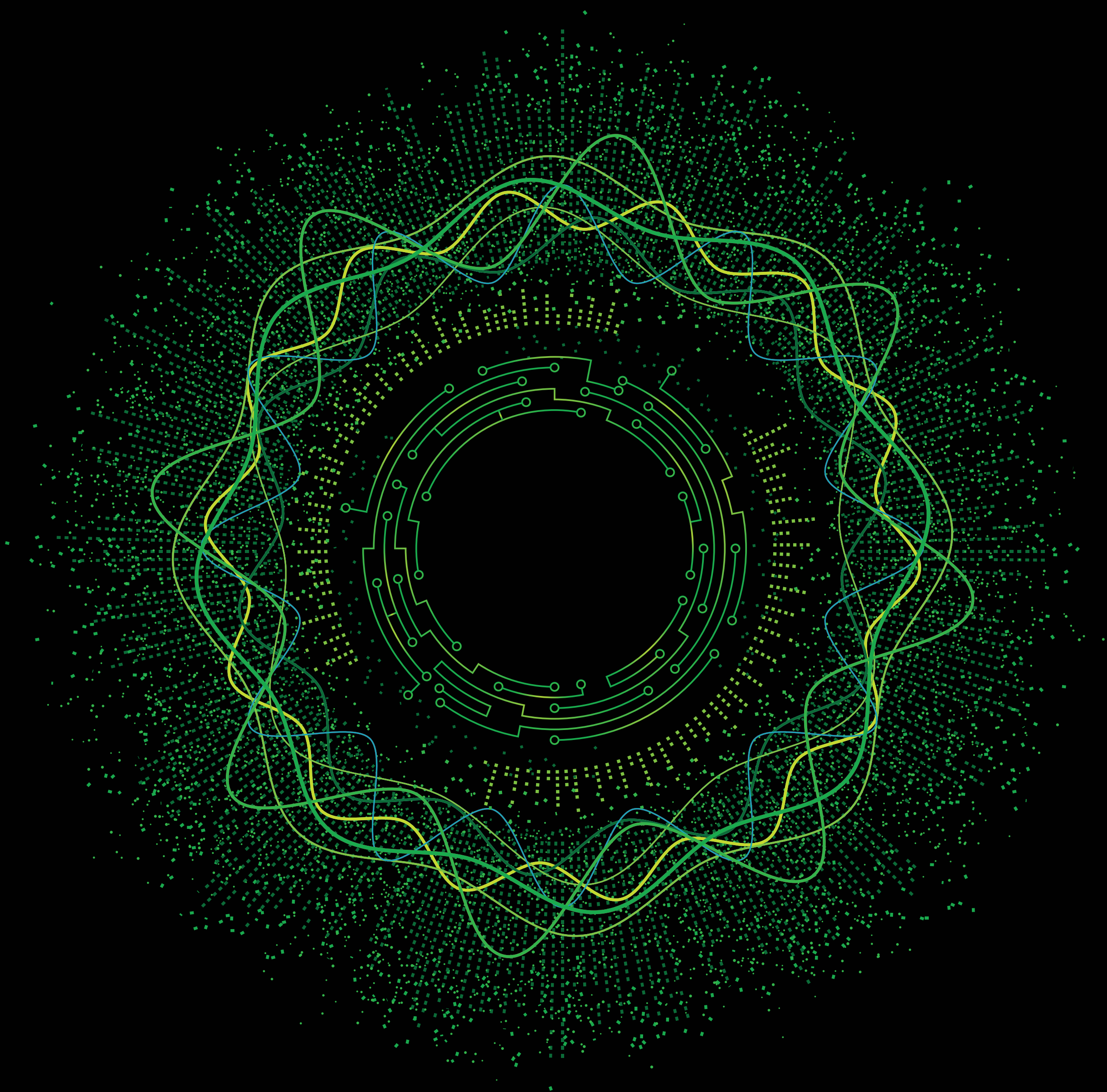


ACS Australia's Digital Pulse

Unlocking the potential of Australia's technology workforce

2020

Foreword

ACS Australia's Digital Pulse is an annual snapshot of Australia's digital economy where we investigate the current supply of technology workers and forecast future workforce and skills needs based on demand.

This year, there is the added complexity of the COVID-19 health crisis and the resulting economic crisis, where Australia will have its first recession in almost thirty years.

Australia's borders were closed to all non-residents on the 20th of March 2020. The impact of closed borders on education as Australia's fourth largest export earner and incoming travellers as our fifth largest export earner, was always going to be significant. As parts of industry were locked down in response to the health pandemic, over 850,000 jobs were lost from the Australian economy across March and April 2020.

We have a dedicated chapter looking at the immediate impacts of the health and economic crisis on the workforce. We also analyse new digital norms and look to identify the long-term legacy of new technology adoption.

Australia's exports are not very diverse, and don't generally employ many people as a percentage of Australia's total 12 million person workforce. Further, the sophistication of Australia's broader human capital (comparatively speaking) is not very high. This is a risk to future standards of living in our nation.

We have a burning platform to move to a truly digital economy both for the health benefits and the economic benefits. The question is how.

Our thanks once again to the team at Deloitte Access Economics for their investigation into these areas. We look forward to *ACS Australia's Digital Pulse 2020* providing valuable insights into answering the question of how.

Andrew Johnson
Chief Executive Officer

Contents

Glossary

Term	Definition
Multi-factor productivity (MFP)	MFP reflects the overall efficiency with which labour and capital inputs are used together in the production process. Changes in MFP can reflect the effects of changes in management practices, brand names, organisational change, general knowledge, network effects, spill overs from production factors, adjustment costs, and economies of scale.
Information, Media and Telecommunications (IMT) sector	This industry is defined by the Australian Bureau of Statistics (ABS) industry classification system based on the Australian and New Zealand Standard Industrial Classification 2006 (ANZSIC06). The division includes the following subdivisions: publishing (except internet and music publishing); motion pictures and sound recording activities; broadcasting (except internet); internet publishing and broadcasting; telecommunications services; internet service providers, web search portal and data processing services; and library and other information services.
Technology sector	This terminology refers to workers and economic activity generated by both certain elements of IMT industry and the large number of technology workers outside the IMT industry (for example, software developers working in the banking industry). There are also some employees in the IMT industry who are not technology workers (for example, publishers of print newspapers). In this study, employment figures for technology workers 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 Industry Economic Research (CIIER) lead researcher, Ian Dennis FACS, and used in the ACS's 2008–13 statistical compendiums and other CIIER analysis. For a list of which occupations and industries have been classified as technology workers, refer to Table A.3.
The Internet of Things (IoT)	The Internet of Things, or IoT, refers to the billions of physical devices around the world that are now connected to the internet, all collecting and sharing data. The term "IoT device" is often used to refer to physical objects that are connected to the internet to either be controlled or communicate information.

Executive summary

Digital technology underpins daily life. Information technology (IT) powers almost everything we do: from work and shopping, to entertainment and communication. The latest wave of use cases — artificial intelligence, advanced manufacturing and big data being some examples — are creating new opportunities for businesses. Economically, this powers productivity and economic growth. The Australian economy (measured through Gross Domestic Product or GDP) is 6.5%, or $126 billion, larger in 2019 than it would have been without the productivity benefits of digital technology.

Behind this technology is talent. Digital workers are fundamental to Australia's ability to access the economic and social benefits of the digital economy. *ACS Australia's Digital Pulse* provides an annual stocktake of Australia's digital economy and workforce. Prepared by Deloitte Access Economics, the series provides a detailed examination of digital workforce trends, aimed at informing public debate about this important area of our economy.

Australia had over three quarters of a million (772,100) technology workers in 2019. The technology workforce has increased at a faster rate than other parts of the economy. The number of technology workers increased by 6.8% between 2018 and 2019 — 1.5 times the growth in the number of professional occupations over the same period.

This report estimates that, in the medium term, these numbers will continue to grow. On average, the technology workforce is expected to grow at 3.1% on average for the next five years; double the expected growth in the labour force in general. At that pace, by 2027, there will be **more than one million technology workers in Australia.**

However, it will not be a straight path forward. Australia's GDP fell by 6.4% in the first half of 2020, while unemployment rose to 7.1% — and is expected to exceed 8.0% before the end of the year.

Like other sectors, the technology workforce will be affected by the economic consequences of COVID-19. **We estimate that COVID-19 will lead to 35,000 fewer technology workers in the Australian economy between March and December 2020**; a result of reduced migration and a temporary fall in demand for technology workers as a result of the broader economic downturn.

This is not to say that COVID-19 has made technology, or technology workers, any less important. Digital tools have been instrumental in keeping the economy moving while restrictions on movement and contact are in place. Increased reliance on digital, though, has also proven a test for some organisations. Nearly half (46%) of Australia's workforce were working from home in April. Existing system weaknesses and digital pain points have gone from being seen as relatively minor issues to major strategic flaws. Boardroom executives are increasingly focused on technology, planning to invest in digital capabilities and infrastructure to enable future growth.

Assuming that the health and economic shockwaves of COVID-19 subside in the next two years, our estimates suggest that by 2025, there will be an additional 156,000 technology workers in Australia, bringing the total number of workers up to 928,700.

Even with this forecasted growth trajectory, Australia is not on track to become a digital leader. In the United Kingdom, technology workers make up 9% of the entire workforce. To catch up, Australia would need to add over 60,000 new technology workers every year to 2025 — double the current forecast.

But the world's leaders in digital technology will not wait. This year's assessment of international competitiveness shows Australia ranks 7th out of the 16 nations considered. Where comparisons with previous years are possible, **Australia has fallen in rank for more than half of the indicators in the past two years.** This is not because Australia's performance has declined, but is primarily a result of other countries improving more quickly than Australia.

Attaining the full benefits of digital technology will require policy designed to promote investment in digital technology and skills. This year's *Digital Pulse* explores six key areas to improve the performance and competitiveness of Australia's digital economy and workforce.

Upskilling and reskilling

The Australian Government has announced subsidies to encourage students to undertake courses in a number of disciplines — including in IT. These courses will help workers from other industries to reskill and move into entry-level digital occupations. However, subsidies should also be designed to encourage existing technology workers to upskill their capabilities. This will enable greater productivity benefits for businesses using technology. Government should also collaborate with industry associations to promote reskilling and upskilling opportunities.

Investment in digital capacity

The Australian Government should extend programs to support small businesses to overcome barriers and digitally transform. One example is the Australian Government's Small Business Digital Champions demonstration program, which funds the development and adoption of digital transformation strategies for 100 small businesses across Australia through procured goods and services up to the value of $18,500. This support can be used to develop professional websites, file sharing software and other digital tools and training.

Research and development (R&D)

The current set-up of the R&D tax incentive limits the attractiveness for small to medium businesses (SMBs). Making R&D tax refunds more frequent and providing greater certainty to SMBs on eligible expenditure could promote greater participation by SMBs.

Shaping the digital landscape through e-invoicing

E-invoicing provides an opportunity to streamline current invoicing practices for businesses and government agencies. However, these benefits hinge on widespread adoption. To raise awareness of the new system and develop a critical mass of users, the Australian Government should establish a timeframe for all federal and state government agencies to transition. The Government should also consider providing time-limited financial assistance to help businesses overcome barriers to transitioning from legacy systems and barriers to adoption.

Encourage technology start-ups through employee share schemes (ESS)

ESS provides an additional source of remuneration to employees that is dependent on the future performance of the company. This can enable start-ups to offer greater incentives for talent to remain during critical expansion periods. Yet businesses report that the complexity of the scheme creates uncertainty for employees, limiting its effectiveness. Simplifying the ESS could encourage its usage by technology start-ups.

Measuring the ICT sector

The Australian Bureau of Statistics (ABS) should publish statistics on the Information and Communications Technology industry to acknowledge its important role in the Australian economy and inform decision makers. This role is currently hidden by the structure of the ABS national accounting framework, which combines ICT-related subdivisions with unrelated industries such as print media. Understanding the role of ICT will be particularly pertinent during a post COVID-19 environment, where the sector is expected to play a key role in economic recovery.

1. Introduction

The *ACS Australian Digital Pulse* series highlights the importance of the technology workforce in Australia and the demand for digital skills in a diverse range of Australian industries, such as agriculture, health, manufacturing and financial services.

The 2020 report represents the sixth edition in the *ACS Australian Digital Pulse* series. Compared to previous years, the economic environment is unprecedented. COVID-19 and the associated economic impact has already significantly affected the technology workforce in Australia.

In addition to profiling Australia's digital economy and workforce and the impact of COVID-19, this year's *Digital Pulse* updates the international competitiveness indicators last explored in the 2018 edition, to explore trends in Australia's technology sector compared to other relevant countries.

The research is based on information from a range of sources, including:

- Data from the ABS, both from publicly available data and a customised data request on the technology workforce
- Data and reports published by various Australian sources, particularly Australian Government departments such as the Australian Taxation Office (ATO), Education, Home Affairs and Industry
- Data from a recently published report by Faethm
- Consultations with RMIT Online, Data for the People and Scape

The remainder of the report is structured as follows:

- Section 2 examines the impact of COVID-19 on the Australian economy and the digital economy
- Section 3 is a snapshot of Australia's technology workforce and skills in 2019, including analysis on levels of demographic diversity and geographic distribution
- Section 4 outlines the productivity benefits from digital technology to the Australian economy
- Section 5 forecasts future employer demand for technology workers, and highlights the need for reskilling to improve digital skills in the workforce
- Section 6 updates the assessment of Australia's international competitiveness in ICT relative to other developed countries
- Section 7 discusses some key digital policy issues, including the need for technology reskilling, promoting small business investment in digital technology and incentivising start-ups and R&D.

2. COVID-19 and the digital economy

In a matter of months, the COVID-19 pandemic spread to over 200 countries and territories around the world. While Australia appears to have escaped the worst of the health crisis, the pandemic has still had a significant effect on the economy.

Large sections of the economy have effectively shut down and others have been forced to dramatically change how they operate. Some of Australia's largest service exports have been significantly affected, including tourism and international education — the latter usually generating nearly $37.6 billion in revenue to the economy, and supporting 240,000 jobs (ABS, 2019). As a result, GDP declined by 6.4% during the first half of 2020, while unemployment is forecast to exceed 8.0% by the end of the year (Deloitte Access Economics, 2020a).

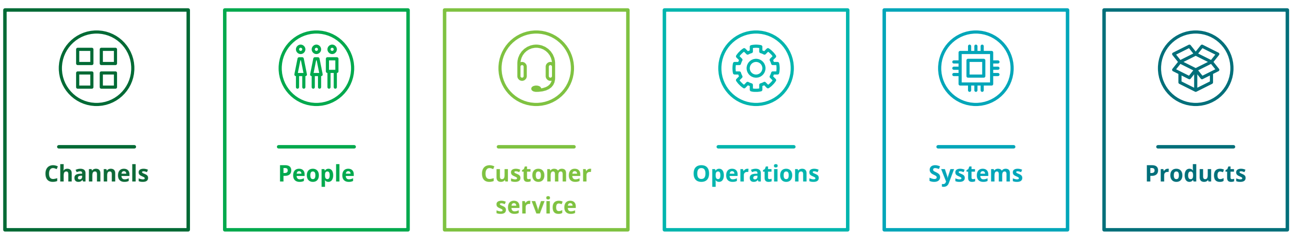
During the COVID-19 crisis, digital tools have been instrumental in keeping the economy moving while restrictions on movement and contact are in place. An increased reliance on digital, though, has also proven a test for some organisations. Existing system weaknesses and pain points have gone from being seen as relatively minor issues to major strategic flaws. Some business leaders have eyed digital investments and infrastructure as key to enabling future growth.

This chapter explores changes in the role of digital, including the new demands on digital technology during the crisis, the immediate impacts on the workforce and the possible long-term legacy the pandemic will leave.

2.1 Accelerating digital transformation

Many businesses have undergone a digital transformation to deal with the challenges of the crisis. This transformation has taken place in every part of business — products, channels, people, customer service, operations and systems.

Figure 2.1: Elements of business transformation due to COVID-19



Source: Deloitte Access Economics.

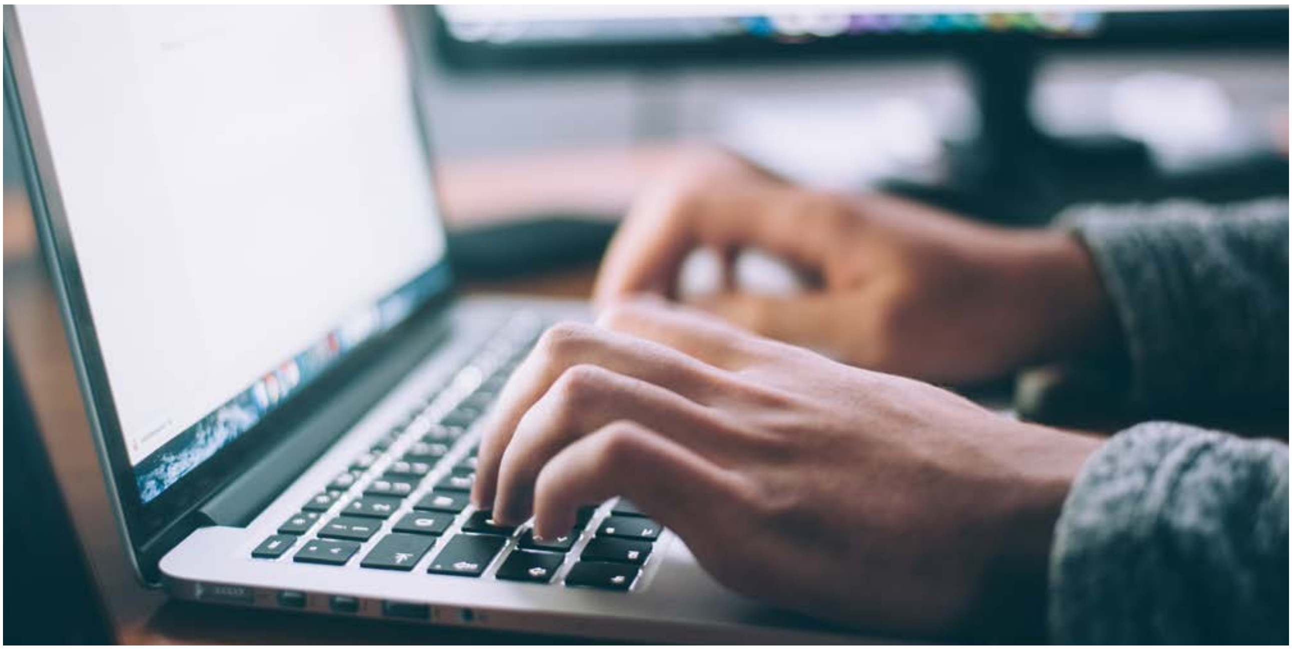
Previously physically-delivered industries have transformed their products, offering new online services to consumers. In the health sector, telehealth services were used to deliver 4.3 million health and medical services to more than three million patients by mid-April (Hunt, 2020). A survey of over 1,000 Australians found the 48% of respondents who visited their general practitioner between April and May did so virtually. Almost two-thirds report they would continue using telehealth services into the future (NBN Co, 2020a). Hospitality has also seen a boost to online orders, with consumer expenditure on food delivery services up 230% compared to pre-COVID levels (AlphaBeta, 2020).

For office-based businesses, the crisis has led to a significant change in how their people work. In April, at the height of lockdowns, an ABS survey found that some 46% of Australians were working from home. For some businesses it was even more. Westpac quickly transitioned 21,000 employees, or 85% of their total workforce to work remotely. Some international businesses had even higher levels, with global tech giant Cisco transitioning over 140,000 employees and partners around the globe to remote working in just 10 days (ZDNet, 2020).

Businesses have adapted their systems to new ways of working. Optus recently revealed a 1,125% increase in the number of Australians using Zoom on their networks, a 560% increase in users of Cisco's Webex and a 108% increase in users of Microsoft Teams (Canopus Networks, 2020).

Retailers shifted towards digital purchase channels or new ways of providing customer service. Closures and social distancing requirements meant that some restaurants, clothing stores and other retail moved substantially or entirely online. Almost two-thirds of consumers made a purchase online in one week in April (Deloitte Access Economics, 2020b), compared to 70% during the entirety of 2018 (Australia Post, 2019).

Many businesses have been forced to digitally transform their usual business operations. Prior to the spread of the virus, 92% of businesses anticipated that their business models would need to adapt given digitisation (McKinsey Digital, 2020). Some companies have achieved this by investing in improving their website platforms, or adopting new digital tools such as live chat technologies.



Deloitte Digital's COVID-19 Super Bot

The quick onset of COVID-19 has accelerated the adoption of digital technologies in Australia's banking and financial sector, illustrated among some superannuation funds. When financial markets began to react to the spread of the virus in early February, many superannuation fund call centres found themselves overwhelmed by a sudden surge in member inquiries. The volume of inquiries increased even more after the Australian Government's announcement of the Early Access regime in mid-March. Joel Lipman, Partner at Deloitte Digital, heard from some fund managers that this led to some of their busiest days of calls ever. Not normally designed to meet such a sudden increase in inquiries, many contact centres were overwhelmed with demand.

Over the course of one weekend, the Deloitte Digital team programmed and released the COVID-19 Super Bot ('the Bot'). The Bot is an Artificial Intelligence-enabled chatbot technology optimised for answering member inquiries for superannuation funds. Producing the Bot required quickly adapting chatbot technology which Deloitte Digital had previously developed for other financial institutions. For example, Deloitte Digital has worked with National Australia Bank to developed a live virtual assistant, which has completed over 20,000 customer queries and conducted over 9,000 chats per month since its release in August 2018.

The COVID-19 Super Bot's underlying intelligence engine was sourced from a Melbourne-based start-up, inGenious AI, using Google's Dialogflow technology. The Bot was also programmed with additional rapid reporting and training features, to enable effective reporting on what topics it could and couldn't answer. Joel noted that "this was the key to success of the Bot, as it was able to quickly learn to match new topics and phrases, improving its ability to answer a growing number of customer inquiries over time".

Over one week of operating for one of Australia's largest superannuation funds, the Bot helped to answer the inquiries of approximately 1,500 members. This represents a significant time and cost saving for the fund, enabling it to rapidly scale to meet unexpected bursts of inquiries and reduce ongoing stress on contact centres. The technology also offers convenient and flexible assistance for members, helping to avoid long hold queues and provide answers over the weekend and after normal office hours. Joel describes this improvement in customer experience at a time of high stress levels as "invaluable" for Deloitte Digital's superannuation fund clients.

While COVID-19 has resulted in more institutions trialling and adopting a greater range of digital technologies, many customers may still prefer to deal with a person when working with their financial institutions. Nonetheless, offering greater convenience and flexibility for both financial institutions and customers, chatbots like the COVID-19 Super Bot are likely to become more common — and more intelligent — over time.

2.2 New demands on digital

The accelerated digital transformation has acted as a stress test for digital infrastructure and capability. The demand for internet servers globally has increased by over 30% from pre-crisis levels (Heficed, 2020). In Australia, use of the National Broadband Network during business hours has increased by 67% as more Australians work from home (see Figure 2.2).

The number of people trying to interact with businesses and government online has created additional strain. While two-thirds of Australians attempted to shop online during April, 70% of them encountered issues relating to stock availability, delivery and their online experience (Deloitte Access Economics, 2020b). Major government websites have also been affected as traffic spiked. In late March, the MyGov website crashed as thousands of people sought Centrelink help during the early days of the lockdown (Australian Broadcasting Corporation, 2020).

The rapid transition to remote working has also tested the cybersecurity preparedness of companies. The increased use of personal devices, which are less likely to have the latest security protections, has made business more vulnerable to cyber attacks (Deloitte, 2020). In Australia, 62% of workers reported using a personal device to conduct business transactions while working from home during the COVID-19 shutdown (CrowdStrike, 2020).

Critical infrastructure and government services have been the subject of increasing, opportunistic cybersecurity attacks. Cyber criminals are impersonating health organisations and other government entities in malicious email campaigns designed to invoke fear. Unprotected devices could lead to the loss of data, privacy breaches, and systems being held at ransom. Cloud-based systems are vulnerable to attack from cyber criminals.

The COVID-19 pandemic has not only tested digital technology, but has also placed greater pressure on IT support staff. The transition to remote working has led to a sharp increase in demand for IT trainers and support workers. Deloitte Access Economics forecasts that this year alone there will be an 85% increase in demand for IT trainers, and an 11.5% increase in demand for ICT Support workers.

2.3 The long-term legacy

Businesses stand to benefit from embedding the digital tools they have adopted during the crisis. On average, highly digitally engaged businesses earn 60% more revenue per employee and grow 28% faster than businesses with poor digital engagement (Deloitte Access Economics, 2019e).

Technological changes made in response to COVID-19 also present opportunities for future growth. For example, the manufacturing industry has been using automation, robotics and 3D printing to create medical equipment during the crisis. With global supply chains disrupted, the government has indicated that this demonstrates an opportunity for growth in the industry (Andrews, 2020).

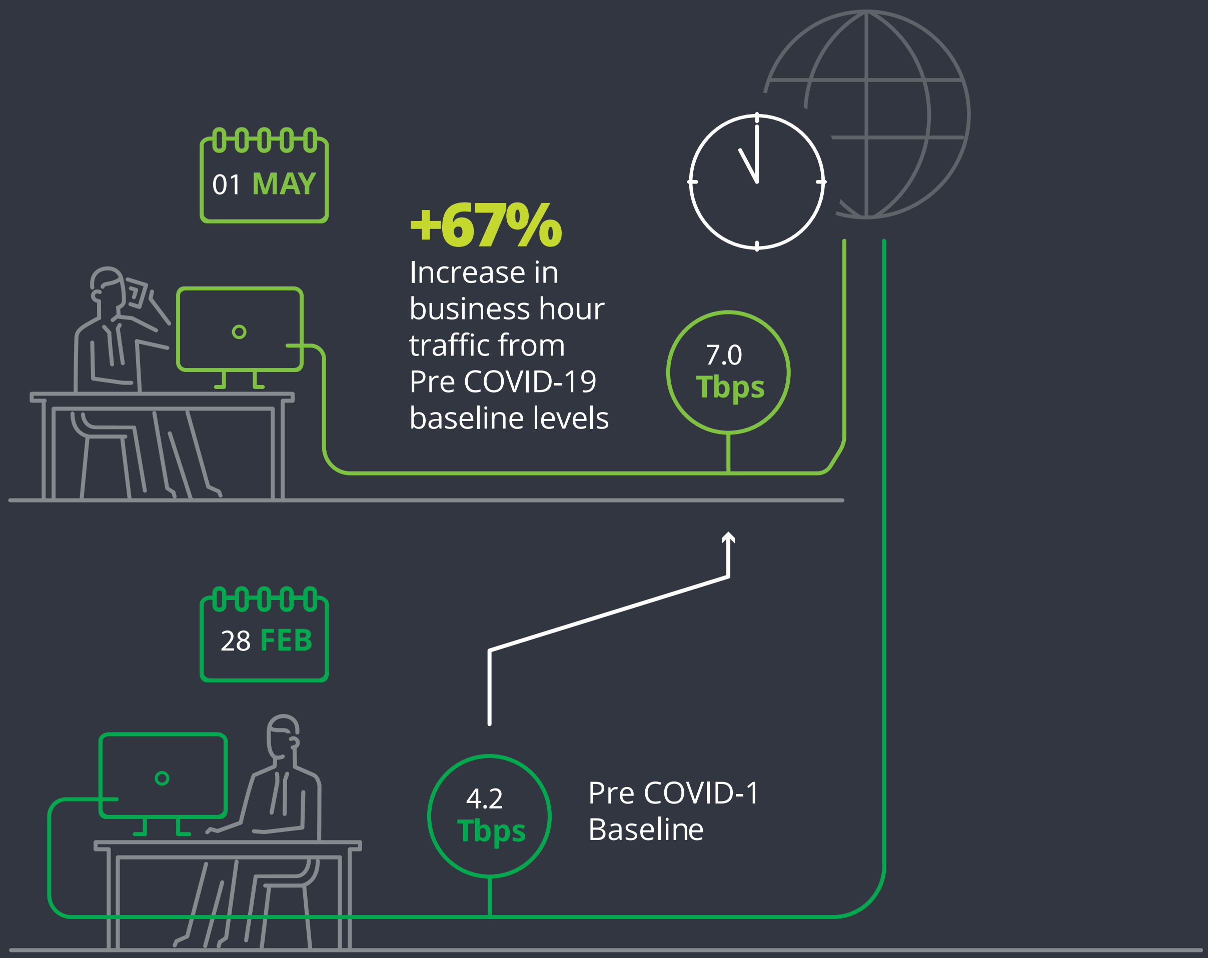
However, the crisis should be seen as kick-starting more digital transformation, rather than reaching a new plateau. Higher education providers, for example, could further expand their online offerings to create new opportunities. Australia's shared time zone with Asia provides a comparative advantage in the delivery of synchronous online education relative to many of the world's largest importers of tertiary education services (Deloitte Access Economics, 2015).

Workers, suppliers and customers will also demand that businesses continue to offer high levels of digital service going forward. One quarter (26%) of Australians plan to work more from home once the COVID-19 crisis ends, and 24% plan to spend more time shopping and browsing online (Deloitte Access Economics, 2020b).

The digital challenges faced during the crisis have highlighted the importance of investing in digital workers and digital infrastructure. The Australian Government is already taking steps in this direction with the establishment of the Digital Technology Skills Organisation (SO) pilot. The Digital Technology SO aims to ensure the national training system is responsive and flexible enough to deliver the digital skills that industry needs now and into the future (DESE, 2020).

Figure 2.2:

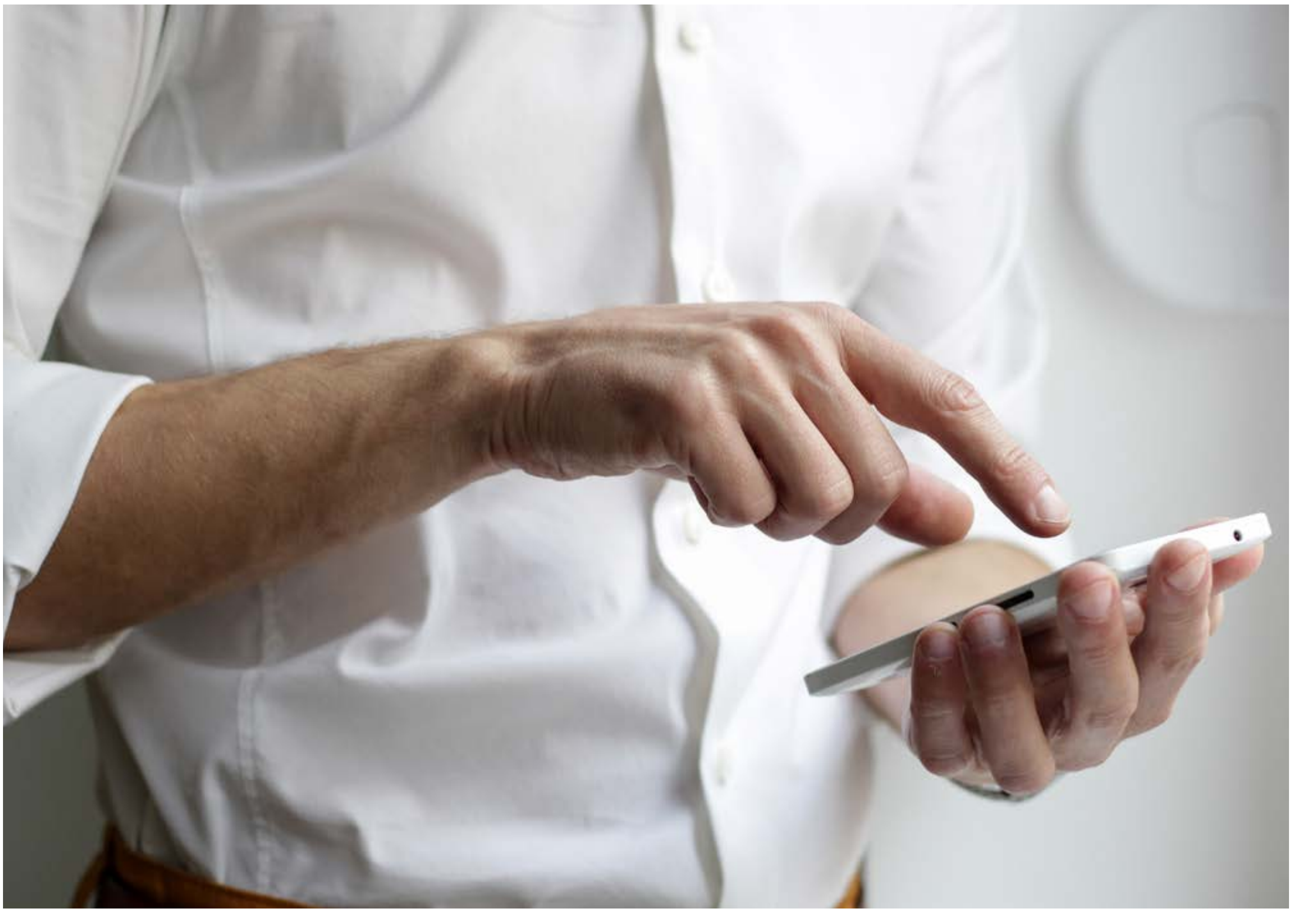
Increased demand on the national broadband network



Source: NBN Co (2020).

Yet in some instances, creating an enduring digital legacy may also require regulatory change. For instance, while some jurisdictions now allow the electronic signing of legal documents, these provisions are often temporary (Saxon, Lumsden and Husband, 2020). Similarly, Medicare-supported telehealth services, which have proved incredibly popular during the crisis, have only temporarily been made available to all Australians (Hunt, 2020).

Another digital transformation opportunity will come in the recovery phase following the crisis. As governments look to build and facilitate new infrastructure to stimulate the economy, there will be an opportunity to embed sensor technology so that infrastructure is smart. As governments consider broader reforms to encourage new businesses, the policy framework could also be enhanced to deal with long-standing digital issues regarding reskilling and investment. Some of these possibilities are discussed later in this report.



Evolving business practices in challenging circumstances

As a non-executive director for a number of both public and private companies, Anouk Darling says that while many businesses develop high-level contingency plans for "black swan" events, they rarely anticipate actioning those plans or for those plans to become the new normal. However, businesses have been forced to adapt quickly in order to stay operational during COVID-19. Anouk explains, "COVID-19 has caught many businesses unawares, as they didn't realise their own blind spots in digital strategies and capabilities. As a result, businesses have had to leapfrog their digital adoption forward."

One company that Anouk is involved in which has been forced to pivot quickly due to COVID-19 is Scape, which provides purpose-built student accommodation. Scape operates over 14,000 rooms nationally for students. At the outbreak of the pandemic, Scape had to act quickly to ensure the safety of the 1,500 students living in Scape facilities at the time.

Scape took action promptly, rather than waiting for guidance from government. Before February, it had already developed support initiatives including free medical assessments, provisions for voluntary 14-day isolation (before any government announcements) and a range of enhanced protections in the facilities for students to limit transmission. As the situation evolved, so too did Scape's offerings. Scape is now providing nurses, extra cleaning, security, access to Sonder, a 24/7 safety app, and many virtual events and wellbeing activities to provide support and peace of mind to students.

While restrictions limited some business activities, Anouk noted that changes to trading should not mean that businesses stop maintaining their relationships with their customers. In fact, Anouk argued that building brand and communicating with customers is even more important during a crisis. "We — as consumers, individuals and citizens — are seeking empathy and understanding of the situation. Now is the time to lean in and get to know what your customer is going through and what resonates with them," explains Anouk.

For example, Scape worked with the Queensland Government to provide crisis housing for people at risk in boarding house accommodation during the pandemic, by offering alternate studio-style accommodation to limit exposure to COVID-19. Scape worked with the Queensland Government and university students during April to make room for these at-risk individuals, while providing alternate accommodation for students in their other properties.

Businesses will also need to consider the extent to which changes made for COVID-19 will be embedded in the long-term. For instance, what does a contactless environment mean? For Scape, this means thinking about the recovery from COVID-19 and mapping the future experiences of students in their facilities. This has involved planning to replace or augment physical processes with technology or new socially-distanced processes to improve the safety of students, including safety and hygiene programs and grab-and-go meals. Anouk said that businesses ultimately need to be flexible, and "act strategically while also staying true to their values. Both are required if a business will survive in this turbulent environment."

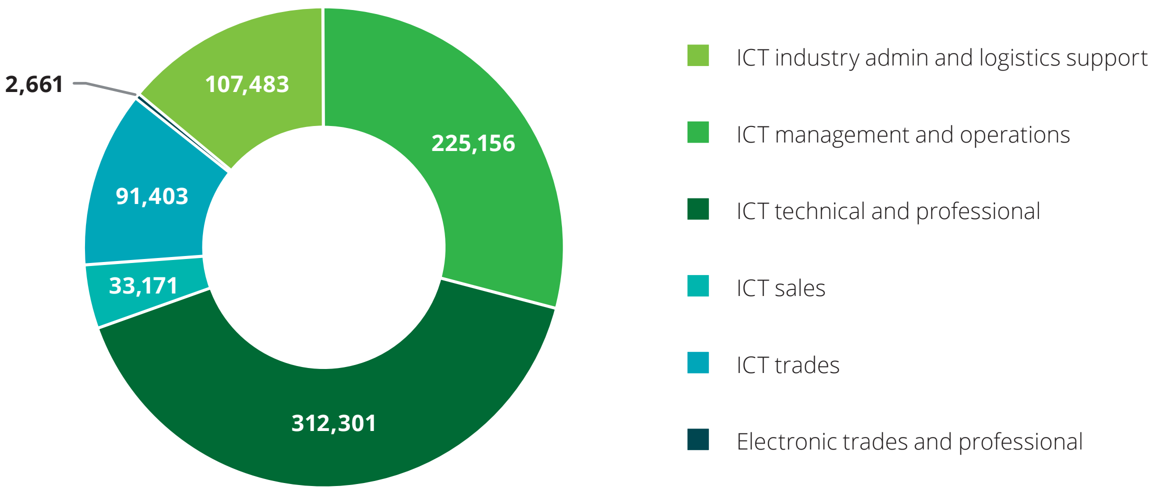
3. Recent growth of the technology workforce

3.1 Technology related occupations and industries

Before the advent of COVID-19, the technology workforce in Australia displayed strong growth. The number of technology workers grew by more than 48,000 additional workers from 2018, bringing the total to 772,125 in 2019.[1,2] This represents growth of 6.8% in a year. The technology workforce has grown 1.5 times faster than the increase for professional occupations (4.5%) more broadly — pointing to continued strength in demand for technology workers across the economy.

Much of this growth was driven by an increase in the number of ICT technical and professional workers, which grew by 13.7% to 317,661 workers in 2019 (Chart 3.1). This group includes occupations such as software programmers, graphic and web designers and telecommunications technical professionals. By comparison, occupation groupings such as ICT sales and ICT trades saw little or no growth in the year. The number of employees within the electronic trades and professions grouping — including electronics trades workers and technicians employed in telecommunications or computer system industries — fell from 2018 levels.

Chart 3.1: Technology workers by CIIER occupation groupings, 2019

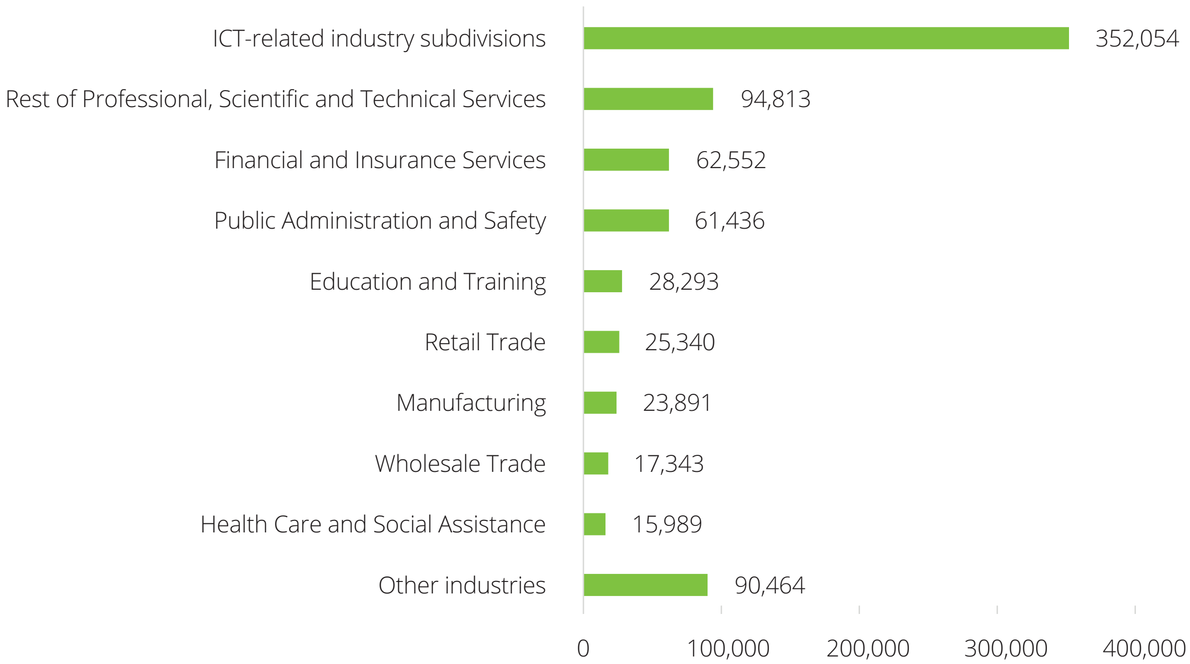


Source: ABS customised report (2020).

1. ABS industry classifications include an 'Information Media and Telecommunications' (IMT) industry. However, in practice there are a large number of technology workers outside the IMT industry (for example, software developers working in the banking industry) and there are some employees in the IMT industry who are not technology workers (for example, publishers of print newspapers). In this study, employment figures for technology workers 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 CIIER lead researcher, Ian Dennis FACS, and used in the ACS's 2008–13 statistical compendiums and other CIIER analysis. For a list of which occupations and industries have been classified as technology workers, refer to Table A.3. Note that this figure reflects a change in methodology compared to the previous *Digital Pulse* editions, including the addition of 3,435 workers assigned to 'not fully defined (nfd)' occupations. Where appropriate, these workers have been included into the estimate of the technology workforce. Where growth rates from 2018 are presented in this chapter, the base figure has been adjusted to include nfds.
2. In this report, we use the term "technology workforce" to describe the group of workers previously called the "ICT workforce" in past editions of *Australia's Digital Pulse*.

While much of Australia's technology workforce is directly employed in ICT-related industry subdivisions, many are also employed in other industries and sectors across the economy. Breaking down Australia's technology workforce by industry of employment, nearly half are employed in ICT-related industry subdivisions such as computer system design, telecommunication services and internet service provision (Chart 3.2). The remainder are employed in other industries throughout the economy, chiefly in professional, scientific and technical services. The number of technology workers in the financial and insurance services industry grew by just over 10,000 workers in 2019. This represents approximately 20% growth, while employment in the financial and insurance services grew by only 3% between February 2018 and February 2019 — illustrating the importance of technology skills to that sector.

Chart 3.2: Technology workers by industry, 2019

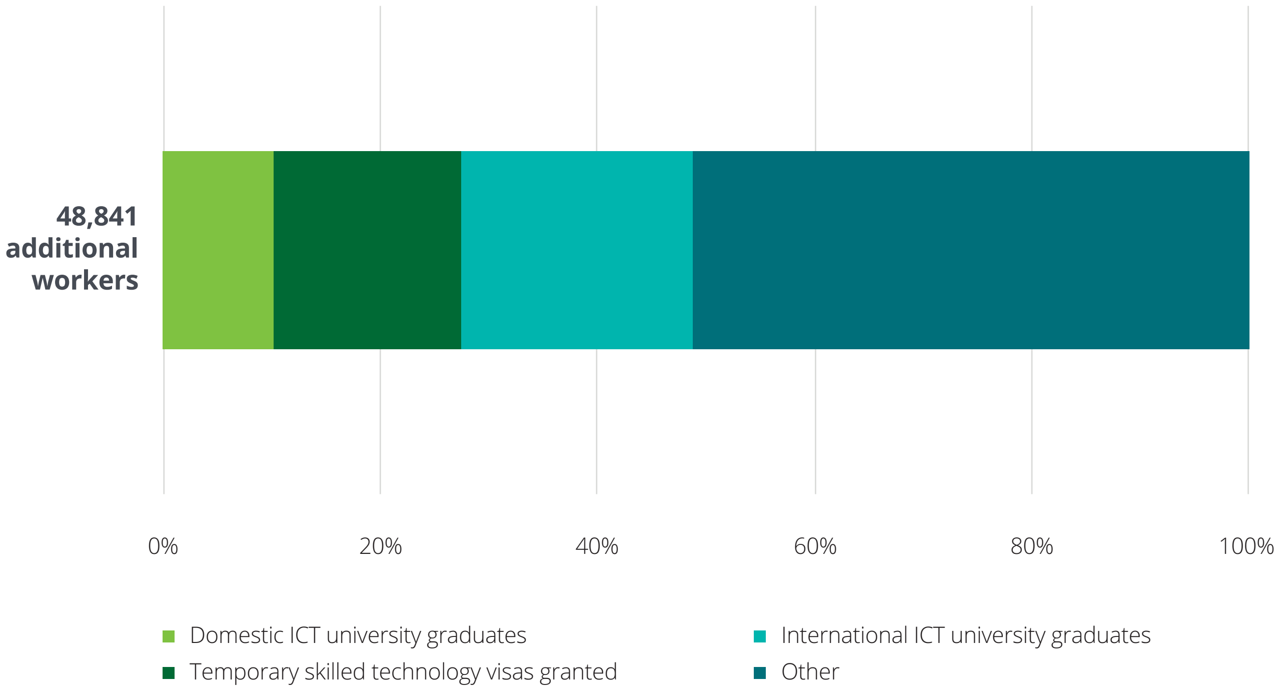


Source: ABS customised report (2020).

3.2 Supply of technology workers

Gross inflows of domestic and international ICT university graduates and the temporary migration of skilled technology workers accounted for less than half of the growth in Australia's technology workforce in 2019 (see Chart 3.3). Other sources for the supply of technology workers might include graduates from non-ICT degrees or qualifications, permanent migrants to Australia and workers transitioning from other occupations. The growth in these categories would need to be larger than the net growth in the sector to account for outflows (emigration, retirements, and movements out of technology occupations) over the past year.

Chart 3.3: Growth of technology workers, by source

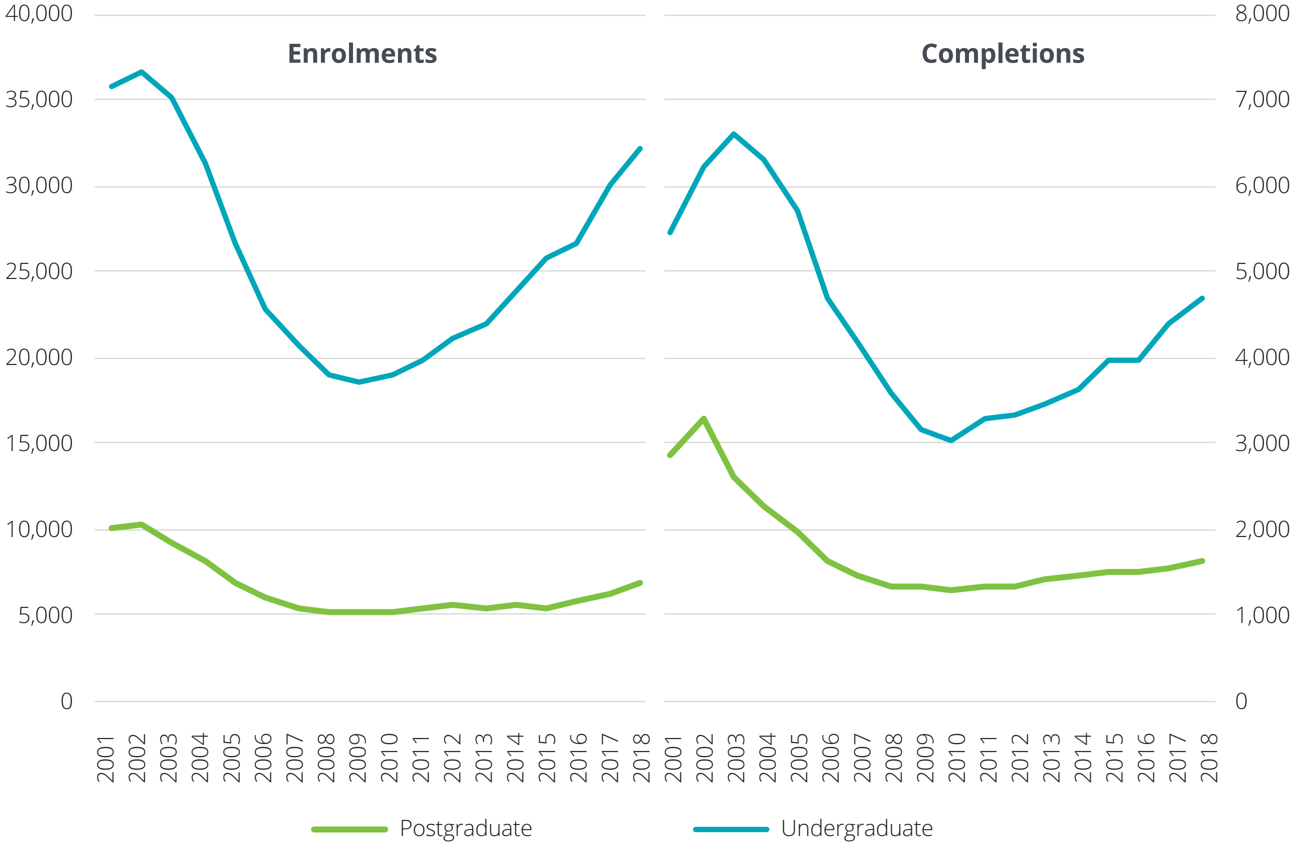


Source: Deloitte Access Economics estimates, Department of Education uCube (2019), Department of Home Affairs Temporary Work (Skilled) Visa Program pivot table (2020).

3.2.1 Universities

Domestic enrolments in undergraduate and postgraduate ICT degrees at Australian universities continued to increase in 2018, growing by 7.5% from 2017 to a total of 32,188 undergraduate enrolments, and a total of 6,875 enrolments in postgraduate studies. Domestic completion rates also continued to increase, although at a slower pace, growing by 6.6% over the year (Chart 3.4).

Chart 3.4: Domestic enrolments in, and completions of, IT degrees, 2001–2018



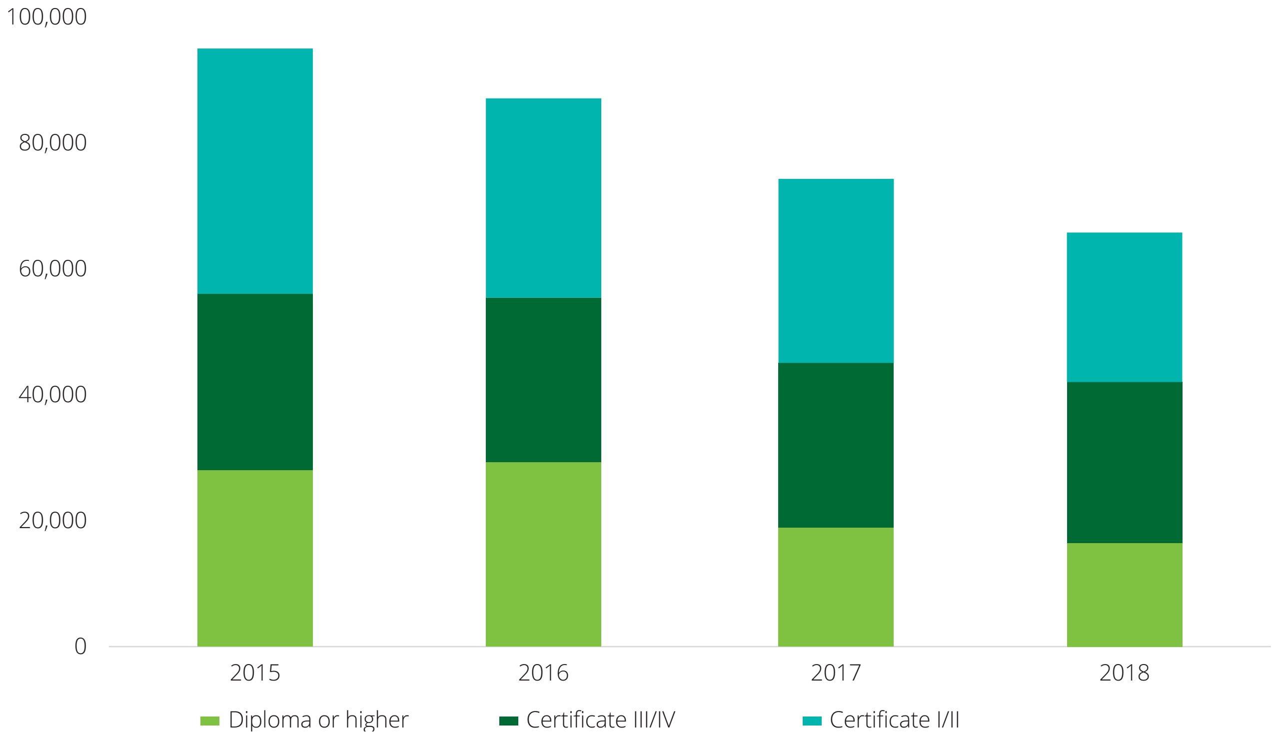
Source: Department of Education uCube (2020).

3.2.2 Vocational training

Enrolments in VET ICT subjects continued to decline in 2018, particularly for enrolments in entry-level Certificate I/II courses (which fell by 12% on 2017, or nearly 40% from 2015) and Diploma and above courses (which fell by 18.8% on 2017, or nearly 40% on 2015). By comparison, enrolments in Certificate III/IV courses have remained comparatively stable, falling 3.4% in 2018, or 10.9% since 2015 (Chart 3.5). Courses at this level tend to offer more job-specific training compared to the basic skills taught in introductory courses, and may not require completion of an earlier Certificate I/II course.

This change in composition of demand for vocational training courses may indicate that students are interested in gaining more job-specific skills compared to those offered in Certificate I/II courses. The shorter timeframe and reduced cost compared to Diploma courses may also offer an advantage for many students.

Chart 3.5: Vocational Education Training (VET) ICT subject enrolments by qualification level, 2015–18



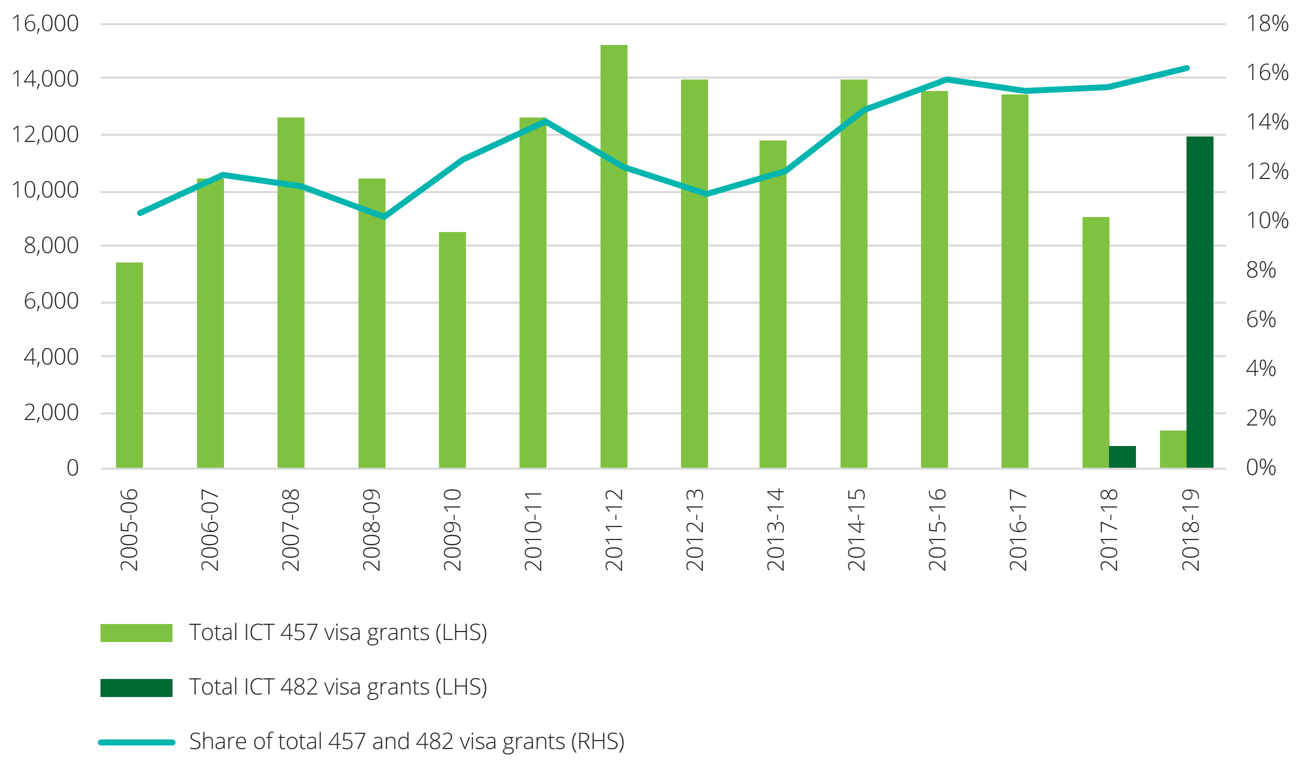
Source: NCVER Total VET Students and Courses 2018 Data Slicer (2019).

3.2.3 Migration

The number of temporary skilled migrants joining Australia's technology workforce also rose in the 2018–19 financial year, with the number of visas granted to migrants in technology occupations rising more than 30% from 2017–18 (Chart 3.6). This shows recovery from the sharp decline brought about by the replacement of the Subclass 457 Work Visa with the Subclass 482 Temporary Skills Shortage Visa in 2018, bringing the share of Australia's technology workforce employed under temporary skilled visas to approximately 2%.

Overall, the share of temporary skilled visas granted to technology workers grew slightly in 2018–19 by nearly one percentage point on 2017–18. ICT occupations were among the top categories of all visas granted; of the four most commonly granted occupations, three included software engineer, ICT business analyst and program developer (Department of Home Affairs, 2019).

Chart 3.6: Subclass 457 (temporary skilled worker) and 482 visas granted to technology workers, FY2010–FY2018*



Source: Department of Home Affairs Temporary Work (Skilled) Visa Program pivot table (2020).

*Excludes ICT industry admin and logistics support, for which breakdowns are unavailable; electronic trades and professional data is for all industries.

In addition, the Global Talent Scheme Pilot was made permanent in mid-2019. Applicants can apply for a place as a Global Talent Employer Sponsored (GTES) worker or a Global Talent Independent (GTI) worker.

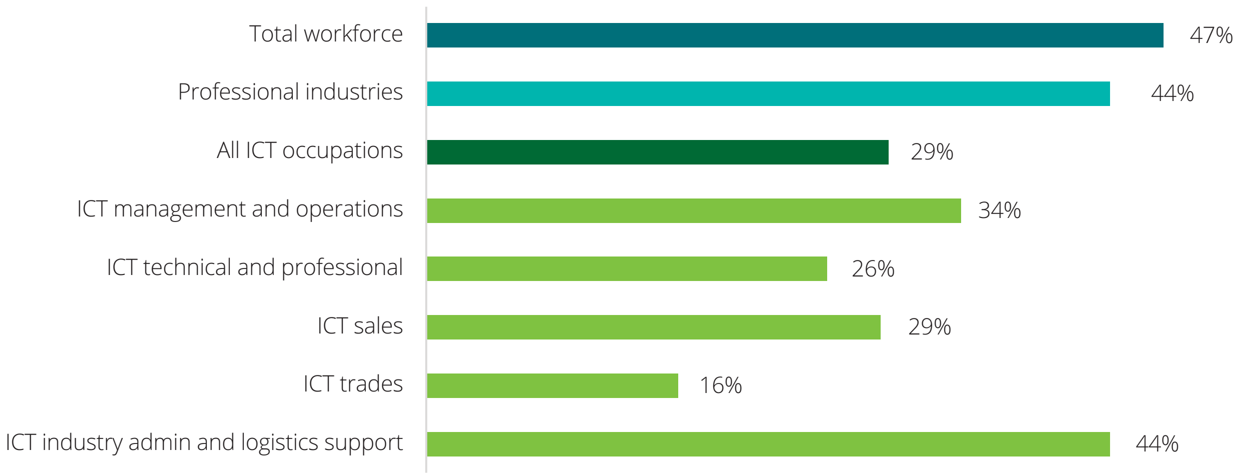
The GTES program mirrors the pilot introduced in July 2018, aimed at attracting high-skilled technology workers to established businesses and start-ups. It enables applicants to bypass the requirement to be employed in a designated skills-shortage occupation under the subclass 482 visa. This is a potential hindrance for technology start-ups, where employees may not easily fit into established occupation categories. However, the Department of Home Affairs has clarified that the program is only intended for use by a low volume of applicants, or only "highly-skilled niche occupations that cannot be accessed through existing skilled programs" (Department of Home Affairs, 2019a).

Similarly, the new GTI program offers a streamlined priority visa for highly skilled workers from seven target sectors: AgTech, Space and Advanced Manufacturing, FinTech, Energy and Mining Technology, MedTech, Cyber Security and Quantum Information/ Advanced Digital/Data Science/ ICT. Applicants for the GTI must demonstrate the ability to attract a salary above the Fair Work high-income threshold, which was set at $148,700 in July 2019. Applicants need not be sponsored by an employer to apply, but must be endorsed by a 'nominator' — an Australian citizen or organisation with a 'national reputation' in the same field as the applicant. As of January 2020, 140 applications have been granted out of a maximum of 5,000 offered in the 2019–20 financial year.

3.3 Diversity in the technology workforce

Women continue to be significantly underrepresented in Australia's technology workforce in 2019, with the overall share (29%) of women in technology occupations remaining unchanged from the previous year. This is significantly lower compared to 44% of female workers in professional industries and 47% of the total workforce (Chart 3.7).

Chart 3.7: Share of women in technology occupations, 2019



Source: ABS customised report (2020).

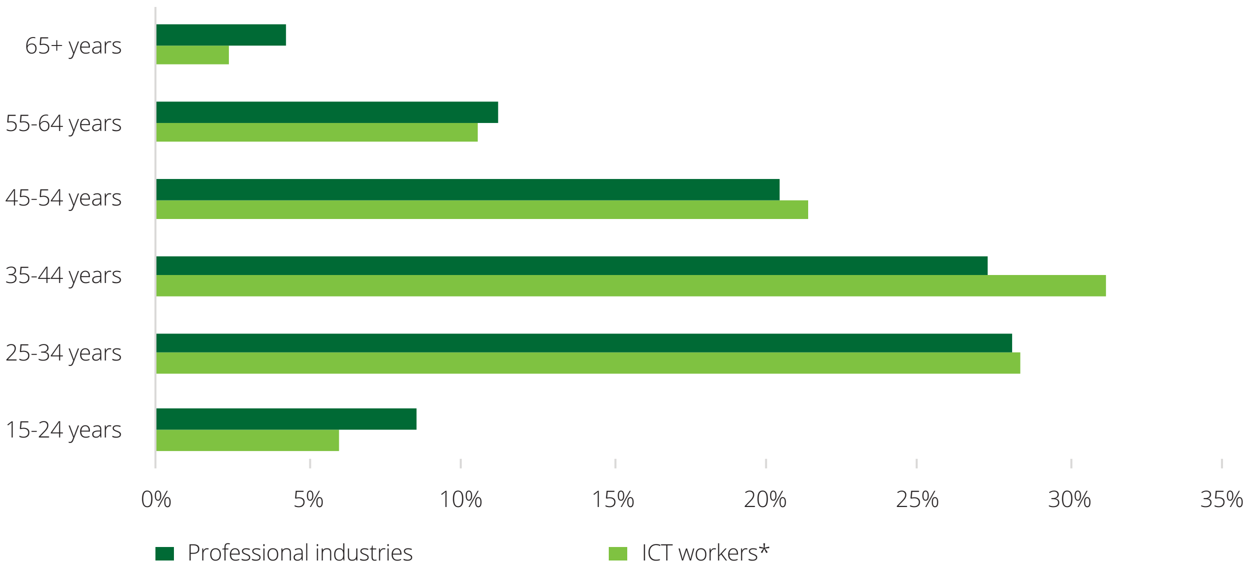
This year, several ICT occupations experienced marginal gains in their share of women, including ICT management and operations (up one percentage point on 2018 to 34%), ICT technical and professional (up one percentage point to 26%), ICT sales (up one percentage point to 29%) and ICT industry administration and logistics support (up two percentage points to 44%). ICT trades was the only grouping to see a decline in the share of women by occupation, falling by one percentage point to 16%.

To encourage more women to enter science, technology, engineering and mathematics (STEM) education and careers, the 2018–19 budget provides an additional $4.5 million over four years to progress a Women in Science Strategy. The aim of the strategy is for sustained increases in women's STEM participation, particularly at a school education level (Department of Industry, Science, Energy and Resources, 2019).

Recent research shows that the low participation of women in trades, particularly in the area of electronic and telecommunications trades, may be a result of sociocultural barriers that lead career advisers to steer females away from trades. These forces continue even in training and during employment as well, leading to lower retention of female workers. (Charles Stuart University, 2019). Organisations such as Trades Women Australia seek to encourage the recruitment and retention of women in skilled trade roles that are often male-dominated.

Older workers also continue to be underrepresented in Australia's technology workforce in 2019. There were 92,103 ICT workers aged 55 to 64 years in 2019, representing 13.0% of the total technology workforce (Chart 3.8). This represents an increase of one percentage point since 2018. By comparison, the same age bracket represented 15.6% of Australia's total professional workforce in the same year.

Chart 3.8: Age profile of technology workers, 2019



Source: ABS customised report (2020).

*Excludes ICT industry admin and logistic support for which breakdowns are unavailable.

Increasing the participation of underrepresented cohorts — such as older workers — in technology occupations could be a valuable source of knowledge for businesses. Retaining older worker will require businesses to use flexible working arrangements. A survey of workers aged 65 and over suggests that flexible working hours is the top enabler (cited by 40% of respondents) for them to remain in the workforce (AHRI, 2018).

The recent switch to flexible working as a result of COVID-19 could lead to increasing participation from older workers. Flexible work arrangements have gone from an optional extra offered by some, to a necessary tool utilised by many. As we move into economic recovery, retaining these flexible arrangements could improve retention for different workforce cohorts, such as primary caregivers and older workers.

3.4 The geographic distribution of technology workers

Australia's technology workforce is highly concentrated in state and territory capital cities. Nearly nine out of ten technology workers (87.4%) were employed in one of Australia's eight capital cities according to ABS census data (ABS, 2016).[3] The difference between ICT employment in Australia's capitals and the rest of the country is also present when comparing ICT workers as a share of the total workforce. Across all states and territories, ICT workers make up a substantially larger share of the workforce in capital city areas than they do in the rest of the country (see Table 3.1).

The concentration of technology employment in capital cities is most pronounced in New South Wales and Victoria (ABS, 2016). In Sydney and Melbourne, ICT workers make up a four times larger share of the workforce than in the rest of New South Wales and Victoria respectively (ABS, 2016).

Within Sydney and Melbourne, the distribution of ICT employment is also highly concentrated to particular Local Government Areas (LGAs) (see Figure 3.1). In Sydney, 61% of technology workers are employed in three out of 35 LGAs (ABS, 2016). In Melbourne, nearly 50% of ICT workers are employed in one LGA alone (ABS, 2016).

The geographically concentrated nature of Australia's technology workforce is to be expected given the significant benefits of industry clusters. For instance, some technology roles require digital infrastructure which can only be found in major cities. Businesses also benefit from access to the larger pool of specialised technology skills found in metropolitan areas (Fullerton and Villemez, 2011). More broadly, there are economic benefits as clusters of similar businesses can be more productive, more innovative and encourage the creation of new businesses. This, in turn, can facilitate greater economic growth (Porter, 1998).

Both federal and state governments have for some time tried to combat the growing regional skills gaps. While the concentration of ICT workers in large capital cities delivers many benefits, it also draws skilled labour away from regional areas.

Table 3.1: Share (%) of ICT workers in the total workforce, 2016*

	NSW	Vic	Qld	SA	WA	Tas	ACT	NT	Aus
Greater capital city area	8.1	7.3	5.5	4.5	4.2	4.3	10.9	3.1	6.6
Rest of state/territory	2.0	1.9	2.0	1.0	1.0	1.7	NA	1.6	1.8

Source: ABS (2016).

*Excludes workers who listed no fixed address for their place of work.

3. The workforce figures used in this section of *Digital Pulse* are based on ABS Census data. This differs from the customised labour force survey used to generate workforce statistics. This means there is a small difference between the absolute technology workforce figures in this section and the 2017 *Digital Pulse*. However, the same occupations are used in both analyses (according to the CIIER definition of technology workers) for comparable results.

To this end, the Australian Government introduced two new regional skilled visas in November 2019 to encourage skilled migrants to settle in regional areas (Department of Home Affairs, 2019).

Yet encouraging more technology workers into regional areas may require additional investment in digital infrastructure. In New South Wales, the State Infrastructure Strategy (SIS) sets out the Government's aim to improve state-wide connectivity and realise the benefits of technology, such as greater competitiveness for regional businesses (Infrastructure NSW, 2018). In order to help realise this objective, New South Wales has committed $400 million to bringing a faster and more reliable digital network to regional areas. This includes greater mobile coverage and improved internet and data services which will deliver the connectivity required to support the adoption of agricultural technology (NSW Government, 2020).

With more digital infrastructure investment in regional areas and an increase in flexible working arrangements due to COVID-19, there may be an increase in the regional share of technology workers (Deloitte Access Economics, 2020a). If workers and businesses are able to achieve many of the benefits of a physically-concentrated workforce by using online collaborative platforms, there may be fewer barriers for regional technology workers.

Figure 3.1:

The distribution of technology workers in state capital cities, 2016*

Notes: Darker shades of green indicate a greater share of ICT workers in a given LGA.

Source: ABS (2016).

* ICT employment numbers exclude electronic trades workers.

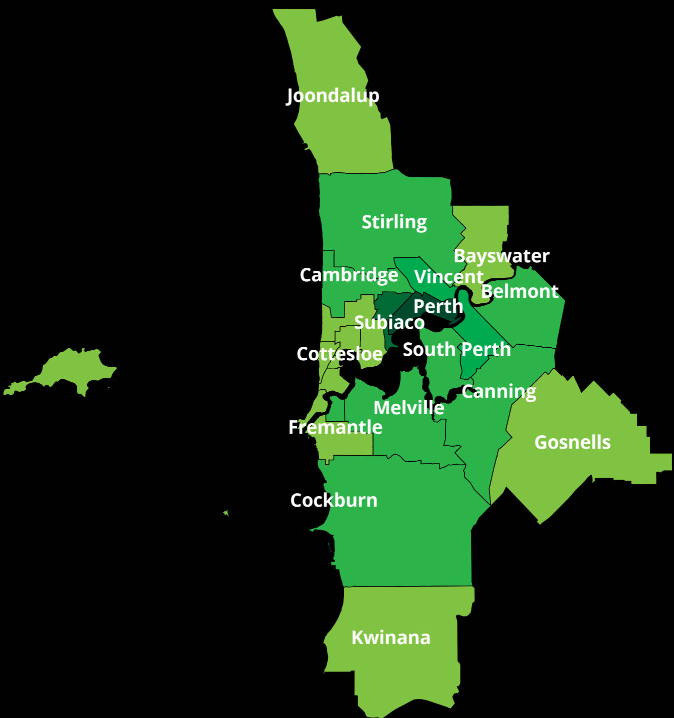
Brisbane

Hobart

Notes: Darker shades of green indicate a greater share of ICT workers in a given LGA.
Source: ABS (2016).
* ICT employment numbers exclude electronic trades workers.

0% 24%

Adelaide



Perth

Notes: Darker shades of green indicate a greater share of ICT workers in a given LGA.
Source: ABS (2016).
* ICT employment numbers exclude electronic trades workers.

0% 24%

4. Economic importance of the digital economy

The economic importance of digital technology to the Australian economy can be estimated in a number of ways. The amount of employment supported throughout the economy is one measure, explored in the previous section of this report.

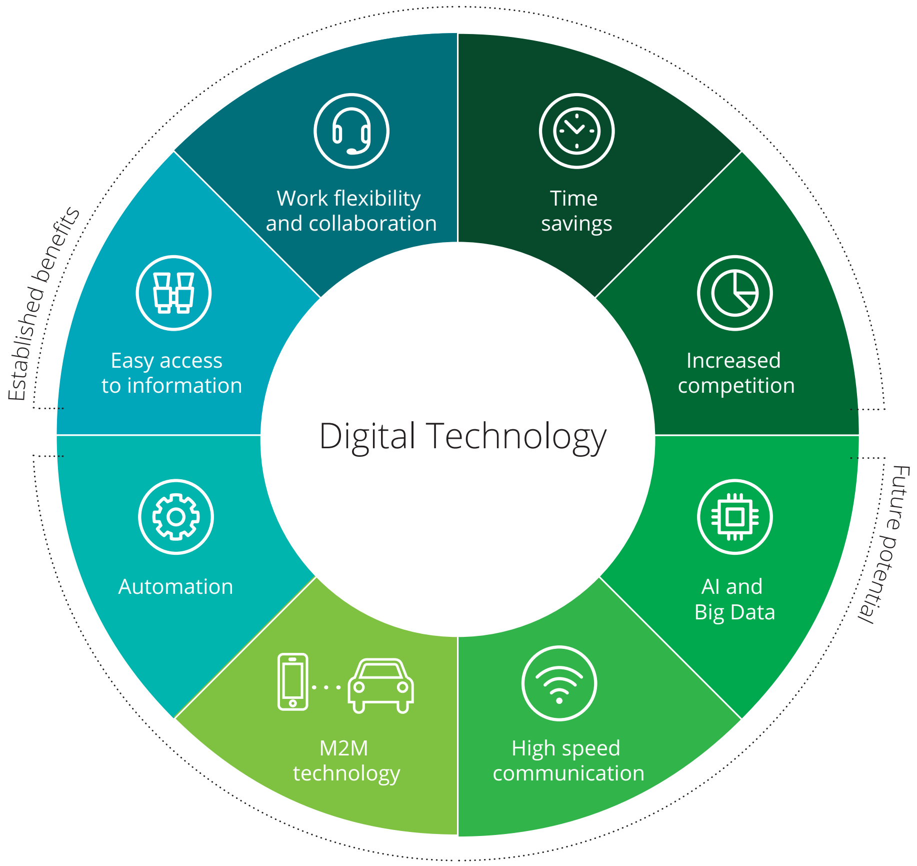
Another way is by estimating the value added by ICT-related economic activity — or the value created by the production and distribution of technology and digital services — in the Australian economy. One estimate is that ICT subdivisions generated over $56 billion in Gross Value Added (GVA) to the Australian economy in 2019 (CIIER, 2020).

Yet the economic benefits of digital technology stretch far beyond the value added by the operations of the ICT industry subdivisions. Digital technology supports productivity and participation across the economy, resulting in increased GDP and associated living standards in Australia.

4.1 The productivity benefits of digital technology

Raising productivity is crucial to improving living standards over time. In the words of Philip Lowe, Governor of the Reserve Bank of Australia, "lifting productivity is the key to building on our current prosperity and ensuring sustained growth in wages and incomes" (RBA, 2018).

Figure 4.1: The future and established productivity benefits of digital technology



Source: Deloitte Access Economics.

However, Australia, like many other developed economies, has experienced a recent decline in both labour and multi-factor productivity (MFP) growth rates in recent years. The latest ABS estimates reveal a decline in MFP of 0.4% in 2018–19, marking the first fall since 2010–11 (ABS, 2019a). Labour productivity also fell by an estimated 0.2% in 2018–19, the first decline in labour productivity since the time series began in 1994–95 (ABS, 2019a).

One way to improve productivity growth is through the development and adoption of productivity-enhancing technology (Productivity Commission, 2009). The adoption of digital technology has already delivered significant productivity benefits to the Australian economy and the future potential of digital-led productivity growth is significant.

4.1.1 The established productivity benefits of digital technology

The internet and online search engines have provided **easy access to terabytes of information** for millions of Australians. This has boosted productivity not only by reducing the time and effort required to find information, but also by making it easier for people to acquire new skills. As far back as 2009, search engines alone created US$780 billion in value worldwide (McKinsey, 2011).

For many workers, online **communication and collaboration** tools have significantly improved workplace productivity. By enhancing communication, knowledge sharing and collaboration they raise the productivity of high-skill knowledge workers, such as managers and professionals, by up to 25% (McKinsey, 2012). Such tools also increase the productivity of capital by allowing employees to work remotely, reducing the need for office space.

The adoption of digital technology has also sped up processes and created significant **time savings** for both individuals and businesses. It has reduced travel costs and made transactions like banking and shopping easier and faster. Furthermore, the more than one trillion-fold increase in computing performance from 1956 to 2015 has sped up most tasks and helped to unlock productivity-boosting but computationally intensive methods, such as (Insightass, 2017).

Digital technologies also create spillover effects such as **increased competition,** in turn boosting productivity (Qu, Simes & O'Mahony, 2017). For example, the retail market has become more competitive with the increased popularity of online shopping (Sims, 2016). Greater competition leads to higher productivity by stimulating innovation and driving businesses to use resources more efficiently (ACCC, 2015).

4.1.2 Quantifying the impact of digital to date

Deloitte Access Economics estimates that, between 2005 and 2019, the productivity benefits from the growing digital economy increased Australia's steady state GDP per capita by 6.5%. This means that the **adoption of digital technology during this period added an additional $126 billion (real GDP, in 2018–19 dollars) to the Australian economy in 2019** (Deloitte Access Economics, 2019a). By way of comparison, this is larger than the total value added of the entire construction industry in 2017–18 (ABS, 2019b).

With the adoption of 5G and other emerging digital technologies, the contribution of digital to productivity will only grow. In the last edition of *Australia's Digital Pulse*, Deloitte Access Economics estimated that mobile technology alone would add $65 billion to GDP by 2023, with 40% of this contribution occurring between 2018 and 2023 (Deloitte Access Economics, 2019d).

Further details regarding the econometric modelling techniques used in this section can be found in Appendix B.

It is also important to note the limitations of this modelling. Data limitations mean that we cannot explicitly model the productivity benefits of specific improvements in digital technology, such as those from new IoT devices or greater processing power. Instead, our approach relies on the best available proxies which can be used to estimate the economy-wide productivity benefits of digital technology.

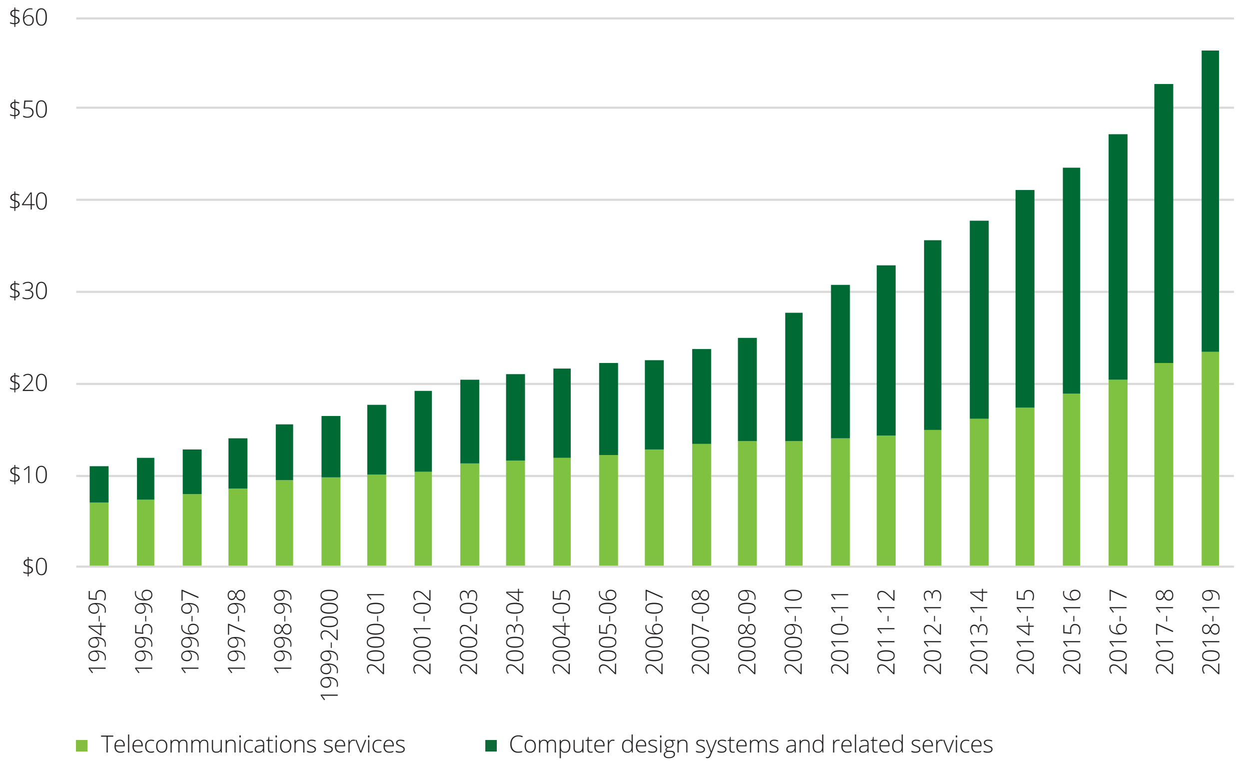
Of course, productivity is only one measure of wellbeing and does not capture all of the benefits that advances in digital technology bring. For instance, consumers may also derive social welfare benefits from the increased convenience and 'useability' of new digital devices such as smart phones, or improvements in software which do not increase productivity.

Estimating the contribution of ICT to Australia's economy

The importance of the ICT industry to Australia's economy can also be measured by looking at its direct contribution to Gross Value Added (GVA). This measures the total value of the goods and services generated by an industry after accounting for the costs of production.

The Centre for Innovative Industry Economic Research (CIIER) has analysed GVA estimates of the telecommunications services and computer system design and related services industry subdivisions, finding that overall, ICT directly contributed $56.3 billion to Australia's economy in 2018–19 (Chart 4.1). The economic activity supported by these industry subdivisions has grown significantly in recent decades, but especially since the Global Financial Crisis in 2008, driven by significant growth in computer system design and related services.

Chart 4.1: Estimated contribution of the ICT industry, 1994–95 to 2018–19 ($b)



Source: ABS catalogue 5204.0 (2020).

4.1.3 The future potential of digital technology

Digital technology is driving the development of Industry 4.0 — the current trend towards increasing automation, data intensity and the use of IoT devices. While many of these technologies are already being used, they are still in relatively early stages and many of their benefits are expected to accrue in the near future.

Some Industry 4.0 trends, such as the use of **AI and Big Data** are already having a visible impact on productivity. In a 2019 survey of 65 Fortune 1000 executives, almost all (97%) said their firms were investing in Big Data and AI to become nimbler, more competitive businesses (NewVantage Partners, 2019).

However, the productivity benefits of using AI and Big Data are set to grow exponentially. By 2030, the use of AI will contribute an estimated US$13 trillion to the global economy, boosting GDP by approximately 1.2% per year (McKinsey, 2018).

The benefits of other emerging technology, such as 5G, may be less visible now but will grow rapidly in the near future. Research by the Australian Government's Bureau of Communications and Arts (2018) found that by 2030, 5G mobile networks could be adding between $1,300 and $2,000 in additional GDP per person after the first decade of rollout, partly due to the creation of new products and industries, such as making autonomous vehicles or drones practical for mainstream use by businesses or consumers.

4.2 Cybersecurity as an enabler of digital technology

Cybersecurity represents both a significant opportunity and a rising concern. It has the potential to increase trust in digital technology and encourage its broader adoption and use. However, with more devices, more data and more value in online transactions, the incentives for malicious cyber attacks are also growing.

Strong cyber protections are crucial for businesses looking to adopt productivity-enhancing digital technology. Digitally-engaged businesses perform better than other businesses. They are more likely to be growing in revenue, be exporting and be innovating (Deloitte Access Economics, 2017). Yet, three in five businesses in the Asia Pacific (APAC) region have put off digitisation out of fear of cyber attacks (Microsoft, 2018). This fear is not unfounded, with cyber crime rated as one of the top five risks globally by the World Economic Forum in 2019 (World Economic Forum, 2019). Large organisations stand to lose tens of millions of dollars in the event of a major cyber breach (Microsoft, 2018).

As businesses look to mitigate cyber risks, investment in cybersecurity has grown to become an important digital industry in its own right. Global expenditure on cybersecurity was worth US$145 billion in 2018, and over AU$2 billion was spent on cybersecurity in Australia in 2016 (AustCyber, 2019).

With cyber threats expected to increase, expenditure on cybersecurity is forecast to grow significantly. By 2026, global spending on cybersecurity is expected to rise by 86% to US$270 billion (AustCyber, 2019). Australia is also increasing its cybersecurity capabilities. According to AustCyber, the value of the Australian cybersecurity sector is expected to triple by 2026 to AU$6 billion, creating an additional 18,000 jobs (AustCyber, 2019).

The COVID-19 pandemic has acted as a reminder of the importance of cyber security for many businesses. Remote access and mobile working have both increased dramatically, raising the likelihood and potential impact of a cyber breach (Scarfone, 2020).

The uncertainty surrounding the COVID-19 pandemic has also attracted scammers. Email phishing attacks related to COVID-19 have increased by more than 600% since February (Barracuda, 2020). The World Health Organisation (WHO) has also seen a fivefold increase in the number of scammers impersonating WHO to solicit donations via email (World Health Organisation, 2020).

Achieving the productivity benefits from technology outlined in this chapter will be supported by the further development of Australia's cybersecurity capabilities. Increasing the cybersecurity across the APAC region could lead to an additional US$145 billion over 10 years due to the higher adoption of new technology, leading to higher capital investment and productivity growth (Deloitte Access Economics, 2020).

While Australia's investment in cybersecurity is increasing, its cybersecurity capabilities are falling behind other wealthy nations (ITU, 2019). Further investment in cybersecurity will be required to enable consumers and businesses to invest in new technology, and help unlock the productivity benefits that technological advancements can bring.

Developing the next digital innovation at the ATO

Digital technology has already provided substantial benefits to the Australian economy through innovations such as mobile payments, Internet of Things, and artificial intelligence. Yet recent initiatives by the Australian Taxation Office (ATO) in digital innovations like e-invoicing are set to deliver further benefits by streamlining invoicing for both business and government agencies. E-invoicing would also progress the Digital Transformation Strategy objective of providing world-leading digital services in Australia.

E-invoicing involves the automatic exchange of invoice information directly between a buyer's and supplier's accounting systems and improves processes from procurement to payment. It will be available in Australia during the second half of 2020 and will provide a marked improvement to the 1.2 billion paper and PDF invoices that are mostly processed and exchanged manually in Australia every year.

Maximising the benefits of e-invoicing has involved the development of a standardised invoicing format that aligns with an international open standard used in 34 countries, called the Peppol framework. The ATO has been designated the Peppol Authority for Australia and is responsible for customising the system to local conditions (for example, using GST rather than VAT) and promoting uptake of the system.

Deloitte Access Economics has estimated that e-invoicing may lead to $28 billion in savings for the Australian economy over 10 years. This is based on savings expected to be acquired at an individual business or government agency level. It costs on average $30.87 and $27.67 per invoice to process paper and PDF invoices respectively, while the cost to process an e-invoice is only $9.18. This is due to less time re-keying or scanning invoices, making corrections or chasing missing information.

Achieving these benefits form an important element of the Australian Government's economic response to COVID-19. The current economic climate has led many businesses to consider ways to reduce inefficiencies to remain profitable over the long-term. By reducing administrative processing time and costs, e-invoicing can improve cash flow for businesses and government agencies.

However, transitioning to new systems or processes can be difficult in the short-term. The ATO has partnered with stakeholders to support businesses transition and mitigate risks, especially for larger organisations where established processes mean that transitioning requires more resources.

5. Future demand for technology workers and skills

COVID-19 has had a severe impact on Australia's labour market. An estimated 2.9 million Australians have taken up employment support though JobKeeper, while 200,000 more are unable to find work — including many technology workers. Another 500,000 have given up the job search and left the labour force entirely (ATO, 2020; ABS, 2020a). These impacts are not restricted to any one sector, with 18 out of 19 industries recording job losses (ABS, 2020a).

These short-term impacts are overlayed on a longer-term trend of digitisation of the workforce. Before COVID-19, advances in technology were replacing some jobs, augmenting others, and creating new ones.

Some of these long-term impacts have accelerated as a result of the crisis. For example, digital skills have become more important as day-to-day work becomes more reliant on technology.

While the economic recovery is anticipated to restore some jobs, some changes will likely be lasting. Demand for workers with digital skills will be higher than ever before, in technology and non-technology enabled businesses alike. This may represent an opportunity for those who have lost employment. Reskilling with the right digital skills could create a pathway into a new — and highly demanded — career.

5.1 Short-term pain

Forecasting employment in the current climate is a complex task. The desire to prevent secondary outbreaks has created significant uncertainty around the timing of the staggered removal of restrictions, and the form that Australia's eventual economic recovery will take.

To account for the impact of COVID-19 on the technology workforce, Deloitte Access Economics has modelled that growth in the technology workforce will be disrupted over the next two years (2020 and 2021). After that period, growth in the technology workforce will rebound sharply during 2022 — before returning to the historically high rate of growth experienced in recent years.

On this basis, we estimate that there will be 35,000 fewer technology workers in December 2020 than there were at the end of 2019. A significant portion of this decline will be attributable to restrictions placed on migration, which have led to a sharp fall in the inflow of migrant workers who usually make up an important part of Australia's technology workforce.[4] Overall, the Australian Government expects that net overseas migration will fall 30% this financial year compared to 2018–19 levels. These impacts are predicted to persist into the next financial year, with some forecasting an 85% decline in net overseas migration in 2020–21 relative to 2018–19 levels (PRwire, 2020).

Domestically, further job losses among technology workers are also expected to result from the knock-on effects of the economy-wide downturn. Forecasts suggest a 6% decline in technology spending in Australia during 2020 compared to the previous year, equating to an $8.8 billion expected decline in investment (Gartner, 2020). Some research suggests that most of this decline will be felt in traditional technology sectors — such as hardware, software and telecommunications — while new and emerging technology sectors such as AI, augmented and virtual reality and cybersecurity will increase their share of IT spending (IDC 2020).

5.2 Return to growth

Following this short-term decline, Deloitte Access Economics forecasts a return to the historically high rate of growth in the sector. **By 2027, we forecast that there will be over one million technology workers in Australia**, up from the 772,175 workers recorded in 2019 (Table 5.1).

4. Since 2016, migrant inflows have accounted for over 17,000 new workers to the technology workforce as discussed in Section 2

Table 5.1: Employment forecasts by CIIER occupation groupings, 2019–25

Occupational grouping	2019	2025	Average annual growth, 2019–25
ICT management and operations	225,156	269,873	3.1%
ICT technical and professional	312,301	365,087	2.6%
ICT sales	33,171	39,506	3.0%
ICT trades	91,403	117,723	4.3%
Electronic trades and professional*	2,661	3,474	4.5%
ICT industry admin and logistics support*	107,483	133,056	3.6%
Total technology workers	**772,175**	**928,718**	**3.1%**

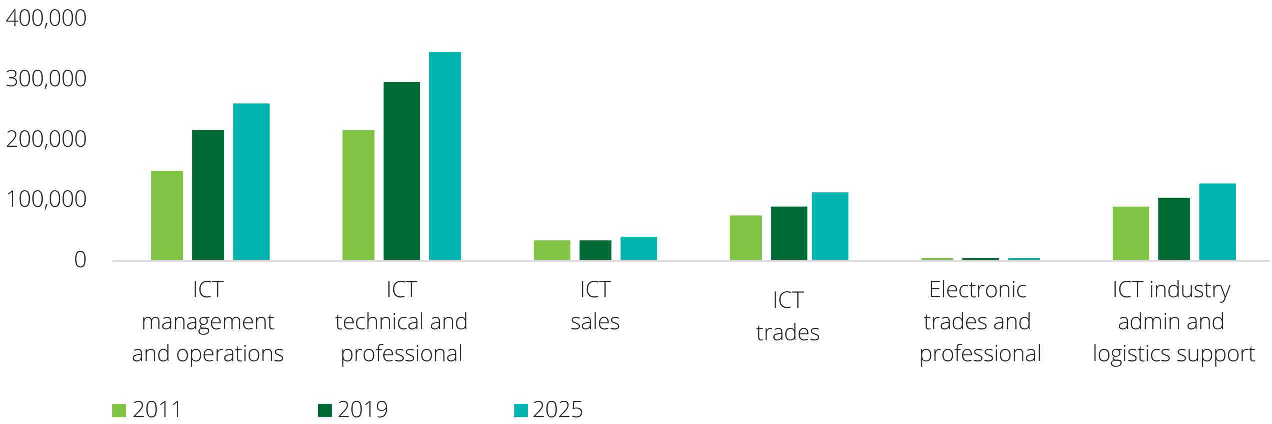
* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2020).

Many of these new workers will enter the workforce after the shock of COVID-19 has passed. By 2025, there will be 150,000 more technology workers in the Australian workforce than there are today, representing an average annual growth rate of 3.1% (Table 5.1). This exceeds the forecast growth rate for the overall Australian workforce, which is expected to increase by 0.8% per annum over the same period.

Around one-third of this growth is forecast to occur in ICT technical and professional roles (52,800 additional workers), while a further 28% of growth is expected to occur in ICT management and operations roles (projected to increase by 44,700 workers) (Table 5.1 and Chart 5.1). The specific occupations forecast to experience the largest increase in employment include ICT support technicians (24,000 more workers between 2019 and 2025), management and organisation analysts (20,600), and software and application programmers (18,300).

Chart 5.1: Historical and forecast technology employment, 2011–25



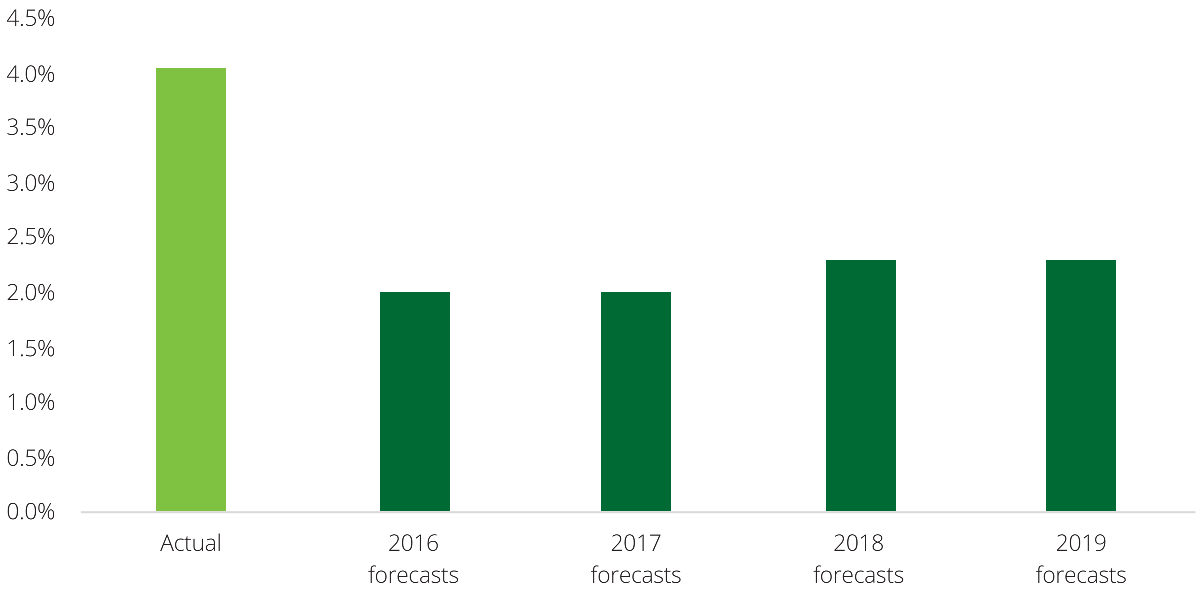
Source: Deloitte Access Economics (2020).

Tech employment growth: exceeding expectations

Employment in the technology sector has grown at a rate well above predictions made in previous forecasts by Deloitte Access Economics. From 2015 to 2019 the technology workforce in Australia has grown at an average rate of over 5% per annum. Over the same period, Deloitte Access Economics forecasted growth ranging between an average of 2% to 2.5% growth per annum. These forecasts were based on a portfolio approach, using growth expected in different technology occupations. By comparison, employment forecasts based on performance in individual years can be unreliable due to year-on-year volatility in the ABS employment data series.

However, Chart 5.2 shows that our forecasts have been significantly under actual growth rates across the past three years, demonstrating stronger growth in the technology workforce across this period.

Chart 5.2: Average annual growth rate, 2015–19, actual and Deloitte Access Economics forecasts



Source: Deloitte Access Economics (2020).

To account for these higher levels of growth, Deloitte Access Economics has adjusted its forecasting approach to place greater weight on recent performance. This has the added benefit of being sensitive to more recent growth trends than the previous forecast methodology, which may be particularly important in assessing future changes to the workforce in the post-COVID-19 economy.

5.3 Reskilling: the opportunity to become part of the digital workforce

Building digital skills represents an opportunity for all workers — irrespective of whether their jobs have been directly impacted by COVID-19 or not. Beyond the short-term impacts associated with the crisis, long-term workforce trends are likely to make digital skills increasingly relevant for workers across the economy. Increasing the skills of the labour force is also crucial to improving labour productivity over the medium to long-term.

Prior to the outbreak of COVID-19, Faethm predicted that automation would displace 2.7 million Australian jobs, or 21% of the workforce, by 2034. At the same time, automation is also expected to augment 4.5 million workers, creating new technology-enabled roles that will need to be filled (Faethm, 2020).

Deloitte has also predicted that 86% of jobs created between now and 2030 in Australia will be for knowledge workers (Deloitte, 2019). Some of these roles will be for technology workers, as discussed in Section 5.2. However, many roles will also be created in the broader workforce — among those who use digital tools, but are not directly technology workers.

Despite these forthcoming challenges and opportunities, few Australian adults currently engage in the education or reskilling required to develop technology-relevant skills. Around a third of adults aged 25 to 64 participated in structured work-related training and adult learning in 2016–17 (ABS, 2017c).

For those who do look to reskill, different workers will face varying levels of difficulty at retraining and adapting to the new roles and jobs created by technological advancements. Faethm further predicts that at least 400,000 workers in traditional industries may be entirely unable to adapt, and potentially face structural unemployment (Faethm, 2020). For these workers, reskilling will become a necessity for future employment.

5.3.1 The broader digital workforce

Technology workers are crucial to Australia's digital economy. However, they represent only a modest proportion of the total digital workforce, as defined by the OECD (2012).

Australia's broader digital workforce comprises a broad group of workers who regularly use technology as part of their jobs. People like accountants, solicitors and scientists rely on technology skills to perform their work.[5] Many occupations may require digital capabilities, even though they are not captured in the ACS definition of core ICT workers measured in this report.

5. A full list of occupations which are included in this broader measure can be found in Table A.4.

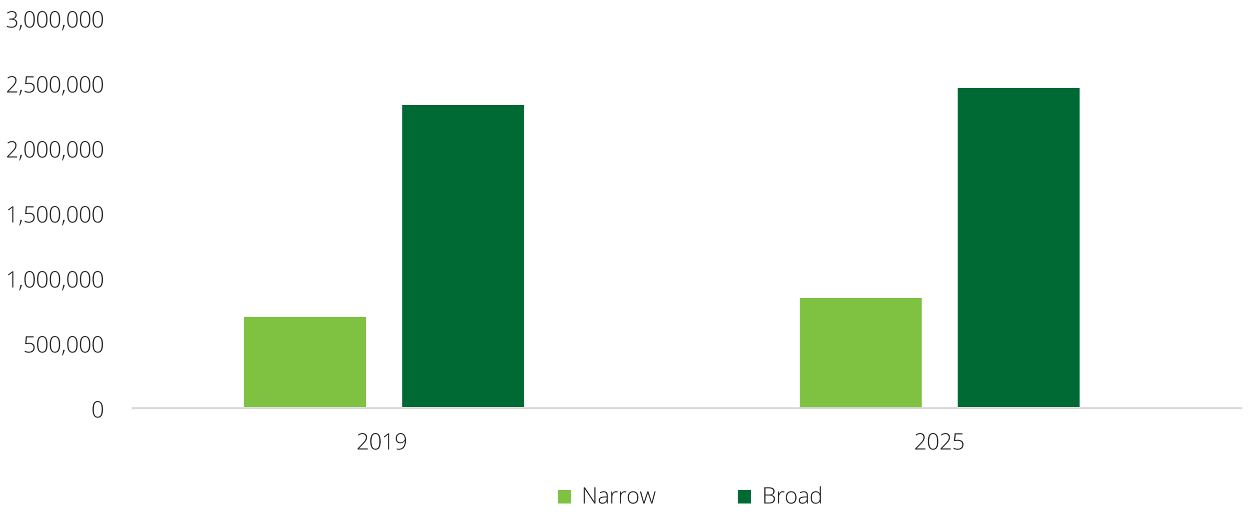
Deloitte Access Economics forecasts that demand for this broader category of digital workers will increase by around 129,000 workers between 2019 and 2025, representing an average annual growth rate of 0.9% (Chart 5.3). This is close to the average annual growth rate forecast for Australia's total workforce over the same period, of 0.8%.

However, this broader category of digital workers does not capture the full extent of digitisation which has taken place across many occupations in Australia's workforce over recent years. Since the OECD definition of ICT occupations was created eight years ago, many additional occupations — such as health and education — have come to rely on the regular use of digital technologies. Also, the use of digital technology in these occupations has risen since 2012, which is not reflected in the forecasts. For example, librarians and other records managers likely rely to a greater extent on digital records and databases today compared to 2012 – however, this increased digitisation is not captured in the static OECD measure of the digital economy.

Reskilling to enable a transition into the digital workforce could benefit a range of workers in these occupations and industries. Analysis of five-year projections of industry employment shows that of the 81 occupations currently facing declining demand, 96.4% could find a viable transition to a higher paid job (Department of Employment, Skills, Small and Family Business, 2019).

However, there is evidence that some workers may have concerns about reskilling later in their careers. Only 6% of Australians aged 40 and older participate in formal education, compared to 35% of workers aged 20 to 29 (Productivity Commission, 2017). Yet investments in reskilling later in life can lead to 'encore careers', by providing the relevant skills needed to extend a career (Adult Learning Australia, 2020). This may be particularly important for those workers who have given up the job search and left the labour force as a result of the COVID-19 crisis.

Chart 5.3: Technology workforce growth under narrow and broad measures, 2019–25



Source: Deloitte Access Economics (2020).

Building digital skills through Data to the People

It is estimated that more than 40 zettabytes of data have been created, captured or replicated worldwide, and this figure is predicted to rise to 175 zettabytes in 2025 with individuals each generating an additional 2.5 quintillion bytes of data each day (IDC, 2018).* With more data available than ever, accessing, interpreting and working with data has become integral to both our personal and professional lives. Jane Crofts, the founder of Data To The People, states that "data is the macrocosm of our everyday interactions and transactions, it is the micro-dust of everything we do and everything we don't do."

The ability to extract and act on the value from data is crucial for organisations. Having higher levels of data literacy in an organisation is associated with three to five per cent higher levels of enterprise value, which is estimated to be worth around US$320-$534 million to businesses (Data Literacy Project, 2018a). Yet nearly three quarters (74%) of employees report feeling unhappy when working with data (Data Literacy Project, 2018). Jane says "with an increasing proportion of organisations looking towards digital transformation and data driven strategies, this is a big problem. It impacts the morale of organisations and takes a toll on employees. It means that only a limited subset of the organisation — those in traditional 'data roles' — are confident in their ability to develop and deliver these strategies. We must not miss out on the opportunity to reflect the views and experience of the majority of the organisation, the voice of those who are not in traditional 'data roles' — and ultimately limit our diversity of thought."

Data literacy — the ability to read, write and comprehend data — is key to helping individuals and organisations reach their full potential, together, through data. This is not to say that everyone inside an organisation needs to be a data expert. "Each profession requires different sets and levels of skills. However, it is important that all individuals are encouraged and supported to understand the shared language of data — this will become the foundation for acquiring and enhancing those role-specific skills."

Data To The People works with organisations across the world to measure, map and develop lifelong data literacy, which Jane explains will be "as important in childhood and adult life as literacy and numeracy." For individuals wanting to learn, there are many opportunities to grow their level of data literacy. For organisations, lifting capability begins with first understanding the starting point. Jane states "we need to understand where we are starting from but also where we want to go — our future state. Only then will we be able to find the right path to help individuals and organisations improve their level of data literacy."

** This statistic relates to the servers of Google, Amazon Web Services, Microsoft and Facebook only.*

5.3.2 Technology workers

Reskilling in technology knowledge and skills may offer a **wage premium of around $10,348 per year.**[6] The increased demand for technology workers thus represents an opportunity for professionals from a range of other occupations to grow their incomes as well as their skills.

Consistent with the projected growth in the technology workforce from 2019 to 2025, demand for ICT qualifications is also expected to increase. Deloitte Access Economics forecasts that **employers will demand over 170,000 more ICT qualifications in 2025.** This demand for qualifications depends not only on forecast employment growth, but also on other labour market considerations such as the demand for workers with different levels of education. As a result, the largest growth in demand is forecast to occur for workers with the highest levels of qualifications. This includes an expected increase of approximately 73,700 workers with undergraduate degrees and 48,200 workers with postgraduate degrees in the technology workforce by 2025 (Table 5.2).

Beyond traditional pathways and formal qualifications, a range of structured reskilling methods are emerging to help workers reskill.

Firstly, **shorter form courses** to reskill are proving popular for workers. This may partly explain the declining composition of introductory and advanced level VET courses compared to the relatively steady demand for the more job-focussed Certificate III/IV courses in Australia's vocational training sector (see Chart 3.5).

Similarly, an emerging trend in reskilling is **micro-credentialing**, or the process of gaining certification in a specific skill through short-form credentials. Micro-credential training is intended to improve the efficiency of linkages between the education sector and the labour market by better aligning the skills taught with the skills demanded in the workplace. This can offer a range of benefits for existing workers and jobseekers alike, by enabling them to obtain targeted skills or knowledge in a shorter timeframe and at a reduced cost relative to traditional tertiary education.

Micro-credentialing also offers benefits for employers by increasing the availability of skills which are in demand, and reducing the likelihood of a skills mismatch between prospective workers and employers. Micro-credentialing may also assist employers reskill and retain existing workers, avoiding recruitment costs and the risks associated with new hires.

Table 5.2: Forecasts of total qualifications held by technology workers, 2019–25*

Occupational grouping	2019	2025	Average annual growth, 2019–25
Postgraduate	228,777	277,023	3.2%
Undergraduate	480,433	554,152	2.4%
Advanced diploma / Diploma	202,502	228,057	2.0%
Certificate III and IV	150,086	168,469	1.9%
Certificate I and II	71,986	76,328	1.0%
Total	**1,133,783**	**1,304,030**	**2.4%**

* One person may hold multiple qualifications.

Source: Deloitte Access Economics (2020).

6. Calculated as the difference between the average annual wage earned by technology workers ($102,460), and workers employed in professional industries in 2019 ($92,112). This represents a relevant comparison as previous editions of *Australia's Digital Pulse* have found that one in four technology workers had a previous job that was a non-technology role.

Building digital skills at RMIT Online

Both employees and organisations recognise the importance of lifelong learning, especially when it comes to digital skills. As such, education providers are looking for new ways to deliver these skills to students. RMIT Online was established in 2016 to meet growing demand for more flexible learning. It now offers more than 30 shorter courses to support individuals develop new skills during their career. Last year, there were 19,000 enrolments across RMIT Online's accredited and short course portfolios.

Helen Souness, CEO of RMIT Online, says that courses focused on how to apply new technologies have proven particularly popular amongst students. Helen says that "one of the most popular courses involves Artificial Intelligence applications for marketing. In general, all digital skills in are in high demand." Another example is an RMIT Online course covering blockchain strategy, which was at full capacity within 48 hours.

To ensure the best education outcomes, RMIT Online builds courses that allow students to balance their work and study commitments. Helen explains that "online content is delivered in shorter, bite sized pieces with some 7-minute videos, webinars being scheduled in evenings after normal workdays finish and plenty of opportunities for students to interact online with the guidance of an industry mentor."

The digital skills required by industry can change very quickly. As such, RMIT Online has over 70 industry partners including REA Group Ltd, Accenture, AWS and Adobe, who play an important role in course design. "It's critical to engage with industry right from the start," explains Helen. "RMIT Online regularly consults industry on skill gaps they identify, seeks input into course design and uses mentors from industry to provide one-on-one support with students."

Some businesses directly approach RMIT Online with requests to deliver specialist skills in their workforce. For instance, Telstra sought to provide training to their engineers on the latest developments in telecommunications network architecture. RMIT Online worked closely with Telstra to design the course and make sure the content was delivered to over 40 employees in each cohort in engaging ways based on best practice for online education.

Helen believes businesses need to think strategically and act now to address skills gaps. Helen believes this particularly true in the current environment where travel restrictions has limited labour mobility. "Too often a business will look to hiring someone new, rather than training their existing workforce," says Helen. "Now more than ever, for business to succeed, their workforce needs to have a strong understanding of the core parts of today's technology. These new skills are often empowering for workers and can have a profound impact on employees' careers and business performance."

Many students and workers are also showing an increased preference for **self-directed and online learning methods** (BCG, 2019). The adoption of online learning resources can offer some efficiencies, by avoiding duplication of effort and the costs typically associated with face-to-face delivery. Many tertiary education institutions have started offering a range of Massive Open Online Courses (MOOCs), but very low retention rates have so far hampered student outcomes (Hajkowiz et al, 2016). It remains to be seen whether the transition to online learning platforms necessitated by COVID-19 will permanently change, or potentially improve, online offerings in the tertiary education sector. Many education providers have sought to improve online education offerings to workers who may face time pressures.

5.4 Reskilling can help businesses navigate skills shortages

Developing the skills of the workforce is crucial to Australian businesses. Nearly a third of all businesses have experienced a skills shortage or deficiency in their core business activity (ABS, 2018). While a number of skills are in short supply, digital literacy is third largest skill shortage reported by businesses in Australia in 2019 - behind only customer service, and organisation and time management (Deloitte, 2019). As businesses increasingly transition to digital operations as a result of COVID-19, these skills are likely to become even more important for many more businesses as well. The Secretary of the Treasury (Treasury, 2020) has recognised:

"Over time, the uncertainty around the progression of the virus will diminish and more economic activity will return.

But new challenges will have emerged. Some jobs and businesses will have been lost permanently."

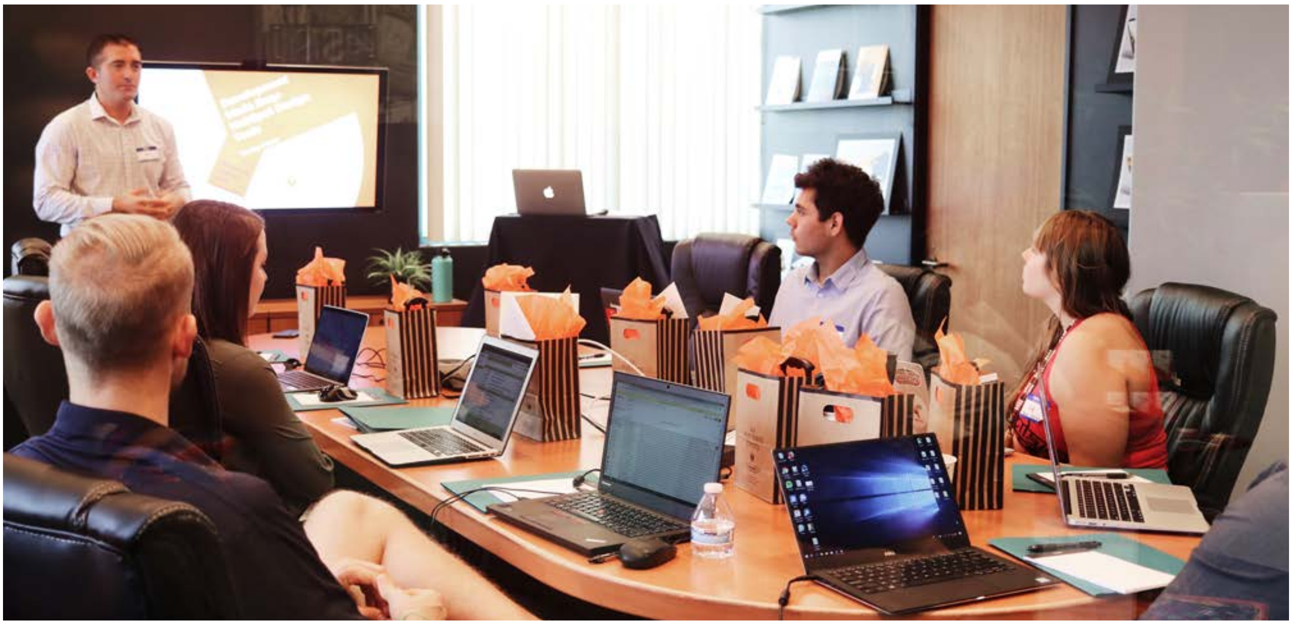
– Dr Steven Kennedy PSM

Businesses face a choice when confronted by a skills shortage. They can either recruit new workers to fill the shortage, or reskill and retrain existing staff. Recent surveys suggest that historically, businesses have tended to choose the former. Organisations spend an estimated $7 billion annually on recruitment processes, compared to $4.5 billion on formal training (Deloitte Access Economics, 2019b).

However, there are a range of benefits to investing in existing staff which businesses should consider. Retraining avoids the loss of any on-the-job skills, which, although not often recognised or quantified, hold significant value for businesses. There are also risks to hiring a new employee rather than building skills from within. The average costs of replacing a bad hiring decision within six months are estimated to be more than double the worker's salary (Yager, 2012).

There are also significant business benefits to upskilling existing technology workers. Fast-paced technological change has meant digital skills for workers need to be refreshed regularly to keep up with the latest developments and applications. A business that increases the amount of upskilling undertaken by its workforce will be able to fully benefit from its digital investments and capabilities.

Yet developing the required skills among an existing workforce requires careful planning, strategy and resources. A survey of 600 professional businesses in Australia found that 15% felt that they lacked the means to address skill shortages in their organisation (Deloitte Access Economics, 2020c). For those businesses which felt they did have the means to address skills gaps, 93% provided support to their employees to undertake training. This was commonly through payment for learning, promoting opportunities or providing unpaid leave (Deloitte Access Economics, 2020c).



6. International Competitiveness

Comparing Australia's digital economy and workforce to other countries provides a benchmark to assess the performance of the sector. This benchmarking approach shows Australia is falling behind despite growth in many indicators. As a nation, our spot on the digital leaderboard has slipped. **Australia has fallen in rank for more than half of the indicators where comparisons are possible over the last two years.**

Falling behind digital leaders can have a range of consequences. Businesses may find it more difficult to attract and retain talent. Meanwhile, foreign investment in Australia may diminish and domestic businesses may move operations overseas. Ultimately, losing the race for international competitiveness in ICT will limit the economic and social benefits of the digital economy for Australia.

6.1 How Australia compares

When examining the international competitiveness of Australia's ICT sector, Australia performs 'middle of the pack', with **an average rank of seventh out of 16 countries in 2019** (see Figure 6.1).[7] This is based on an assessment across 24 indicators covering workforce, business use, consumer uptake, government use and regulatory landscape and aggregate sector-based indicators.[8]

This year's assessment of international competitiveness comes two years after Deloitte Access Economics previously benchmarked the sector (DAE, 2019c). **Overall, Australia has declined one rank on average over two years.** This is primarily due to other countries improving their performance at a greater rate, as opposed to declining performance.

Key findings

- Australia has an average rank of seventh out of 16 countries in 2019 across 24 indicators.
- Across the 12 indicators for which comparisons over time are possible, Australia has fallen in rank for more than half of the indicators over two years.
- A new area of comparison has been the government/regulatory landscape. Australia performs relatively well in this category, with an average rank of fifth.
- Across all the categories considered, Australia performs the weakest in aggregate figures for the ICT sector with an average rank of ninth.

7. The countries considered for this comparison are: Canada, Denmark, France, Germany, Israel, Italy, Japan, New Zealand, Norway, Singapore, South Korea, Spain, Turkey, United Kingdom and the United States. Australia's ranking across all individual indicators has been scaled to relative rankings for the fact that not all indicators include all 16 countries.

8. Due to data availability from source documents, some of the indicators considered in the previous edition of this report were not updated for this edition. The following discussion of indicators only considers new and previously included indicators that were able to be updated for this report.

Figure 6.1:

Summary of Australia's relative performance in ICT competitiveness indicators

Consumers

AUS average rank = 8

Indicator	Average fixed broadband latency (ms, 2019)	Digital Evolution Index (2017)	Internet users (% population, 2019)	Mobile subscribers (per 100 people, 2019)	Trust in information from social media (% respondents, 2019)	Wireless mobile broadband subscriptions (per 100 people, 2019)
1	SIN (11)	NOR (3.79)	DNK (97.6%)	ITA JAP NZL SIN (130)	JAP (26%)	JAP (177)
2	DNK	DNK	KOR	=ITA JAP NZL SIN (130)	KOR	USA
3	KOR	SIN	GBR	=ITA JAP NZL SIN (130)	DNK	**AUS (144)**
4	NZL	KOR	CAN	=ITA JAP NZL SIN (130)	DEU GBR	DNK
5	CAN GBR	GBR	NZL	KOR	CAN ITA SIN ESP	ISR
6	=CAN GBR	USA	DEU	DEU	=CAN ITA SIN ESP	NOR
7	DEU ESP	**AUS CAN (3.55)**	SIN	DNK	=CAN ITA SIN ESP	NZL
8	=DEU ESP	=AUS CAN (3.55)	USA	USA	=CAN ITA SIN ESP	SIN
9	**AUS (24)**	NZL	**AUS (86.5%)**	GBR	NZL	ESP
10	USA JAP	JAP	ESP	ESP	USA	GBR
11	=USA JAP	DEU	JAP	**AUS (114)**	TUR	FRA
12	ITA	FRA	FRA	FRA	**AUS (12%)**	ITA
13	FRA TUR	ISR	ITA	TUR	=AUS (12%)	DEU
14	=FRA TUR	ESP	TUR	CAN	FRA	CAN
15	=FRA TUR	ITA	na	na	na	TUR
16	=FRA TUR	TUR	na	na	na	na

Source: Deloitte Access Economics based on ABS (2017a, 2017b, 2018); A.T. Kearney (2015); EIU (2020), IEA (2017); OECD (2020, 2019, 2012a, 2017a, 2017b), WTO (2019) and ITU (2019b).

Businesses

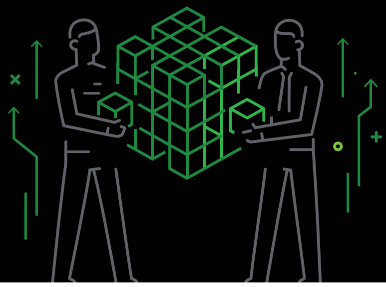
AUS average rank = 8

Indicator	Business broadband connectivity (% all enterprises, 2016)	Cloud usage (% enterprises with ten or more persons employed)	Digital competiveness (index, 2019)	ICT R&D (% GDP, 2015)	ICT use for business-to-business transactions (Index, 2016)	Trust in Non-government websites and apps (% respondents, 2019)	Appreciation for e-finance (% respondents, 2019)
1	NZL (99)	JAP (45%)	USA (100)	NZL (1.74)	JAP (60.6)	SIN KOR (24%)	TUR (72%)
2	CAN	DNK	KOR	ISR	GBR	=SIN KOR (24%)	CAN
3	ESP	SIN	DNK	USA	SIN	JAP	KOR
4	**AUS (97)**	GBR	SIN	JAP	KOR	ESP	SIN
5	FRA	**AUS (31%)**	NZL	KOR	ISR	**AUS GBR DNK DEU (18%)**	GBR
6	NOR	CAN	CAN	DEU	DEU	=AUS GBR DNK DEU (18%)	ESP
7	DNK	ITA	**AUS (90)**	SIN	DNK	=AUS GBR DNK DEU (18%)	FRA
8	DEU	ESP	GBR	FRA	CAN	=AUS GBR DNK DEU (18%)	DNK
9	JAP	FRA	ISR	CAN	NOR	USA	**AUS (44%)**
10	GBR	DEU	DEU	DNK	**AUS (5.5)**	=USA	DEU
11	ITA	NZL	NOR	GBR	FRA	NZL ITA CAN	USA
12	SIN	TUR	JAP	**AUS TUR (0.14)**	TUR	=NZL ITA CAN	ITA
13	TUR	na	FRA	=AUS TUR (0.14)	ESP	TUR	JAP
14	na	na	ESP	NOR	ITA	FRA	na
15	na	na	ITA	ITA	na	na	na
16	na	na	TUR	ESP	na	na	na

Source: Deloitte Access Economics based on ABS (2017a, 2017b, 2018); A.T. Kearney (2015); EIU (2020), IEA (2017); OECD (2020, 2019, 2012a, 2017a, 2017b), WTO (2019) and ITU (2019b).

ICT Sector

AUS average rank = 9



Indicator	Cybersecurity (GCI score, 2018)	ICT exports (% exports, 2018)	ICT employment (% of total employment,	ICT IVA (% of total IVA, 2015)
1	GBR (0.93)	ISR (12.9%)	NOR (4.95%)	NZL (10.3%)
2	USA	GBR	CAN	USA
3	FRA	ESP	DNK	JAP
4	SIN	DNK	**AUS (3.77%)**	GBR
5	ESP	FRA	DEU	DEU
6	NOR	DEU	ITA	FRA
7	CAN	USA	FRA	**AUS (4.4%)**
8	**AUS (0.89)**	CAN	JAP	DNK
9	JAP	NOR	ISR	CAN
10	KOR	ITA	NZL	ESP
11	TUR	NZL	na	ITA
12	DNK	**AUS (1.0%)**	na	SIN
13	DEU	KOR	na	TUR
14	ITA	JAP	na	na
15	NZL	TUR	na	na
16	ISR	na	na	na

Source: Deloitte Access Economics based on ABS (2017a, 2017b, 2018); A.T. Kearney (2015); EIU (2020), IEA (2017); OECD (2020, 2019, 2012a, 2017a, 2017b), WTO (2019) and ITU (2019b).

Workforce Skills

AUS average rank = 6

Indicator	Adult digital literacy (% population, 2019)	Mathematics (PISA scale, 2018)	Science (PISA scale, 2018)
1	**AUS CAB DNK FRA DEU JAP NZL KOR GBR USA (100%)**	JAP (527)	JAP (529)
2	=AUS CAB DNK FRA DEU JAP NZL KOR GBR USA (100%)	NZL	NZL
3	=AUS CAB DNK FRA DEU JAP NZL KOR GBR USA (100%)	CAN	CAN
4	=AUS CAB DNK FRA DEU JAP NZL KOR GBR USA (100%)	DNK	NOR
5	=AUS CAB DNK FRA DEU JAP NZL KOR GBR USA (100%)	TUR	TUR
6	=AUS CAB DNK FRA DEU JAP NZL KOR GBR USA (100%)	SIN	**AUS DEU (503)**
7	=AUS CAB DNK FRA DEU JAP NZL KOR GBR USA (100%)	**DEU**	SIN
8	=AUS CAB DNK FRA DEU JAP NZL KOR GBR USA (100%)	FRA	GBR
9	=AUS CAB DNK FRA DEU JAP NZL KOR GBR USA (100%)	NOR	**DNK**
10	=AUS CAB DNK FRA DEU JAP NZL KOR GBR USA (100%)	**AUS (491)**	FRA
11	ITA	ITA	SIN
12	ESP	KOR	KOR
13	SIN	ISR	ITA
14	TUR	ISR	ESP
15	na	ESP	ISR
16	na	na	na

Source: Deloitte Access Economics based on ABS (2017a, 2017b, 2018); A.T. Kearney (2015); EIU (2020), IEA (2017); OECD (2020, 2019, 2012a, 2017a, 2017b), WTO (2019) and ITU (2019b).

Government

AUS average rank = 5

Indicator	e participation (index, 2018)	ICT regulatory tracker (index, 2018)	Trust in Government websites and apps (% respondents)	Use of Government technology (index, 2019)
1	DNK (0.92)	ITA (97)	SIN (66%)	NZL (86)
2	**AUS (0.91)**	NOR	DNK	SIN
3	NZL	UK	NZL	DNK
4	GBR	**AUS (94)**	CAN	KOR
5	KOR	TUR	**AUS (54%)**	DEU
6	NOR	FRA	GBR	USA
7	FRA	DEU	TUR	GBR
8	JAP	SIN	DEU	CAN
9	USA	DNK	JAP	**AUS (79)**
10	DEU	ESP	ESP	FRA
11	SIN	CAN	FRA	NOR
12	ESP	KOR	USA	JAP
13	CAB	NZL	KOR	ESP
14	ITA	JAP	ITA	ISR
15	ISR	ISR	na	ITA
16	TUR	USA	na	TUR

Source: Deloitte Access Economics based on ABS (2017a, 2017b, 2018); A.T. Kearney (2015); EIU (2020), IEA (2017); OECD (2020, 2019, 2012a, 2017a, 2017b), WTO (2019) and ITU (2019b).

6.1.1 Consumers

Figure 6.2: Summary of Australia's progress in consumer indicators

Internet access	Broadband latency	Broadband access	Mobile subscribers	Trust in social media
Fell two ranks since 2018	Rose two ranks since 2018	Rose one rank since 2017	Unchanged since 2017	Fell two ranks since 2017

Source: Deloitte Access Economics based on EIU (2020) and (OECD, 2019).

Consumers' ability to access and use technological advancements plays a vital role in modern economic development. Narrowing the 'digital divide' — the gap between individuals with no or inadequate access to digital infrastructure, and those with effective access — is an important focus for governments around the world (United Nations, 2018). Widespread uptake of basic technology—such as the internet and mobile devices — can also contribute to developing the digital literacy and ICT skills of the general population as well as providing a strong source of demand for the local technology sector.

In the consumer uptake category, Australia's average rank is eighth. Of the indicators for which progress over time has been able to be measured, Australia has declined one rank on average.

6.1.1.1 Internet access

In 2019 Australia ranked ninth out of 14 countries for internet access, with 87% of the population connected to the internet in 2019 (EIU, 2020). This ranking is two places lower relative to 2018, as Australia lags behind other developed nations in terms of providing basic internet to its population.

Denmark leads the world in terms of internet access with 98% of the population having access in 2019. This is followed by South Korea (96%), the United Kingdom (95%) and Canada and New Zealand (both at 91%) (EIU, 2020).

The digital divide between Australia's urban and rural areas is a still a major factor in terms of internet access. The sheer distances of Australia's geography (especially when considered against countries such as Denmark and South Korea) poses a challenge in terms of providing universal internet coverage.

6.1.1.2 Average fixed broadband latency

Convenient and reliable internet access can enable greater uses for both consumers and businesses. Average fixed broadband latency provides one measure of the quality of internet access. For this indicator, Australia ranks ninth with 24 milliseconds (ms) (EIU, 2020). Due to its reduction in latency, Australia has seen an improvement in ranking of two places compared to 2018. Out of the nations considered, Singapore is ranked number one in terms of average fixed broadband latency at 11 ms.

6.1.1.3 Mobile broadband access and mobile subscribers

Access to mobile devices and their associated services has grown rapidly in Australia over the last two decades. Access to mobile devices and their applications is recognised as an essential tool for modern economic development, contributing to global integration, efficiency, and transparency (United Nations, 2018).

On access to wireless mobile broadband, Australia ranks third out of 15 countries, with 144 wireless mobile broadband subscriptions for every 100 inhabitants across the country in 2019. This is one rank higher relative to Australia's performance in 2017 with 116 wireless mobile broadband subscriptions for every 100 people (OECD, 2019). Japan is the highest ranked nation with 177 subscriptions for every 100 people. This is followed by the United States with 150.

Australia ranks eleventh out of 14 counties in terms of mobile phone subscriptions, with 114 mobile subscriptions for every 100 people in 2019. Australia's rank remains unchanged from 2018. Four counties, Italy, Japan, New Zealand and Singapore, are tied for first place with 130 mobile subscriptions for every 100 people (EIU, 2020).

6.1.1.4 Trust in social media

Australia ranks 12th out of 14 countries in terms of trust in information received by other people using social media (EIU, 2020). This is with 12% of respondents claiming that they either 'mostly' or 'completely' trust other people using social media in 2019. Trust in social media has gone down by four percentage points relative to 2018, when Australia was ranked tenth (a decline of two). Japan ranks first in this indicator with 26%. This is followed by South Korea (24%) and Denmark (22%).

The majority of countries considered have experienced a decline in trust in social media over the last year. The most significant declines have been experienced by France (26 percentage points) and the United States (15 percentage points). The only exceptions to this decline are Japan, South Korea and Germany who reported an increase in trust for social media.

6.1.2 Businesses

Businesses both inside and outside the ICT sector have continued to expand their use of new and existing technologies. A focus on building Australia's business technology capabilities is essential for both current and future economic growth. In the business category, Australia's average rank is eighth. Of the indicators for which progress is able to be measured, Australia has declined two ranks on average.

Figure 6.3: Summary of Australia's progress in business

E-commerce	Trust in business apps & websites
Fell three ranks since 2018	Fell three ranks since 2018

Source: Deloitte Access Economics based on EIU (2020),

6.1.2.1 The importance of e-commerce

In 2019, Australia ranked ninth out of 13 countries, with 44% of survey respondents claiming to have purchased goods from internet retailers at least once a month (EIU, 2020). Australia has stagnated against its international peers in terms of consumers utilising e-commerce to purchase goods and services, falling three places relative to 2018. At this time, 48% of survey respondents had purchased goods from internet retailers in the past month.

Turkey ranks first out of the nations considered with a score of 72%, followed by Canada (66%) and Singapore and South Korea (both scoring 62%).

6.1.2.2 Trust in non-government apps and websites

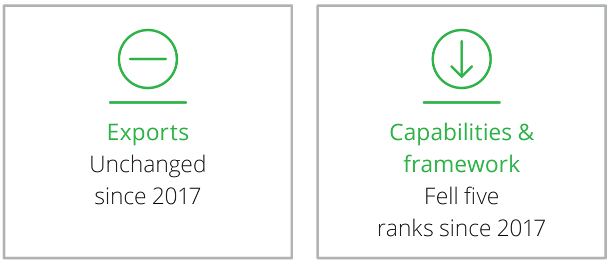
In terms of public trust in the business sector's use and application of consumer data, Australia ranks equal fifth (alongside Germany, Denmark and the United Kingdom) out of fourteen nations at 18% in 2019 (EIU, 2020). This ranking is one spot lower than its rank in 2018, with trust falling eight percentage points. Singapore and South Korea both rank number one in terms for trust in non-government apps and websites, with scores of 24 in 2019.

Across the globe trust in how the business sector treats consumer data has fallen since 2018. This decline in trust is not an isolated issue for Australia, with countries such as France and Turkey experiencing much larger declines.

6.1.3 ICT sector

The size and sustained development of the ICT sector indicates the strength of the technological core underpinning a country's digital economy. While the *Digital Pulse* recognises the importance of technology adoption and skills across the economy, a well-developed ICT sector indicates that a country is better equipped to capture a larger share of the growth in global consumer and business demand for ICT goods and services. In the ICT sector category, Australia's average rank is ninth. Of the indicators for which progress is able to be measured, Australia has declined two ranks on average.

Figure 6.4: Summary of Australia's progress in the ICT sector



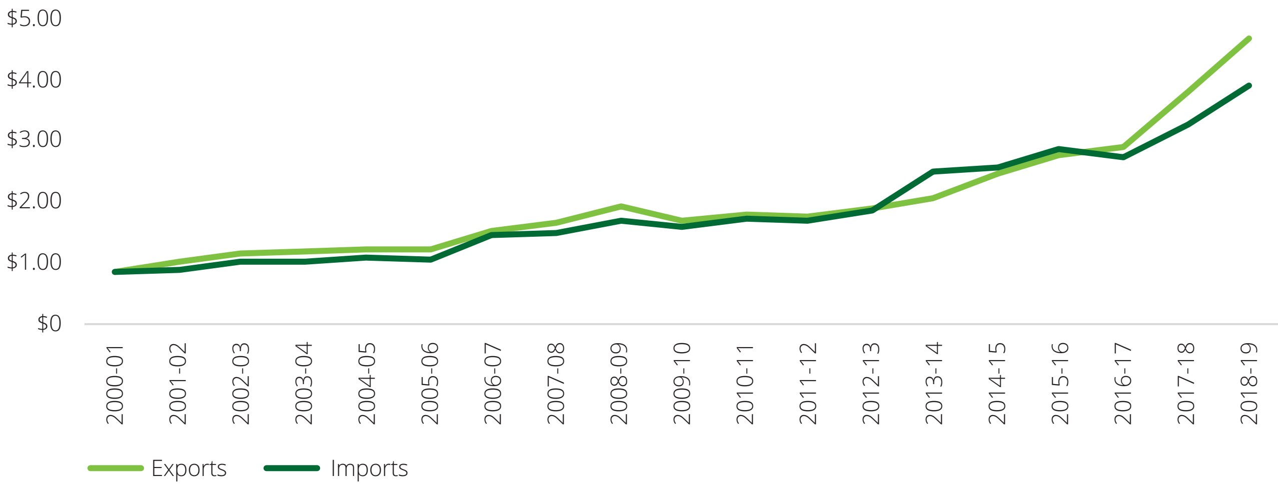
Source: Deloitte Access Economics based off WTO (2019) and ITU (2019),

6.1.3.1 ICT exports

ICT service exports are a measure of the extent to which a country's production of ICT goods and services is competitive at a global scale and demanded by consumers around the world. The available international comparison data examines exports of ICT services, as a share of total exports. The data shows that Australia ranks twelth out of the sixteen nations considered. Australia's exports of ICT services made up 1.01% of total exports in 2018 (WTO, 2019). This is marginally lower than the 1.03% recorded in 2017, where Australia also ranked thirtieth.

ICT exports totalled $4.69 billion in 2018–19, increasing almost 23% from the previous year (Chart 6.1). Meanwhile, ICT imports increased by just under 20% to reach $3.92 billion. Despite significant growth, and the resulting trade surplus of $770 million, this has still not matched the 12.9% share of total exports that Israel's ICT sector has achieved.

Chart 6.1 ICT exports and imports for Australia ($b), 2000–01 to 2018–19



Source: Deloitte Access Economics based on EIU (2020).

6.1.3.2 Cyber capabilities and framework

There is increasing attention focused towards trust and governance associated with the security of information stored and transferred digitally, especially for personal or financial data. Assessing the cybersecurity skills and infrastructure of a country's ICT sector provides an indication of its capabilities in defending against cyber-attacks and managing cyber-related risk, as well as its resilience in recovering from such activities should a significant cybersecurity incident arise.

In the 2018 Global Cybersecurity Index, Australia ranked eighth out of 16 nations with a score of 0.89 (ITU, 2019). This compares to the United Kingdom, which ranked first with a score of 0.93. While Australia has increased its index score seven points since 2017, its ranking has declined substantially from its previous position of third. Of the 16 nations considered, Australia's performance in the index was the second lowest, followed only by Singapore (the previous leader) who declined by almost three points. However, despite the poor performance relative to its global peers, Australia still maintains its third place in the APAC region in 2018, receiving a perfect score in both the legal and organisation pillars.

6.1.4 Workforce skills

Developing technological competency across the Australian population is an important driver of success in the modern digital age. It is essential all Australians have the capability to participate in the broader ICT sector. As a consequence, the digital capabilities and ICT skills of individuals within a country — across students, workers and the general population — is an important consideration when evaluating Australia's competitiveness both now and into the future.

The minimum amount of required digital skills is also likely to increase in the future. Increasing automation is raising the complexity of tasks and requiring higher skill levels for entry level positions (Hajjowicz, 2016).

In the workforce skills category, Australia's average rank is sixth. Of the indicators for which progress is able to be measured, Australia has declined one rank on average.

Figure 6.5: Summary of Australia's progress in workforce skills

Mathematics
Fell one rank since 2015

Science
Unchanged since 2015

Digital literacy
Rose one rank since 2017

Source: Deloitte Access Economics based on OECD (2020) and EIU (2020).

6.1.4.1 Students ability in maths and science

Having strong capabilities in school-level STEM subjects continues to be a crucial factor in determining Australia's future potential and ability to compete against its global peers.

In 2018 Australia ranked tenth in mathematics and sixth in science out of the 16 nations considered (OECD, 2020). Relative to 2015, Australia has fallen one rank for Mathematics and remains unchanged in science. Japan was the number one performer in both disciplines in 2018. These indicators are based on the OECD's Programme for International Student Assessment (PISA). Australia's performance in science and mathematics has been declining over the past decade.

6.1.4.2 Digital literacy

Digital literacy considers the extent to which the population can use the internet for 'useful' purposes such as for education, health services and news gathering. Australia ranks first, tied with nine other counties, with 100% of the population over the age of 15 years old being considered as digitally literate in 2019 (EIU, 2020). This is a slight increase on 2017, where 99% of the Australian population was considered digitally literate and Australia was tied second.

6.1.5 Government and regulatory environment

While government can set rules and demonstrate leadership, ultimately the vast majority of factors determining cyber risk and preparedness relate to business and individual activities. The challenge, however, is for governments to provide a regulatory and policy framework which inspires confidence in its citizens and allows businesses to innovate. If done correctly, this has the potential to maximise the potential benefits from digital while also minimising cyber risks (Deloitte Access Eeconomics, 2020).

In the government category, Australia's average rank is fifth. Trust in government websites and apps is the only indicator for the government category that can be compared through time. For this indicator, Australia has increased seven ranks since 2018.

Figure 6.6: Summary of Australia's progress in government and regulatory environment

Trust in government websites & apps
Rose seven ranks since 2018

Source: Deloitte Access Economics based on EIU (2020).

6.1.5.1 Trust in government websites and apps

Due to the public sector's essential role in developing universal digital abilities throughout Australia, trust in the Australian Government's application and capabilities is essential. In terms of public trust in government, Australia ranked third in 2019 — increasing seven ranks since 2018. This is with 54% of respondent's claiming that they either 'mostly' or 'completely' trust government websites and applications (34% in 2018). This compares to Singapore which scored 66% (EIU, 2020).

6.1.5.2 Use of government technology

As a significant employer and having major purchasing power, government use of technology has significant influence on the demand for technology workers and products. Broader use of technology could develop private sector capacity in emerging areas. Australia ranks ninth for this indicator with an index score of 78.6 compared to Korea with a score of 86.1. These scores are based on the Network Readiness Index's score of the government, based on a variety of measures that combine a variety of measures of usage and skills (Portulans Institute, 2019).

6.1.5.3 E-participation

Australia ranks second out of the 16 countries considered for e-participation of government, being marginally surpassed by first placed Denmark. E-participation is used to measure the readiness and capacity of national institutions to use digital technologies to deliver public services. This measure includes consideration of the scope and quality of online services (United Nations, 2018).

6.1.5.4 ICT regulatory tracker

The establishment of regulatory authorities and the appropriate policy settings are required for appropriate development of the digital economy. The International Telecommunications Union (ITU) analysed data from 75 countries and found that a stronger regulatory environment (measured through the ICT Regulatory Index Tracker) can contribute to industry growth (ITU, 2018a). The main mechanisms for this are through encouraging investments in infrastructure and the adoption of digital technology by other industries.

To facilitate international comparison, the ITU has developed an ICT Regulatory Tracker which provides an overall assessment of a country's legal and regulatory environment. The tracker comprises 50 indicators grouped into four categories: the regulatory authority, regulatory mandate, regulatory regime and competition framework. Measured through this indicator, Australia ranks fourth compared to the selected countries with a score of 94.5 and not far from first placed Italy that achieved a score of 97.3 (ITU, 2018a). Importantly, the tracker does not measure the quality, the level of implementation or the performance of regulatory frameworks in place, but records their existence and features. Australia's high rank does not assess the effectiveness of the regulations themselves but suggests that Australia has the features in place usually required for effective regulation.

6.2 The size of the prize

Based on the assessment of international competitiveness of its ICT sector, Australia is a middling country. Despite significant growth in areas such as employment or ICT service exports, Australia has declined in relative performance when compared to other similar countries.

In the current COVID-19 climate, other countries are expected to continue to accelerate their digital transformations. To merely keep up with competitors, Australia must do more. But to become a digital leader, Australia will need to double down on building the required workforce skills, encourage investment and adoption in technology, and support new businesses to thrive. Some starting points are outlined in the next section.

But what does digital leadership look like?

Deloitte Access Economics has considered what would be required for Australia's technology sector to become a digital leader. Four characteristics have been identified for Australia to reach position of a global leader:

- growth in the technology workforce
- growth of new technology companies
- diversification of exports towards more technology services
- greater readiness for adopting emerging technologies.

One requirement of a digital leader is **significant growth in the technology workforce.** For Australia to be a world leader in this area would require technology workers to grow by more than double the current rate forecast to reach the United Kingdom's technology workforce size of 9% of total employed persons (Tech Nation, 2020).[9] This would require an additional 388,000 technology workers, including the 156,000 workers forecasted in Section 5.2.

Another requirement of a digital leader is **encouraging the growth of new technology companies.** This requires an environment that encourages future start-ups and scaling-up for recently established businesses.

9. Similar to *Australia's Digital Pulse*, the *Tech Nation* report calculates technology employment in traditional ICT industries as well as technology occupations in other sectors. *Tech Nation* uses employment data from the Office for National Statistics (ONS) Annual Population Survey (APS) to calculate the employment in ICT industry. It also uses official data from the ONS Business Structure Database (BSD) to estimate employment within technology occupations across various industries in the United Kingdom.

Table 6.1: Largest companies in Australia and the United States by market capitalisation

	Australia 1978	Australia 2020	United States 1980	United States 2020
1	BHP	CSL	**IBM**	**Microsoft**
2	Conzinc Rio Tinto	CBA	**AT&T**	**Apple**
3	MIM	BHP	Exxon	**Amazon**
4	Hamersley	Westpac	Standard Oil of Indiana	**Alphabet**
5	Bank of New South Wales	National Australia Bank	Schlumberger	**Facebook**
6	CSR	ANZ Banking Group	Shell Oil	Berkshire Hathaway
7	Australian Guarantee	Woolworths Group Ltd	Mobil	Visa
8	ANZ Banking Group	Wesfarmers Ltd	Standard Oil of California	JP Morgan Chase
9	National Australia Bank	**Telstra Corporation Ltd**	Atlantic Richfield	Johnson and Johnson
10	Coles Group	Transurban Group	General Electric	Walmart

Source: Eureka Report (2020), ASX (2020), EFTB (2020), Disfold (2020).

Historically, Australia has not performed well in promoting growth of technology start-ups. Table 6.1 compares the largest companies by market capitalisation in Australia and the United States (technology companies are bolded). The table shows that over the last 40 years, some technology companies in the United States have become the largest companies in the country.

This does not suggest that there has not been digital innovation or success in Australian technology start-ups. Businesses such as Atlassian and Canva have generated significant commercial success from technology solutions. Yet the relatively limited number of companies attaining the level of commercial success compared to companies in the United States demonstrates that this path is difficult to replicate in the Australian environment.

Recent research suggests that the environment of a start-up is almost as important as the efforts of its founders (Genome, 2019). In this respect, Australian cities are behind in a number of key indicators to other global cities. In fact, Sydney has fallen from 17th position in 2017 to 23rd in 2019. Again, this is driven by international competitors accelerating faster than Australia (Genome, 2020).

Becoming a global leader will also require **further diversification of exports** towards ICT services and products. Other countries represent a significant source of demand for Australian businesses.

Yet, as discussed in section 6.1, Australia's ICT services exports as a share of total exports has remained relatively unchanged over recent years. The lack of export diversification in Australia has been recognised as a factor in the 93rd ranking of Australia in the Harvard Economic Complexity Index (ECI) (Harvard, 2019). While the absolute value of ICT exports has been increasing, the fact that Australia's ranking remains relatively constant implies that growth is only maintaining pace with our global competitors.

Future development of Australia's technology industry will also require **greater adoption of emerging technology.** New waves of technology provide new opportunities for businesses as long as they are ready to take advantage of its potential uses. In this respect, Australian companies are not as prepared as other countries to adopt some emergency technology such as AI. As demonstrated in the case study below, Australia under-performs compared to its global peers in a number of indicators measuring attitudes towards AI (shown in Chart 6.7) (Deloitte, 2019a).

Spotlight on: Artificial Intelligence

AI is a technology that can be used to increase the efficiency, safety and quality of production processes in almost every industry. The technology has multitude of use cases ranging from more efficient customer service to data analytics. As a result, AI is believed to have the potential to deliver a substantial return to labour productivity in the future.

Investment in AI is continuing to grow throughout the world, mostly coming from the public sector (CSIRO, 2019).

Yet Australia under-performs compared to its global peers in a number of indicators measuring attitudes towards AI (shown in Chart 6.7). To obtain a global view of how organisations are adopting and benefiting from AI technologies, Deloitte surveyed 1,900 business executives from companies that are early adopters of AI (prototyping or implementing AI solutions). Seven countries were represented: Australia, Canada, China, Germany, France, the United Kingdom, and the United States (Deloitte, 2019a).

Chart 6.7: Global attitudes towards AI

		Overall	Australia	Canada	China	France	Germany	United Kingdom	United States
Maturity	Percentage that are 'seasoned' AI adopters	21%	17%	19%	11%	16%	22%	15%	24%
	Have a comprehensive company-wide AI strategy	35%	34%	27%	46%	28%	26%	41%	37%
Urgency	Believe AI is very critically important to company's success now	63%	54%	58%	54%	49%	46%	61%	69%
	Achieve strong competitive advantage with AI	37%	22%	31%	55%	27%	47%	44%	37%
	Believe AI will transform their business within three years	56%	51%	51%	77%	63%	60%	55%	55%
Challenges	Major or extreme concerns about AI risks	43%	49%	44%	16%	48%	29%	35%	46%
	Cybersecurity vulnerabilities of AI are a top-three concern	49%	46%	42%	54%	49%	51%	44%	50%
	Moderate-to-extreme AI skill gaps	68%	72%	72%	51%	57%	62%	73%	68%

Source: Deloitte State of AI in the Enterprise Survey, 2nd Edition 2018 via Deloitte 2019b.

Scale: 10% – 80%

Australia ranks fourth in terms of AI maturity and sixth in terms of urgency. Across all three indicators associated with "challenges" associated with AI, Australia has an average rank of third. In fact, while an AI skills gaps is an issue for all seven economies considered, Australia ranks second in terms of business leaders identifying skills shortages. Australia is ranked first in terms of having 'major or extreme concern' about the risk of AI (Deloitte, 2019a).

There are opportunities for Australia to leverage its strengths in science and technology to develop its capabilities in AI and fill niches in the global marketplace. In response to the growing importance of AI, Australian education institutions are investing in upskilling the future workforce in understanding and finding commercial applications for this new technology (Deloitte, 2019a).

Australia is not unique in its challenges towards further adopting AI. However, if Australia does not revaluate its global position in investment in emerging technology, there is a risk of being left behind.

7. How do we get there?

Government plays a key role in the digital economy, and Australia's digital competitiveness. It is a significant buyer of digital services and a significant employer.

The public sector accounts for 16% of all employed people in Australia, with over two million employees in 2019 (ABS, 2020). While only 6% of the Australian public sector is considered in ICT fields (Australian Public Service Commission, 2019), *Digital Pulse* demonstrates the importance of technology in a much broader range of industries and occupations.

Government policy affects and influences the broader digital economy. A well-established regulatory environment can contribute to industry growth by encouraging investments in infrastructure and promoting digital technology adoption (ITU, 2018).

COVID-19 has amplified the importance of government and policy. The Australian Government has announced several short-term stimulus measures during the current shutdown. However, the recession is likely to extend beyond the shut-down. As such, policymakers are also considering measures that will support productivity growth over the medium term.

This is an important opportunity. Removing policy roadblocks and investing in the future of the digital workforce could power Australia's economy in the medium-term. It also has the potential to propel Australia's digital economy going forward.

7.1.1 Upskilling and reskilling for the future

Education policies are emerging as an important focus of the federal response to COVID-19 and associated economic downturn. The Australian Government released the Higher education relief package in April, which introduces significant discounts for students undertaking short online courses at universities and other higher education providers, for study taking place at the diploma level and above.

Policy recommendations

- Targeted support for Information Technology short courses for workers seeking to upskill and reskill.
- Promoting successful small businesses digital technology grant programs.
- Support cybersecurity training for small businesses.
- Introduce quarterly R&D tax incentive credits and provide greater certainty on eligible projects to businesses.
- Drive e-invoicing, including by identifying a timeframe for all Australian Government agencies and departments to transition to e-invoicing.
- Reduce the complexity around employee share schemes (ESS) to support existing technology start-ups and encourage future start-ups.
- ABS to publish more information on the ICT industry.

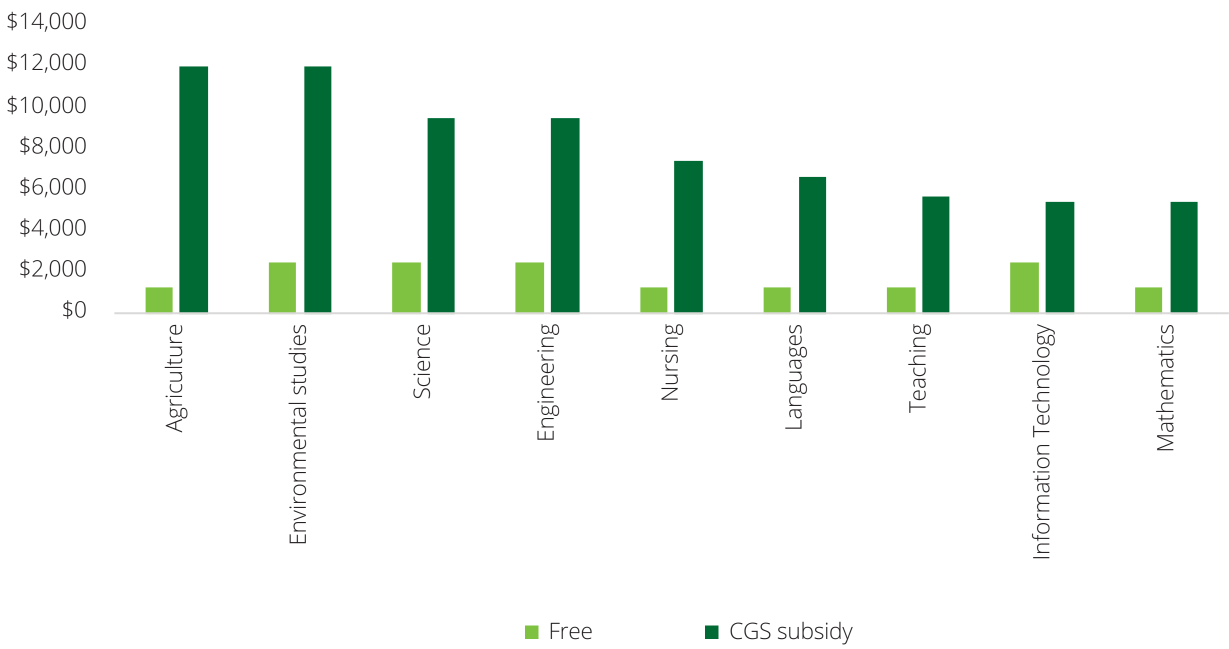
The courses identified as areas of national priority — including IT, teaching, and health science — have been significantly discounted (DESE, 2020). However, IT has the second lowest Commonwealth Government Subsidy (CGS) with $5,411 being offered to prospective students. This is significantly lower than other natural science and technology related fields such as science and engineering.

The subsidy level for courses is based on the cost of providing the course. While the subsidy recognises IT as an important field of study, the demand by businesses for these skills suggests that a higher subsidy should be considered. Digital skills are the third most demanded skill by Australian business (Deloitte, 2019). This is reflected in the higher share of graduates of computing and information systems (75.9%) attaining employment compared to all study areas (72.9%) (QILT, 2020).

Education policy should also consider the need to upskill existing technology workers. During recessions, businesses look to cut costs, and professional development may be one area considered for reductions. However, this can be counter-productive as investing in technology skills promotes growth in the longer-term by improving productivity. Government should look to support existing workers to update and improve their technology skills throughout their career to facilitate these benefits.

The National Skills Commission, established in July 2020, should also consider how best to address the shortage in digital skills and upskilling existing technology workers. The Commission is expected to release forecasts of in-demand skills. These forecasts should be used to develop a greater understanding of the need for digital skills and how subsidies could be used to encourage greater engagement in digital reskilling within the Australian workforce.

Chart 7.1: Course fees and Commonwealth Government Subsidy by field of education



Source: DESE (2020).

Beyond subsidies, the National Skills Commission should work closely with industry bodies and businesses to promote in-demand skills to the general workforce and greater reskilling and upskilling of existing technology workers. Promoting the need for reskilling and the availability of short form courses may contribute to higher take-up levels of these courses. In addition, communicating the benefits of reskilling employees to businesses could lead to businesses prioritising training and developing existing staff rather than looking solely to recruitment to fill skill gaps.

7.1.2 Small business grants program to support investment in digital

While small businesses stand to gain from increasing their digital uptake (see Section 4.3), the current economic climate may make investment difficult. Gartner forecasts that technology spending will decline 6% decline in 2020, and 16% of Australian businesses reported a reduction in their capital expenditure intentions between December 2019 and March 2020 (ABS, 2020).

Grant programs to incentivise business adoption of digital technology could assist in countering the expected drop in business investment and to support productivity growth in businesses over the medium term.

One example of an Australian Government grant program is the Small Business Digital Champions Program. The Program has funded the development and adoption of digital transformation strategies for 100 small businesses across Australia. Each business received $18,500 in digital support services, enabling them to improve and update their business hardware, software, online content or digital training. Some of the businesses were also selected as Digital Champions and received additional support from an expert digital mentor.

Promoting this and other similar programs could enable more small businesses to access the benefits of greater investment in digital technologies through new websites or software programs.

Businesses could also benefit from investment in skills required for cybersecurity. A 2019 survey showed 62% of small businesses reported they had previously been a victim of a cybersecurity incident (ACSC, 2020). There has also been a recent increase in COVID-19 themed malicious cyber activity across Australia. A grant to promote the development of cybersecurity skills could provide an opportunity to encourage more secure engagement with digital technology.

7.1.3 Ensuring the R&D tax incentive is accessible

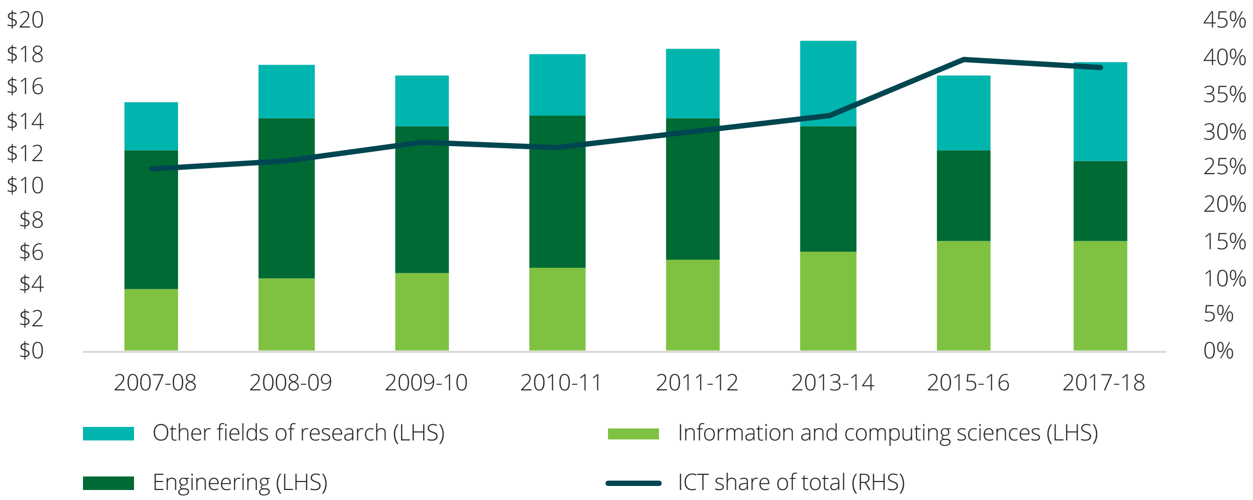
The Australian Government has introduced legislation in December 2019 to limit the scope of the R&D tax incentive. This would include lifting the expenditure threshold limit from $100 million to $150 million; linking the refundable R&D tax offset to corporate tax rates plus a 13.5 percentage point premium; and introducing a cap on the refundability of the R&D tax offset at $4 million per annum (Parliament of Australia, 2020).

While a number of the proposed changes were only relevant to larger businesses, some changes will affect small to medium businesses (SMBs). Estimates suggest that in the 2017 financial year, the value of the incentive for SMBs dropped from 45% to 43.5%. If the proposed changes are followed through, the value of the incentive for small businesses will drop to 41% (MYOB, 2020).

Limited accessibility of the R&D tax incentive could reduce investment in digital technology. Technology related fields represent a growing proportion of this expenditure on R&D, increasing from 25% of total private expenditure in 2007–08 to 39% in 2017–18 (Chart 7.2).

Business expenditure on R&D in Australia is already relatively low compared to other countries. In fact, UNESCO's research into global R&D expenditure shows that ten countries cumulatively account for 80% of worldwide expenditure on R&D. Australia is the fourteenth largest spender on R&D, with total R&D expenditure amounting to 2.2% of GDP (UNESCO, 2019).

Chart 7.2: Business expenditure on R&D by fields of research ($b), 2007–08 to 2017–18



Source: ABS catalogue 8104.0 (2019).

This legislation could reduce the use of the R&D tax incentive at a time when R&D expenditure would be expected to fall. Further, it could impact Australia's attractiveness as an R&D destination, given that varying R&D incentives are offered globally. Reducing local incentives may lead some Australian-based ICT companies to outsource their R&D activities or abandon them entirely (AIIA, 2020).

The use of the R&D tax incentive should be promoted, particularly for small businesses and start-ups. This would require the tax incentive expenditure threshold to be lowered rather than increased. This could enhance the additional R&D expenditure enabled through the tax incentive, which previously has been found to higher for smaller businesses (CIE, 2016).

Greater certainty around the tax incentive could also lead to a higher take-up by smaller businesses. A recent review of the R&D tax incentive found that the regulators' (ATO and Department of Industry, Innovation and Science) compliance activity could adversely affect SMBs. Consultation revealed regulators' audits of claims were often retrospective and commenced several years after the relevant activity was undertaken and the refund was received. This was found to adversely affect smaller businesses (Australia Small Business and Family Enterprise Ombudsman, 2019).

The review suggests any audits should be conducted at most one year after the business registers R&D activities and before the business claims the benefit with the ATO to increase small business certainty.

Introducing quarterly R&D tax credit refunds would also improve the financial viability of SMBs. SMBs and start-ups rely on refunds received by the program. Changing from annual tax credits to quarterly would reduce delays and improve cashflows for these businesses. It is also a revenue neutral improvement to the program.

7.1.4 Public sector shaping the digital landscape.

Digitisation of public sector operations can lead to substantial productivity dividends while also incentivising the private sector towards more digital operations. An obvious example is the implementation of a consistent e-invoicing system, which is expected to lead to a national productivity dividend worth $28 billion over ten years.

There have been a number of steps taken by the Australian Government to promote adoption of e-invoicing within the public and private sector. The ATO has become the Peppol Authority, which enabled it to sign up access points for businesses. Since the beginning of 2020, government agencies signed up to e-invoicing have been required to pay contracts valued up to $1 million within five days or face interest on late payments, as long as the seller is also using e-invoicing.

While these actions have started the process, there is more to be done. E-invoicing has been adopted by some large businesses and their suppliers. Yet many more businesses will need to join the network for it to be truly interoperable and achieve the estimated benefits. Some businesses have also begun using automatic PDF invoicing options, which do not achieve all the efficiency benefits of genuine e-invoicing.

The Australian Government should establish a timeframe for all federal and state government agencies to transition to e-invoicing. The use of e-invoicing by all government agencies would be consistent with the Digital Transformation Agency's Digital Transformation Strategy aim for the Australian Government to become a world leader in digital services. By acting as a first mover to the new system, the Australian Government would take some of the risks away from business that will need to transition.

The National COVID-19 Coordination Commission (NCCC), which has been established to provide the Australian Government with advice on its response to the crisis, could play a support role in the transition for both the private and public sector. The NCCC could examine common barriers for organisations using digital technology during the crisis and the best practices used to overcome them, which could support the adoption of broader digital transformations such as e-invoicing. This may reduce help to lower the transition costs for many businesses.

7.1.5 Encouraging technology start-ups through Employee Share Schemes (ESS)

Many of today's biggest technology companies were founded during the 2008 Global Financial Crisis (GFC) — such as Instagram, Uber, and WhatsApp. While not all start-ups succeed, there's an opportunity now to build new companies that will contribute to the economy going forward.

Many start-up businesses are capital constrained. This is likely to be worse during a recession. A global survey of start-ups found that 74% of start-ups have already had to let go full-time employees, with 26% having to let go more than 60% of their full-time staff (Genome, 2020).

ESS can assist by providing additional sources of remuneration to employees that are dependent on future performance.

While the current ESS concessions for start-ups introduced in 2015 have gone some way to making it attractive for start-ups to issue equity remuneration, feedback from businesses is that more needs to be done. In particular, businesses report that complexity of the tax treatment means employees are not often clear on potential benefits and tax costs that can arise as a result of the ESS grant, which hampers its effectiveness (Australian Financial Review, 2020).

Recently, Treasurer Josh Frydenberg directed the House of Representatives standing committee on tax and revenue to launch an inquiry on the effectiveness of the 2015 changes to the tax treatment of employee share schemes (APH, 2020). The review should consider ways of simplifying the ESS and increasing its use.

Processes for establishing and implementing Employee Share Schemes (ESS) could be streamlined to encourage growth in the 1,752 technology start-ups in Australia (Upwise, 2019).[10] It could also make Australia a more attractive option for future technology start-ups.

7.1.6 Understanding the importance of the technology sector

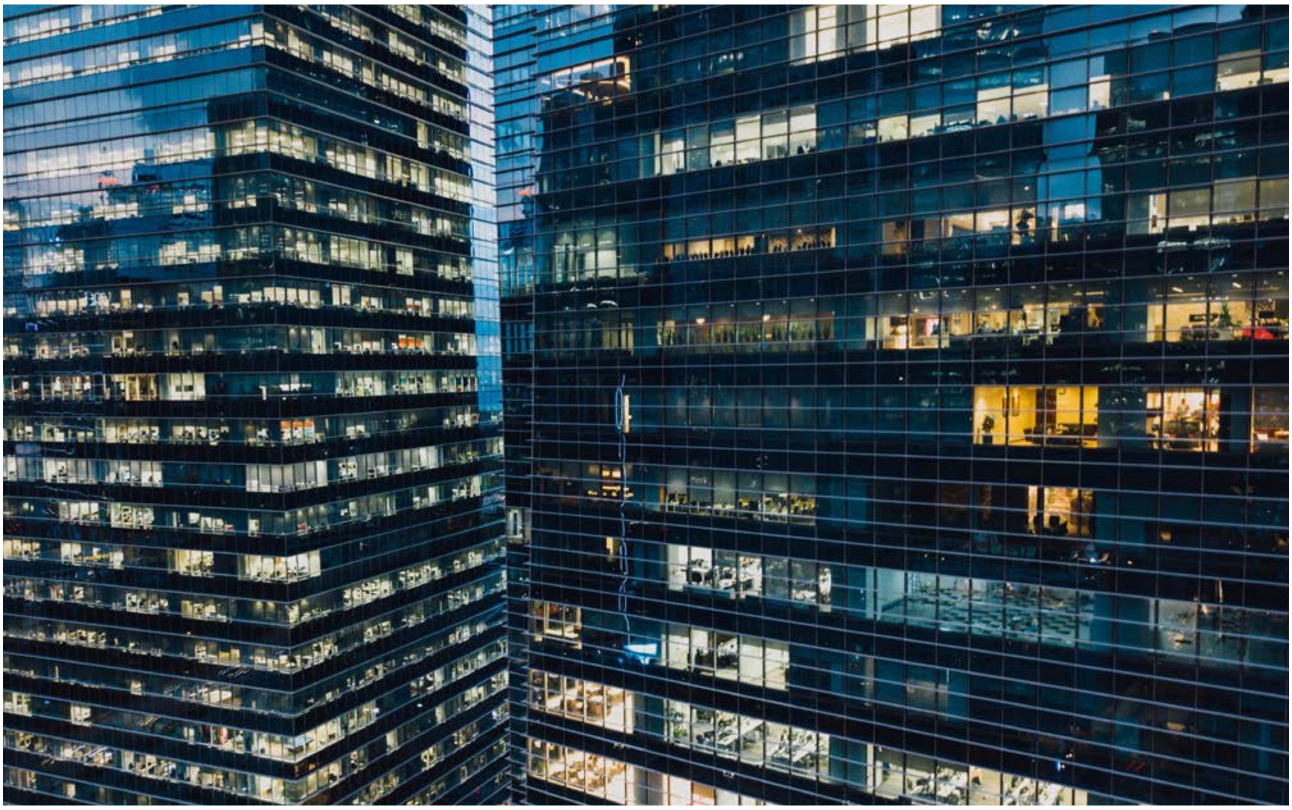
Promoting a greater understanding of the technology landscape will inform decision makers when making policies that affect the industry. As demonstrated in this report, the technology workforce is significantly larger than the Information Media and Technology (IMT) industry. The IMT industry combines ICT subdivisions (Telecommunications Services and Internet Service Providers, Web Search Portals and Data Processing Services) with unrelated industries such as print media. In fact, more than half of ICT employment is located in industries outside of those industries traditionaly associated with ICT. The current structure of the national accounting framework therefore hides the importance of ICT to the Australian economy.

10. Upwise identify start-ups as: a company founded in Australia that is active and operating, has more than one employee, has developed an innovative product or technology-related service, and was founded since 2014.

This situation diminishes the significance of the ICT sector and its role in the economy. The size and role of ICT was previously recognised in a special catalogue produced by the ABS on the ICT industry (ABS, 2008). The catalogue produced industry statistics — such as number of businesses, employment and value added.

The ABS has continued to provide similar bespoke insights into the tourism industry. Similar to ICT, the tourism industry is spread through a number of different industries such as retail, food and accommodation and transportation. The ABS Tourism Satellite Accounts have been published since 1997–98 and provide estimates of the share of GDP, gross value added, and employment that can be attributed to tourism.

The ABS 8126 catalogue should be reinstated to inform decision making about the industry. This is particularly pertinent during a post COVID-19 environment where ICT is expected to play an increasingly important role in economic recovery.



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Appendix A: Statistical compendium

At a glance – Australia

Table A.1: Summary of key national statistics

Indicator	Statistic	Period
Technology workers in Australia (actuals)	772,175	2019
Of which: ICT-related industry subdivisions	352,054	2019
Other industries	420,121	2019
Of which: Technical, professional, management and operational occupations	537,678	2019
Other occupations (including trades and sales)	234,497	2019
Technology workers' proportion of total workforce	5.99%	2019
Forecast size of technology workforce	928,718	2025
Inbound temporary migration of technology workers (457 and 482 visas granted)	13,250	2018–19
Net migration inflow of technology workers	20,664	2015–16
Female share of technology workers	29.5%	2019
Older workers' (aged 55+) share of technology workers	13.0%	2018
Businesses' ICT research and development expenditure	$6.75bn	2017–18
Total ICT service exports	$4.69bn	2018–19
Total ICT service imports	$3.92bn	2018–19
IT university enrolments by domestic students	39,063	2018
IT university completions by domestic students	6,333	2018
IT university enrolments by international students	60,978	2018
IT university completions by international students	13,399	2018

Source: ABS catalogues 5368.0 (2019) and 8104.0 (2020) and customised report (2020), Department of Education uCube (2020); Department of Immigration and Border Protection Subclass 457 Visa Statistics (2020)

At a glance – states and territories

Table A.2: Summary of key state statistics

Indicator	NSW	Vic	Qld	SA	WA	Tas	ACT	NT
Technology workers in Australia (2019)	289,354	246,934	109,314	34,761	52,822	8,037	26,621*	4,331*
Of which: ICT-related industry subdivisions	133,971	116,565	48,458	17,148	22,312	4,005	N/A	N/A
Other industries	155,383	130,369	60,856	17,613	30,511	4,031	N/A	N/A

Indicator	NSW	Vic	Qld	SA	WA	Tas	ACT	NT
Technology workers' proportion of total workforce (2019)	7.0%	7.2%	4.3%	4.1%	3.9%	3.2%	N/A	N/A
IT university enrolments by domestic students (2018)	13,388	12,199	7,391	2,184	1,851	348	1,434	130
IT university completions by domestic students (2018)	2,433	1,910	1,017	338	288	66	241	15

* While the 2019 labour force data from the ABS contained combined figures for the NT and the ACT for confidentiality reasons, NT employment has been separated from ACT employment at an aggregate and occupational level using the Deloitte Access Economics employment forecast model.

Sources: ABS customised report (2020), Deloitte Access Economics (2020) and Department of Education uCube (2020)

At a glance – ICT employment

Table A.3: CIIER classification of technology workers at the four-digit Australian and New Zealand Standard Classification of Occupations (ANZSCO) level

ICT management and operations
1351 ICT managers
2232 ICT trainers
2247 management and organisation analysts
2249 other information and organisation professionals
2621 database and systems administrators, and ICT security specialists
2632 ICT support and test engineers
ICT technical and professional
2324 graphic and web designers, and illustrators
2611 ICT business and systems analysts
2612 multimedia specialists and web developers
2613 software and applications programmers
2631 computer network professionals
2633 telecommunications engineering professionals
3132 telecommunications technical specialists
2600 ICT professionals nfd
2610 Business and Systems Analysts, and Programmers nfd
2630 ICT Network and Support Professionals nfd
3130 ICT and Telecommunications Technicians nfd

ICT sales
2252 ICT sales professionals
6212 ICT sales assistants
ICT trades
3131 ICT support technicians
3424 telecommunications trades workers
Electronic trades and professional*
3123 electrical engineering draftspersons and technicians*
3124 electronic engineering draftspersons and technicians*
3423 electronics trades workers*
ICT industry admin and logistics support*
All other occupations where the employee works in an ICT-related industry subdivision (telecommunications services; internet service providers, web search portals and data processing services; and computer system design and related services)

* For these occupations, only workers employed in the ICT-related industry subdivisions (telecommunications services; Internet service providers, web search portals and data processing services; and computer system design and related services) are counted as technology workers

Sources: Australian Computer Society and CIIER

Table A.4: OECD's broad measure of ICT-skilled employment at the four-digit ANZSCO level

1111 chief executives and managing directors	2349 other natural and physical science professionals
1112 general managers	2512 medical imaging professionals
1311 advertising and sales managers	2600 ICT professionals nfd
1320 business administration managers not further defined (nfd)	2610 business and systems analysts, and programmers nfd
1322 finance managers	2611 ICT business and systems analysts
1323 human resource managers	2612 multimedia specialists and web developers
1324 policy and planning managers	2613 software and applications programmers
1332 engineering managers	2621 database and systems administrators, and ICT security specialists
1335 production managers	2630 ICT network and support professionals nfd
1336 supply and distribution managers	2631 computer network professionals
1351 ICT managers	2632 ICT support and test engineers
1419 other accommodation and hospitality managers	2633 telecommunications engineering professionals
1494 transport services managers	2710 legal professionals nfd
2210 accountants, auditors and company secretaries nfd	2711 barristers

2211 accountants	2712 judicial and other legal professionals
2212 auditors, company secretaries and corporate treasurers	2713 solicitors
2220 financial brokers and dealers, and investment advisers nfd	3100 engineering, ICT and science technicians nfd
2221 financial brokers	3123 electrical engineering draftspersons and technicians
2222 financial dealers	3124 electronic engineering draftspersons and technicians
2223 financial investment advisers and managers	3130 ICT and telecommunications technicians nfd
2232 ICT trainers	3131 ICT support technicians
2241 actuaries, mathematicians and statisticians	3132 telecommunications technical specialists
2242 archivists, curators and records managers	3400 electrotechnology and telecommunications trades workers nfd
2243 economists	3420 electronics and telecommunications trades workers nfd
2244 intelligence and policy analysts	3423 electronics trades workers
2246 librarians	5100 office managers and program administrators nfd
2247 management and organisation analysts	5121 office managers
2249 other information and organisation professionals	5122 practice managers
2251 Advertising and marketing professionals	5211 personal assistants
2252 ICT sales professionals	5212 secretaries
2320 architects, designers, planners and surveyors nfd	5321 keyboard operators
2321 architects and landscape architects	5510 accounting clerks and bookkeepers nfd
2322 cartographers and surveyors	5511 accounting clerks
2326 urban and regional planners	5512 bookkeepers
2331 chemical and materials engineers	5513 payroll clerks
2332 civil engineering professionals	5521 bank workers
2333 electrical engineers	5522 credit and loans officers
2334 electronics engineers	5523 insurance, money market and statistical clerks
2335 industrial, mechanical and production engineers	6111 auctioneers, and stock and station agents
2336 mining engineers	6112 insurance agents
2341 agricultural and forestry scientists	6212 ICT sales assistants
2342 chemists, and food and wine scientists	6399 other sales support workers
2343 environmental scientists	7123 engineering production systems workers
2344 Geologists and geophysicists	2349 other natural and physical science professionals
2345 life scientists	

Source: OECD (2012)

Table A.5: Technology workers by industry and CIIER occupational grouping, 2019

	ICT management and operations	ICT technical and professional	ICT sales	ICT trades	Electronic trades and professional	ICT industry admin and logistics support	Total technology workers
Industry divisions							
Agriculture, forestry and fishing	1,040	488	0	24	0	0	1,551
Mining	2,565	2,972	0	1,947	0	0	7,485
Manufacturing	9,224	11,772	593	2,301	0	0	23,891
Electricity, gas, water and waste services	4,110	4,874	571	1,610	0	0	11,165
Construction	2,902	1,877	131	6,863	0	0	11,773
Wholesale trade	4,845	6,706	2,853	2,940	0	0	17,343
Retail trade	5,778	8,031	6,091	5,440	0	0	25,340
Accommodation and food services	566	819	372	0	0	0	1,757
Transport, postal and warehousing	6,936	5,788	261	2,318	0	0	15,304
Rest of information media and telecommunications*	1,215	7,945	135	1,771	0	0	11,066
Financial and insurance services	26,251	32,760	392	3,149	0	0	62,552
Rental, hiring and real estate services	1,921	1,647	0	472	0	0	4,040
Rest of professional, scientific and technical services**	49,347	41,031	750	3,685	0	0	94,813
Administrative and support services	3,433	6,341	356	1,417	0	0	11,546
Public administration and safety	35,425	18,948	270	6,794	0	0	61,436
Education and training	10,592	12,658	334	4,708	0	0	28,293
Healthcare and social assistance	7,285	5,723	180	2,800	0	0	15,989

	ICT management and operations	ICT technical and professional	ICT sales	ICT trades	Electronic trades and professional	ICT industry admin and logistics support	Total technology workers
Arts and recreation services	2,059	4,251	0	565	0	0	6,875
Other services	2,542	3,166	305	1,889	0	0	7,902
ICT industry subdivisions							
Telecommunications services	7,871	21,403	5,516	17,043	563	41,228	93,624
Internet service providers, web search portals and data processing services	441	1,316	518	950	22	4,596	7,843
Computer system design and related services	38,810	111,785	13,542	22,716	2,075	61,659	250,587
Total technology workers	**225,156**	**312,301**	**33,171**	**91,403**	**2,661**	**107,483**	**772,175**

* Excluding telecommunications services, and internet service providers, web search portals and data processing services, which are separately identified as ICT industry subdivisions.

** Excluding computer system design and related services, which is separately identified as an ICT industry subdivision.

Source: ABS customised report (2020)

Table A.6: Technology employment forecasts by occupation grouping, 2019–25

Occupation grouping	2019	2025	Average annual growth (%)
ICT management and operations	225,156	269,873	3.1
ICT technical and professional	312,301	365,087	2.6
ICT sales	33,171	39,506	3.0
ICT trades	91,403	117,723	4.3
Electronic trades and professional*	2,661	3,474	4.5
ICT industry admin and logistics support*	107,483	133,056	3.6
Total technology workers	**772,175**	**928,718**	**3.1**

* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2020)

Table A.7: Technology skills forecasts by occupation grouping, 2019–2025

	2019	2025	Average annual growth (%)
ICT management and operations			
Postgraduate	80,357	98,418	3.4
Undergraduate	145,148	172,064	2.9
Diploma or Advanced Diploma	58,663	67,695	2.4
Certificate III or IV	33,156	37,748	2.2
Certificate I or II	17,593	18,864	1.2
ICT technical and professional			
Postgraduate	99,274	111,698	2.0
Undergraduate	229,263	249,971	1.5
Diploma or Advanced Diploma	83,115	87,331	0.8
Certificate III or IV	41,029	42,733	0.7
Certificate I or II	22,278	21,964	-0.2
ICT sales			
Postgraduate	5,768	7,130	3.6
Undergraduate	13,977	16,788	3.1
Diploma or Advanced Diploma	5,765	6,735	2.6
Certificate III or IV	4,020	4,643	2.4
Certificate I or II	2,290	2,448	1.1
ICT trades			
Postgraduate	21,632	34,095	7.9
Undergraduate	43,215	59,695	5.5
Diploma or Advanced Diploma	21,795	29,798	5.4
Certificate III or IV	29,458	37,271	4.0
Certificate I or II	13,021	15,611	3.1
Electronic trades and professional			
Postgraduate	3,748	4,945	4.7
Undergraduate	9,183	11,265	3.5
Diploma or Advanced Diploma	10,999	12,641	2.3
Certificate III or IV	21,002	24,205	2.4
Certificate I or II	7,457	8,093	1.4

	2019	2025	Average annual growth (%)
ICT industry admin and logistics support			
Postgraduate	17,997	20,736	2.4
Undergraduate	39,647	44,368	1.9
Diploma or Advanced Diploma	22,165	23,857	1.2
Certificate III or IV	21,421	21,869	0.3
Certificate I or II	9,347	9,349	0.0

Source: Deloitte Access Economics (2020)

Technology worker migration

Table A.8 Temporary skilled migration (457 & 482) visa grants for technology occupations, 2014–15 to 2018–19

	2014–15	2015–16	2016–17	2017–18	2018–19
1351 ICT managers	939	919	852	524	708
2232 ICT trainers	10	15	22	16	28
2247 Management and organisation analysts	1,445	1,345	1,362	990	1,218
2249 Other information and organisation professionals	452	399	350	177	183
2252 ICT sales professionals	527	531	604	376	557
2324 graphic and web designers, and illustrators	472	411	459	220	219
2611 ICT Business and items analysts	2,098	2,208	2,125	1,709	2,334
2612 multimedia specialists and web developers	162	133	121	55	106
2613 Software and applications programmers	5,231	4,984	4,909	3,900	5,241
2621 Database and systems administrators, and ICT security specialists	383	385	424	269	383
2631 Computer network professionals	272	260	294	257	469
2632 ICT support and test engineers	767	854	864	829	956
2633 telecommunications engineering professionals	127	99	81	48	70
3123 electrical engineering draftspersons and technicians	351	353	305	177	234
3124 electronic engineering draftspersons and technicians	127	99	71	N/A	N/A
3131 ICT support technicians	320	291	273	143	176
3132 telecommunications technical specialists	52	43	79	99	155
3423 electronic trades workers	115	80	94	90	168
3424 telecommunications trades workers	102	121	117	38	45
Total technology workers*	**13,937**	**13,521**	**13,406**	**9,917**	**13,250**

* Excludes ICT industry admin and logistics support, for which breakdowns are unavailable; electronic trades and professional data is for all industries.

Source: Department of Home Affairs 457 and 482 Visa Statistics (2020)

Table A.9: Net migration of technology workers dataset is no longer published.

ICT higher and vocational education

Table A.10: Domestic enrolments and completions in IT degrees, 2001–18

	Course enrolments		Course completions	
	Undergraduate	Postgraduate	Undergraduate	Postgraduate
2001	35,661	10,161	5,451	2,850
2002	36,647	10,280	6,219	3,294
2003	35,172	9,118	6,580	2,588
2004	31,232	8,139	6,283	2,272
2005	26,527	6,923	5,696	1,976
2006	22,762	6,101	4,672	1,642
2007	20,709	5,488	4,185	1,474
2008	18,905	5,077	3,577	1,349
2009	18,545	5,143	3,159	1,315
2010	18,966	5,213	3,050	1,275
2011	19,902	5,386	3,266	1,353
2012	21,047	5,562	3,339	1,326
2013	22,055	5,447	3,463	1,423
2014	23,829	5,560	3,638	1,468
2015	25,700	5,482	3,949	1,491
2016	26,596	5,774	3,985	1,517
2017	29,993	6,342	4,405	1,553
2018	32,188	6,875	4,695	1,638

Source: Department of Education U-Cube (2020)

Table A.11: International enrolments and completions in IT degrees, 2001–18

	Course enrolments		Course completions	
	Undergraduate	Postgraduate	Undergraduate	Postgraduate
2001	17,009	10,225	2,993	3,558
2002	20,843	11,238	4,157	4,821
2003	21,701	11,087	5,659	4,337
2004	20,683	12,638	6,010	3,586
2005	17,480	13,512	5,213	5,428

	Course enrolments		Course completions	
	Undergraduate	**Postgraduate**	**Undergraduate**	**Postgraduate**
2006	15,475	11,580	5,021	5,635
2007	14,415	10,265	4,433	4,258
2008	14,236	10,964	3,715	4,369
2009	15,113	12,104	3,851	4,009
2010	15,018	11,435	4,120	5,037
2011	15,108	9,452	3,996	4,528
2012	14,495	8,992	3,749	3,385
2013	13,978	10,908	3,673	3,223
2014	14,152	13,742	3,617	3,573
2015	14,217	15,406	3,516	4,537
2016	16,063	17,953	3,602	5,263
2017	19,488	24,368	4,046	5,604
2018	25,314	35,664	5,007	8,392

Source: Department of Education U-Cube (2020)

Table A.12 Government-funded VET subject enrolments in the IT field of education, 2015–18

	2015	2016	2017	2018
Diploma or higher	26,285	27,790	17,970	15,805
Certificate IV	11,080	10,765	10,870	11,170
Certificate III	15,965	14,285	14,085	12,930
Certificate II	16,755	13,305	12,970	10,425
Certificate I	19,840	16,310	14,740	12,085

Source: National Centre for Vocational Education Research (2019)

Women in technology

Table A.13: Female technology workers by industry, 2019

	Female technology workers	Percentage of female technology workers	Percentage of female workers in all occupations
Industry divisions			
Agriculture, forestry and fishing	320	21	32
Mining	2,362	32	16
Manufacturing	8,194	34	27
Electricity, gas, water and waste services	2,682	24	25
Construction	1,569	13	12
Wholesale trade	3,029	18	32
Retail trade	6,876	27	56
Accommodation and food services	455	26	55
Transport, postal and warehousing	2,933	19	22
Rest of information media and telecommunications*	3,864	35	38
Financial and insurance services	21,879	35	50
Rental, hiring and real estate services	873	22	49
Rest of professional, scientific and technical services**	32,064	34	42
Administrative and support services	3,433	31	54
Public administration and safety	21,094	35	51
Education and training	10,206	36	71
Healthcare and social assistance	6,689	42	78
Arts and recreation services	3,438	50	50
Other services	2,241	28	46
ICT industry subdivisions			
Telecommunications services	23,664	25	25
Internet service providers, web search portal and data processing services	3,055	39	39
Computer system design and related services	65,706	26	26
Total technology workers*	**227,473**	**29**	**47**

* Excluding telecommunications services, and internet service providers, web search portals and data processing services, which are separately identified as ICT industry subdivisions.

** Excluding computer system design and related services, which is separately identified as an ICT industry subdivision.

Source: ABS customised report (2020)

Older technology workers

Table A.14: Older technology workers by CIIER occupation grouping, 2019

	Number of ICT workers aged 55+	Percentage of total technology workforce
ICT management and operations	36,440	16
ICT technical and professional	3,545	11
ICT sales	30,440	10
ICT trades	10,428	11
Electronic trades and professional	11,251	27
Total technology workers*	**92,103**	**13.0**

* Excludes ICT industry admin and logistics support, for which breakdowns are unavailable; electronic trades and professional data is for all industries.

Source: ABS customised report (2020)

ICT research and development

Table A.15: Business expenditure on R&D, 2011–12 to 2017–18

	2011–12	2013–14	2015–16	2017–18
Information and computing science	$5,496,165	$6,073,221	$6,634,394	$6,747,648
Engineering	$8,686,256	$7,474,231	$5,538,180	$4,710,279
Technology	$1,235,487	$1,689,446	$1,409,803	$1,958,471
Medical and health sciences	$941,159	$1,123,956	$1,253,415	$1,791,237
Chemical sciences	$425,941	$565,758	$632,619	$654,046
Agricultural and veterinary sciences	$455,372	$533,754	$404,003	$431,150
Earth sciences	$122,476	$286,511	$166,626	$231,970
Environmental sciences	$281,155	$270,044	$158,043	$170,354
Built environment and design	$231,743	$238,591	$152,082	$162,413
Commerce, management, tourism and services	$144,273	$227,088	$110,793	$158,118
Other fields of research	$301,295	$346,838	$199,338	$421,899

Source: ABS catalogue 8104.0 (2019)

Table A.16: Government expenditure on ICT R&D, 2011–12 to 2016–17

	2011–12	2012–13	2014–15	2016–17
Commonwealth ICT R&D expenditure	$314,437,000	$240,828,000	$247,462,000	$254,504,000
Commonwealth ICT share of R&D expenditure	13%	10%	11%	12%
State and territory ICT R&D expenditure	$8,596,000	$12,778,000	$20,882,000	$38,627,000
State and territory ICT share of R&D expenditure	1%	1%	2%	3%

Source: ABS catalogue 8109.0 (2018)

Trade in ICT services

Table A.17: Exports and imports of ICT services, 2012–13 to 2018–19 ($bn)

	2012–13	2013–14	2014–15	2015–16	2016–17	2017–18	2018–19
Exports	1.91	2.08	2.50	2.78	2.93	3.82	4.69
Imports	1.87	2.50	2.59	2.88	2.76	3.28	3.92

Source: ABS catalogue 5368.0 (2020)

Detailed state figures

Table A.18: State breakdown of technology workers by industry, 2019

	NSW	Vic	Qld	SA	WA	Tas	ACT*	NT*
Industry divisions								
Agriculture, forestry and fishing	0	557	772	80	71	46	N/A	N/A
Mining	428	988	1,944	139	3,986	0	N/A	N/A
Manufacturing	11,755	6,192	2,470	1,327	1,942	53	N/A	N/A
Electricity, gas, water and waste services	2,984	5,318	623	433	1,536	91	N/A	N/A
Construction	3,430	3,502	2,738	300	1,385	179	N/A	N/A
Wholesale trade	7,575	5,573	2,623	476	847	113	N/A	N/A
Retail trade	9,543	9,350	3,857	850	1,409	281	N/A	N/A
Accommodation and food services	422	372	659	75	160	68	N/A	N/A
Transport, postal and warehousing	5,436	5,856	3,234	288	351	0	N/A	N/A

	NSW	Vic	Qld	SA	WA	Tas	ACT*	NT*
Rest of information media and telecommunications**	4,642	3,554	1,498	427	486	28	N/A	N/A
Financial and insurance services	33,922	19,547	4,671	1,051	2,890	115	N/A	N/A
Rental, hiring and real estate services	1,184	1,629	986	0	76	0	N/A	N/A
Rest of professional, scientific and technical services***	35,047	30,949	12,103	4,277	7,493	691	N/A	N/A
Administrative and support services	2,611	5,639	1,253	368	757	0	N/A	N/A
Public administration and safety	15,889	14,501	10,492	3,727	3,948	1,062	N/A	N/A
Education and training	10,033	6,954	4,786	2,816	1,658	706	N/A	N/A
Healthcare and social assistance	5,549	4,687	3,909	378	690	245	N/A	N/A
Arts and recreation services	1,774	2,758	1,054	287	442	207	N/A	N/A
Other services	3,156	2,442	1,182	315	382	144	N/A	N/A
ICT industry subdivisions								
Telecommunications services	30,778	32,374	17,163	5,448	5,030	1,253	N/A	N/A
Internet service providers, web search portals and data processing services	3,873	1,877	532	420	924	72	N/A	N/A
Computer design and related services	99,320	82,314	30,763	11,280	16,357	2,681	N/A	N/A
Total technology workers	**289,354**	**246,934**	**109,314**	**34,761**	**52,822**	**8,037**	**26,621***	**4,331***

* While the 2019 labour force data from the ABS contained combined figures for the NT and the ACT for confidentiality reasons, NT employment has been separated from ACT employment at an aggregate level using the Deloitte Access Economics employment forecast model.

** Excluding telecommunications services, and internet service providers, web search portals and data processing services, which are separately identified as ICT industry subdivisions.

*** Excluding computer system design and related services, which is separately identified as an ICT industry subdivision.

Sources: ABS customised report (2020), Deloitte Access Economics (2020)

Table A.19: NSW technology employment forecasts by CIIER occupation grouping, 2019–25

	2019	2025	Change	Average annual growth rate (%)
ICT management and operations	76,683	99,361	22,678	4.4
ICT technical and professional	120,179	153,595	33,415	4.2
ICT sales	12,299	16,246	3,947	4.7
ICT trades	35,614	50,331	14,716	5.9
Electronic trades and professional*	976	1,381	1,262	50.4
ICT industry admin and logistics support*	44,458	48,567	4,109	1.5
Total technology workers	**289,354**	**369,481**	**80,127**	**4.2**

* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2020)

Table A.20: Victoria's technology employment forecasts by CIIER occupation grouping, 2019–25

	2019	2025	Change	Average annual growth rate (%)
ICT management and operations	72,813	85,396	12,583	2.8
ICT technical and professional	108,055	110,731	2,676	0.4
ICT sales	10,334	12,314	1,980	3.0
ICT trades	21,669	23,819	2,150	1.7
Electronic trades and professional*	1,391	1,018	-373	3.2
ICT industry admin and logistics support*	32,673	38,790	6,117	4.0
Total technology workers	**246,934**	**272,067**	**25,133**	**1.8**

* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2020)

Table A.21: Queensland's technology employment forecasts by CIIER occupation grouping, 2019–25

	2019	2025	Change	Average annual growth rate (%)
ICT management and operations	32,775	36,150	3,375	1.6
ICT technical and professional	36,638	43,053	6,414	2.7
ICT sales	6,412	6,086	-326	-0.9
ICT trades	16,556	24,807	8,251	7.0
Electronic trades and professional*	373	489	116	4.6
ICT industry admin and logistics support*	16,559	20,133	3,574	3.3
Total technology workers	**109,314**	**130,718**	**21,404**	**3.0**

* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2020)

Table A.22: South Australia's technology employment forecasts by CIIER occupation grouping, 2019–25

	2019	2025	Change	Average annual growth rate (%)
ICT management and operations	7,726	9,533	1,807	3.6
ICT technical and professional	15,078	16,902	1,824	1.9
ICT sales	1,501	2,035	533	5.2
ICT trades	5,291	5,897	605	1.8
Electronic trades and professional*	130	155	25	3.0
ICT industry admin and logistics support*	4,732	6,921	2,189	6.5
Total technology workers	**34,459**	**41,443**	**6,984**	**3.1**

* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2020)

Table A.23: Western Australia's technology employment forecasts by CIIER occupation grouping, 2019–25

	2019	2025	Change	Average annual growth rate (%)
ICT management and operations	18,252	18,935	683	0.6
ICT technical and professional	20,486	21,372	887	0.7
ICT sales	1,811	1,938	127	1.1
ICT trades	6,447	7,630	1,184	2.8
Electronic trades and professional*	516	235	-282	-12.3
ICT industry admin and logistics support*	5,311	12,487	7,176	15.3
Total technology workers	**52,822**	**62,597**	**9,775**	**2.9**

* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2020)

Table A.24: Tasmania's technology employment forecasts by CIIER occupation grouping, 2019–25

	2019	2025	Change	Average annual growth rate (%)
ICT management and operations	2,321	3,244	923	5.7
ICT technical and professional	2,380	2,968	588	3.7
ICT sales	464	189	-275	-13.9
ICT trades	1,603	2,286	683	6.1
Electronic trades and professional*	27	38	11	5.9
ICT industry admin and logistics support*	1,241	1,454	213	2.7
Total technology workers	**8,037**	**10,179**	**2,143**	**4.0**

* Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2020)

Table A.25: Northern Territory's technology employment forecasts by CIIER occupation grouping, 2019–25*

	2019	2025	Change	Average annual growth rate (%)
ICT management and operations	1,634	1,776	141	1.4
ICT technical and professional	1,211	1,327	116	1.5
ICT sales	24	371	348	58.4
ICT trades	1,124	1,138	14	0.2
Electronic trades and professional**	15	21	5	5.2
ICT industry admin and logistics support**	345	869	525	16.7
Total technology workers	**4,352**	**5,501**	**1,149**	**4.0**

* While the 2019 labour force data from the ABS contained combined figures for the NT and the ACT for confidentiality reasons, NT employment forecasts have been produced separately from ACT employment forecasts using the Deloitte Access Economics employment forecast model.

** Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2020)

Table A.26: Australian Capital Territory's technology employment forecasts by CIIER occupation grouping, 2019–25*

	2019	2025	Change	Average annual growth rate (%)
ICT management and operations	11,521	15,478	3,957	5.0
ICT technical and professional	9,826	15,140	5,314	7.5
ICT sales	305	327	22	1.2
ICT trades	3,414	1,815	-1,599	-10.0
Electronic trades and professional**	90	137	48	7.3
ICT industry admin and logistics support**	1,445	3,834	2,389	17.7
Total technology workers	**26,601**	**36,731**	**10,130**	**5.5**

* While the 2019 labour force data from the ABS contained combined figures for the NT and the ACT for confidentiality reasons, NT employment forecasts have been produced separately from ACT employment forecasts using the Deloitte Access Economics employment forecast model.

** Employment in these occupations has only been counted for the ICT-related industry subdivisions, consistent with the definitions in Table A.3.

Source: Deloitte Access Economics (2019)

Table A.27: State breakdown of net overseas migration of technology workers dataset is no longer published.

Table A.28: State breakdown of domestic enrolments and completions in IT degrees, 2018

	Course enrolments		Course completions	
	Undergraduate	**Postgraduate**	**Undergraduate**	**Postgraduate**
NSW	10,774	2,614	1,796	637
Vic	9,860	2,339	1,412	498
Qld	6,599	792	845	172
SA	1,237	614	123	165
WA	1,922	262	259	79
Tas	318	30	57	9
NT	116	14	13	2
ACT	1,227	207	165	76
Multistate	135	3	25	0

Source: Department of Education U-Cube (2020)

Table A.29: State breakdown of international enrolments and completions in IT degrees, 2018

	Course enrolments		Course completions	
	Undergraduate	**Postgraduate**	**Undergraduate**	**Postgraduate**
NSW	7,873	9,647	1,434	2,935
Vic	11,196	16,165	1,956	2,951
Qld	2,389	6,211	583	1,674
SA	779	1,032	176	213
WA	992	1,078	326	261
Tas	776	740	186	150
NT	124	71	19	22
ACT	1,031	646	268	178
Multistate	154	74	59	8

Source: Department of Education U-Cube (2020)

Appendix B: Productivity modelling

B.1 Theoretical modelling framework

This report follows previous Deloitte Access Economics and OECD research in taking a panel approach to identify the growth effects of digital technology usage controlling for policy and institutional influences. The econometric methods employed largely follow the approach of Qu, Simes and O'Mahony (2016), and Bassanini, Scarpetta and Hemmings (2001).

The modelling approach adheres to previous research with some changes to the main variable of interest. The underlying framework is based on a standard Solow-Swan model augmented with human capital. Output at time ***t*** is given by:

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} \big(A(t)L(t)\big)^{1-\alpha-\beta}$$

Where *Y, K, H* and *L* are respectively output, physical capital, human capital and labour, ***α*** and ***β*** are the partial elasticity of output with respect to physical capital and human capital, and ***A(t)*** is a composite measure of technical progress ***Ω(t)*** and economic efficiency ***I(t)***:

$$A(t) = I(t)\Omega(t)$$

Economic efficiency includes a range of 'enabling services', $V_j(t)$, such as advertising, trade, transport and logistics, professional and support services, and innovation. These enabling services provide support to firms at all stages of production. In addition to measures of digital technology, controls are included for each country's urbanisation rate and trade exposure, both of which are widely recognised as key determinants of economic efficiency. Other technological progress, ***Ω(t)***, is assumed to be exogenous and to grow at a rate ***g(t)***.

The following equations can be used to describe the time paths of the various factors of production over time.

$$\dot{k}(t) = s_k(t)A(t)^{1-\alpha-\beta}k(t)^{\alpha}h(t)^{\beta} - \big(n(t) + d + g(t)\big)k(t)$$

$$\dot{h}(t) = s_h(t)A(t)^{1-\alpha-\beta}k(t)^{\alpha}h(t)^{\beta} - \big(n(t) + d + g(t)\big)k(t)$$

$$\dot{A}(t) = g(t)A(t) = g(t)I(t)\Omega(t)$$

$$\ln I(t) = p_0 + \sum\nolimits_j p_j \ln V_j(t)$$

$$\dot{\Omega}(t) = g(t)\Omega(t)$$

$$\dot{L}(t) = n(t)L(t)$$

Where ***y=Y/L*** and ***k=K/L*** are output and physical capital in intensive terms, ***h=H/L*** stands for average human capital, s_k and s_h are the investment rate in physical and human capital respectively, ***n(t)*** is the growth rate of labour, ***g(t)*** is the rate of technological change and ***d*** is the common (time-invariant) depreciation rate.

Under the assumption that ***α + β < 1*** (decreasing returns to scale in human and physical capital), this system of equations can be solved to obtain steady-state values of ***k**** and ***h**** defined by:

$$\ln k^*(t) = \ln A\,(t) + \frac{1-\beta}{1-\alpha-\beta}\ln s_k(t) + \frac{\beta}{1-\alpha-\beta}\ln s_h\,(t) - \frac{1}{1-\alpha}ln\big(n(t) +\ d +\ g(t)\big)$$

$$\ln h^*(t) = \ln A\,(t) + \frac{\alpha}{1-\alpha-\beta}\ln s_k(t) + \frac{1-\alpha}{1-\alpha-\beta}\ln s_h\,(t) - \frac{1}{1-\alpha}ln\big(n(t) +\ d +\ g(t)\big)$$

These steady-state values of physical and human capital can used to express the steady state output per capita as:

$$\ln y^*(t) = \ln A(t) + \frac{\alpha}{1-\alpha}\ln s_k(t) + \frac{\beta}{1-\alpha}\ln h^*(t) - \frac{\alpha}{1-\alpha}\ln\big(g(t) + d + n(t)\big)$$

Steady state human capital, ***h****, is unobservable, but it can be expressed as a function of the actual level of human capital, ***h(t)***:

$$ln\ h^*(t) = ln\ h(t) + \frac{1-\psi}{\psi}\Delta\, ln\left(\frac{h(t)}{A(t)}\right)$$

Substituting this into the previous expression for steady state output per capita yields:

$$\ln y^*(t) = \ln A(t) + \tfrac{\alpha}{1-\alpha}\ln s_k(t) + \tfrac{\beta}{1-\alpha}\left(\ln h(t) + \tfrac{1-\psi}{\psi}\Delta\ln\left(\tfrac{h(t)}{A(t)}\right)\right) - \tfrac{\alpha}{1-\alpha}\ln\big(g(t) + d + n(t)\big)$$

Adding convergence dynamics and expanding the productivity term ***A(t)*** yields the transitional equation for output per capita.

$$\Delta\ln y(t) = -\phi\left(\ln y(t-1) - \frac{\alpha}{1-\alpha}\ln s_k(t) - \frac{\beta}{1-\alpha}\ln h(t) + \frac{\alpha}{1-\alpha}\ln(g(t) +\ n(t)\ +\ d) -\ g(t)t - \ln A(0)\right)$$

$$+\frac{1-\psi}{\psi}\frac{\beta}{1-\alpha}\Delta\ln h(t) + \left(1-\frac{\phi}{\psi}\right)g(t)$$

This last equation represents the functional form that was empirically estimated in this report. The coefficient estimate ϕ represents the convergence parameter, which reflects the speed at which countries converge to their new steady-state output.

B.1.1. Theoretical limitations

It is important to recognise that under the conditional convergence model used in this paper, various forms of capital as well as policies and institutions are assumed to have a permanent impact on cross-country differences in GDP per capita levels but only temporary effects on growth rates. This means the observed growth in output in any given period, abstracting from cyclical fluctuations, is a combination of three different forces:

- Exogenous growth in other technological progress.
- A convergence process towards the country-specific steady-state path of output per capita.
- Shifts in the steady-state that arise from changes in policy and institutions, digital technology adoption as well as investment rates and changes in population growth rates.

It should also be noted that the framework is derived under the assumption of equilibrium employment and hence that variations in the intensity of labour utilisation are not explicitly taken into account.

B.2. Empirical approach

In this report we use a standard growth equation from the human-capital augmented Solow-Swan model. When empirically estimating this equation some simplifications can be made. Specifically, to the extent that ***g(t)*** is not observable, it cannot be empirically distinguished from the constant term. Thus, the estimated growth equation can be re-written as:

$$\Delta \ln y_{i,t} = -\phi_i \left(\ln y_{i,t-1} - \theta_1 \ln s_{i,t}^{k} - \theta_2 \ln h_{i,t} + \theta_3 n_{i,t} - a_1 t + \sum_j p_j \ln V_{j,t} - \theta_{0,i} \right) + a_2 \Delta \ln h(t) + \epsilon_{i,t}$$

This form effectively represents an error-correction model where θ_1 represents the long-run elasticity of steady state GDP per-capita with respect to changes in the rate of capital accumulation, θ_2 the long-run elasticity of steady state GDP per-capita with respect to changes in observed human capital and p_j the long-run elasticity of steady state GDP per-capita with respect to changes in productivity enhancing policy variable $V_{j,t}$.

To estimate this equation the empirical work in this report employs a pooled mean-group estimator (PMG). The PMG approach provides an effective middle ground between imposing homogeneity on all slope coefficients when using a dynamic fixed effect estimator (DFE), and the imposition of no restrictions when using a mean group estimation approach (MG). The validity of DFE depends on the assumptions of common technology and convergence parameters that in turn require both common technological change and population growth across countries. These are very strong assumptions which do not hold empirically. On the other hand, the MG estimator is consistent, but the number of parameters required to be estimated is so large it makes it implausible for use in cases such as ours with relatively short panels (small *T*) and with many independent variables to be estimates (high *k*). With both DFE and MG estimators having significant drawbacks the PMG estimator was deemed the best available approach (Qu, Simes & O'Mahony, 2016).

It is still worth noting the PMG approach is not without its limitations. Chiefly, PMG still requires the estimation of a large number of parameters, which can cause likelihood convergence issues and estimates sensitive to model specification changes (Qu, Simes & O'Mahony, 2016). In practice, this means that controlling for a large number of policy and institutional variables can be difficult. To help avoid this problem we take a parsimonious approach to the controls we include in our estimates and then check that our results are consistent across other specifications with different combinations of control variables.

B.2.1. Index motivation

We employed an index approach to capture the effect of multiple digital variables, for theoretical and empirical reasons. Firstly, it is difficult to separate fixed and mobile networks as there are increasing crossovers between the two. For example, dongles use the mobile network on PCs and other devices that are usually considered to be part of the fixed network, such as when using fixed broadband penetration as a proxy. Estimating the combined impact of mobile and fixed through an index allows us to partly capture this integration.

Empirically, an index of mobile and fixed variables also helps counteract the limitations of the PMG estimator, through the ability to simultaneously control for, and measure, the impact of several digital variables. Including multiple explanatory digital variables in the same model often resulted in convergence problems or estimates highly sensitive to model specification changes.

The index of digital variables measures the contribution of the entire digital industry. The individual contribution of each industry, fixed and mobile, is then calculated as a proportion of the total contribution based on each industry's share of revenue, traffic and use within the digital industry.

B.2.2. Index methodology

The methodology underlying the creation of the digital index in this report largely follows that of the ICT Development Index (IDI) developed by the International Telecommunications Union (ITU) (2019).

To capture the effect of digital technology on productivity growth, we use a combination of three digital variables, namely mobile phone penetration, percentage of individuals with access to the internet, and fixed broadband penetration. It is important to note that these variables do not provide a perfect measure of changes in the digital industry. However, in the absence of reliable data that could reflect these underlying changes in technology over a sufficient time period, these variables serve as a good starting point to measure the impact of fixed and mobile digital technologies in Australia.

In order to combine the three variables into a single index, each is first normalized following methods outlined by the ITU. The reference value for fixed broadband is defined as 60 connections per 100 inhabitants; for mobile penetration, 120 per 100 inhabitants; and for the percentage of individuals with internet access, 100% of the population. Following normalization, the following weights are used to combine the three variables.

Table B.1: Index weights

Parameters	Index
Fixed-broadband internet subscriptions per 100 inhabitants	0.3
Percentage of individuals using the internet	0.3
Mobile-cellular telephone subscriptions per 100 inhabitants	0.4

Source: Deloitte Access Economics and International Telecommunications Union (2019)

B.3. Data and modelling results

The modelling in this report uses a sample of 37 countries between 2005 and 2017. Where appropriate, data is converted to constant 2015 US dollars using constant Purchasing Power Parity, consistent with OECD standards.

Table B.2: Country list

Country list			
Australia	France	Korea	Slovak Republic
Austria	Germany	Luxemburg	Slovenia
Belgium	Greece	Mexico	South Africa
Canada	Hungary	Netherlands	Spain
Chile	Iceland	New Zealand	Sweden
China	Ireland	Norway	Switzerland
Czech Republic	Israel	Poland	Turkey
Denmark	Italy	Portugal	United Kingdom
Estonia	Japan	Russia	United States
Finland			

Source: Deloitte Access Economics

Table B.3 outlines the parameters used in the econometric modelling. In addition to variables for primary factors of production such as physical capital accumulation, the stock of human capital and population growth, the model also takes into account the contribution of other productivity enhancing factors, such as a country's degree of trade openness and urbanisation.

Table B.3: Data sources

Parameter	Variable	Source
$y(t)$	Gross domestic product per capita	OECD
$h(t)$	Tertiary education attainment (% of 15+ population)	Barro-Lee
$n(t)$	Total population growth	OECD
$s_k (t)$	Gross capital formation (% of GDP)	Worldbank
V_1	Urbanisation (% of population in urban areas)	Worldbank
V_2	Exports and imports of good and services (% of GDP)	Worldbank
V_3	Index of mobile and fixed variables (see above)	ITU & Worldbank

Source: indicated in table

Table C.4: Model results

Parameter	Variable	Coefficient
Long-run coefficients		
ln $h(t)$	Tertiary education attainment (% of 15+ population)	0.319*** (7.27)
ln $n(t)$	Total population growth	–0.426 (–0.94)
ln $s_k(t)$	Gross capital formation (% of GDP)	0.477*** (19.4)
ln V_1	Urbanisation (% of population in urban areas)	0.933*** (4.69)
ln V_2	Exports and imports of good and services (% of GDP)	0.080*** (2.68)
ln V_3	Index of digital variables	0.127*** (3.79)
Implied share of physical capital	**32.30%**	
Implied share of human capital	**21.60%**	
Implied share of Labour	**46.11%**	

Source: Deloitte Access Economics

Notes: t-statistics are reported in parenthesis. * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

The results presented here are consistent with the academic literature with respect to the estimated shares of capital and labour. Further, the estimated coefficient for the included digital index is statistically significant at the 1% level.

The coefficient on the digital index, V_3, can be interpreted as the long-run elasticity of output per-capita with respect to changes in the digital index. If the digital index increases by *x*%, then the resultant percentage change in long-run steady state GDP per capita, *y*, is approximately given by,

$$y = V_3 \cdot x = 0.127 \cdot x$$

Put another way, a 1% increase in the digital index leads to an approximate 0.127% increase in steady state GDP per capita.

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Deloitte Access Economics
CAN: 149 633 116
Grosvenor Place
225 George Street
Sydney NSW 2000
Tel: +61 2 9322 7000
Fax: +61 2 9322 7001

Australian Computer Society
ABN: 160 325 931
International Tower One, Level 27
100 Barangaroo Avenue
Sydney NSW 2000
Tel: +61 2 9299 3666
Fax: +61 2 9299 3997

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