WORKPLACE SAFETY FUTURES

The impact of emerging technologies and platforms on work health and safety and workers' compensation over the next 20 years

safe work australia

DATA 61

CSIRO

CITATION

Horton J, Cameron A, Devaraj D, Hanson RT, Hajkowicz SA (2018) Workplace Safety Futures: The impact of emerging technologies and platforms on work health and safety and workers' compensation over the next 20 years. CSIRO, Canberra.

ACKNOWLEDGMENTS

This report was commissioned by Safe Work Australia.

We would like to thank Safe Work Australia and the Department of Jobs and Small Business for providing support and constructive feedback. Our gratitude also goes to the many individuals and organisations who kindly shared their time, resources, expertise and knowledge through the interview process.

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EXECUTIVE SUMMARY

This report considers the impact of six megatrends on work health and safety (WHS) and workers' compensation over the next 20 years (Figure 1). The narrative of the future is based on a structured process of strategic foresight which identifies megatrends and illustrates their possible impacts using future scenarios.

As digital technologies advance in capability and decrease in cost, they are likely to enter the work environment in greater numbers and in a wider variety of roles. Major advances in automation, artificial intelligence (AI), digitisation, augmented reality (AR) and virtual reality (VR), cyber-physical systems and other technologies are on the horizon. Enabled by technological developments, the worldwide growth of peer-to-peer (P2P) platforms, such as Uber, Airtasker, and Gobi, has the potential to fundamentally shift employment patterns and structures toward a 'gig economy' where freelance task-based work is common. This is occurring in the context of an Australian workforce facing a number of key changes: a transition to professional service-based employment; the end of the mining boom; and the demographic shift towards an older workforce.

Given these emerging changes, a key question for WHS and workers' compensation policymakers is the extent to which current regulatory and compensation systems are able to meet future challenges. Scenario planning seeks to address this question by sketching out the plausible conditions that may or may not require change based on a series of proven and relevant megatrends shaping the future. This enables stakeholders and decision makers to begin thinking about plausible futures *before* they eventuate, and make wiser planning and strategic decisions.

A megatrend is a deep-set trajectory of change that occurs at the intersection of numerous trends with tighter and more specific temporal, spatial and typological definitions.

Figure 1. Megatrends describing the impacts of emerging technologies and platforms on work health and safety and workers' compensation over the next 20 years

Megatrends develop gradually but eventually reshape the environment. The megatrends identified in this study are:

1. **The extending reach of automated systems and robotics.** The costs of advanced automated technologies are likely to continue falling and the capabilities and widespread deployment are likely to continue rising.
2. **Rising issue of workplace stress and mental health issues.** Australia's workforce is registering increasing levels of stress and mental health issues. New and intensifying uses of digital technologies in the workplace may exacerbate problems with mental health and stress, but technology also presents opportunities to manage these issues.
3. **Rising screen time, sedentary behaviour and chronic illness.** The amount of daily screen time has grown for both adults and children and there is a continued drift away from manual jobs towards sedentary jobs. Rates of obesity, cardiovascular disease, type 2 diabetes, and other chronic illnesses continue to rise.
4. **Blurring the boundaries between work and home.** An increasingly large share of Australian workers are entering into work arrangements that enable them to work from home or other locations, blurring the boundaries between work and home life.
5. **The gig and entrepreneurial economy.** The gig economy refers to freelance task-based work organised through online platforms or 'apps'. It changes the way we work away from traditional employment models. Although the Australian gig economy is still relatively small, at least some growth is anticipated.
6. **An ageing workforce.** The average age of Australia's workforce is increasing along with the ageing of the population as a whole, and older Australians are having to stay in the workforce longer.

This report presents four plausible future scenarios based on alternative ways the megatrends could play out. The scenarios are constructed on two axes, which are continuums of uncertainty and impact ranging from one extreme to another. The vertical axis captures the spread of automated systems, which is patchy at the low end and ubiquitous at the high end. The horizontal axis refers to the state of the gig economy: at the low end it occupies a niche position, while at the high end, it has become mainstream.

These megatrends and scenarios are, by necessity, a simplification and abstraction of a much more complex reality. However, scenarios enable the stress testing of alternative policy designs and strategic frameworks.

These two axes give rise to four scenarios for the future of WHS and workers' compensation in Australia.

1. **Business as usual**. There has been change but it's followed a fairly predictable business-as-usual trajectory. Automated systems have had limited and patchy impacts on work and the gig economy hasn't really had much impact. Future modes of employment are more or less the same as today.
2. **Enabled**. Employment models are roughly the same, but work has been transformed by technologies that have automated a large number of tasks previously performed by humans.
3. **Restructured**. Albeit with an increase from today, technology hasn't had the extent of impact that some people foresaw. However, the way businesses engage workers (and vice versa) is radically different. The majority of the Australian workforce has multiple employers, and freelancing or portfolio work are the norm. Small start-ups have been the main job generators and large organisations have for some time seen net job losses.
4. **Transformed**. Technology combined with new models for engaging staff have transformed the way work is done. Businesses are engaging workers differently and technology has automated a large number of tasks.

The report finishes by identifying several issues and questions for further exploration and discussion, including:

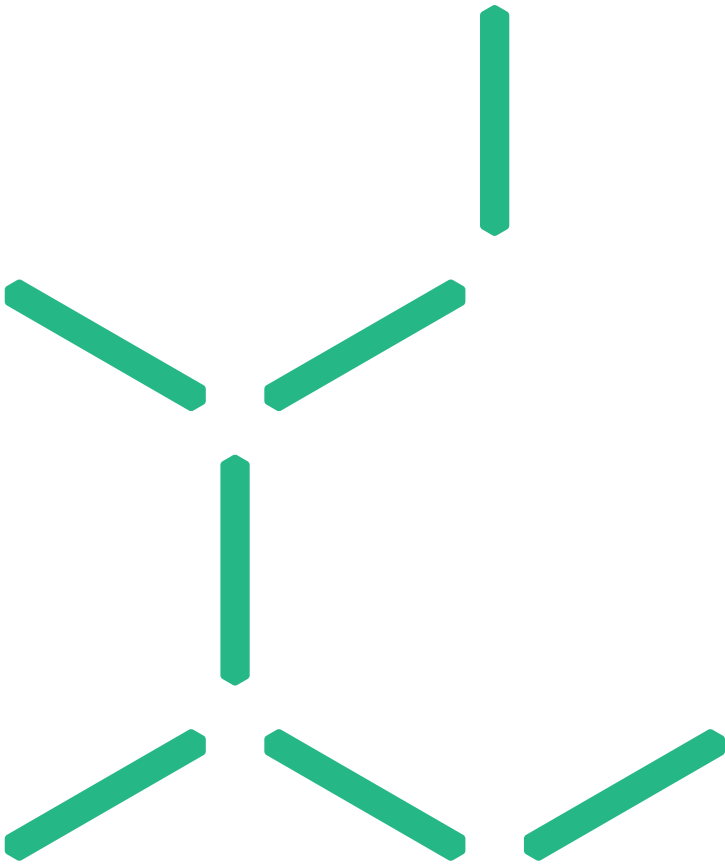
The gig economy within WHS and workers' compensation frameworks. Do WHS laws, regulations and codes of practice adequately cover the gig economy? Are current definitions of 'workers' and 'independent contractors' fit for the gig economy? What are the obligations of platform companies in relation to workers' compensation? And are these adequate to protect gig workers and consumers into the future? Do gig workers know about their WHS responsibilities and their compensation entitlements? How can information be better disseminated to gig workers?

WHS frameworks, safety standards and support with the increasing use of autonomous systems in the workplace. Are current control measures and frameworks adequate to address the use of robots in the workplace? Are current WHS regulations and duties on the designers, manufacturers, importers, and suppliers of plant suitable for the advancement of autonomous systems?

Leveraging new and emerging technologies to improve WHS and workers' compensation. What are the most effective and easily applied technologies that could improve WHS? How could data be better collated and deployed within the WHS and workers' compensation systems to drive improvements? Should the use of robots or automation for dangerous tasks be mandated and regulated in the future? Could technology be used to reduce the rate of injuries and workers' compensation claims from older workers?

Understanding technology and mental health, including opportunities for improved awareness, prevention and treatment. How does technology in the workplace impact mental health and wellbeing? Is more research needed, particularly for emerging economies? Do current WHS frameworks provide adequate guidance to manage technology within the workplace and safeguard employees? What are the opportunities to use technology to improve workers' mental health, for example online support services?

The coming 20 years will bring significant changes that are likely to have disruptive impacts on the Australian working environment. Anticipating these impacts and preparing for a range of plausible futures is an important step in ensuring the long-term effectiveness of Australian WHS and workers' compensation systems.



1 INTRODUCTION

Information communication technology (ICT) and enabled platforms (EPs) are reshaping workforces and working environments all over the world. Sensory systems, artificial intelligence (AI), robotics, automation, online platforms, predictive analytics, confidential computing, the internet of things (IoT), big data and other digital technologies will transform economic activity, governance models and lifestyles over the coming decades.

The unprecedented development in ICT-EPs has been likened to a new industrial revolution.[a] In the last couple of years this revolution has been referred to as the fourth industrial revolution,[2-5] sometimes as the second machine age,[3] but mainly as Industry 4.0.[6-8] This period is often seen as distinct from its predecessors for two main reasons: (i) a faster and exponential rate of technological development and penetration; and (ii) the ubiquity of impacts across all industries and geographic regions. These changes are already having significant impacts on the nature of employment, the design of jobs and tasks, and the environment in which work takes place. Work 4.0 is the logical extension of the discussion and thinking around the emerging Industry 4.0. New employment models, job designs, labour markets and social expectations will reshape the requirements and expectations of effective work health and safety (WHS) and workers' compensation.[10]

In Australia, Work 4.0 is occurring against a backdrop of significant structural and demographic changes that are separate to, but intersecting with, the development of new digital technologies. Economic pressures and the ageing population will see an older Australian workforce over the coming decades; meanwhile, Australia is entering the post-mining boom era and is positioned to grow its white-collar workforce and diversify into services, knowledge and innovation exports.[11]

This convergence of changes has major implications for the Australian WHS and workers' compensation environment, potentially affecting everything from the types and nature of hazards in the workplace, to the control and mitigation strategies available to manage them, to the expectations and appetite by management, employees, regulators and policymakers for action. Worldwide, the capacity for regulators to contend with the perceived rate of change presented by Industry 4.0 has been questioned.[12] Consequently, the question is, 'Do current WHS regulatory frameworks and compensation systems adequately address these changes or should these be adapted, extended or even reinvented for these changes?'[5]

This report seeks to elevate the profile of Industry 4.0 in the context of WHS and workers' compensation in order to better prepare decision makers for potential change. Specifically, the report focuses on the plausible WHS and workers' compensation risks and opportunities brought about by new technologies. These risks and opportunities are presented through the discussion of six megatrends identified as relevant to the Australian WHS and workers' compensation environment, and through four plausible scenarios for the future of Australian industry and employment. The report concludes by briefly exploring some policy implications and potential areas for action.

This study contains the analysis, interpretation and foresight, created by Data61 in consultation with subject matter experts. The intended outcome is to provide advance notice of the potential challenges, risks and opportunities expected to change workplaces over the next 20 years, with a particular focus on advances in ICT-EPs, and the associated rise of new economic structures and business models which utilise those advances. While change is inevitable, future destinations are not. Individuals, communities, companies, and governments can identify and implement transition pathways based on this narrative of the future to achieve better outcomes.

[a] For the purposes of this report, the term ICT-EPs relates to digitisation, AI, and robotics. ICT-EPs include technologies that generate and transmit information as well as technologies dependent on ICT, such as wearables and autonomous vehicles.

2 CURRENT PROFILE

2.1 Work health and safety

WHS regulatory frameworks aim to secure the health and safety of workers and workplaces. In Australia, there are nine central WHS jurisdictions (one for each state, territory and the Commonwealth) each with its own WHS regulator. In addition to these, there are a number of industries which are regulated under specific, separate safety laws, such as the heavy vehicle industry, maritime industry, offshore petroleum industry, and in some states, the mining industry.

The model WHS laws were developed as part of the Council of Australian Government (COAG) National Reform Agenda that aimed to reduce regulatory burden and create a seamless national economy. The formal process began with the establishment of the *Intergovernmental Agreement for Regulatory and Operational Reform in Occupational Health and Safety* in July 2008. The model WHS laws were informed by the *National Review into Model Occupational Health and Safety Laws 2008/2009*. One of the factors the review panel considered was the changing nature of work and employment arrangements.

Model WHS laws have been implemented in all jurisdictions, with the exception of Victoria and Western Australia. They consist of an Act which contains broad, overarching general duties supported by more specific regulations, and codes of practice that provide practical guidance. The broad duties in the model WHS Act are designed to be robust enough to encompass all types of modern working arrangements. The primary duty holder is the person conducting the business or undertaking (PCBU), who primarily has duties to workers regardless of how the workers are engaged, but also has duties to other persons. This move away from 'employers' owing duties to 'employees' was designed to ensure the way a business is set up or a worker is engaged does not impact on safety.

The model WHS Act[13] imposes a primary duty of care on all PCBUs to ensure, so far as is reasonably practicable, the health and safety of workers and that the conduct of the business or undertaking does not put other persons at risk. This includes:

- the provision and maintenance of a working environment that is safe and without risks to health, including safe access to and exit from the workplace
- the provision and maintenance of plant, structure and systems of work that are safe and do not pose health risks
- the safe use, handling, storage and transport of plant, structure and substances
- the provision of adequate facilities for the welfare of workers at work
- the provision of information, instruction, training or supervision to workers needed for them to work without risks to their health and safety and that of others around them
- that the health of workers and the conditions of the workplace are monitored to prevent injury or illness arising out of the conduct of the business or undertaking, and
- the maintenance of any accommodation owned or under their management and control to ensure the health and safety of workers occupying the premises.

A 'worker' is defined in the model WHS Act as '*any person who carries out work for a PCBU, including work as an employee, contractor, subcontractor, self-employed person, outworker, apprentice or trainee, work experience student, employee of a labour hire company placed with a "host employer" and volunteers.*'[13]

A PCBU is defined as '*a person conducting a business or undertaking alone or with others, whether or not for profit or gain.*' A PCBU may be a body corporate or an individual person.

The model WHS laws also impose duties on 'officers'. An officer is defined under section 4 of the model WHS Act as:

a) an officer within the meaning of section 9 of the Corporations Act 2001 of the Commonwealth other than a partner in a partnership; or

b) an officer of the Crown within the meaning of section 247; or

c) an officer of a public authority within the meaning of section 252, other than an elected member of a local authority acting in that capacity.

Officers are usually senior people within a business, such as company directors or chief executive officers (CEOs). This ensures the individuals who control the business must exercise due diligence to ensure compliance by the PCBU with its health and safety obligations. The maximum penalty for officers who fail to meet their duty is $600,000 or five years in prison, or both. Section 4 of the model WHS Act excludes a partner in a partnership from being an officer of a PCBU. This is to avoid double liability for the partners as they are individually and collectively a PCBU and would owe duties under the Act and have the potential liabilities of a PCBU.

2.2 Workers' compensation

Workers' compensation aims to protect and support workers once they are injured or become ill as a result of their work. There are two elements: (i) an insurance scheme which covers lost wages and medical costs; and (ii) 'return to work' which sets rules and supports workers in returning to work where possible.

There are 11 main workers' compensation systems in Australia. Each of the eight Australian states and territories has their own workers' compensation scheme, and there are three Commonwealth schemes for Commonwealth Government employees, seafarers and Australian Defence Force personnel.

Currently, there is no nationally consistent approach to workers' compensation in Australia. The 11 workers' compensation schemes are administered in different ways, with insurers playing different roles within the schemes (e.g. from privately underwritten schemes to schemes operated entirely by the government). Differences also exist in jurisdictional legislation to reflect insurance arrangements, entitlements, definitions, dispute resolution processes and the interaction with other legislation such as access to common law.

While workers' compensation schemes differ in many ways, all the schemes share key underpinning aspects, including:

- employers are required by law to have workers' compensation to cover potential liabilities associated with injured employees and some contractors
- workers' compensation laws are 'no fault' in that an injured employee does not need to prove negligence on the part of the employer, and
- injured employees are entitled to compensation covering income replacement, medical treatment, rehabilitation, death benefits and compensation for permanent impairment.

Table 1 outlines and compares the key features of the state, territory and Commonwealth (Comcare) schemes.

Table 1. Comparison of state, territory, and Commonwealth (Comcare) workers' compensation schemes

	NSW	VIC	QLD	WA	SA	TAS	NT	ACT	COMCARE
EMPLOYEES COVERED FOR WC (2014–15)	3,299,290	2,672,911	2,147,528	1,261,363	729,928	218,752	129,017	128,639 [b]	383,118
NUMBER OF SERIOUS CLAIMS WITH ONE WEEK OR MORE INCAPACITY (2014–15)	33,800	21,970	24,710	11,640	7,950	2,480	1,080	1,720	1,900
NUMBER OF SERIOUS CLAIMS PER 1000 EMPLOYEES (2014–15)	10.2	8.2	11.5	9.2	10.9	11.3	8.3	13.4	4.9
COMPENSATED DEATHS PER 100,000 EMPLOYEES (2014–15)	1.3	1.2	1.9	2.1	0.6	2.3	0.0	0.8	1.8
SCHEME FUNDING	Managed	Central	Central	Private insurers	Central	Private insurers	Private insurers	Private insurers	Central
ACCESS TO COMMON LAW	Yes	Yes – limited	Yes	Yes	Yes – limited	Yes	No	Yes	Yes – limited

Managed scheme funding in New South Wales refers to the scheme being run by the nominal insurer managed by icare. Central scheme funding means a single public insurer, a government agency, performs most, if not all of a workers' compensation insurer's functions. Central insurers are responsible for underwriting their scheme.

Source: Information provided on request by Safe Work Australia – Comparison of workers' compensation arrangements in Australia and New Zealand 2017, Table 2.3: Key features of schemes

[b] Private sector workforce

THE GIG ECONOMY AND WORKERS' COMPENSATION

Generally, gig economy platforms have argued their workers are 'independent contractors' rather than employees. As such, comparison of the various workers' compensation schemes on whether or not an 'independent contractor' is entitled to workers' compensation is useful (Table 2). It should be noted there are other ways gig economy workers can get insurance for personal injury or income replacement. They may take out commercial insurance, either on an individual basis or through a platform-based opt-in scheme.

2.3 Terminology

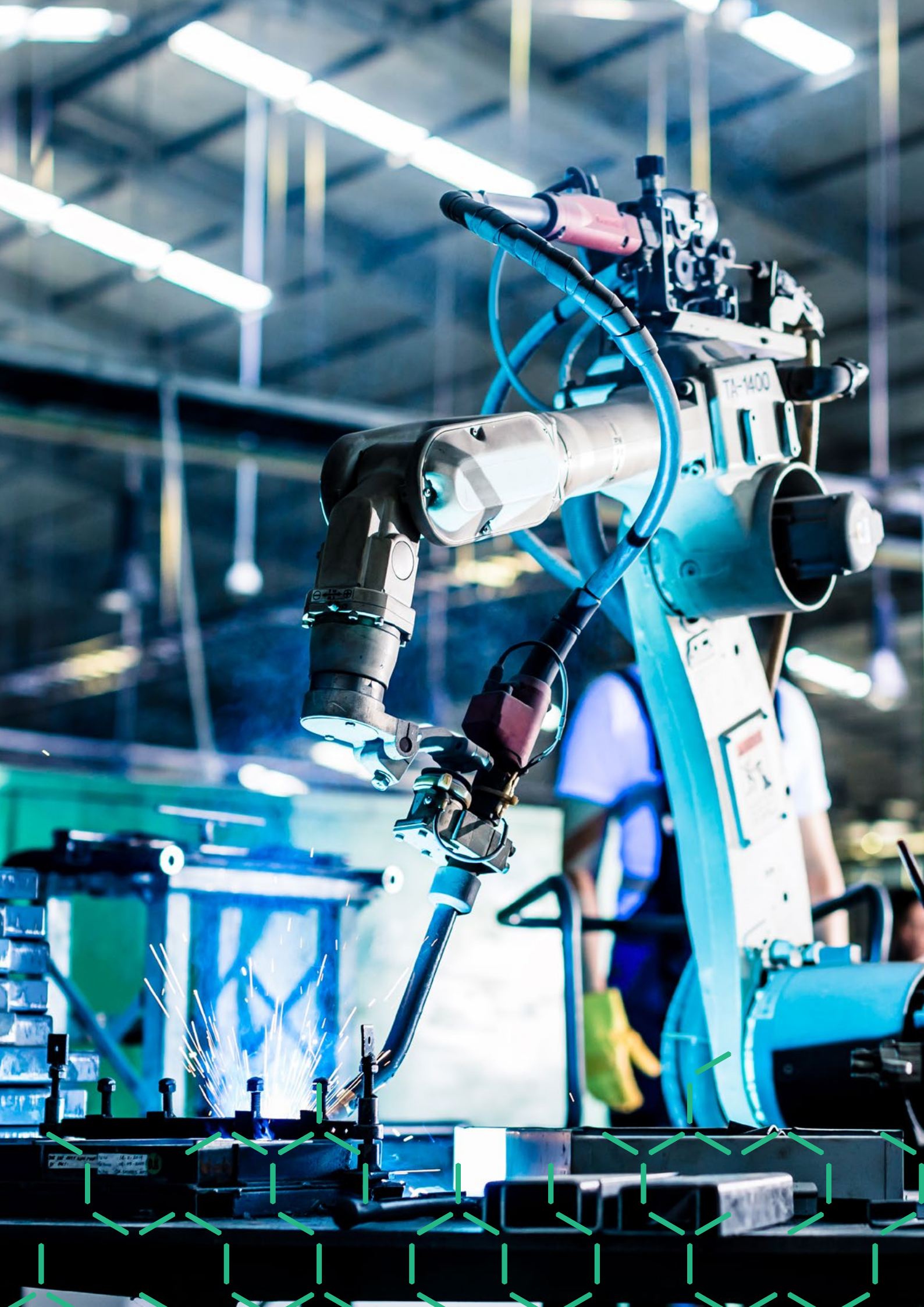
WHS and workers' compensation use different terminology. The model WHS laws use the terms 'PCBU' and 'worker'. These terms are deliberately broad to ensure the laws adequately capture all types of modern working relationships. In contrast, workers' compensation laws generally use 'employer' and 'employee' because it needs to be very clear who is required take out insurance.

Table 2. Comparison of state, territory and Commonwealth workers' compensation coverage of independent contractors

SCHEME	COVERAGE OF INDEPENDENT CONTRACTORS
NEW SOUTH WALES	Not unless contractor is a deemed worker pursuant to schedule 1, *Workplace Injury Management and Workers Compensation Act 1998*
VICTORIA	Not unless the contractor is a deemed worker pursuant to clause 9 of schedule 1 of the *Workplace Injury Rehabilitation and Compensation Act 2013* (broadly based on 80% of time or income from one employer)
QUEENSLAND	No, unless determined an employee using the ATO Decision Tool
WESTERN AUSTRALIA	No, unless employed under contract for service and remunerated in substance for personal manual labour or service
SOUTH AUSTRALIA	Yes, if covered by definitions in section 4 of the *Return to Work Act 2014*: • 'worker' which includes a person by whom work is done under a contract of service (whether or not as an employee) • 'contract of service' which includes if person undertakes prescribed work or work of a prescribed class
TASMANIA	Persons engaged under a contract for services are not covered unless the contract is for work exceeding $100 that is not incidental to a trade or business regularly carried out by the contractor. A contractor is not covered during any period for which they have personal accident insurance — section 4B of the *Workers' Rehabilitation and Compensation Act 1988*.
NORTHERN TERRITORY	No, unless determined an employee using the ATO Decision Tool
AUSTRALIAN CAPITAL TERRITORY	No, if employed under contract for services; however, there are provisions for the coverage of regular contractors
C'WEALTH COMCARE	No, compensation only through employment of employees
C'WEALTH SEACARE	No, compensation only through employment of employees
C'WEALTH DVA	Yes

ATO = Australian Taxation Office, C'Wealth = Commonwealth, DVA = Department of Veterans' Affairs

Source: Information provided on request by Safe Work Australia – Comparison of workers' compensation arrangements in Australia and New Zealand 2017, Table 2.4a: Summary of coverage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3 MEGATRENDS

3.1 The extending reach of automated systems and robotics

The cost of advanced AI, sensory systems and robotics is declining while the capability of these systems continues to improve. This will see a push to automate systems currently operated by humans, presenting both challenges and opportunities from a WHS and workers' compensation perspective. While the technological developments of automated systems and the IoT can improve workplace safety, remove the need for human workers to operate in dangerous jobs and offer relief from the boredom associated with highly routinised tasks, they may also cause displacement and increase rates of unemployment and underemployment. Even jobs which are not replaced by automated systems will change in response to their increasing prevalence, including through human–robot collaboration in the workplace.

This technology can provide workers with information and guidance in real-time. Mixed reality headsets are useful for providing mentoring through training and education (either from another person or automated), and providing reference data (such as schematics).[2,15] Both mixed reality devices or other smart devices are capable of providing tutorials, prompts and real-time health and safety monitoring that may improve overall productivity and WHS for the workplace.[5]

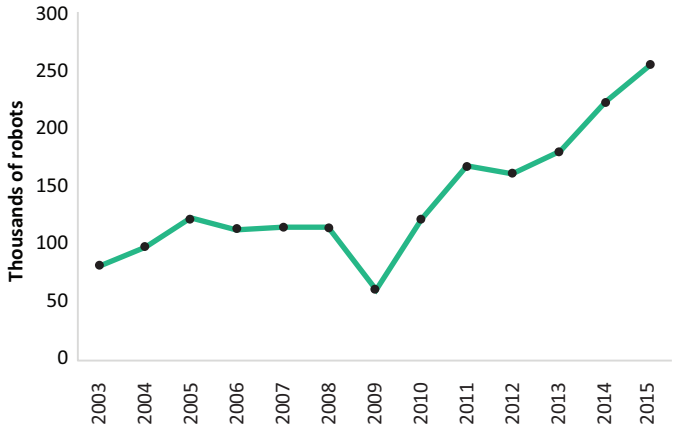


Figure 2. Estimated worldwide annual sales of robotic devices
Data source: International Federation of Robotics[14]

The safety and legal implications of automated systems and robotics in workplace settings are just beginning to be understood. Gaining a better understanding of, and responding to these implications where required, is critical to ensure WHS and workers' compensation systems are robust and sustainable into the future.

Robots are getting smarter and more pervasive across the workforce. Estimates of the numbers of jobs that may be replaced by robotics and AI over the next decade range from 9 to 43 percent.[16,17] The integration of AI into robotics and workplace tools is increasing the numbers of 'service' robots – used in industries such as healthcare, customer service, transport and logistics, security services and as personal companions. These are being integrated with machine-to-machine learning systems, often in a broader network of the IoT.[18] Many industries such as road transport, agriculture and construction are seeing the introduction of commercial unmanned vehicles. Most examples of unmanned vehicles include drones, or remotely piloted aircraft. However, large-scale investment and trials are occurring with regards to automation in vehicles, farm machinery and construction equipment.

Automation can make the workplace safer. Investment in automation in the workplace will need to consider the human element, such as upskilling, organisational development and staff redeployment, as well as safety. Safety considerations should include possible benefits stemming from automation – for instance, reduced injuries, better prevention mechanisms and increased creative capacity for humans.

Physical and psychological workplace injury is predicted to fall by 11 percent by 2030 as a result of more pervasive automation in the workplace.[19] Robotics including AI and drones can make work safer by replacing 'dull, dirty and dangerous' tasks. They can do this through:

- replacing many of the physical jobs that cause higher levels of injury
- reducing travel, especially on farms and mines
- operating in dangerous environments – such as mines, metal mills, farms, laboratories, factories, energy plants and battlefields. Robots and drones are increasingly being used in emergency service work – including building collapses, earthquakes, bushfires, house fires and terrorist attacks

- being able to respond to sensors that detect dangerous situations or alert people to dangerous situations, including in relation to their own health and bodies, and
- operating at levels, routines and/or times that would cause worker fatigue or psychological stress.[18,20]

However, as the use of robots grows, workers at all levels will be more likely to be working in physical proximity to automation. Robots operating near and with humans are referred to as collaborative robots or 'co-bots'. It will be imperative for businesses to understand how automation and robots can affect the safety of business tasks and processes. The international standard for robots and robotic devices, states that new types of risk assessments will be '*necessary to identify the hazards and estimate the risks associated with a collaborative robot system application so that proper risk reduction measures can be selected.*'[21] Current risk assessment processes in Australia may need to be reviewed to ensure that these adequately identify the relevant risks.

Robotics are impacting more industries. As autonomous systems enter more 'human' professions involving advanced cognitive function, they could also start to replace work in white-collar professions traditionally filled with university-educated employees, rather than just filling manual labour roles. Despite requiring education, many of these jobs are also highly routinised and skilled in ways that can be programmed – such as diagnosing communicable disease, searching for legal texts, trading stocks, operating mining equipment or carrying out requested computer-search tasks. The repetition of these jobs can be boring and, when performed on a day-to-day basis with little variety, can cause significant job dissatisfaction and mental health issues.

Robots are being used more. In 2017 there were an estimated 1.9 million industrial robots around the world. This is an increase of 37 percent in just four years, up from 1.2 million in 2013. The International Federation of Robotics estimates that worldwide annual sales of robotic devices have increased from 81,000 in 2003 to 254,000 in 2015 (see Figure 2). Many of these robots are in factories, although they are becoming increasingly common outside of the factory setting. North America and Japan have the highest levels of industrial robots.[20]

Robotic capabilities are breaking thresholds. Robots are becoming better at assembly, cheaper and increasingly able to collaborate with people. AI continues to advance, with notable examples being IBM's Watson, a question-answering computer system already utilised in the field of medicine; the Battlefield Extraction Assist Robot (BEAR) which can locate and extract soldiers from the battlefield; automated driverless vehicles; and Japan's Henn-na Hotel, staffed almost entirely by robots. Recent strides made in the effort to build 'artificial brains' (machines with creativity and intelligence equal to humans) suggest that this development is not far off.[22] Microsoft researchers recently reported a 5.9 percent error rate for automated speech transcription, which is about equivalent to the human error rate.[23] This has significant implications for industries that rely on or would be augmented by speech recognition. The researchers noted that, '*the next frontier is to move from recognition to understanding*.'[22]

The impact of automation on mental health is largely unknown. As robotics, AI and machine learning replace the least interactive, least stimulating and least satisfying jobs in the workplace, the positions of value will increasingly be the ones involving more human-orientated traits – interpersonal skills, creative reasoning and entrepreneurialism. Predictions are that up to 62 percent of workers will be more satisfied in their jobs in 2030 than they are today, due to the phasing out of boring, repetitive, low-skilled positions.[19] However, this may be counterbalanced by workplace stress which may result from spending a greater proportion of time on higher functioning tasks and increased worker surveillance and time management by automated systems.

The jobs of the future will involve different tasks. While technology may eliminate jobs, it has yet to eliminate work. Indeed, history demonstrates that increased productivity and efficiency is more likely to result in increased jobs, and that AI may be a driver for job creation. It is anticipated jobs that are not replaced by new and emerging technologies will change significantly and require new skills. Many of these will be soft or creative skills, entrepreneurial skills, use-of-technology skills, or science, technology, engineering and mathematics (STEM) related skills to build new ICT products and services. Some suggest that as AI tools become more pervasive, jobs will start to be centred around new 'job clusters': generators, artisans, carers, informers, co-ordinators, designers and technologists, with carers, informers and technologists likely to see the strongest growth in the immediate future.[19]

Robotics and autonomous systems are blurring the lines of responsibility for error and injury. The safety of autonomous systems, in particular autonomous vehicles and AI medical diagnostics, is the subject of considerable and ongoing legal debate. Case law interpreting WHS and workers' compensation laws is still developing along with the technology. Many trials of new autonomous systems compare computer/AI error to human error and deem a system acceptable when the error rate is an improvement on that of humans.[24] Unlike human judgement, however, autonomous systems are often interdependent on other systems – the internet, GPS technology, IoT systems, wireless networks and central databases – and are open to hacking or remote interference. This was recently highlighted when a US pacemaker manufacturer recalled pacemakers surgically inserted in thousands of people worldwide, due to the risk of them being hacked.[25]

Upstream duties for automated systems. The model WHS Act imposes duties on the designers, manufacturers, importers and suppliers of plant as well as the person with management or control of a workplace where plant is used.[13] However, as plant becomes more automated and connected, ambiguities may arise around these duties. The possibility of automated systems being connected to the internet means that their safety could be compromised by hackers; therefore, should those responsible for an organisation's cybersecurity also have WHS duties for WHS in automated systems? As programming is the key factor differentiating a robot from another object,[26] should the role of the software programmer in ensuring health and safety be made more explicit? Furthermore, if a programmer provides regular software updates to plant, they may also retain some control over the system – simultaneously occupying the position of 'designer' and 'person with management or control of fixtures, fittings or plant at a workplace'.

AI and workers' compensation insurance. The rise of AI and the IoT may see insurance companies better able to collect and analyse more data about their customers and better predict risk. Some companies already offer discounted insurance to customers who allow their insurer access to data about their behaviour. This is known as behavioural policy pricing. For example, a car transmits driving data back to the insurer allowing them to charge a premium based on behaviour. Workers' compensation insurance premiums could be discounted where businesses fill out risk assessments using a smart phone app or their workers use AI to identify risks and find the best way to minimise them.

3.2 Rising issue of workplace stress and mental health issues

Mental health is a relatively recent component of WHS frameworks and understanding, but a highly important one. The prevalence of work-related stress and mental health issues are reported to be increasing in the Australian workforce. While only 6 percent of claims are for psychological injuries, these claims are typically more difficult to manage, result in more time off work and have poorer return-to-work outcomes when compared to physical injuries.[27]

AI can be used as a tool to help fight anxiety and depression. Developments in psychological AI technology are allowing people access to affordable, on-demand mental healthcare. For example, X2AI's 'Tess' holds conversations with people to help with their emotional problems by educating them on coping mechanisms and encouraging emotional wellbeing.[28,29] Using existing technology-based communications such as SMS and instant messaging applications, Tess monitors the user by analysing their emotional state and returns appropriate comments, questions and recommendations. It is likely technological developments such as Tess and other similar psychological AI will contribute to ongoing improvement in understanding, support and awareness of mental health issues, thus presenting an opportunity to reduce psychological injuries.

It is estimated that workplace stress affects around 32 percent of all Australians. One in five Australian workers are likely to be experiencing poor mental health at any given time[30] and approximately 14 percent of Australians will be affected by an anxiety disorder in any 12-month period.[31] Stress affects mental and physical health and is a significant factor in workplace performance.[32] However, proving that a psychological injury is work-related can be difficult, and compensation claims based on psychological injuries are more likely to be disputed by employers.[27]

Compensation payouts for work-related psychological injuries are larger and result in longer leave and recovery times than other workers' compensation claims. Around 7,500 Australians are compensated for work-related mental conditions each year, which accounts for 6 percent of all workers' compensation claims.[33] Around 90 percent of mental condition claims are attributed to mental stress. In 2014–15 the total cost of work-related mental stress claims was approximately $345 million, with a typical compensation claim costing $20,800, compared to $2,600

for all claims (see Figure 3). Mental stress claims resulted in an average of 10 weeks off work compared to 1 week for all claims.[34] Work pressure and work-related harassment and/or bullying are the most common causes of workplace mental stress.[34]

Pre-existing conditions blur the lines of responsibility in claiming for mental conditions, and stigma around mental health issues deters people from seeking help. Employees may have a pre-existing condition or a history of mental illness that makes establishing the work-relatedness of mental conditions difficult. It is also difficult to attribute the symptoms experienced by an employee to an event or series of interactions in the workplace. The stigma around admitting to mental illness or mental stress symptoms deters many employees from seeking help, as they fear it would be viewed negatively in relation to their work performance or advancement. The Mental Health Council of Australia estimates that 69 percent of workers are uncomfortable disclosing their mental health concerns or issues to their employer, and 35 percent say they wouldn't disclose it at all for fear of discrimination or misunderstanding.[30,35]

Digital technologies are assisting in mental health treatments and monitoring. Australia has been a world leader in developing approaches to online and telephone based mental health services. In 2012, the E-Mental Health strategy was announced,[36] followed by a surge of digital mental health solutions, including online diagnosis, support, apps and resources. In 2013, telepsychiatry was introduced, and by 2014 comprised 50 percent of all telehealth consultations in at least four Australian states (Victoria, New South Wales, South Australia and Queensland). A review of five e-health interventions conducted by the Black Dog Institute[37] found all but one demonstrated positive effects, with adherence rates similar to face-to-face studies. In 2016 the Australian Government announced funding of $2.5 million for a first release version of a digital mental health service delivered online to provide consumers, carers and service providers with the tools and information they need to successfully navigate the mental health system and make informed choices about their care. This was launched in October 2017.[38 39]

New technologies are changing the landscape. Advances in medical technologies – such as wearable sensors, brain stimulation and imaging, and exome and whole-genome sequencing – are providing ground-breaking opportunities to study the biological factors associated with mental health at a microscopic level. For example, a recent study using a new form of diffusion tensor imaging revealed disruptions in white matter (the pathways connecting regions of the brain) in first-episode schizophrenia. The study identified the cells likely to be involved, potentially opening the way for new treatments for schizophrenia.[40] These advances may lead to better treatment options and outcomes for rehabilitating workers with psychological injuries and returning them to work.

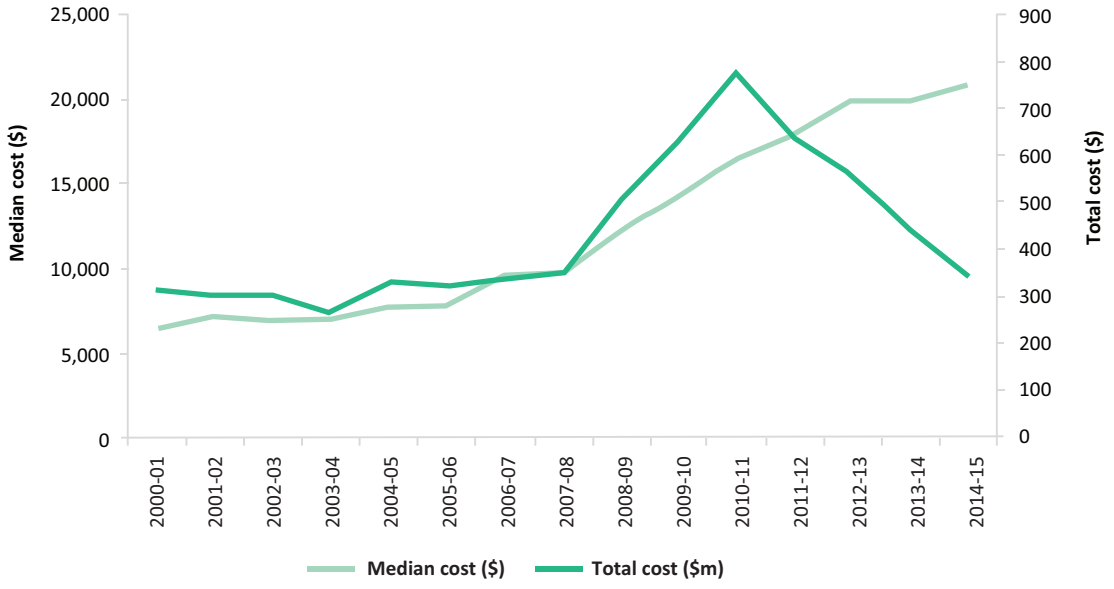


Figure 3. Median individual workers' compensation payments and total annual payments for claims involving mental stress, 2000–01 to 2014–15
Source: Data provided on request by Safe Work Australia from the National Data Set for Compensation-based Statistics

Technology can have negative impacts on employee mental health. Workplace stress associated with technology can be caused by a number of factors, including increased employee monitoring; rising performance and productivity expectations; increased work out of normal business hours; the frequent need to learn how to use new systems; lack of human interaction enabled by technology;[41] and lack of workforce consultation and involvement around the implementation of new technologies.[42] Therefore, as ICT-EPs become more widespread in workplace settings, there may be an increase in mental-health related WHS issues and workers' compensation claims.

3.3 Rising screen time, sedentary behaviour and chronic illness

Changes to the economy are already leading to changes in the type of work Australians do, and technology advancements and automation are likely to drive further changes. As automation and digital technologies begin to take over routine production in primary industries, jobs may increasingly become service-oriented, knowledge-intensive or computer-bound. The trend towards a service-oriented economy coincides with a growth in white-collar occupations that involve non-routine tasks. Meanwhile, many blue-collar occupations are in decline (Figure 4). A workforce transitioning toward services will present new workplace risk factors. For example, sedentary lifestyles and extended screen time are associated with increased risk of diabetes, obesity, heart and cardiovascular disease, poor posture and premature mortality. These risks may be mitigated, however, by using digital technologies like wearable health monitors, interactive apps, telehealth and online communications.

White-collar occupations experienced the greatest increase in their national employment shares over the last two decades. Australian jobs have been increasingly service-oriented since the 1950s.[45] This post-industrial shift means that white-collar work, involving the occupations of 'community and personal services', 'professionals' and 'managers' has been experiencing growth. In fact, the national employment share of white-collar workers has experienced the most growth of all occupations. Meanwhile, blue-collar occupations including 'technicians and trades', 'machinery operation and driving' and 'labouring' all experienced a decline in their national employment shares.[43,44]

White-collar occupations are often the most sedentary, associated with higher risks to health. Sedentary behaviour can generally be defined as sitting or lying down for various activities.[46] Being seated is often necessary in order to use computers which are used by most white-collar workers. White-collar professionals, managers and clerical/administrative workers sit down for at least 22 hours per week, far exceeding the average sitting times for most blue-collar occupations.[46] Australian Bureau of Statistics

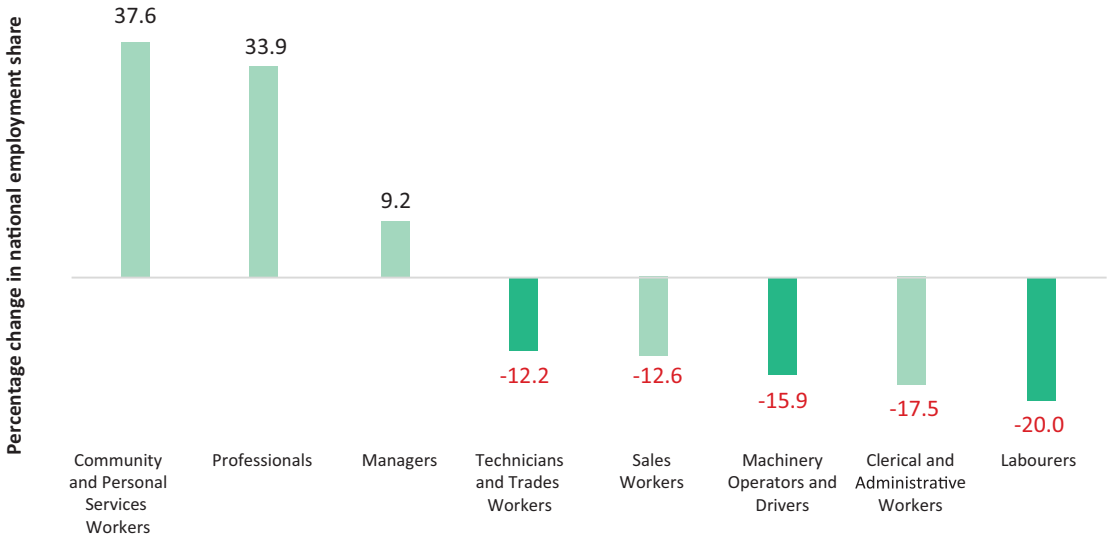


Figure 4. Change in national employment share by occupation, 1997–2017. Occupation types: Australian and New Zealand Standard Classification of Occupations

Data source: Australian Bureau of Statistics[43,44]

(ABS) figures suggest adults engage in sedentary activities for 39 hours per week on average, including both work and leisure,[46] and Medibank estimates that Australians are sedentary for 77 percent of the working day.[47] Sedentary behaviour at work, along with lack of physical activity generally, has been associated with increased risk of obesity, diabetes, heart and cardiovascular disease, and premature mortality.[47]

Increased screen time is also associated with increased health risks. Increased time looking at a screen is linked to a higher risk of markers for metabolic syndrome and cardiovascular disease.[48] Medibank estimates found that the cumulative screen time of an average adult per day was 9.5 hours, meaning that many of us spend more time on the screen than we do sleeping.[47] Yet almost half of those surveyed were unaware that excessive screen time is linked to obesity, attention difficulties, low self-esteem and depression. Screen time can have significant effects on postural habits and musculoskeletal health, and psychological effects include the possibility of internet addiction, which is estimated to afflict between 1.5 and 8.2 percent of the US and European populations.[49] However, digital technology could also help to mitigate these risks – for instance, a 2016 study found that screen time can actually be reduced by the use of personal-tracking applications allowing users to collect and view data about their screen time habits and practices.[50]

Causality of lifestyle risk factors is difficult to establish. Where lifestyle-related factors contribute to worker health conditions it can create issues for both WHS and workers' compensation. The delineation of responsibility between the PCBU and the individual worker can be less clear. For instance, if a job requires largely sedentary work, can the PCBU be held accountable for employees being overweight and developing associated conditions or injuries? Can an employee in a high-stress job who develops hypertension and/or cardiovascular disease attribute causality to their work?

The current approach to claims assessment generally errs on the side of not attributing lifestyle diseases to work conditions. Lifestyle illnesses are currently unlikely to be the basis of workers' compensation claims but they may make workers more susceptible to other illnesses or injuries which are eligible for workers' compensation.

Chronic disease is the leading cause of illness, disability and death in Australia. Chronic diseases are characterised by their long-lasting and persistent impacts upon a person's life and are distinguished from acute conditions which manifest only over a short time period.[51] According to the Australian Institute for Health and Welfare (AIHW), more than 11 million Australians in 2014–15 reported having at least one of the following chronic conditions: arthritis, asthma, back pain and problems, cancer, cardiovascular disease (such as coronary heart disease and stroke), chronic obstructive pulmonary disease (COPD), diabetes or mental health conditions (such as depression).[51] Moreover, the prevalence of chronic diseases is significantly higher for those aged over 65 or amongst socially and economically disadvantaged people.[51]

Obesity is an important factor in the total chronic disease burden. One major cause of many chronic diseases is obesity, which is alarming given that 63 percent of Australians were overweight or obese in 2014–15. Australia was the fifth most obese country out of 35 OECD countries in 2017.[52] Obesity accounts for 7 percent of Australia's disease burden.[51] Obesity caused 10 percent of chronic musculoskeletal conditions in 2011, of which it caused 44.6 percent of osteoarthritis cases – an issue highly relevant to increased WHS risk.[53] There is also significant evidence that workers who are overweight are at higher risk of sustaining workplace injuries, particularly musculoskeletal disorders.[54,55]

Digital technology can help reduce the risks of screen time and sedentary behaviour. There is the potential for digital technology to influence human decision making in order to invoke behaviour-based safety. This could be achievable through the use of wearables, such as smart watches and smart glasses, or even the design of various user interfaces – for example, playing sounds or vibrations to alert users to hazards. Examples include CSIRO's use of telehealth and self-management to monitor chronic diseases, which is capable of reducing patient mortality by 40 percent whilst saving the healthcare system up to 24 percent in costs.[56] Successful digital innovation has produced digital platforms that can aid in diabetic management,[57] or smoking cessation,[58] or to digitally deliver services in cognitive behavioural therapy (CBT).[59]

It is a good design principle for new technologies and products to enable and support behaviour-based safety, however, there are ethical questions about the use of digital technologies to influence user behaviour.

There is a risk these technologies may see a resurgence of behavioural monitoring where the focus of WHS is on the individual worker's behaviour and not on implementing more reliable control measures. This was the focus of early WHS systems which put the responsibility for managing risks on the individual worker.

3.4 Blurring the boundaries between work and home

Digital technologies allow for flexible working arrangements, involving employee discretion over work hours, patterns and/or locations. Internet connectivity, 5G mobile communications, cloud computing and digital platforms mean workers can coordinate effectively amongst themselves and at a distance. The use of digital technology and tele-networks to work remotely – or from home – is often labelled 'teleworking'. A confluence of factors (including the national broadband network (NBN) rollout and an ageing population looking for more flexible work arrangements) is fuelling the growth of teleworking in Australia.

The rising uptake of teleworking means the blurring of the boundaries between work and home is increasing. This may complicate WHS where an organisation has limited visibility or control of the physical workplace. These issues are not new but they may become more prevalent. PCBUs already encounter these issues with workers who regularly work outside a single physical workplace, such as community nurses.

Teleworking is on the rise. Australia lacks methodologically consistent data about teleworking over time. However, we can loosely compare 2008 and 2014 data by using the Household Income and Labour Dynamics in Australia (HILDA) survey[60] along with data from the ABS[61] (Figure 5). The wave of 2008 HILDA surveys revealed that 22.8 percent of employees worked at least some hours at home in their main job. The share of employed people working most hours at home was 4.9 percent. ABS data from 2014–15 show that these numbers are likely to have increased. It found that the total share of employed persons accessing the internet for home-based work was 43.9 percent, whilst 16.5 percent of employees did so on a regular basis. Though there are differences in method, it is clear that Australian teleworking is experiencing growth.[62]

Teleworking, WHS and workers' compensation. Under the model WHS Act, a PCBU is required to ensure, so far as is reasonably practicable, the health and safety of workers while at work. This duty applies regardless of where a worker is performing their work. That is, the duty is not limited to where a worker is performing work at the PCBU's business premises. A worker can also be at work under the model WHS Act if the worker is performing work from home. As such, employers are generally found to have liability for work-related incidents that occur in the home – as demonstrated in several high-profile successful workers' compensation claims from employees who were injured while trying to complete work-related tasks at home.[63] A 2006 report by the Australian Telework Advisory

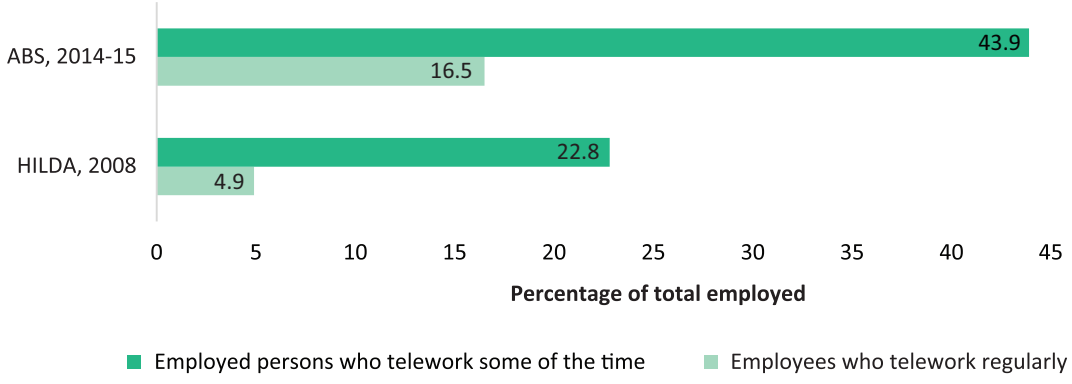


Figure 5. Share of people working from home

Data source: Melbourne Institute of Applied Economic and Social Research 2008[60] and Australian Bureau of Statistics 2014–15[61]

Committee recommends that '*employers should develop policies and procedures to cover the OH&S issues of working at home, including job design, hours of work, breaks and task variation*.'[64] The report notes that employers' fear of workers' compensation claims could deter the adoption of teleworking.

However, it may be more difficult for employers to identify and manage WHS risks for teleworkers.[65] Explicit policies have an important role in managing the risks of these arrangements. For instance, many businesses require employees to complete and sign a safety checklist before being approved to work from home. Businesses with a high percentage of telecommuting workers may take additional steps such as requiring workers to submit photographs of their workspace to monitor safety and potential hazards.[66]

Teleworking and mental health. Research has found telework can be associated with increased role ambiguity and reductions in support and feedback, leading to negative job engagement.[67] If not managed well it can also isolate workers.[68] A review of the telework literature notes the importance of social interaction for workplace inclusion and the avoidance of social isolation.[62] Blurred boundaries between work and home could negatively impact an employee's work–life balance, if work hours and patterns are undefined. A 2012 survey found that 48.2 percent of teleworkers did so to catch up on work,[69] and qualitative research participants have reported a breakdown of the physical distinction between work and family.[70] If not managed correctly, increased teleworking may present a risk to employee mental health, possibly counterbalancing its positive WHS impacts. In the interviews for this project, stakeholders noted there is currently a lack of effective controls for monitoring stress associated with teleworking.

Digital technologies are establishing trust in teleworking. The OECD has suggested that the IoT could make use of sensors to establish an 'Internet of Trust', with greater visibility of remote workplaces and supply chains.[71] As smart devices become smaller and harder to break, they may increase their ability to monitor physical health and the safety of physical surroundings.[5,72] Connectivity also provides access to cloud computing, which can leverage other people's computers and networks in order to realise efficiencies.[1] 5G is the next version of mobile connectivity that will allow high-bandwidth connection to AI and cloud services. This could plausibly allow for an immersive interface of natural spoken language and gesture control to

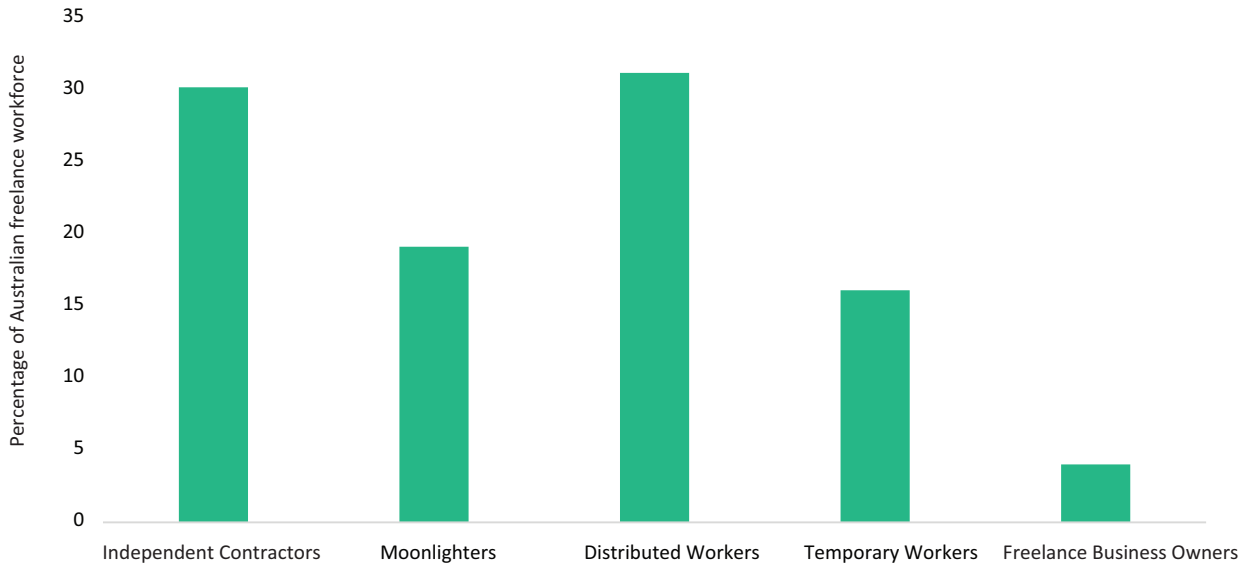


Figure 6. Types of freelancers in Australia, by percentage of freelance workforce[c]
Data source: Edelman Berland[76]

[c] Independent Contractors: 'traditional' freelancers who do not have an employer and instead do freelance, temporary, or supplemental work on a project-to-project basis
Moonlighters: professionals with a primary, traditional job who also moonlight doing freelance work
Distributed Workers: people with multiple sources of income from a mix of traditional employers and freelance work
Temporary Workers: individuals with a single employer, client, job or contract project where their employment status is temporary
Freelance Business Owners: freelancers who have one or more employee and consider themselves both a freelancer and a business owner

equip workplaces with high situational awareness and built-in safety features.[2,5] The IoT could provide faster and more detailed information, conducive to better decision making in terms of productivity and health and safety.[5]

Teleworking may facilitate labour force participation. This is particularly the case for older workers and people in regional or remote locations. In 2012, research found that 60 percent of mature workers would take NBN-enabled telework if it were available to them, effectively allowing them to delay retirement by an average of 6.6 years.[73] In the Australian economy where underemployment appears to be an issue, it was found that 73 percent of those not in the labour force with family or carer duties would take NBN-enabled teleworking opportunities if they could.[73] Furthermore, 70 percent of those not in the labour force in regional and remote Australia would take telework employment if given the opportunity.[72]

Teleworking can improve job satisfaction. A recent McCrindle Research study found 80 percent of people surveyed stated that they would be more likely to remain with an employer if their jobs provided flexibility or remote working.[74] Research has also found that home-based workers reported higher job satisfaction than main-office workers, valuing the flexibility and autonomy of telework.[75] However, the relationship between teleworking and worker mental health is complex. While teleworking increases job satisfaction, it can also cause workers to become isolated, increase mental stress and lead to a breakdown of the delineation between work and home life. From a workers' compensation perspective, telework may assist in improving return-to-work rates, as an employee who is not yet able to re-enter the office physically may be able to perform their job from home.

3.5 The gig and entrepreneurial economy

The gig economy refers to forms of contingent work arrangements where individuals contract their labour through digital platforms such as Uber, Airtasker, Freelancer or Gobi. There is nothing new about people performing piecemeal work in their own time, but the 21st century gig economy is distinguished by its reliance on internet-based platforms supported by technological advancements like cloud, mobile and service-oriented computing.[77]

While there has been rapid growth in the worldwide gig economy,[78] its impact on the Australian labour market is unclear. Figure 6 shows the types of freelancers in Australia. There are estimates suggesting that in 2014–15, 32 percent of the Australian workforce undertook some kind of freelance work,[79] and 53 percent of Australians participated in the collaborative economy.[80] However, other reports have claimed that only 80,000 Australians (0.5 percent of the adult population) work on peer-to-peer (P2P) platforms more than once a month,[78] and researchers have reported no significant change in non-standard employment since 2001.[81]

Gig economy platforms often argue their workers are 'independent contractors' rather than employees and that the primary relationship is between the consumer and the worker not the platform and the worker. As independent contractors, they may be treated the same as employees under WHS laws, but may be prevented from accessing workers' compensation.[78] The classification of gig economy workers in Australia is widely anticipated to be disputed in the Courts in Australia in the coming years as interested parties search for clarity on the application of the law to gig economy workers. Until there is clarification in Courts or through regulatory reform the classification of gig economy workers will remain uncertain.

Platforms have different levels of control and ability to anticipate and manage WHS risks. Policymakers will need to consider these new and emerging business structures to ensure that the WHS and workers' compensation frameworks are fit for purpose.

Status of gig workers. Gig economy workers are generally classified by gig economy platforms as 'independent contractors' rather than employees.[77,82] Workers for platforms like Uber and Deliveroo – companies with arguably more direct control over the performance of work, compared to, for example, Airtasker – do not provide the traditional benefits of independent contracting, such as negotiating payment or terms. The lack of clarity on the application of regulation in this area has led to a largely case-by-case negotiation of the rights and status of gig economy workers. Recently, small groups of Uber drivers in New York[83] and the UK[82] were determined to be treated by the relevant business as employees under the UK laws by the courts, while startup Homejoy was forced to shut down over misclassifications.[84] In all of these cases, the Courts have ruled in favour of the workers. However, these decisions only impact the rights and entitlements of the individuals who have been successful in the Courts. Despite the outcomes of these decisions, most platforms have yet to change their assertion that their workers are independent contractors. This issue has only recently been considered in Australia in the Fair Work Commission (FWC).[85] The FWC

was required to determine whether it had the jurisdiction to hear an unfair dismissal application of an Uber driver. The FWC determined that in the particular circumstances of the case, the Uber driver was an independent contractor and therefore the FWC did not have jurisdiction to consider the unfair dismissal application. The precedential value of this case remains unclear. Governments continue to closely monitor this issue.

It remains to be seen how platforms will change the way they engage workers in response to these decisions. In a recent decision by the Central Arbitration Committee in the UK, contractual changes made by Deliveroo to allow riders to substitute other riders if they are unable to make a particular shift was cited as the key factor in deciding the riders are technically self-employed.[86] This decision has raised concern for many commentators that platforms will attempt to 'contract out' their obligations as employers.

Online platforms are designed to make it easier for individuals to provide services. This may mean they are establishing a business without understanding they have done so. As the gig economy expands, adaptation to the circumstances of gig economy workers may be a challenge for Australian workers' compensation systems.

Who manages safety? A challenge in regulating WHS in the gig economy is the different business models and levels of control platform companies have over the work being undertaken. In most cases platforms will be PCBUs and have associated WHS duties, as may gig workers. However, these duties will be qualified by what is '*reasonably practicable*', which will take into account '*what the person concerned knows, or ought reasonably to know, about the hazard or the risk*.'[13] These parameters are likely to be tested through case law.

Gig economy workers performing a specific task (e.g. Uber drivers) are likely to encounter a fairly uniform set of WHS risks, which Uber could reasonably be expected to manage. However, gig economy workers on 'miscellaneous task' platforms (e.g. Airtasker, Gobi, Freelancer, etc.) are likely to encounter a far broader range of risks within a variety of environments. The platform may find it difficult to manage these risks and may have little to no influence over how or where work is performed. In some circumstances it may be the consumer who has duties to manage WHS and their knowledge of this and ability to do so may be limited. Where platforms or consumers don't manage WHS risks, workers may find themselves in a position of taking the management of risks into their own hands, regardless of whether this is appropriate or not.

Tasks carried out by gig workers include those which are known to carry safety risks particularly in transportation, delivery, or the provision of home services.[87] Hazards may be associated with road traffic, interactions with the public, use of household-cleaning agents and/or intensive keyboard activity at poorly arranged workstations.[88]

The precariousness inherent to gig work can have significant mental health impacts, as chronic job insecurity is known to cause stress.[88] However, choice plays a large role – a study of women with temporary jobs found that psychological distress was much lower in those who preferred temporary work.[89]

Finding effective methods to articulate, manage, and minimise these risks. These may not come in the form of traditional WHS management systems but could include platforms providing general information and education around risks and safety management.

Workers' compensation and entrepreneurial economy. Australia has some of the highest rates of entrepreneurship among developed economies,[90] with a new firm entry rate (i.e. the number of new firms as a percentage of total firms operating) of 14.6 percent.[91] However, startups have an extremely high failure rate.[92] Former employees of failed businesses are able to claim workers' compensation through their state-based scheme even after the business has failed. If the business had the mandatory workers' compensation insurance while it was trading, a claim can be made against this insurance. If the business did not have workers' compensation insurance, most jurisdictional workers' compensation schemes have an arrangement for the worker to be paid their entitlements and the scheme will then attempt to recover costs from the employer, however, this may be difficult where the business is no longer trading.

Worker representation in the gig economy. As the gig economy grows, some groups of workers have begun to establish representation: for instance, drivers who work for Uber, Lyft, and Sidecar have started 'App-Based Drivers Associations' in at least two US states.[88] Recently, Deliveroo riders in the UK organised a successful strike action in response to drastic proposed pay cuts.[93]

In Australia, an 'association of … independent contractors' can be recognised as a union under the model WHS Laws so long as it is registered or capable of being recognised under a State or Territory industrial law.[13] In Australia, some unions have recently provided support for gig economy workers – for instance, Unions NSW and Airtasker have reached an agreement to promote above-minimum pay rates and introduce an independent dispute-resolution process overseen by the FWC.[94]

UK approach to workers' compensation. In the UK, the Taylor Review of Modern Working Practices has recommended that the government introduce the term 'dependent contractors' or 'independent workers' to clarify eligibility for worker rights. The Review recommends that it be a statutory requirement for employees and dependent contractors to receive a written statement of their status on day one of their job, and that individuals should have a standalone right to bring a claim for compensation if the employer does not provide this statement.[95]

Opportunity for platform-based insurance schemes. Some form of insurance equivalent to workers' compensation that works within the gig economy is possible. Currently, in Australia, commercial personal injury insurance appears to be the most popular option. Deliveroo has claimed that they provide a personal injury insurance group scheme, which riders can access via a fee deducted from their payments.[96] Airtasker has indicated that they have developed an opt-in scheme for release in late 2017.[94] Insurance company YourCover now offers Roobyx – an injury insurance policy specifically designed for gig economy workers.[97] Other examples of schemes include:

- Uber has recently announced that it will provide a sick pay and injury cover scheme for its British drivers, where any driver who has completed at least 500 trips will be eligible to pay into a £2/week scheme under the Association of Independent Professionals & the Self-Employed.[98]
- Similarly, the US Freelancers' Union provides a set of 'portable benefits' (including disability insurance) that are tied to the worker, rather than the employer. In 2015, a group of startup, public policy and union leaders signed an open letter calling for the introduction of a universal portable benefits scheme for independent workers.[99]
- The Black Car Fund is a not-for-profit workers' compensation scheme for limousine and black car drivers (including Uber drivers) in New York, which adds a 2.5 percent surcharge to passenger fares to cover the cost of workers' compensation.[95] All so-called black car bases in New York must provide coverage for their drivers through membership in the scheme.[87]
- Another approach is to redirect a portion of the platform company's 'cut' on each task toward workers' compensation. For instance, Unions NSW has suggested that, '*the 15.0 percent fee Airtasker takes from all tasks should include all mandatory entitlements associated with dependent employment, including workers' compensation insurance, superannuation and a casual loading payment in exchange for the lack of sick leave and annual leave entitlements*.'[100]

The Hamilton Project's Proposal for Modernizing Labor Laws proposes an opt-in system wherein platform companies in the US are, '*permitted to opt to provide expansive workers' compensation insurance policies to the independent workers with which they work without transforming these relationships into employment. In exchange for this no-fault insurance coverage, intermediaries would receive limited liability and protection from tort suits. States could require that the policies provide the same level or more protection to independent workers than their state workers' compensation system*.'[101]

If there is a significant shift towards gig work in Australia there may be broader implications, with fewer workers covered by workers' compensation. The schemes themselves require a critical mass in order to be viable. If workers are not covered by some form of insurance, either workers' compensation or personal injury and income protection insurance, then the injured worker may be reliant on public health and social security systems.

3.6 An ageing workforce

The participation of older people in the Australian labour force has steadily risen over the past decades (see Figure 7). This trend is likely to continue given the increasing age of pension eligibility, record low interest rates reducing retirement savings and forcing many working-age Australians to work longer,[103] and Australia's significant retirement savings gap[d] of 13 years. Australia's retirement savings gap is the largest in Asia and the fourth largest globally.[104] This substantial demographic shift and the unique needs of an ageing workforce will present new challenges and opportunities, which may require adaptation by existing WHS and workers' compensation models. These include both physical and psychological factors, as the ageing workforce will encounter significant changes and the need to adapt to new technologies, as well as physical demands.[10]

Changing patterns of employment present opportunities for an older workforce. In Australia, employment is trending downwards in manual-labour industries such as manufacturing, agriculture and mining. However, white-collar industries like education and training; professional, scientific and technical services; and public administration and safety are gaining in employment share.[43] This shift is likely to enable older Australians to stay in the workforce for longer and with lower WHS risks, as these occupations involve fewer physical demands. These industries have lower rates of serious injuries[105] so this may also see a reduction in workers' compensation claims from older age groups over time.

Older workers and workplace injury. Data show that the prevalence of work-related injuries or illness falls considerably for the oldest workers, which could be at least partly explained by older workers in physically demanding jobs transitioning into retirement or less strenuous types of employment. The ABS' Work Related Injuries survey found that persons aged 65 years and over reported the lowest rate of work-related injuries and illnesses, with 25 per 1,000 persons who had worked at some time in the last 12 months, while those in the 50–54 year age group had the highest, a rate of 52 per 1,000 persons who had worked at some time in the last 12 months.[106] This is consistent with Safe Work Australia data which show that the rate of serious claims drops substantially to 5.8 serious claims per million hours worked in the 65 years and over age group, compared with those in the 60–64 year age group, which have the highest rate (7.6 serious claims per million hours worked).[105] Similarly, workers aged 61 and over also had slightly lower return-to-work rates than the average (72 percent compared to 76 percent, respectively).[107]

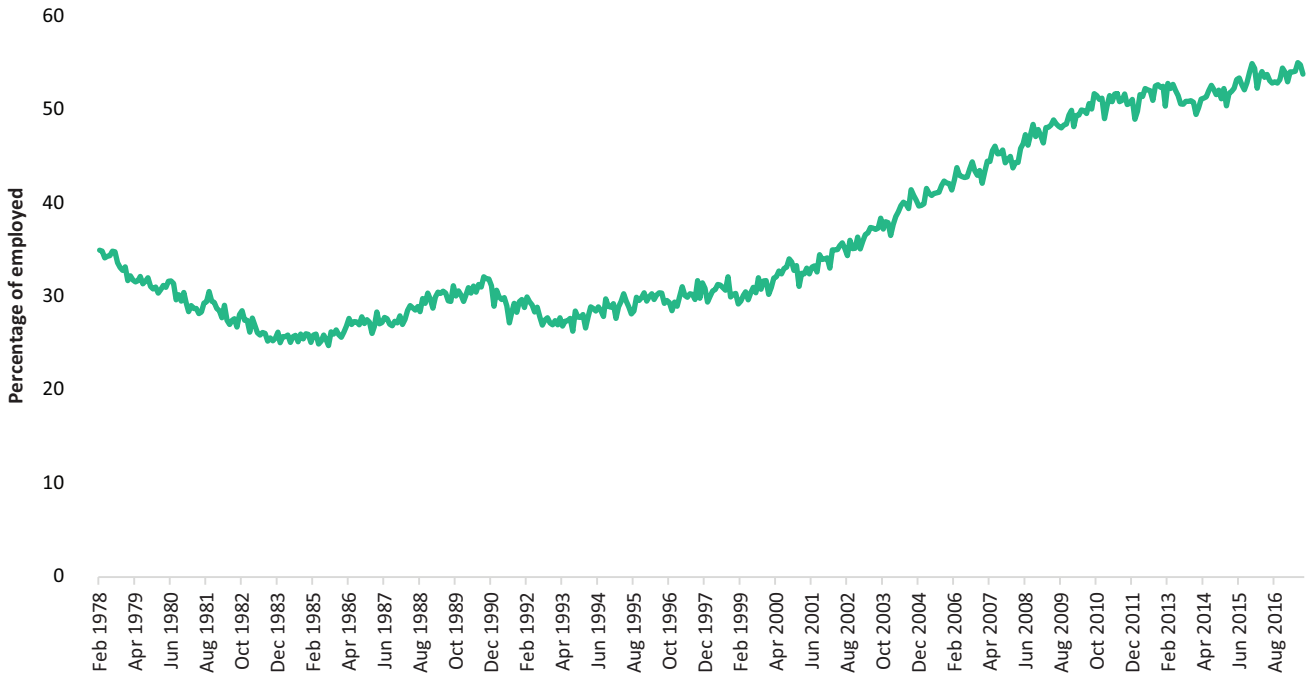


Figure 7. Employment rate of Australians aged 60–64 years

Data source: Australian Bureau of Statistics[102]

d A retirement savings gap is the difference between the number of years retirees can self-finance and the number of years they will live once retired.

The changing definition of 'retirement age'. Most workers' compensation schemes link the end of income replacement payments to an employee's retirement age (i.e. the age they are eligible for the Age Pension).[e] While exact conditions vary between jurisdictions, incapacity payments will usually cease at or within 12 months of retirement age. The retirement age continues to be pushed up – increasing to 67 years from 1 July 2023 – which could result in longer periods of incapacity payment or a shortfall between the cessation of workers' compensation payments and the beginning of Age Pension payments.

Perceived workers' compensation gaps are a disincentive to remaining in the workforce. Remaining in the workforce for longer periods is the most effective way for older Australians to improve their standard of living, and it also provides broader economic benefits.[108] Multiple studies conducted in Australian workplaces found employees are interested in transitional employment; for example, moving to part-time work, phased retirement, job sharing, or working from home.[109,110] In addition many workers incorrectly believe that those aged 65 and over are ineligible for workers' compensation. They are generally entitled to compensation, but the period they receive income replacement payments may be limited.[111] The Australian Human Rights Commission has identified '*the need for a nationally consistent workers' compensation framework that provides coherence and fairness in the income insurance provisions for people who work beyond pension age*.'[108]

An older workforce is more susceptible to being overweight or obese. Higher rates of overweight/obesity are recorded in older age groups for both men and women,[112] and the most recent ABS data show that around 70 percent of people aged 55–64 are classified as overweight or obese, compared with 37 percent of people aged 18–24.[113] Between 1980 and 2000, the number of obese older Australians (aged 55 and over) trebled, and by 2004 more than one in five seniors were obese.[114] For those in the workforce, sedentary work patterns are likely to contribute to and exacerbate the problem.[113]

Age-based discrimination. Research shows that older workers are, on the whole, more likely to become victims of workplace bullying.[115] Research by the University of South Australia found that 27 percent of Australians aged 50 years and over have had recent experience of age-based discrimination in the workplace.[116] The Australian Human Rights Commission cites numerous cases of older workers who have been targeted by jokes and comments about retirement, ignored and isolated by colleagues, and not given enough time by managers to learn new skills.[117] This may be exacerbated by the increasing use of technology in the workplace, which may prove difficult for older employees. The Australian Digital Inclusion Index (ADII) – measuring digital inclusion through the indicators of access, ability and affordability – finds that Australians aged 50–64 have an average ADII score of 52.6 (compared to a national average of 54.5), scoring lowest within the 'Ability' category.

Technology presents new opportunities. Although older workers have different and often additional needs from a WHS perspective, these can also be opportunities for new technologies and innovations. For instance, Japan's ageing population is driving demand for machine-assistive technologies so that older workers can stay employed and injury-free. Japanese hauling company Tatsumi Shokai Logistics has recently invested in a robot exoskeleton to take the physical strain off its workers[118] and Tokyo's Haneda Airport has partnered with robotics company Cyberdyne to equip its luggage haulers with exoskeletons.[119] Tech company Ai Squared has developed software for people with macular degeneration – an eye condition largely affecting older people – which transforms the text and background colours on a screen.[120] Technologies such as voice recognition software, touch screens and wearable health devices can also assist older employees with disabilities or impairments to stay in the workforce.[121] As technological capabilities advance, these innovations are likely to become more widespread and will need to be recognised and incorporated into WHS models and practices. They may also assist in helping older workers' compensation claimants return to work within a shorter timeframe.

The expansion of aged care. Healthcare and social assistance (covering aged-care workers) is the top-employing industry in Australia, employing 12.8 percent of the national workforce in November 2016.[122] The aged-care workforce is, on average, older than the Australian workforce as a whole – in 2016, 27 percent of the direct care workforce was aged 55 years or over.[123] Aged care workers are also slightly less healthy than average – while 60 percent reported their own health as very good or excellent, this is lower than the Australian workforce average of 63 percent.[124] This may account for the large number of serious claims made in this sector – in 2014–15, the healthcare and social assistance industry accounted for 16 percent of all serious claims for disease and injury. This was the highest rate of any industry and represented a 14 percent increase on 2000–01 claims.[125]

e The exceptions are Queensland and Western Australia.

4 SCENARIOS

Strategic foresight is a process that imagines 'What if?' and illustrates these questions through scenarios that present the decision maker with an engaging image of the future. These plausible futures are designed to present questions in the forms of opportunities, risks and implications for their consideration. Scenarios are a tool for arranging arguments for alternative future environments that will be influenced by decisions made today.

Our scenarios are based on the deductive reasoning approach taught at the Oxford University Scenario Planning School.[126] This involves identifying, usually two, axes of critical uncertainty about the future relating to the trends and drivers (see Figure 8). The axes also capture critical impacts on the focal issue – in this case the impacts of ICT-EPs on the future of WHS and workers' compensation in Australia. Two axes generate four quadrants and therefore four scenarios.

4.1 Vertical axis: Automated systems (patchy to ubiquitous)

The vertical axis relates to the extent to which automated systems have been adopted within the future Australian working environment. Both endpoints of the axis involve some technological progress from today; a future with less technology than the present is highly unlikely. Even minor advancement in automated systems will see jobs displaced, created and changed.

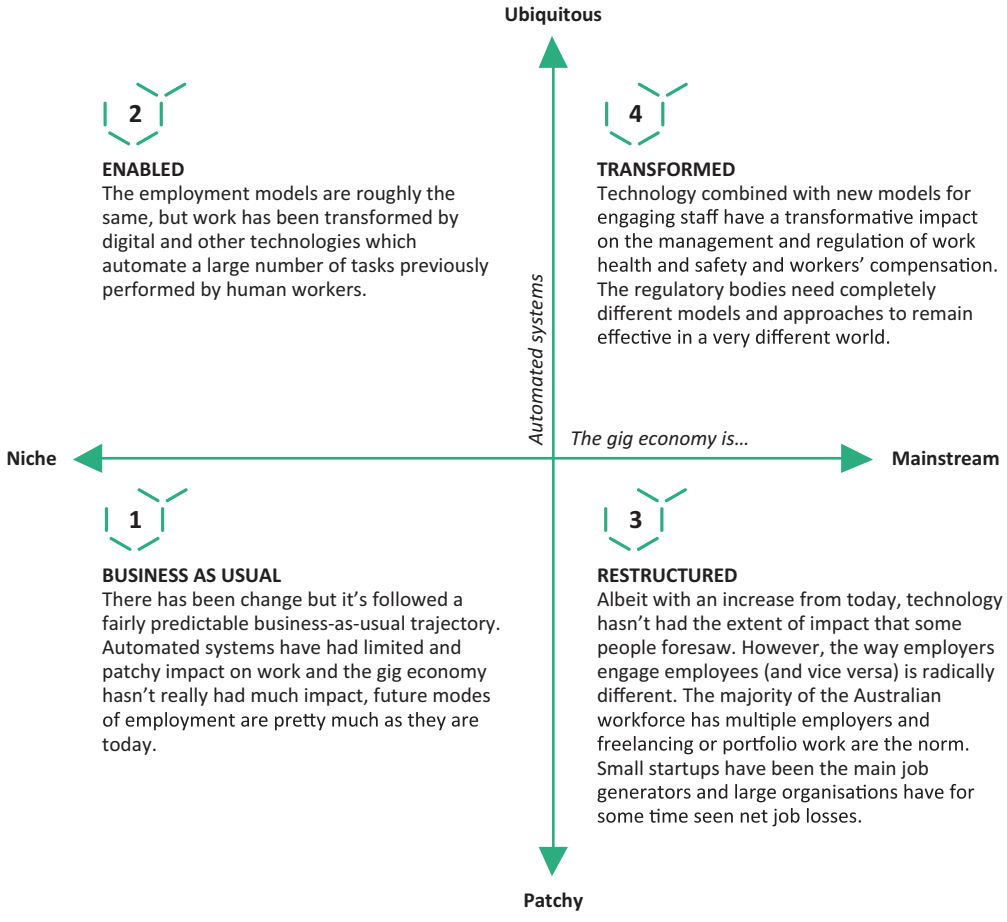


Figure 8. Scenario models for Australia's workforce in 2037

4.1.1 PATCHY ADOPTION OF AUTOMATED SYSTEMS

At the low end of the axis, diffusion of automated systems is patchy and there is only minor change from today. The technological capabilities of robots and AI have continued to advance, but no major thresholds have been broken. Advanced technologies remain expensive and inaccessible for most.

Many of the automated systems that were anticipated to reach the mainstream have not proven good enough for widespread adoption – for instance, driverless cars are not reliable enough to be widely used. Interoperability – a long-established problem for many digital systems[127,128] – has worsened with the release of more and more competing products. The significant cost of replacing legacy IT systems[129,130] has discouraged many businesses from implementing cutting-edge automated systems. Businesses find that the time, effort and labour cost of upgrading existing automated systems rarely pays off in the form of significantly increased workforce productivity.

Some robots have been adopted to perform highly repetitive, basic tasks in controlled environments – for instance, packing and distribution warehouses. However, they remain unable to compete with human workers for the majority of jobs, particularly those involving non-routine cognitive and manual tasks.[45]

4.1.2 UBIQUITOUS ADOPTION OF AUTOMATED SYSTEMS

At the high end of the vertical axis, a range of advanced automated systems – including sensory systems, AI, data analytics, e-commerce and others – have been ubiquitously adopted and have transformed processes at the business, government and individual level.

The cost of sensory technology has decreased while its capabilities have increased, enabling networks of miniature sensors to be embedded in almost any surface at near-zero cost.[131] Computing power has continued to advance while dropping in cost,[132] making the technologies of 2025 far superior to those available even a decade ago.[11] The estimates of 40–50 percent of jobs lost to automation[133,134] have been proven correct, and every new technological advancement sees still more jobs replaced by automated systems. Robots have replaced humans not only in 'dull, dirty, and dangerous' jobs, but also in service industries – a state of affairs anticipated by developments such as Microsoft speech recognition technology reaching human parity,[23] the development of an artificially intelligent local council employee,[135] and a hotel staffed almost entirely by robots.[136]

However, other jobs have been created by the expanding digital economy. Non-automatable 'soft skills' like empathy, creativity, self-awareness, teamwork, and abstract problem-solving are in high demand. The demand for these skills – coupled with the capacity of a large labour force displaced from jobs now automated – has spawned entirely new occupations and industries. This endpoint describes a future where the effects of digital technology on the workforce have been more significant than most people anticipated.

4.2 **Horizontal axis**: The gig economy (niche to mainstream)

The horizontal axis captures the status of the gig economy in Australia. A future with no change from today – or with a declining gig economy – was not viewed as plausible. As such, even the low endpoint of the axis captures some advancement in the gig economy relative to the current situation, although it has been sluggish and incremental. At the high endpoint, the gig economy has evolved faster and has had a greater effect than most anticipated.

4.2.1 THE GIG ECONOMY IS NICHE

At the low end of the axis the Australian gig economy remains a niche pursuit, and most people still conform to traditional models of employment. Issues with reliability, quality of work, and worker welfare have damaged the reputation of the gig economy. While platforms like Uber and Airbnb have largely displaced their traditional competitors and become the norm for consumers in the ride-sharing and accommodation markets, the employment generated by these companies remains comparatively miniscule, and most higher-skill jobs have not become freelance.

Public support for platform employment models has decreased following concerns over the working conditions of gig workers, (including allegations of underpayment,[137] declining wages,[138] sudden slashes in commission,[93]

and worker surveillance[139]) combined with a number of high-profile scandals.[140,141] On the supply side, Australian freelancers were put off by the intense competition in the global peer-to-peer market (for instance, on platforms for online tasks like writing, editing, and translating) from others willing to accept far lower wages. Most Australians were also already satisfied with the levels of freedom and flexibility afforded by their jobs,[142] and saw little need to go freelance. Some did move into gig work, but this was largely driven by necessity as other jobs (e.g. those generated by the mining boom) disappeared. The majority of Australians preferred the stable wages, entitlements, and security of a traditional job. As such, the growth of platform models worldwide continued to have a minimal effect on patterns of employment in Australia.

4.2.2 THE GIG ECONOMY IS MAINSTREAM

At the high end of the axis, the gig economy has gone mainstream and the majority of the Australian workforce are freelancers performing multiple 'gigs'. Digital platforms have evolved and largely resolved initial problems of trust, reliability and usability, leading to massive uptake on both the supply and demand side. Most jobs have been transformed into a series of tasks, which are made available on digital platforms and performed by a freelance workforce on a task-by-task basis. Traditional offices are largely obsolete; this new workforce works from home, in clients' homes or in co-working centres.

The newest generation of Australian workers are 'digital natives' who are intuitive users of platform companies, and who value greater flexibility in their working lives.[143] The willingness of younger people to participate in the platform economy was identified as early as 2014, when research found that 71.3 percent of Australians aged 25–34 were willing to earn income as a service provider on digital platforms.[144] Governments responded to the demand and introduced legislation supporting the gig economy – early examples include the legalisation of Uber in most Australian states and territories[145] and regulatory support for Airbnb in NSW.[146] As platforms grew and proliferated, more and more people took the opportunity to set their own working hours and fit paid work around their other activities. This endpoint describes an environment where freelance work is the norm, and traditional employment is unusual and largely undesirable.

4.3 Scenario 1: Business as usual

The Business as usual scenario encompasses a situation where some change has occurred, but the grand transformative predictions surrounding both automation and the gig economy have not eventuated. Many manual labour jobs have been lost to automation, particularly in the agriculture, construction, mining, manufacturing, and postal and warehousing industries. However, the disruption has not been as widespread as once feared – human workers are still needed for more complex and cognitive tasks within these industries, and humans perform service industry jobs and 'knowledge work' with little fear of future disruption by automation. The gig economy has grown somewhat – spurred by the influx of workers who lost their jobs to automation and were unable to find new ones – but the majority of businesses and employees prefer the security and quality associated with a formal employment structure.

As a result of the minor changes along both axes, WHS and workers' compensation regulators and policymakers do not face significant shortfalls between existing legislation and the conditions of this future. There is a handful of court cases regarding individual gig economy workers who claim that they should be reclassified as employees in order to access workers' compensation, but these are decided on a case-by-case basis. With the widespread automation of manual-labour jobs comes an increase in sedentary and screen-oriented work. This can lead to higher rates of obesity which is one of the factors which can increase a worker's risk of musculoskeletal injuries. Workers' compensation claims from older people also spike as the Australian workforce ages and more people move into the age brackets at greatest risk of injury. This is somewhat mitigated by technological developments assisting older workers with WHS, but most of these new technologies remain expensive and adoption rates are low. Similarly, technologies largely fail to develop to the point where widespread teleworking is possible or desirable, and traditional office environments persist as the norm. WHS models which assume standard employment in a uniform work environment are still largely appropriate to much of the labour force. Some minor changes are necessary, but these are easily inserted within existing legislation and policies.

4.4 **Scenario 2**: Enabled

In the Enabled scenario, automated systems have advanced and been widely adopted in the workplace. Manual labour jobs are more or less completely automated and advances in AI have facilitated the automation of many service-industry jobs. However, there are still some jobs for humans in creative, non-routine fields and new industries have grown around the need for human supervision and control of automated systems. While some of these jobs – particularly those heavily comprised of discrete tasks – are now gigs, most are still performed by workers in a traditional employment relationship.

Advances in technology have made substantial progress in preventing injuries at work. Sensory systems monitor and detect the need for maintenance of building infrastructure before any breakage occurs, preventing incidents. Advanced health-monitoring sensors assist with identifying health problems and making return-to-work assessments. The collection of big data from these sensors helps with identifying trends and patterns at the workforce, industry, and demographic level. Those in the growing older-age brackets of the workforce are able to keep working for longer, with fewer injuries and claims. However, other WHS and workers' compensation issues have arisen. The increasing control and surveillance by automated systems over human workers – as well as the stress associated with job disruption and teleworking – has led to a spike in workers' compensation claims for psychological injuries. There are a number of high-profile incidents involving human workers being injured by malfunctioning co-bots, raising the question of liability and the need for standardised co-bot risk assessments[147] and maintenance regulations. Some 'self-programming' autonomous systems cannot always be controlled by human managers. WHS and workers' compensation policymakers are tasked with adapting to these new problems and some substantial changes are needed. However, the enduring prevalence of traditional employment (as opposed to gig work) means that these changes can be achieved within existing frameworks.

4.5 **Scenario 3**: Restructured

The Restructured scenario captures a future where automated systems have achieved only patchy adoption rates, but employment arrangements have radically changed. Automation is largely confined to 'dull, dirty, and dangerous' jobs in highly controlled settings such as farms, factories, and warehouses. Humans continue to work in service roles and those involving non-routine tasks, but this work no longer comes in the form of a job. Rather, tasks are made available via platforms and are performed by workers who contract their labour on a task-by-task basis.

This has had significant implications for WHS and workers' compensation. Following the mass shift toward gig work and freelancing, it has become necessary to introduce legislative changes formally recognising the category of gig worker and defining their workers' compensation entitlements. The question of what form workers' compensation for gig economy workers should take, and how it should be funded, is highly contested. While government struggles to manage this contestation and implement legislation appropriate to the gig economy, hundreds of thousands of workers are left without effective coverage. On the WHS side, it has become far more difficult to regulate WHS given the wide variety of working environments that many gig workers encounter. Many people work from home or perform gigs that involve travelling and/or work in private homes. Offices have largely been converted into co-working centres. The practical difficulties involved with assessing and regulating WHS in these environments has led to a greater share of WHS responsibility being assumed by gig workers themselves, who now must be given comprehensive WHS training to assess their own working environments. Unions representing gig economy workers have also emerged and are another point of contact for the recording and resolution of WHS concerns.

4.6 Scenario 4: Transformed

In the Transformed scenario, the promises of AI and automated systems have been fully realised, even exceeding the expectations of many. Peer-to-peer business models have become commonplace and most people earn a living through freelancing and gig work. However, the rise of automation has also impacted the types of work that are available – for instance, Uber has followed through on its plans to replace all its drivers with a fleet of automated vehicles,[148] and many customer-interaction roles are now filled by AI systems.[135] The new gig economy offers roles for humans in supervising automated systems and in tasks that emphasise creativity, empathy, and lateral thinking. Many organisations are 'virtual networks' of skilled workers that expand and contract based on supply and demand cycles.[11]

WHS and workers' compensation requirements in this new environment have changed significantly. The mental health and co-bot safety issues of the Enabled scenario also apply in Transformed, but are complicated by the fact that the employment structures governing traditional WHS and workers' compensation models no longer apply to most people. Major legislative changes are required to bring WHS and workers' compensation laws into line with the current environment – for instance, legally recognising the status of gig workers and defining their workers' compensation entitlements (if any); developing safety procedures for automated systems; and consistently applying the WHS responsibilities of platform companies given the wide variety of gig-working environments.

However, technology has also been able to address some of the issues raised by these new circumstances. For instance, faced with the difficulties inherent in conducting WHS assessments when most workers lack a defined 'workplace', an app was developed which can scan a given environment and identify possible safety hazards. WHS regulators and platform companies developed centralised online systems and/or AI services through which gig economy workers can report possible safety hazards and seek advice. Co-working spaces and other places where workers congregate – for instance, laboratories and universities – were equipped with a range of IoT sensors feeding data back to human WHS regulators, and some platforms even implemented the use of drones and wearable health and safety sensors to monitor and enforce safety remotely. WHS and workers' compensation policymakers are tasked with reforming models, legislation, and policy to reflect this transformed reality.

5 IMPLICATIONS

The megatrends and scenarios identified in this report hold relevance for WHS and workers' compensation future frameworks, policies, legislation, and ways of thinking. We have identified the following areas as worthy of further investigation from a policy perspective.

The gig economy and WHS and workers' compensation frameworks. While the Australian gig economy remains relatively small, at least some growth over the coming decades is likely to occur. Traditional means of providing and regulating WHS and workers' compensation may become less and less workable over the coming 20 years. Considerations include:

- Do WHS laws, regulations and codes of practice adequately cover the gig economy and 'miscellaneous task' platforms like Airtasker? Is legislative change needed or are there other ways to expand the capacity of platforms to manage WHS?
- Are current definitions of 'workers' and 'independent contractors' fit for the gig economy? Is there a need for a 'model definition' of gig-economy workers? This would involve consideration of various existing proposals, such as the Taylor Review's recommendations.[94]
- What are the obligations of platform companies in relation to workers' compensation? And are these adequate to protect gig workers and consumers into the future? Is there a need for platforms to take out workers' compensation insurance covering all workers (i.e. the current employer/employee model); to offer opt-in personal injury insurance schemes through the platform; or the obligation to provide all workers information on appropriate personal insurance? This could form part of the ongoing movement towards platforms taking a leading role in improving conditions for workers – for instance, Airtasker's recent collaborative agreement with Unions NSW.
- What is the potential impact on workers' compensation premiums and scheme viability if significantly more workers move to gig-economy platforms?
- Can the IoT be leveraged to help employers and regulators collect relevant data to assist them to identify and manage WHS risks? Could this data assist WHS regulators to monitor compliance and adapt to an increasing number and diversity of worksites? How can this be done without infringing on workers' privacy and negatively affecting mental health?
- Do gig workers know about their WHS responsibilities and their compensation entitlements? How can information be better disseminated to gig workers? And how can regulators encourage platforms to provide WHS and workers' compensation information to their workers?

WHS frameworks, safety standards and support with increasing autonomous systems. Autonomous systems are getting cheaper and their capabilities are increasing, making it highly likely that they will be introduced into a wide variety of workplaces and work in close proximity to humans. It is important to clarify the WHS obligations and standards around autonomous systems in the workplace. Considerations include:

- Are current control measures and frameworks adequate to address the use of robots in the workplace, especially as their roles and functions change?
- Are current WHS Regulations and duties on the designers, manufacturers, importers, and suppliers of plant suitable for advancement of autonomous systems? For example, who has WHS duties to ensure that industrial robots connected to the internet are not hacked? Does a software programmer who issues regular software updates maintain control over the system? Can self-programming autonomous systems be said to be 'under management or control' of any particular person?

Leveraging new and emerging technologies to improve WHS and workers' compensation. While digital technologies and the new business models they underpin and enable may present adaptation challenges to WHS and workers' compensation, there are also opportunities to improve systems and practices. Considerations include:

- What are the most effective and easily applied technologies that could improve WHS (e.g. wearable sensor devices, safety helmets, digital behavioural-change tools)? Should governments encourage adoption of these technologies among employers and workers?
- Could data be better collated and deployed within the WHS and workers' compensation systems to drive improvements? What are the barriers (e.g. institutional willingness to disclose; technological ability to analyse) to leveraging 'big data' and how can they be overcome?
- Should the use of robots or automation for dangerous tasks be mandated and regulated in the future?
- Various technologies exist that could help reduce injuries in older workers. Should their use be encouraged?
- Are steps needed to assist older workers transitioning to new technologies, including those associated with the gig economy, and to prevent undue stress to workers who have not kept up to date with technology?

Understanding technology and mental health, including opportunities for improved awareness, prevention and treatment. As the Australian workforce shifts toward white-collar office jobs, the risk of physical workplace injuries lessens. However, the mental health implications of technology-enabled office work are just beginning to be understood. In order to operate effectively in a future where technology plays an ever-larger role in the workplace, it is important to better understand the intersections between technology and mental health. Considerations include:

- How can WHS and worker's compensation regulators and employers gain a clear understanding of how technology in the workplace impacts mental health and wellbeing? Is more research and guidance needed?
- The mental health impacts of gig-economy work may be different to those of other forms of employment. How can WHS regulators investigate these impacts and develop strategies for gig workers and platform companies to manage them?
- Do current frameworks provide adequate guidance to WHS regulators and employers to manage technology within the workplace, with a view to safeguarding employees' mental health? Or are new approaches needed; for instance, managing stress associated with increased monitoring by automated time-management systems, and ways of managing isolation and stress associated with teleworking?
- What are the opportunities to use technology to improve workers' mental health? For instance, these technologies might include online support services that are accessible on a smartphone (and possibly anonymous to reduce stigma); private wearable mood/depression/emotion monitors;[149] and/or the collation and analysis of big data to help anticipate workplace injuries related to mental conditions and enable preventative or early action. Which of these are feasible and how can WHS regulators and worker's compensation authorities encourage their adoption within the workforce?

6 METHODOLOGY

Strategic foresight is an emerging research field and profession which aims to explore plausible futures and help people make wiser choices. It occurs at the intersection of multiple disciplines including geography, economics, management science, operations research and planning theory. The field of strategic foresight attracts regular conferences, university courses and dedicated research and professional journals.

Concepts of strategic foresight emerged after World War II with an early focus on technology forecasting. In the 1960s and 1970s the field was given a boost by the formation of the Royal Dutch Shell (an energy company) scenario-planning team. Over the decades that followed, thousands of scholarly articles, professional guides and books have been published on methods and applications of strategic foresight. Cutting-edge research is developing processes via which future scenarios can be combined with decision making.

Over the past seven years the Data61 Insight Team, housed within one of CSIRO's business units, has developed a generic strategic-foresight process (Figure 9) pioneered through multiple megatrends, scenario planning and strategy projects delivered in diverse industry sectors. It draws upon numerous theories developed by researchers worldwide and on CSIRO's own practical experience in delivering many strategic-foresight projects to private and public-sector clients. This process for identifying megatrends and scenarios has been applied in the current study. There are five key stages of strategic foresight used in this process.

In the first stage, the process commences with a background study and scope definition. The background study documents the current conditions, size, structure, opportunities and challenges within the industry, region or societal grouping being studied. Unlike the later stages, the background study is concerned with the current status and historic conditions. It does not attempt to look into the future. The scope defines the stakeholder groups, timeframe and issues to be considered throughout the remainder of the project.

In the second stage, trends are identified by an environmental-scanning process. This casts a wide net over all patterns of change which are potentially relevant to the organisation. The environmental scan errs on the side of being overly inclusive rather than exclusive. The trends are typically grouped as geopolitical, social, economic, environmental and technological. However, an alternative and tailored nomenclature can be designed to classify the trends based on the unique needs of the organisation.

Processes of validation and screening are used at a secondary stage to remove any 'by-catch', which refers to trends which are unsubstantiated or irrelevant. The screening and validation process checks to ensure trends pass two tests: (i) evidence that the pattern of change is actually occurring and likely to continue occurring into the future; and (ii) evidence that it matters to the organisation. The process of validation often involves checking the proposed trend against datasets, expert opinions and research findings published in journals to ensure accuracy. Sometimes evidence is found both supporting and undermining the trend and the foresight team need to make a difficult judgement call about where the weight of evidence lies and whether the trend should be included.

WHAT ARE **MEGATRENDS** AND **SCENARIOS?**

Megatrends are gradual and deep-set trajectories of change that will at some point reshape the business and policy environment. They typically have a decadal time frame (e.g. 5–20 years) and occur at the intersection of multiple trends. Trends are more specific patterns of change which typically have shorter duration and relate to specific geographies or issues. The term megatrend was introduced by US economist and academic John Naisbitt in his 1982 book of the same title and is today used widely in foresight studies which describe the future. In our approach, megatrends are shown using an overlapping Venn diagram to illustrate the connections. A scenario is an evidence-based and plausible narrative about the future at a set point in time. Scenarios represent an estimation about how the megatrends unfold based on best available data. Because the future is uncertain there are multiple plausible scenarios. In our approach scenarios are created by axes – continuums of uncertainty and impact associated with the megatrends. Two axes will create four quadrants and four scenarios.

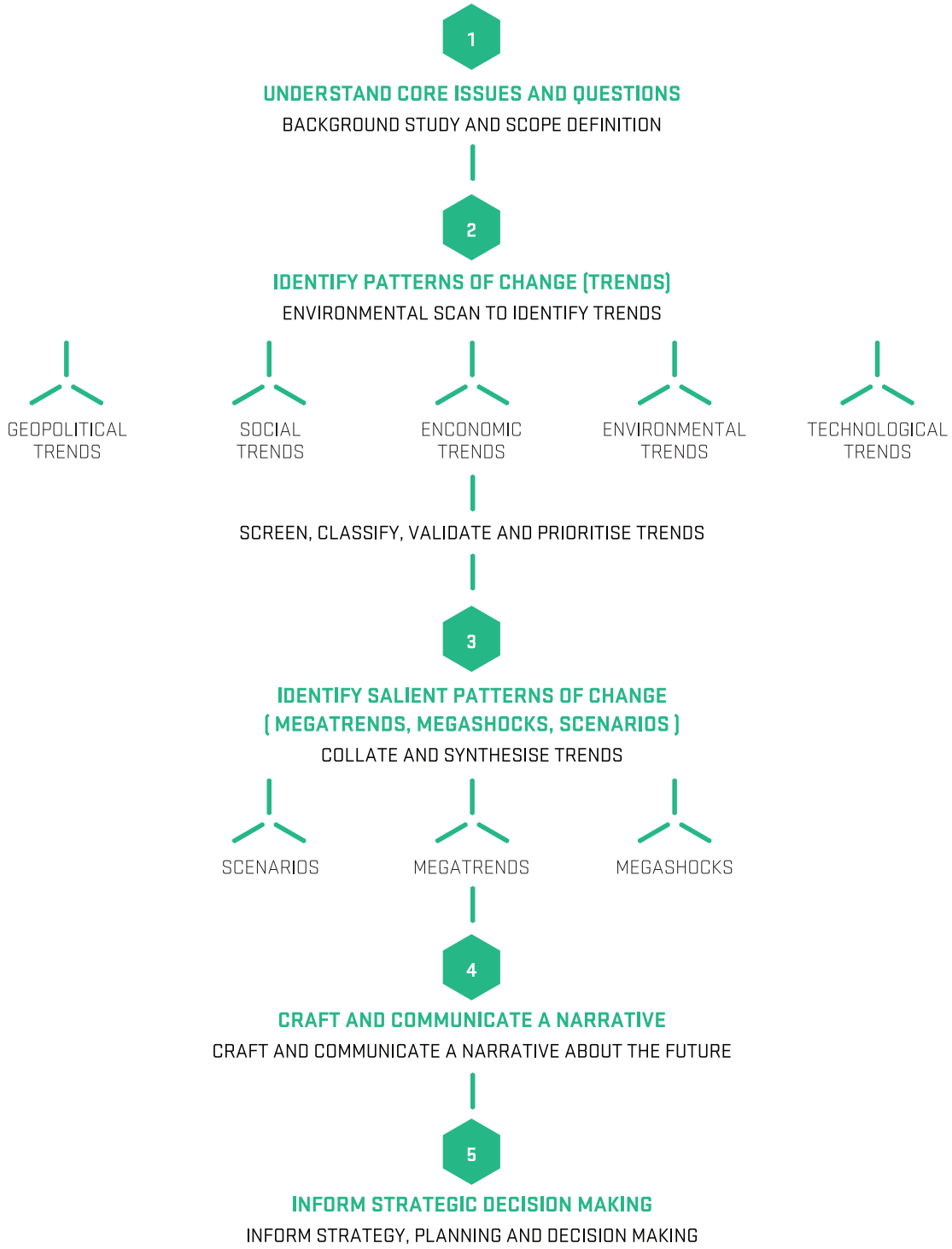


Figure 9. Generic foresight process developed by CSIRO and Data61

In the third stage, the trends are collated and synthesised to identify more salient patterns of change and possible future events which hold significant implications for decision makers. These are captured as building blocks – scenarios, megatrends and risks. These building blocks are not necessarily mutually exclusive and a foresight study may use one, some or all in developing a narrative about the future.

The final two stages involve crafting and communicating a narrative about the future and then injecting that narrative into strategic decision-making processes. The narrative captures all of the relevant building blocks and describes the methods and information sources so that the audience has confidence in the results.

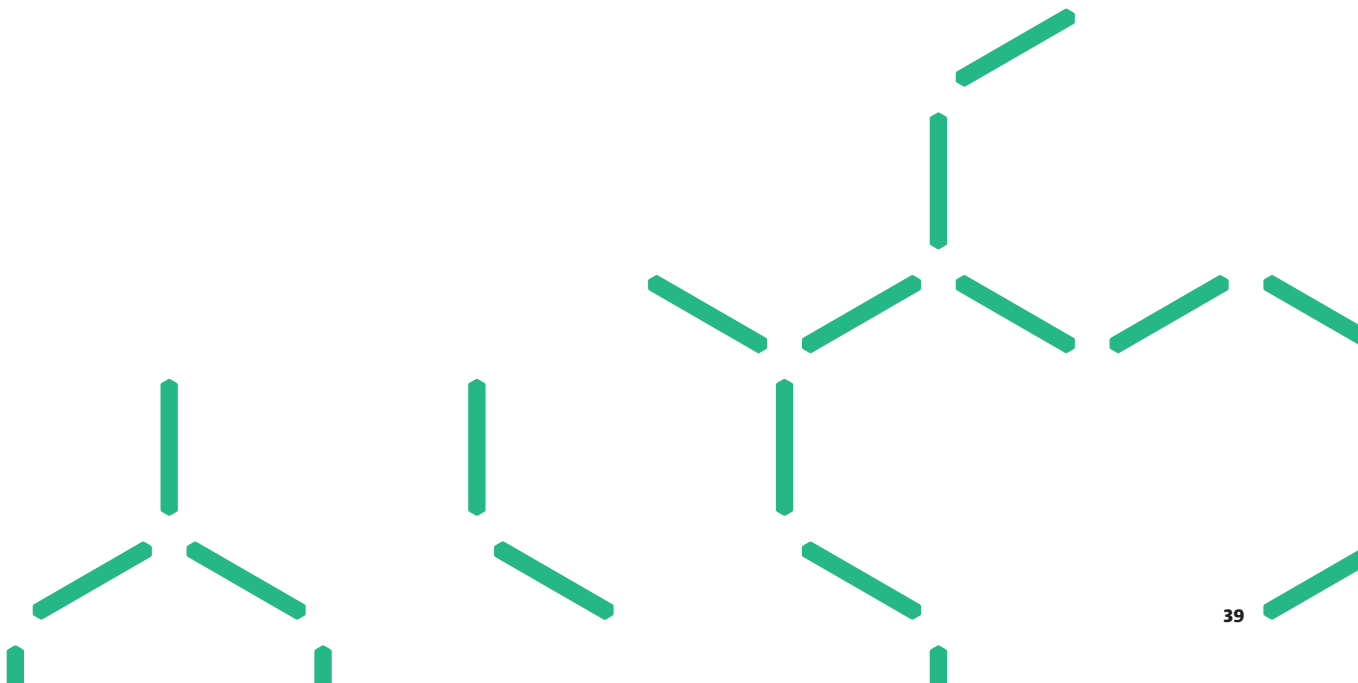
7 CONCLUSION

Given the falling cost and increasing capability of digital systems, it is widely agreed that digital technology will significantly impact the nature of work in the future. Automation will disrupt the workforce to a greater or lesser degree, and even those jobs not replaced by robots will change as human workers are required to use and interact with a wide range of digital technologies.

Developments in AI, robotics, autonomous systems, and the IoT – among others – will change the composite tasks and fundamental nature of many jobs. Technological advancement has also enabled the rise of platform companies and the 'gig economy', which has the potential to change employment markets and organisational structures. At the same time, the Australian workforce is undergoing structural and demographic changes: there is a shift away from manual-labour industries and toward white-collar and professional occupations; and the workforce is ageing as the large baby-boomer generation enters the older-age brackets while staying in the workforce. This convergence of forces has the potential to shape a radically transformed future.

WHS and workers' compensation frameworks face the challenge of anticipating, and adapting to, the risks and opportunities presented by this future. In order to assist with meeting this challenge, this report has applied strategic foresight to examine the potential impacts of advances in technology and the gig economy on the Australian workers' compensation and WHS environment over the next 20 years. The study has identified a set of megatrends shaping the future workforce environment for Australia, including advancing automation; the increasing threat of workplace stress and mental health issues; a shift toward sedentary, screen-oriented work; blurred boundaries between work and home; the challenge of providing WHS and workers' compensation in the gig economy; and the ageing workforce. These megatrends and the various possibilities therein influenced the development of four plausible future scenarios, constructed along the axes of the adoption of automated systems and the status of the gig economy in Australia. These scenarios outlined four of the plausible futures under which WHS and workers' compensation frameworks may be operating in 20 years' time. The scenarios do not represent an exhaustive list of possible futures, but they do provide decision makers with a perspective on plausible developments and an idea of the challenges, implications and opportunities that the future may hold.

As this report has outlined, the development of emerging technologies and new ways of working present both risks and opportunities from a WHS and workers' compensation perspective. The future holds many challenges, including some that may require reviews of existing models, legislation, and ways of thinking. However, there are also significant opportunities to leverage new technologies to enable better WHS and workers' compensation systems, compliance and regulation, which accurately reflect and effectively operate within the workforce environment of the future.



8 GLOSSARY

TERM	DESCRIPTION
5G MOBILE TECHNOLOGY	5th generation mobile networks, providing faster internet connection speeds compared to current 4G networks.
AIRBNB	Platform business allowing users to rent short-term accommodation.
AIRTASKER	Platform business connecting users for a broad range of tasks.
ARTIFICIAL INTELLIGENCE (AI)	AI is categorised into two types: Narrow AI, which addresses specific application areas such as playing strategic games, language translation, self-driving vehicles and image recognition. Narrow AI is not a single technical approach, but rather a set of discrete problems where the solutions rely on a toolkit of AI methods along with some problem-specific algorithms. The diversity of Narrow AI problems and solutions, and the apparent need to develop specific methods for each Narrow AI application, has made it infeasible to 'generalise' a single Narrow AI solution to produce intelligent behaviour of general applicability. Narrow AI underpins many commercial services, such as trip planning, shopper recommendation systems and ad targeting, and is finding important applications in medical diagnosis, education and scientific research. General AI (sometimes called artificial general intelligence, or AGI) refers to a notional future AI system that exhibits apparently intelligent behaviour at least as advanced as a person across the full range of cognitive tasks. A broad chasm seems to separate today's Narrow AI from the much more difficult challenge of General AI.[150]
AUGMENTED REALITY (AR)	In AR, real-world views are overlaid with contextual information, usually via a display, sometimes worn over the eyes.[2] AR is a type of mixed reality.
AUTONOMY	Autonomy is the ability of a system to operate and adapt to changing circumstances with reduced or without human control. For example, an autonomous car could drive itself to its destination. Despite the focus in much of the literature on cars and aircraft, autonomy is a much broader concept that includes scenarios such as automated financial trading and automated content curation systems. Autonomy also includes systems that can diagnose and repair faults in their own operation, such as identifying and fixing security vulnerabilities.[150]
AUTOMATION	Automation refers to machines performing work that might previously have been performed by a person. The term relates to both physical work and mental or cognitive work that might be replaced by AI. Automation, and its impact on employment, has been a significant social and economic phenomenon since at least the Industrial Revolution. It is widely accepted that AI will automate some jobs, but there is more debate about whether this is just the next chapter in the history of automation or whether AI will have a greater impact than past waves of automation.[150]
BEHAVIOUR-BASED SAFETY	A safety partnership between management and employees that continually focuses people's attention and actions on their, and others', daily safety behaviour.[151]
BIG DATA	High-volume, high-velocity and/or high-variety data that can be analysed computationally to reveal patterns, trends and associations.[152]
CLOUD COMPUTING	Cloud computing is where a network of remote servers, hosted on the internet, is used to store, manage, and process data, rather than a local server or a personal computer. 'The cloud' enables convenient, on-demand access to a shared pool of computing resources regardless of physical location, making it possible for geographically dispersed groups of workers to collaborate and share files, data, and information.
COGNITIVE BEHAVIOURAL THERAPY (CBT)	A type of psychological therapy focused on helping a person to change unhealthy habits of thinking, feeling, and behaving.
CYBER-PHYSICAL SYSTEMS	Cyber-physical systems or 'smart' systems are co-engineered interacting networks of physical and computational components, providing the basis of much critical infrastructure.
DELIVEROO	Platform-based business for ordering and delivering food from a range of restaurants.
EXOSKELETON	Robotic-based technologies used to augment human activities and strength, or to overcome disabilities. Such devices are becoming increasingly available, cheap and capable.[2]
FREELANCER	Platform business connecting businesses with freelance workers for tasks such as web development, graphic design, internet marketing and software development.
GIG ECONOMY	Freelance task-based work organised through online platforms or 'apps'.
GOBI	Platform business for babysitting.
HAZARD	A situation or thing that has the potential to harm a person. Hazards at work may include: noisy machinery, moving vehicles or machinery, chemicals, electricity, working at heights, a repetitive job, bullying and violence at the workplace.[153]
INDUSTRY 4.0 (ALSO KNOWN AS THE FOURTH INDUSTRIAL REVOLUTION)	The use in industrial production of recent, and often interconnected, digital technologies that enable new and more efficient processes, and which in some cases yield new goods and services. The associated technologies are many: from developments in machine learning and data science, which permit increasingly autonomous and intelligent systems, to low-cost sensors which underpin the IoT, to new control devices that make second-generation industrial robotics possible.[8]

TERM	DESCRIPTION
INTERNET OF THINGS (IOT)	A network of everyday devices that are connected to the internet and/or to each other, enabling them to send and receive data.
LYFT	Platform business for ridesharing.
MIXED REALITY	Mixed reality is the result of blending the physical world with the digital world through the use of computer vision, graphical processing power, display technology, and input systems.
OFFICER	Under the Model WHS Act – consistent with the Corporations Act 2001 – an 'officer' of a corporation means: (a) a director or secretary of the corporation; or (b) a person: i. who makes, or participates in making decisions that affect the whole or a substantial part, of the business of the corporation; or ii. who has the capacity to affect significantly the corporation's financial standing; iii. in accordance with whose instructions or wishes the directors of the corporation are accustomed to act (excluding advice given by the person in the proper performance of functions attaching to the person's professional capacity or their business relationship with the directors or the corporation); or (c) a receiver, or receiver and manager, of the property of the corporation; or (d) an administrator of the corporation; or (e) an administrator of a deed of company arrangement executed by the corporation; or (f) a liquidator of the corporation.
PERSON CONDUCTING A BUSINESS OR UNDERTAKING (PCBU)	The model WHS Act places the primary duty of care on the PCBU. A PCBU can be a: company; unincorporated body or association; sole trader or self-employed person. Individuals who are in a partnership that is conducting a business will individually and collectively be a PCBU. A PCBU does not include volunteer associations or elected members of a local authority.[13]
RISK	The possibility that harm (death, injury or illness) might occur when exposed to a hazard.[153]
ROOBYX	Injury insurance specifically designed for gig economy workers offered by insurance company YourCover.
SIDECAR	Platform business for ridesharing.
SOFTWARE ROBOTS, OR ROBOTIC PROCESS AUTOMATION (RPA)	RPA involves the use of 'software robots' capable of liberating humans from highly structured and mundane tasks. Recently, such robots have also been integrated with AI algorithms, allowing them to learn from experience, adapt and respond to new conditions. These evolving capabilities have created the potential for computerising a wide variety of tasks currently performed by workers, who can eventually be substituted with cognitive agents. RPA has clear economic advantages over human agents. Its cognitive agents can process information three times faster than the average human, work 24/7, eliminate manual error and do not present the high turnover rates typically associated with human workers.[10]
TELEWORKING	The use of technology (e.g. computers, telephones, cloud computing and teleconferencing) enabling employees to work outside the workplace. Teleworking includes working from home, working at customer locations (e.g. services or sales), working while travelling (e.g. in planes and hotel rooms) and working during business trips (e.g. trade fairs, conferences).
UBER	Platform business for ridesharing.
VIRTUAL REALITY (VR)	An immersive computer-simulated or multimedia-generated experience that can be multi-sensory and enables the participant to interact with the virtual environment. VR is a type of mixed reality.
WORK 4.0	The term 'Work 4.0' picks up on the current discussion about Industry 4.0 but puts forms of work and employment relationships centre stage. Work 4.0 will be more interconnected, digital and flexible.[10]
WORKER	Under the model WHS Act, a 'worker' is any person who carries out work for a person conducting a business or undertaking, including work as an employee, contractor or subcontractor (or their employee), self-employed person, outworker, apprentice or trainee, work experience student, employee of a labour hire company placed with a 'host employer' or as a volunteer.[13]
WORKPLACE	Under the model WHS Act, a 'workplace' is any place where work is carried out for a business or undertaking and includes any place where a worker goes, or is likely to be, while at work. This may include offices, factories, shops, construction sites, vehicles, ships, aircraft or other mobile structures on land or water.[13]

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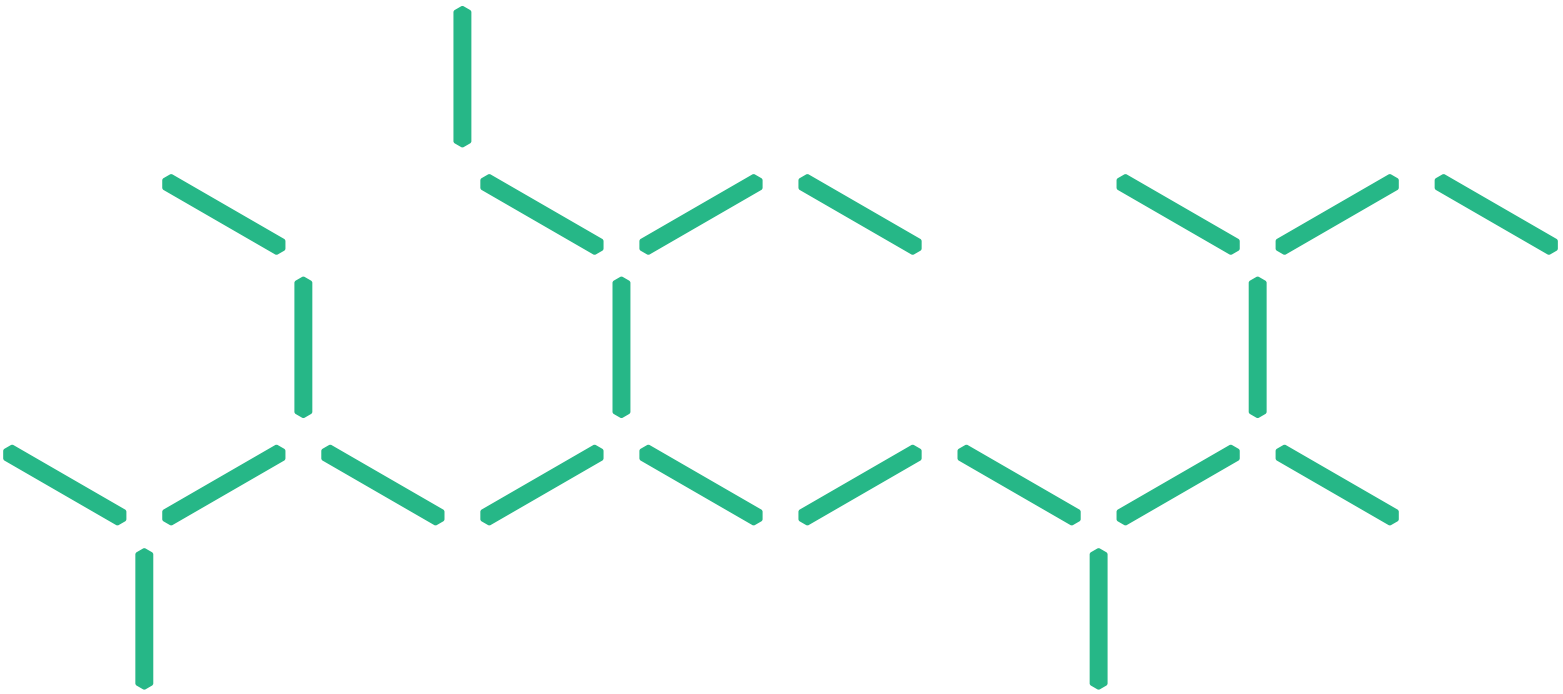

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