Chapter 13
Conclusion and Comparisons

Alan Nankervis, John Burgess, Julia Connell, and Alan Montague

Abstract The final chapter of this book reflects on the key aspects of 4IR technologies identified amongst the eleven industry sectors featured in relation to both the production and service sectors. Key implications for Australia's governments and industry are outlined. These include: the need for a national technology policy; significantly increased investment in AI development and training programs offered in both formal educational settings and inhouse by industry to upskill both current and future employees. The authors stress the necessity to urgently address these implications for Australia to make a positive impact in an era where technological advances are having and will continue to have an unprecedented impact even with the recent COVID-19 challenges taking place.

Keywords 4IR sector impacts · Australia · COVID-19 challenges · National technology policy

A. Nankervis (✉)
Centre for Organisational Change and Agility (COCA), Torrens University, Adelaide, SA, Australia

School of Management and Law Curtin University, Perth, NSW, Australia
e-mail: a.nankervis@curtin.edu.au

J. Burgess
Torrens University, Adelaide, SA, Australia
e-mail: john.burgess@torrens.edu.au

J. Connell
Newcastle Business School, College of Human and Social Futures, University of Newcastle, Newcastle, NSW, Australia
e-mail: julia.connell@newcastle.edu.au

A. Montague
School of Management, RMIT University, Melbourne, VIC, Australia
e-mail: alanjmontague@gmail.com

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Revisiting the Purpose of the Book

This book was created in response to a gap in knowledge concerning the application of the transformative technologies associated with the 4IR across nations, regions, and industries. The 4IR has raised the widespread possibility of job loss, due to the dominance of robotics and artificial intelligence displacing humans. Such scenarios include the extension of control and surveillance in the home and workplace, a situation further enabled during the COVID-19 global crisis. Positive outcomes suggest the phasing out of work that is physically demanding, safer workplaces, new jobs and skills, improved work-life balance, increased earnings, and new career paths. Although the advent of the 4IR has attracted rhetoric, hype, and unsubstantiated predictions, the new technologies associated with it are real, and they are being applied across the globe albeit with uneven applications and impacts due to the contextual conditions determining the speed and scope of the changes taking place.

A national and industry context frames the discussion and analysis of the impact of 4IR technologies on work, jobs, and skills in industry settings in order to examine the extent to which these technologies have transformed production, employment, skills, and training. An industry broadly represents a collection of enterprises (private, public, and non-government organisations) that produce similar goods and services. Associated with goods or services, similar production processes and requirements for labour, capital, and technology permeate many industry sectors. In an industry context the purpose of the book is to address the following questions:

(a) What are the characteristics of each industry sector, and its current strengths and weaknesses?
(b) What key technologies are currently impacting on the sector and what technologies are likely to have a future impact on the sector?
(c) What is the impact of technological change on the size and composition of the sector's workforce?
(d) What is the impact of technological change on the skill requirements of the sector?
(e) Are there active programs in place to support organisations and workers to accommodate the predicted technological changes? and
(f) What programs and policies are required to address the predicted changes within the sector?

Paralleling the research questions explored within each chapter, the key responses to these questions are summarised in the appendix of this chapter by sector.

The research findings outlined in this book represent eleven of the key industry sectors in the Australian economy – construction, mining and agriculture; manufacturing; retail; accommodation and food services; transport and logistics; media; financial and insurance services; local government; higher education; healthcare; and utilities. This list does not include all industries but is sufficiently diverse to indicate the range and application of technologies that are being applied across Australian workplaces. Two of the studied industries – the healthcare and retail

sectors – are the largest employers in Australia, and coincidentally, are also the sectors which have best survived or even grown during the COVID-19 crisis. Two other sectors – higher education and tourism – have been decimated by the crisis wrought by the pandemic, enduring significant revenue losses and redundancies. However, in both sectors, future business models will most likely be transformed using 4IR technologies towards virtual learning or travel experiences for their clients and customers. In the other sectors, there have been both challenges and opportunities provided by the unexpected (and unwanted) confluence of the COVID-19 virus and the development of 4IR technologies, together with the adverse effect on exporters posed by the strained relationship between Australia and China (Chan 2020). However, in almost all industry sectors the quantity and quality of the workforce will probably change irrevocably. These changes are expected to require governments, industry associations, individual employers, education and training institutions, unions and employees themselves, to undertake collaborative, comprehensive and strategic human resource planning processes to ensure that the employees who remain are adequately supported, trained and retrained; and effectively rewarded to ensure that they are equipped and motivated to perform new roles in their future workplaces and industrial environments (Deloitte Access Economics (2018a). A summary of the findings relating to the featured Australian industry sectors follows. The summary mirrors the structure of the book and is divided into two sections – production and services.

Technological Changes and Challenges in the Production Sectors

In the *Construction, Mining & Agriculture (CMA) sector* (Chap. 2) each component has its challenges and opportunities. Thus, while employment in construction has generally maintained its employment levels since the advent of the 4IR, it is likely to displace some workers with the implementation of building information modelling, prefabrication, offsite manufacturing, and 3D printing technologies. Arguably, this circumstance may also disrupt the current large building corporations-small contractor nexus which has been a key structural characteristic for many decades in Australia. Mining, on the other hand, has experienced significant boom and bust periods and is threatened by the growing trade war with China and the frequent use of a fly-in-fly-out (FIFO) workforce which is currently hampered by COVID-19. Mining employers have been relatively eager to adopt new technologies such as autonomous vehicles and haulage trains; robots for processing hazardous materials; automated drilling and centralised remote monitoring systems. That said, the pace of implementing these technologies is likely to increase further in the future for both efficiency, profitability and occupational health and safety reasons. Jobs such as truck operators, geologists and surveyors, drill operators, miners and earth moving operators are poised to decline. Agriculture has been challenged not only by

COVID-19 and new technologies, but also by climate change, bushfires, drought, and the inadequacy of the water supply in parts of Australia. The sector has also experienced a slow general decline in employment over the last few decades. This is due to its ageing workforce and youth migration to the cities, exacerbated by the recent dearth of a seasonal vegetable and fruit picking workforce due to the Australian COVID-19 lockdown. For these long-and shorter-term reasons, employers are likely to welcome new cropping technologies, automated food production and packaging, drones for livestock, plant monitoring and maintenance, and blockchain technologies to track food production and supply chains.

Chapter 3 focuses on *manufacturing* which has experienced a long-term decline in terms of employment and contribution to GDP due partly to the 'resources curse' and the preference for low-cost overseas manufacturers in China and India. However, a glimmer of hope for a return to limited local manufacturing has been provided by both the short-term imperative to produce large quantities of personal protective equipment (PPE) and ventilators for COVID-19 protection and treatment. This has been coupled with the possible benefits of low-cost manufacturing from 4IR technologies such as 3D printing; better connectivity between customers and supply chains through real-time access to production information, logistics and monitoring; and enhanced workplace safety. However, the adoption of these technologies will come at the cost of significantly reduced workforces, and the adverse effects on apprenticeships and employee reskilling from the decimation of the Vocation Education & Training (VET) sector (Deloitte Access Economics (2018b).

Technological Changes and Challenges in the Services Sectors

Conversely, the *retail sector* (Chap. 4) has benefitted from the COVID-19 crisis due to the transition of many customers from face-to-face to online purchasing. It is highly likely that many employers in this sector will expedite the implementation of 4IR technologies, such as blockchain inventory management, robotic warehouse and store cleaners, hazard identification and reduction and shelf-stacking, to replace its majority low-skill, low-wage, casual and contract workforce. However, of all the industry sectors discussed in this book, the *accommodation and food services* (AFS) component of the tourism and hospitality sector (Chap. 5) has arguably borne the brunt of the COVID-19 pandemic, with most hotels, restaurants, cafes, travel agents and airlines closed or only partially operational, with the consequent reduction or redundancy of many employees. It has also been considered to be the sector with the highest level of 'automation susceptibility' due to technologies such as AI reservation systems; keyless entry and hotel check-in systems; virtual reality tourism experiences; robot baristas and room cleaners; and online food ordering with home delivery. In common with the retail sector, the AFS sector has a mostly female, low-paid, low-skill and precarious workforce. It is also likely to become one of the highest future adopters of 4IR technologies with its associated deep impact on the quantity and quality of its workforce. Automation and digital transformation have

reportedly had a significant effect on the *transport sector* (Chap. 6); however, disparate forms and degrees of implementation have been experienced in its different sub-components. Expertise in robotics, systems, and electronics engineering, as well as digital literacy, digital business, business analytics and computer science skills will be required in its future workforce. As with other industry sectors, the workforce challenges are likely to include job displacement and/or reconfiguration, and the emergence of new skills and competencies.

Perhaps the industry sector which has made the most significant progress towards the widespread application of 4IR technologies in Australia is the *media and communications* sector (Chap. 7). The Australian Information Media & Telecommunications sector comprises newspaper and internet publishing, journalism, film production, television and radio broadcasting, together with the telecommunications infrastructure and networks; and as such, is probably the most globalised and competitive of all sectors discussed in this book. Although the sector experienced strong employment growth between 2015 and 2020, future challenges are apparent, as trends indicate the increased prominence of large global media conglomerates in the media market. Unlike some other sectors, media production now relies totally on information technology to drive media for screens, laptops, I-pads and mobile telephones and media networks have begun gathering points for these data flows. AI technologies are used in robot-controlled newsrooms; virtual, computer-generated, non-human screen 'actors' and AI algorithms are used in the selection and promotion of story material in publishing and screen story-telling. The impact of these 4IR technologies on employment in this sector has been, and will remain, profound. On the positive side, occupations such as film and television production and direction are likely to have their roles augmented by 4IR technologies, together with jobs involving 3D printing design and Big Data analysis; whereas, on the negative side, human roles in screen, literary and arts production such as camera operators, journalists and news reporters are most likely to be supplanted by such technological advances.

The *finance and insurance sector* (Chap. 8) also lends itself to significant automation, given its heavy reliance on data collection and analysis. Its activities include raising funds; receiving deposits; issuing securities incurring liabilities, investments, and a broad range of financial assets; and pooling risks by underwriting insurance and annuities. Central banking, regulation and monetary control of financial activities are all embedded in this sector, which in turn are heavily regulated by state and federal government agencies. The AI applications currently in use, or predicted for the future, include (inter alia) robo-advisors for customer investment advice; credit-scoring algorithms using standard programmed machine learning; and other applications which predict investment risk or default, assist in fraud prevention and mitigation; and software that assesses compliance with government regulations and improves system efficiencies and effectiveness. It is anticipated that future applications of these technologies will significantly reduce current workforces, not only in repetitive jobs but also those which involve analytical and decision-making capabilities, including insurance brokers, financial investment advisors, bank managers, insurance risk surveyors and insurance investigators.

However, some observers have suggested that comprehensive workforce planning may be able to augment, rather than replace, some of these positions, and still allow the Australian finance and insurance sector to thrive and grow in an increasingly competitive local and international marketplace.

Whilst there are government players in many of the industry sectors already discussed, the *local government sector* (Chap. 9) stands alone as an entirely public entity, different in its aims, structure, management, and operations from all the others. Given its history, traditions, structure, and relatively high union density compared to some of the other sectors, it is likely that its trajectory towards the adoption of 4IR technologies will also be different. Local government in Australia is the third tier of government, sitting underneath the federal and state government sectors, and there are more than five hundred local councils with nearly 200,000 employees in approximately 390 different occupations. Despite the similarity of their services, they have substantial diversity in terms of their financial capacities, employment profiles, demographic and geographic characteristics. The 4IR technologies most relevant to their future operations and priorities include the digitisation of records; automation of property maintenance, traffic and parks management, and waste management; online delivery of such community services such as libraries, planning and the billing of council rates. The sector also uses satellite technology, drones, smart meters, CCTV and smartphone applications for parking and traffic management, and for land-care, animal management, and emergency plans. The impact of 4IR technologies on local government occupations is anticipated to include a combination of the displacement of semi-skilled jobs (for example, maintenance and clerical) and the augmentation of higher-skilled positions (town planners, architects, and financial managers). Potential obstacles to the widespread adoption of AI include uneven access to the IT infrastructure (especially in rural and remote areas), different levels of funding between councils, digital skills shortages, and diverse opportunities for workforce reskilling in these competencies.

Whilst most *higher education* institutions (Chap. 10) in Australia are public universities financed by a combination of government, student and research funding; there is also a small number of private institutions as well. New 4IR technologies have affected every part of the higher education (HE) system, ranging from human resource management processes for staff to all aspects of student learning and administration, and research activities. Whilst online learning has been a feature of HE for several decades, the COVID-19 pandemic has necessarily enhanced this learning option, resulting in both decline in the number of lecturers (especially casual and contract ones) and the need for many staff to acquire new skills, including (but not limited to) data fluency, digital competence, big data analysis and the use of complex computerised algorithms. It has been predicted that job losses in the sector could rise to more than 21,000 staff Australia-wide, and although this was initially caused by the pandemic, it is likely that many (if not most) institutions will choose to maintain largely online learning technologies in their efforts to reduce the funding debts caused by the dramatic decline in international student income. Not only will this severely reduce the numbers of full-time academics, but it will also curtail the career paths of casual, fixed term contract teaching and research staff.

In contrast to HE, the *healthcare sector* (Chap. 11) received a significant boost from COVID-19 as its services were in great demand. However, some allied occupations (for example, dentistry, cosmetic surgery and physiotherapy) suffered due to the closure of their services for several months during the height of COVID-19's impact in Australia. As in other sectors, the adoption of 4IR technologies has been growing in a myriad of healthcare occupations over the last few decades. For example: AI is employed to identify potentially cancerous lesions in radiology images; deep learning is used in the treatment of diabetic retinopathy; a robot called 'Matilda' supports elderly people in aged care homes; and 'Pepper', a social robot with emotion recognition abilities, is being trialled in Australian hospitals to study how robots could improve the quality of patient care. With respect to the employment impact of these technologies, there are likely to be both positive and adverse consequences – increased specialist employment opportunities, new skills and competencies, and opportunities for re-skilling, on the one hand; and job losses and a reduction in the socio-emotional aspects of patient care on the other.

Finally, the *utilities sector* (Chap. 12) has recognised that it needs to increase its competitive edge by conducting a digital transformation whilst facing new challenges, including an increase in competition and changes in customer demands. As examples: energy companies are upgrading their infrastructure by adopting new technologies such as the Industrial Internet of Things (IIoT), machine learning, Cloud computing, smart meters, and predictive maintenance amongst many other initiatives. In the water management space, remote sensors have been employed to monitor the ageing water infrastructure, water scarcity, corroding pipes and leaks; and in the oil and gas sector, to conduct asset integrity management, reduce costs and minimise human interventions to reduce data-entry errors and potential security risks. The key challenges faced in the sector include talent shortages, cyber-physical attacks, and security; and achieving an appropriate balance between traditional and renewable energy sources whilst maintaining profitability without compromising ethical and social responsibilities. As in most other sectors, the utilities sector will inevitably be forced to reduce low-skilled occupations as well as enhancing their higher-skilled counterparts.

The key challenges and opportunities associated with the 4IR in all the sectors discussed above are summarised in Appendix 13.1 at the end of this chapter. The key technologies that contribute to the 4IR, as identified in Chapter one, have the potential to impact on all sectors in terms of production, productivity, employment, skills, and training. As previously mentioned in chapter one the technologies have the potential to restructure sectors internally and to break down the barriers between sectors. As internet networks roll out across the economy massive changes are afoot as all sectors will have access to cloud computing, big data, the internet of things and machine learning. The Cisco/Oxford Economics report (2019) analysis on the impact of technological and structural change in Australia suggested that those occupations most at risk of displacement were found in the trades and routine workers, especially in manufacturing, construction, transport, agriculture, and mining. Those sectors that are capital-intensive such as agriculture, mining, transport, construction, and manufacturing can access robotics and artificial intelligence to

increase productivity and augment and displace labour. For more labour-intensive sectors that depend on the direct personal provision of services such hospitality, education, entertainment, healthcare, and retailing, there is scope for the displacement of labour engaged in routine activities through different modes of service delivery such as online entertainment, online retailing, online education, and online food delivery. Across all sectors, routine jobs that have limited autonomy and independent decision-making, are likely to be replaced by technology. The 4IR technologies will augment many jobs, but at the same time, require skills development, especially in soft and IT skills. The Cisco/Oxford Economics (2019) analysis suggested that skills shortages were present across all occupations and industries in terms of IT skills, soft skills, and elementary skills such as verbal and written communication, and teamworking. The implication is that for all vocations and professions there is a need for continuous skill upgrading to accommodate the new technologies.

Implications for Governments and Industry

The challenges for government (Federal and States) are linked to supporting technological implementation and managing the current and future workforce needs for the respective sectors. The 4IR technologies require supporting infrastructure that covers mobile and internet networks; logistics and transport networks; sustainable and renewable energy networks; and a skilled workforce that can employ the new technologies at the workplace. Preparing for the challenges and opportunities afforded by the 4IR requires policy action in many areas including industry, trade, security, education, training, R&D, migration, infrastructure, labour regulation, and regional development. For this reason, a national technology policy that incorporates these areas is required to map the challenges and develop an integrated policy program. The challenges and opportunities identified in this book refer to industry perspectives. For the Federal government the challenge is to develop a holistic national program that incorporates planning for both the opportunities and challenges, and strategies directed not only towards technological solutions but also addressing potential adverse consequences including job loss, deskilling and inequality in the impact of technology across regions, occupations and age groups. Any national program must accommodate not only immediate challenges but also consider the longer-term challenges of technological change in concert with other changes in demography, climate, and workforce skills.

The scope of the technologies is extensive in their application and impact and poses challenges to existing regulatory systems. For example, the digital online economy generates new jobs and opportunities for firms, and the potential for mobile and homework. However, for governments there are challenges to labour and product market regulation, taxation, and dealing with dominant international tech companies. A joint Australia and New Zealand inquiry into the digital economy (Productivity Commission 2019) commented that regulations currently in place

were designed for a previous technological epoch and are continually challenged by the online economy.

The WEF (2018) regarded reskilling and retraining the workforce as the priority for organisations, industries, occupations, and government to respond to the 4IR technologies. However, while the need for action is apparent, the execution of strategies from the workplace to the national domains is constrained by a lack of information and detailed forecasting of future jobs and skill requirements, as well as a short-term focus across all key stakeholders. The Cisco/Oxford (2018: 43) report commented that 'the faster the rate of change, the greater the disruption imposed on the workforce, and the steeper the challenge for workers and businesses to reskill and adapt'. Given the uneven impact of technological change, the Cisco/Oxford (2018) Report recommended several policy actions as follows:

> 'In the medium term, this may have implications for fiscal policy, as a matter of redistributing the economic gains to ensure a smooth transition for those who lose out. In the longer term, it also means understanding the impact on the trajectory of the earnings and wellbeing of different cohorts of society. As part of this challenge, policymakers are also charged with facilitating the skills transition the economy needs to take advantage of the opportunity's technology will bring. This means understanding the multifaceted nature of the skills challenge that technological change presents, and the training vehicles to meet it' (p. 43).

In terms of education and training, the Australian Industry & Skills Commission (AISC 2017) mapped the implications for more TAFE education and training in Australia. It suggested that: there will be a greater need for collaboration between industry and education; lifelong learning should be part of the training agenda; disciplinary boundaries should be reduced through cross disciplinary education and that the learning models need to become more fluid, capable of on line delivery and provide courses on demand to any location. Hence, education and training systems need to be transformed, and the assumptions that supported the current model of curriculum, design, and delivery are no longer relevant in the context of ongoing structural and technological changes. Similarly, the Pearson (2019) international survey of learning indicated that the construct of a stable, long-term career was no longer applicable, and that future learning processes would be dependent on digital and virtual learning, with greater emphasis on soft skill development.

The chapters in this book demonstrate that there are uniform challenges across all sectors that require a national policy approach. The key national issues are as follows:

1. *Job displacement needs to be addressed*. Jobs will be lost, and government should be proactive in supporting programs that retrain and upgrade skills for displaced workers. Job losses are predicted to occur in low skilled, routine, and non-cognitive employment. However, many skilled and professional jobs will also be lost or transformed in the trades and professions. National workforce planning requires a re-alignment of training and education programs towards continuous and lifelong learning.
2. *Skills and competencies across all occupations and professions need to be reviewed and qualifications upgraded.* This national task addresses point 1 above.

Throughout the chapters a recurring theme is that the 4IR will require new skills and the re-design of these skills would be required for many existing jobs. There was an identified need for soft skills and for education and training institutions to incorporate soft skill development into training and degree programs.

3. *Address the skills shortages*. The third objective is that of addressing the skills shortages that are projected to be present across all sectors. This can be dealt with in part through the first two objectives, but also requires an ongoing evaluation of the size and composition of the skilled migration program. Part of the response is, as the WEF (2018) indicated, to make sure that there are opportunities for women and older workers to access skills, jobs, and careers.
4. *Ethical challenges*. Data storage, data sharing and automated decision-making processes raise important ethical challenges. These ethical and regulatory challenges are present across all the sectors surveyed, are of importance in the public and financial sectors and have been highlighted by recent cases in the banking and government sectors (for example, the banking royal commission and the Robodebt scandal).
5. *Equity challenges*. Finally, there are distributive and equity challenges in terms of not having equal access to opportunities and protections and being adversely impacted by the consequences. Digitally supported work such as crowd working, online working and gig work offer new job opportunities and flexible employment,. although some evidence suggests ambiguous employment status, invisible employers, and eroded employment conditions (de Stefano 2016). In particular, the contours of division emerge – those with limited skills and education are at risk of displacement or exclusion from the workforce; those living outside of capital cities are at risk from exclusion from access to the internet, and those with established skills and vocations are at risk of being displaced by automation and AI; and in terms of age, youth and older workers at different ends of the age spectrum, face transitional challenges in accessing careers.

In Search of a National Technology Policy

According to the Australian Trade and Investment Commission (2017: 1–2), Australia is in an excellent position to capitalise on the opportunities presented by AI technologies. One initiative, for example, is the Australian Department of Industry, Science, Energy & Resources (DISER) which commissioned CSIRO's Data 61 to develop a roadmap entitled *Artificial Intelligence: Solving problems, growing the economy and improving our quality of life* (Hajkowicz et al. 2019: 2–3) which included three key objectives:

1. highlighting areas of focus to advance the development and adoption of AI technologies in Australia including skills, infrastructure, research, regulation and data governance;

2. identifying three areas where Australia could build on its existing strengths and capabilities, with opportunities to solve national problems and export AI-driven solutions, and
3. framing policy discussion to maximise the benefits for Australia.

The roadmap included industry grants, the creation of a Digital Technologies Hub to provide online educational resources and a Data 61 PhD Scholarship Program to promote studies in AI, machine learning and other data-driven technologies. Asserting that robotics and machine learning are imperative for any future manufacturing sector, Hajkowicz et al. (2019, p47) also argued that Australia needs a strategic plan focussing on AI and ML to remain globally competitive in "all industries" with agriculture and bio-sciences requiring priority consideration' (p. 47). Post COVID-19, some observers, such as Davidson (2020: webpage) encapsulated the message from CSIRO through Hajkowicz et al. (2019) stating: 'Australia urgently needs to figure out a national AI strategy if it is to even keep up with the rest of the world'.

Davidson (2020) was forthright in claiming that state and federal government AI strategies and funding have to date fallen significantly short in attempting to reach these objectives or goals. For example, in its statement to its broad membership the Australian Information Computer Technology (ICT) industry signalled problems with the Australian government's current 4IR strategy and policy, asserting that 'currently {Australia} lacks access to relevant local skills, and is not supported by an effective Research and Development Taxation Incentive (R&DTI) Program that fosters an environment of innovation, commercialisation and export of high-quality Australian AI products and services' (Anonymous 2019: webpage).

While there is not yet a dedicated national AI strategy, the government recently published *Australia's Tech Future*. The plan touches upon the economic importance of AI, as well as skills shortages in AI and data science, as part of a broader discussion of opportunities presented by digital technologies. The 2018–19 national budget included an allocation of AU$29.9 million over four years to boost the country's AI capabilities, including the development of a technology road map and frameworks for standards and AI ethics. However, AI experts are issuing warnings that greater levels of spending will be needed for Australia to keep up with other countries that are lavishing public funds on AI initiatives (Loucks et al. 2019: 10).

Deloitte (2020: webpage) explained the lack of effective government policy bluntly maintaining that there is 'no national strategy or proper funding.' It further claimed that Australia did not have a 'dedicated national AI strategy' despite several 'prominent Australian business and industry leaders … urgently pushing for {a} national debate on the policies needed to address AI risks'. Further they cited industry leaders' comments that were critical of the meagre '2018-19 federal budget' allocation of 'AU$29.9 million over four years to boost the country's AI capabilities' (Deloitte 2020: webpage). It also suggested that AI experts have warned that significantly increased levels of spending are required for Australia to keep pace with other countries. 'China for example … has a comprehensive national AI strategy and plans to spend billions to become a world-leading AI innovator. Specifically,

Beijing announced a US$2.1 billion AI-centric technology park, and Tianjin plans to set up a US$16 billion AI fund (Deloitte 2020: webpage).

Smith (2019) reflected the concerns expressed by Deloitte (2020) and Loucks et al. (2019), stating that 'Australia's funding for AI-related initiatives has been comparatively thin' when compared with other developed countries' (Smith 2019: 5). The lack of policy on the 4IR in terms of expenditure is contrary to the fiscal context, as Hajkowicz et al. (2019) argue 'digital technologies, including AI, are potentially worth AU$315 billion to the Australian economy by 2028 and AI could be worth AU$22.17 trillion to the global economy by 2030' (p. v). The $29.9 million in artificial intelligence development under the 2018–2019 budget spread over four years represents such a small fiscal commitment that Australia may be destined for an economic state of disadvantage compared with other global and regional competitors. As comparative examples, France has committed €1.5 billion ($2.4 billion Australian) over five years leading up to 2022; the South Korean government committed to 2.2 trillion won ($2.7 billion) over the same period; India and the European Union also published ambitious AI strategies; Canada pledged $C125 million ($131 million) over five years starting in 2017′ and Singapore committed $S150 million ($155 million) from 2017 to 2022 (Seo 2019: webpage).

Furthermore in Australia, there is an absence of discussion on some of the big issues linked to the 4IR, specifically around how to distribute the productivity gains of the 4IR as efficiency gains could be potentially translated into job losses, higher wages, lower product prices, reduced working hours, and increased profitability. Some key questions posed by the ILO (2017) are also worthy of note. For example, the ILO raised these questions: should there be a social dividend to compensate the losers in the process and should new technology, especially if it displaces labour, be subjected to a new form of tax for industry? (ILO 2017).

Industry Strategies

As apparent from the chapters in this book, specific industry challenges differ but there are shared challenges linked to skill shortages, skills development, and the management of structural adjustments to the industries linked to 4IR technologies. All industry sectors need to significantly increase their support for investment and ongoing research into 4IR technologies to reap the potentially enormous benefits to the economy and their own businesses. Blumenstein (a fellow of the Australian Computer Society), predicted that AI could contribute around $22.17 trillion to the global economy by 2030 according to the Australian Computer Society (ACS) (2020). However, to participate, Australia must boost AI investment according to Blumenstein, quoted by ACS (2020):

> 'I believe we have a long way to go to increase our investment in AI, said Blumenstein. It's really great to look at roadmaps because they are a snapshot of the current status. By ranking of the number of scientific publications and the research output we create in this country, we are number one by capita. The challenge there is the translation of that research. We

have the top ranking by research in the world in AI – the next big step is investing and growing that pie' (webpage).

The Australian Trade & Industry Commission (2017: 1) stated that Australia's transition from a resource-based to a services-based economy is 'driving opportunities in disruptive technologies across multiple sectors, including advanced manufacturing, agriculture, services, health, infrastructure, and resources and energy' (sectors that are included in this book). The Australian Trade & Industry Commission (2017:1) argued that the key strengths for Australian industry to capitalise on due to the 4IR include 'niche solutions and proven capability in additive manufacturing, artificial intelligence, automation, big data and analytics, blockchain, cloud, cybersecurity, immersive simulation, the Internet of Things and systems integration.'

The CSIRO Roadmap (Hajkowicz et al. 2019: 47–51) suggested seven priorities for government and industry to focus on for the effective future management of 4IR technologies in Australia, including government policy issues. These strategies include:

1. Developing an AI specialist technical workforce to meet the operational needs of industry;
2. Helping workers whose jobs are likely to be positively or negatively impacted by AI and related digital technologies make early and strategic career transitions;
3. Ensuring effective data governance and access as AI is typically data hungry and machine learning algorithms need "training data" to be developed and tested;
4. Building trust in AI by ensuring high standards and transparency for all applications developed and applied in Australia;
5. Increasing the activity within the science, research and technology development pipeline to ensure advanced AI capabilities for government and industry in the future;
6. Improving digital infrastructure (for data transmission, storage, analysis and acquisition) and cybersecurity so that AI can be safely and effectively used across Australian cities and regions, and
7. Developing appropriate systems and standards to ensure safe, quality-assured, interoperable and ethical AI is developed and applied within Australia'.

These priorities indicate that 4IR technologies should be a focus for policymakers and government for some time to come. Of course implications will vary across different sectors and this will need careful management as the government and educators work to ensure that the skills required by businesses as they endeavour to adopt new technologies can be delivered quickly.

Conclusion

The WEF (2018) survey of large corporations revealed a split between industries that saw future skill requirements being stable, and those that saw them as being disrupted. Those industries considered to have stable skill needs include health, energy, retail, media, and professional services. Skill disruptions were forecast in the financial services, ICT, logistics, and infrastructure sectors. The future strategies that were seen to be effective in addressing skill needs and shortages included: investment in reskilling current employees; support for mobility and job rotation; collaboration with educational institutions; targeting female talent; attracting foreign talent and offering increased apprenticeships (WEF 2018).

This book has drawn on the expertise of several Australian based academics to examine how new technologies are either impacting industry sectors, or how they may do so in the future. The impact on workplaces due to technical change is an issue that should concern everyone. Underemployment or unemployment can induce economic problems for individuals and the broader society. As a result, there is a need for policy interventions and significant investment and planning to hold a society together and build a robust economy. This concluding chapter, and elsewhere suggests that currently a policy vacuum is apparent as far as the Australian Federal Government policies are concerned, which is in stark contrast to the investments being made by other countries within the competitive global marketplace. The impact of technological change on the skill requirements of the industry sectors covered in this book has been signalled throughout. Unfortunately, we were able to identify little in terms of active programs in place to support organisations and workers to accommodate the predicted technological changes. The development of skills to address the 4IR technologies is more promising in our tertiary institutions, although more policy intervention is undoubtedly needed in the educational domains as well as the need for informal and formal training for current employees. In addition to relevant programs and policies to meet predicted changes within all the Australian industry sectors, broader policy development is vital. Australia certainly has the potential to make a positive impact in a new era where technological advances have unprecedented impact even with the recent COVID-19 challenges considered.

As outlined in chapter one, although this book addresses draws on multiple data sources, the analysis is exploratory in nature, mainly drawing on secondary sources from the key stakeholder groups associated with each industry sector. As the assimilation of 4IR technologies, government policies and education/training programs matures in Australia it is recommended that future research may include broader and deeper research that may focus for example on just one sector, or on a particular aspect across sectors such as skills to provide important insights for strategic planning and more. As the Cisco/Oxford Economics report (2019: 44) points out ‘How well the stakeholders in Australia’s future can capitalise on those opportunities, for the net benefit of the whole population, will depend on how well it deals with the skills transition’.

Appendix 13.1: Summary of Chapter Findings

Chapter	Industry Overview	Key Technologies (KT)	Impacts of KT on employment/ occupations/productivity	Challenges & Opportunities
2. Agriculture, Construction & Mining	Contributing more than $63 billion or 2.3% to Australia's GDP, Australia is already the 12th largest exporter of agricultural products in the world. Impacted by consequences of climate change: drought, bushfires pressure on river systems and over fishing.	Cropping technologies, automated food production/ packaging; drone livestock maintenance and blockchain, to track food production and supply chains.	Slow decline in employment. Ageing workforce & youth migration out of rural and regional areas. Some manufacturing may be brought back onshore as capabilities such as 3D printing help Australian manufacturers meet demand for highly customised products.	**Challenges:** Without coordinated reskilling efforts, the automation of low-skilled positions could see a large proportion of the agricultural workforce facing unemployment. **Opportunities:** FishTech and 'aquabotics', aquaculture, cell cultured meat and cellular agriculture.
3. Manufacturing	The share of GDP derived from manufacturing fell from 10.7% in 1991–1992 to 5.8% in 2017–2018. While manufacturing and agriculture were dominant industries in the past, service industries are now increasingly important for employment.	Artificial intelligence (AI), digital sensors, big data analytics, additive manufacturing (i.e. 3D-printing), virtual reality (VR), augmented reality (AR) and machine learning (ML).	Improved manufacturing innovation and output, market share and competitiveness. High-value employment in 4IR will require the integration of technical skills with personal skills.	**Challenges:** A downturn in apprenticeships as a result of COVID-19 could present labour shortfalls. **Opportunities:** The 'deglobalisation' implications of COVID-19 may facilitate a resurgence in manufacturing.

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Appendix 13.1 (continued)

Chapter	Industry Overview	Key Technologies (KT)	Impacts of KT on employment/ occupations/productivity	Challenges & Opportunities
4. Retail	The retail sector is the largest employer in Australia. It ranks 8th of all industry sectors in terms of revenue and employment growth and first by employee numbers. Much employment is in unskilled or low-skilled occupations.	Virtual assistants, augmented reality, algorithms, data-driven insights, AI-enabled chatbots and biometric payments system.	Jobs likely to be 'augmented' by 4IR technologies include software developers, process improvement specialists, data engineers and infrastructure service analysts. New digital technologies and the transition to greater online selling will reduce employment at the lower end of the occupational spectrum. Revenues and profits may surge, accompanied by structural changes favouring large international and domestic retailers.	**Challenges:** The shift in emphasis away from semi-skilled or skilled jobs to highly-skilled professional roles is likely to specifically disadvantage women, transitional workers and retail employees in rural and remote areas of Australia. **Opportunities:** Many retailers may benefit from significantly reduced production, delivery, product promotion and infrastructure costs, enhanced competitiveness and profitability.
5. Accommodation & Food Services	Tourism industries collectively contributed over $100 billion to Australia's GDP and employed nearly one million people in 2019. One-third of AFS sector related jobs were lost due to disruptions caused by COVID-19.	Industrial and social robots, self-service kiosks, artificial intelligence, chatbots, face recognition technology, voice-controlled technologies, wearable and implanted technologies, 3D printing, the internet of things, and other automation technologies that are used instead of human employees.	Innovations such as accommodation providers adopting a fully automated online business model without any face-to-face contact with customers at the time of bookings, making payments for the services and during the stay. The increasing adoption of technologies will increase the demand for digital competencies in the AFS workforce. The hospitality sector has one of the highest levels of automation susceptibility in Australia.	**Challenges:** The lack of 4IR readiness and growing shortage of skilled and semi-skilled labour. The COVID-19 pandemic, and deteriorating diplomatic relations with China, will reduce the number of tourists visiting Australia. **Opportunities:** The lack of overseas travel means that post COVID-19 domestic tourism is likely to get a boost.

6. Transport & Logistics	The transport industry accounts for about 4.6% of GDP. The Australian freight logistics industry accounts for 8.6% of GDP. The sector's workforce is characterised by an ageing workforce, and struggles to attract younger workers.	Automation (such as driverless trains and trucks), Connected and Automated Vehicles (CAVs), robotics, artificial intelligence, human-machine interfaces, advanced computer systems and big data to create 'smart' processes and products.	New occupations have emerged because of these disruptive technologies. Increased demand for expertise in robotics, systems and electronics engineering, as well as digital literacy, digital business, business analytics and computer science. CAVs will see existing drivers replaced with employees with new skills in cybersecurity and automated systems. Technological advances are reducing new infrastructure cost, improving road safety, and improving the efficiency of freight transport. Collaborative electronic platforms will replace many administrative staff. There will be an increase in short-term contracts or freelance work as opposed to permanent jobs.	**Challenges:** As government policy on workforce digital transformation in Australia is lacking, employers must not only implement extensive in-house re-and up-skilling for their workers but also actively develop a sustainable pool of workers for the 4IR. Without an effective and sustainable response to the skills question in the sector, the economy faces significant challenges since efficient transport services are critical to Australia's access to domestic and international markets. **Opportunities:** Future growth in the land freight sector will be facilitated by automation, such as driverless trains and trucks. Automation of stevedoring operations will continue to improve the operational efficiency of major transport and logistic hubs in Australia.

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Appendix 13.1 (continued)

Chapter	Industry Overview	Key Technologies (KT)	Impacts of KT on employment/ occupations/productivity	Challenges & Opportunities
7. Media & Communications	Digital platforms, such as Facebook and Google, have resulted in significantly reduced advertising revenue within traditional media. In the last decade, the print media have experienced a decline in revenue of 45% to AU$3 billion, and television revenue has also fallen considerably.	Artificial intelligence as a news-gathering tool, automated advertising, automated news systems, robo-writing, machine learning, AI in the scripting, shooting, post-production and distribution of media materials.	Many employees who previously worked within complex workflows have now been superseded by digital production processes. Workers, such as journalists and screen producers, may benefit from further specialist training in areas that enhance their digital literacy, such as programming, data analytics, virtual or 360 production skills, web or software design.	**Challenges:** Citizens, who are elderly, lowly-paid, in precarious employment, or lacking tertiary education, are less likely to be "digitally" included. **Opportunities:** AI-driven processes can achieve a high level of technical precision and organisation which promises a positive future for them as augmenting agents which assist the work of humans in the field. There will be increased demand for analysts and machine trainers to detect and disclose biases that may be inherent in the processes of machine learning.
8. Financial & Insurance Services	4% of the workforce is employed in the sector. The 'Big 4' banks together account for 40% of total sector employment.	AI-aided customer- and self-service, automation, robo-advisors, machine learning for lending decisions and credit scoring.	15–30% of employment will be in the risk zone due to automation. Jobs most threatened include those that are described as routine, repetitive tasks conducted physically and cognitively (such as, accounts and bank clerks, secretaries, receptionists, call centre staff, credit and loans officers and debt collectors).	**Challenges:** Due to the economic effects of COVID-19, the profitability and net interest margins of lenders are likely to be squeezed with a significant impact on employment **Opportunities:** There is potential for automation to be utilised more in back-office activities, assisting employees in customer interactions that require emotional intelligence.

9. Local Government	Total employment in the local government (LG) sector is around 190,000 and it manages non-financial assets valued at over $400 billion.	Automation and digital technology, drones, solar energy cells, sensors, satellite technology and cloud computing.	Automation and digital technology can support many LG functions such as monitoring the environment, planning and development, customer feedback, parking, the maintenance of parks, gardens, roads and footpaths. Clerical and administrative positions are most likely to be replaced by technology.	**Challenges:** Ethical challenges around data storage, surveillance systems, data sharing, and automated decision making in the delivery of public services. Due to the economic effects of COVID-19, the financial capacity to deliver services will be negatively affected. **Opportunities:** Technology has supported the extension and accessibility of services within local communities.
10. Higher Education	Australian universities employ over 130,000 people in academic and professional roles. Downturn in student enrolments due to COVID-19 has led to widespread job losses.	Blockchain technology, artificial intelligence and robotics, virtual reality simulations, supercomputers, web-based learning, and educational robots.	Academic workloads and costs can be reduced through AI tools such as automated marking, record-keeping and student feedback. The loss of casual academic staff means that those in permanent academic roles are likely to have to take on more teaching and will therefore be unable to conduct as much research as before. Academics are taking on greater teaching loads - much of it online.	**Challenges:** AI and machine learning cannot deal with creative intelligence tasks, and AI-powered tools cannot work with social intelligence tasks. When AI is in use, more attention is needed in terms of ethics and efficacy. Moreover, transparent and accountable systems of governance need to be considered when adopting AI in education. **Opportunities:** Educational cobots - robots that work alongside humans - can help lecturers differentiate instructions between each learner so that learners receive more tailored teaching.

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Appendix 13.1 (continued)

Chapter	Industry Overview	Key Technologies (KT)	Impacts of KT on employment/ occupations/productivity	Challenges & Opportunities
11. Healthcare	The health sector is the largest employing industry. The sector employed 1.7 million healthcare workers in 2019.	Machine learning in precision medicine, AI-based healthcare applications covering assisted surgery, preliminary diagnosis, and administrative workflows. Healthcare, such as blood tests, provided by robots.	AI and automation will replace 20% of occupations in the public sector, such as those in health and education, by 2030. However, by 2025, all healthcare workers including nurses, doctors and midwives, are expected to remain in the workforce. There will be a shift in the workforce to more specialised employment roles capable of dealing with the advancement of technology It is predicted that by 2030 there will be a shortage of 600,000 university graduates in the health sector. One of the most significant benefits of AI is helping people to manage their own health.	**Challenges:** The over-usage of technology could have negative effects on clinical practices, such as communication and the socio-emotional aspects of patient care. In addition, the communication skills of physicians may deteriorate due to reliance on technology. **Opportunities:** The support AI offers healthcare staff may free up their time from administrative tasks and allow them to spend more time with patients supporting their socio-emotional needs. AI creates opportunities for new job roles, upskilling through the utilisation of data generated by AI.

12. Utilities	The utility industry has the overall responsibly for the production and distribution of energy, water, and gas throughout Australia. The utility sector includes approximately 155,000 jobs.	Distributed energy resources (DER), Industrial internet of things (IIoT), blockchain, machine learning, and Cloud computing on asset monitoring, drones, smart metering, sensor networks and predictive maintenance.	Lower skills jobs (truck drivers, recycling and rubbish collectors, "other" stationary plant operators), and chemical, gas, petroleum and power plant operators, are most susceptible to automation. Some medium skill jobs, such as electrical distribution trades workers, are also susceptible to automation. More highly-skilled roles, such as programmers, auditors and professional consultants, will be required.	**Challenges:** Training is required to equip employees with the skillsets and tools for better utilisation of data. Privacy and ethical concerns are associated with personal data being collected. Digital technologies can improve the overall utilisation of utilities, while at the same time making them more vulnerable and fragile to supply and demand fluctuations, software glitches and cyber-attacks. **Opportunities:** The deployment and maintenance costs of a Utility 4.0 network can be vastly reduced by the use of blockchain technologies.

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