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AUSTRALIA**

Committee for



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Has the future of work arrived?

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Summary of Key Findings

- The adoption and fusion of new technologies, including artificial intelligence, is changing work, the workforce and the workplace in Australia. This type of workforce transformation is not new, yet it is expected to accelerate over the coming decade.
- A substantial body of research has emerged, which suggests that, in the short- to medium-term future, ongoing processes of technological advancement and structural change in the workforce will speed up, potentially leaving large numbers of workers susceptible to redundancy. Yet there is no singular concrete statistic, nor broad agreement, concerning the number of job losses that will occur, and it is apparent that new jobs will be created by automation and technological change.
- There is consensus among researchers that technology and automation will alter the types of industries people work in, the nature of the jobs people perform and the skills needed to perform these jobs. There is also agreement that although the longitudinal processes of workforce change has seen a decline in the demand for people to conduct routine and manual tasks, the demand for non-routine and abstract tasks remains and will accelerate.
- Australia's economy has been shifting from a goods-producing economy towards a services-oriented economy over the past four decades. This has generated a shift in the types of skills and workers most in demand across all states, territories and capital cities.
- In Greater Perth, the region's unique specialisation in mining means that while a structural shift towards a services-oriented economy is evident, it has been less pronounced than in other capital cities in Australia.
- Sectors such as mining are rapidly shifting towards more technologically advanced, autonomous production models. This shift delivers benefits such as enhanced productivity and efficiency, yet there is a risk that it will exacerbate the emerging mismatch between the skills available in the workforce and the skills required by the key industry sectors.
- The impact of future work changes on low-skilled workers could be exacerbated by job losses and accelerated technological adaptation resulting from the COVID-19 pandemic and associated recession. It is important for industry, the workforce and State Government to understand these impacts.



Introduction

Few people in Australia will have missed the media headlines in recent years warning that robots are coming to take our jobs: “Artificial intelligence coming sooner than you think, experts say,” warned the Australian Broadcasting Commission’s Thuy Ong in 2017, and “What if AI is coming for jobs faster than we thought?” probed Alex Salkever in a 2018 report for Big Think.

This is not the first time that people have perceived technological progress as a threat to jobs. In the 19th and 20th centuries, major waves of technological progress heightened fears about job losses, but these fears ultimately proved unfounded. Over the past three industrial revolutions more jobs were created than displaced, and living standards within industrialised nations increased, as did every other social indicator (Menon, 2019).

Yet contemporary interest in, and concern about, the potential impacts of new technology associated with the Fourth Industrial Revolution on the future of work, the workforce and the workplace has been growing. Despite this, a lot of questions remain regarding exactly what ‘future of work’ means and what this future looks like for industries and workers in Australia, particularly at a state and regional level. It is also unclear whether future of work changes are issues for the future—or issues for today.

This bulletin aims to investigate some of these questions. It does this by examining the future of work and offering a review of national and international future of work literature. This information is linked to current Australian Bureau of Statistics (ABS) economic and labour force statistics, which provide an indication of the structural

changes in the Australian economy and workforce to date, and signal likely changes and impacts in the short-term future.

The bulletin focuses on understanding the economic structure of Western Australia and Greater Perth, offering a comparison with Australia as a whole and its major capital cities. Its objective is to identify the unique challenges and opportunities facing the state and region as it shifts towards a more service-oriented and technologically advanced future.

Given that this research has been prepared in the midst of the economic and social turmoil generated by COVID-19, the bulletin also considers whether the COVID-19 pandemic is likely to fast-track the adoption of future of work changes and its associated impacts.

What is the Future of Work?

While often identified as a twenty-first century phenomenon, technological changes have altered the types of jobs people do and the way people work for centuries. Consequently, discourse about the impacts of technology on production and employment has featured within published literature since the First Industrial Revolution (Lehman, 2015). In the 1942, for example, the term 'creative destruction' was coined by Joseph Schumpeter. It refers to the incessant processes of innovation through which new production units replace outdated ones.

Most recently, this discussion has focused on the Fourth Industrial Revolution, with published literature, media and industry

seeking to understand how technology will change the future of work, the workforce and the workplace. See Figure 1 for the four waves of industrial revolution.

As Moshe Vardi wrote in 2017 for *The Conversation*:

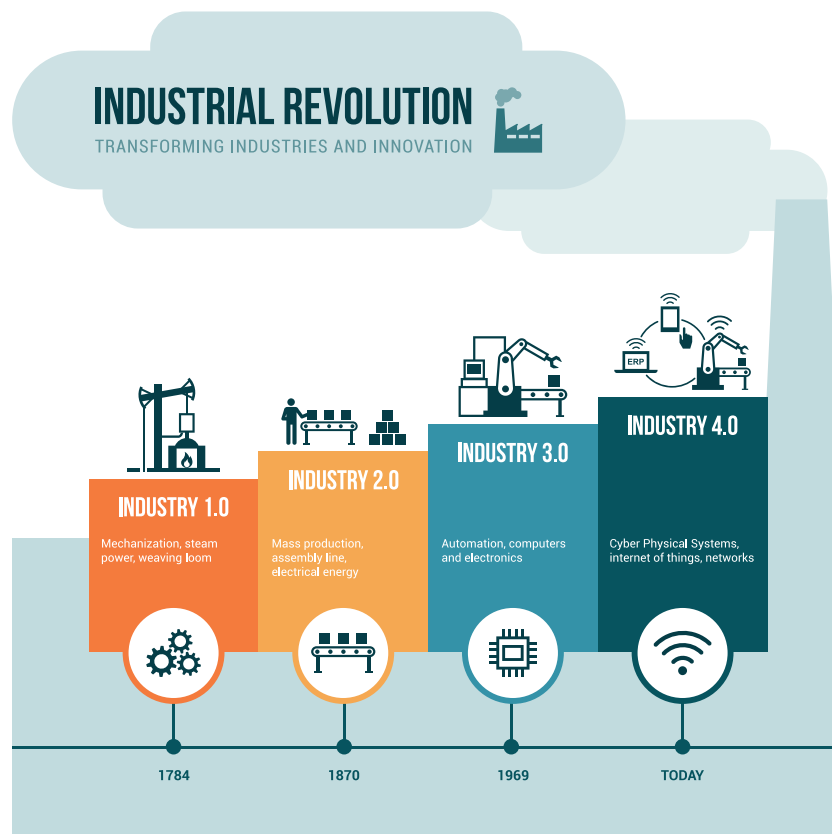
The (First) Industrial Revolution was a tipping point. For many thousands of years before it, economic growth was practically negligible, generally tracking with population growth: Farmers grew a bit more food and blacksmiths made a few more tools, but people from the early agrarian societies of Mesopotamia, Egypt, China and India would have recognised the world of 17th-century Europe.

But when steam power and industrial machinery came along in the 18th century, economic activity took off. The growth that happened in just a couple hundred years was on a vastly different scale than anything that had happened before. We may be at a similar tipping point now, referred to by some as the 'Fourth Industrial Revolution,' where all that has happened in the past may appear minor compared to the productivity and profitability potential of the future."

The Fourth Industrial Revolution is described as a fusion of technologies that are blurring the lines between physical, digital and biological spheres (Schwab, 2016). This includes developments in fields such as artificial intelligence (AI) and machine learning, robotics, nanotechnology, 3D printing, genetics and biotechnology, all of which are building on and amplifying one another. Smart systems—for homes, factories, farms, electricity grids, transport systems or entire cities—are also predicted to help tackle problems ranging from supply chain management to climate change (Schwab, 2016).

Like previous industrial revolutions, the Fourth Industrial Revolution is expected to both displace some existing jobs and create new jobs. However, two key factors have been reported to be driving concern about the impact of the Fourth Industrial Revolution on the future of work compared to technological changes in the past.

Figure 1: The Four Waves of Industrial Revolution



Firstly, when compared with the previous industrial revolutions, the Fourth Industrial Revolution is reportedly evolving at an exponential rather than a linear pace, it is disrupting almost every industry and it is heralding the transformation of entire systems of production and management.

The speed of this change is generating concern that automation and technology will replace jobs faster than new jobs can be created (Brougham, 2018; Spencer, 2018).

Secondly, concurrent to the technological revolution, the

world has been experiencing broader socioeconomic, geopolitical, environmental and demographic megatrends that have been influencing work, the workforce and the workplace, as detailed in Table 1.

Table 1: Summary of Global Megatrends Influencing the Future of Work

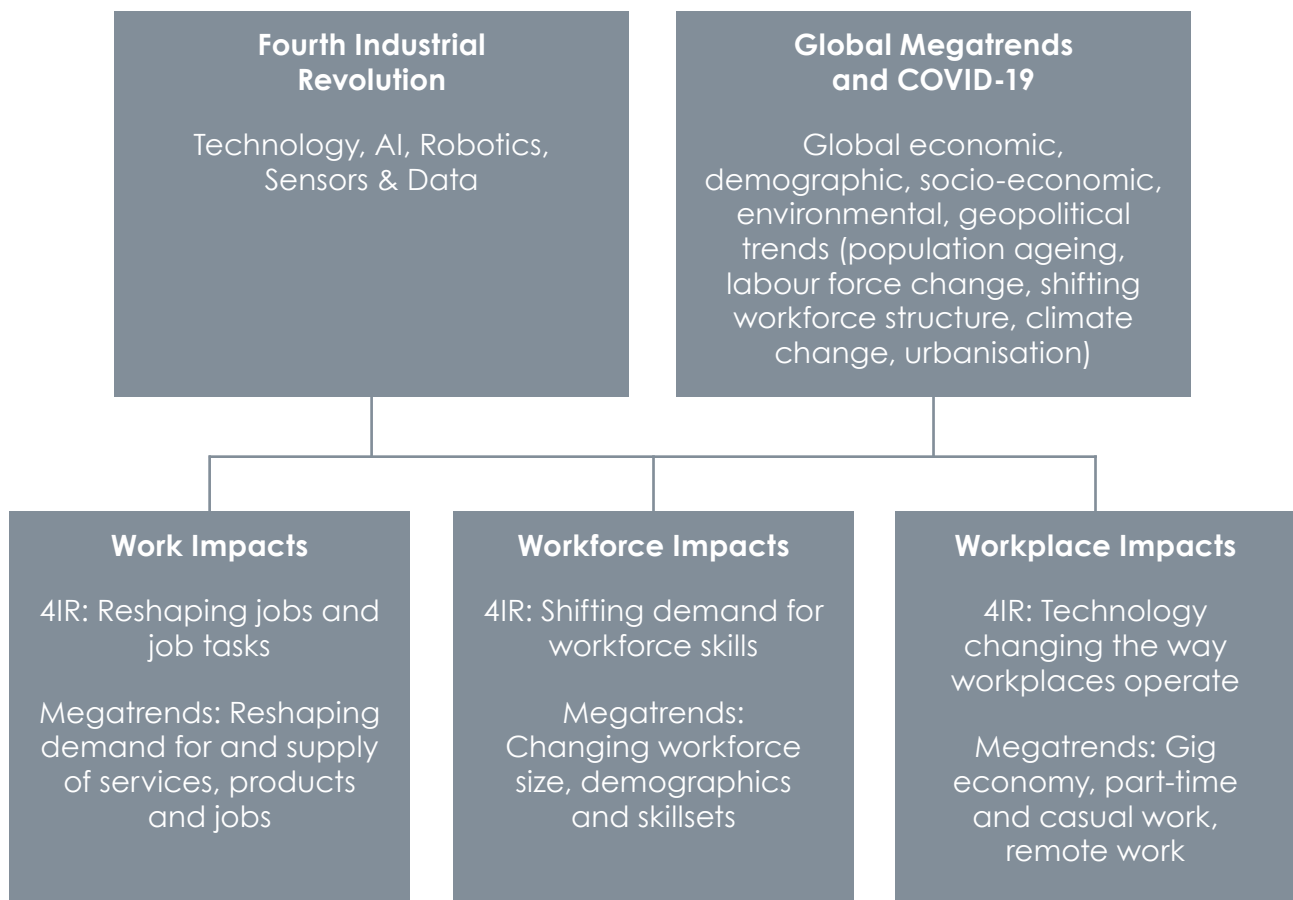
Global megatrend	Summary and reported impacts
Economic globalisation (1950s onward)	Economic globalisation refers to a process of closer economic integration of global markets: financial, trade and labour migration (Gurría, 2006). Economies have been becoming more integrated for centuries, yet the process of globalisation accelerated in the late twentieth century (Gurría, 2006; O'Rourke & Williamson, 2000). The acceleration of globalisation has been reflected in rising flows of trade, finance and migration, driven not only by market opening but also by rapid technological change. The share of trade in global gross domestic product (GDP) has tripled since 1950, the level of outward Foreign Direct Investment relative to GDP has quadrupled among Organisation for Economic Co-operation and Development (OECD) countries since the early 1970s, and the number of immigrants entering OECD countries on average each year has more than tripled from the mid-1980s to mid-2000 (Gurría, 2006). Notably, it has been observed and reported that the world has currently reached a period during which international political consensus of the universal economic benefits of globalisation is breaking down. As a result the process has started to recede, with countries increasingly focused on sovereignty over unilateralism (Flew, 2018; Nussbaum, 2010).
Changing structure of work (1970s onward)	The structure of the Australian labour market has changed over the past fifty years. Two of the most significant changes have been an increase in labour force participation, particularly among females, and a decline in standard full-time employment (Davis & Leggett, 2019). Declining full-time employment has been associated with steady growth in the proportion of workers employed part-time, ¹ who accounted for one-third of all workers in Australia in 2017 (Lab & Wooden, 2019). Other forms of employment increased in the late twentieth century, yet have fluctuated over the past two decades. For example, the proportion of workers employed in fixed-term contracts in Australia rose from 7.2% in 2001 to 9.1% in 2017 (although rates of growth were very uneven), while the share of workers employed casually exhibited a pattern of decline from 20.3% in 2001 to 17.9% in 2010, before rising to 19.9% in 2017 (Lab & Wooden, 2019).
Remote work/working from home (1990s onward)	The proportion of employees who report undertaking at least part of their work from home increased during the latter part of the twentieth century, yet these figures plateaued and slightly declined over the past two decades (prior to the 2020 COVID-19 outbreak). In 2001, approximately 28% of Australian employees reported working some of their hours from home (Healy et al., 2017). By 2015 this proportion had declined to 25%, with an estimated 7% of all working hours done at home in 2015, a slight reduction from the estimated 10% recorded in 2001 (Healy et al., 2019). While it has been reported that 88% of Australian organisations encouraged employees to work from home during the early months of the COVID-19 pandemic, the long-term implications of this change are unclear (Mitchell, 2020).
Population and workforce ageing (1990s onward)	The populations of Australia and Western Australia are ageing. This trend is expected to continue and by 2060 it is projected that 1 in 4 Australians will be aged 65 years or older (Davis, 2017). Population ageing is reducing the proportion of the population that is of traditional working age, resulting in increased labour force participation among older people, intensifying demand for education and training to upskill the workforce, and heightening global competition for young, skilled workers. Population ageing is also increasing demand for health services and employment in health and caring professions (Committee for Perth, 2018).

¹ Part-time employment is classified by the ABS as working less than 35 hours across all jobs in a usual working week.

It is also apparent that the COVID-19 pandemic is disrupting economies, industries and workers around the world, and is delivering levels of global economic turmoil unseen since the Great Depression of the 1930s. Current discourse suggests that this could accelerate the

speed of twenty-first century work and workforce change in Australia and around the globe. See Figure 2 for a summary of the effects of the Fourth Industrial revolution, global megatrends and COVID-19 on work, the workforce and the workplace.

Figure 2: Fourth Industrial Revolution, Global Megatrends and COVID-19



Reported Impacts of Technology and Automation

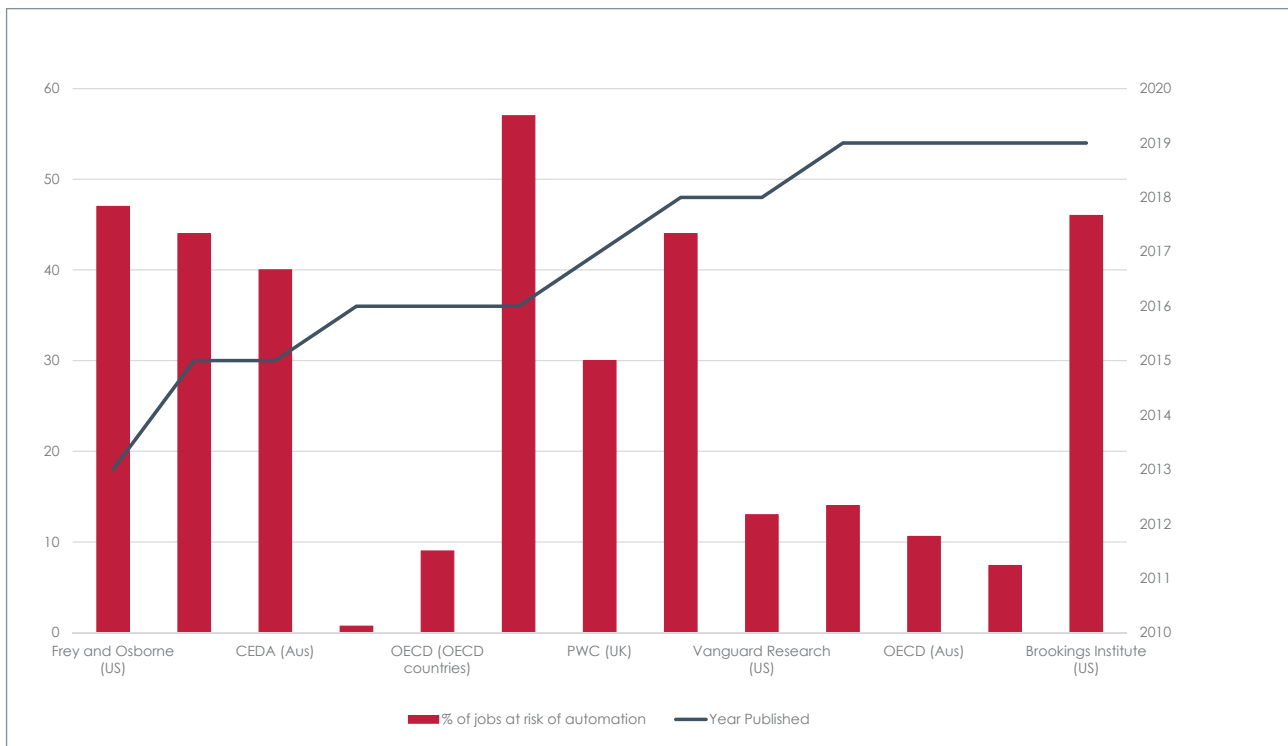
Research into the impact of technology and automation on work emerged and has intensified over the past two decades in response to ongoing concern—and disagreement—about the driving forces behind the disappearance of routine jobs and higher rates of unemployment within advanced economies (Frey & Osborne, 2013). During this period, research emerged which suggested that low rates of employment were associated with the disappearance of jobs dominated by routine tasks and procedures that could increasingly be performed by sophisticated computer systems. This included low and middle income jobs in manufacturing and tasks associated with occupations such as bookkeepers, cashiers and telephone operators (Frey & Osborne, 2013).

The result was a structural shift in the labour market, with workers reallocating labour from jobs in industries such as manufacturing, many of which delivered middle incomes, to low income service occupations (Frey & Osborne, 2013). This shift was thought to be because service occupations incorporating routine tasks are less susceptible to computerisation as these tasks require a higher degree of flexibility and physical adaptability (Autor & Dorn, 2013; Autor, et al., 2003; Goos & Manning, 2007). As a result, between 1995 and 2015 employment in the manufacturing sector in OECD countries decreased by 20%, while service sector employment grew by 27% (OECD, 2019a).

Consequently, academic researchers sought to examine and predict the potential impacts

of technology and automation on jobs and the workforce in the future. Frey and Osborne (2013) were the first researchers who sought to quantify this impact. Their seminal and much quoted research predicted that 47% of jobs in the United States were at high risk of automation in the near future. Importantly, the research projected that the impacts of computerisation in the workforce would extend beyond low paying manual and routine work to that of middle to high paying middle class jobs—domains commonly defined as non-routine. This included jobs in transport, data analysis, health care diagnostics, legal and financial services, as well as in environmental, systems, mechanical, security and health care monitoring services.

Figure 3: Estimates of the Proportion of Jobs Susceptible to Automation 2013–2019



Data source: Frey & Osborne, 2013; Edmonds & Bradley, 2015; CEDA, 2015; World Economic Forum, 2016; Arntz et al., 2016; PwC, 2017; OECD, 2018; OECD, 2019a; OECD, 2019b; Deloitte, 2019 Office for National Statistics, 2019; PwC, 2018; Davis et al., 2018; Badishkanian et al., 2016; Munro et al., 2019



This generated global interest in the future of work and spawned multiple estimates of the proportion of jobs susceptible to automation on both a global and a national scale. A summary of these predictions is outlined in Figure 3, which shows that estimates of the proportion of jobs at risk of automation vary widely. This is a result of variations in research methodology as well as differing sentiments regarding the impacts of automation on jobs—whether large proportions of jobs are at risk of being lost to automation or if technology and AI will change the way that job tasks are performed and the skills that are needed to do them.

For example, in 2015, Edmonds and Bradley, on behalf of Australia's Department of Innovation and Science, estimated that 44% of Australian jobs were highly susceptible to automation, while the Committee for Economic Development Australia (CEDA) projected that 40% or close to 5 million Australian jobs could be replaced by computers between 2015 and 2035.

On a global scale, the McKinsey Global Institute (2017) estimated that roughly one-fifth of the global workforce would be impacted by the adoption of technology and automation, with the most significant impact occurring in developed nations. They projected that automation would decrease demand for full-time staff by 2022 and that robots could replace some 800 million workers globally by 2030.

By contrast the World Economic Forum (2016) projected significantly fewer job losses. Their research estimated that 7.1 million jobs would be lost to disruptive labour market changes over the period 2015 to 2020, with a gain of 2 million new jobs—leading to a total loss of 5.1 million jobs. The study anticipates that new jobs will be concentrated in fields such as computer science, mathematics, architecture and engineering. It also indicated that while manufacturing and production roles would experience an ongoing decline, they also have relatively good potential for upskilling, redeployment and productivity enhancement.

More recently, OECD (2019a) forecast that technology and AI will lead to the automation of approximately 14% of current jobs across OECD countries, with 32% of jobs experiencing significant change. In Australia, this was projected to be 10.6% and 25% respectively (OECD, 2019b). Importantly, the research found that a significant future decrease in the total number of jobs available for humans was not expected. Rather, it projected a change in the types of jobs available and the skills needed, with notable growth in demand for high-skilled workers (OECD, 2019a).

This perspective was reiterated by Deloitte Access Economics (2019), who asserted that in Australia, technology and AI will not be a substitute for people but that it has the potential to make workforces more productive. They expect that technology and automation will augment jobs rather than replace them, which means that jobs will change in nature and in skill requirements but they will not disappear altogether.

Combined, this highlights the fact that there is little agreement concerning the number of job losses that will occur or the quantity of new jobs that will be created by automation, yet there is agreement that the types of skills required by industries will change. It also reveals that the impacts of technology will vary by industry, country and region and emphasises that changes in work are liable to be far from homogenous. Rather it is probable that impacts will be highly contextual to local histories, economies, political systems and resources.

Tasks and Industries Susceptible to Automation

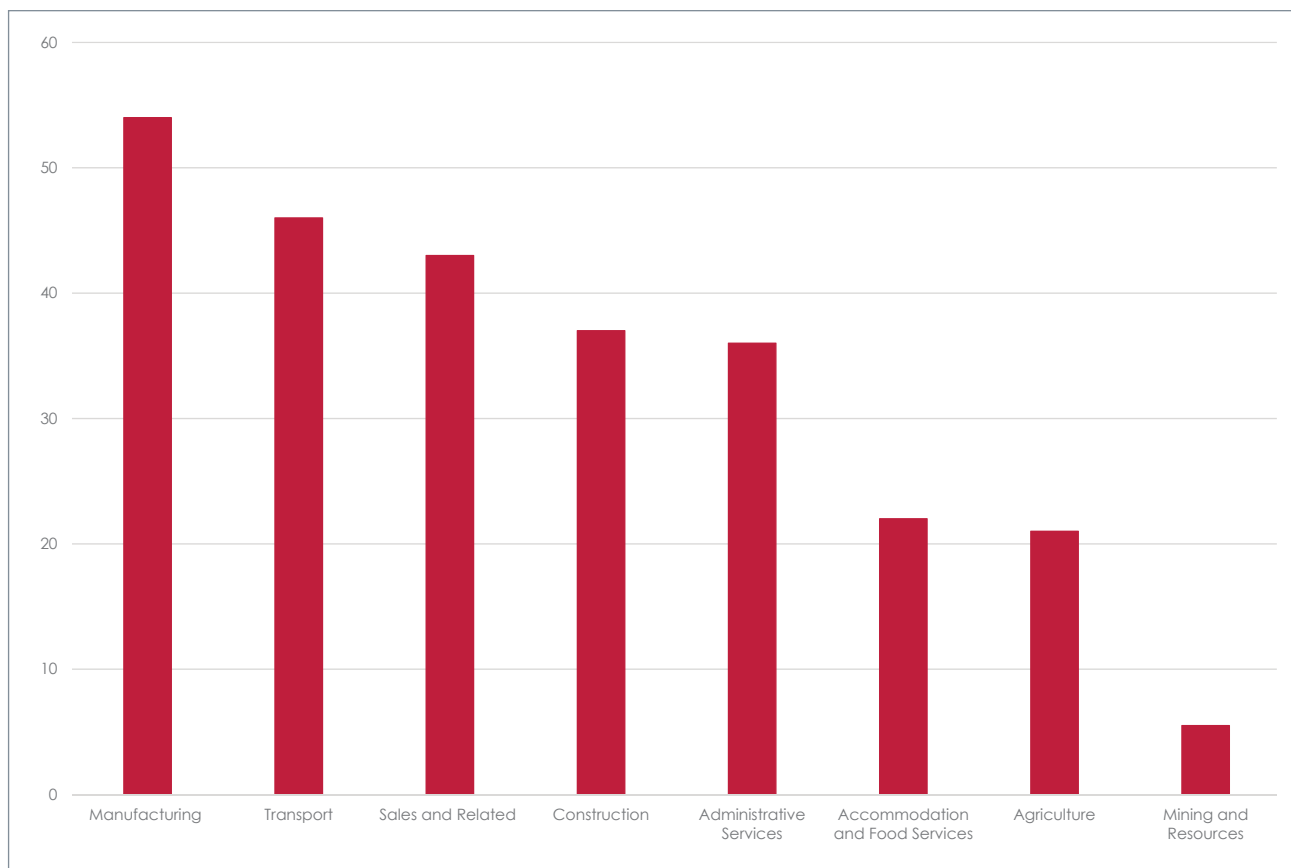
There is general consensus within published literature that in the short- to medium-term future, technological innovations will mean that the need for people to conduct routine and manual tasks in the workforce will decline, while demand for non-routine and abstract tasks will remain and even increase. Non-routine tasks are those that require creativity, problem solving skills, the ability to synthesise information, interpersonal skills and compassion (AlphaBeta, 2017; Autor, 2020; Sorgner, 2017).

Ultimately, it is suggested that the most tedious, least valuable and sometimes dangerous work currently performed by people can be taken over by machines, while more complex, 'human work' can continue to be performed by people (AlphaBeta, 2017; World Economic Forum, 2018).

Employment industries identified within international literature as vulnerable to automation include manufacturing; transport; sales (including retail and

real estate); construction; office administration; accommodation and food services; agriculture; and mining and resources (see Figure 4). It is noted that some of these sectors, such as manufacturing, have also been heavily influenced by globalisation, with competition from low cost countries pushing the manufacture and production of many labour intensive products offshore.

Figure 4: Industries Most Susceptible to Automation and Technological Change



Data source: Frey & Osborne, 2013; Edmonds & Bradley, 2015; CEDA, 2015; World Economic Forum, 2016; Arntz et al., 2016; PwC, 2017; OECD, 2018; OECD, 2019a; OECD, 2019b; Deloitte, 2018; Office for National Statistics, 2019; PwC, 2018; Davis et al., 2018; Badishkanian et al., 2016; Munro et al., 2019

Industries consistently identified within international literature as least prone to automation include education; health; information and communications technology (ICT); computer science; business management and financial services; professional and scientific services; and arts and recreation services (Figure 5).

As a result, researchers argue that 'human' cognitive and interpersonal skills, such as those required for jobs in the fields of education, health and technology, are expected to become increasingly hard to find in countries across the globe. Demand for these skills will also be boosted by global megatrends such as population

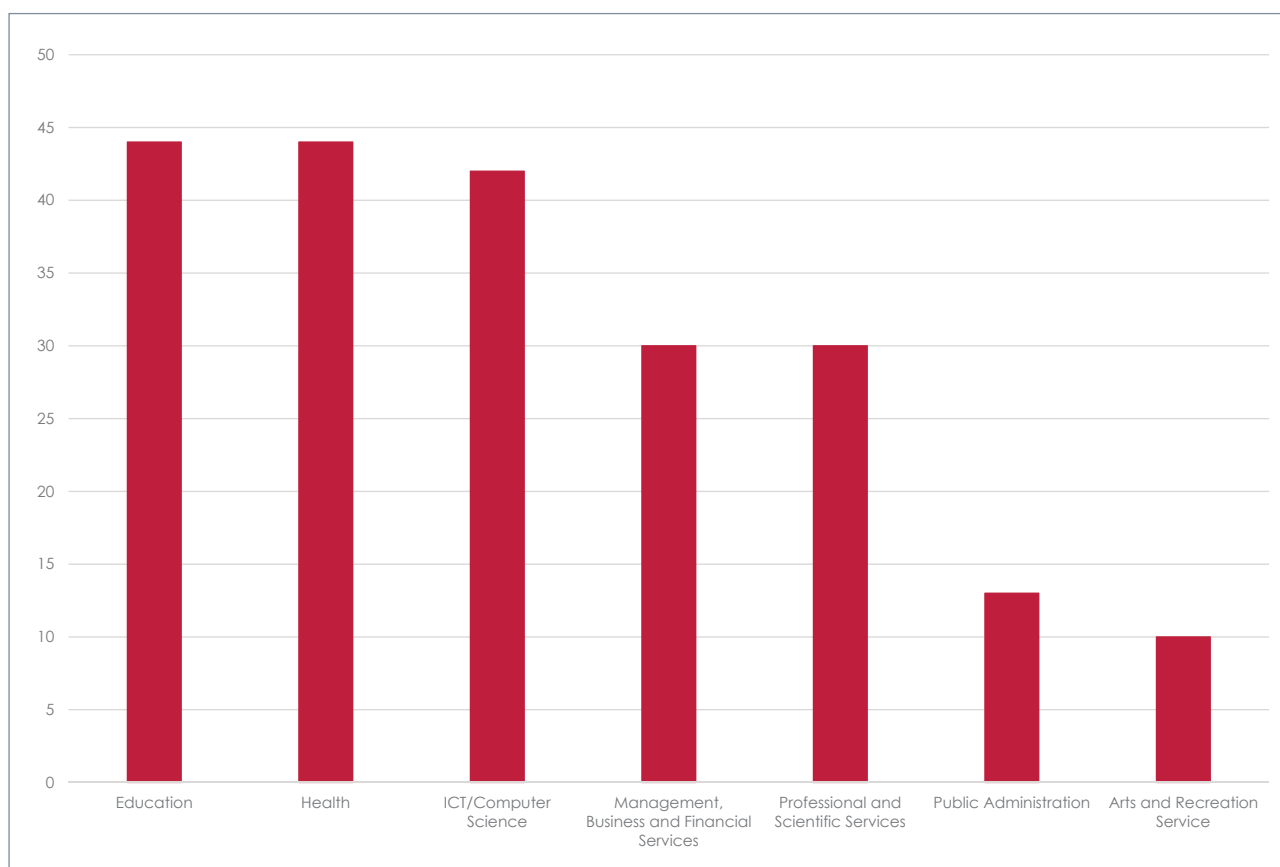
ageing and climate change. At the same time, a decline in demand for low-skilled workers in industries and jobs that are most susceptible to automation is expected (Autor & Dorn, 2013).

However, the extent and pace of the shift towards high-skilled workers is expected to vary substantially depending on each economy's productive structure or technology level. Research by OECD indicates that countries with firms at the technology frontier who produce and adopt new technologies are already struggling to find workers with the necessary skills to operate these innovations (OECD, 2018). In those labour markets, demand for highly skilled professionals is substantial, creating shortages.

Conversely, labour market demands in countries linked to more traditional industries, productive patterns and conventional or out-dated technologies have retained demand for medium- and low-skilled workers.

Countries such as Finland, the Netherlands, Sweden and Denmark have been identified by OECD as economies with strong pressures (shortages) for high-skilled workers, while countries such as Peru, Brazil, Turkey and South Africa continue to exhibit strong demand for low- and medium-skilled workers. Australia currently sits in the centre of this spectrum (OECD, 2018).

Figure 5: Industries Least Susceptible to Technological Change



Data source: Frey & Osborne, 2013; Edmonds & Bradley, 2015; CEDA, 2015; World Economic Forum, 2016; Arntz et al., 2016; PwC, 2017; OECD, 2018; OECD, 2019a; OECD, 2019b; Deloitte, 2018; Office for National Statistics, 2019; PwC, 2018; Davis et al., 2018; Badishkanian et al., 2016; Munro et al., 2019

Technology, Automation and Structural Change in Australia's Economy

Australia's economy has also experienced structural changes, moving away from a goods-producing economy towards a more services-oriented economy. This is reflected in the share of GDP contributed by industry sectors and the share of employment generated by each industry over the past three to four decades.

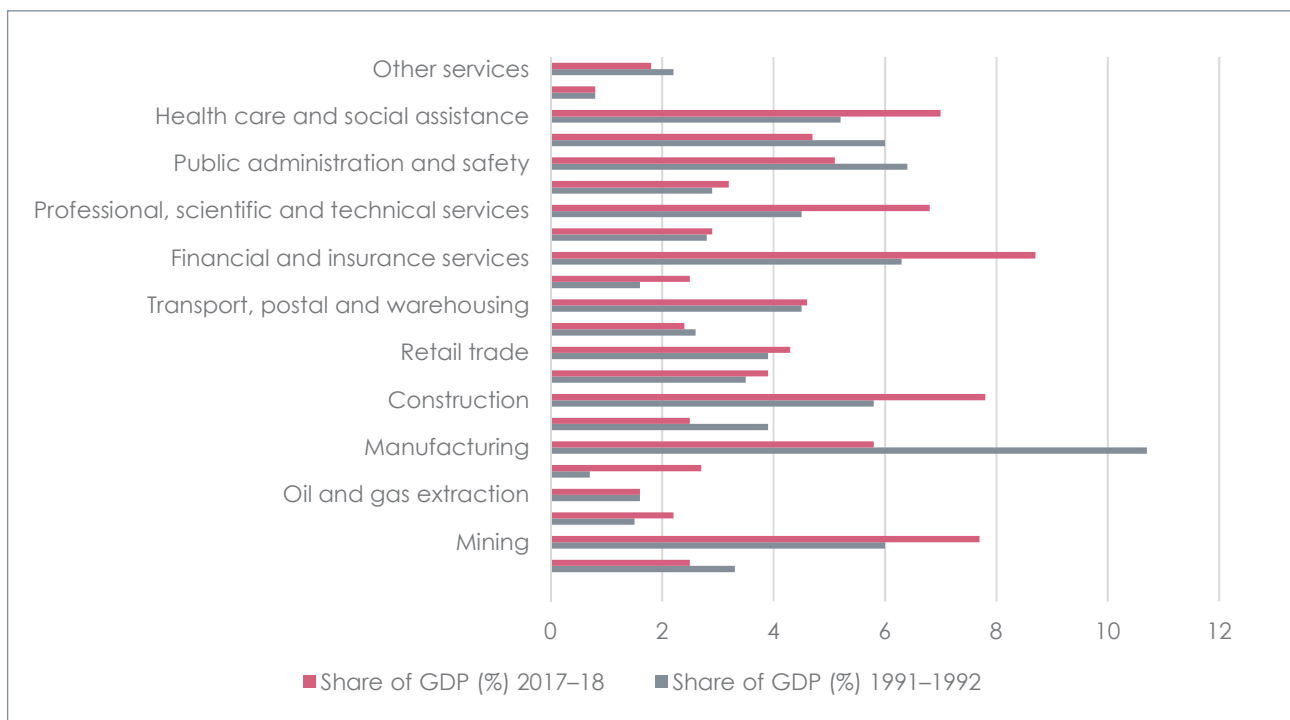
Figure 6 illustrates the share of GDP contributed by each industry sector in 1991–1992 compared to 2017–2018. It shows an increase in the share of GDP contributed by key service sectors, most notably health care and social assistance; professional, scientific and

technical services; and financial and insurance services. Non-service sectors such as mining and construction exhibited an increase in GDP contribution over this period, while the share of GDP contributed by the manufacturing and transport, postal and warehousing sectors declined.

This change has been accompanied by an increase in demand for workers in service sectors such as health care and social assistance, and professional, scientific and technical services (OECD, 2018). Research indicates that these fields require highly skilled

and educated workers who are able to complete non-routine 'human' tasks (OECD, 2018). The shift towards service sector employment in Australia is illustrated in Figure 7 (see page 12), which shows a rise in the proportion of service sector employment from the mid-1980s to 2019, associated with a corresponding decline in non-service sector employment.²

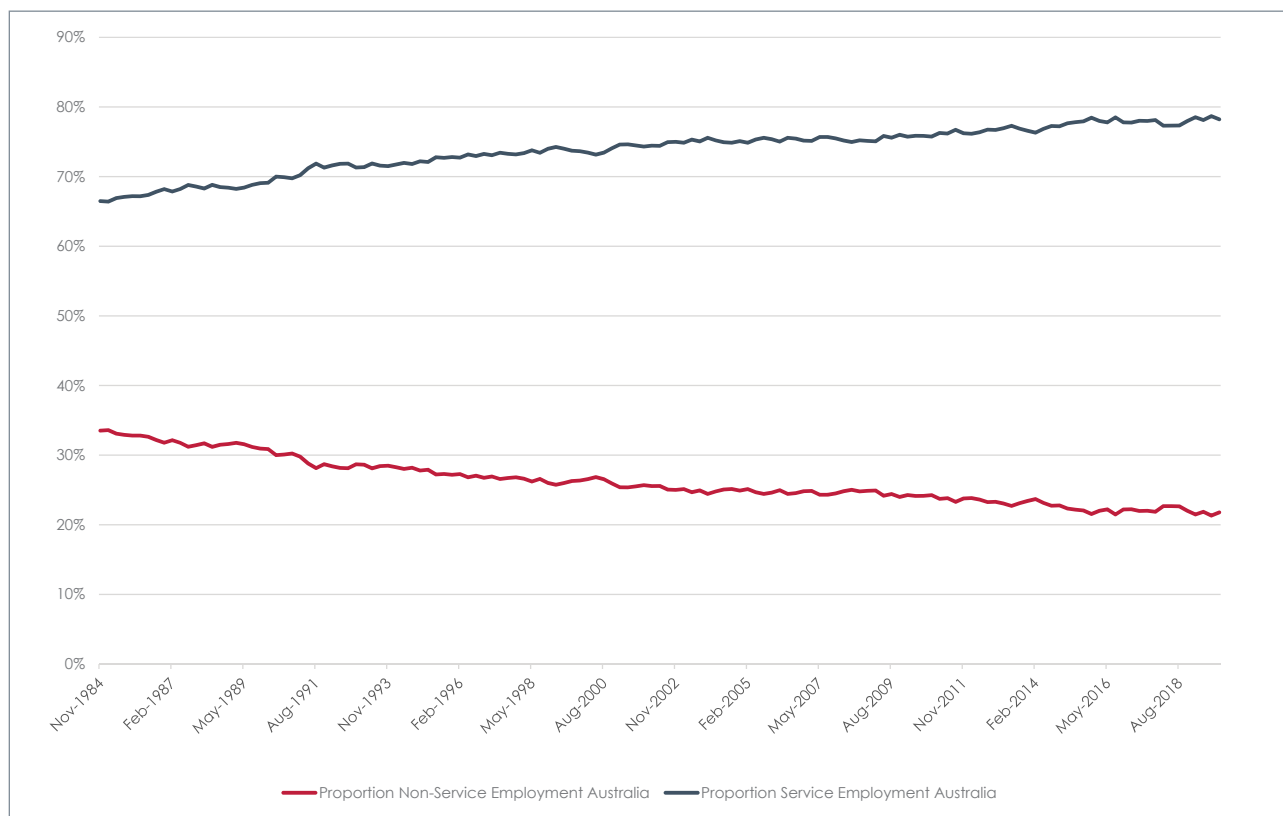
Figure 6: GDP by Industry Sector 1991–1992 to 2017–2018



Data source: ABS, 2018

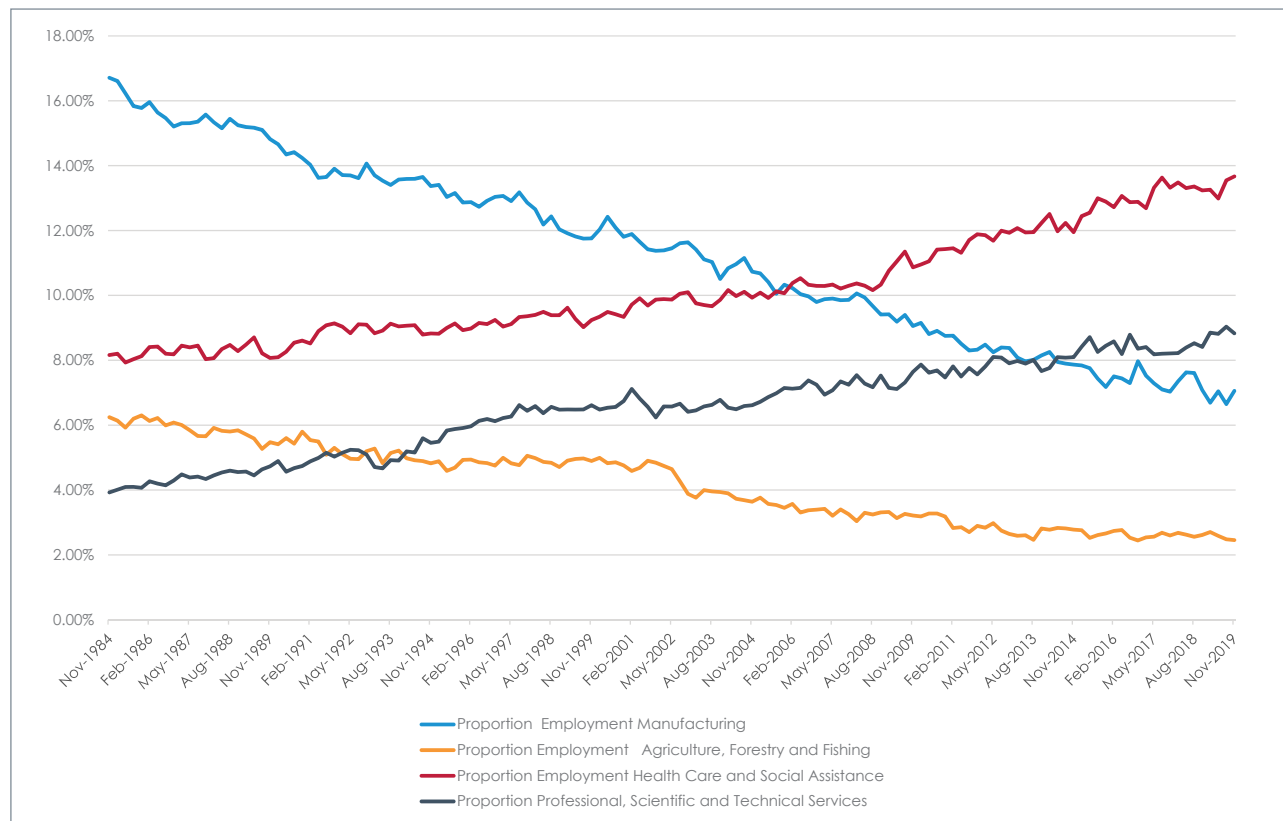
² Service industries are defined as all industries apart from manufacturing; construction; agriculture, forestry and fishing; mining; and electricity, gas, water and waste services.

Figure 7: Proportion of Service and Non-Service Sector Employment in Australia 1984–2019



Data source: ABS, 2020

Figure 8: Proportion of Employment in Australia by Industry Sector 1984–2019

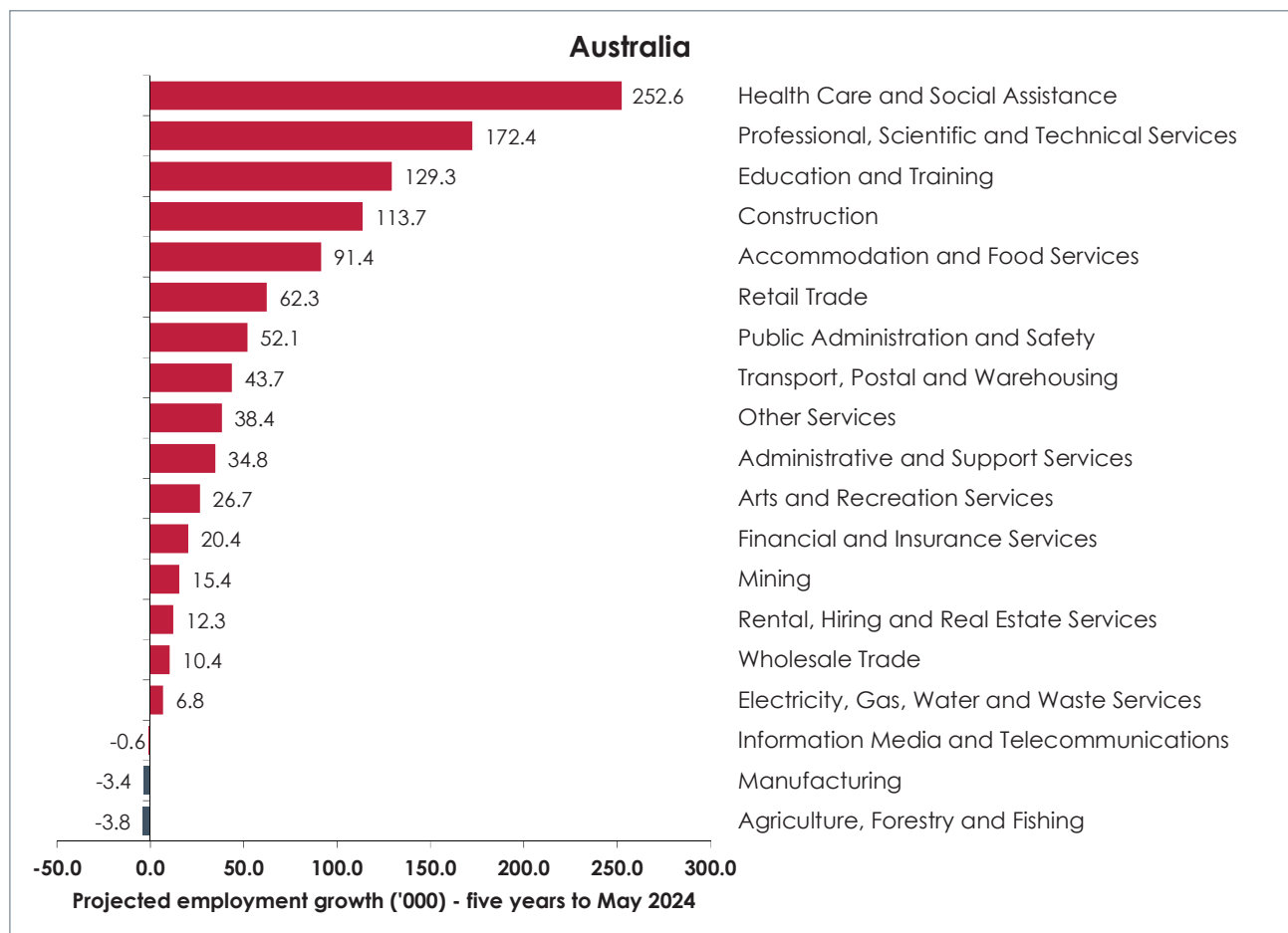


Data source: ABS, 2020

At a sector-specific level, employment statistics also show that in 1984, manufacturing was the largest employing industry in Australia, accounting for 17% of total employment. By 2019 manufacturing had dropped to the sixth largest employment sector in Australia, accounting for 7% of total employment. By contrast, employment in the health care and social assistance sector grew from 9% in 1984 to 14% in 2019, making it the largest employment sector in the nation (see Figure 8).

This trend is projected to continue in Australia over the coming decade, with growth in employment in the health care and social assistance sector; the professional; scientific and technical services sector; and the education and training sector expected to be most significant, while employment in the manufacturing sector and the agriculture, forestry and fishing sector is projected to decline (see Figure 9).

Figure 9: Projected Employment Growth Australia 2019–2024



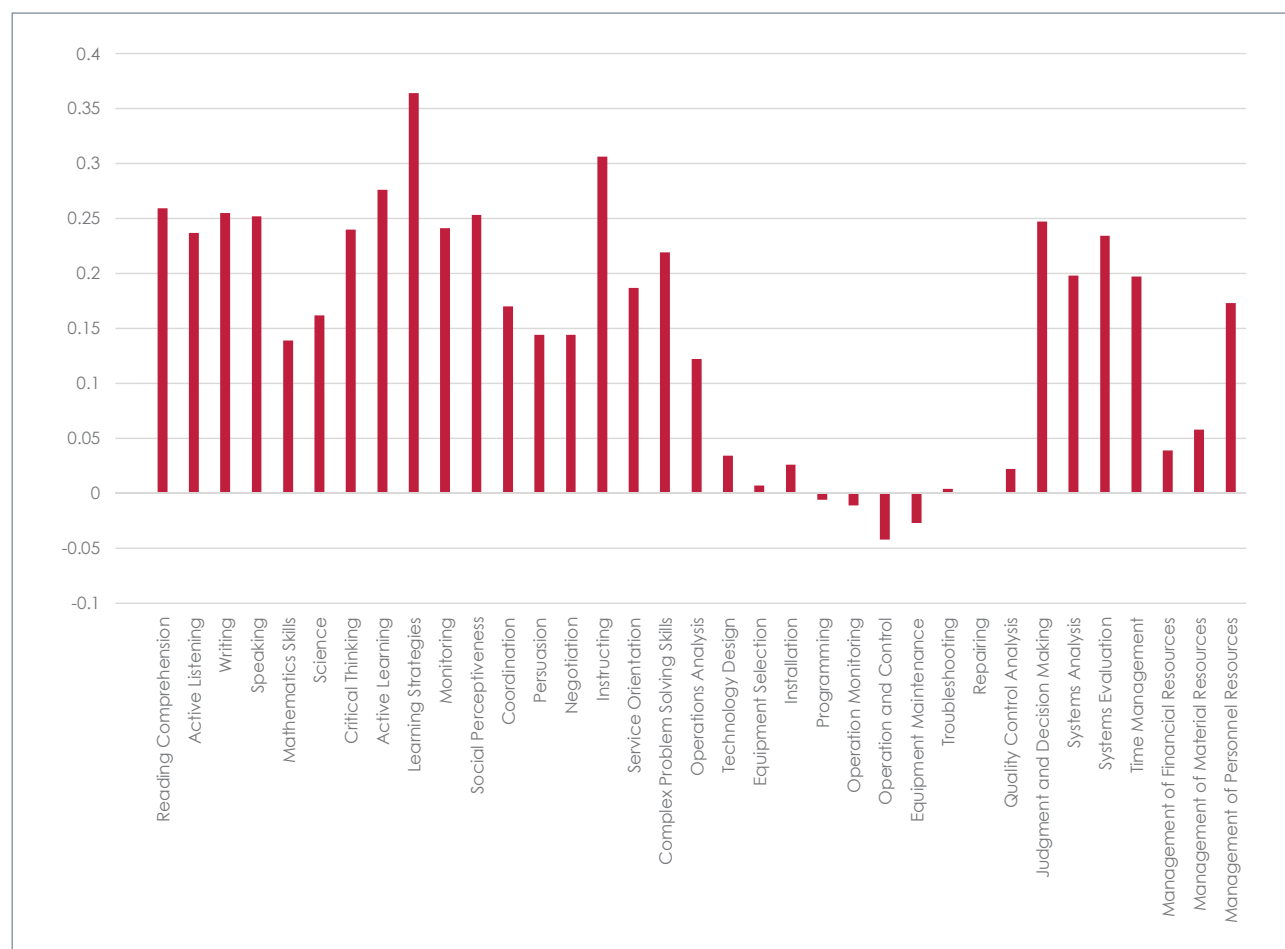
Data source: Department of Employment, Skills, Small and Family Business, 2019

A key impact of this structural shift is likely to be a shortage of 'human' and 'thinking' skills in Australia, particularly over the coming decade—although some disparity is evident within published research regarding the skills most likely to be impacted.

The OECD (2018) forecast an increase in demand in Australia for basic, social and complex problem solving and technical skills such as learning strategies, instruction, active learning and reading comprehension, while demand for technical skills associated with equipment maintenance, operation and control is expected to decline (see Figure 10).

In contrast, Deloitte Access Economics (2019) estimate that Australia will face a shortage of workers with skills in customer services; organisation and time management; digital literacy; leadership; health; conflict resolution; problem solving; sales; written communication; and innovative thinking. Alternatively, they predict that skills in information gathering and processing, critical thinking, media, legal, manual work, manufacturing, and maintenance and repair will be in surplus.

Figure 10: Projected Demand for Skills in Australia as Identified in the OECD Skills and Jobs Database



Data source: OECD, 2018

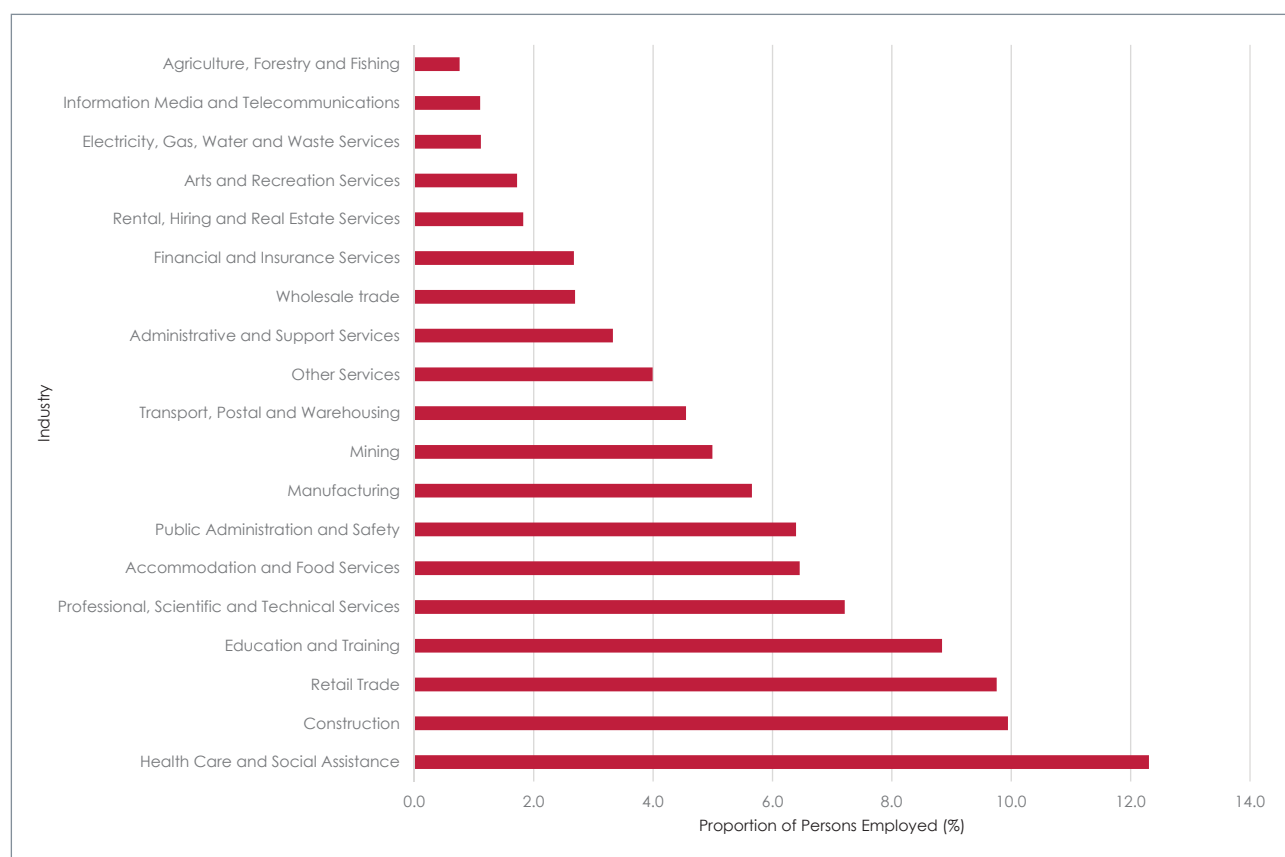


Economic Structure of Australian States and Capital Cities

Just as the impacts of technology and automation differ between countries, it can be expected that the impacts will vary across Australia's states, territories and capital cities, reflecting the differences in the economic structure of geographic regions.

In Greater Perth, the sectors that employ the largest numbers of people include health care and social assistance, construction and retail (Figure 11). Yet not all of these sectors are 'propulsive' or growth industries.

Figure 11: Greater Perth's Proportion of Employment per Industry 2016



Data source: ABS, 2017

Table 2 details the breakdown by industry of location quotients in the five major Australian capital cities. Locational quotients measure the concentration or dominance of industries in each city compared to Australia as a whole. Where an industry has

a location quotient value of 1.0 or greater, it is considered highly specialised or propulsive for that regional economy. This table shows that the economic structure of the five major Australian capital cities differs considerably.

Table 2: Location Quotient by Industry and Capital City

Industry sector	Greater Perth	Greater Adelaide	Greater Brisbane	Greater Melbourne	Greater Sydney
Agriculture, forestry and fishing	0.274	0.434	0.362	0.251	0.165
Mining	1.889	0.342	0.573	0.117	0.136
Manufacturing	0.928	1.226	1.032	1.287	0.927
Electricity, gas, water and waste services	1.064	1.214	1.024	0.989	0.739
Construction	0.973	0.730	0.839	0.818	0.808
Wholesale trade	0.979	1.032	1.053	1.309	1.288
Retail trade	1.055	1.133	0.994	1.089	0.966
Accommodation and food services	0.981	0.994	0.963	0.993	0.986
Transport, postal and warehousing	0.977	0.893	1.228	1.110	1.068
Information media and telecommunications	0.676	0.887	0.845	1.366	1.692
Financial and insurance services	0.794	0.906	0.945	1.343	1.833
Rental, hiring and real estate services	1.137	0.878	1.221	1.073	1.169
Professional, scientific and technical services	1.039	0.896	1.114	1.323	1.390
Administrative and support services	0.885	0.944	0.932	0.995	0.964
Public administration and safety	1.018	1.192	1.114	0.807	0.852
Education and training	1.085	1.059	1.089	1.058	0.947
Health care and social assistance	1.025	1.260	1.067	0.992	0.926
Arts and recreation services	1.094	0.912	0.902	1.297	1.006
Other services	1.088	1.069	1.011	0.009	0.943

Data source: Kazalac, 2018

The most notable feature of Greater Perth's economy is its strong and unique specialisation in the mining sector. With a locational quotient of 1.889, mining is more important to the Greater Perth economy than any other sector is to any other capital city. By contrast, the economies of Greater Sydney and Greater

Melbourne exhibit specialisation in multiple service sectors.

These distinctions in industry structure are apparent in state labour force trends in Western Australia and Greater Perth over the past 35 years (see Table 3). While all states have experienced a shift away from manufacturing

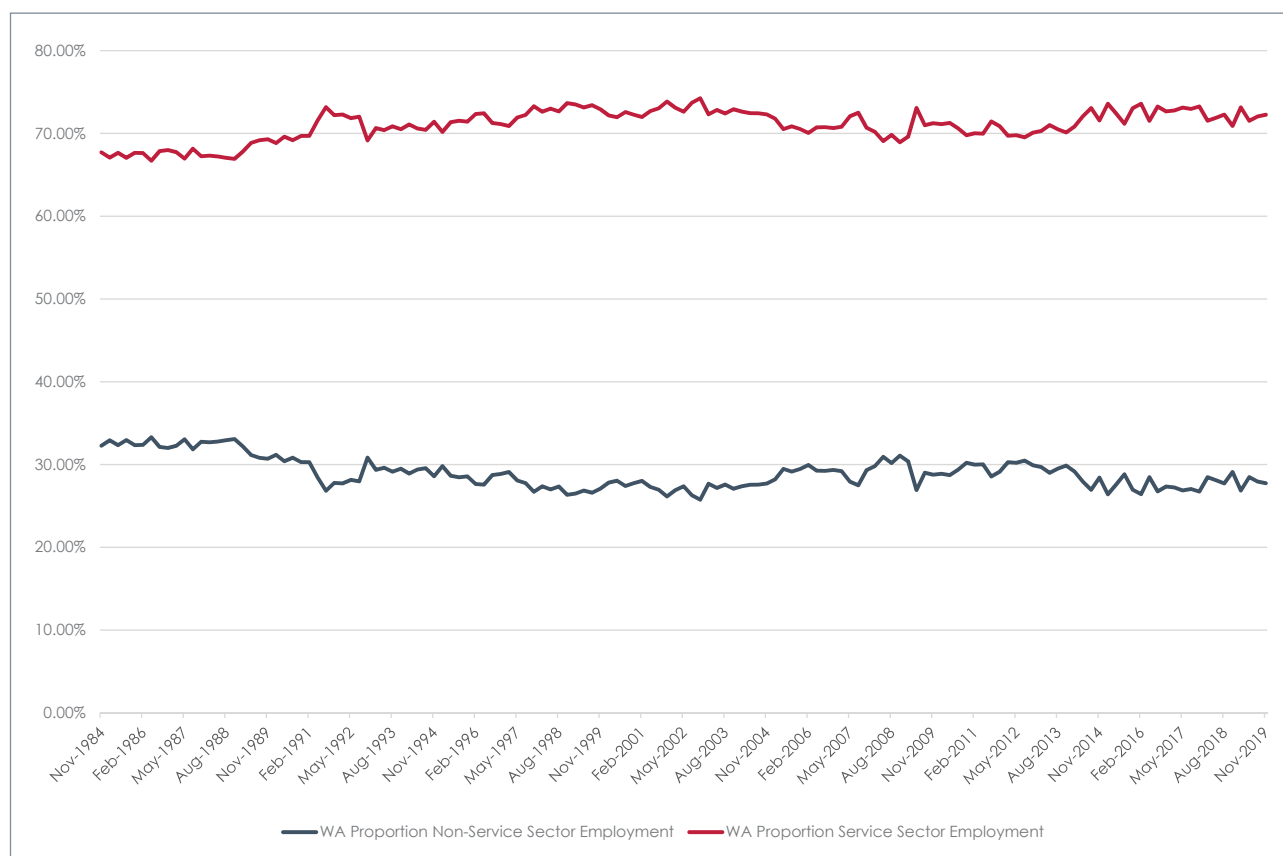
and non-service sector employment towards service sector employment over the past three decades, the trend is more pronounced in other states than in Western Australia, where 28% of the labour force continues to be employed in non-service industries (see Figure 12).

Table 3: Total Growth in Service and Non-Service Sector Employment by State November 1984 to November 2019

State	Percentage growth in service sector employment
Western Australia	4.54%
New South Wales	13.94%
Victoria	13.68%
Queensland	9.71%
South Australia	12.47%

Data source: ABS, 2020

Figure 12: Proportion of Service and Non-Service Sector Employment in Western Australia 1984–2019



Data source: ABS, 2020

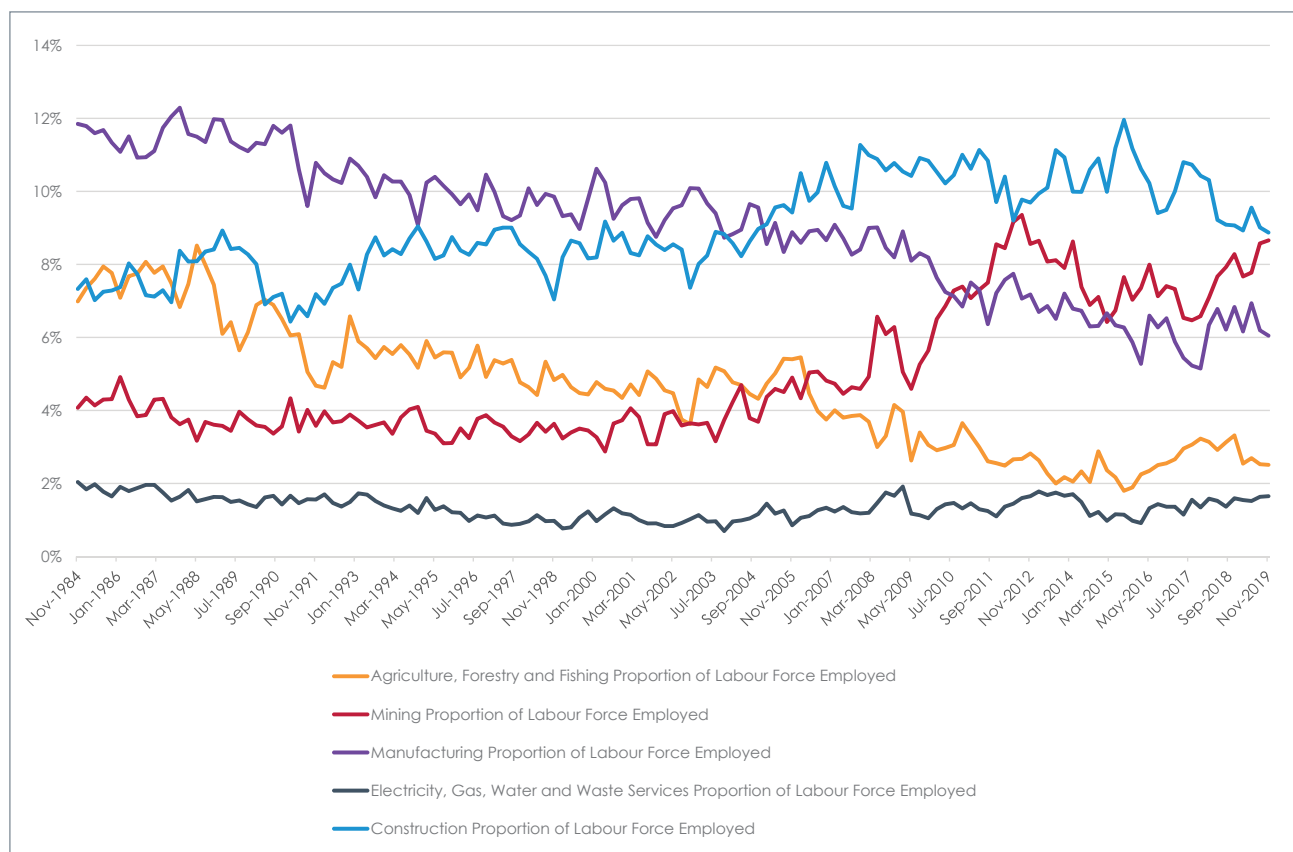
This is further illustrated by growth in the proportion of employment in specific service industries in Western Australia over the past three and a half decades compared to growth Australia-wide. Notable trends in non-service sector growth in Western Australia include substantially higher rates of employment growth in the mining sector and a less significant retraction in employment in manufacturing, as outlined in Table 4. Growth trends in non-service industries in Western Australia are illustrated in Figure 13.

Table 4: Non-Service Sector Employment Growth in Western Australia Compared to Australia November 1984 to November 2019

Industry sector	% change in Australia	% change in Western Australia %	Proportion of labour force employed in Australia	Proportion of labour force employed in Western Australia
Agriculture, forestry and fishing	-3.79%	-4.48	2.46%	2.51%
Mining	+0.5%	+4.58%	1.93%	8.66%
Manufacturing	-9.65%	-5.8%	7.06%	6.05%
Electricity, gas, water and waste services	-1.12%	-0.39	1.19%	1.65%
Construction	+2.33%	+1.54%	9.15%	8.87%

Data source: ABS, 2020

Figure 13: Proportion of Employment in Key Non-Service Industry Sectors in Western Australia 1984–2019



Data source: ABS, 2020

Employment statistics also reveal that while service industries are the largest and most propulsive employment sectors in Western Australia (see Figure 14 on page 21), rates of employment growth and proportional

employment are lower than the Australian average in these sectors, including health care and social assistance; education and training; and professional, scientific and technical services (as illustrated in Table 5).

Table 5: Proportional Growth in Employment in Key Sectors in Australia and Western Australia November 1984 to November 2019

Industry sector	% change in Australia	% change in Western Australia	Proportion of labour force employed in Australia	Proportion of labour force employed in Western Australia
Wholesale trade	-2.39%	-2.09	2.9%	2.76%
Retail trade	-0.87%	-1.89%	9.81%	9.07%
Accommodation and food services	+2.14%	+0.74%	7.15%	6.11%
Transport, postal and warehousing	+0.82%	-1.12%	5.07%	5.2%
Information media and telecommunications	-0.57%	-1.26%	1.61%	1.02%
Financial and insurance services	-0.43	-1.97%	3.55%	2.06%
Rental, hiring and real estate services	+0.44	-0.14	1.66%	1.55%
Professional, scientific and technical services	+4.9%	+4.17%	8.83%	8.09%
Administrative and support service	+1.52%	1.4%	3.37%	3.19%
Public administration and safety	+0.63%	1.08%	6.44%	6.38%
Education and training	+1.6%	+1.27%	8.38%	8.12%
Health care and social assistance	+5.51%	+3.56%	13.67%	12.34%
Arts and recreation services	+0.87%	+0.83%	1.94%	1.89%
Other services	-0.36	-0.03%	3.85%	4.47%

Data source: ABS, 2020

Despite this, Western Australia recorded the second highest rate after Queensland of total jobs growth in the 35 years from 1984 to 2019. Yet over the past ten year

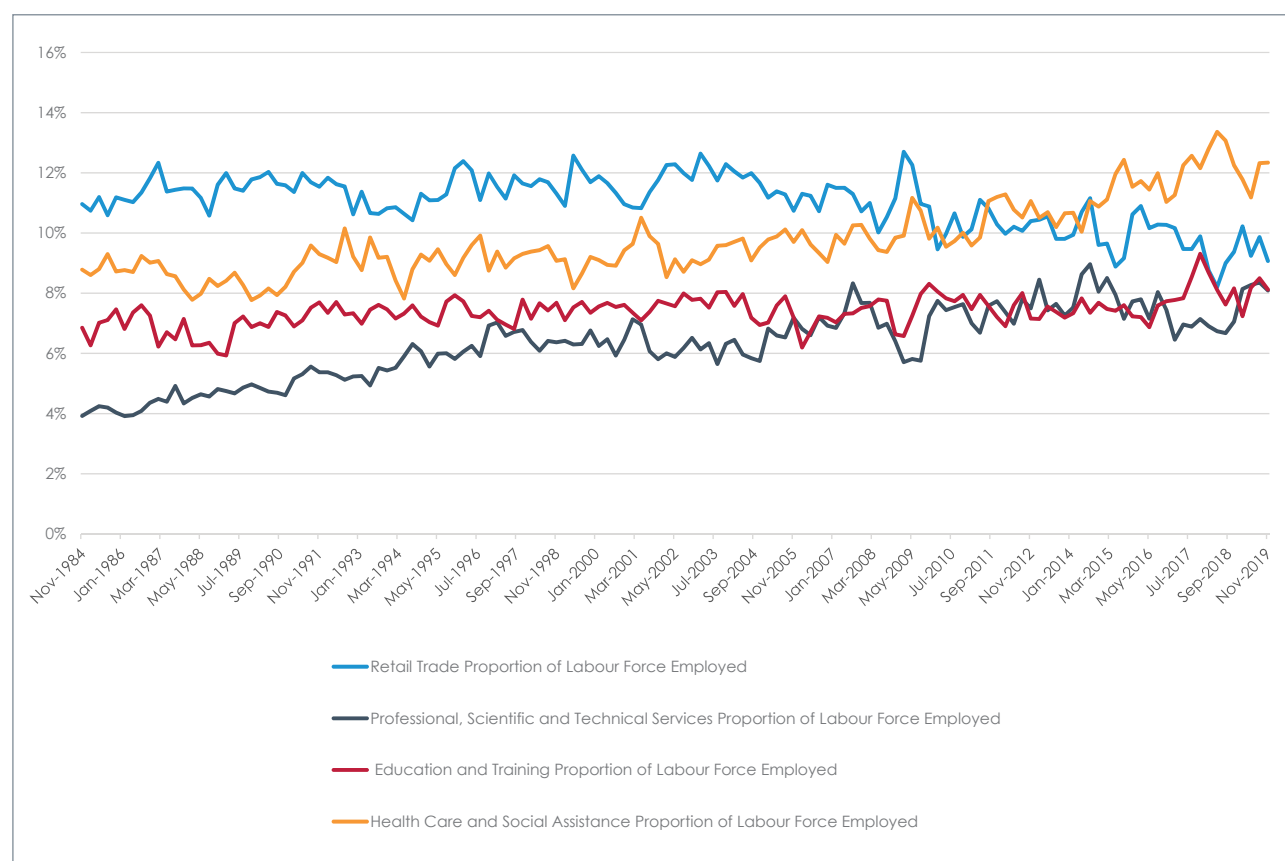
period, Western Australia has had the second weakest employment growth of any state or territory (see Table 6).

Table 6: Employment Growth by State 1984–2019

Employment growth	Western Australia	New South Wales	Victoria	Queensland	South Australia	Australia
Annual employment growth 1984–2019	3.60%	2.30%	2.75%	4.40%	1.34%	2.79%
Annual employment growth 2009–2019	1.60%	2.19%	2.67%	1.72%	0.72%	2.00%

Data source: ABS, 2020

Figure 14: Proportion of Employment in Key Service Industry Sectors 1984–2019



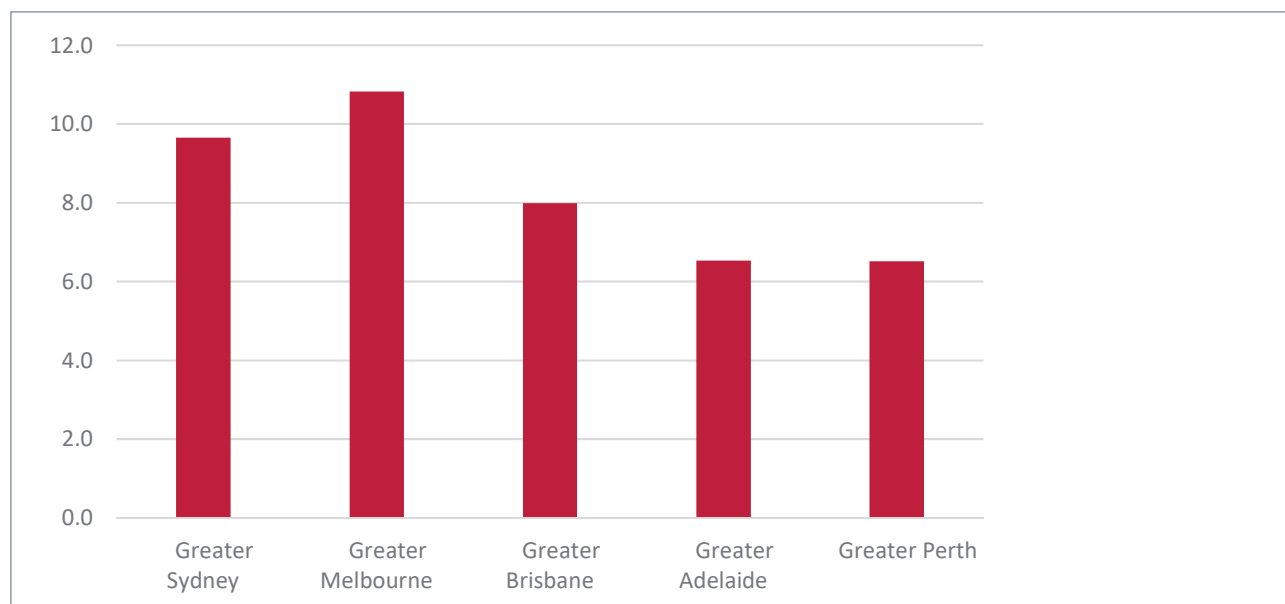
Data source: ABS, 2020

This trend has been anticipated to continue. In 2019, the ABS projected that from 2019 to 2024, employment growth would be highest in Victoria and New South Wales and lowest in Western Australia and South Australia.

Employment in Greater Perth and Greater Adelaide was projected to grow 6.5%, the lowest rate of growth expected among the five major capital cities. This includes higher rates of employment growth in the

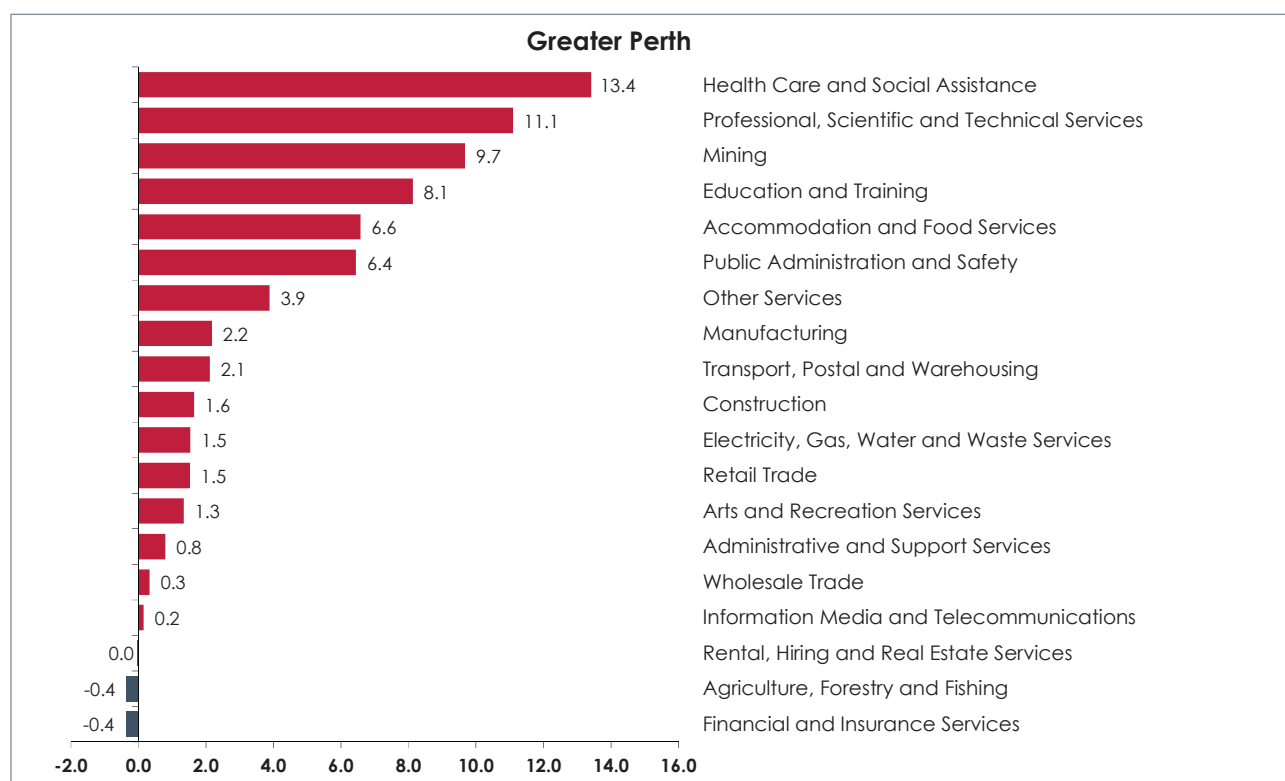
mining (12%) and manufacturing (3.1%) sectors, and lower rates of employment growth in the major service sectors in Western Australia (Figure 15) and Greater Perth (Figure 16) compared to the Australian average (ABS, 2020).

Figure 15: Projected Jobs Growth by State Capital City 2019–2024



Data source: Department of Employment, Skills, Small and Family Business, 2019

Figure 16: Projected Employment Greater Perth 2019–2024



Data source: Department of Employment, Skills, Small and Family Business, 2019

Future of Work Impacts in Western Australia and Greater Perth



Employment data, as discussed previously, suggests that while the economy of Western Australia and Greater Perth is experiencing a structural shift away from a goods-producing economy towards a more services-oriented economy, the State's unique specialisation in the mining sector means that this shift is occurring at a slower pace than in Australia's other larger states and capitals. As a result, labour market demands in Western Australia have retained stronger links to traditional industries, including mining and manufacturing.

This may mean that over the coming decade, Greater Perth will be more susceptible to challenges associated with future of work changes such as mismatches between jobs and skills and job displacement than other larger Australian capitals as the shift towards more technologically advanced, autonomous production models in these industries accelerates.

In Western Australia's mining sector this change is already evident. While jobs growth in this

sector has been relatively strong, advancements in technology and AI have enabled a shift to more autonomous mining operations and this is changing the types of jobs available and the job skills the industry requires (Bellamy & Pravica, 2011; Gollschewski, 2015).

For example, the introduction of automated vehicles and drilling on mine sites has displaced jobs for truck and train drivers and drillers, but it has also created new skilled jobs in the science, technology, engineering and mathematics (STEM) streams, including engineers in mechatronics, automation and AI, and data analytics (Gollschewski, 2015; Toscano, 2019). This trend is expected to continue as mines become fully automated over the coming five to ten years (Gray, 2019).

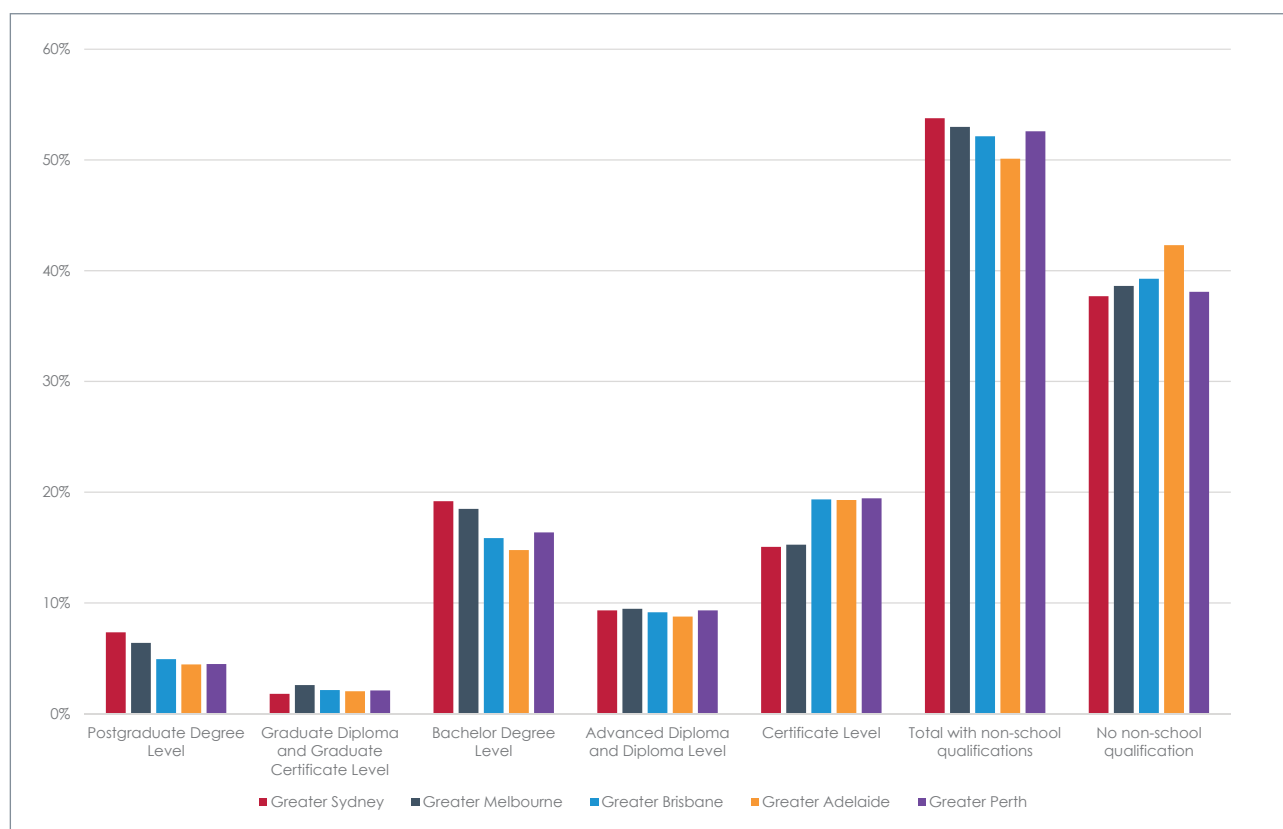
This is delivering both benefits and challenges for the industry and for workers. Benefits of automation include increased productivity and improved occupational health and safety, including fewer fatalities and workplace injuries. For example,

in 2019, BHP reported that haulage automation had reduced heavy vehicle safety incidents by up to 80% (Creagh, 2019). Other advantages include the generation of new jobs that are more challenging, diverse and fulfilling for workers than the displaced 'routine' job tasks, and a reduced need for people to work in remote and hostile locations (Creagh, 2019; Gollschewski, 2015).

Challenges of automation include the generation of a spatial skills mismatch, particularly in regional areas. This mismatch occurs when the localised demand for skills changes quickly and significantly, leaving the skill base of the local population poorly matched to the requirements of the local job market. This generates a need to rapidly retrain existing workers whose skills no longer match the types of skills needed in the sector (Bellamy & Pravica, 2011; Gollschewski, 2015). However, for some employees, it can also lead to long-term unemployment, as evidenced by the closure of car manufacturing plants in Australia over the past decade (Kurmelovs, 2016).

This is important because Western Australia's and Greater Perth's existing human capital base is strongly linked to the traditional skill needs of the mining and resource sector (Committee for Perth, 2018). This includes higher proportions of workers with Certificate III and IV level qualifications, and smaller proportions of workers with a tertiary qualification when compared to other Australian states and capitals with larger populations and more service-oriented economies (ABS, 2017), as shown in Figure 17 (see page 24).

Figure 17: Education Attainment by Capital City



Data source: ABS, 2017

Greater Perth's shift to a more services-oriented economy is generating significant shortages of skilled workers in key service sectors, most notably health care professionals (Department of Training and Workforce Development, 2020). Additional shifts in demand from low- and medium- to high-skilled workers in sectors such as mining and manufacturing is likely to exacerbate this trend, and this risks generating a significant surplus of low- and medium-skilled workers experienced in undertaking routine tasks and a heightened shortage of highly skilled and educated workers with 'human' and 'thinking' skills such as creativity, inventiveness, problem solving, innovative thinking, communication and empathy.

A skills mismatch, or a lack of appropriately skilled workers to fill job vacancies, would hinder the pace and efficiency of technological advancement. In addition, as highlighted by Autor and Dorn (2013) and Frey and Osborne (2017), there is a threat that workers in lower skilled occupations would experience wage polarisation and inequality due to stagnant or declining real earnings and employment.



COVID-19—A Future of Work Accelerator

The 2019–2020 COVID-19 crisis has substantially impacted the outlook for labour market activity in all states of Australia—yet the scale of this impact remains uncertain. What is clear is that the pandemic will decrease job growth and increase unemployment in all Australian states and territories across almost all industry sectors. It also means that labour market predictions prior to the crisis can no longer be relied upon (Department of Employment, Skills, Small and Family Business, 2020).

A potential additional impact of the COVID-19 pandemic and associated economic recession, highlighted in global literature and the media, is the acceleration of industry adoption of new technologies and associated future of work impacts. This is based on international observations that, historically, labour-replacing

automation has occurred in waves associated with economic downturns, rather than at a steady, gradual pace.

According to Munro et al. (2019), “automation happens in bursts, concentrated especially in bad times such as in the wake of economic shocks, when humans become relatively more expensive as firms’ revenues rapidly decline”. This is because during recessions, employers shed less-skilled workers and replace them with technology and high-skilled workers, which increases labour productivity as a recession tapers off (Munro et al., 2019). However, not all jobs disappear; many jobs evolve and with the assistance of technology, become more productive (Davis et al., 2018).

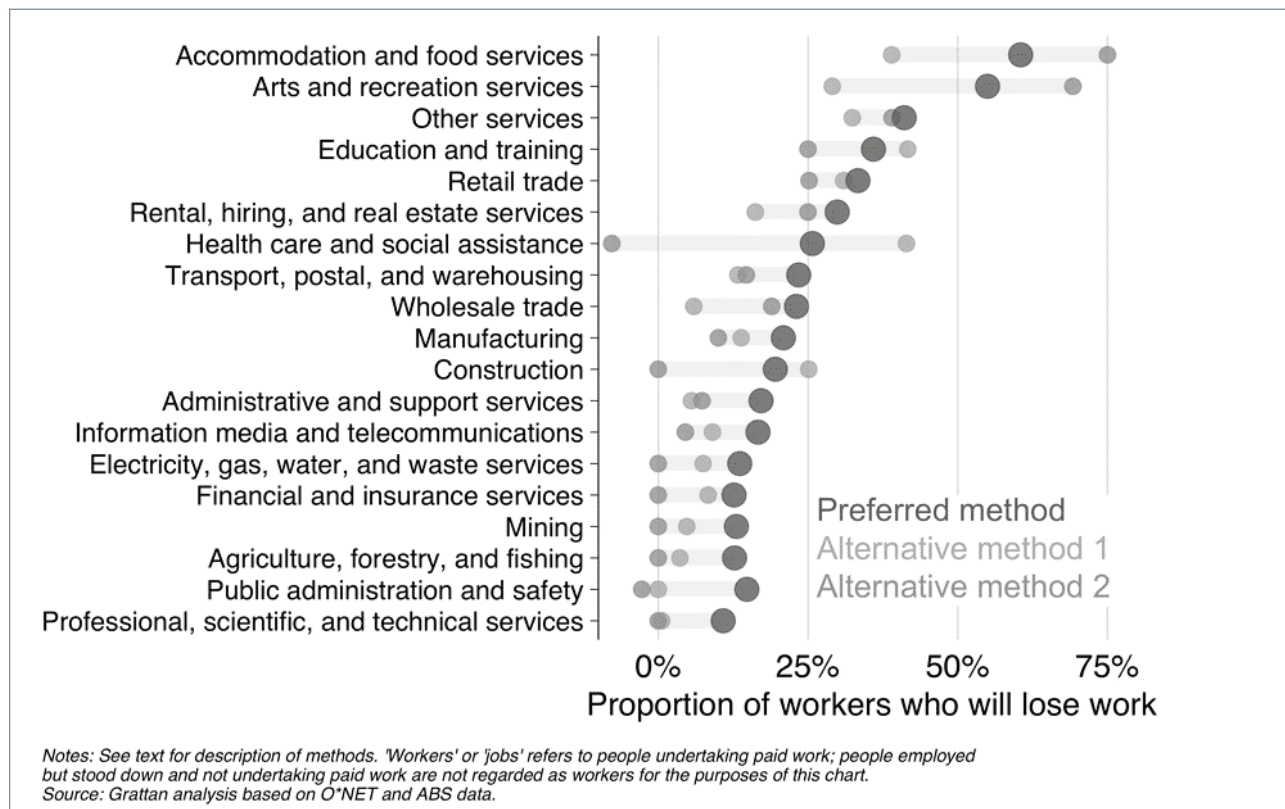
For example, Jaimovich and Siu (2020) reported that over three recessions in the last 30 years, 88%

of job losses took place in routine, automatable occupations—meaning such jobs accounted for almost all of the jobs lost in the crises. In addition, Hershbein and Kahn (2018) found that following the Great Recession of 2008–2009, technology displaced many workers in routine manual jobs.

Yet in some sectors, technology emerged to complement people, and employment and wages in these jobs have increased modestly. According to Hershbein and Kahn (2018), “Rather than disappearing entirely, surviving routine-cognitive occupations appear to have become both relatively higher-skilled and more productive”.

Reports of the impacts of COVID-19 on technology in the workplace to date are strongly associated with the adaptation to working conditions in a lockdown environment and

Figure 18: Projected COVID-19 Job Losses



Data source: Coates et al., 2020

reflect an acceleration of trends already in place (Chainey, 2020). This includes rapid adoption of existing technologies and cloud computing; a result of increased use of video conferencing services, online shopping, online education and delivery services. As a result, expansion is occurring in sectors associated with ICT infrastructure and delivery. In addition, disruption to manufacturing and global supply chains has accelerated adoption of technologies such as 3D printing, while drone and autonomous robots are being used to provide contactless delivery services (Standage, 2020).

Research undertaken in New Zealand during COVID-19 lockdown periods indicates that 73% of workers reported being equally or more productive while

working from home, and that 89% want to continue to work from home at least part of the time post lockdown (O'Kane, 2020). While tech giants including Google, Facebook, Twitter and Microsoft have announced plans for their employees to continue to work from home in the short-to medium-term, the long-term impacts of these workforce adjustments are difficult to predict (Brownlee, 2020).

The potential for technological adaptations associated with the COVID-19 pandemic to accelerate processes of structural change within industry sectors is not yet known. Coates et al. (2020), on behalf of the Grattan Institute, estimate that employment in almost all industry sectors in Australia will be significantly impacted as a result of the COVID-19 pandemic

(see Figure 18). Workers in the accommodation and food services; retail trade; rental hiring and real estate services; transport postal and warehousing; and wholesale trade sectors are identified as among those at highest risk of job losses. Whether these impacts will be short term or last long enough to trigger or hasten structural change is uncertain.

Conclusion

This research has established that future of work changes associated with the adoption of new technology and AI are transforming work, the workforce and the workplace in Australia today and these changes are likely to accelerate in the short-term future.

Although future of work changes may not lead to mass job losses, it will change the types of industries people work in, the nature of jobs people perform and the skills needed to perform them.

In the short- to medium-term future, this means that demand for people to conduct routine and manual tasks in the workforce will decline, while demand for non-routine and abstract tasks will remain and even increase.

Australia's economy has been shifting from a goods-producing economy towards a services-oriented economy over the past four decades. This is generating a shift in the types of skills and workers most in demand across all states and capital cities. However, this shift is likely to gain pace as industries adopt new technologies and seek to maximise productivity and efficiency in response to global economic conditions and the forthcoming COVID-19 recession.

In Greater Perth, the region's unique specialisation in mining means that while a structural shift towards a services-oriented economy is evident, it has been less pronounced than in other major Australian capital cities. As a result, a higher proportion of the workforce in Greater Perth and the State remain employed in traditional sectors such as mining and manufacturing.



These sectors are, however, rapidly shifting towards more technologically advanced, autonomous production models. While this is a positive shift expected to enhance industry productivity and global competitiveness and generate safer, more challenging employment opportunities, it may also exacerbate the emerging mismatch between the skills available in the workforce and the skills required by the key industry sectors.

This skills mismatch could generate significant negative impacts for industry by hindering progress towards technological advancement, and for some workers by reducing the availability of jobs they are qualified to perform. Impacts for low-skilled workers associated with future of work changes could be exacerbated by job losses resulting from the

COVID-19 pandemic and associated recession.

Looking forward, it is therefore more critical than ever before for industry, the workforce and the State Government to gain a detailed understanding of the likely impacts of future of work changes on the economies of Greater Perth and Western Australia and to identify measures to ensure industries and workers are best placed to prosper from technological change.

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About FACTBase

FACTBase is a collaborative research project between the Committee for Perth and The University of Western Australia. It aims to benchmark the liveability of Perth and its global connectedness through an examination of Perth's economic, social, demographic and political character.

The FACTBase team of academics and researchers condense a plethora of existing information and databases on the major themes, map what is happening in Perth in pictures as well as words, and examine how Perth compares with, and connects to, other cities around the world.

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About the author



Gemma Davis is a research, policy and strategic planning professional with 20 years of experience working in Australia, New Zealand and the Republic of Ireland. Gemma has undertaken a wide range of research projects on behalf of the Committee for Perth over the past decade.

Gemma is currently a Director with e3Scientific in New Zealand and is an Honorary Research Fellow with The University of Western Australia. Gemma has authored major reports for the Committee for Perth, including *Towards a Bright Future*, *Get a Move On!* and *Bigger & Better Beyond the Boom: Perth's Pathway to Prosperity*.