills certifications, despite the fact that managers give greater hiring preference to candidates with digital certifications than they do to candidates with a non-computer science bachelor's degree.

1 The largest comparable survey Gallup found is the Program for the International Assessment of Adult Competencies, an international collaboration between government agencies led by the Organization for Economic Cooperation and Development (OECD). That survey, among other things, tests problem-solving in a technologically rich environment and collects data on the use of computers and computer skills at work. The sample size is approximately 5,000 per country across 40 countries, administered in various years.

2 For a full explanation of the methods used to administer the survey and analyze its data, please refer to the Methodology section.

Top 5 Takeaways

1 Advanced digital skills raise global GDP by an estimated $6.3 trillion each year by boosting worker income and productivity.

While most workers in the countries studied do not use advanced digital skills as part of their job, the income gains these workers garner scale to large national and global value. Advanced digital skills generate an estimated $4.2 trillion in annual GDP in the 19 countries included in this study and $6.3 trillion globally due to the income and productivity of these workers. When basic and intermediate digital skills are included, the total annual global value of digital skills comes to $18.5 trillion, which is approximately 12% of global GDP.

Of course, the digital skills that yield gains in national GDP also generate significant income premia for the workers who use them. Across the 19 countries surveyed, the average worker with advanced digital skills in high-income countries reported earning 50% more than similar workers who do not use digital skills; in middle-income countries, the income premium was 72%.

Gallup analysis of salary ranges listed for more than 100 million job openings posted between June 2021 and May 2022 tells a similar story. As the number of digital skills listed in a job vacancy increases, so too does the salary associated with that vacancy. Jobs that require 10 or more digital skills pay salaries that are 40% higher than jobs in the same country that require identical levels of education and experience but no digital skills.

2 In addition to workers' economic gains, job satisfaction and job security also rise with digital skill proficiency.

Workers who acquire advanced digital skills realize benefits beyond higher salaries. Nearly three out of four workers (72%) who use advanced digital skills at work express high job satisfaction, compared to less than half of workers who only use basic digital skills (43%). Importantly, this is true even after controlling for other factors that may influence job satisfaction, such as age, gender and level of education. Additionally, workers with advanced digital skills express higher confidence in their job security than those with basic digital skills (72% versus 48%).

3 Organizations that rely heavily on advanced digital skills, digital technologies and cloud technology realize success rates for revenue growth and innovation that are notably higher than businesses that use fewer digital skills.

The employer survey shows that companies with high levels of digital skill utilization report annual revenues that are approximately 168% higher than companies that do not use digital skills after adjusting for the number of employees, country and sector effects. Highly digital organizations are also more likely to have brought an innovative new product to market between 2020 and 2022: 72% of organizations that employ advanced digital workers reported introducing a new product in the past two years, compared to 47% of organizations that employ basic digital workers.

Findings further show that organizations that employ advanced digital workers were 44% more likely to report steady annual revenue growth (meaning at least 10%) over the past year than organizations that employ only basic digital workers.

Additionally, 66% of companies that run some or most of their business on the cloud reported innovating in the past two years, a rate roughly five times higher than the 13% of companies that do not use the cloud. Cloud-based companies were also more likely to experience revenue growth, which may create incentives for businesses to implement these systems and hire workers who are cloud proficient.

4 Most organizations report hiring challenges related to roles requiring digital skills, yet many maintain rigid bachelor's degree requirements.

Across the 19 countries studied, just 31% of workers with advanced digital skills held a bachelor's degree or postsecondary equivalent. Yet, among employers surveyed, 36% report that a postsecondary degree is required for even an entry-level job requiring digital skills. Likewise, analysis of international job vacancy data finds that just over half of jobs with digital skill requirements (51%) list a postsecondary degree preference.

Further evidence of an employer preference for university degrees — particularly a degree in computer science — is clear from an experiment conducted with managers. Gallup asked employers to select between two hypothetical candidates for a technology job, varying the candidates' characteristics randomly by level of education, certification status, gender, age, reputation of school, recommendations, nativity and experience. Having a computer science degree was almost worth 10 years of tech experience, and candidates with this credential were almost always preferred over otherwise identical candidates.

Greater recognition of certifications can ease hiring challenges. Even with the strong preference for a bachelor's degree, 75% of employers agree or strongly agree that a certification or training is an acceptable substitute for an academic degree. Additionally, the study found that candidates who obtained a technology certification were more likely to get hired than individuals without one. In the above experiment, having a technology certification increased a candidate's likelihood of being hired by 38 percentage points, compared to a nearly identical individual without a certification. This effect was smaller than the positive influence of having a bachelor's degree in computer science but shows that certifications are recognized as valuable alternatives.

5 5G, cryptocurrency and the Metaverse are here to stay.

While most organizations already say hiring for the digital skills they need is a challenge, they also need to prepare for the hiring challenges of the future. When asked how likely it is that each of 10 emerging technologies — including the Metaverse, blockchain and artificial intelligence — will become a standard part of their business in the future, 66% of employers say it is highly likely that at least one emerging technology will become part of their operations. More than half (53%) believe multiple technologies will become standard, and 13% say all 10 will be a part of their organization's business in the future.

Detailed Findings

Growth in the technology sector has exploded in the early 21st century. In the United States, the data processing, internet publishing and information services industry grew fivefold from 2000 to 2021, and over that same period, the four information technology-heavy sectors increased from 2% of U.S. GDP to 8%.[3] Likewise, information technology companies are overrepresented among the fastest-growing businesses in Europe and Asia.[4,5]

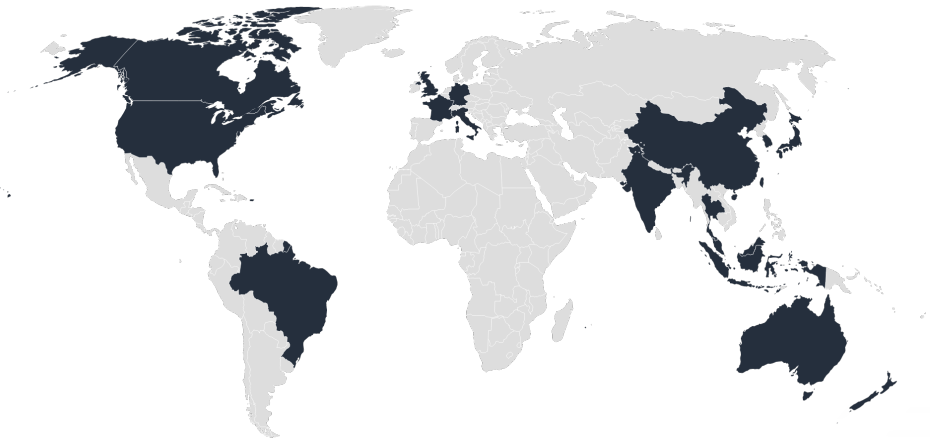
This growth is likely to continue over the next decade: According to the Bureau of Labor Statistics (BLS), computer and mathematical occupations in the U.S. are projected to be among the fastest growing groups of occupations between 2021 and 2031 due to "expected strong demand for IT services…expected robust growth in data — in part related to Internet of Things (IoT) and the connectivity of consumer products and industrial machinery — and demand for data to be collected and analyzed."[6] These employment projections estimate that software developers will be the third-fastest growing occupation over the next decade.

To quantify how accelerating digitization will affect businesses and workers — and how they may not only contend with its future challenges but also benefit from it — Gallup gathered feedback from

more than
30,000
working adults and

9,000
employers

across
19
countries.



3 Source: Gallup analysis of data from the U.S. Bureau of Economic Analysis, "Real Value Added by Industry." The four sectors are computer equipment manufacturing; data processing, internet publishing, and other information services; software and other publishing; and computer systems design.

4 Kelly, M. (2021, March 1). *FT 1000: the fifth annual list of Europe's fastest-growing companies.* Financial Times. https://www.ft.com/content/8b37a92b-15e6-4b9c-8427-315a8b5f4332

5 Bell, A. (2022, March 16). *FT ranking: Asia-Pacific High-Growth Companies 2022.* Financial Times. https://www.ft.com/high-growth-asia-pacific-ranking-2022

6 *Employment Projections: 2021-2031 Summary.* (n.d.). U.S. Bureau of Labor Statistics. https://www.bls.gov/news.release/ecopro.nr0.htm

Workers who use some level of digital skills in their job were segmented into three categories based on whether they use:

- basic digital skills (e.g., email, word processing, social media posting)
- intermediate digital skills (e.g., drag-and-drop website design, troubleshooting applications, data analysis)
- advanced digital skills (e.g., cloud architecture or maintenance, software or application development, artificial intelligence and machine learning)

As part of this study, Gallup also conducted a separate survey of managers responsible for hiring or managing IT activities at organizations employing digital workers.

These workers and employers shared feedback on the ways they acquire, use and ultimately benefit from digital skills, as well as their perspectives on how emerging technologies — including artificial intelligence and blockchain — will play a role in their future careers and business operations.

To validate and supplement income and revenue findings from both surveys, Gallup also used third-party datasets that provided detailed information about all advertised job vacancies between June 2021 and May 2022, totaling more than 100 million unique job postings. These data provided important macroeconomic context, such as the percentage of job postings that require any level of digital skills, as well as a robust assessment of current jobs' most commonly required digital skills.

Results reveal a strong desire from digital workers to broaden their digital skill sets, as well as a heavy reliance on these skills by employers, which are likely to intensify in future years. The results also suggest that increased reliance on digital skills would result in myriad positive outcomes for all parties, including higher salaries and job satisfaction for the workers who use those skills, increased revenue and innovation for the organizations employing those workers, and strong economic growth for the countries in which they reside.

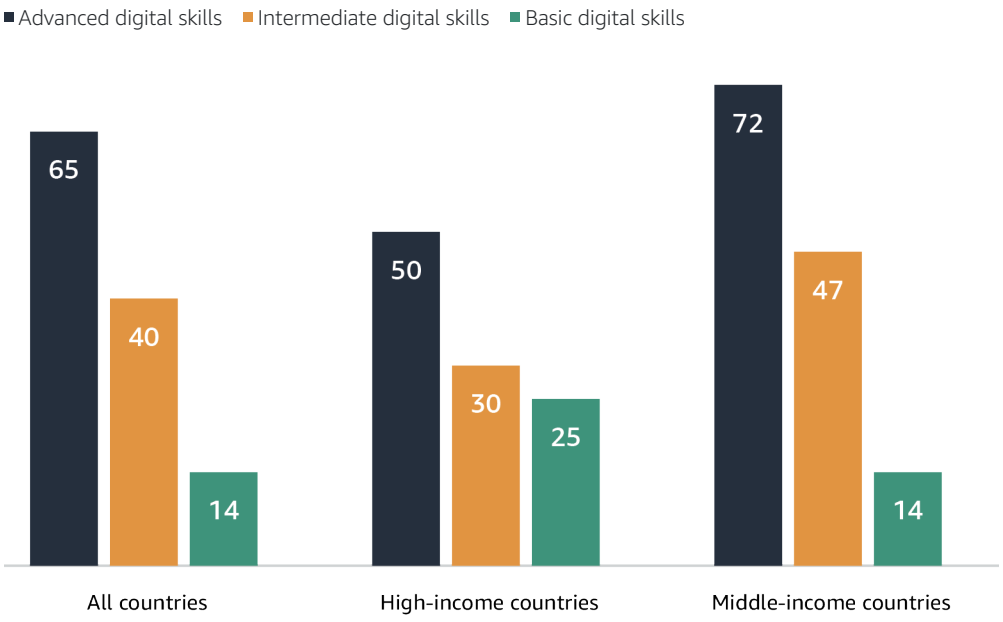
A Rising Tide: Digitally savvy nations create huge benefits for all.

One of the most common reasons workers express interest in broadening their digital skill sets is the prospect of a higher salary. And while advanced digital workers, such as software developers and cybersecurity engineers, command the most lucrative salaries, analysis of income data from workers across the 19 countries included in this study finds that even workers who use basic digital skills — such as email or office productivity software — earn 25% more on average than workers who use no digital skills in high-income countries, and 14% more in middle-income countries.[7]

CHART 1

Income premia for individual digital workers over non-digital workers

% Premium, by level of digital skill and economic designation



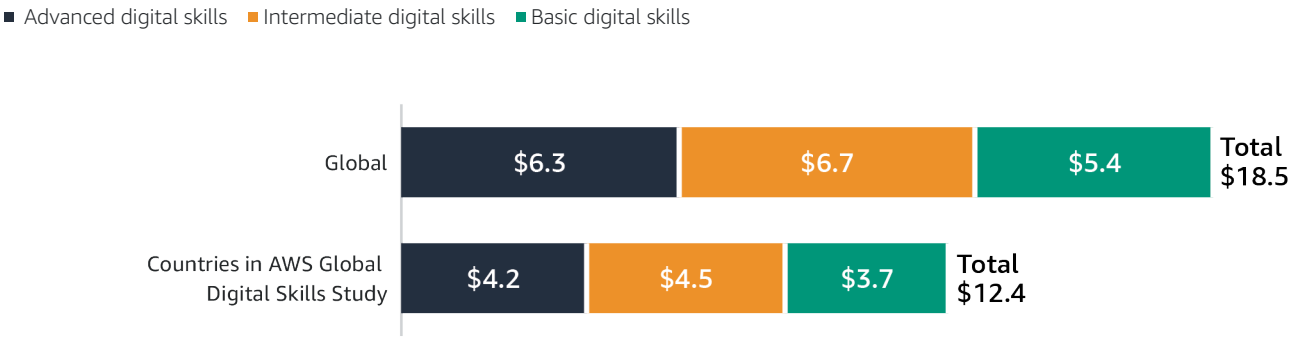
Though these individual income gains — particularly the 65% income premium that advanced digital workers garner globally — can be transformative for individuals and their families, they also have a tremendous impact on national economies and global GDP. When these income premia are scaled across the approximate number of workers with each level of digital proficiency, they total to an additional $12.4 trillion in annual GDP of these 19 countries. Moreover, Gallup estimates that digital workers generate more than $18 trillion in additional GDP each year for the global economy.

7 Economic designations are based on World Bank income classifications. For a full list of country designations, please reference the Methodology section.

CHART 2

National and global GDP gains generated by digital workers

In trillions of 2022 USD



Just as individual workers realize economic benefits as a result of their digital skills, so too do the organizations that employ them. Organizations that employ advanced digital workers (e.g., cloud architects and software developers) report median annual revenue that is more than four times higher than organizations that employ workers with intermediate digital skills, and 10 times higher than organizations whose employees only use basic digital skills.

CHART 3

Effects of increasing digitization within businesses on revenue and growth

Bubble size corresponds to median annual revenue in 2021 (in billions of 2022 USD)[8]

8 Revenue estimates are weighted by the 2021 GDP of the country the organization is located in.

Additionally, fifty-nine percent of companies that employ advanced digital workers report annual revenue growth of 10% or more, a rate 13 points higher than companies employing intermediate digital workers and 18 points higher than companies that employ basic digital workers.

These benefits are not simply the result of digital organizations' workforce size. After controlling for the number of employees, industrial sector, country and ownership status, organizations that employ advanced digital workers report 168% higher revenue than organizations that use only basic digital skills. This productivity premium slightly exceeds what Brookings scholars found in the U.S. in an analysis of advanced industries, but yields the same directional results. Brookings' research showed that output per worker is 99% higher in advanced industries — defined as having high rates of science, technology, engineering and mathematical (STEM) workers and investment in research and development (R&D) — compared to non-advanced industries.[9]

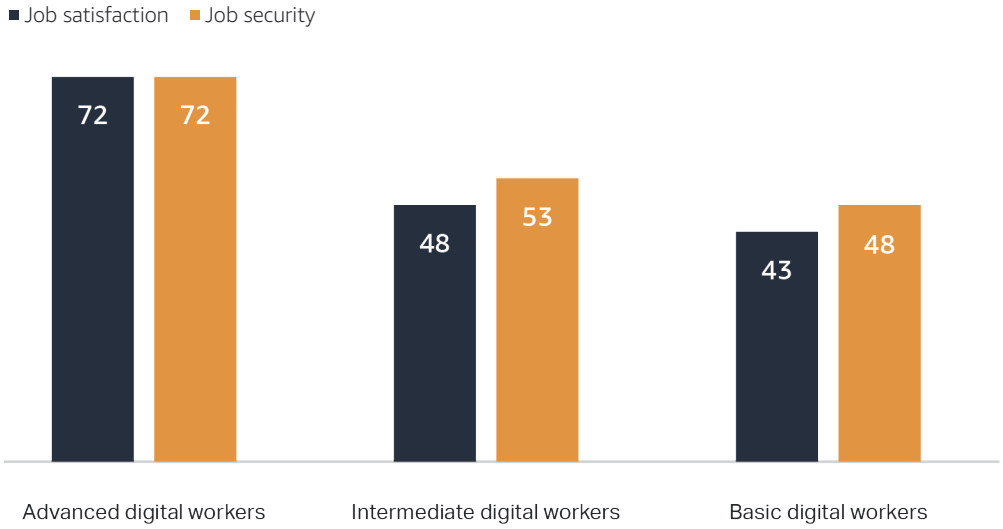
Digitally skilled workers have higher job satisfaction, improved job security and better pay.

At a time when approximately 60% of the global workforce is not engaged[10] — the so-called "quiet quitters" who are psychologically detached from their job and doing the minimum required of them — many workers are likely looking for a job that is more fulfilling. The data suggest one way to increase workers' satisfaction is to increase the level of digital skills they use in their job: 72% of workers who use advanced digital skills rate their job satisfaction as an 8 or higher on a scale of 0 to 10, compared to 43% of workers with basic digital skills and 48% of those with intermediate digital skills.

CHART 4

Job satisfaction and job security among digital workers

% Rating job satisfaction or security an 8 or higher on a 0-10 scale



9 Muro, M., Rothwell, J., Andes, S., Fikri, K., & Kulkarni, S. (2015, February 3). *America's Advanced Industries: What They Are, Where They Are, and Why They Matter.* Brookings. https://www.brookings.edu/research/americas-advanced-industries-what-they-are-where-they-are-and-why-they-matter/ Specifically, output per worker in 2013 for advanced industries was $218,000. Taking BEA estimates for 2013 nominal GDP and employment and subtracting the advanced industries figures yields an estimate for non-advanced industries of roughly half ($110,000).

10 Gallup, Inc. (n.d.). *Global Indicator: Employee Engagement*. Gallup.com. https://www.gallup.com/394373/indicator-employee-engagement.aspx

Moreover, these advantages in job satisfaction based on digital skills remain even when controlling for demographic factors such as age, gender and educational attainment.

In its 2020 Great Jobs Survey, Gallup found that 91% of workers said job security was extremely important or highly important to their assessment of the overall quality of their job, second only to stable and predictable pay (92%), and more important than level of pay (86%).[11]

The 2022 AWS Global Digital Skills Study finds that workers who have advanced digital skills are far more confident in their job security than their peers with lower digital proficiency.

When asked to rate their perceived job security on a scale of 0 to 10, 72% of workers with advanced digital skills rated their job security as an 8 or above, compared to 48% and 53% of workers with basic or intermediate digital skills, respectively.

Organizations with digitally skilled workforces innovate more regularly than non-digital peers.

In addition to realizing the highest levels of revenue gains, organizations that rely heavily on digital skills and technology also report significantly higher levels of innovation over the past two years than organizations that use fewer digital skills. Seventy-two percent of businesses that employ advanced digital workers report they have introduced new innovative products within the last two years. This rate is 15 percentage points higher than businesses that employ intermediate digital workers, and 25 points higher than basic digital organizations. Likewise, businesses that rely heavily on cloud computing are far more likely to have introduced an innovative new product over the last two years.

TABLE 1

During the period from 2020 to 2022, did your organization introduce to the market any new or improved products — either goods or services — that differed significantly from your business' previous products?

By level of digital skills employed and cloud technology adoption

Highest level of digital skills employed	% Yes	Cloud technology adoption	% Yes
Advanced	72	Currently runs most or some of business from the cloud	66
Intermediate	57	Runs none of business from the cloud, but plans to adopt in the future	44
Basic	47	Runs none of business from the cloud, and does not plan to adopt the cloud	13

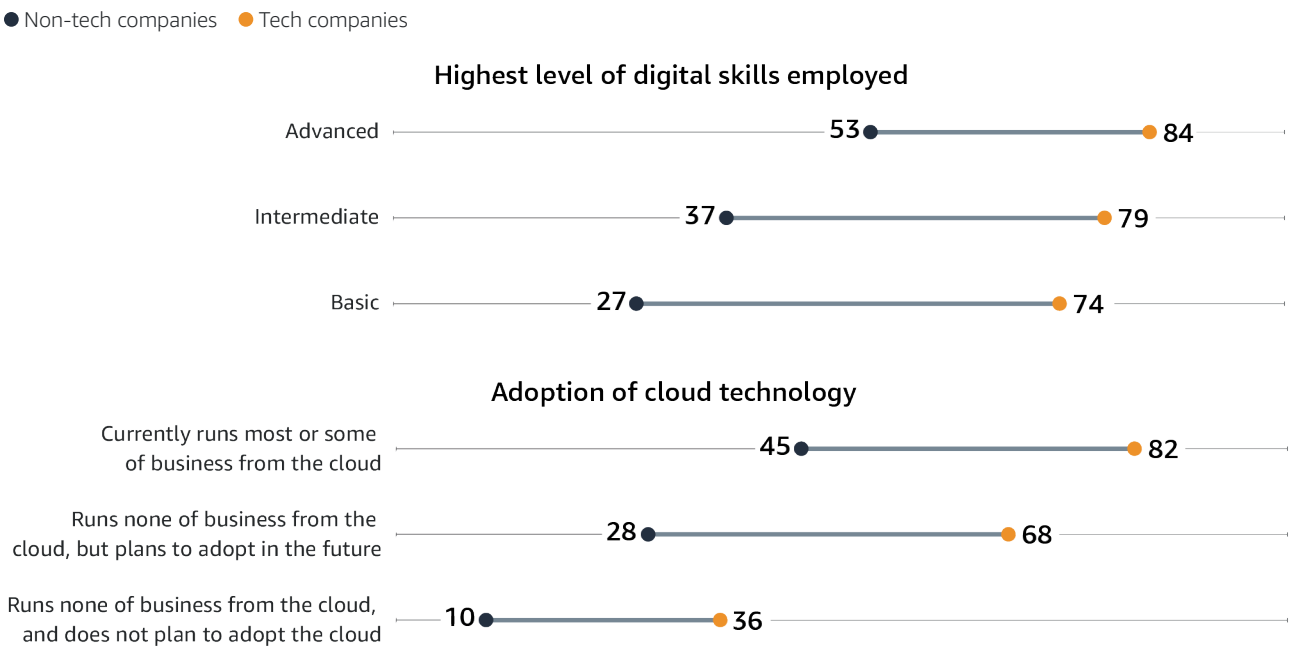
11 Gallup, Inc. (n.d.). *Great Jobs Report: COVID-19 and the Quality of Work.* Gallup.com. https://www.gallup.com/education/267590/great-jobs-report.aspx

While technology companies are more likely than non-technology companies to employ advanced digital workers and cloud solutions — and as a result, to have introduced innovative products in recent years — advanced digital skills and cloud adoptions also facilitate innovation within non-technology companies.

CHART 5

During the period from 2020 to 2022, did your organization introduce to the market any new or improved products — either goods or services — that differed significantly from your business' previous products?

% Yes



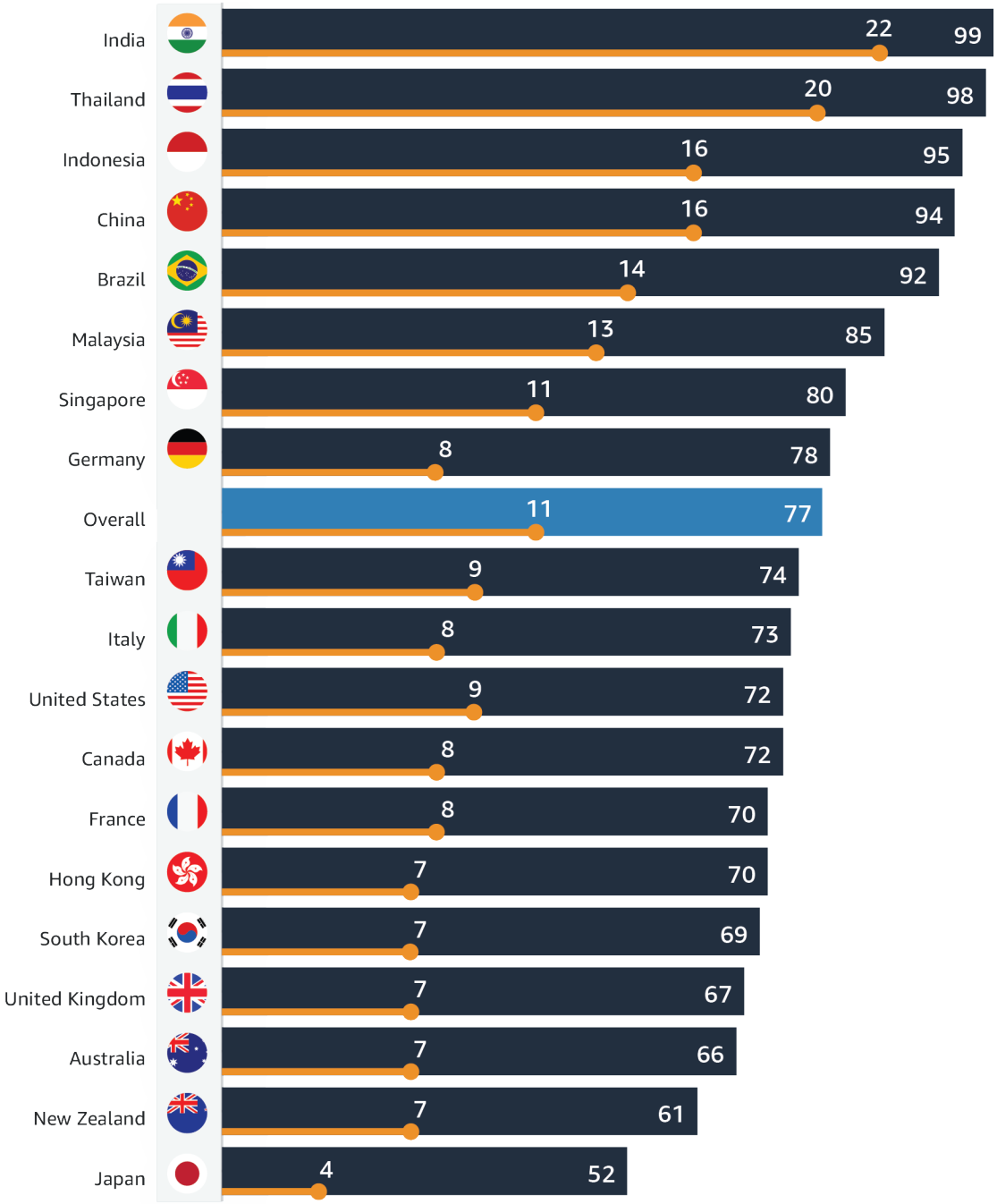
Workers overwhelmingly express interest in pursuing additional digital training.

CHART 6

Interest in obtaining training in additional digital skills

Please indicate your interest in obtaining training in each of the following digital skills within the next two years.

■ % Extremely + Very interested in training in at least one digital skill
● Mean number of skills (out of 26) workers are extremely or very interested in training in



Considering the sizable advantages that advanced digital workers experience in salary, job security and overall quality of employment, it is perhaps unsurprising that the overwhelming majority of digital workers express interest in expanding their digital skill sets. More than three-quarters (77%) of digital workers are extremely interested or very interested in obtaining training in at least one of 26 digital skills listed in the survey.[12] Importantly, this interest is generally not limited to a single skill, but instead, a broad range: The average digital worker is very interested in pursuing 11 of the 26 skills that were listed.

While workers who already have a high degree of technical proficiency are the most likely to express interest in growing their skill set (93%), a strong majority (69%) of workers who generally use basic digital skills (such as email or productivity software) also want to undergo additional technology training.

Workers offer a variety of reasons for their widespread interest in digital skills training. The five most frequently cited reasons for this interest are that training will make them more efficient in doing their work (49%), earn them a higher salary (44%), improve their employability (42%), increase their opportunities for promotion (37%), and improve their job security (36%).

TABLE 2

The 5 most frequently cited reasons for interest in digital skills training

Increased efficiency in doing my work	49%
Increased salary	44%
Improved employability	42%
Increased opportunities for promotion	37%
Improved job security	36%

For nearly all workers who have recently undergone digital training, these benefits are not theoretical: Among the 48% of workers who completed digital skills training in the past year, 98% say their career has experienced at least one positive benefit as a result. This includes 48% who say it made them more efficient in their work, 40% who believe it improved their opportunities for promotion and 38% who received an increase in salary.

who have undergone digital skills training in the last year say they have experienced at least one career benefit as a result.

12 For a full list of skills, please reference the definitions of key concepts in the Methodology section.

Barriers to digital training are nearly as pervasive as interest in acquiring it.

The strong desire among digital workers to obtain additional digital skills — whether to improve their current job situation or to transition into a new career — is evident. But for nearly all workers who want to develop these skills, something is getting in the way: 92% of workers who are very interested in additional training say they face at least one barrier to acquiring it.

While the cost of training is a barrier to interested digital workers, it is not the primary challenge. A plurality of interested workers cite a lack of time (47%) as an impediment, followed by a lack of financial resources (38%) and knowledge of the skills they need to advance in their careers (37%).

Employers can be proactive in helping their workforce move up the learning curve by subsidizing skills training. Forty-eight percent of digital workers would be extremely interested or very interested in acquiring a digital certification if their employer paid for it. Moreover, employers can play a role in subsidizing not only the cost of these trainings but also the time and space required for employees to participate.

> Providing training to existing and interested employees may alleviate some of the hiring pressures organizations feel, while offering their current workforce an attractive opportunity.

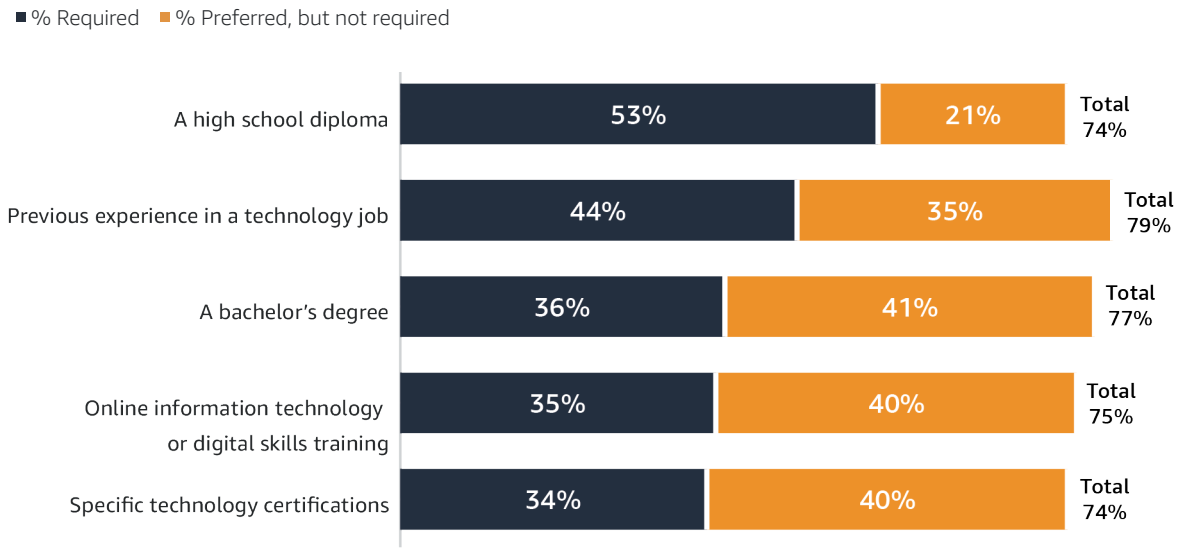
Employers' degree preferences may exacerbate digital hiring challenges by overlooking qualified candidates.

In addition to supporting their workers in developing essential skills, organizations may need to revisit their hiring practices — particularly the minimum qualifications and requirements for digital workers — to contend with the hiring needs of the future. When hiring entry-level technology staff, nearly half (44%) of employers say previous technology experience is required, and more than one-third (36%) require a bachelor's degree.

CHART 7

Job requirements for entry-level tech or IT staff

When hiring entry-level tech or IT staff, please indicate if [characteristic] is:



However, the preferences of employers, as well as the credence they give to certain candidate characteristics, may differ from the stated requirements in a job posting. To assess alignment between the preferences of employers and their organizations, Gallup employed a statistical technique commonly referred to as "conjoint" analysis.[13]

In this exercise, employers were randomly assigned two hypothetical candidates applying for a technology job at their organization. Based on the characteristics randomly assigned to those hypothetical candidates — which included varying levels of prior technology job experience, educational background, digital training, and demographic characteristics such as age, gender and nationality — employers were asked to indicate which of the two candidates they would be more likely to hire.

The results of this experiment reveal that employers do prefer candidates with a postsecondary degree in computer science. However, a certification in a digital skill or technology was more positively influential on a candidate's likelihood of being hired than all attributes tested besides a postsecondary degree in computer science or 10 years of experience in a technology job. All else being equal, digital skills certifications are about three times more influential in a candidate's likelihood of being hired for an IT position than non-computer science bachelor's degrees.

In short, while employers strongly prefer candidates with a university degree in computer science, candidates with an information technology certification are also highly valued.

13 For a full explanation of the methodology used to conduct the conjoint experiment, please reference the Methodology section of this report.

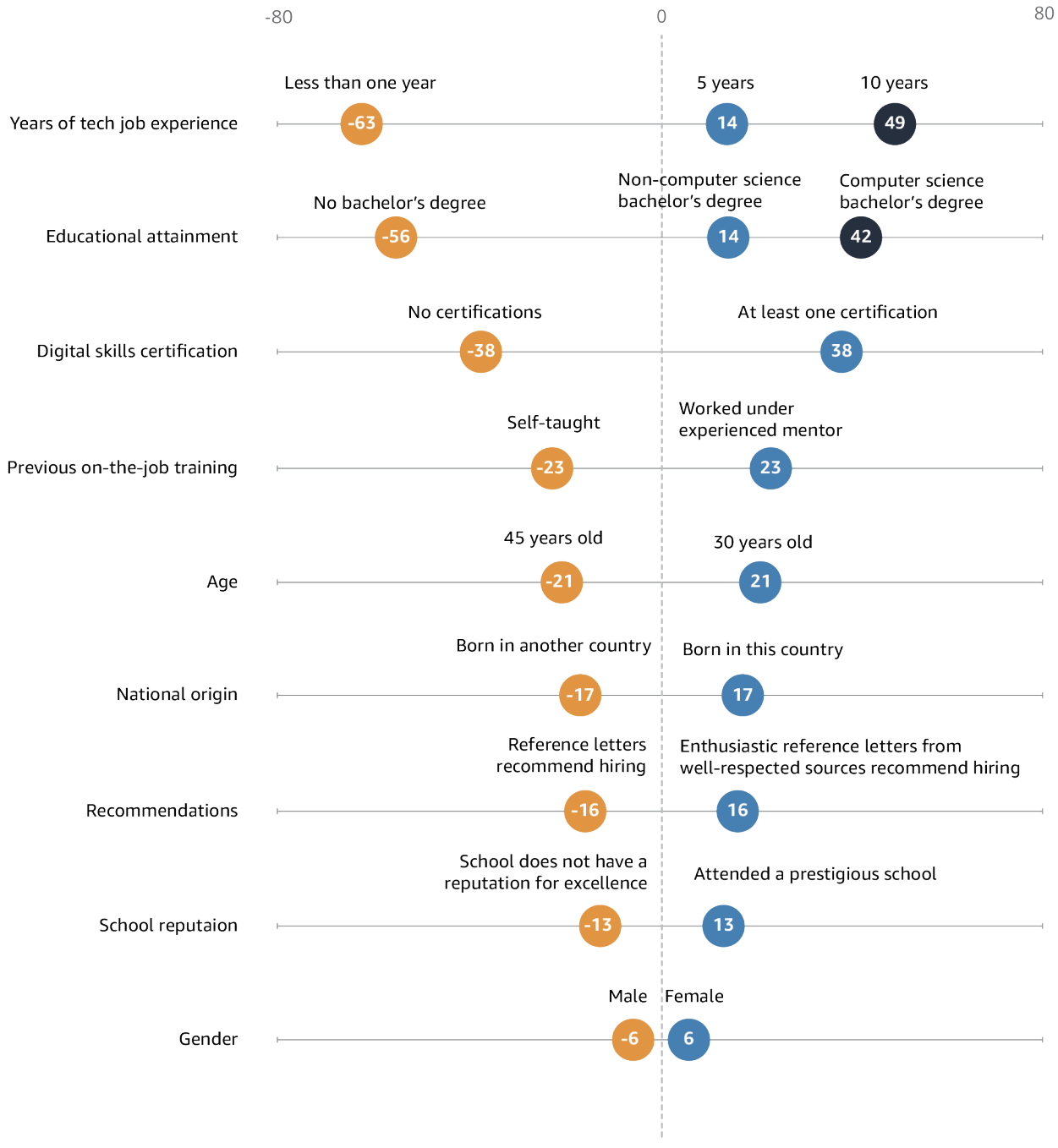
CHART 8

Each dot on the chart indicates the influence a characteristic has on a candidate's likelihood of being hired over a similar candidate who does not possess that characteristic.

For example, if an employer is considering two candidates who are nearly identical in their profiles, but one has a digital skills certification, the candidate with a digital skills certification is 38 percentage points more likely to be hired than the candidate who did not indicate whether they have a certification.

Effects of candidate characteristics on likelihood to be hired for an IT job

% Increase or decrease of hiring probability

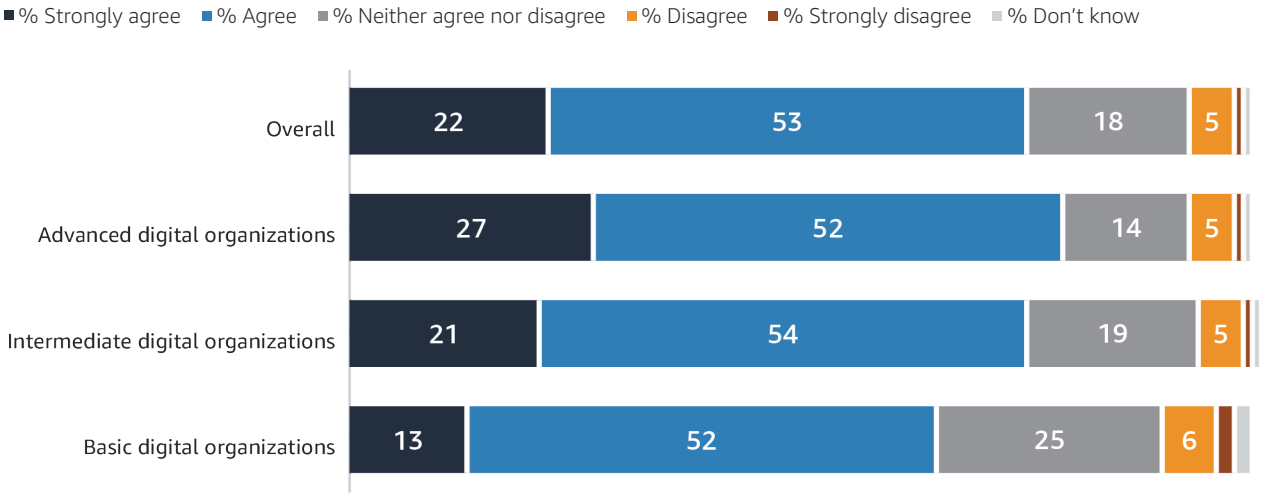


These experiment findings have implications for workers who aspire to join the ranks of the advanced digital workforce. Digital certifications greatly outnumber four-year degrees (or equivalents) among digital workers: 28% of these workers hold a bachelor's degree, while 44% hold a technical certification. In imposing strict degree requirements on their digital job vacancies, organizations may be excluding from consideration the more than half (56%) of advanced digital workers who have certifications but not a degree — despite the fact that a majority of these advanced digital workers are already employed in a technical role.

While the percentage of employers readily accepting digital skills certifications in place of degrees may be relatively low, results indicate an openness on the part of employers to begin accepting digital certifications as a substitute. Seventy-five percent of employers agree that digital certifications are an acceptable substitute, suggesting that there are a number of circumstances in which they would be sufficient — perhaps, for example, when paired with informal training or previous technology work experience. Additionally, the organizations most likely to accept certifications are those that employ advanced digital workers and are most familiar with the requirements and qualifications of technology roles.

CHART 9

When hiring for technology jobs at your organization, digital skills certifications are an acceptable substitute for a tertiary qualification in a relevant field.



Note: Percentages less than 5% not shown.

When paired with results suggesting that employers prefer candidates with digital skills certifications to those with non-computer science bachelor's degrees — despite the degree requirement that roughly one in three organizations places on entry-level technology positions — there is evidence that increased acceptance of and participation in digital training may be a currently underused option attractive to both employers and developing digital workers.

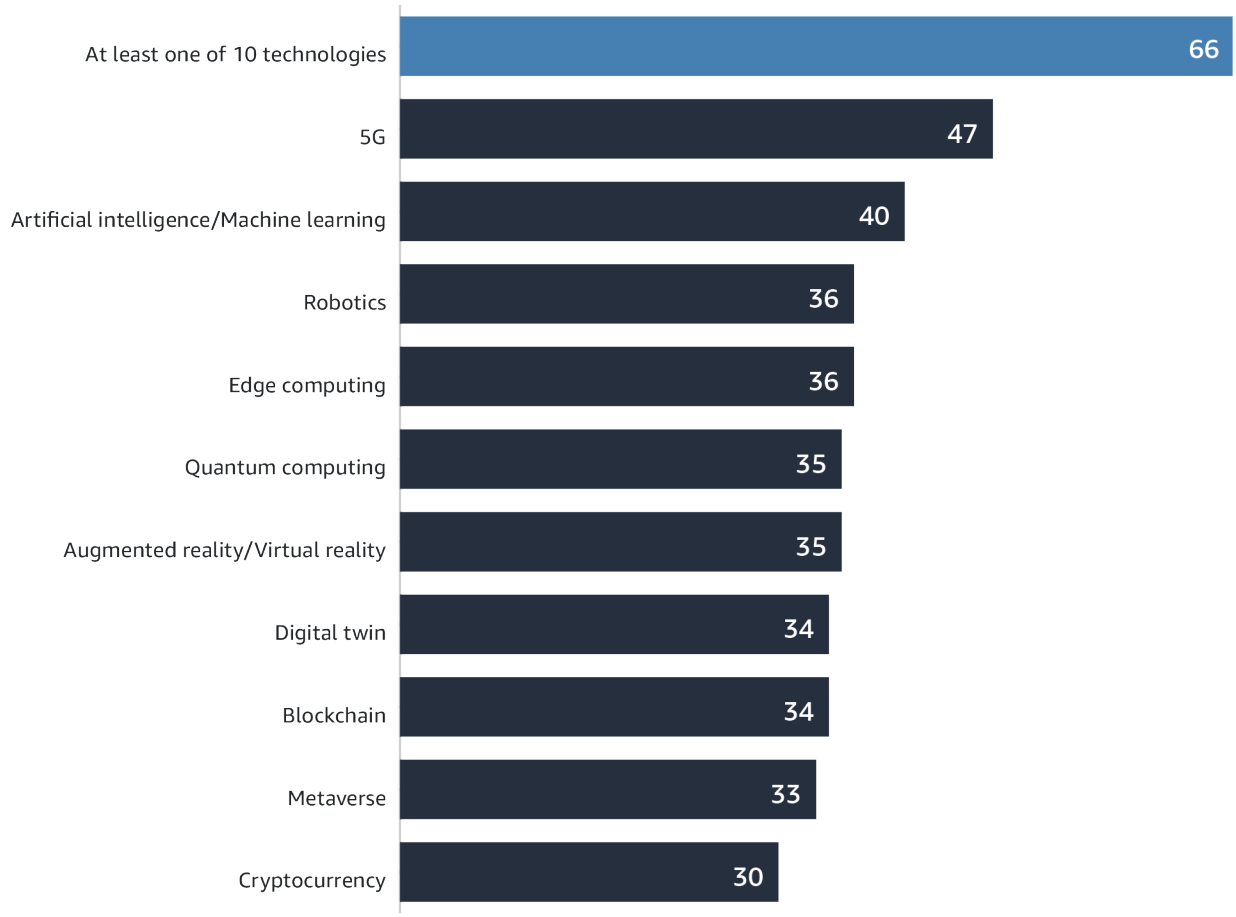
Future-Ready: 5G, cryptocurrency and the Metaverse are here to stay.

While most organizations say hiring for the digital skills they need is a challenge, they must also begin preparing for the hiring challenges of the future. When asked how likely it is that each of 10 emerging technologies will become a standard part of their business in the future, 66% of employers say it is highly likely that at least one emerging technology will become part of their operations; more than half (53%) believe multiple technologies will become standard, and 13% say all 10 will be a part of their organization's business in the future.

CHART 10

How likely or unlikely is it that each of the following become a standard part of how your organization does business in the future on a scale of 0 to 10, where 0 means "not likely at all" and 10 means "extremely likely"?

% 8 or higher



About Amazon Web Services

Amazon is committed to investing hundreds of millions of dollars to provide 29 million people around the world with access to free cloud computing skills training by 2025. The company is providing this free skills training through a range of AWS-designed programs, making the latest technical knowledge accessible to anyone who has ever considered a career in cloud computing. To learn more and to get started, visit **aboutamazon.com/29million**.

About Gallup

Gallup delivers forward-thinking research, analytics and advice to help leaders solve their most pressing problems. Combining more than 80 years of experience with its global reach, Gallup knows more about the attitudes and behaviors of the world's constituents, employees and customers than any other organization. Gallup consultants help private and public sector organizations boost organic growth through measurement tools, strategic advice and education. Gallup's professionals deliver services at client organizations through the web and in more than 30 offices around the world.

Methodology

Contents

Country economic designations

World Bank Income Classification	Country
High Income	Australia
	Canada
	France
	Germany
	Hong Kong
	Italy
	Japan
	New Zealand
	Singapore
	South Korea
	Taiwan
	Thailand
	United Kingdom
Middle Income	Brazil
	China
	India
	Indonesia
	Malaysia
	Thailand

Data sources and sample

Gallup Surveys

Findings from the AWS Global Digital Skills Study are based on web surveys conducted Aug. 2-23, 2022, with the following worker and employer populations and markets globally:

Country	Languages	Worker	Employer
Australia	English	2,164	775
Brazil	Portuguese (Brazilian)	1,755	336
Canada	English	1,501	391
China	Chinese (Simplified)	1,233	394
France	French	1,715	355
Germany	German	1,533	367
Hong Kong	Chinese (Traditional)	1,298	356
India	Hindi, English	2,005	769
Indonesia	Bahasa Indonesian	1,412	348
Italy	Italian	1,342	353
Japan	Japanese	2,796	974
Malaysia	English, Malay	1,405	357
New Zealand	English	1,448	374
Singapore	English, Chinese (Simplified)	1,258	351
South Korea	Korean	1,483	364
Taiwan	Chinese (Traditional)	1,400	339
Thailand	Thai	1,296	359
United Kingdom	English	1,522	390
United States	English	3,010	1,178
	Total:	31,576	9,130

Respondents were recruited using an opt-in, online sample in each country. Thus, only workers and employers aged 18 and older who are internet users were included in this research. Workers were eligible to participate in the first section of the survey if they were employed in any way, and they were eligible for the digital skills section if they worked in a job that involved handling information and used a computer. This digital skills restriction terminated the survey for 4,601 respondents out of 31,576.

For the employer survey, respondents were eligible if they were employed and indicated that they were a mid- or senior-level business leader, information technology (IT) leader, or IT decision-maker working in the private or public sector in an organization with at least five employees. For the digital skills section, employers were also required to employ workers that use a computer. This digital skills restriction terminated the survey for 502 respondents out of 9,130.

The worker data are weighted to match national demographics in each of the selected countries of gender, age, race (U.S. only), Hispanic ethnicity (U.S. only), education, employment status and region (all except Singapore). Demographic weighting targets are based on the most recent Gallup World Poll data figures for online population aged 18 and older in each of the target markets. Gallup also created projection weights based on population figures for analyzing global, aggregate-level data, which were used for some analyses. The weighting process was as follows:

- The base weights are set to 1 for all cases collected for the survey.
- Gallup constructed post-stratification weights to correct for age, gender, education, region and employment status. For the U.S., race and Hispanic ethnicity were also adjusted through post-stratification. For Singapore, region was not included in post-stratification.
- The weights obtained through the post-stratification step were further trimmed to avoid extreme small weights. The trimmed weights were then normalized to make sure they sum up to the number of completed interviews.
- The normalized weights were further projected to the population size of adults (18 and older) with access to internet within each country. The population size is estimated with age 15 and older population size released by the World Bank (exception: U.S. age 15 and older population size is based on 2021 Current Population Survey) and estimated percentages of age 18 and older internet users among age 15 and older population based on 2021 Gallup World Poll estimates.

Below is the summary of credibility intervals and design effects for each country for the worker survey data:

		Credibility Intervals for Sample Size Used for Analysis													
Country	**Design Effect**	100	200	350	500	750	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000
Australia	1.44	12.0%	8.5%	6.4%	5.4%	4.4%	3.8%	3.1%	2.7%	2.4%	2.2%	2.0%	1.9%	1.8%	1.7%
Brazil	1.19	10.9%	7.7%	5.8%	4.9%	4.0%	3.4%	2.8%	2.4%	2.2%	2.0%	1.8%	1.7%	1.6%	1.5%
Canada	1.31	11.5%	8.1%	6.1%	5.1%	4.2%	3.6%	3.0%	2.6%	2.3%	2.1%	1.9%	1.8%	1.7%	1.6%
China	2.00	14.1%	10.0%	7.6%	6.3%	5.2%	4.5%	3.7%	3.2%	2.8%	2.6%	2.4%	2.2%	2.1%	2.0%
France	1.93	13.9%	9.8%	7.4%	6.2%	5.1%	4.4%	3.6%	3.1%	2.8%	2.5%	2.3%	2.2%	2.1%	2.0%
Germany	1.52	12.3%	8.7%	6.6%	5.5%	4.5%	3.9%	3.2%	2.8%	2.5%	2.3%	2.1%	2.0%	1.8%	1.7%
Hong Kong	2.27	15.1%	10.7%	8.1%	6.7%	5.5%	4.8%	3.9%	3.4%	3.0%	2.8%	2.5%	2.4%	2.2%	2.1%
India	2.82	16.8%	11.9%	9.0%	7.5%	6.1%	5.3%	4.3%	3.8%	3.4%	3.1%	2.8%	2.7%	2.5%	2.4%
Indonesia	1.43	11.9%	8.4%	6.4%	5.3%	4.4%	3.8%	3.1%	2.7%	2.4%	2.2%	2.0%	1.9%	1.8%	1.7%
Italy	2.14	14.6%	10.4%	7.8%	6.5%	5.3%	4.6%	3.8%	3.3%	2.9%	2.7%	2.5%	2.3%	2.2%	2.1%
Japan	1.19	10.9%	7.7%	5.8%	4.9%	4.0%	3.5%	2.8%	2.4%	2.2%	2.0%	1.8%	1.7%	1.6%	1.5%
Malaysia	1.50	12.2%	8.7%	6.5%	5.5%	4.5%	3.9%	3.2%	2.7%	2.4%	2.2%	2.1%	1.9%	1.8%	1.7%
New Zealand	1.23	11.1%	7.9%	5.9%	5.0%	4.1%	3.5%	2.9%	2.5%	2.2%	2.0%	1.9%	1.8%	1.7%	1.6%
Singapore	1.69	13.0%	9.2%	6.9%	5.8%	4.7%	4.1%	3.4%	2.9%	2.6%	2.4%	2.2%	2.1%	1.9%	1.8%
South Korea	1.84	13.6%	9.6%	7.3%	6.1%	5.0%	4.3%	3.5%	3.0%	2.7%	2.5%	2.3%	2.1%	2.0%	1.9%
Taiwan	2.09	14.5%	10.2%	7.7%	6.5%	5.3%	4.6%	3.7%	3.2%	2.9%	2.6%	2.4%	2.3%	2.2%	2.0%
Thailand	1.64	12.8%	9.1%	6.8%	5.7%	4.7%	4.1%	3.3%	2.9%	2.6%	2.3%	2.2%	2.0%	1.9%	1.8%
United States	1.13	10.6%	7.5%	5.7%	4.8%	3.9%	3.4%	2.7%	2.4%	2.1%	1.9%	1.8%	1.7%	1.6%	1.5%
United Kingdom	1.15	10.7%	7.6%	5.7%	4.8%	3.9%	3.4%	2.8%	2.4%	2.1%	2.0%	1.8%	1.7%	1.6%	1.5%

Credibility intervals replace margins of error in cases where nonprobability samples were used. Refer to the American Association for Public Opinion Research (AAPOR) statement on credibility intervals, "Understanding a credibility interval and how it differs from the margin of sampling error in a public opinion poll" for more information about credibility intervals for nonprobability samples.

Question wording and practical difficulties in conducting surveys can introduce error or bias into the findings of public opinion polls. Opt-in panel samples can also introduce bias due to the sample available in each country. For example, in developing countries, opt-in panel respondents tend to be in urban areas, earn a higher income and be more educated.

Job vacancies

Gallup purchased data for 33 countries from Burning Glass, a U.S.-based labor market analytics company, which was recently merged with Emsi and is now called Lightcast. The sample was all advertised vacancies between June 2021 and May 2022, for a total of 101 million distinct jobs. A limitation of the sample is that Burning Glass scrapes ads from company websites and other online sources, so job vacancies filled through offline advertisements are missed. Previous research in the U.S. finds that this introduces a slight bias against vacancies in low-paying service and construction jobs.[14] The countries include all European Union member countries except Hungary and Slovenia (25 countries). The data also include former EU member the United Kingdom, the U.S., Canada, New Zealand, Australia, Singapore, Hong Kong and India. Thus, the sample overlaps with 11 of the 19 countries surveyed (Germany, France and Italy are the others).

The analysis proceeded in several steps: 1) classify all skills as digital or not, 2) analyze the prevalence of digital skills, education requirements and salary premium for each country, and 3) aggregate country-level estimates to the all-country total using the number of ads as the weight.

The classification of digital skills required different techniques for the various countries. Skills are captured at the advertisement level by Burning Glass and listed discretely for each ad. Burning Glass classifies skills into aggregated categories called "families" and "clusters" — one of the families is "information technology." All skills under this family were counted as digital skills, but AWS and Gallup concluded that other skills would also count. The search uncovered several clusters with digital skills: "drafting and engineering," "robotics," "data mining," "animation and game design," "graphic and visual design software," "user interface and user experience," "graphic and visual design," "online marketing," and the discrete skill: "blockchain." All skills listed under these clusters were included. The final compendium resulted in 1,681 total discrete digital skills advertised in the U.S. The same method was used in the United Kingdom, Canada, Singapore, Australia and New Zealand.

For the EU member countries, India and Hong Kong, Burning Glass did not classify skills into aggregate groups. Therefore, Gallup researchers classified skills as digital by building a list from information technology and related occupations. For the EU, researchers used the list of skills associated with Information Technology Professionals and Technicians as well as Science and Engineering Professionals (both using the EU's European Skills, Competencies, Qualifications and Occupations (ESCO) level 2 typology for occupations). To streamline the analysis, the largest economy, Germany, served as the reference. This resulted in 463 skills, which were then hand-coded as digital or not. Three hundred and thirty-nine were deemed digital. This list was then combined with the U.S.-based list and the combined list of discrete skills was used to classify all discrete skills advertised across the EU. A similar method was employed for India and Hong Kong, using the skills associated with information technology, data science, engineering and other science occupations. There were many spelling variants of coding languages and related skills, and the final list was 19,939 discrete skills in both countries combined.

Other external sources

Gallup World Poll, which uses random sampling methods to achieve representative samples, was used to estimate the number of employed people in the country and the percentage of households that have access to the internet. National government agencies were used to estimate mean wages for workers.

To adjust income to 2022 USD, researchers started with 2017 Purchasing Power Parity indexes from the World Bank International Comparisons Program, then projected 2017 PPPs to June of 2022 using national consumer price growth indexes from 2017 to June 2022. These data were obtained from the U.S. BLS, OECD Stats and national data sources.

14 Rothwell, J. (2014, July 1). *Still Searching: Job Vacancies and STEM Skills.* Brookings. https://www.brookings.edu/interactives/still-searching-job-vacancies-and-stem-skills/

Definitions of key concepts

Digital skills

This survey defined digital skills in the native language of each respondent using the following statement: *"Some people use computers and similar devices as part of their work. The term 'digital skills' refers to the ability to effectively use digital devices, communication applications, and electronic information networks to perform work."*

The survey then asked respondents to classify themselves into one of four digital skill categories, which were used in the analysis.

Which of the following best describes the extent to which you use digital skills in your current job?

1) *I do not use a computer or tablet as part of my job.*
2) *I use basic digital skills such as email, word processing, filling out electronic forms or entering data from them, or social media posting.*
3) *I use intermediate digital skills that require some training but do not require knowledge of a programming language. For example, drag-and-drop website design, troubleshooting applications or network performance, or data analysis.*
4) *I use advanced digital skills that require a programming language or involve skills such as cloud architecture design/maintenance, software/application development, artificial intelligence or machine learning.*

Commonly used digital skills

As an alternative item and digital skills classification and validation, the survey also asked respondents which of 26 digital skills they use at work, if any. This item was asked on both the worker and employer surveys, with slightly different wording. The number of skills selected was used to assess the depth and level of digital skill use at the individual and organizational levels. At the individual level, respondents who use five or more digital skills were considered advanced digital users. There was a moderately positive correlation between self-identified advanced digital users and the number of skills selected (r=.33).

Which of the following digital skills do you currently use at work? Please select all that apply.

1) *Animation and Game Design*
2) *Application Development, Security, Interface*
3) *Artificial Intelligence*
4) *Augmented Reality/Virtual Reality (AR/VR)*
5) *Blockchain*
6) *Cloud-based tools (e.g., file-sharing services, messaging applications like Slack, cloud-based CRM tools)*
7) *Data Mining*
8) *Internet of Things (IoT)*
9) *Routine business software (e.g., Microsoft Office, Google Docs, Apache Open Office, etc.)*
10) *Network Configuration, General Networking*
11) *Graphic and Visual Design*
12) *Online Marketing*
13) *Robotics*
14) *Software Development Principles*
15) *Technical Support*
16) *Web Development*
17) *System Design and Implementation*
18) *SQL Databases and Programming*
19) *Enterprise Resource Planning (ERP)*
20) *Database Administration*
21) *JavaScript and jQuery*
22) *Cybersecurity*
23) *Operating Systems*
24) *Scripting Languages*
25) *Software Quality Assurance*
26) *Java*

Analytic methods

Prevalence of digital skills by country

To estimate the percentage of workers in each country that use no, basic, intermediate or advanced digital skills, researchers started with weighted country-level means. Weighting targeted the working population with internet access. Thus, weighted country-level results pertain to the internet-using population, but they were not intended to represent the working population more generally.

To estimate more general working-population means, researchers multiplied the percent of households with internet access, available through Gallup World Poll, by the percentage of internet users with digital skills. Define DS as the share of workers with digital skills and subscripts "L," "C" and "I" as referring to the level of digital skills, the country, and the internet-using population, respectively. "I" refers to the share of households with internet access. The following formula (1) calculates the share of workers with skill level "L." The share with no digital skills (NS) is then calculated as 1 less the sum of the DS shares for each skill level (other than none).

1) $DS_{l,c}=DS_{l,c,I}xI_c$

2) $NS= 1-\sum DS_{l,c}$

This is equivalent to assuming that workers with no internet access do not use a computer or other digital skills at work. This is a conservative assumption, but it corrects for the strong bias in the opposite direction: that internet users are far more likely to use digital skills at work. The ideal estimate of digital skills prevalence would be drawn from a random sample of all workers, regardless of internet status, but as that was not possible in this study, this method provides the next best alternative estimate.

Salary premium of digital skills

The digital skill salary premium is the marginal percentage increase in income for those using advanced digital skills compared to those who do not use digital skills at work but are otherwise similar in their observable productive characteristics.

This requires the collection of accurate self-reported income data. One concern is that the sample, especially in developing countries, is biased toward respondents with higher socioeconomic status, since internet access is a prerequisite for participation. One tool to guard against this bias is to constrain outliers. Researchers considered implementing a rule based on the number of standard deviations from the mean, but realized even the mean was obviously biased upwards in the sample when compared to national estimates (for most countries). Researchers decided to use objective data on the income distribution from the World Inequality Database, which uses data from national tax records. Specifically, researchers downloaded the income thresholds for adults in the 95th and 99th percentiles of the national income distributions for every country in the sample. For self-reported incomes between the 95th and 99th percentiles, the minimum WID threshold was imputed. For incomes that were at or above the top 1%, the top 1% (or 99th percentile) threshold was imputed. This affected 10% of the sample (6% from the top 1%). Researchers strongly believe this gives more accurate data and certainly constrains the outliers.

The estimation equation, which follows the Mincerian wage regression, can be written down as follows:

3) $Ln(Income_i)= \alpha+\beta(DS_{i,C})+\delta_{i,c}+\kappa_c+\varepsilon$

The log of income is regressed on a binary variable for the level of digital skills, with workers who do not use digital skills at work omitted as a reference category. A vector of demographic characteristics is included, consisting of binary variables for age categories, hours worked, gender, nativity and education. Country and province/regional level fixed effects are included. For global estimates, these estimates were weighted by the projection weight, described above, which essentially gives higher weight to respondents that represent more workers. Point estimates on advanced skills are well above zero with 95% confidence intervals with or without clustering errors by country and region.

To test the robustness of these results, researchers also controlled for sector and occupational fixed effects and re-estimated the model using the number of skills selected instead of the "advanced." These results were qualitatively similar, suggesting the benchmark model was robust. The beta coefficient on advanced digital skills in the global sample was 0.65. The coefficient on use of five or more digital skills was 0.55.

As another, more substantial robustness check, the salary data associated with advertised vacancies using the Burning Glass database was analyzed. To estimate the digital skill premium for each country, researchers

took the average of the minimum and maximum salary range associated with each advertisement, coded discrete experience and educational requirements into binary categories, and regressed the log of income on digital skill intensity. Both binary coding (ad lists at least one digital skill) and levels of digital skill intensity were used. All ads were coded by the number of digital skills listed into 0,1,2,3,4,5 to 9, or 10 or more. Salary premium models used both definitions of digital skills, but the preferred estimate compares ads with 10 or more digital skills to those with 0, as salary rises in a linear fashion with the number of digital skills in all countries in the sample.

Given the huge sample size (101 million vacancies), these estimates were precisely estimated and revealed a wage premium for advanced digital skills of 40% in the sample of 33 countries and a similar value in the matched-country sample. Reassuringly, the premium did not appear to vary in the countries with aggregated skill data relative to the countries where researchers created their own digital skills tag.

GDP estimates

To calculate GDP estimates at the country level, researchers ran the preferred regression model (equation 3) separately for each country and used the country-specific betas as effect estimates. In this way, GDP estimates were calculated based on the digital skills premium associated with basic, intermediate and advanced skills. These premia were multiplied by the average wage for each country, the total number of workers in each country and the percentage of workers in each skill domain, after making the adjustments discussed above. The result of the adjustments was to greatly reduce the estimated population of digitally skilled workers and therefore suppress the GDP estimates. The national average wage, obtained from external sources, was used instead of the survey-based sample average wage, because the latter was artificially high due to the opt-in internet-only sample bias, even after the trimming discussed above.

Country-level estimates were replicated using the alternative method for identifying advanced digital users (i.e., the selection of five or more skills). The results were largely well-aligned, except for Japan, where the coefficient on advanced digital skill use turned from negative (in the baseline model) to significant, large and positive. Further investigation revealed many high-earning Japanese workers who use many digital skills classified themselves as intermediate rather than advanced digital users. Coefficients also became notably larger in New Zealand and Australia.

The countries in the sample represent 67% of global GDP and include a mix of lower-middle, upper-middle and high-income countries. Given the diversity of the sample, its high weight in global GDP, and the omission of countries with large tech sectors (e.g., most of Europe, Mexico, Western Asia, Russia, Argentina), it is reasonable to assume that the GDP-weighted contribution of digital skills to GDP is similar in the countries not sampled. Thus, the estimate of global GDP divides the observed GDP effect by the observed global share of GDP.

Hiring experiment (conjoint)

The hiring experiment was implemented with all respondents on the employer survey who work for a company that employs people with digital skills. Respondents saw the following text:

In the next set of questions, we are going to show you two potential employee profiles. Each has applied for a "tech job" at your organization and you have been asked to recommend one of the candidates based on the information given. A "tech job" is one that requires knowledge about technological devices, internet services, computer software, hardware, or similar services/products.

For the sake of this exercise, please select all that are at least somewhat qualified to do the job.

For each, select the employee profile you would be most likely to hire.

The hypothetical job candidate was given a random attribute from six of nine themes, which were also randomly assigned. Each theme had two or three attributes. The full list is shown below. Each respondent performed this exercise eight times. This randomization across so many exercises allows researchers to estimate the marginal effect of each attribute on the probability of hiring a candidate at the individual respondent level and any higher level of aggregation. Theme effects are estimated by subtracting the minimum effect of one attribute from the maximum effect within each theme. These are known as "utilities" in the field of conjoint experiments.

Conjoint

Programmer: Create two candidate profiles (A and B). Randomly assign six themes to each respondent and randomly assign one attribute from each theme to each candidate.

Theme	Attribute 1	Attribute 2	Attribute 3
Experience	Less than one year of experience working in a tech job	5 years of experience working in a tech job	10 years of experience working in a tech job
Education	Did not complete a tertiary degree	Holds tertiary degree in non-computer science field (e.g., bachelor's degree)	Holds tertiary degree in computer science (e.g., bachelor's degree)
Recommendation	The candidate's reference letters recommend hiring	The candidate's reference letters enthusiastically recommend hiring and are from well-respected sources	
Prestige of schooling	The candidate attended a very prestigious school	The candidate's school does not have a reputation for excellence	
Certification	The candidate does not have a digital skills/information technology certification	The candidate has a digital skills/ information technology certification	
Foreign status	The candidate was born in this country	The candidate was born in another country	
Gender	The candidate is a woman	The candidate is a man	
Age	The candidate is 30 years old	The candidate is 45 years old	
Training	The candidate worked under an experienced mentor who provided on-the-job-training in digital skills	The candidate's digital skills were mostly self-taught	

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