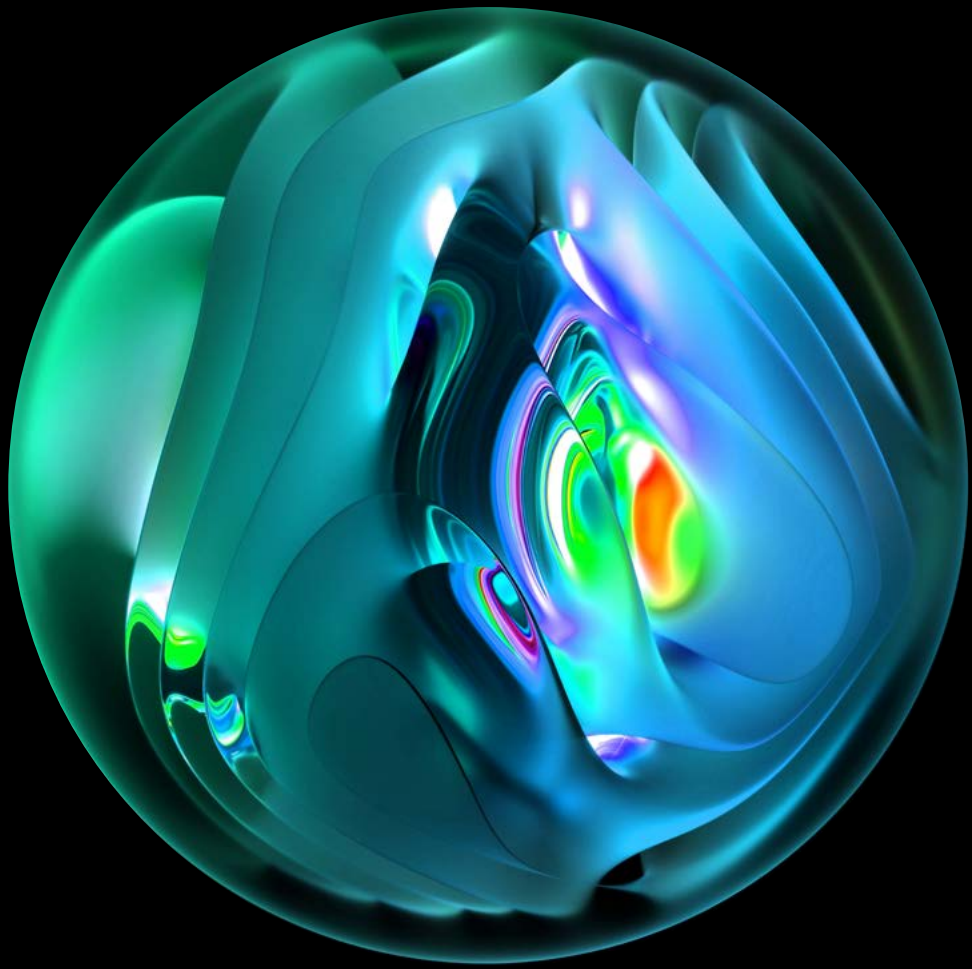
Deloitte.



ACS Australia's Digital Pulse

A new approach to building technology skills

2023

Foreword

Bombshell technologies like Gen AI are ushering in a new wave of tech capability with the power to upend business models faster than any digital innovations before them.

ChatGPT's arrival in November last year signalled a transformation of interaction points between digital and human, making it more intuitive and accessible than ever to engage with technology platforms and data. How far Gen AI will change the very fabric of our world can only be guessed at. But what we can say for certain is it's a revolutionary force. And it's one of many reshaping the tech ecosystem right now.

Gen AI's rapid take-up is a critical input into why the ACS believes a skills-first approach to tech talent is so vital to Australia's future. Because the very nature of what it means to be a skilled technology worker is being rewritten.

Which brings us to the 2023 Australia's Digital Pulse, our ninth annual edition. Over the years, this publication has provided an important platform for understanding the impact of digital disruption on Australia's economic prosperity through the lens of our technology workforce and expertise. It's also been a useful tool for guiding policy makers and ACS's efforts to improve the skills and stature of technology workers.

But as we look to the critical technologies of most importance to Australia's national interests to 2030, the approach we've used to measure and track the technology workforce and how we build their expertise needs to change.

We are at a moment in time where we have to do something transformative to recalibrate how 'technology' skills are understood across the entire ecosystem. This needs to be developed in such a way that shores up significant skills gaps we're experiencing across the current 'technology workforce', plus skills prepared through traditional mechanisms of talent sourcing: Uni graduates, migrants and upskilling existing tech workers. We need to embrace more diversity, more women in tech, more strategic frameworks and more ways of facilitating access to skills if we're to keep up with critical tech adoption.

The overwhelming narrative coming out of this year's report is technology isn't just a standalone function. Increasingly, business functions are recruiting technology skillsets to cope with the latest tidal wave of digital disruption. This means our focus must shift from technology jobs, to understanding the tech skills needed to drive Australia's economic prosperity.

This year's report strives to unlock the power of the tech sector by exploring the evolving tech skills mix. We recommend a systems approach that creates a skills pipeline enabling more Australians to come into a technology fuelled enterprise.

This report puts ACS on the journey from assessing 'technology professionals' to developing and facilitating access to the 'technology skilled professional' of tomorrow.

We are only on the cusp of comprehending the skills needed to leverage critical technologies. In this report, we calculate current needs and draw conclusions on future ones. Extensive modelling is supplemented by qualitative discussion.

Yet skills come in varying degrees of competence. What's more, people and specialist skills are increasingly required alongside technical expertise. AI is impacting business skills not just 'tech' functions. Many more tech skills and roles are not yet in existence.

ACS acknowledges to truly build a holistic picture of what's required to 2030, more data and insight, iterative industry consultation and partnerships are needed. We won't get there by applying current perspectives of tech workforces or skills as we understand or rate them. It's equally clear ACS must go beyond its heritage in tech skills assessment to support skills accessibility.

We can't do this alone. ACS is committed to building a coalition willing to push this agenda forward and put Australia in the best possible position to recognise, build and make available skills supporting tech innovation and usage in an adaptive way. Here, we outline five key principles to guide this new approach.

The myriad findings here are a basis for conversation and commitment to navigating the challenge ahead. From here, ACS intends to embark on a fact-finding mission to continue informing a future-focused approach that enables Australia to build the skills required for tomorrow's technologies.

Dr Nick Tate FACS CP
ACS President

Chris Vein
ACS CEO

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ACS Australia's Digital Pulse 2023

Critical technologies such as artificial intelligence, robotics and advanced data analytics are crucial to our prosperity, social cohesiveness and national security, but they will also dramatically disrupt the workforce. Australia needs to make the most new technologies have to offer.

Key principles of the new approach

All hands on deck

Skills first

Driving diversity

Lifecycle of learning

Systems approach

$135b

Annual investment in critical emerging tech in Australia by 2030

11.2m

Number of Australian workers that will need some reskilling because new tech will affect at least 20% of work time

1.3m

The number of additional skills needed by 2030 for Australia's tech workforce to adapt to 10 critical technologies

$16b

Cost of the tech labour shortage by 2030 without a reskilling uplift

Executive Summary

Labelling the impact of critical technologies such as Artificial Intelligence (AI), virtual worlds and advanced data analytics on Australian technology skills 'seismic' is a safe bet. Quantifying the extensive and rapid impact these disruptive technologies will have on Australia's tech skills landscape is much more problematic.

What Generative AI and many critical technologies are rapidly teaching industry, government, educators and businesses is just how many unknown factors we face in building the tech skills of the future. But what we do know is we must transform the way we understand and facilitate tech skills development if we're to harness their full economic impact.

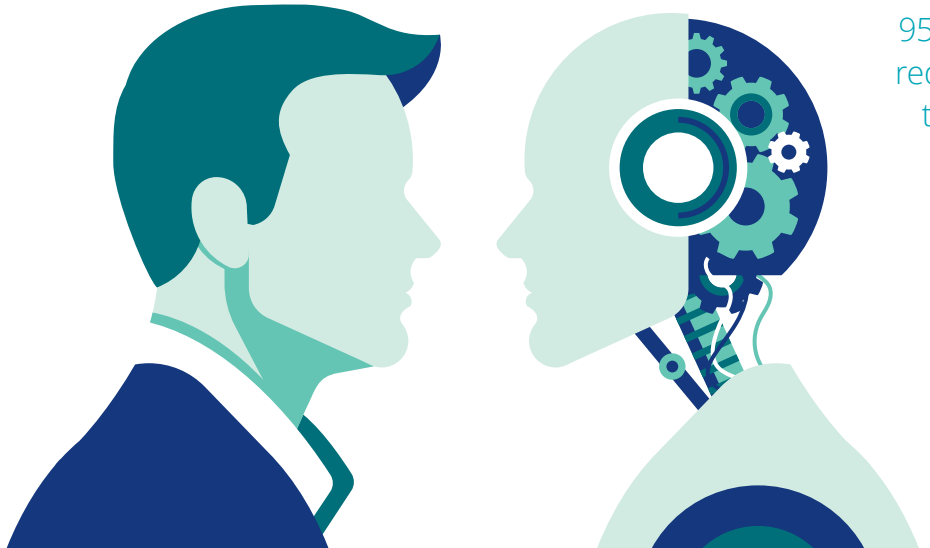
The scope of critical technology disruption is breathtaking. By 2030, at least half of Australian businesses expect to be using these technologies, generating investment in technology of upwards of $261 billion. In AI alone, spend is forecast to increase seven-fold as applications and the user base dramatically expands.

Yet employees are moving quicker to adopt these valuable tools than businesses. Deloitte's *Generation AI: Here We Come Ready or Not* report observes Generative AI is unparalleled to previous waves of tech disruption for the lack of control IT departments or coordinated strategies possess around its use. Millions of additional global users start interacting with ChatGPT every month.

The impact of critical technologies on Australia's workforce will be all-encompassing. Almost every worker – 95% or 11.2 million employees – will be affected as tasks are increasingly accomplished with the assistance of AI, robotics, advanced data analytics, virtual worlds, additive manufacturing and advanced communications.

That's based on what we can forecast using data and demand discernible today. Tech skills required to utilise and innovate through these critical technologies are only just being envisaged and perceived. Disruptive digital technologies are reshaping tasks as industry, government, business and education providers have understood them, challenging 'tech worker' stereotypes.

They are beginning to blur the lines between tech functions and the rest of the professional workforce. As critical technologies mature, additional, unforeseen and exciting roles will be created throughout every organisation. Every worker will be a tech worker in some way.



95% of the Australian workforce require some reskilling as critical technologies will significantly impact their role.

A totally new approach to technology and skills will be needed to ensure Australia's workforce adjusts and embraces this next wave of advanced digital disruption. To make this happen, it's critical we recognise we're no longer facing a tech jobs challenge, but a tech skills conundrum.

The 2023 *Australia's Digital Pulse* provides comprehensive projections around tech skills demand through to 2030 against the critical technologies disrupting the economy. We explore where gaps lie between these skills and current workforces and detail the way critical technologies are expected to reshape the professional workforce, with a focus on specialist business functions and roles. These insights are combined with ACS's expertise around what it takes to build strong tech workers, and a commitment to championing the skills, inputs and considerations that can help Australia manifest them.

What the the best available data indicates is the skilled technology professional of 2030 is one Australia is only partially equipped to create right now.

Size and scope of the tech skills revolution

Projections show 1.8 million new tech skills will be needed by 2030, an increase of 1.3 million on today's levels. These are skills identified in areas such as scripting languages and software development principles. However, the nascent nature of critical technologies, their swift take-up and the ways they are developing will keep changing the skills needs in unpredictable ways.

In assessing the critical technologies of Australia's future, we particularly acknowledge AI's unprecedented rate of adoption, democratisation and accessibility from a user perspective. The human/digital connection it facilitates is unprecedented: AI is creating a more profound relationship between humans and technology than the internet, smartphone and cloud before it.

How different the skills mix is going to be in the face of such transformative digital change is equally significant. Take coding, one of the top skills in demand in Australia over the last 10 years. As Generative AI introduces English for the first time as a coding language, the shape of the coding job, as well as the skills required, alters. It's not just the technical expertise in programming languages like Python, JavaScript or PHP either; critical thinking, people skills, governance processes and practical use-case applications become as important as the 'tech' skill itself.

The pervasiveness of digital change is such that no aspect of business is immune. Not only does the technology workforce need to reorient its skills base and invest in new capability; every function of business requires technology upskilling.

Top occupations where emerging critical technology skills are currently in greatest demand include Actuaries, Mathematicians and Statisticians, Sales Representatives, Accountants, Contract, Program and Project Administrators, Advertising, Public Relations and Sales Managers.

Critical technologies will also usher in jobs only dreamt of in 2023. Take AI conceptualisation: This will require AI ethicists, personality designers, algorithm bias auditors – tech jobs either not available right now, or which may have roots in functions such as design, production, compliance and finance.

This blurring line between traditional concepts of the technology function and business roles exponentially impacted by critical technologies means tech skills aren't sitting in a silo anymore; they're an integral part of every function across the business.

A multi-faceted approach to skills

In this report, we've used a comprehensive array of data sets to put the skills gap in context. We shine a light on how many technology workers are expected to be needed by 2030 and the tech skill needs in roles considered outside the tech workforce until recently. It's imperative we do so because the size of the gap is considerable.

Three in four working hours done by the entire Australian workforce by 2030 will be impacted by critical technologies. Add to this stark evidence that technology professionals joining the workforce don't have the right skills for the task at hand today, and the gap in adequate tech skills becomes even more apparent. Only 3% of tech employers believe IT graduates are job ready; 3 in 5 businesses believe their workforces lack or have outdated digital skills.

Digital change has placed Australia at a critical juncture in its economic prosperity. Already, Australia has been shown to lag in several areas of technology adoption. While Australian businesses have one of the highest adoption rates in cloud compared to OECD countries, we are falling behind in other emerging technologies like AI and advanced data analytics. One recent survey found Australian businesses currently lag in AI deployment, ranking 13th of 14 leading economies in 2022.

At a minimum, Australia needs 445,000 more technology skilled workers to reach the 1.3m workers projected as needed by 2030 to keep pace with international economies. That's a net increase of 60,000 tech workers each year. Who are these workers? What mix of skills do they need? Are they even 'tech workers' as we know them? These are the questions that cannot be answered with certainty in 2023.

What we do know is an orientation around building tech skills and talent is a vital piece in the puzzle. ACS's extensive history over the past five decades in identifying and assessing tech workers provides important learnings as we make this shift. Insights into the technology skills gaps existing right now, and what it's going to take to plug them, are critical inputs into how Australia actions change in this transformative time.

New levels of responsibility

Another critical input into the tech skills mix by 2030 is responsible use. Additional social, environment and governance (ESG) burdens are being placed on professionals as the plethora of technologies enabling data to be accessed and used by anyone in the world expand. Technologies increasingly relying on personal data elevate the need for professionals to be accountable for contextual use of these technologies and their outcomes. Addressing responsible use cases will require technical expertise as well as a mix of specialist business and people skills.

A third vital lens is inclusiveness. There is a need to encourage women into technology to fill yawning gaps over coming years. Inclusivity further extends to neurodiversity, accessibility, cultural difference and diversity of experience. Adjusting skills development and ways of working to enable all professionals to thrive becomes another vital input into the way we build technology skills for the future and the workforce needed for Australia's prosperity.

Systemic change calls for a coordinated approach

Achieving such systemic change requires a concerted and coordinated effort across businesses, industry, government, unions and education providers that sets out clear objectives, proposes innovative solutions and tracks progress against recommended targets. However, a regulatory reaction can take too long to implement and quickly become outdated. An approach that recognises the importance of a market systems approach will be key to ensuring skills development is flexible to ever-changing needs and can facilitate rapid scale-up of successful models to building skills.

Five key principles should inform the new approach, as outlined below.

These entail significant policy change and shifts in ways of working and learning. We need national, state and territory digital skill strategies and roadmaps that enable us to identify and track progress to address reskilling needs across the whole workforce. We need a systems approach that connects IT graduates and professional workers so they can become part of Australia's next-generation technology workforce. We need career transition schemes, better mechanisms to allow skilled migrants to bring their knowledge into our organisations, and to foster inclusivity.

ACS's historical expertise around the technology workforce and what's needed to build and facilitate access to tech skills enables the organisation to play a key coordination role. But it's through a coalition of willing stakeholders, industry, government and education providers backing a national skills strategy and progress milestones the greatest changes can be made. Only be taking action now through a holistic approach can we build the tech skills Australia needs to flourish.

01 All hands on deck

The transformation outlined in this edition of Australia's Digital Pulse is not a tech issue, it's a workforce issue that will impact Australia's economic prosperity. We need all actors across private and public sectors to play a role.

02 Skills-first

We have designed our education system to focus on producing people ready for certain roles with limited reskilling or upskilling, resulting in high numbers of workers with the outdated skills. Instead, we need to first and foremost identify and then build in-demand skills based on critical technologies shaping businesses and industries.

03 Driving diversity

We need people with the right skills. Excluding or not fully utilising the existing talent in our workforce is not only wrong in principle but imposes significant costs on the Australian economy.

04 Lifecycle of learning

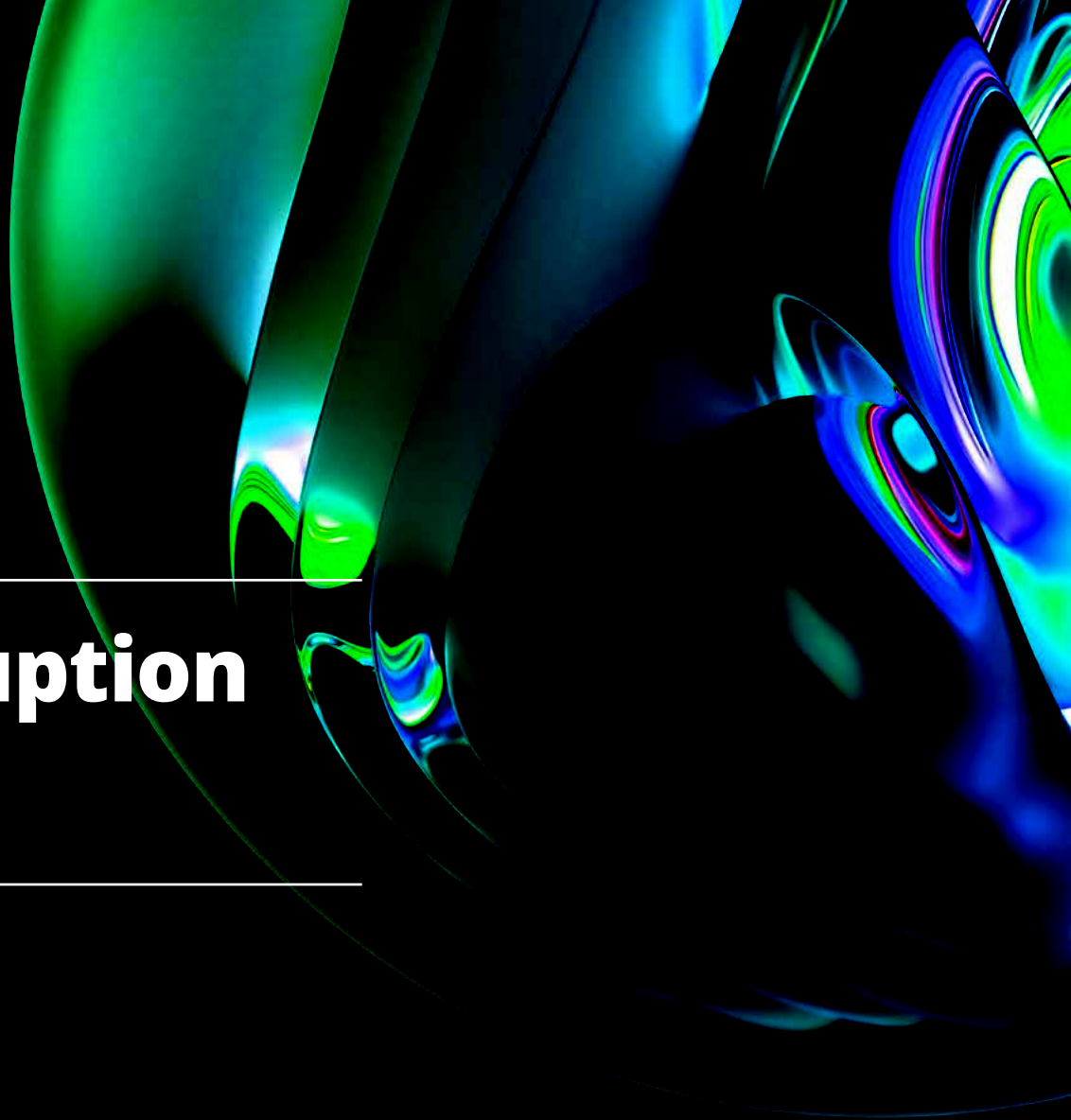
The half-life of our skills is quickly shrinking and while we have analysed skill needs out to 2030, we know these will change in unforeseeable ways. Building a culture of continual skills development is the only solution to make sure we have the right skills in the workforce.

05 Systems approach

Too often we are working on solving the same problem in silos. Combining our efforts and thinking holistically about our networks, organisations and institutions is necessary to maximise the impact of our initiatives.

01

Accelerating disruption from critical tech



Accelerating disruption from critical tech

Australian businesses and institutions are not ready for the change

We live in a remarkable era of rapid technological change and digital adoption. As the pace of advancements accelerates and the impact of technology becomes more widespread, the potential benefits are significant. Technologies such as big data analytics and Artificial Intelligence (AI) have the potential to reverse slowing productivity growth, create a more sustainable economy allow Australians to connect and work together in previously unimagined ways.

The most recent wave of disruption caused by Generative AI has been faster than other technologies. While the majority of technology change and adoption is driven by businesses investment decisions such as in cloud computing or cyber security, Generative AI is an employee-led technology, leaving businesses and policy makers trying to catch up.

The impact of these technologies is fundamentally changing business operating and the future of work. One global study found AI could automate 300 million jobs.[1] The World Economic Forum report found 37% of businesses tasks are currently performed by machines, with this expected to increase to 42% by 2027.[2] While most studies point to a net rise in employment from adoption of new technologies, there is going to be greater labour market turnover alongside greater reskilling and upskilling needs.

This is the ninth edition of Australia's Digital Pulse. Please find a detailed overview of the data sources and methodology used to develop the analysis contained in the report in the Appendix.

The Australian Government has recognised the crucial role of technology and digital innovation in reshaping business and the Australian workforce. In response, The *List of Critical Technologies in the National Interest* has been developed which identifies 63 key critical technologies within 7 fields that will have the greatest impact on Australia's national interest in terms of our economic prosperity, national security and social cohesion in the years to 2030 and beyond.[3]

Australian businesses have high levels of adoption of key digital infrastructure such as cyber security and cloud, but lower adoption of more advanced technologies. This is set to change over the remainder of this decade with many looking to use more advanced technologies in their operations. In fact, half of Australian businesses expect to be using AI, advanced data analytics and Internet of Things (IoT) by 2030. These figures are based on business expectations around adoption and are likely to significantly increase as technology continues to evolve and businesses realise more use cases.

Yet business adoption in some of these key technologies is lagging behind employees. A separate study by Deloitte found that 32% of employees use some of Generative AI for work purposes, but nearly two thirds believe their managers don't know about it. The case study below details further findings from this research.

While currently at lower levels of adoption, quantum technology, virtual worlds, advanced robotics, and sensors show promising potential for growth. Projections for 2030 indicate a surge in interest: quantum from 1% to 15%, virtual worlds from 1% to 23%, and robotics from 1% to 15%. This indicates a growing recognition of the potential of these technologies.

While Australian businesses have one of the highest adoption rates in cloud compared to OECD countries, we are falling behind in some other emerging technologies like AI and advanced data analytics.[4] One recent survey found Australian businesses currently lag in AI deployment, ranking 13th of 14 leading economies in 2022. Based on the survey, only 24% Australian businesses had deployed AI in 2022 compared with 39% of businesses in Singapore or 34% of businesses in Germany.[5]

Adoption of critical technologies by Australian businesses, 2022 and 2030

	2022	2030
Cyber security	63%	78%
Enabling cloud technology	59%	84%
Internet of Things (IoT)	6%	45%
Advanced data analytics	5%	54%
Additive manufacturing	2%	-
Artificial intelligence, machine learning and natural language processing	1%	63%
Advanced robotics and sensors	1%	15%
Virtual worlds	1%	23%
Quantum technologies	1%	15%

Source: Australian Bureau of Statistics (2023), Deloitte research (2023)

Australia's investment in technologies is set to grow to $261 billion in 2030

Looking at business adoption figures of critical technologies can obscure the full extent of impact these technologies have on businesses and their daily operations. While not a perfect measure, investment does provide another indicator that demonstrates the importance of these technologies.

Forecasts from the International Data Corporation (IDC) indicate that investment in digital technologies will increase from $172 billion in 2023 to $261 billion in 2030. This means that Australian investment in technology will increase 6.1% per year on average for the next seven years.[6] AI will experience the greatest proportional increase in investment of all the emerging technologies, increasing by nearly seven fold to the end of the decade or 28.6% per year on average.

The growth in technology investment is nearly three times the rate of anticipated business investment in the economy out to 2030, which is expected to increase 2.3% on average each year for the next seven years.

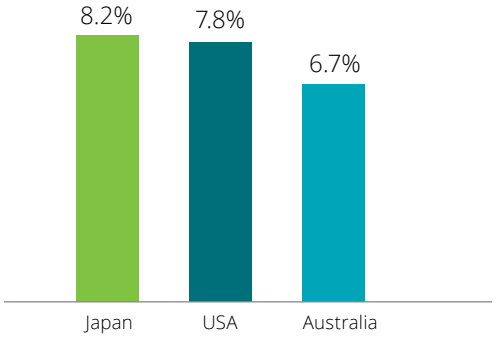
Meanwhile, significant investment will continue to be made in enabling cloud technology and IoT, which will reach $41 billion and $34 respectively by 2030, making up nearly 30% of the total Australian investments in technology in that year. The average annual increase in investment for these technologies to 2030 will be 10.6% and 8.0% respectively.[7]

Previous editions of this report have pointed out Australia's digital economy is middling when compared to its international peers based on 24 indicators. When it comes to adoption of and investment in digital technologies, a middling country represents a lost economic and social opportunity.

Our analysis of IDC data shows Australia is currently trailing in terms of investment in technology as share of GDP with only 6.7% invested in technologies, compared with 8.2% in Japan and 7.8% in the USA. This means a greater proportion of the economy's resources in Japan and USA are being allocated to investment in greater adoption and use of these key technologies.[8]

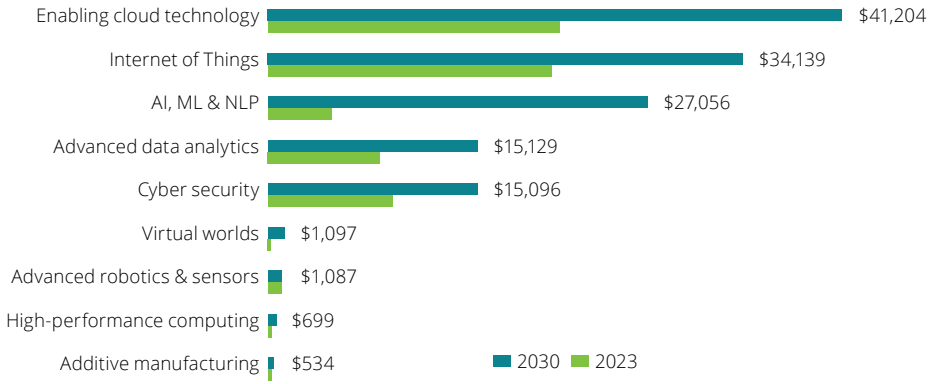
Yet even fast growth over the period ahead is not enough to close the gap between Japan or the USA by the end of the period. This may mean lost economic opportunities throughout decade and more should be done to encourage Australian businesses to adopt these key technologies earlier to realise benefits from adoption.

Share of investments in emerging technology compared to total economy, 2022



Source: IDC's custom data request (2023)

Investment in emerging technologies in 2023 and 2030 ($m)



Source: IDC's custom data request (2023)

CASE STUDY

Generation AI driving disruption

Australian businesses risk being left behind by their own employees

While Australia's Digital Pulse expects half of businesses to adopt AI by 2030 and business investment is set to increase sevenfold in the same period, employees are adopting this technology faster than organisations ever could consider. User-friendly tools, like ChatGPT, have put the power of Gen AI into everyone's hands.

A new report by Deloitte Access Economics puts the spotlight on the people who are leading the charge of Gen AI adoption – who we have dubbed 'Generation AI'. This cohort refers to Australia's students and young workers who are digital natives embarking on their careers in a world increasingly dominated by AI.

We found Generation AI is already using this technology for work and study. Students, for instance, are nearly twice as likely as employees to have used Gen AI. When these students graduate and enter the workforce, they will transform how employees engage with and harness Gen AI. Younger workers (aged 18-24) are also three times more likely to use Gen AI than mid-career workers (aged 45+). There is also a rapid increase of Gen AI users, with the share of employees using the technology from 10% in January 2023 to 35% in April 2023.

However, employees are concerned about risks associated with Gen AI. Nearly 90% of surveyed employees identified at least one concern about its use. Specifically, employees are uncertain if using Gen AI applications will lead to leaks of personal, confidential or sensitive information (75%) and factual errors (73%). Business leaders share similar concerns. Separate research indicates 70% of executives believe using Gen AI will create more security risks, as well as potential issues with integrating the technology within existing technology stacks.

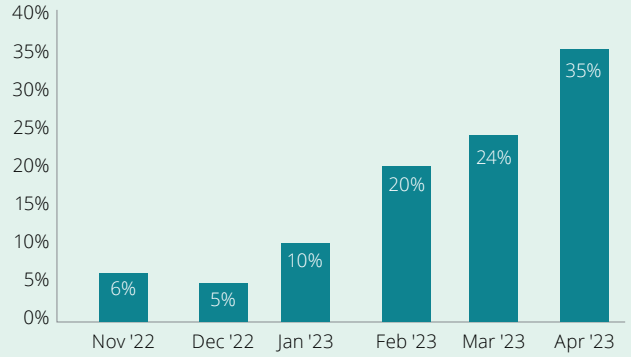
However, businesses that do not explore the use of Gen AI in their organisations or industry risk being left behind. Over a quarter of the economy, accounting for nearly $600 billion in economic activity will be rapidly disrupted by Gen AI including finance, ICT and media, professional services, education and wholesale trade.

This wave of disruption caused by Gen AI will be faster than previous waves of digital disruption. While the majority of technology change and adoption is driven by businesses' investment decisions such as in cloud computing or cyber security, Gen AI is an employee-led technology, leaving businesses and policymakers trying to catch up. Two in five employees do not believe their businesses are ready for the upcoming wave of technology disruption.

Adoption rate of 100 million users for internet-of-things services and technology in 2022

Source: Statista, 2022

The share of employees first using Gen AI is increasing every month



Source: Deloitte Gen AI survey, 2023

A business design perspective

"Individuals naturally embrace tech faster than business – but Gen AI has seen this happen faster than ever before, broadening the gap between a business and its workforce. Yes, this leads to a disruptive threat; but it leads to an even bigger opportunity. Let's not forget businesses are made up of lots of individuals, each with the power to disrupt."

Dr. Kellie Nuttall
Lead Partner, Strategy and
Business Design & AI Institute
Deloitte Australia

CASE STUDY

Building the $6 billion quantum computing industry in Australia

Building the quantum industry in Australia requires people skills and attracting greater investment

Quantum computing has the potential to reshape many key industries in Australia. The ability of quantum computing to tackle complex problems not possible with traditional computers, or in a fraction of standard computing time, has a variety of potential use cases. Key use cases of quantum computing include:

Healthcare: can enable more targeted and effective public health strategies through quantum computing's enhanced ability to process large datasets and complex algorithms. This can be used to analyse population health trends and identifying patterns of disease spread. Quantum computing can also potentially improve diagnostic capabilities, enable personalised medicine and aid development of new drugs and therapies.[9]

Finance: could enhance data processing, pattern recognition, and optimisation tasks leading to more sophisticated AI models which can enable portfolio optimisation.

Logistics and transport: can be used to solve complex optimisation problems such as route planning, supply chain management, and resource allocation. This can be used to streamline operations and achieve efficiencies in the current high cost environment facing the industry.[10]

Quantum computing is still at very early stages of development. However, according to CSIRO estimates, Australia's quantum technology industry could generate nearly $6 billion in revenue and account for 19,400 new jobs by 2045.[11] Some of the key skills required for quantum computing are quantum mechanics, quantum hardware, linear algebra and complex numbers, precision manufacturing, computer science and business skills.[12,13]

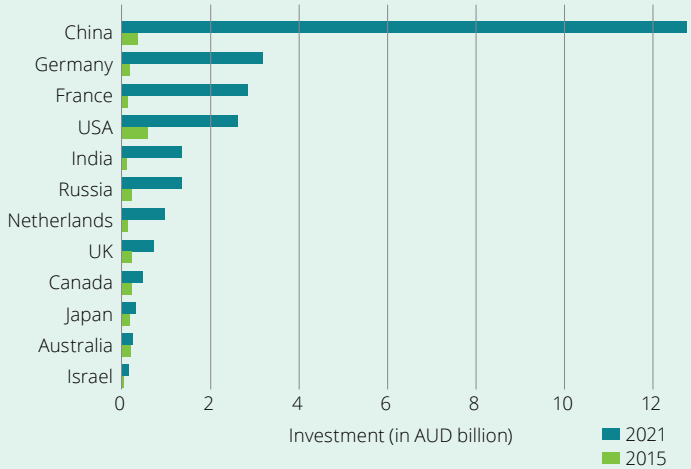
Australia has well-established quantum research capabilities. In 2021, there were 22 quantum related research institutes and two quantum-focuses Centres of Excellence in Australia. Additionally, there were 16 quantum-related private organisations.[14]

There is significant investment being made globally in quantum computing by governments alongside private investment. The Australian Government investment lags comparable jurisdictions with the second lowest investment out of 12 countries.[15] Australian Government investment has increased by 88% between 2015 and 2021, while the average increase in investment for the other 12 countries is 2,061%. It reinforces the fact Australia may miss a significant opportunity unless more investment is encouraged in this important technology.

Skills needed for quantum computing

- Quantum mechanics
- Linear algebra & complex numbers
- Computer science
- Quantum hardware
- Precision manufacturing
- Business skills

Government investing in quantum technologies, 2015 & 2021



Source: Deloitte, Quantum Computing: Hype or Reality (2021)

A regulatory perspective

"Creating the right environment and settings for critical technologies like AI, advanced data analytics and extended reality is not a matter of compliance; it's a cornerstone of a prosperous and ethical digital future. As we navigate the constant waves of disruptions, its our responsibility to ensure these technologies empower society, protect privacy and drive progress for all."

Dr Ian Oppermann
NSW Chief Data Scientist
& UTS industry professor

02

Australia’s workforce skills challenge

Critical technologies will significantly impact the work of 95% of the workforce

Collectively these technologies will impact 74% of work hours across the Australian economy

An analysis was conducted using the National Skills Commission's (NSC) 2,136 task taxonomy of 229 Australian occupations and academic research on the impact of eight key technologies on tasks to understand the potential impact of critical technologies for the Australia workforce.[1] Further details about the methodology to estimate the workforce impact from critical technologies is available in the Appendix.

This analysis revealed the extent of impact these critical technologies could have on the Australian workforce. An estimated 95% of workers are expected to see at least 20% of their work time replaced, augmented or otherwise impacted by the adoption of critical technologies. At 2022 levels, this translates to over 11.2 million workers across the economy. The analysis also demonstrates the intensity of change coming from such technologies, with three-quarters or 280 million working hours impacted by their introduction.

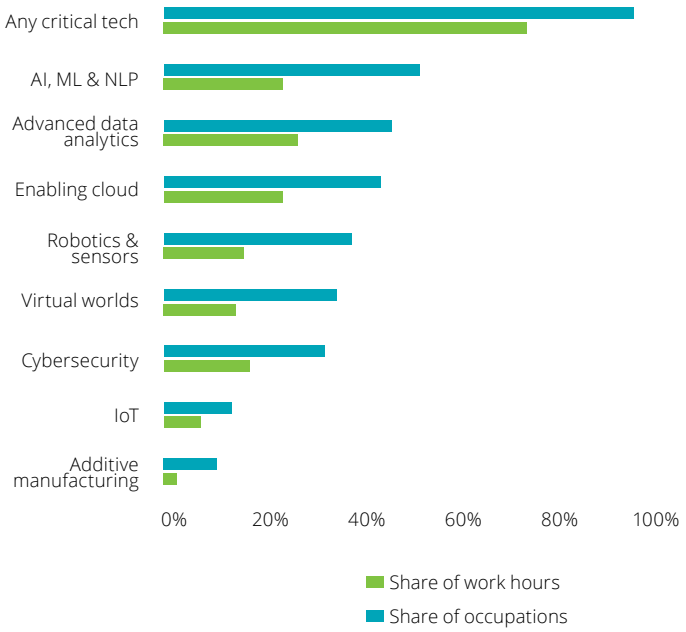
The nature of these impacts will differ substantially depending on the technology and the tasks that it is being affected. The introduction of technology can mean:

- The tasks a worker undertakes is changed by using technology. For example, repetitive or lower value programming exercises such as translating code from one language to another is made easier, allowing programmers to focus on higher value tasks
- The task becomes automated. For example, AI chatbots have replaced some customer call support roles in organisations.

This analysis is high-level only and it is possible critical technologies and jobs evolve in different ways. Other studies have distinguished between the augmenting impact and automating impacts of technologies including from the New South Wales Productivity Commission, Revelio Labs and Goldman Sachs.[2,3,4]

While studies conclude jobs will be replaced, they also indicate there will be net additional jobs created by the implementation of technology. The research from the NSW Productivity Commission conservatively estimates by 2035, 7% of existing jobs may be lost due to emerging technologies. However, this it will be offset by a 4% gain in new jobs as a result of these technologies and a 19% gain attributable to the growth of existing jobs. The report also suggests technology occupations are likely to be among those experiencing growth due to emerging technologies.[5]

Share of affected workforce and % of working hours impacted



Source: National Skills Commission (2023), ABS Census (2022), Fenton et al (2022), Deloitte analysis

Critical technologies will impact nearly every job in Australia

ICT workers, psychiatrists and bank workers will be most impacted by the next wave of tech change

The roles anticipated to be most affected by incoming disruption are characterised by having repetitive or codified tasks that are more amenable to assistance or automation by technology. The extent of impact will differ across different critical technology. AI will be among the biggest disruptors of roles in the economy, significantly affecting almost 6 million people and 25% of all working time.

Different technologies will affect different types of workers. For example, a broad range of occupations involved in routine office work such as Human Resource managers, bank workers and bookkeepers are most likely to be most affected by cloud while livestock farmers, mobile plant operators and electrical engineers are more likely to be impacted by IoT.

While critical technologies will impact a broad cross section of the workforce, technology workers are among those most affected, representing 8 of the top 20 occupations with highest share of work time exposed.

Top 20 occupations impacted by critical technologies

Occupation	Worktime
Electronic Engineering Draftspersons and Technicians	100%
Psychiatrists	100%
ICT Support and Test Engineers	100%
Database and Systems Administrators, & ICT Security Specialists	100%
ICT Managers	100%
Bank Workers	100%
Bookkeepers	100%
Management & Organisation Analysts	100%
Survey Interviewers	100%
Telemarketers	100%
Payroll Clerks	99%
Debt Collectors	98%
Human Resource Clerks	98%
Sales Assistants (General)	97%
ICT Sales Assistants	97%
Filing and Registry Clerks	97%
Electronics Trades Workers	96%
Electrical Engineering Draftspersons & Technicians	96%
Insurance Agents	96%
Library Assistants	96%

Source: National Skills Commission (2023), ABS Census (2022), Fenton et al (2022), Deloitte analysis

More occupations will be intensive users of technology

Currently almost 200,000 workers outside of the technology workforce have skills in emerging technologies. The proportion of non-technology job advisements requiring emerging technology skills is forecast to increase to 6% by 2030. This will see the number of non-technology workers possessing these skills grow to an estimated 470,000 by 2030.[6] And that's just what we're able to comprehend now.

The top occupations outside the technology workforce where these key emerging technologies skills are currently in greatest demand include: Actuaries, Mathematicians and Statisticians, Sales Representatives, Accountants, Contract, Program and Project Administrators, Advertising, Public Relations and Sales Managers.

Impacts of AI on workforce skills by 2030

One of the most profound impacts of critical technologies on workforce skill needs will come from AI, ML and NLP (AI technologies).

Out of 285 specialist skill clusters from the National Skills Council framework, some 61 will be directly affected by AI technologies, including: verifying accuracy of data or documents, create and update databases, manage operational budgets, and gather or analyse information.

In total, 86% of occupations have skills that will be affected by AI technologies, and 25% of all worktime will be affected. 52% of occupations will have at least 20% of their work time impacted by AI, and will be those mostly likely to need reskilling to make most use of the technology, or develop new skills to continue to create value for their employers or organisations.

Which workers will be most affected by AI technologies?

Many of the workers most affected will be tech workers themselves, including ICT support and test engineers (90% of worktime), ICT business and systems analysts (81%), and graphic and web designers and illustrators (78%).

Deloitte's Generative AI research indicates tech workers will also face the most imminent disruption alongside workers within the finance, professional services and education industries.

However, many other workers will be strongly affected too, including journalists and other writers (70%), librarians (68%), and visual arts and crafts professionals (66%).

Of course, how these impacts play out in coming years is difficult to predict. For some, AI technologies will simply be a tool that operates inside an app, possibly without their direct involvement or knowledge. For others, it may substitute for their efforts, requiring them to learn other skills and diversify. What we can say with greater certainty is reskilling will be needed on a scale never before seen in the Australian economy.

Skills & jobs impacted by AI, NLP, and ML by 2030

Specialist skill clusters affected

- **Verifying accuracy of data or documents**
- **Create and update databases**
- **Manage operational budgets**
- **Gather or analyse information**
- **Provide financial advice**
- **Design diagrams, models & templates**
- **Distribute, write, edit or compile documents**
- **Provide customer service & communicate information**
- **Develop education materials & programs**
- **Test computer or software performance**

Tech roles most impacted (% of working hours impacted)

- 90% **ICT Support & Test Engineers**
- 81% **ICT Business & Systems Analysts**
- 78% **Graphic & Web Designers, & Illustrators**
- 74% **Software & Applications Programmers**
- 73% **Computer Network Professionals**

All workforce most impacted (% of working hours impacted)

- 70% **Journalists & Other Writers**
- 68% **Librarians**
- 66% **Visual Arts & Crafts Professionals**
- 63% **Insurance Agents**
- 63% **Public Relations Professionals**

Please find the analysis of seven other critical technologies on the broader workforce in the Appendix

News roles that will be created from critical technologies

Uncertainty underscores the need for adaptable skills and continuous learning

When a new technology is introduced, its potential applications might not be immediately evident. It may take time for industries to explore and understand how to harness its capabilities effectively. This uncertainty makes it challenging to predict the specific skills and jobs that will be needed in the medium or long-term. The rise of the Internet, cloud and smartphones has already reshaped job markets. It is challenging to predict the diverse multitude of jobs and the exact skill sets required to leverage these technologies today when they were first emerging a decade or more ago.

Some of the key job types that will emerge in coming years could include AI specialists (such as ethicists and personality designers), virtual world professionals, and quantum data analysts. These new jobs and skills requirements will not only be traditional 'tech' roles; critical tech is fundamentally changing the skillsets in line-of-business functions too, blurring the line between 'tech workers' and 'professional workers' more generally.

Predicting the emerging cross-disciplinary roles is challenging as they require a combination of skills not always apparent in today's job market.

There will also be a need for government roles to evolve alongside technological roles. Embracing and comprehending emerging technologies is crucial for effective policymaking, as it enables governments to harness the potential of these innovations while mitigating potential risks and challenges. Moreover, by staying abreast of technological developments, governments can proactively address issues like cyber security, privacy concerns, and digital infrastructure requirements.

Critical technologies are not implemented or used in isolation. The way they interact and complement each other will drive efficiency and innovation to unprecedented levels compared to if each tech was only used individually.

For example, advanced data analytics can leverage the vast amounts of data collected by IoT devices, enabling businesses to make data driven decisions in real-time. Extended reality can be used to facilitate training and, when paired with data analytics, to tailor the education experience. This combination of tech has been used by DetectedX to provide radiology training programs allowing clinicians to test and improve their skills diagnosing chest images. The work has been shown to improve clinican's diagnostic accuracy by between 21%-31%.

The combination of technologies will have unexpected implications for the skills required by the workforce as necessary skills may be complemented or offset by the interaction of the technologies. For example, quantum computing may require a large increase in coding skills while Generative AI may streamline the need for in-depth knowledge of coding specific knowledge.

While these interactions make it difficult to precisely forecast the skills required with high levels of precision, it's clear change can be expected quickly. It's imperative the Australian workforce begins preparing now for these emerging skill needs.

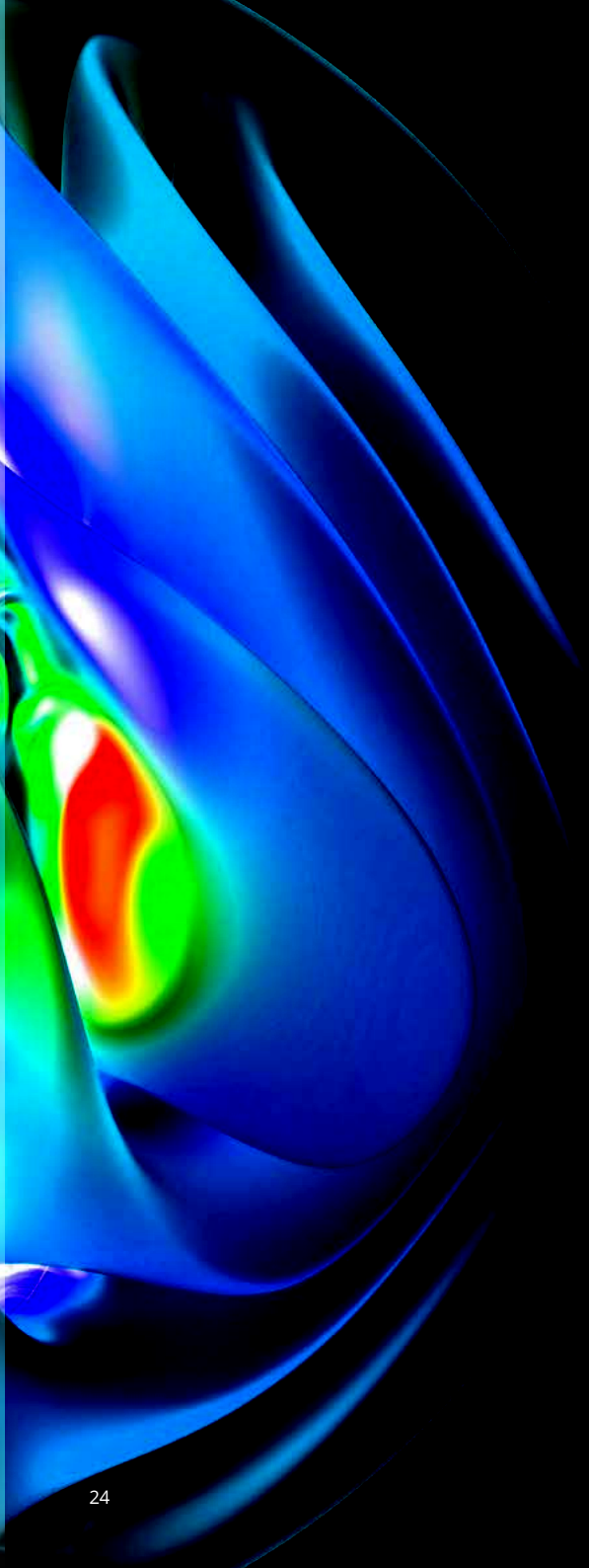
Potential future jobs enabled or increased in importance by technologies

- AI Ethicist
- AI Personality Designers
- Virtual Worlds Safety Officers
- Quantum Data Analysts
- Human-Computer Integration
- Holographic Engineers
- Government regulation

A futurist perspective

"Over the past 20-30 years technology has been erasing the distinction between something you know and something you can google (easily learn), a trend that will accelerate with the introduction LLMs as they slash the cost of engaging with technical skills while providing a smoother path to expertise."

Peter Evans-Greenwood
Centre for the Edge



03

Deep dive into the tech workforce

Australia will need to skill an additional 237,000 workers by 2030 to keep up with international peers

Based on currently available data, Australia will need to spend an additional $92 billion through to 2030 in critical technologies to be at the forefront of forthcoming disruption. This translates to a projected worker gap now of 205,000 to 237,000 by 2030. Of course, these projections are based on current trends. As we have seen in the recent wave of interest in Gen AI, these figures are likely to be conservative as more technological innovations occur.

Australia's technology workforce has grown strongly to meet the needs of businesses and the economy. The number of technology workers has grown by over 320,000 in 8 years when the first edition of Australia's Digital Pulse was published.

There are now 928,000 people employed in the Australian technology workforce in 2022, with a net increase of 57,600 workers in that year alone. While our forecasts suggest this strong growth will continue, there is a risk the Australian technology workforce will not grow quickly enough to meet the rapidly growing demand in technology skills.

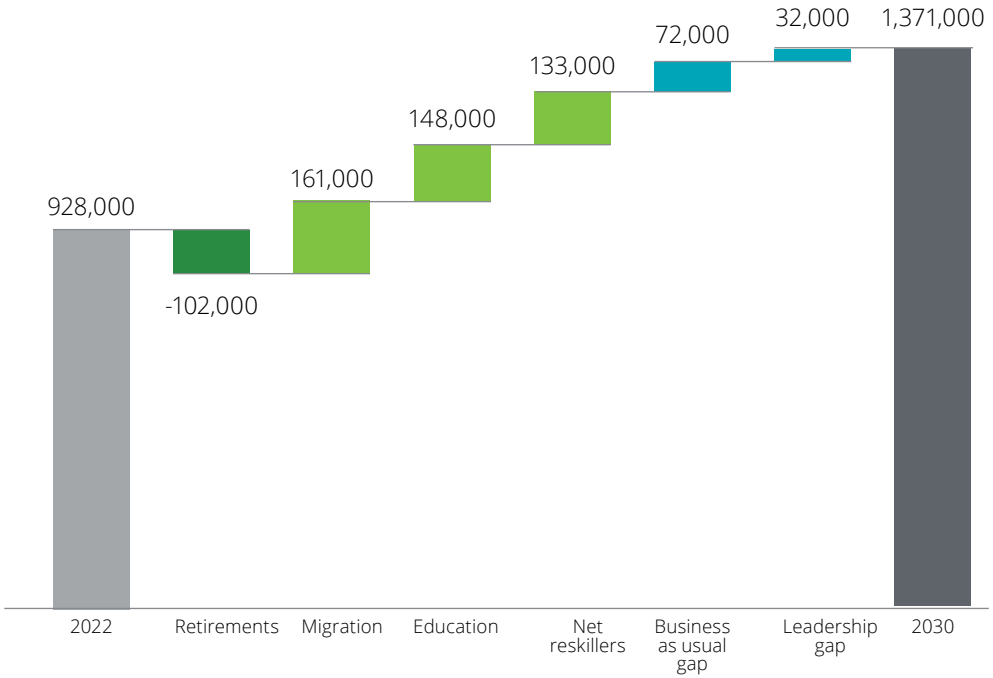
The number of workers in Australia's technology workforce grows and shrinks based on a number of drivers. These include:

- Retirements capturing those workers expected to leave the labour force through to 2030
- Migration accounting for permanent and temporary workers in the sector
- Education accounting for domestic and international students who work in the tech sector after completing their studies
- Net reskillers accounting for workers coming and going from technology occupations.

Projecting the supply of workers from each of these sources between 2022 and 2030 (chart below) suggests Australia's technology sector will need to skill an additional 205,000 workers to match business-as-usual demand by 2030. This rises to an additional 237,000 workers if Australia was to match levels of spending on critical technology in the USA (proportionate to GDP).

With 7% year-on-year growth in job advertisements for technology workers, increasing recruitment difficulty, and labour shortages across the economy, this skilling task will require concerted action to increase the number of workers entering the sector.[1] These workers can come from attracting additional skilled migrants, training more people domestically or encouraging more people to switch occupations into the technology workforce.

Projected source of technology workers, 2022-2030



Source: Deloitte Access Economics (2023)

The core tech workforce challenge: 326,000 to work in critical technology by 2030

Australia doesn't just need more tech workers, we need new skills focused on critical technologies

It will be essential professionals of all shapes and sizes have the right skills to effectively harness and leverage the key emerging technologies identified in the previous chapters. Without them, the full potential of digital technologies will remain untapped. For example, the use of Large Language Models like ChatGPT has seen increasing need for researchers and knowledge workers to ask the right 'prompt' questions to leverage Gen AI's capabilities. They must also present the thinking necessary to then analysing the outputs.

Modelling for this report shows the share of new technology workers requiring skills in critical technologies will double by 2030. The ratio of job advertisements requiring the key emerging technology skills increased from 13% in 2012 to reach 32% in 2023. This growth is expected to accelerate to hit 61% by 2030.

About 215,000 additional technology workers will be required with these emerging technology skills by 2030 for a total of 326,000 workers, representing almost a quarter of the technology workforce in that year.

Please find detailed methodology and analysis of skills needed in the core technology workforce in the Appendix

Share of job advertisements requiring key emerging technology skills

Technology	2012	2022	2030
Additive manufacturing	<0.1%	<0.1%	<0.1%
Advanced data analytics	3.5%	13.3%	23.4%
Advanced robotics and sensors	0.1%	0.7%	0.4%
AI, ML & NLP	0.2%	4.0%	26.9%
Cyber security	4.2%	7.1%	8.3%
Enabling cloud technology	5.4%	14.6%	27.3%
High-performance computing	<0.1%	0.1%	0.1%
Internet of Things	<0.1%	0.9%	1.4%
Virtual worlds	0.1%	0.1%	0.6%
Any emerging technology	**13%**	**32%**	**61%**

Source: Deloitte Access Economics (2023)

Next-generation tech professionals require a mix of technical and people skills

People skills will be increasingly in demand across all roles with technical and specialised skills being needed by different groups of workers

The number and types of skills needed for the emerging technology workforce of 2030 will look vastly different to those in use today. In addition, the top 20 skills expected to be in demand by 2030 are expected to grow by 20% each year. Technical skills associated with AI and advanced data analytics are projected to dominate, with demand for data science and machine learning growing at a forecast annual rate of 37% and 36% respectively.

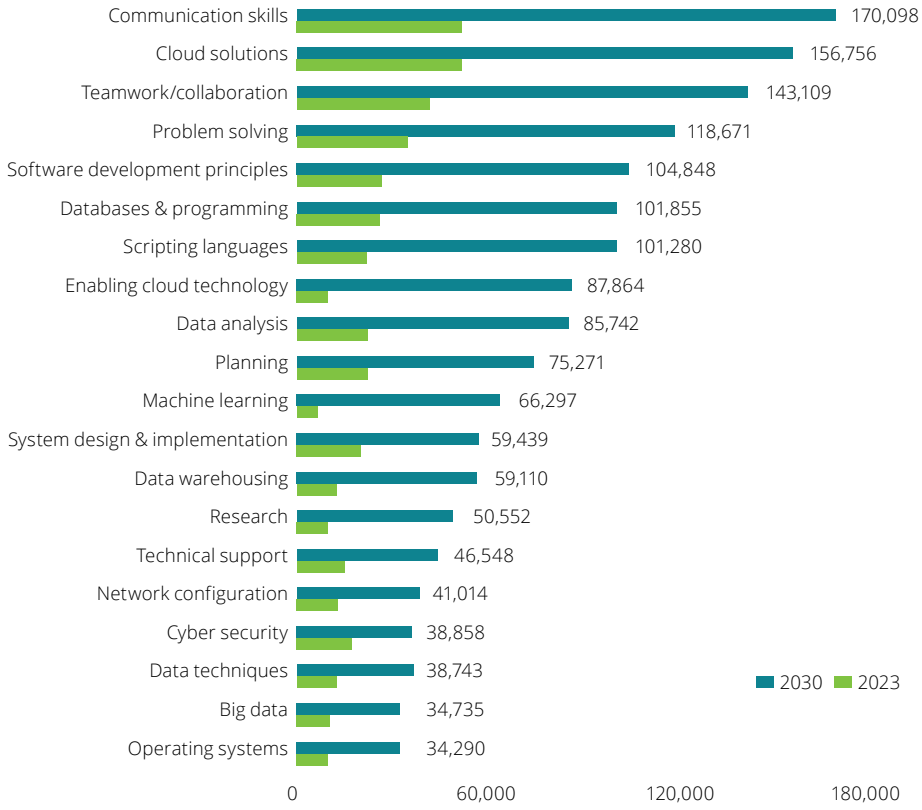
In total, skill needs for critical technology workers reach 1.8 million by 2030, representing an increase of almost 1.3 million skills compared to the current state of the workforce.

Key enabling skills in cloud solutions and software development will also become more important across workforces.

But technical aptitude is only one slice of the skills pie. Thanks to critical technologies, people skills will continue to be essential for the technology workforce, making up three of the top five most demanded skills by 2030. These skills include communications skills, teamwork and problem solving.

People skills complement and amplify the effectiveness of technical abilities. Communication skills enable technology professionals to convey complex concepts and ideas clearly, facilitating collaboration and understanding. Problem solving and critical thinking skills empower workers to navigate challenges clearly and find innovative solutions to complex problems. Technology workers with people skills can effectively lead and work in diverse teams, adapt to rapidly changing circumstances, and empathise with end-users to develop user-centric solutions.

Number of skills needed for critical technologies, 2023 and 2030



2030 skills for Artificial Intelligence, Machine Learning and Natural Language Processing

One of biggest areas of additional skill requirements will come from Artificial Intelligence (AI), Natural Language Processing (NLP), Machine Learning (ML). Annual business investment in these areas is forecast to jump from less than $5 billion in 2022 to over $27 billion by 2030. Business use of these technologies will grow from less than 1% in 2022 to almost two-thirds by 2030.

What skills will tech workers need for this enormous change?

Already, we know the essential technical skills include: Data Science Principles, Data Analytical Thinking, Programming, Scripting Languages, Machine Learning, and Software Development Principles. Workers will also need people skills such as planning, research, problem-solving, effective communication, collaboration, and teamwork.

How many extra professionals and how much more skilling will be needed?

The number of tech workers focusing on AI, ML and NPL is expected to grow from just 14,500 in 2022 to 129,000 by 2030. There will also be some 76,000 workers in AI, NPL and ML in the broader workforce by 2030. This does not include the millions of workers who could be users or AI or have jobs more generally affected by the new technology.

The total skill requirement to support just the core tech workforce is projected to grow 693% from 62,515 in 2022 to 558,192 in 2030. The gap between skills now and in the future is a staggering 495,687 technical and people skills.

The introduction of these new technologies will also give rise to new job roles, including positions such as AI Ethicist, AI personality designers, algorithm bias auditors, information validators, and AI regulatory roles.

Find our detailed skills analysis for seven other critical technologies in the appendix

Skills sets demanded for AI, NLP, and ML by 2030

- **Data science** 78,023+
- **Machine learning** 58,518+
- **Data analysis** 28,685+
- **Scripting languages** 55,075+
- **Data warehousing** 26,390 +
- **Databases & programming** 32,127+
- **Software development principles** 40,159+

129k **Skilled workers needed** (2030)

496k **Skills gap** (2030)

+793% **Growth in skilled workers** (2022–2030)

People skills

Teamwork/collaboration	39,012+
Communication skills	39,012+
Problem Solving	29,832+
Research	25,243+
Planning	17,211+

Extra skills identified

- Ethical & responsible use of AI
- Critical thinking
- Linear Algebra and Calculus
- Machine Learning
- Deep Learning

We note that of all the projections of job and skill needs, this one is most uncertain. Dramatic growth in 2023 could be a sign that the jobs need vastly exceeds the 200,000 projected here for the tech and broader workforce. It will depend significantly on how the technology evolves. If more skills are needed in the development and application of AI, the number will be higher, but if the technology develops so most people can simply use it in software or applications, the core AI development workforce will be more modest.

04

Issues with current tech skills development

Why today's approach to tech skills creation isn't working

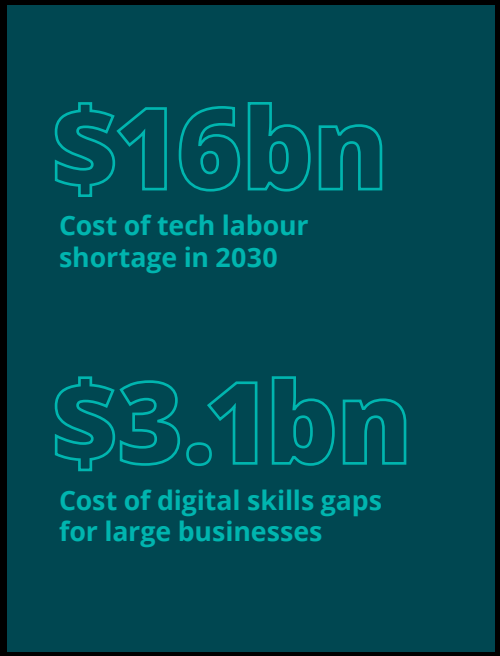
The current approach to building tech skills across the economy is not working. Deloitte Access Economics expects a labour shortage of 237,000 in the number of tech workers by 2030. The lack of technology workers with the right skills is a missed opportunity for Australian businesses and the economy. This tech labour shortage will cost the Australian economy $16 billion by 2030 (in today's dollars) in foregone economic activity. This cost includes lost wages for workers who could have been in more productive, higher paying roles and the lost returns to business owners from not having these technology workers.

More broadly, the issues in building Australia's tech skills impacts the whole economy. Consider the following:

Australia's economy is 7.8% larger, or $195 billion richer, in 2023 because of the use of digital technologies. Without such skills, we hamper growth in this important source of productivity in the future.

Over three in five Australia businesses believe their workforce lacks or has outdated digital skills, costing large businesses alone $3.1 billion per year. A Deloitte survey of employers found it would cost them $1.5 billion to upskill their current employees.[1] The total cost to Australia's economy is even higher when factoring in the lack of adequate skills in small to medium businesses, government and other sectors of the economy.

We have identified several issues with the current approach that prevents Australia developing the tech skills needed for Australian businesses and the economy. These issues include an outdated focus on roles rather than skills, inefficiencies in job matching and a fragmented ecosystem of actors. These issues and others are explored in the following pages of this report.



Source: Deloitte Gen AI survey, 2023

01 An outdated focus on roles rather than the skills

Most people in tech didn't start there and only by helping more people reskill can we address Australia's tech talent shortfall

Our educational system is geared towards producing qualified people prepared for occupations such as accountants, software developers or teachers. Yet we know the work and tasks for 11.2 million Australian workers are changing significantly in response to critical tech. A more appropriate starting point for our education system and labour market institutions is to focus on the skills required to participate in the modern economy that can be used as critical technologies become more commonplace and enable workers to transition across a number of occupations.

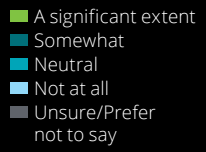
This 'skills first' approach was recommended in an OECD paper, *Skills for the Digital Transition: Assessing Recent Trends Using Big Data*.[2] The OECD believes this approach can help in identifying the areas where reskilling is needed so people can move from declining to thriving occupations. One example is from advertising sales agent to digital marketing specialist – two occupations with a 0.46 occupational similarity index.

A greater skills first approach could also address high share of tech graduates who are not job-ready. An AIIA survey found tech businesses who believed the education system produced job-ready candidates was just 3% in 2023.[3] This is supported by the 2022 QILT (Quality Indicators for learning and Teaching) Employer Satisfaction Survey found IT was ranked last for 'employability'.[2] There is dissatisfaction with the quality of IT education from the workforce as well. Only one-third (35%) of graduates said their education had significantly helped prepare them for their career.

A greater 'skills first' focus would also encourage greater continuous learning and reskilling. Most of Australia's technology workforce (70%) is actually made up of people who did not start their career in tech or have a formal IT qualification through a university or VET provider. Greater support is needed for professionals to retrain and upskill with the required and most needed skills. In previous research by Deloitte Access Economics for RMIT Online, one of the key barriers to learning new skills include work commitments (18% of surveyed employees) and cost of training courses (12%). These can prevent workers from reskilling and upskilling into growth areas including tech.[4,5]

Extent to which education prepared for future career

Source: Technology workforce survey (2023)



Field of Study	Percentage of technology workers
Information Technology	29.4%
Management & Commerce	19.5%
Engineering & related technologies	14.9%
Creative Arts	6.8%
Society & Culture	6.2%

Source: ABS Census (2022)

02 Inefficiencies in job matching

Businesses struggle to find those people with the right skills

Technology workers wait 3.5 months on average to find their first technology role. Meanwhile nearly 40% of businesses report difficulties when trying to fill a technology role. These figures demonstrate inefficiencies in the current set up of the tech labour market in Australia.[6]

Our technology workforce survey found that recruitment agencies were integral in securing a technology role, with 31% of tech workers rating them as important or extremely important. This figure increases to 51% for workers who have reskilled into a technology role from another sector. This suggests that many candidates face difficulties in finding and securing a technology role on their own and therefore turn towards intermediaries. Other factors rated important or extremely important for securing a technology role were internships and work integrated learning (25%), micro-credentials (22%) and self directed learning (21%).

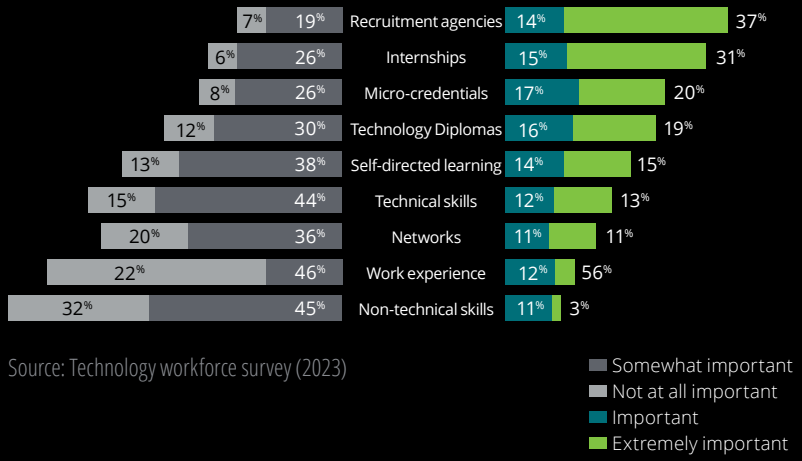
Candidates can often face barriers when seeking a role in technology. Our technology workforce survey identified that the top three barriers to getting a role in technology were insufficient valuation of skills, lack of networks, and incompatibility of available roles with skills and interests. For recent migrants to Australia, the main barriers were their lack of networks in Australia, insufficient valuation of skills, and visa restrictions.

There is also underutilisation of technology workers who are employed, particularly for migrants. Nearly 1 in 5 (18%) of migrants in the tech workforce believe their skills are underutilised in their current workplace. This is a huge problem because 45% of Australia's tech talent is born overseas.

Underutilisation means not getting the most out of workers and adding to the likelihood they leave the profession. Ways they could be better utilised include being allocated more complex tasks and providing more management opportunities.

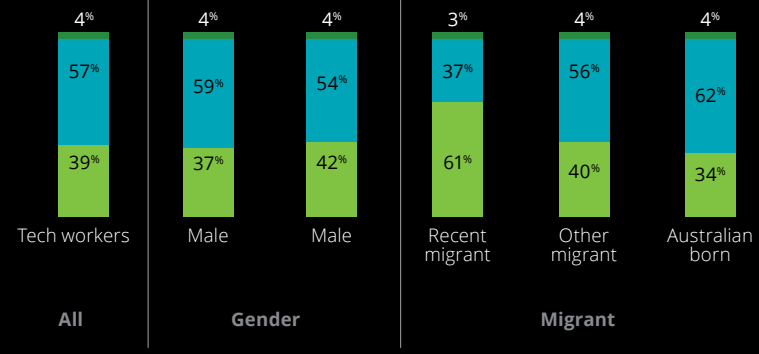
Another form of underutilisation comes when workers want to work more hours than they currently do. Our survey of tech workers found that 61% of migrant tech workers would like to work more hours, which is double the share of Australian born tech workers. The biggest barriers to working more hours being caring for children (14%), could not find full-time work (13%) and visa work restrictions (12%).

Ranking for factors important for re-skillers finding a technology role



Source: Technology workforce survey (2023)

Extent of under-utilisation in the technology sector



Source: Technology workforce survey (2023)

03 A fragmented ecosystem

There is a lack of coordination across business, government and education to scale up solutions

The issues with Australia's tech skills have not appeared overnight. While a lot of activity and policy effort is already underway, the quantum, quality and coordination has not been strong enough. Some initiatives focus on making digital skills part of a broader digital agenda, while others are part of changes to the education and training system.

In a report for the NSW Skills Board, Accenture identified 74 initiatives already in place. The creation of Jobs and Skills Australia in 2022 was recognition the country needed more evidence about changing workforce needs and policy priorities for the education and training sector.[7]

The Commonwealth's Annual Jobs and Skills Report 2023 signalled a major step towards the skilling vision outlined in this year's edition of Australia's Digital Pulse.[8] That report acknowledged that 'Australia faces a skills challenge not seen since the 1960s,' and said, 'In 2023, Australia is experiencing a tight labour market and extensive skill shortages.' In response to these challenges, the report called for a national jobs and skills roadmap and a joined-up national skills system, piecing together the importance of vocational education and training (VET), higher education, and migration.

The Productivity Commission released its second 5-year Productivity Inquiry Report entitled *Advancing Prosperity in 2023*, making 71 recommendations.[9] None of the recommendations directly attack the challenge of tech workforce. However, some would help such as use more education technology in schools, consolidating support for lifelong learning and increasing flexibility in occupational definitions and training accreditations. Most of the work is delegated to State and Territory governments, who are asked to reform VET, mostly through the newly formed Jobs and Skills Councils (JSCs).

The Future Skills Organisation (FSO) was established in 2020 as the Digital Skills Organisation to strengthen the training system and funded for 3 years. Its work culminated in a final report with 9 recommendations for: industry consultation, a digital workforce strategy, a digital careers campaign, define digital career pathways, measure workplace digital literacy, Digital Skills Standards, agile and adaptable forms of training, scale the networks of digital intelligence, and optimise training options. The DSO's work has now transitioned into the JSC for Finance, Technology and Business.

While these initiatives from various levels of government and business all have merit, it is not enough to shift the dial in terms of tech talent.

04 Changes in skill needs are accelerating

Skills needs are shifting rapidly based on innovations in critical technologies

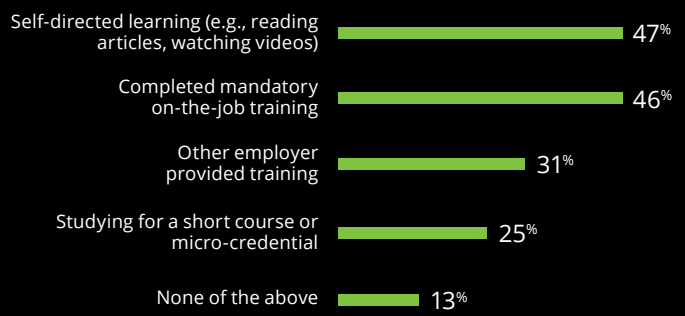
Disruptive digital technologies are reshaping tasks. They are also beginning to blur the lines between tech functions and the rest of the professional workforce. As critical technologies mature, additional, unforeseen and exciting roles will be created throughout every organisation. Every worker will be a tech worker in some way.

The disruptive nature of these critical technologies means that skill needs are shifting and changing. The shelf life of skills in tech and other business functions are diminishing as a result. IBM recently estimated the half-life of technical skills at less than 2.5 years.[10] This means that lifelong learning based on upskilling and reskilling will need to become the new normal for the Australian workforce.

Our technology workforce survey found that nearly half (47%) of technology workers look to upskill by undertaking self-directed learning through channels such as reading articles and watching video while 46% undertook some mandatory employer provided training. A quarter were also studying for a short course or micro-credential.

Yet we know the broader workforce is less likely to reskill. Latest data from the ABS suggests fewer than one quarter of Australians undertook either formal or informal study for work or career purposes in the past 12 months.[11] This shows us more needs to be done to increase the reskilling and upskilling in the Australian workforce.

Types of upskilling undertaken by current technology workers



Source: Technology workforce survey (2023)

23%

of Australians undertook formal or informal study for work purposes in the past 12 months

Source: ABS (2023)

05 Tech graduates are not seen as job-ready

Job-readiness in IT is a national issue

A wealth of evidence suggests tech graduates are not job-ready. An AIIA survey found just 3% of tech businesses believed the education system produced job-ready candidates in 2023. Nearly half of technology businesses found graduates need further training to be effective employees.[12]

There is dissatisfaction with the quality of IT education from the workforce as well. Only a third (35%) of graduates said their education had significantly helped prepare them for their career.

The 2022 QILT (Quality Indicators for learning and Teaching) Employer Satisfaction Survey found IT was the second highest ranked field of education for employer satisfaction – but last for 'employability'.[13]

QILT Employer Satisfaction Survey 2022, field of education ranking

	F	A	C	T	E	OS
Engineering & related technologies	2	9	1	3	2	1
Information & technology	3	3	10	6	11	2
Education	9	4	11	6	5	3
Agriculture & Environmental studies	1	1	3	1	1	4
Health	10	10	9	8	9	5
Society & Culture	5	5	5	4	6	6
Total	7	6	7	5	7	7
Natural & Physical Sciences	4	2	4	2	4	8
Managment & Commerce	8	8	8	10	8	9
Architecure & Building	11	11	6	11	10	10
Creative Arts	6	7	2	9	3	11

Components that feed into overall satisfaction

F — Foundation skills
General literacy, numeracy & communication skills & the ability to investigate & integrate knowledge

A— Adaptive skills – the ability to adapt & apply skills/knowledge & work independently

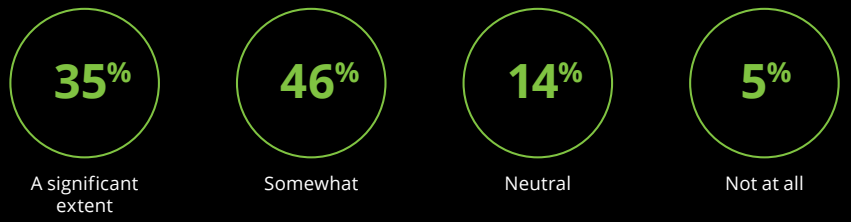
C — Collaborative skills – teamwork & interpersonal skills

T — Technical skills – application of professional & technical knowledge & standards

E — Employability skills – the ability to perform & innovate in the workplace

Source: Quality Indicators for Learning and Teaching (QILT)
Note: The table above shows rankings only for each component and overall satisfaction. Descriptions of each component are outlined above

Extent to which education prepared for future career



Source: Technology workforce survey (2023)

06 A lack of interest in tech study amongst the next generations

But younger people being exposed to learning about technology at a young age helps

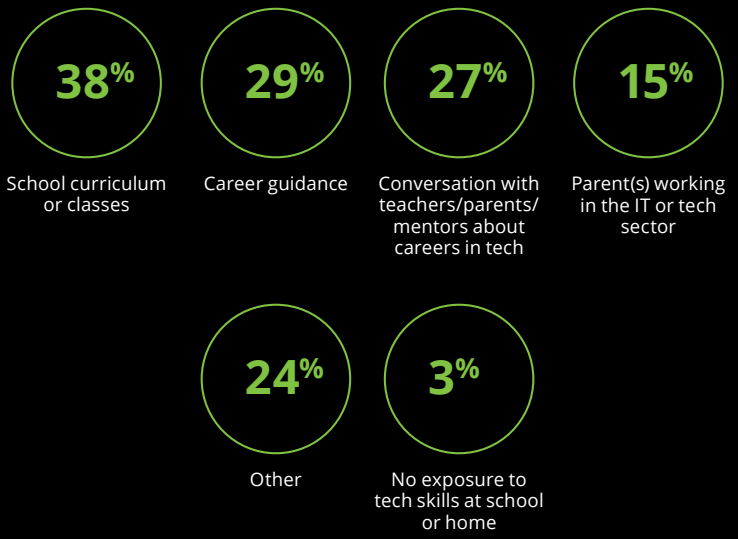
The number of domestic IT graduates increased 21% in 2021 to reach nearly 10,000 people. This increase is partly recognition of the importance of digital skills for future career opportunities. Yet this source of tech talent is still well short of the 60,000 additional tech workers Australia needs every year based on today's estimates.

The main problem is young people not being prepared or interested in tech early in life. Lack of exposure to technology may be a factor limiting the number of young people studying IT or considering a career in tech. Research suggests guidance from career counsellors can be particularly important. Those currently working in the technology sector were twice as likely to have received formal career guidance than those who have left the technology sector (29% and 12% respectively).

The STEM Equity Monitor found only 10% of students indicated an interest in a future career in Computing or IT. Boys were four times more likely to report an interest in Computing/IT as a career (16% vs 4% for girls).[14] The STEM Equity Monitor also showed there was limited recognition among secondary school teachers about the importance of technology skills, with only half (56%) considering such skills to be important for students' future job opportunities.

There is also difficulty for educators to make sure they have the right skills and knowledge to inform future generations of technology workers. Only 29% of educators felt they had a high ability to explain what different STEM careers involved.

Exposure to technology content or tech industry while growing up



Source: Technology workforce survey (2023)

IT University degree completions by qualification level and citizenship category, 2001 to 2021

Source: Department of Education, Skills and Employment (2023)

A workforce perspective

"Nearly the entire Australian workforce will be impacted by coming waves of technology innovation and disruption. Some people and particular generations will be much more used to jumping in and trying new tech when compared to others. To help the transition we need our education systems and workplaces to empower people to try new technologies, learn new skills and share their ideas about how these powerful technologies can be used."

Pip Dexter
Chief People and Purpose Officer, Deloitte Australia

Addressing the issues will progress multiple objectives

There is a strong need to address problems with current approaches to developing tech skills. We reiterate: the lack of the right tech skills is a missed opportunity for Australian businesses and the economy.

Beyond economic outcomes, not addressing the problems with the current approach will also hinder the ability to achieve broader aspirations and objectives for the workforce. This includes making the technology workforce more inclusive and diverse. When compared to professional services more broadly, the tech workforce is more diverse in terms of cultural and linguistic diversity, sexual orientation and neurodiversity but has lower levels of diversity when considering sex, age and location of workers.

The tech workforce performs particularly poorly when it comes to the share of women professionals. The 276,000 women in the tech workforce made up only 29% of the overall tech workforce in 2022. This share declined for the first time in nine editions of tracking this important metric. Already, the tech sector is behind other industries as women make up 44% of people employed in professional industries, and 47% of the total workforce.[16]

The economic and social benefits associated with addressing the issues in the tech labour market are summarised in the adjacent figure.

A professional association perspective

"Science, technology and innovation have always been the driving force of human progress. At the same time, there are risks and sometimes misuse, which is complicated by the speed of change we are currently experiencing.

The critical factor to making sure we get the right outcomes is to enable society to trust in the promise of technologies. We need to make sure we have trust in tech and the people using the tech to thrive in this fast paced environment."

Chris Vein
Chief Executive Officer,
Australian Computer Society

05

A new approach to building the skills Australia needs

Building a holistic approach that addresses Australia's growing skills challenge

Australia is not on track to develop the technology skills we need to meet the demands of businesses, let alone match global technology leaders. Currently, efforts are fragmented or operate in isolation. Job and Skills Australia and other government and industry associations have made reasonable suggestions to address these challenges. Yet accountability is lacking and our fragmented system continues on without significant change.

As the organisation representing technology professionals, ACS has a key coordination role. But it cannot solve Australia's tech skills challenges alone.

It will require concerted and coordinated effort for businesses, industry, government, unions and education providers working as a coalition if we are to see systemic change and get close to filling these tech skills gaps.

Solutions will not come from mandates issued by these organisations. Leveraging a market systems approach to skills development as advocated by the International Labour Organisation will be key. A market is crucial to enable the flexibility and responsiveness required in the face of rapid technology changes and will help scale up successful models or solutions from different actors.

To develop this new approach to building tech skills, this year's *Australia's Digital Pulse* outlines five key principles needed to guide individual policies and initiatives.

Using these as our foundation, we've then outlined 7 policy recommendations we believe will help a coordinated technology ecosystem bring a systemic approach to tech skills development to life. While several policies align with multiple principles listed here, they all illustrate how solutions should and can bring about transformative change.

01
All hands on deck

The transformation outlined in this edition of *Australia's Digital Pulse* is not a tech jobs issue, it's a skills issue that will impact Australia's economic prosperity. We need all actors across private and public sectors to play a role.

02
Skills first

We have designed our education system to focus on producing people ready for certain roles with limited reskilling or upskilling, resulting in high numbers of workers with outdated skills. Instead, we need to first and foremost identify and build in-demand skills based on the critical technologies shaping businesses and industries.

03
Driving diversity

We need people with the right skills. Excluding or not fully utilising the existing talent in our workforce is not only wrong in principle but imposes significant costs on the Australian economy. Without proactive steps taken to recruit more women into the tech sphere, we also miss the opportunity to narrow the skills gap to 2030.

04
Lifecycle of learning

The half-life of our skills is quickly shrinking. While we have analysed skill needs out to 2030, we know these will change in unforeseeable ways. Building a culture of continual skills development is the only solution to make sure we have the right skills in the workforce.

05
Systems approach

Too often we are working on solving the same problem in silos. Combining our efforts and thinking holistically about our networks, organisations and institutions is necessary to maximise the impact of our initiatives.

01 All hands on deck

The transformation outlined in this edition of *Australia's Digital Pulse* is not a tech issue, it's a workforce issue that will impact three quarters of working hours. We need all actors across private and public sectors to play a role.

Currently, efforts are fragmented or sit in isolation and no one is accountable. Jobs and Skills Australia, the FSO and other government and industry associations have made reasonable suggestions to address the challenges facing Australia's tech skills pool. Yet the system continues on without significant change.

The Productivity Commission released its second 5-year Productivity Inquiry Report entitled *Advancing Prosperity* at the start of 2023. More recently, the FSO has identified 7 recommendations. These documents sit alongside reports and recommendations by state and territory departments and other industry association like the Tech Council of Australia.

Yet many of these recommendations are not implemented and there is no clear tracking of progress despite common goals. An all hands on deck approach is needed to avoid duplication of effort and focusing resources on key priorities.

One important application of the all hands on deck principle would be development of a National Digital Skills strategy with clear objectives and a plan to track progress. The strategy should collate and prioritise initiatives that build Australia's tech skills. The strategy should be co-developed and endorsed by a coalition of relevant stakeholders, thereby providing greater pressure to implement the required recommendations.

The National Digital Skills strategy should be supported by consistent underlying state or territory digital skills strategies with their own objectives and targets that develop best-practice initiatives. This is an important feature as state and territory public sectors are big employers and have a significant role in education delivery at school and VET levels. State and territory strategies could focus on specific needs per state, such as manufacturing and defence in South Australia and professional and financial services in NSW.

All hands on deck is about providing a coordinated, systemic approach to addressing Australia's tech skills challenges and distributing responsibility for owning or implementing any initiatives across all stakeholders. There should be change across the whole ecosystem of actors including government, industry and professional associations, education providers, tech employers and unions.

Recommendation

A national digital skills strategy to address skills challenge and track progress

The problem

Currently, efforts to address Australia's tech skills challenge are fragmented and no one entity is accountable. The FSO and other government and industry associations have made reasonable suggestions to address the challenges inhibiting Australia's tech capability and skills progression. Yet these are disconnected and the system continues on without significant change.

The Productivity Commission released its second 5-year Productivity Inquiry Report, *Advancing Prosperity,* at the start of 2023, making 79 recommendations to unlock the benefits of digital technologies. Of these, 16 relate to education and reskilling, and 12 to improving the migration system. No real progress has been made on implementing these initiatives. More recently, the FSO has identified 7 recommendations.

These documents sit alongside reports and recommendations by state and territory departments as well as other industry associations like the Tech Council of Australia. Yet many of these recommendations are not implemented and there is no clear tracking of progress despite common goals.

The solution

A National Digital Skills strategy should be developed with clear objectives and a plan to track progress. The strategy should collate and prioritise recommendations, including other recommendations in this report, aimed at solving Australia's skills challenge. The strategy should also consider any successful initiatives being trialled that should be scaled up for greater impact. The strategy should emphasise a 'digital-first' approach to other government policy areas as well.

The remit should be digital skills across the workforce, not just specific occupations or degrees. The strategy should be co-developed and endorsed by a coalition of relevant stakeholders to encourage implementation of required recommendations. Involvement from a wide range of stakeholders will help ensure progress is made in a timely and efficient manner.

An evaluation strategy should be developed tracking the implementation and impact of these different initiatives. The National Digital Skills strategy should be supported by consistent and underlying state and territory digital skills strategies with their own objectives and targets encouraging best-practice initiatives and development.

The impact

The National Digital Skills strategy and underlying state and territory strategies will aim to provide a coordinated, systemic approach to addressing Australia's tech skills challenges. Key is identifying priorities so decision makers can ensure focus is placed on recommendations with the greatest impact. Strategies will also distribute responsibility for owning or implementing recommendations across all stakeholders. The result is change across the whole ecosystem of actors responsible for tech skills evolution.

Development of these strategies will involve program administration and change management costs. Some of this will be borne by various levels of government and involved stakeholders. But there is a requirement for resources from other stakeholder bodies. The cost of setting up such strategies is expected to be modest and a core responsibility of governments. Tracking progress over time and collecting necessary data may require additional resources. It's likely actions and initiatives derived from these strategies as well as those recommended in our report will incur further costs.

These strategies provide a platform for implementing systemic changes that can make real impact towards addressing skills gaps. Without initiatives being implemented effectively, there will be no better skills outcomes or economic benefits supercharging Australia's prosperity.

02 Skills first

Few problems in Australia's labour market are more significant than the inadequacy of digital skills: 3 in 5 organisations believe their workforces have outdated digital skills. This issue has many causes. But chief among them is that our education system and employers focus on an outdated notion of roles rather than skills needed.

Our education system is geared towards producing qualified people prepared for occupations such as Accountants, Software Developers or Teachers. A more appropriate starting point for our education system and labour market institutions is to focus on skills required to participate in the modern economy that can evolve as critical technologies become more common place, enabling workers to transition across a number of occupations. This approach was recommended in an OECD paper, *Skills for the Digital Transition: Assessing Recent Trends Using Big Data*.

Skills should be at the forefront of education and training reform in Australia. The Australian Government in collaboration with other actors should build a skills framework designed for future skills needs that have been identified in this report. Schools, universities and education providers should assess their content and courses for the skills developed by students and candidates. Higher education providers should be encouraged to publish them so students can make better choices about what to study, based on jobs skills they will develop, not just occupational knowledge they will learn.

The Future Skills Organisation and Jobs and Skills Council along with ACS and other industry associations should play a role in assessing tech and other courses for their currency. The Australian Government should consider ways to extend financial support arrangements for education from accredited programs to include micro-credentials to help with workforce reskilling as recommended by the *Australian Universities Accord Interim Report*.

By implementing these recommendations and adopting a skills-first approach, Australia's workers will be more job ready and have the contemporary skills needed for the rapidly evolving workplace.

Recommendation

Skills first framework to address the $3.1 billion a year deficit

The problem

The inadequacies of Australia's labour market when it comes to digital capability are significant: 3 in 5 organisations already believe skillsets across their workforces are outdated.

It is a problem with many causes. A chief one, however, is Australia's education system is simply not set up to build digital skills. Computer courses and digital skills have been added to school curriculum and tertiary education providers over time. It's a situation that sees Australian tech graduates ranked low on employability scores. Nor are most Australian tech degrees considered world leading, according to QS. Vocational education and training (VET) providers, industry and business run their own ad hoc training programs. The Australian Government's financial support for students does not even extend to those seeking upskilling through micro-credentials, except for one recently announced pilot.

The other problem is degrees and other accredited courses and workplace training materials orient around tech occupations. Rapid technology change renders these structures obsolete. Instead, the OECD advocates for a 'skills-first' approach to help identify areas where reskilling is needed most. The *Australian Universities Accord Interim Report* and the *Australian Qualifications Framework Review* released this year recognise these fundamental issues.

The solution

Skills should be at the forefront of education and training reform in Australia. Government, in collaboration with other actors, should build a skills framework designed for future skills of the workforce. This will require collaboration to identify specific skills needed.

Schools, universities and education providers should assess their content and courses for the skills developed by students and candidates and publish them with course information for students to make better choices about what to study. Relevant government agencies along with industry associations should play a role in assessing tech and other courses for their currency. The Australian Government should consider ways to extend financial support arrangements for education from accredited programs to include micro-credentials as recommended by the *Australian Universities Accord Interim Report*.

Implementation of this recommendation will need complementary consideration of different regulatory and governance frameworks around schools, university and VET providers.

There should be promotion of successful and best-practice skills education across the entire ecosystem.

The impact

By introducing a 'skills-first' approach, the incoming generation of students will be more ready to adapt to the needs of a changing work environment. This will help businesses gain the capabilities necessary to increasing their adoption of critical technologies.

The largest financial outlay associated with this recommendation is upfront cost for education providers to develop new course materials and be able to assess the ability of students to demonstrate these skills.

Implementation of this recommendation should benefit many Australian workers, including those graduating with IT degrees. By placing a greater emphasis on broader underlying skills rather than content specific structures, there should be an increase in job readiness across tech graduates. Currently, nearly 14% or 1,400 tech graduates don't end up working in their field or don't get a job at all after completing their degrees. Ensuring these people get a role significantly increases tech talent and will lead to approximately $150 million in increased salaries for these workers.

There is also significant benefit for the broader Australian workforce through an uplift in the quality of digital skills over time, reducing the $3.1 billion this skills deficit costs large businesses right now.

03 Driving diversity

Increasing diversity across Australia's tech talent pool is not only the right thing to do, it's an economic imperative. People holding tech roles receive a significant wage premium of approximately $11,000 per year. Other Deloitte Access Economics research suggests there is a wage premium associated with digital skills more generally as well.

Yet barriers remain preventing certain segments of the population from entering the tech workforce or acquiring and using tech skills effectively.

When compared to professional services more broadly, the tech profession is more diverse in terms of cultural and linguistic diversity, sexual orientation and neurodiversity. Yet it has lower levels of diversity when considering sex, age and location of workers.

The tech workforce performs particularly poorly when it comes to the proportion of women engaged in employment. There are 276,000 women in tech jobs, making up 29% of the overall tech workforce in 2022. This share declined for the first time in nine editions of tracking this important metric. This is alarming given the tech sector is already behind other industries when it comes to representation of women.

For example, women make up 44% of people employed in professional industries and 47% of Australia's total workforce. Setting a clear target for greater representation of women in the tech sector, implementing initiatives to support their achievements and monitoring progress will be critical if we're to realise progress around gender diversity in technology.

Lifting the share of women in tech by 1 percentage point per year until 2030 is an important stretch goal for the sector. This would involve bringing half a million women into technology roles by the end of the decade.

A second aspect of diversity is Australia's migrant population. Migrants make up nearly half the nation's tech workforce. Yet soon to be released research by the Australian Computer Society found that 39% of migrants took longer than 12 months to find their first job in tech. Our survey also found nearly 1 in 5 (18%) believe their skills and experience are not fully utilised in their current jobs. With 48,000 tech migrants expected to arrive Australia between now and 2030, such underutilisation has hefty economic consequences if not addressed.

One way to improve outcomes for migrants and ensure they reach their full potential is by having better support mechanisms in place once migrants begin work in Australia. Provision of workshops, training and networking events by businesses and tech employers can help migrants gain local networks and exposure to the broader labour market.

There are many different demographics experiencing unique barriers that prevent them building and utilising tech skills. Improving how we utilise migrant skills more effectively is just one example of a tailored solution that improves equity in Australia's digital future.

Recommendation

500K women in tech by 2030 to narrow the skills gap

The problem

Despite efforts to promote inclusivity and equal opportunities, women continue to be under-represented in technology. Currently, only 29% of the technology workforce in Australia are women.

Numerous factors contribute to this disparity, starting from early education and societal norms that discourage girls from pursuing STEM subjects. The existing gender gap exacerbates the issue, as it creates a cycle of male-dominated environments that may be unwelcoming to women, further dissuading them from pursuing tech careers.

Such lack of gender diversity in technology not only hinders the professional growth of women, it has significant implications on Australia's innovation and product development pipelines. Gender imbalance perpetuates harmful stereotypes and biases in technology, as certain products may perpetuate gender discrimination or reinforce gender norms.

As reported in the 2022 edition of *Australia's Digital Pulse*, women in technology are 20% more likely to experience discrimination in the workplace than men. The report further stated those to have experienced discrimination were twice as likely to expect leaving their occupation within two years compared to those who had not.

The solution

Setting a clear target to achieve greater representation of women in tech and monitoring progress will be important to realising gender diversity advancement.

Lifting the number of women in technology by just 1 percentage point by the end of the decade is a milestone that's achievable and necessary.

Realising this goal will require a number of supporting interventions. Firstly, businesses will need to sign up to have a return to work policy for women in tech, and support an inclusive culture. Secondly, an explicit focus on women across other initiatives proposed in *Australia's Digital Pulse* would help, including the Career Transition Scheme, the tech skills platform and migrant support mechanisms.

Reaching this ambition of more women in tech could be coordinated by an organisation with an interest in promoting gender diversity in the technology workforce. Industry bodies and large technology employers should endorse the target of 500,000 women in tech and seek government support for this initiative. The coordinator will then work with tech employers to verify return to work policies as well as their other diversity and inclusion initiatives.

The impact

Increasing the share of women in technology can pay significant dividends. According to the 2021 edition of *Australia's Digital Pulse*, increasing gender diversity across the technology workforce would create almost 5,000 full-time equivalent jobs on average and grow Australia's economy by $1.8 billion every year on average over the next 20 years.

Gender diversity in technology helps break down stereotypes and encourages more young women to pursue careers in technology, bridging the gender gap and creating a longer-term pipeline of talent for the future.

Improving the share of women in tech is likely to raise average productivity and salaries. Supporting tech employers can enjoy reputational benefits by demonstrating their workplaces as inclusive places to work.

Improving diversity in the tech workforce could be a significant way to address the expected labour shortage and skills gap in the technology workforce. This will help avoid the $16 billion cost to the economy of not meeting growing tech skills demand to 2030.

The key costs associating with the program include promoting and tracking progress against the targets set, stakeholder engagement and media, and business costs in implementing measures to meet targets.

Recommendation

Better utilising 48,000 migrants into the tech workforce by 2030, generating $186 million in value

The problem

Skilled migrants account for about 45% of the technology workforce. Yet soon to be released research by the Australian Computer Society found that 39% of migrants took longer than 12 months to find their first job in tech. The ACS research suggests that almost of 90% of migrants currently work in tech, however this suggests a non-insignificant share are not working in tech or not working. In addition, our survey also found nearly 1 in 5 (18%) migrant technology workers believe their skills and experiences are not fully utilised in their current jobs.* This is supported by ABS data that showed about a quarter of surveyed migrants experienced difficulty finding their current job. Key challenges identified in the ABS survey included a lack of Australian work experience/ references, lack of local contacts and networks, and language difficulties.

Underutilising migrants within the technology workforce is costing the economy. Businesses are left looking to fill skills, while migrants themselves are unable to work in the jobs that realise their full potential.

Previous Deloitte research on migrant skills underutilisation in Queensland found 49 in every 100 migrants and refugees with overseas skills and qualifications do not use their highest skills or qualifications, or are unemployed. This eventuates even when migrants have their skills officially recognised.

The solution

Ensuring migrants are supported once they begin work in Australia is an important way of helping them reach their full potential. Provision of workshops, training and networking events by businesses and tech employers can help migrants gain local networks and exposure to the broader labour market. The ACS Professional Year program, aimed at developing job-readiness for recent full-time study graduates through internships, offers on example of what these types of programs could look like.

Ongoing skills development for migrants once they are working is also crucial to ensure these professionals are well-equipped to meet Australian business needs. This goes beyond just technical skills – there is an important need to help migrants build the people skills increasingly required for tech roles now as well as those evolving to 2030. These may differ significantly in Australia compared to other countries.

To start implementing a people skills program targeted to migrants, the list of people skills based on existing analysis by government industry associations should be consolidated and updated with business needs. Business, industry and government should then develop a validation process and if required, supplementary training material. Businesses would be responsible for sponsoring their workers to attend, and participate where relevant (i.e. in networking events).

The impact

Providing targeted training and development opportunities to migrants will increase both the quality and number of migrants in the technology workforce. Research shows that skilled migrants have a net benefit to the Australian economy over time and addressing any underutilisation will mean the benefits will be realised earlier and potentially to a greater amount.

A focus on developing and validating people skills will have economic benefits for both workers and businesses. Deloitte research for DeakinCo found the average Australian business could increase revenue by over $90,000 by improving the quality of people skills among its staff. A follow up report exploring worker benefits found a 10% increase in human skills (i.e. people skills) leading to a 5% increase in wages.

Better utilised migrants is another benefit. CEDA research on migrant underutilisation estimates $1.25 billion was lost to the Australian economy between 2013 to 2018 in terms of foregone wages. Previous Deloitte research has shown that for Queensland alone, the total cost of skill underutilisation was over $21.9 million per annum.

If incoming technology migrants out to 2030 experienced underutilisation at the same rate as surveyed migrants, this means 48,000 migrants could be better utilised through the acquisition of more people skills over the next 7 years. This equate to approximately $186 million over the period.

*ACS longitudinal research on the experiences of migrants undertaking a Migration Skills Assessment or Professional Year with the ACS is set to be released later in 2023.

04 Lifecycle of learning

Growing demand and ever-changing requirements for tech skills requires early exposure to tech skills development. It also means upskilling and reskilling need to become regular features of participating in the Australian workforce.

Yet fewer than one quarter of Australians undertook formal or informal study for work or career purposes in the past 12 months, suggesting more needs to be done to increase the reskilling and upskilling undertaken throughout a person's career.

Previous research by Deloitte Access Economics for RMIT Online identified two key barriers to learning new skills across surveyed employees: work commitments (18%) and cost of training courses (12%). The government already provides some support for students in higher education. In addition to FEE-HELP loans to pay all or part of students' tuition fees, Austudy provides a means-tested $280 per week for those aged over 25 years or older.

However, these payments fall short for employed professionals looking to reskill, with the weekly minimum wage in Australia being $812.60. Greater support is needed for professionals to provide them with appropriate payments that enable them to retrain, above and beyond existing payments. This aligns with the Productivity Commission's recommendation to consolidate support for lifelong learning.

One solution is the Australian Government introducing a Career Transition Scheme involving a stipend tied to further tech study. The Career Transition Scheme should target Australian residents aged over 30 years old and offer participants a payment at the rate of the minimum wage or half average annual earnings (i.e. worth around $23,000), rather than rely on other allowances provided during study. The scheme would commence with a trial of 1,000 participants for the first year with 5,000 participants for subsequent years. If the scheme was run over a decade, the present value benefits of 46,000 participants would be over $3 billion through higher wages and business productivity.

More also needs to be done at a school level to promote greater interest in tech skills. To increase awareness, a National Technology Career Mentoring Program should be instituted for secondary school students in Years K-12. The Program would pair schools with an early career technology professional to inform students about technology careers and career pathways.

These benefit demonstrate the significant returns available by promoting Australian workers to embrace a lifecycle of learning around tech skills.

Recommendation

Adding 46,000 upskilled professionals, delivering $3 billion to the economy by 2030

The problem

Growing demand for technology skills makes it critical Australia effectively facilitates people transitioning into tech careers. This is even more crucial as the evolving skills mix required for emerging technologies by 2030 takes shape.

The Productivity Commission's 5-year Productivity Inquiry outlines job mobility as a key contributor to productivity, allowing resources to flow to more productive firms in a competitive labour market. However, there has been a decline in job mobility amongst Australians over the past three decades.

Other significant barriers to reskilling exist too. Previous research by Deloitte Access Economics found key barriers to learning new skills include work commitments (18% of surveyed employees) and the cost of training courses (12%).

The government already provides some support for students in higher education. In addition to FEE-HELP loans to pay all or of part of students' tuition fees, Austudy provides a means-tested $280 per week for those aged over 25 years. However, these payments fall short for employed professionals looking to reskill, with the weekly minimum wage in Australia being $812.60. Greater support is needed for professionals to provide them with appropriate payments that encourage them to retrain.

The solution

To address cost barriers to retraining, the Australian Government should introduce a Career Transition Scheme, involving a stipend tied to further tech study. The Scheme should target Australian residents aged over 30 years old who are seeking to reskill in technology. For six months, the scheme would offer participants a payment at the rate of the minimum wage or half average annual earnings (i.e. worth around $23,000), rather than relying on other allowances provided during study.

The Scheme would commence with a trial of 1,000 participants for the first year. The Scheme will be evaluated during the trial period to assess effectiveness. Based on pilot results, the Scheme could be expanded and scaled accordingly. It could be targeted at 5,000 participants per year, for example.

Although this Scheme is initially proposed for retraining individuals in technology skills given the fast pace of technological change, a similar scheme could apply to any in-demand occupation experiencing skills gaps. Accredited courses from universities, VETs and accredited raining providers would be eligible to participate in the Scheme. Implementing the Scheme would require relevant Federal Government agencies working with education providers.

The impact

While this Scheme is not designed to meet the full demand for tech skills, it will make a solid contribution towards achieving necessary skills and encourage more people to enter tech careers. Over a 10-year period with a target of 5,000 participants a year and an initial 1,000-person first-year trial, the Scheme will enable an additional 46,000 individuals to skill up.

Increasing job mobility increases productivity by allowing workers to take advantage of better paying jobs. In fact, technology workers earn a wage premium of $11,336 per annum on average in 2022 compared to workers in the professional services sector. If the Scheme was run over a decade, the present value benefits of 46,000 participants would be over $3 billion through higher wages and business productivity. Additional personal income and company tax collections over a decade would be around the same as the government outlays on the Scheme.

These outlays include administration of the Scheme and costs for providing additional payments to participants compared to previous allowances, such as Austudy. Over a decade, the program would be expected to cost approximately $700 million.

Recommendation

Tech career mentoring in schools to tackle skills availability over the long term

The problem

A lack of awareness of technology careers amongst secondary school students leads to fewer students pursuing tertiary education or a career in tech. The STEM Equity Monitor found only 10% of students indicated an interest in a future career in Computing or IT. Boys were four times more likely to report an interest in Computing or IT as a career (16% vs 4% for girls).

The 2020-21 *STEM Influencer Report* also found career advisors were more likely to recommend IT to boys than girls. In addition, there was limited recognition among secondary school teachers about the importance of technology skills, with only half (56%) considering such skills as important for students' future job opportunities. Furthermore, only 29% of educators felt they had a high ability to explain what different STEM careers involved.

Early mentoring and career guidance can influence students throughout their careers. A Deloitte survey of technology workers found those still working in technology were twice as likely to have received formal career guidance than those who have left the technology sector (29% compared to 12% respectively).

The solution

To increase awareness and interest in pursuing technology as a career, a National Technology Career Mentoring Program should be instituted for students in Years K-12. This would pair schools with an early career technology professional to inform students about technology careers and career pathways. The mentors should provide students three presentations a year, with the first two presentations designed to be for entire year groups. Subsequent smaller group mentoring sessions could be delivered to students who express interest in finding out more. The scope of mentoring should evolve as the students move through the school years. Participation of mentors who identify as women or culturally diverse is important to positively influence under-represented cohorts.

There should also be another workshop directed towards teachers to provide an industry view around the importance of digital skills and effective teaching methods based on experiences of the mentors.

Successful implementation of the Program will require coordination between schools, employers, government and industry bodies. There are 9,614 schools in Australia. The mentoring program could initially commence as a pilot program in 20 government schools in each state and territory and could be expanded to a further 50 schools per year.

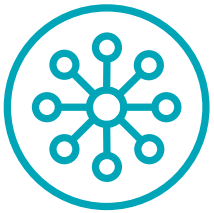
The impact

The National Technology Career Mentoring Program is aimed at increasing the awareness of technology careers amongst school students. As it is aimed towards school students, the workforce impacts will have a long lead time. Yet when fully implemented, this could be a powerful lever in influencing career and education decisions. By involving female mentors, the Program will make technology a more accessible career choice for girls.

Mentors and participating businesses will incur costs as they will be diverting their time from work towards the Program. It is estimated the cost to business would be $1,347 per mentor annually based on average tech graduate salaries.

There will likely be a long-term increase in the number of students studying technology at university, providing a pipeline to increase the technology workforce and skills in Australia.

Mentors participating in the program will develop leadership and mentoring skills that will also be beneficial for their employers and likely increase job satisfaction and fulfilment. Participating businesses can enjoy reputational benefits through facilitating the professional development of school students.



05 Systems approach

The issues with Australia's tech skills have not appeared overnight. While a lot of activity and policy effort is already underway, quantum, quality and level of coordination has not been strong enough. Some initiatives focus on making digital skills part of a broader digital agenda, while others are part of changes to the education and training system.

While these initiatives from various levels of government and business all have merit, it is not enough to shift the dial in terms of developing connective tissue across the Australian labour market or broader tech institutions.

For example, technology workers wait 3.5 months on average to find their first technology role. Meanwhile, nearly 40% of businesses report difficulties when trying to fill a technology role. These figures demonstrate inefficiencies in the current set up of the tech labour market in Australia.

To overcome friction in the labour market, there is an opportunity to develop a national skills platform to better connect current and prospective technology professionals with employment opportunities to meet their education and career development needs.

The platform would require both professionals and businesses to develop a profile outlining the skills and capabilities they possess or require. The platform will then match individuals and businesses to the most appropriate opportunities and facilitate engagement. The platform could also be used to encourage people to undertake reskilling by providing example educational pathways required to develop skills required for particular positions advertised on the platform.

Technology workers earned a wage premium of $11,336 per annum on average in 2022 compared to workers in the professional services sector, according to ABS data. By encouraging prospective tech professionals to reskill, these workers can take advantage of this wage premium.

In fact, if the skills platform could attract 60,000 professional workers looking to reskill in technology, the economic benefit would amount to $680 million per annum.

Recommendation

Skills platform creating a ‘no wrong door’ marketplace for 60,000 professionals worth $680 million per annum

The problem

Although there are people with in-demand skills, they may face difficulties finding the right opportunities with employers requiring these skills. According to the ABS, 16% of businesses reported insufficient staff skills and capability which limited or prevented them from using key technologies.

Our survey suggests tech-qualified people take an average of 3.5 months to find their first tech role. We also found 60% of people who have an IT qualification are not currently working in tech and would considering coming back to the sector if access to tech jobs was more accessible.

The 2022 *Australia’s Digital Pulse* also found 9% of professional services workers reported definitively wanting to move into a technology role. Based on overall employment in the professional services sector, this equates to nearly 120,000 workers who could help meet the demand for tech skills if they were adequately reskilled.

Despite many initiatives by governments and education providers, there is a clear lack of connective tissue between the needs of current and prospective technology professionals and the needs of industry. A central source of truth is needed to help overcome these inefficiencies in the tech labour market.

The solution

To overcome frictions in the labour market, there is an opportunity to develop a national skills platform to better connect current and prospective technology professionals with employment opportunities or to meet their education and career development needs.

The platform would require both professionals and businesses to develop a profile outlining the skills and capabilities they possess or require. The platform will match individuals and businesses to the most appropriate opportunities. The platform could also be used to encourage people to undertake reskilling by providing example educational pathways to develop the skills required for particular positions advertised on the platform.

Development of the platform would require key partnerships with major employers across a variety of industries that benefit from in-demand technology skills; for example, financial and insurance services, government and professional services. Once the platform has been developed, it will require an initial phase that encourages and targets adoption from employers and education providers. A critical mass of users is key to realising the benefits of an established market facilitation.

The impact

The platform will assist in better matching tech skills capabilities with demand from businesses. By enabling individuals with a variety of skills to use the platform, the platform will promote the idea of a ‘no wrong door’ into the tech workforce. This alignment between existing tech skills and business demand for skills will also lead to more effective use of skills across the tech labour market. In addition, the platform will provide an entry point for prospective tech professionals to explore tech-related education and employment.

The main costs of the platform would be its development and ongoing operation.

Technology workers earned a wage premium of $11,336 per annum on average in 2022 compared to workers in the professional services sector, according to ABS data. By encouraging prospective tech professionals to reskill, these workers can take advantage of this wage premium.

In fact, if the skills platform could attract 60,000 professional workers looking to reskill into tech realised this benefit, it would amount to a $680 million benefit per annum. With 10,000 IT graduates entering the workforce each year, reducing the time it takes to find the right job could also deliver substantial benefits.

Conclusion: It's time to act now

This edition of *Australia's Digital Pulse* demonstrates digital disruption from critical technologies is not a future prospect; it's already happening. Australia is set to spend $261bn in the next 7 years on these emerging innovations – and even that's below par when it comes to what other nations are spending. What's more, disruption will accelerate as uptake of critical technologies gathers even more pace. The collision of such tech with human enterprise is set to be profound.

2023 will be remembered as the year when Generative AI exploded onto the scene. Through its meteoric and largely grassroots adoption, we've seen how individuals and organisations can rapidly learn to apply new technology when they want to, recognise value in its application and most importantly, have access to such tools on their own terms. The phrase "democratisation of AI" is regularly used to describe the impact of Generative AI and it's an apt one. Rightly or wrongly, it's easier to start prompting ChatGPT than it is to use many smartphones or smartwatches.

The consequence is consumers and line-of-business workers along with people across the tech spectrum from infrastructure and security specialists, software engineers and data scientists increasingly working together to learn together.

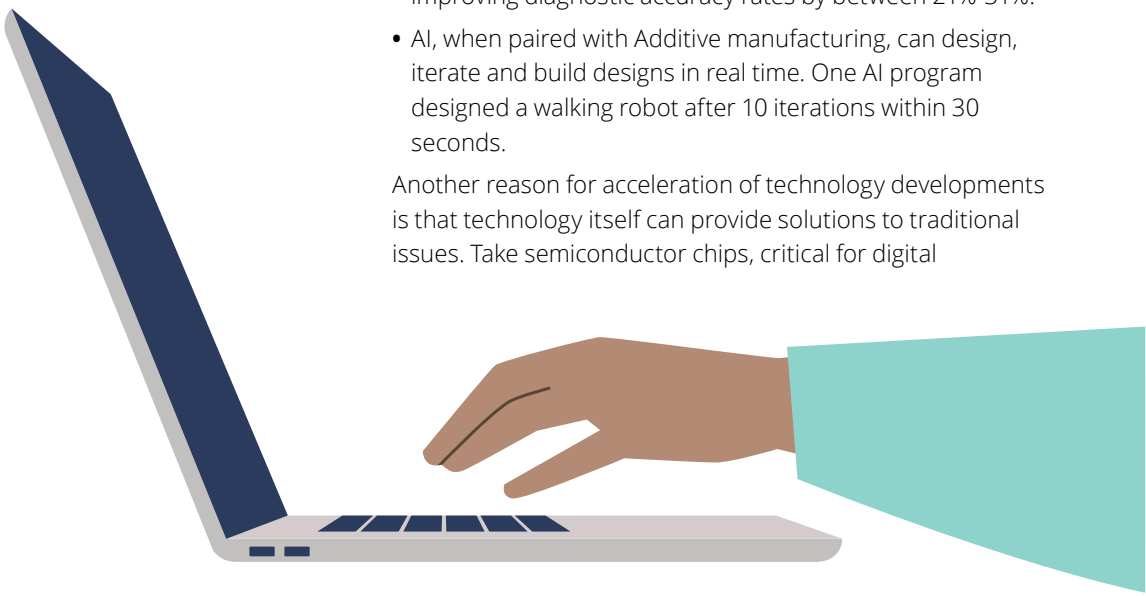
There are no Generative AI university graduates as the courses don't yet exist. But that hasn't stopped open source communities forming platforms and language integration frameworks such as Langchain and Hugging Face. Their evolution is outpacing anything that could be developed through a traditional education model. In addition, major technology players such as Amazon, Google and Azure have been swift to extend platforms and develop courses, certifications and micro-credentials aimed at helping organisations and institutions employ this emergent technology.

Yet even with explosive take-up, a key part of successfully democratising Generative AI is ensuring full participation. It is incumbent on us all to help educate and build people's capability in this new era of technology. We also need to do it in a safe and secure manner.

What Generative AI also illustrates is just how difficult it is to chart technology's trajectory precisely. Each of the critical technologies discussed in this report have the ability to dramatically shift the technology landscape. We can also expect the lines between them to blur as business models gain dependence on multiple technologies being used at once. Such interdependence will drive efficiency and innovation to unprecedented levels compared to each technology used in isolation. Illustrative examples include:

- Combining IoT devices with machine learning and cyber security can improve the safety and security of valuable assets. One Australian business is using a Machine Learning algorithm to identify users through biometric features like their gait and physical features, improving security for defence or emergency vehicle access.
- Extended reality, when paired with data analytics, can tailor and enhance the education experience. One Australian company is using these technologies to train radiographers, improving diagnostic accuracy rates by between 21%-31%.
- AI, when paired with Additive manufacturing, can design, iterate and build designs in real time. One AI program designed a walking robot after 10 iterations within 30 seconds.

Another reason for acceleration of technology developments is that technology itself can provide solutions to traditional issues. Take semiconductor chips, critical for digital



hardware. Since the dawn of the computer age, computation performance advancement has adhered to 'Moore's Law' and a doubling of capacity about every two years. Adopting AI techniques into the process is speeding up design innovation, accelerating how quickly performance leaps enter the market.

Putting aside all the hype around an all-encompassing Metaverse, immersive Web 3.0 technologies are at a stage of maturity where augmented, extended and virtual reality are having significant impact across screen and entertainment production. Coupled with a new way of commerce, open data control and digital ownership, Web 3.0 has the power to increasingly transform industries from health, education, construction and manufacturing to defence, agriculture and artistic endeavour.

Unparalleled human and technology endeavour

At a people level, the technologies discussed in this report are going to continue making seismic capability jumps that redefine what value humans contribute to work. As recognised by Dr Ian Opperman, NSW Government's Chief Data Scientist, we have seen the role of technology expand from automating or streamlining manual tasks, to augmenting cognitive tasks, to now providing a source of creativity based on previous work or data. Understanding the shifting role of humans and the natural advantages of technology will be important realising the full potential of both humanity and technology.

While this report focuses on the use of technology and implications on the workforce, it is obvious the changes from technology will have broader impact on society itself, good and bad. The rapid expansion of data analytics and AI in coming years has the potentially to negatively impact the environment, because of energy and water needs and the significant carbon emissions that come with their use at scale. But these technology tools will also play an important role in mitigating climate change, by helping our machines work more efficiently, and assisting in the transition to renewable energy sources.

In general, tech leaders are aware of their responsibilities. According to a global survey of C-suite executives in 2022, technology leaders were 13% more likely to target net-zero by 2030 compared with other executives. Maximising the potential of technology to help in the fight against climate change will require tech companies and professionals to work collaboratively with sustainability and other specialists, It's a spirit that's in keeping with much of this report, which emphasises 'all hands on deck' and a systems approach to problems.

While the repercussions of tech are spreading across Australia's economy and society, our policy and regulatory framework is trying to adapt. The speed and impact of change

"The advancement of tech forces us to rethink what is possible. The combination of biology and information systems has allowed us to change an organism's DNA through CRIPR technology that could advance human health in ways unfathomable only a short time ago. There are countless opportunities to harness the potential of tech to reshape our world."

Dr Ian Oppermann
NSW Government's Chief Data Scientist

means our approach to evolving technology use cases needs to be flexible. Technology specific regulation can have harmful impacts on business or become quickly outdated as technology evolves. Principle-based regulation and the production of industry and business guidelines are necessary to ensure appropriate use of technology.

A watershed moment for skills

What this tells us is we are on the cusp of a watershed moment for tech skills in this country.

What skills will Australians need to navigate a future with any number of these trends dramatically transforming and disrupting how we live and work? In 2023, we don't know exactly. That's the point. There is no predictive model of all the skills Australia will need in advance. Some skills are obvious – software engineering, UX Design, networking and infrastructure, for instance. But the art of the possible in us all may create completely unanticipated skills needs.

Such rapid change and uncertainty means Australia can no longer rely on incremental change management projects to our relatively static education system to keep up. We need to fundamentally shift towards a dynamic system focusing on adaptive skills and lifelong learning so workers, just like the technology they're harnessing and engaging with, can evolve over time.

The Commonwealth's *Annual Jobs and Skills Report 2023* signalled a major step towards the skilling vision outlined in this *Australia's Digital Pulse*. That report acknowledged 'Australia faces a skills challenge not seen since the 1960s'.

Top megatrends disrupting the labour market as identified in the report include digitalisation, automation and the emergence of artificial intelligence. In response, the report called for a national jobs and skills roadmap and a joined-up national skills system, piecing together the importance of vocational education and training (VET), higher education and migration.

Some reforms are already underway including a national jobs and skills roadmap in partnership with Jobs and Skills Councils, states and territories, business and unions, the education and training sector, and Australian Government agencies. Of all of its 14 priority actions, an especially important one is developing a national skills taxonomy in a collaborative partnership between business, unions, higher education and VET, and the Jobs and Skills Councils.

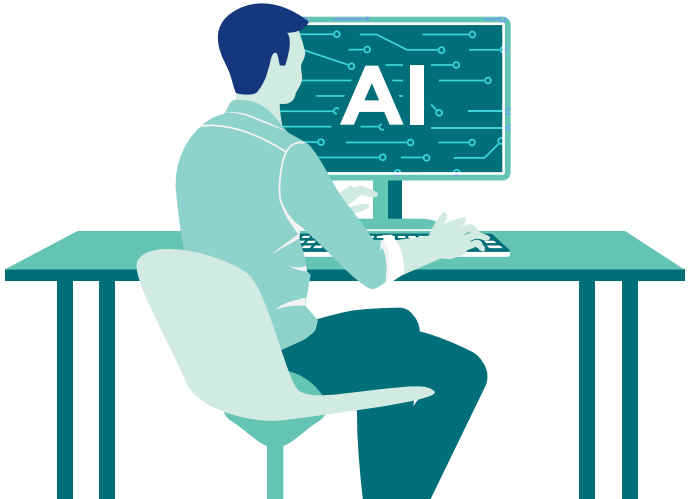
Without this, the discussion of skills shortages is stuck in occupational thinking centred around the same questions: What 'jobs' does Australia need to fill with migrants? What 'jobs' does the Australian education and training system need to prepare them for?

What this report makes blatantly clear is digital skills are not only changing, they're bleeding across traditional occupational lines. We need to reframe the questions from being about jobs, to being about skills. For example: What data analytics skills will all sorts of workers need? Because if we don't, workers won't be prepared for the changes ahead.

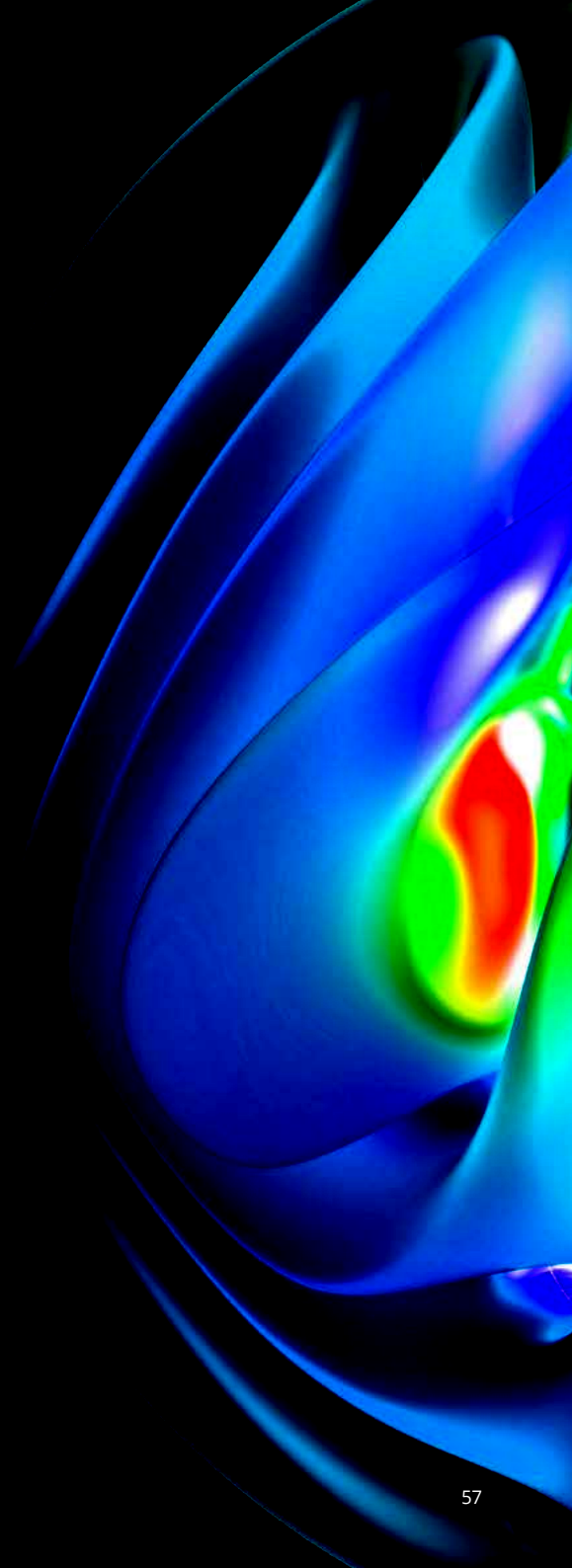
Taking transformative action

Inaction is not an option. A lack of progress will conservatively cost Australia $16 billion in 2030 (in today's dollars) in foregone economic activity. A lack of the right digital skills is costing Australian businesses $3.1 billion each year already. It will also jeopardise the prosperity of the nation by holding back innovation and making businesses less competitive. Without action, millions of Australians will not receive the reskilling they need to thrive in the workplaces of tomorrow, and our nation will have a smaller, less diverse workforce than it needs.

The new approach outlined in this report, along with the five key principles presented, is a starting point to getting businesses, workforces and the economy ready for future disruption. The task of addressing Australia's developing tech skills market is too immense for government or business alone. Realising the potential of critical technologies to the Australian economy and society requires all of us working together.



Appendices



Appendix A: Data sources and methodology

Data sources used in Australia's Digital Pulse

This is the ninth edition of the ACS Australia's Digital Pulse written by Deloitte for the Australian Computer Society.

This edition of Australia's Digital Pulse recognises the accelerating pace technological change and digital adoption. The Australian Government has recognised the crucial role of technology in reshaping business and the Australian workforce. In response, The List of Critical Technologies in the National Interest has been developed which identifies 63 key critical technologies within 7 fields that will have the greatest impact on Australia's national interest. Australia's Digital Pulse has collated a variety of data sources to provide a detailed analysis on 11 critical technologies bolded in the figure below.

The research notes that while the technology workforce in Australia has grown strongly, there are risks to achieving the required growth in skills and people. The analysis in this report is informed by the following data sources:

- A bespoke survey of 805 people including tech workers, IT students and people who have completed IT degrees not currently working in tech roles
- Forecasts from the International Data Corporation (IDC) on investment spending in Artificial Intelligence (AI), cyber security, cloud computing, Internet of Things (IoT), big data and analytics, Virtual Worlds in Australia, Japan and USA
- Lightcast data based on 265,000 technology worker job advertisements in Australia and the required skills for each role, with data extending from 2012 to 2023
- Data from the from Australian Bureau of Statistics, both publicly available and from a customised data request as well as other reports and statistics from Australian government sources.[1]

1 The analysis contained in ACS Australia's Digital Pulse of technology workforce have been calculated using ABS occupation and industry classifications, based on the methodology used in previous editions of Australia's Digital Pulse. This methodology draws upon definitions and nomenclature developed by Centre for Innovative Industries Economic Research (CIIER) lead researcher Ian Dennis FACS, and used in the ACS's 2008 to 2013 statistical compendiums and other CIIER analysis.

Technology workforce survey

The analysis contained in this report has been informed by a survey fielded between May and June 2023, with a total of 805 individuals completing the survey. The survey was focussed on three cohorts:

- current technology workers
- workers with a technology qualification but not working in a technology role
- current technology students

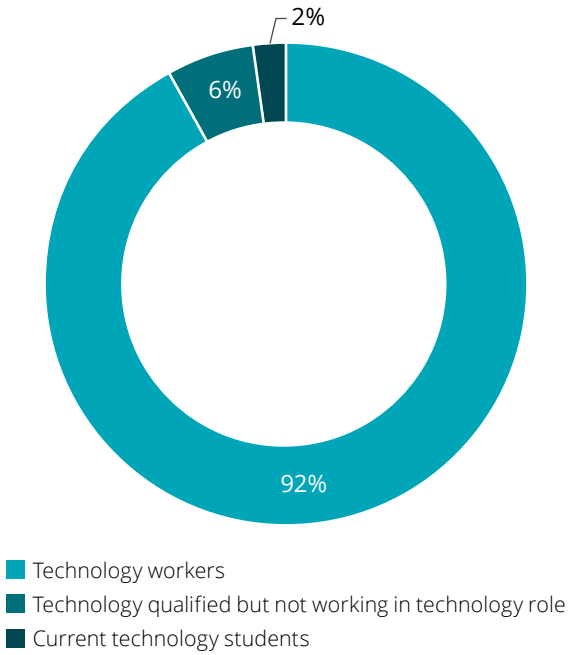
The survey was fielded using two different collection methods. The first was through emails to ACS members and to subscribers of ACS' flagship news publication Information Age, and through ACS' social media channels. The second included a panel of respondents sourced through market research firm Dynata.

The questions were designed to develop a detailed understanding of the career pathways of technology workers and to gauge the level of under-utilisation in the technology workforce.

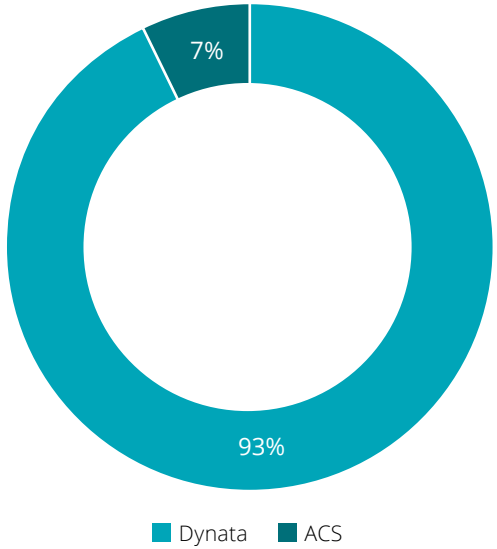
The survey is not representative of the population, and should not be interpreted as such. Other data sources provided by the ABS, such as the Census, are representative of the population and are used in place of the survey to produce detailed breakdowns of the technology workforce in general.

However, the results of this help to gain insights into the workplace experiences and movements for technology workers across different demographics.

Proportion of respondents by cohort



Source of survey respondents

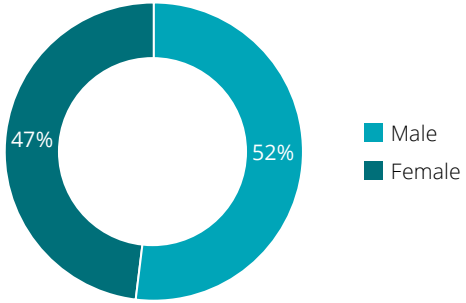


Technology workforce survey

Demographic breakdown of survey respondents

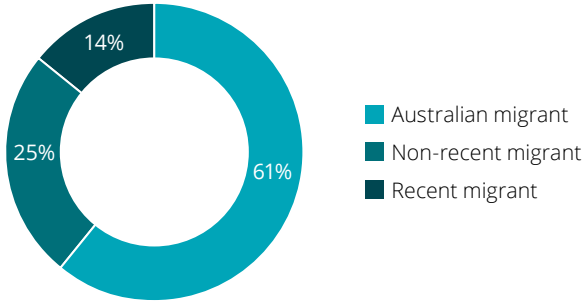
Gender

Of the 805 responses received, 421 were from male respondents and 375 were from females respondents.



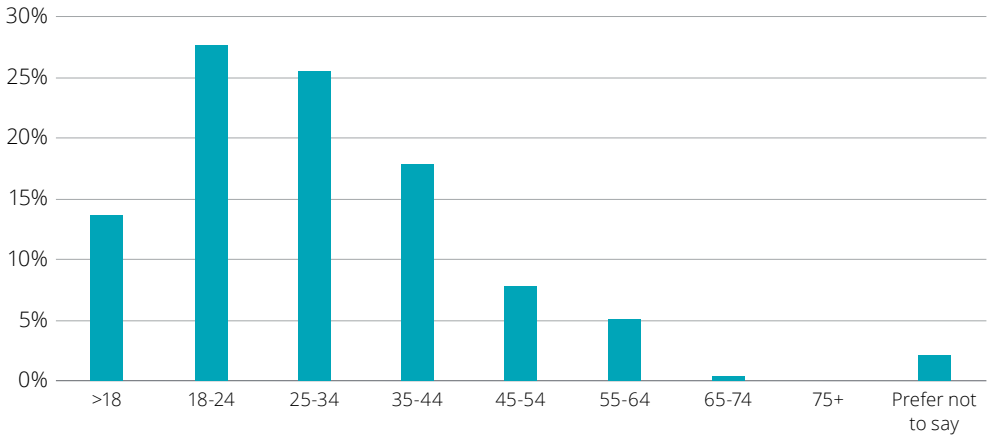
Migration status

Majority of the survey respondents were Australian born (61%), followed by 25% of non-recent immigrants. For the purposes of the survey, migrants are classified as recent immigrants if they arrived in Australia within the last 5 years and as non-recent immigrants if they arrived more than five years ago.



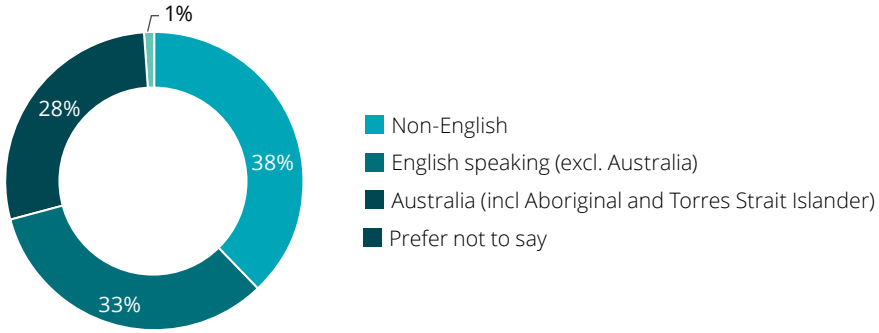
Age

The largest age category of respondents was 18- 24 years (28%) followed by 25 to 34 years (25%), and 35- 44 years (18%)



Ancestry

Ancestry of survey was classified into Australian (including Aboriginal and Torres Strait Islander), English speaking (excl. Australia), and non-English speaking. For the purposes of the survey, English-speaking only includes respondents with New Zealanders (including Māori), British, Scottish. Irish, Welsh and North America (United States and Canada). All other countries are classified as non-English speaking.



Critical technologies included in analysis for Australia's Digital Pulse

See below for more details about each of these fields, including example technologies and applications. These examples are not exhaustive.

Additive manufacturing, including 3D printing

- Critical minerals extraction and processing
- Advanced composite materials
- High specification machining processes
- Semiconductors and advanced integrated circuit design and manufacture

Machine learning, including neural networks and deep learning

AI algorithms and hardware accelerators

Natural language processing, including speech and text recognition, analysis and generation

Advanced data analytics

- Advanced optical communications
- Advanced radiofrequency communications, including 5G and 6G

High-performance computing

Protective cyber security technologies

Virtual worlds

Quantum computing

- Post-quantum cryptography
- Quantum communications
- Quantum sensors

Advanced robotics

- Autonomous systems operation technology
- Drones, Advanced imaging technology

Advanced sensor technologies

- Satellite and positioning technologies
- Advanced aerospace technologies, Nuclear technologies

- Synthetic biology, including biological manufacturing
- Neural engineering and brain computer interfaces
- Genome and genetic sequencing and analysis
- Vaccines and medical countermeasures
- Novel medicines, including nuclear, antiviral and antibiotic

- Emissions reduction technologies
- Advanced energy storage technologies
- Directed-energy technologies
- Large-scale renewable energy generation
- Low-emission alternative fuels, including biofuels
- Small-scale distributed energy harvesting

Enabling cloud technology

Bolded technologies are incorporated in the analysis for this edition of Australia's Digital Pulse

Methodology for critical technologies skills analysis

What will be the impact of critical technology on the skill needs of the Australian workforce in 2030?

Core tech workforce

What additional people and technical skills are needed by technology workers in critical technology by 2030?

Broad tech workforce

Many workers beyond traditional tech roles will be heavily involved in the development of critical technologies – how will their skill needs grow?

All workforce

How much of the broader workforce will be affected by critical technologies - eg as users, making tasks redundant, driving reskilling etc.

The exercise involves a number of steps – identifying the relevant data sets, mapping definitions, validating with other research and checks, and projecting to 2030.

Key data sets used:

- The **List of Critical Technologies in the National Interest** from the Department of Industry 2023.
- **Centre for Innovative Industry Economic Research (CIIER)** definition of the technology workforce including occupations and industries.
- **Australian Bureau of Statistics** data including a customised data request on occupation and industry employment, the Australian and New Zealand Standard Classification of Occupations (ANZSCO), census hours worked and job mobility data.
- **National Skills Commission** database of 284 skills clusters across 230 occupations in Australia.
- **Lightcast data** based on 265,000 technology worker job advertisements in Australia and the required skills for each role, with data extending from 2012 to 2023
- Forecasts from the **International Data Corporation (IDC)** on investment spending in Artificial Intelligence (AI), cyber security, cloud computing, Internet of Things (IoT), big data and analytics, virtual worlds, advanced robotics and sensors, high performance computing, and additive manufacturing. The data includes investment in Australia, Japan and USA between 2021 and 2030.
- We have expanded the approach and stress-tested with experts in labour market modelling, skills, and technology. We have two more external verification opportunities & this work requires QA.

The number of technology workers with skills in each critical technology from 2022 to 2030

Steps	Illustrative example
Technology workforce based on Centre for Innovative Industry Economic Research (CIIER) definition	Occupational examples include Software and Applications Programmers; and Database and Systems Administrators, and ICT Security Specialists
Critical technology skill taxonomy based Lightcast data on skills required by employers in job advertisements and validated by checks against National Skill Commission (NSC), SFIA framework and SME input	We identified 35 top technical skills (eg 26,609 tech workers had databases and programming skills in 2022) and 11 key people skills (eg teamwork)
Estimate growing pool of tech workers using Deloitte Labour market model	We estimate 1.3 million tech workers by 2030, 1.4 million if Australia was to keep pace with growth overseas.
Apply IDC data on investment trajectory of critical technology to determine historical ratio of investment to critical tech job advertisements	The ratio is stable for cloud over the last 8 years, whereas for cyber, jobs have recently grown strongly; for other techs, relationships have been steady for 2 years
Project skill demand using a constant investment/job advertisement ratio and calculate difference from 2022	Database and programming skills needs will rise to 101,855 by 2030, which is a difference of 75,246 compared with today.
Project the critical technology jobs and skills at the industry and state level	For example, the tech workers needing AI jobs skills will be 29,287 for professional services and 56,268 for NSW in 2030. (This will be extended to the skill list in state reports).
Skills analysis is extended to broader workforce outside of technology	The number of workers requiring critical technology skills will increase from 197.000 in 2023 to 470,000 by 2030

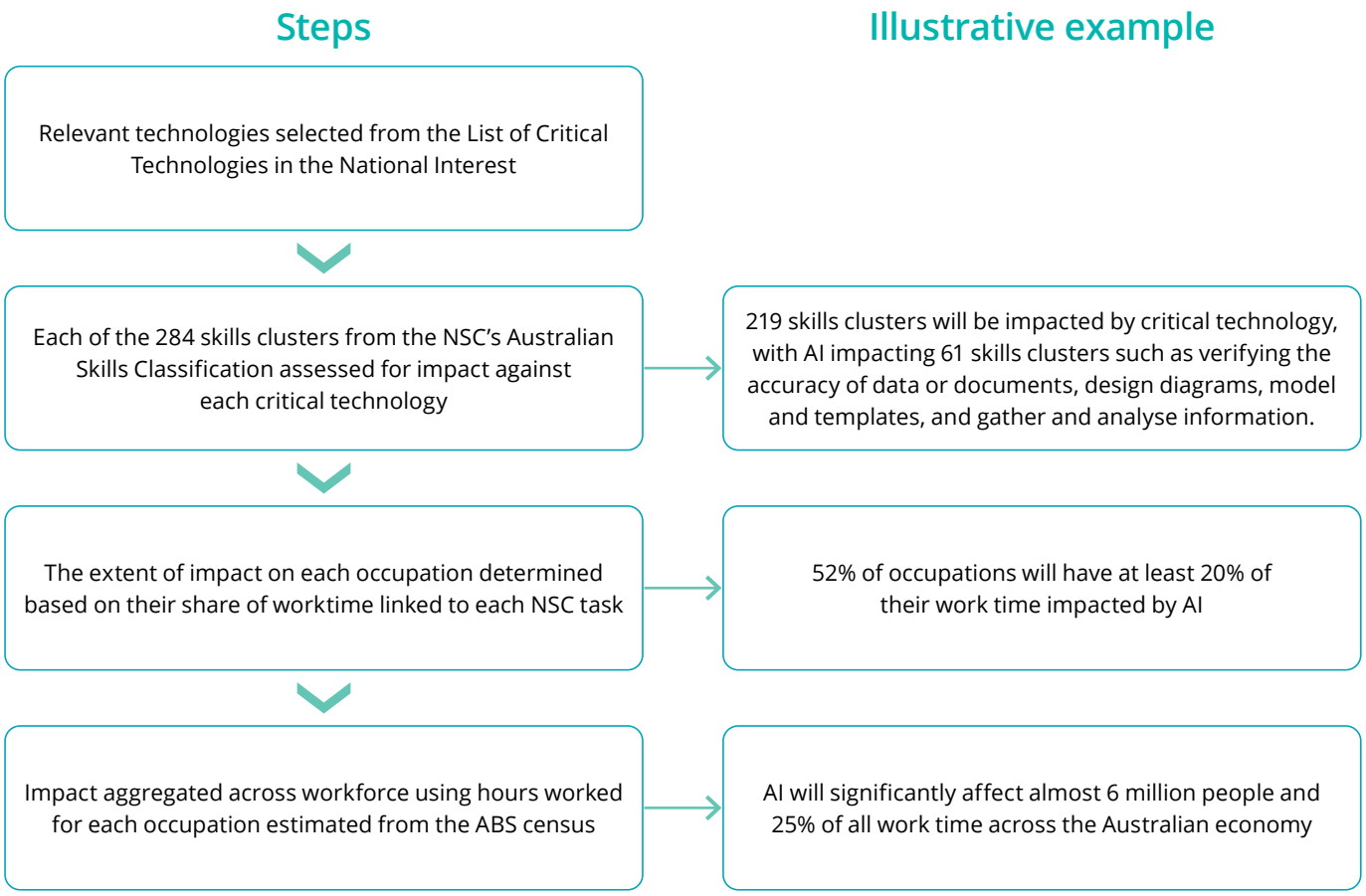
Key findings

- The number of technology workers with critical technology skills will increase to 326,000 by 2030 (representing an increase of 215,000)
- There will be 1.8 million skills needed by the Australian tech workforce to adapt to 9 critical technologies, 1.3 million more than in 2022.
- The technical critical technology skills in most demand in 2030 will be cloud solutions, software development principles and databases and programming skills

Key limitations

- Only includes nine critical technologies, (quantum is covered qualitatively) and does not incorporate the impact of other technologies.
- We can calculate current needs, expected future needs and gap, but this is supplemented by qualitative discussion about quality of current skills. Skills have various degrees of competence rather than just yes/no. Also, we do not have does not have a 'base case' of what will be developed without any further policy action.
- Analysis does not include skills that do not yet exist or are not included in the Lightcast database (so supplemented by discussion about 'future jobs')
- It is assumed, based on historical validation, that the relationship between investment and job advertisements is constant over time
- The state and industry breakdowns are projections assuming stable relationships between factors.
- The definition of who is considered a technology worker may become broader overtime.

Change to Impact of critical technologies on Australian workforce



Key findings

- An estimated 95% of workers expected to have at least 20% of their work time replaced, augmented or otherwise impacted by the adoption of critical technologies
- Collectively these technologies will impact 74% of work hours across the Australian economy
- Technology workers are among those most affected by critical technologies with 92% of work time exposed to change.

Key limitations

- Does not include all critical technologies or other technologies
- The impact does not distinguish between whether the impact of a critical technology is to augment or replace a task
- Cannot identify the extent of the reskilling need
- There is no timeframe associated with the impact of critical technologies on skills. We report tech adoption rates for 2030 and assume that, with such widespread adoption by then, the impact on workforce will also be felt by then.

Appendix B: Workforce skills impacts from critical technologies

Impacts of advanced data analytics on skills across the workforce by 2030

Advanced data analytics will have a large impact on workforce skill needs in the coming years.

Out of 285 specialist skill clusters from the National Skills Council framework, some 60 will be directly affected by advanced data analytics, including: operations research and management, analyse market data and trends, undertake research and analyse data, and create and update databases.

In total, 94% of occupations have skills that will be affected by advanced data analytics, and 28% of all worktime will be affected. 46% of occupations will have at least 20% of their work time impacted by advanced data analytics, and will be those mostly likely to need reskilling to make most use of the technology, or develop new skills to continue to create value for their employers or organisations.

Which workers will be most affected by advanced data analytics?

Many of the workers most affected will be tech workers themselves, including management and organisation analysts (73% of worktime), ICT managers (55%) and ICT sales professionals (51%).

However, many other workers will be more strongly affected, including telemarketers (83% of worktime), bank workers (77%) and financial dealers (77%).

Skills & jobs impacted by advanced data analytics by 2030

Specialist skill clusters affected

- **Operations research & management**
- **Analyse market data & trends**
- **Undertake research & analyse data**
- **Create & update databases**
- **Manage operational budgets**
- **Gather & analyse information**
- **Verify & maintain financial records**
- **Improve operational performance**
- **Evaluate capabilities of athletes**
- **Analyse medical research & data**

Tech roles most impacted (% of working hours impacted)

- 73% **Management & Organisation Analysts**
- 55% **ICT Managers**
- 51% **ICT Sales Professionals**
- 48% **ICT Sales Assistants**
- 39% **Electrical Engineering Draftspersons & Technicians**

All workforce most impacted (% of working hours impacted)

- 83% **Telemarketers**
- 77% **Bank Workers**
- 77% **Financial Dealers**
- 73% **Debt Collectors**
- 72% **Finance Managers**

Impacts of enabling cloud technology on skills across the workforce by 2030

Enabling cloud technology will sit behind and be integral to much of workforce and their skilling needs.

Out of 285 specialist skill clusters from the National Skills Council framework, some 54 will be directly affected by cloud technologies, including: operations research and management, verify and maintain financial records, undertaking financial reporting, documentation and analysis, and coordinate activities or logistics.

In total, 95% of occupations have skills that will be affected by cloud technologies, and 25% of all worktime will be affected. 46% of occupations will have at least 20% of their work time impacted by cloud technology, and will be those mostly likely to need reskilling to make most use of the technology, or develop new skills to continue to create value for their employers or organisations.

Which workers will be most affected by cloud technology?

Some of the workers most affected will be tech workers themselves, including management an organisation analysts (62% of worktime), ICT managers (54%) and other information and management professionals (50%).

However, many other workers will be strongly affected too, including bank workers (80% of worktime), debt collectors (81%) and survey interviewers (76%).

Skills & jobs impacted by cloud technology by 2030

Specialist skill clusters affected

- **Operations research & management**
- **Verify & maintain financial records**
- **Undertaking financial reporting, documentation & analysis**
- **Coordinate activities or logistics**
- **Create & update databases**
- **Maintain sales & business transaction records**
- **Undertake human resources activities**
- **Communicate with others to coordinate work**
- **Manage or document operational process or procedures**

Tech roles most impacted (% of working hours impacted)

- 62% **Management & Organisation Analysts**
- 54% **ICT Managers**
- 50% **Other Information & Management Professionals**
- 35% **Electronic Engineering Draftspersons & Technicians**
- 33% **Database & Systems Administrators, & ICT Security Specialists**

All workforce most impacted (% of working hours impacted)

- 83% **Bank Workers**
- 81% **Debt Collectors**
- 76% **Survey Interviewers**
- 69% **Financial Brokers**
- 69% **Credit and Loans Officers**

Impacts of cyber security on skills across the workforce by 2030

One of the most profound impacts of critical technologies on workforce skill needs will come from cyber security.

Out of 285 specialist skill clusters from the National Skills Council framework, some 29 will be directly affected by cyber security, including to: verify and maintain financial records, develop procedures for data management, gather or analyse information and collaborate with health care professionals.

In total, 84% of occupations have skills that will be affected by cyber security, and 18% of all worktime will be affected. 33% of occupations will have at least 20% of their work time impacted by cyber security, and will be those mostly likely to need reskilling to make most use of the technology, or develop new skills to continue to create value for their employers or organisations.

Which workers will be most affected by cyber security developments?

Tech workers themselves will be impacted by cyber security, including database and systems administrators and ICT security specialists (61% of worktime), management, ICT sales professionals (49%), and telecommunications engineering professionals (45%).

However, many other workers will be strongly affected too, including telemarketers (89% of worktime), survey interviewers (71%), and bank workers (71%).

Skills & jobs impacted by cyber security by 2030

Specialist skill clusters affected

- **Collect information from people**
- **Verify & maintain financial records**
- **Develop procedures for data management**
- **Gather or analyse information**
- **Maintain records, documents or other files**
- **Manage digital data or recordings**
- **Verify personal information & maintain records**
- **Analyse medical research & data**
- **Collect, document & communicate medical information**
- **Collaborate with health care professionals**

Tech roles most impacted (% of working hours impacted)

- 61% **Database and Systems Administrators, and ICT Security Specialists**
- 49% **ICT Sales Professionals**
- 45% **Telecommunications Engineering Professionals**
- 44% **ICT Support Technicians**
- 44% **Telecommunications Technical Specialists**

All workforce most impacted (% of working hours impacted)

- 89% **Telemarketers**
- 71% **Survey Interviewers**
- 71% **Bank Workers**
- 69% **Debt Collectors**
- 54% **Payroll Clerks**

Impacts of for Internet of Things on skills across the workforce by 2030

Internet of Things (IoT) will play a key role in shifting the skilling needs for a set of workers in manufacturing and agricultural sectors.

Out of 285 specialist skill clusters from the National Skills Council framework, some 36 will be directly affected by IoT, including to: undertake agricultural processes and tasks, improve operational performance, inspect, test or maintain equipment or systems, and operate vehicles or material-moving equipment.

In total, 66% of occupations have skills that will be affected by IoT, and 8% of all worktime will be affected. 14% of occupations will have at least 20% of their work time impacted by IoT, and will be those mostly likely to need reskilling to make most use of the technology, or develop new skills to continue to create value for their employers or organisations.

Which workers will be most affected by IoT technologies?

Tech workers involved in electronics and telecommunications will be particularly affected including, electronic engineering draftsperson and technicians (42% of worktime), electronics trades workers (32%), and telecommunications trades workers (31%)

However, many other workers will be strongly affected too, including surveyors and spatial scientists (53% of worktime), other mobile plant operators (52%), air conditioning and refrigeration mechanics (52%) and air transport professionals (47%).

Skills & jobs impacted by Internet of Things by 2030

Specialist skill clusters affected

- **Maintain inventory & stock**
- **Undertake agricultural processes & tasks**
- **Undertake agricultural or forestry operations**
- **Inspect, test or maintain equipment or systems**
- **Monitor equipment, procedures & systems**
- **Improve operational performance**
- **Maintain, adjust or repair flow systems**
- **Operate vehicles or material-moving equipment**

Tech roles most impacted (% of working hours impacted)

- 42% **Electronic Engineering Draftsperson & Technicians**
- 32% **Electronics Trades Workers**
- 31% **Telecommunications Trades Workers**
- 16% **Electrical Engineering Draftsperson & Technicians**
- 10% **ICT Business & Systems Analysts**

All workforce most impacted (% of working hours impacted)

- 53% **Surveyors & Spatial scientists**
- 52% **Other Mobile Plant Operators**
- 52% **Airconditioning & Refrigeration Mechanics**
- 47% **Air Transport Professionals**
- 46% **Livestock farmers**

Impacts of virtual worlds on skills across the workforce by 2030

One of the critical technologies that will impact a large share of the workforce is virtual worlds (including augmented and virtual reality) technology.

Out of 285 specialist skill clusters from the National Skills Council framework, some 50 will be directly affected by virtual worlds technologies, including to: communicate and collaborate, design diagrams, models and templates, design or create graphical representations and monitor equipment, procedures and systems.

In total, 92% of occupations have skills that will be affected by virtual worlds technologies, and 15% of all worktime will be affected. 35% of occupations will have at least 20% of their work time impacted by virtual worlds, and will be those mostly likely to need reskilling to make most use of the technology, or develop new skills to continue to create value for their employers or organisations.

Which workers will be most affected by virtual worlds technologies?

Many of the workers most affected will be tech workers themselves, including graphic and web designers, and illustrators (69% of worktime), other information and organisation professionals (53%) and electronic engineering draftspersons and technicians (43%).

However, many other workers will be strongly affected too, including fitness instructors (69%), psychiatrists (68%) and air transport professionals (53%).

Skills & jobs impacted by virtual worlds by 2030

Specialist skill clusters affected

- **Communicate & collaborate**
- **Communicate with colleagues**
- **Design diagrams, models & templates**
- **Design or create graphical representations**
- **Train staff**
- **Undertake or provide professional skill & knowledge development**
- **Create images or representations**
- **Monitor equipment, procedures & systems**
- **Collect or analyse land surveys & geographics data**

Tech roles most impacted (% of working hours impacted)

- 69% **Graphic & Web Designers, & Illustrators**
- 53% **Other Information & Organisation Professionals**
- 43% **Electronic Engineering Draftspersons & Technicians**
- 34% **ICT Trainers**
- 33% **Telecommunications Trade Workers**

All workforce most impacted (% of working hours impacted)

- 69% **Fitness Instructors**
- 68% **Psychiatrists**
- 53% **Air Transport Professionals**
- 53% **Midwives**
- 53% **Surveyors & Spatial Scientists**

Impacts of advanced robotics and sensors on skills across the workforce by 2030

Advanced robotics and sensors will be an important driver of skilling requirements for workers in specific industries or in specialised roles.

Out of 285 specialist skill clusters from the National Skills Council framework, some 60 will be directly affected by robotics and sensors technologies, including to: collect or analyse land surveys and geographics data, operate material handling machinery, collect or analyse land surveys and geographics data, and monitor vehicles and traffic.

In total, 72% of occupations have skills that will be affected by advanced robotics and sensors , and 17% of all worktime will be affected. 38% of occupations will have at least 20% of their work time impacted by advanced robotics and sensors, and will be those mostly likely to need reskilling to make most use of the technology, or develop new skills to continue to create value for their employers or organisations.

Which workers will be most affected by advanced robotics and sensors technologies?

Robotics and sensor technologies will have a greater impact on technology workers including: telecommunications and trades workers (66% of worktime), electronics trades workers (48%) and electronics engineering draftspersons and technicians (42%).

Workers in roles such as forklift drivers (90% of worktime), paper and wood processing machine operators (83%), and freight and furniture handlers (83%) will be strongly affected by robotics.

Skills & jobs impacted by robotics and sensors by 2030

Specialist skill clusters affected

- **Undertake agricultural processes & tasks**
- **Undertake agricultural or forestry operations**
- **Operate material handling machinery**
- **Operate vehicles or material-moving equipment**
- **Monitor vehicles & traffic**
- **Operate & maintain water vessels**
- **Operate trains or other rail vehicles**
- **Collect or analyse land surveys & geographics data**

Tech roles most impacted (% of working hours impacted)

- 66% **Telecommunications & Trades Workers**
- 48% **Electronics Trades Workers**
- 42% **Electronics Engineering Draftspersons & Technicians**
- 32% **Electrical Engineering Draftspersons & Technicians**

All workforce most impacted (% of working hours impacted)

- 90% **Forklift drivers**
- 83% **Paper & wood processing machine operators**
- 83% **Freight & furniture handlers**
- 83% **Sewing machinists**

Impacts of additive manufacturing (including 3D printing) on skills across the workforce by 2030

Additive manufacturing will play a key role for a small portion of workers.

Out of 285 specialist skill clusters from the National Skills Council framework, some 18 will be directly affected by additive manufacturing technologies, including to: design, repair or fabricate medical equipment, design or assemble equipment and systems, and fabricate, assemble or install components.

In total, 34% of occupations have skills that will be affected by additive manufacturing, and 3% of all worktime will be affected. 11% of occupations will have at least 20% of their work time impacted by additive manufacturing, and will be those most likely to need reskilling to make most use of the technology, or develop new skills to continue to create value for their employers or organisations.

Which workers will be most affected by additive manufacturing?

Tech workers most affected by additive manufacturing include Electronics Trades Workers (16% of work time), electrical engineering draftspersons and technicians (13%), and graphic and web designers and illustrators (6%).

Workers in other occupations will be relatively more affected by additive manufacturing including wall and floor tilers (60%), paper and wood processing machine operators (50%) and cabinetmakers (45%)

Skills & jobs impacted by additive manufacturing by 2030

Specialist skill clusters affected

- **Design, repair or fabricate medical equipment**
- **Design or assemble equipment & systems**
- **Fabricate, assemble or install components**
- **Inspect, test or maintain equipment or systems**
- **Repair equipment & electronics**
- **Plastic fabrication & tool operation**
- **Build or utilise forms or moulds**
- **Operate production equipment & make products**

Tech roles most impacted (% of working hours impacted)

- 16% **Electronics Trades Workers**
- 13% **Electronics Engineering Draftspersons & Technicians**
- 6% **Graphic & web designers, & Illustrators**
- 6% **Telecommunications Trades Workers**

All workforce most impacted (% of working hours impacted)

- 60% **Wall & floor tilers**
- 50% **Paper & wood processing machine operators**
- 45% **Cabinetmakers**
- 43% **Printing assistants & table workers**
- 43% **Paving & surface labourers**

Appendix C: Technology workforce skill impacts from critical technologies

2030 skills for advanced data analytics

Advanced data analytics will require a major skill increase. Annual business investment in these areas is forecast to jump from $8 billion in 2022 to $15 billion by 2030. Business use of these technologies will grow from less than 5% in 2022 to more than half by 2030.

What skills will tech workers need for this enormous change?

The essential technical skills needed for advanced data analytics workers include: Data analysis, Data techniques, Scripting languages, Big data, Databases and programming, and Data warehousing. Workers will also need people skills such as planning, research, problem-solving, effective communication, collaboration, and teamwork.

How many extra professionals and how much more skilling will be needed?

The number of tech workers with skills in advanced data analytics is expected to grow from 48,000 in 2022 to 134,000 by 2030. There will also be more than 160,000 workers in advanced data analytics in the broader workforce by 2030.

The total skill requirement to support just the core tech workforce is projected to grow 179% from 162,384 in 2022 to 452,897 in 2030. The gap between skills now and in the future is a sizable 290,513 technical and people skills.

Skills sets demanded for advanced data analytics by 2030

- **Data analysis** 34,279+
- **Data techniques** 24,852+
- **Big data** 22,281+
- **Scripting languages** 21,138+
- **Data warehousing** 18,853 +
- **Databases & programming** 22,281+
- **Database administration** 19,710+

134k **Skilled workers needed** (2030)

290k **Skills gap** (2030)

+179% **Growth in skilled workers** (2030)

People skills

Teamwork/collaboration	24,852+
Communication skills	29,994+
Problem Solving	22,281+
Research	13,712+
Planning	14,568+

Extra skills identified

Linear Algebra and Calculus
Machine Learning
Critical thinking

2030 skills for cyber security

Cyber security changes will also drive a big reskilling need. Annual business investment is forecast to jump from slightly more than $9 billion in 2022 to $15 billion by 2030. Business use will grow from less than 63% in 2022 to 78% by 2030.

What skills will tech workers need for this enormous change?

Already, we know that the essential technical skills include: Cyber security, System design and implementation, Information security, Network configuration, Cloud solutions and Software development principles. Workers will also need people skills such as planning, stakeholder management, problem-solving, effective communication, collaboration, and teamwork.

How many extra professionals and how much more skilling will be needed?

The number of tech workers focusing on cyber security is expected to grow from 24,700 in 2022 to 48,00 by 2030. There will also be some 36,000 workers in cyber security in the broader workforce by 2030.

The total skill requirement to support just the core tech workforce is projected to grow 94% from 82,815 in 2022 to 160,709 in 2030. The gap between skills now and in the future is a substantial 77,893 technical and people skills.

Skills sets demanded for cyber security by 2030

- **Cyber security** 18,834+
- **Network configuration** 4,883+
- **Cloud solutions** 4,650+
- **General networking** 4,650+
- **Information security** 5,115+
- **Software development principles** 3,953+
- **System design & implementation** 5,580+

48k **Skilled workers needed** (2030)

78k **Skills gap** (2030)

+94% **Growth in skilled workers** (2022–2030)

People skills

Teamwork/collaboration	6,045+
Communication skills	8,836+
Problem Solving	5,115+
Stakeholder management	2,790+
Planning	3,720+

Extra skills identified

Forensics and incident analysis
Cloud security
Adaptability and continuous learning

2030 skills for enabling cloud technology

Over coming years, cloud will shift from emerging to mature technology but skilling needs will continue. Annual business investment in these areas is forecast to jump from almost $21 billion in 2022 to $41 billion by 2030. Business use of these technologies will grow from 59% in 2022 to 84% by 2030.

What skills will tech workers need for this enormous change?

Enabling cloud technology requires a broad set essential technical skills include: Cloud solutions, Software development principles, System design and implementation, Operating systems, Network configuration and Databases and programming. Workers will also need People skills such as planning, research, problem-solving, effective communication, troubleshooting, and teamwork.

How many extra professionals and how much more skilling will be needed?

The number of tech workers with skills in cloud technology is expected to grow from an already sizable 50,500 in 2022 to 154,700 by 2030. There will also be 61,000 workers with cloud technology skills in the broader workforce by 2030.

The total skill requirement to support just the core tech workforce is projected to grow 206% from 193,469 in 2022 to 592,503 in 2030. The gap between skills now and in the future is a substantial 399,034 technical and people skills.

To date, the relationship between business investment in and adoption of cloud has generated significant jobs and skill needs. We note that this relationship could shift considerably by 2030, with businesses able to achieve similar outcomes with fewer cloud specialists. If there is a big change, that will mean these projections overstate the jobs and skill needs.

Skills sets demanded for cloud technology by 2030

- **Network configuration** 20,873+
- **Operating systems** 22,921+
- **Technical support** 25,005+
- **Cloud solutions** 97,935+
- **System design & implementation** 30,214+
- **Databases & programming** 20,837+
- **Software development principles** 31,256+

155k **Skilled workers needed** (2030)

339k **Skills gap** (2030)

+206% **Growth in skilled workers** (2022-2030)

People skills

Teamwork/collaboration	29,172+
Communication skills	37,507+
Problem Solving	25,005+
Troubleshooting	21,879+
Planning	15,628+

Extra skills identified

- Cost optimisation
- Data management
- Service selection
- Collaboration & communication

2030 skills for Internet of Things

Continued proliferation of the Internet of Things will grow the skill requirements for technology workers involved in this technology. Annual business investment in these areas is forecast to jump from less than $20 billion in 2022 to over $34 billion by 2030. Business use of these technologies will grow from less than 6% in 2022 to almost half of businesses by 2030.

What skills will tech workers need for this enormous change?

Already, we know that the essential technical skills include Software development principles, Scripting languages, System design and implementation, Cloud solutions and General networking. Workers will also need people skills such as planning, research, problem-solving, effective communication, project management, and teamwork.

How many extra professionals and how much more skilling will be needed?

The number of tech workers focusing on the Internet of Things is expected to grow from 3,200 in 2022 to 8,300 by 2030. There will also be around 4,200 workers with skills in Internet of Things across the broader workforce by 2030.

The total skill requirement to support just the core tech workforce is projected to grow 156% from 12,108 in 2022 to 30,966 in 2030. The gap between skills now and in the future is 18,858 technical and people skills.

Skills sets demanded for Internet of Things by 2030

- **Internet of Things** 4,550+
- **General networking** 809+
- **Technical support** 859+
- **Scripting languages** 1,365+
- **Cloud solutions** 1,062+
- **Software development principles** 1,921+
- **System design & implementation** 1,315+

8,300 **Skilled workers needed** (2030)

18,858 **Skills gap** (2030)

+156% **Growth in skilled workers** (2022–2030)

People skills

Teamwork/collaboration	1,668+
Communication skills	2,002+
Problem Solving	1,212+
Project management	657+
Planning	657+

Extra skills identified

- Hardware
- Networking
- Remote Sensing
- Security

2030 skills for virtual worlds

Virtual worlds technology including augmented and virtual reality will experience continued growth over the coming years. Annual business investment in these areas is forecast to jump from about $267 million in 2022 to $1 billion by 2030. Business use of these technologies will grow from less than 1% in 2022 to almost one-quarter of businesses by 2030.

What skills will tech workers need for this enormous change?

Essential technical skills for virtual worlds include: Drafting and engineers design, Graphic and visual design software, Animation and game design, Software development principles and Social media. Workers will also need people skills such as planning, research, problem-solving, effective communication, collaboration, and teamwork.

How many extra professionals and how much more skilling will be needed?

The number of tech workers with skills in virtual worlds is expected to grow from just 560 in 2022 to 3,400 by 2030. There will also be around 27,500 workers in virtual worlds across the broader workforce by 2030.

The total skill requirement to support just the core tech workforce is projected to grow from 1,781 in 2022 to 13,155 in 2030. The gap between skills now and in the future is a total of 11,372 technical and people skills.

Skills sets demanded for virtual worlds by 2030

- **Graphic design software** 1,436+
- **Visual design production** 469+
- **Visual design** 909+
- **Social media** 469+
- **Software dev principles** 586+
- **Animation & game design** 1,348+
- **Drafting & engineers design** 2,257+

3,400 Skilled workers needed (2030)

11,372 Skills gap (2030)

+639% Growth in skilled workers (2022-2030)

People skills

Teamwork/collaboration	938+
Communication skills	997+
Organisational skills	440+
Detail-oriented	498+
Planning	586+

Extra skills identified

- 3D modelling and design
- User Interface/ User Experience
- Sensor technologies
- Adaptability to change

2030 skills for advanced robotics and sensors

Advanced robotics and sensors comprise a small share of the overall technology workforce skilled in critical technology. Annual business investment in these areas is forecast to stay steady at around $1 billion a year between 2022 and 2030. Business use of these technologies will grow from around 1% in 2022 to 15% by 2030.

What skills will tech workers need for this enormous change?

Already, we know that the essential technical skills include: Robotics, Software development principles, Scripting languages, Programming languages and Imaging. Workers will also need people skills such as planning, research, problem-solving, effective communication, collaboration, and teamwork.

How many extra professionals and how much more skilling will be needed?

The number of tech workers focusing on advanced robotics and sensors is expected to grow slightly from 2,200 in 2022 to 2,300 by 2030. There will also be about 3,200 workers in advanced robotics and sensors across the broader workforce by 2030.

The total skill requirement to support just the core tech workforce is projected to grow a mere 4% from 2022 to 2030.

The robotics and sensors skills projections are much smaller than other areas of critical technology. This reflects an assumption that robotics and sensors' most profound impacts will be on complementing work and as a tool used by workers, more so than the number of tech workers directly involved in developing the technology. As the projections are off a relatively low base, they are more uncertain.

Skills sets demanded for robotics and sensors by 2030

- **Robotics** 74+
- **Mechanical engineering** 18+
- **Imaging** 19+
- **Scripting languages** 27+
- **Programming languages** 20+
- **Software development principles** 28+
- **System design & implementation** 37+

2,300 **Skilled workers needed** (2030)

350 **Skills gap** (2030)

+4% **Growth in skilled workers** (2022–2030)

People skills

Communication skills	31+
Teamwork/Collaboration	24+
Problem solving	20+
Planning	17+
Research	15+

Extra skills identified

Mechatronics
Electronics and hardware integration
Kinematics and Dynamics

2030 skills for high-performance computing

An early technology expected to grow over the coming years, high-performance computing (HPC) skills will begin to be need in the technology workforce. Annual business investment in these areas is forecast to jump from less than $349 million in 2022 to over $699 million by 2030.

What skills will tech workers need for this enormous change?

Some of the essential technical skills for HPC workers include: Programming principles, Scripting languages, Software development principles and Operating systems. Workers will also need people skills such as planning, research, problem-solving, effective communication, collaboration, and teamwork.

How many extra professionals and how much more skilling will be needed?

The number of tech workers focusing on HPC is expected to grow slightly from 350 in 2022 to 1,300 by 2030. There will also be 1,200 workers in HPC across the broader workforce by 2030.

The total skill requirement to support just the core tech workforce is projected to grow 268% from 1,720 in 2022 to 6,324 in 2030. The gap between skills now and in the future is a 4,605 technical and people skills.

Skills sets demanded for high-performance computing by 2030

- **Programming languages** 232+
- **Systems administration** 280+
- **Operating systems** 380+
- **Scripting languages** 445+
- **Technical support** 398+
- **Programming principles** 927+
- **Software development principles** 2,257+

1,300 **Skilled workers needed** (2030)

4,605 **Skills gap** (2030)

+268% **Growth in skilled workers** (2022-2030)

People skills

Teamwork/collaboration	278+
Communication skills	241+
Problem solving	167+
Research	500+
Planning	160+

Extra skills identified

Parallel Programming
Algorithm Optimisation
Graphics Processing Unit (GPU programming & accelerators

2030 skills for additive manufacturing (including 3D printing)

The expected growth and size of the technology workforce involved in additive manufacturing is comparatively modest. Annual business investment in these areas is forecast to jump from $317 million in 2022 to $434 million by 2030. Business use of these technologies is currently around 2%,

What skills will tech workers need for this enormous change?

For additive manufacturing the essential technical skills include: Drafting and engineers design, Robotics, System design and implementation, Software development principles and Mechanical engineering. Workers will also need people skills such as research, effective communication, technical support, problem-solving, collaboration, and teamwork.

How many extra professionals and how much more skilling will be needed?

The number of tech workers focusing on additive manufacturing is expected to grow slightly from 80 in 2022 to 200 by 2030. There will also be 2000 workers in additive manufacturing in the broader workforce by 2030.

In observing that these numbers appear low, it is important to note that they are simply the tech workers involved with the development of the technology. Additive manufacturing could have dramatic impacts on the manufacturing (and other) workforces and be used by a great many workers.

Skills sets demanded for additive manufacturing by 2030

- **Drafting and design** 121+
- **Operating systems** 18+
- **Robotics** 45+
- **Test automation** 18+
- **Mechanical engineering** 27+
- **Software dev principles** 27+
- **System design & implementation** 36+

199 **Skilled workers needed** (2030)

534 **Skills gap** (2030)

+156% **Growth in skilled workers** (2022-2030)

People skills

Research	46+
Communication skills	42+
Problem solving	30+
Teamwork/collaboration	27+

Extra skills identified

CAD modelling
Material selection
Production and business development
Patent law

Critical technology workers will work in a more diverse range of industries than the existing workforce

Critical technology skills will be demanded right across the economy

The need for skills in each critical technology differs across industries. The concentration of workers with skills in cloud, advanced data analytics and high-performance computing is greatest in Professional, Scientific and Technical Services. Information Media and Telecommunications and Manufacturing are similarly expected to demand an outsized share of workers with virtual world skills.

The industries expected to require the most critical technology workers in 2030 include Professional, Scientific and Technical Services, Financial and Insurance Services, and Public Administration and Safety.

Compared to the existing technology workforce, workers with skills in critical technologies are expected to be more evenly dispersed across industries.

For example, while 54% of technology occupations currently work within the Professional, Scientific and Technical Services, and Information Media and Telecommunications industries only 30% of critical technology works are forecast to do so. The portion of critical technology workers in the education and training, and healthcare and social assistance industries is also expected to be double than its existing share of technology workers.

Number of workers with critical technology skills by 2030, by top 10 industries

Industry	AI, ML & NLP	Cloud	Additive manufacturing	Advanced robotics	Cyber security	Virtual worlds	ADA	HPC	IoT
Professional, Scientific and Technical Services	29,287	45,276	35	575	11,419	1,090	27,420	424	2,060
Financial and Insurance Services	19,615	21,367	0	200	7,041	0	27,833	40	125
Public Administration and Safety	15,486	18,614	23	521	8,390	605	17,360	212	936
Education and Training	11,139	6,918	106	291	2,720	121	7,962	451	520
Health Care and Social Assistance	9,074	14,637	12	127	5,475	0	11,976	13	270
Retail Trade	7,716	11,954	0	48	1,715	40	6,145	0	562
Mining	7,444	5,201	12	109	1,246	282	5,963	40	562
Information Media and Telecommunications	6,140	10,895	0	79	2,538	404	5,385	0	1,103
Electricity, Gas, Water and Waste Services	5,923	4,236	12	67	1,875	40	5,137	53	728
Transport, Postal and Warehousing	5,271	3,153	0	6	1,326	81	5,021	0	270

Source: Deloitte Access Economics (2023)

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