Chapter 1
Introduction

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Abstract Although an extensive literature has been developed that examines the impact of technological change, to date this has not included a focus on the impacts of the Fourth Industrial Revolution (4IR) technologies on industry sectors in Australia. This book sets out to fill that gap by exploring a broad range of Australian industry sectors categorised by the Australian and New Zealand Standard Industrial Classification of Industries (ANZSIC). It explores the types of new technologies associated with the 4IR being implemented across eight sectors; and multiple stakeholders' predictions about the potential changes to the associated labour markets, jobs, and skills.

Keywords 4IR · Covid-19 · Structural change · Technological change

Introduction

The nature and technical capabilities of industry sectors differ, as do their labour requirements in terms of jobs, tasks, and skills. Within the context of the range of technologies linked to the 4IR, the purpose of this book is to examine the actual and projected changes that are taking place across Australian industry sectors by addressing the following questions in each chapter:

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(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?

In addition to outlining the topics and key questions explored in this book in relation to 4IR technologies in the selected industry sectors in Australia, this chapter incorporates a range of definitions and concepts. It begins with the nature and challenges of the 4IR before briefly considering changes in jobs, work, skills and potential new occupations and their associated new skills that have emerged. The chapter outlines structural changes in Australia, the global context of the 4IR, the framework used to structure each chapter, and the research methods used to guide authors' investigations, before providing a summary of each chapter.

What Is the Fourth Industrial Revolution (4IR)?

There has been considerable debate about the nature of what has been referred to as the Fourth Industrial Revolution (4IR) or Industry 4.0. The term 4IR was coined by Klaus Schwab, the founder of the World Economic Forum (WEF 2016), who suggested that the 'velocity, scope, and systems impact (of the 4IR) is evolving at an exponential rather than a linear pace' (Schwab 2016), with new and emerging technologies distinguishing it from previous industrial revolutions. Schwab's (2016) conceptualisation and rationale have been promoted by many authors (see Brynjolfsson and McAfee 2017; Cedefop 2019; EIU 2018; Finextra and Intel 2017; Fluss 2017; Scarpetta 2017), and the term 4IR has since acquired common parlance status. The four industrial revolutions referred to in Schwab's framework are:

> The First Industrial Revolution used water and steam power to mechanize production. The Second used electric power to create mass production. The Third used electronics and information technology to automate production. Now a Fourth Industrial Revolution is building on the Third, the digital revolution that has been occurring since the middle of the last century. It is characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres (Schwab 2016: webpage).

These four stages of technological development cover a period of around two hundred years. However, the 4th revolution has evolved only the past two decades. The short duration between stages 3 and 4 are symptomatic of the speed and extent

of technological change, with the 4th stage being built upon the technological developments of the 3rd stage, leading Schwab to comment:

> There are three reasons why today's transformations represent not merely a prolongation of the Third Industrial Revolution but rather the arrival of a Fourth and distinct one: velocity, scope, and systems impact. The speed of current breakthroughs has no historical precedent. When compared with previous industrial revolutions, the Fourth is evolving at an exponential rather than a linear pace. Moreover, it is disrupting almost every industry in every country. And the breadth and depth of these changes herald the transformation of entire systems of production, management, and governance (Schwab 2016: webpage).

The 4IR is not country or industry specific. It permeates the globe and has the potential to impact on all communities at different stages of development, and in various industry sectors. However, it is unlikely to have a significant impact on countries that have poor infrastructure to support ICT; large labour surpluses; large populations in rural areas or an extensive subsistence and informal economy (Ayentimi and Burgess 2018). The developing world is simultaneously experiencing forces other than technological change which are poised to impact labour markets (Bandura and Hammond 2018). First, it is 'rapidly urbanizing, creating challenges for cities in terms of infrastructure, job creation, and basic social services. Second, different regions are following varied demographic transition paths that will affect the number of potential workers, the composition of the workforce, and the types of jobs created' (Bandura and Hammond 2018: 3). It can also be argued that the emergence of the COVID-19 pandemic may have accelerated the implementation of these innovative technologies in some countries and sectors. This is evident as employers strive to reduce their staffing costs by replacing them with artificial intelligence or machine learning technologies, whilst in others economic factors may constrain such imperatives. As outlined in the chapters in this book there are already significant differences between the various Australian industry sectors in relation to their recovery from the pandemic and their subsequent intentions and capacity to utilise these new technologies.

On the positive side, the 4IR has been promoted as providing significant benefits to organisations and their managers through creating opportunities to deliver increased and higher quality products and services at a considerably cheaper cost, with enhanced speed and improved reliability (Acemoglu and Restrepo 2017; Arnold et al. 2018; Dilsizian and Siegel 2014). Conversely, the anticipated negative consequences of the 4IR have primarily focused on its threats to labour markets, workplaces, jobs (both quantity and quality), skills and employees more generally through the expectation that these new technologies will lead to massive job disruption, significant job losses and employee de-skilling (Bandura and Hammond 2018; Brynjolfsson and McAfee 2017; Finextra and Intel 2017; Fluss 2017, Marrengo 2019). That said, it has been pointed out that computerisation automates tasks, rather than jobs, and consequently the nature of most jobs is likely to change rather than disappear due to automation (Arntz et al. 2016; Susskind 2020).

Nations and industries can potentially encompass all four 'revolutions' through the processes of international trade and investment and the global spread of digital technology and the internet. However, the 4IR concept is not without its critics. The

problems are linked to technological determinism, under which, there are no points of resistance to the changes and the underlying conditions supporting technological change are constant. For example, Rainnie and Dean (2019) state that the literature on Industry 4.0 deals with technology, and the problem-solving of digital transformation issues and embedding firms within production systems. It canvasses issues of standardisation and communication and making the business and consumer case for the digitalisation of manufacturing production. Attention to the impact of (the 4IR) on more pressing human dimensions of digitally-driven industrial change is significantly lacking (p. 17).

What Are the 4IR Transforming Technologies?

In a survey of 371 leading global companies, the World Economic Forum (WEF 2016) identified the main technologies that are driving changes to work, working, jobs, skills, and the future of work (FOW). These technological changes are listed below in order of those regarded by survey respondents as being the most significant changes for their organisation and industry:

1. Mobile internet and cloud technology
2. Advances in computing power and Big Data
3. New energy supplies and technologies.
4. The Internet of Things through remote sensors, communications, and processing power in industrial and household equipment
5. Crowdsourcing, the sharing economy, and peer-to-peer platforms
6. Advanced robotics and autonomous transport
7. Artificial intelligence and machine learning
8. Advanced manufacturing and 3D printing
9. Advanced materials, biotechnology, and genomics

These technologies have potential applications across all industries supporting new production processes, new industries, new ways of working or providing entertainment and consumption. They also support efficiency improvements and productivity increases while changing the skill mix required for many industry sectors. The technological possibilities are extensive. Many of the technologies are transformative and disruptive to existing production employment and distribution arrangements within industry sectors, raising questions linked to the impact of the technologies on jobs and living standards, and how the benefits of these technologies will be supported and distributed. Schwab (2016) discusses the potential inequities that could arise as follows:

> …inequality represents the greatest societal concern associated with the Fourth Industrial Revolution. The largest beneficiaries of innovation tend to be the providers of intellectual and physical capital—the innovators, shareholders, and investors—which explains the rising gap in wealth between those dependent on capital versus labor. Technology is therefore

one of the main reasons why incomes have stagnated, or even decreased, for a majority of the population in high-income countries.

Are All Jobs and Sectors Equally Affected by Technological Change?

The displacement effects of technology will depend on the type of technological applications; the skill composition of jobs; and the extent to which the technologies can be supported and implemented. In Australia, a report produced by Cisco and Oxford Economics (2019: p. 3) suggested that the greatest displacement effects, that is the substitution of technology for jobs over the period 2018–2028, will occur in the following sectors: transport (12.4%); construction (11.2%); mining (10.7%); agriculture (10.4%); utilities (9.5%) and manufacturing (9.4%). Specifically, based on the modelling, 12.4% of equivalent full-time jobs in the transport sector will be displaced by technology over the coming decade with the aggregate displacement effect resulting in 630,000 full-time jobs across the economy. In terms of the most vulnerable sectors due to technological job displacement the report commented that:

> …the relative vulnerability of these sectors to technology-driven displacement is a result of the nature of their work. Workers spend more time operating vehicles, handling objects and controlling machines, all of which have the potential to be completed more efficiently with the application of new and existing technologies, such as advanced robotics and machine learning' (Cisco and Oxford Economics 2019: 9).

In general terms this refers to craft, trades, and transport jobs that are mainly performed by male workers in positions such as drivers, machine operators, mechanics, carpenters, technicians, and warehouse workers.

The Intersection of Structural Changes and the 4IR

One of the challenges in assessing the impact of the 4IR is that, in addition to technological changes there are structural changes that will impact on the level and growth of demand for output and jobs, and the composition of production and employment. Returning to the WEF (2016) discussion of the 4IR, their survey asked respondents from leading global companies to identify what they regarded as the primary demographic and socio-economic factors driving change in their organisations. The most significant factors identified were as follows, with the percentage referring to the proportion of respondents who identified the factor as the most important change:

- Changing work environments and flexible working arrangements (44%): remote working, co-working; teleconferencing; increased sub-contracting.

- Rise of the middle class in emerging markets (23%); rising living standards, especially in Asia, to drive and change the composition of global demand.
- Climate change, natural resource constraints and the transition to a greener economy (23%): innovation in energy development and storage; controls over carbon emissions.
- Rising geopolitical volatility (21%): implications for global trade and investment; increased expenditure on defence and policing.
- Consumer concerns about ethical and privacy issues (16%): ethical investment funds; NGO monitoring of human rights; fair trade and supply chain assessments; on-line privacy.
- Longevity and ageing (14%): especially in advanced economies. Implications for health, labour force participation, education, savings, and international migration.
- Young demographics in emerging markets (13%): population growth in emerging economies with pressures on education, youth labour markets; and implications for international migration.
- Women's rising aspirations and economic power (12%): increased labour force participation; increased household incomes; breaking down gender barriers to participation and
- Rapid urbanisation (8%): pressures on infrastructure and the environment; congestion and commuting.

Aggregating structural changes alongside technological changes will indicate the combined impact on jobs and skill requirements in the coming years. The job displacement effects of technological change are offset by increasing demand due to population and income growth. Automated check-out machines and online shopping will reduce the demand for sales staff in supermarkets and department stores, but as the population and income expands, there will likely be requirements for additional supermarkets and department stores.

The (2019) Cisco and Oxford Economics report forecast the net changes in jobs for the period 2018–2028 by sector in Australia, adding together the technological and income effects. The income effects represent the projected growth in the economy and its impact on sector output and jobs. Combining the two effects (the positive income effects and the adverse displacement effects from technological change) the three sectors that will have contributed the most jobs over the decade were forecast to be (presented in thousands of full-time equivalent jobs): healthcare (79.5); hotels and restaurants (21.6) and wholesale and retail trade (20.5). The three sectors with the most significant net job loss were: construction (73.2); manufacturing (33.3) and transport (26.1).

However, the forecasts were undertaken prior to the COVID-19 pandemic and are therefore unlikely to accurately reflect post-2020 workforce conditions. Such steady-state growth forecasts are of course eroded by unexpected changes and crises (such as bushfires, wars, earthquakes and flooding) which impact on growth, trade, investment, and the uptake of new technologies.

Impact of the 4IR on Work, Skills and Occupations

The WEF (2016) report found that changes in both where and how work is conducted will be one of the major developments from technological change. COVID-19 has forced organisations and workers to embrace mobile technologies and working away from central workplaces as options. Prior to the COVID-19 pandemic, approximately 24% of Australian workers reported working some hours from home. However, between March and April 2020, that number almost doubled, with 48% of workers transitioning to remote work (ABS 2020). In their analysis of future jobs, Ross et al. highlighted new ways of working, including technological versus geographical proximity in work and workplace identity; web intermediated work; coworking and offshoring. They argued that technological developments not only affect job and skill profiles, but also potentially how work is carried out, where and when it is conducted and for whom the work is performed. Internet technologies reconstruct the nature of the workplace, the employer, and the employment relationship. The 4IR promises to fundamentally transform the ways in which we interact with machines, and in addition, the way that machines learn, improve, and build on their own performance. The benefits of these new digital technologies may be considerable (Lu and Burton 2017). However, their impact on future work processes, training needs and workforce structures, as well as the ethical frameworks for their implementation, demand equal consideration by all stakeholders likely to be involved in decisions about their usage in various industry sectors and organisations.

The WEF (2016, 22) analysis on the future of work concluded that:

> …in the face of rapidly rising computing power, an ability to work with data and make data-based decisions will become an increasingly vital skill across many job families as employers scramble to build a workforce with solid skills in data analysis and presentation (e.g. through visualization) and the amount of potentially useful digital information generated and stored keeps increasing exponentially.

This analysis of global firms indicates that skillsets will need to change, and as a result, the potential for skills mismatches will increase as educational and training programs lag behind the skill changes required for the new technologies. Across the industries surveyed, the three primary skills identified were complex problem-solving skills, social skills, and process skills with the largest increase in future skills being cognitive abilities.

Ongoing Structural Change in Australia

Technological change is continuous and disruptive. However, it is not only technology that is changing; the underlying conditions that influence production, investment, and employment are also changing. While technology and automation have the potential to displace labour, other factors increase production and jobs. For

example, underlying wealth and income growth lead to increased trade, and demographic change. As communities become wealthier, they demand products and services that are supported by higher incomes – for example, hospitality and travel. Technology also drives down the cost of products, such as consumer electronics that become more affordable with increased demand. Demographic change alters the composition of production. Australia is ageing, and with it, the ageing community requires additional leisure and health services (Devasahayam et al. 2018; Federal Treasury 2010). The proportion of total participation in the labour market by mature-aged persons (aged 55 years and over) 'increased from 9.1%in May 1989 to 19.3% in May 2019 (Department of Employment, Skills, Small and Family Business 2019: 5). This upward trend reflects the ageing population as life expectancy steadily increases over time (Department of Employment, Skills, Small and Family Business 2019). An important demographic factor in Australia is also net immigration as it offsets ageing since the migrant cohort is, on average, younger than the general population and migrants also provide a source of skilled labour (Devasahayam et al. 2018). Moreover, the younger immigrant cohort increases the demand for such services as housing and schooling (Devasahayam et al. 2018). However, a significant decrease in migration during and following the COVID-19 pandemic will undoubtedly affect this demographic trend in Australia.

In the last thirty years, Australia's labour market has undergone a structural change with a significant shift from production industries to labour-intensive service industries and higher-skilled occupations. Technological advances over the last three decades have resulted in a changing labour market, with amplified automation supporting jobs that 'are non-routine in nature and require people to have skills that are not easily replicated by a machine (such as social skills, emotional intelligence, creativity and advanced reasoning)' (Department of Employment, Skills, Small and Family Business 2019:1). The shift to services and automation, as discussed earlier, has been prominent since 1989–2019.

In 1989, manufacturing was the largest Australian industry sector in terms of employment, accounting for 15.2% of total persons employed (Department of Employment, Skills, Small and Family Business 2019). In 2019 – three decades later, employment in manufacturing has fallen by 316,600 (or 27.2%) and is the seventh-largest employing industry, accounting for 6.6% of the total workforce. In the face of the long-term decline recorded in this industry sector, manufacturing does however remain a substantial employing industry, as 848,700 workers were employed in May 2019 (Department of Employment, Skills, Small and Family Business 2019). Occupations commensurate with the highest skill level (usually requiring a bachelor's degree or higher) accounted for 45.1% of total employment growth over the past three decades. By contrast, occupations commensurate with the lowest skill level (usually requiring Certificate I or secondary education) accounted for only 9.4% of total employment growth (Department of Employment, Skills, Small and Family Business 2019: 3).

The extent and complexity of structural change in Australia and its impact on the labour market have been captured by several studies (Adeney 2018; Connolly and Lewis 2010; Heath 2016). Adeney (2018) indicated that there are internal sectoral

changes that are shifting production from goods and distribution to service production, especially in the business and professional services sectors. These have resulted in a consequential shift in skill requirements across the economy towards business and professional skills- jobs that require high-level cognitive skills.

Further, Heath (2016) demonstrated that the changing composition of jobs can be divided by skill sets into routine and cognitive. Routine jobs involve homogenous and repetitive tasks and are associated with relatively short training periods. Cognitive jobs are characterised by complex and multiple tasks, involve autonomy, and require extensive training. Some routine jobs require cognitive skills, for example, customer inquiry, complaints, and service centres. Using this classification, Heath (2016) argued that the jobs that are increasing have non- routine and cognitive attributes. While the sectoral change will generate changes in the compositions of jobs, together with other conditions such as technology, there are likely to be changes to the skill composition of both existing and new jobs. Across each industry sector the underlying structural conditions determining output and employment differ. These include income, demographic, international and policy conditions. Technology can displace not only labour but can also change the skill requirements for the industry. As a result, when considering the impact of the range of technologies associated with the 4IR, consideration also needs to be given to the other conditions that are changing the demand for labour and skills.

Positioning Australia in the Global Context of the 4IR

The WEF (2016) survey of global corporations reported that the four main barriers that organisations faced in addressing projected skills needs were insufficient understanding of disruptive changes, resource constraints, pressure from shareholders, and workforce strategies unaligned with innovation strategies. Large, sophisticated, and international organisations with embedded human resource management (HRM) programs and strategies were regarded as not being prepared for the workforce and skill changes associated with the 4IR.

The 2019 Australian Industry Group (AIG) report *The Fourth Industrial Revolution – Australian Businesses in Transition* stated that 'Australian businesses are currently transitioning to the Fourth Industrial Revolution (or Industry 4.0)' (p. 5). The report indicated that progress towards Industry 4.0 has been evident mostly from leading local and multinational firms that have been 'doing amazing things with new technology and leading the way for others' (AIG 2019: 5), while the gap between these firms and most other businesses is substantial in terms of the integration of technological advances into productive pursuits. A research report by Renjen (2020) for a *Deloitte Review* focused on exploring readiness to leverage the 4IR to benefit customers, employees, communities, and other key stakeholders. Drawing on findings from 1600 C-level executives surveyed across nineteen countries, in addition to personal interviews, it was reported that many executives lack

confidence in their organisations' readiness to influence and harness the opportunities offered by the 4IR.

For Australia, the findings indicate that only 2% of Australian business leaders felt confident that they could exploit the changes associated with the 4IR, compared with 14% of executives globally (Renjen 2020). That said, the Australian CEOs surveyed were reportedly the most confident concerning the skills and abilities of their current workforce to adapt to the necessary changes. Specifically, 71% of Australian executives (compared with 40% globally) reported that they have people in place with the right skills to maximise their potential. This was the highest percentage of any country surveyed. The two statements appear to be paradoxical, however, as it begs the question as to why CEOs lack the confidence to exploit the necessary changes required for the 4IR if they believe they have employees with the right skills to do so.

An earlier study by the Economist Intelligence Unit (EIU 2018) resulted in the creation of the Automation Readiness Index (ARI) where Australia was ranked 10th out of a total of twenty-five countries. The Automation Readiness Index compares countries on their preparedness for the age of intelligent automation. In assessing the existence of policy and strategy in the areas of innovation, education and the labour market, the study found that little policy was in place that specifically addresses the challenges of AI- and robotics-based automation (EIU 2018: 5).

Countries were compared according to their relative 'readiness' status for automation. Readiness relates to the ability to develop and apply automated solutions, together with their capacity to support the innovation process (through education) and translate it into programs that support workplace adjustment and upskilling. The ARI ranked the selected countries against these criteria. The Index focuses on three policy areas: innovation policy (government and industry); education policy (secondary, vocational, and higher education systems) and labour market policy (government, industry and educational systems) – (EIU 2018). These were informed by fifty-two indicators that were combined to provide a score by each criteria. Across the three key areas that influence readiness, Australia's rankings were: innovation environment (7/25), education policies (11/25), and labour market policies (10/25).

The Economist Intelligence Unit Report (2018: 7) included two key findings, namely:

> Automation thus points toward the augmentation of work, potentially leading to greater job satisfaction, as well as to outright displacement. Humans will continue to play a role in designing or operating these systems, and it is expected that many activities will continue to require the distinct skills of humans. Work performed by people will be continuously redefined, requiring the constant updating of skills. Governments, businesses, educators, labour unions and civil society organisations all have roles to play in developing an understanding of what the impacts of automation are likely to be and to plan initiatives that will help their societies adapt.

A subsequent study conducted in Australia reported on the level of preparedness amongst Australian human resource management (HRM) professionals related to the impact of the 4IR on organisations, workplaces, jobs and skills, as well as on

their professional roles and competencies (Nankervis et al. 2019). Survey findings indicated that, while most HRM professionals felt that 4IR technologies would be useful for their organisations and assist with improving job performance, increasing productivity and making jobs easier for employees, not many intended to use these technologies soon. Many survey respondents also reported that they were not impressed with the lack of current Australian government 4IR strategies and policies. This sentiment is also evident in the Australian Industry Group (AIG 2019:3) report:

> People are right to demand solutions. Real solutions need substance and rigour. There is a growing risk worldwide that anger, distrust, and the need to be seen to be doing something lead to populist or heavy-handed proposals on trade, regulation, and technology. That would undermine the foundations both of global growth and Australia's strong performance over recent decades. Australia needs to achieve inclusive growth. Making the most of the Fourth Industrial Revolution is essential to that goal.

The Framework for Evaluating the 4IR

Critical reviews of the 4IR and the future of work (FOW) highlight the absence of nuanced analyses such as how the new technologies impact the gendered division of labour, the spatial distribution of jobs across regions and countries, and the quality of jobs (Rainnie and Dean 2019). To develop a systematic link between the 4IR and the FOW, there is a need for an analytical starting point and a framework to evaluate the implications for work and skills development. The 4IR is a typology that classifies technological change as a sequential process that is linked by keystone technological developments. However, within the 4IR framework there are contextual and social conditions that intervene to disrupt, regulate, or circumvent the introduction and adoption of new technologies. Three such conditions are infrastructure access and quality; government policies; and industry/labour regulations. Accessing the platform economy becomes difficult if there is only unreliable or limited web and energy access. Industry regulations. policies and procedures governing competition, product standards, immigration, procurement, education and skill development and certification all impact on the processes and consequences of technological change. Labour regulations that proscribe set conditions for employment and redundancy, occupational health, and safety, and limit the unfettered application of technology towards labour displacement and the downgrading of employment conditions mitigate the impact of change.

The focus in this volume is not directly on the 4IR or the FOW. Instead, it is on the impact of technological change within the identified industry sectors, covering the full spectrum from new products and processes, automation, artificial intelligence, internet and platform technologies, data mining, industry, labour and skill needs. At the industry level, the technology, product and labour market conditions and institutional conditions differ. Behind the technological changes, as explained above, there are other conditions that impact differently on industry products and

labour markets. These include global and national growth rates, the demographic profile of the population, the levels and skill composition of migration, patterns of income and consumer expenditure, and the skill and educational profile of the population. Hence, making predictions linked to the 4IR must consider the other conditions that impact on future product and labour markets.

The Research Method

Each chapter in this book addresses the research questions outlined in the introduction and draws on multiple data sources. The analysis is exploratory in nature, mainly drawing on secondary sources from the key stakeholder groups associated with the relevant industry sector. Documentary analysis is used extensively in business and public policy research. However, it should be noted that such documents have potential biases and may present the views of one stakeholder among many. With regard to this book, most of the documents utilised are in the public domain and can be authenticated and they represent organisational, rather than private perspectives. Bryman and Bell (2011: 545) maintain that documents can be analysed according to their authenticity by asking questions such as: authenticity (is the evidence genuine?); credibility (is the evidence free from error and distortion?); representation (is the evidence consistent with similar evidence?); and meaning (is the evidence unambiguous?).

The range of documents sourced and presented is not consistent across the chapters, as the stakeholders are different, and the volume and quality of official data also differs. The purpose of the analysis is to critically assimilate and interpret the documentary material (Bryman and Bell 2011: 561) to help answer the core research questions. To support the research questions the approach to the research reported in this book is summarised by the following points:

A. The 4IR is a set of technological possibilities whose relevance and application across industries form the basis for the research.
B. Technological change is not the only condition impacting on product and labour markets; any analysis of the impact of 4IR should be cognisant of other conditions that will impact on industry employment and skill needs.
C. Industries share common technologies, product and labour market conditions, and institutional conditions, so they represent a suitable framework in which to discuss the impact of technological change on employment and skills.
D. In some cases, standard industry classifications may be unsuitable for capturing production and employment generated through the platform economy, as the 4IR technologies not only generate new products and processes but also restructure industries and blur the boundaries between industries.
E. The identification of salient stakeholders in the selected industries provides a basis for the collection of data and for providing a range of informed perspectives towards assessing the core research questions (Nankervis et al. 2019).

F. The relevant salient stakeholders comprise those groups who have a vested interest in the industry sector and who can influence industry job and skill profiles. These groups include organisations, industry associations, professional associations, trade unions, training and education institutions, state and federal government agencies.

The Organisation of the Book

The chapters in the book are organised by industry sector, broadly following the ANZSIC industry classification. The purpose of the industry classification system is to 'to organise data about business units. It provides a standard framework under which business units carrying out similar productive activities can be grouped together, with each resultant group referred to as an industry' (ABS 2006: webpage).

The industry classifications are grouped broadly to encompass a range of industries. Under the broad groupings, there are subdivisions that are broken down into greater detail where the activities become more uniform. The ABS provides an example – manufacturing as the broad classification, which can be broken down to food product manufacturing, then to meat and meat product manufacturing, and then to meat processing. Here, the industry groupings use the broad classifications, and some of them are aggregated as in the case of agriculture, mining, and construction.

The chapters do not cover all major industry groupings, consequently, there are some notable absences. These include: professional, scientific, and technical services; and administrative and support services. Moreover, the coverage of the selected industries is incomplete, for example the public sector analysis is confined to local government; and the analysis of education is confined to universities. The boundaries between industries are fluid as new business models, products and production processes emerge that are associated with the 4IR. There is greater integration across industries through IT and supply chains, and services are increasingly becoming an important component of those sectors that were previously associated with producing physical goods, such as manufacturing and construction. The ordering of the chapters follows the ANZSIC codes from agriculture through to education and health. Each chapter is structured to provide an overview of the structural developments within the sector, especially in terms of employment and skills; this is followed by a discussion of the key technologies that are impacting production and employment within the sector. This is followed by an analysis of how jobs, work and skills are changing in the sector; and finally, the chapters consider the challenges and opportunities that the technological changes have generated in each sector, together with an evaluation of how the key stakeholders in that sector are responding to these challenges.

The chapters are presented in order of the ANZSIC broad industry divisions:

1. Agriculture, Forestry and Fishing; Mining; Construction

2. Manufacturing
3. Utilities
4. Retail Trade
5. Accommodation and Tourism
6. Transport, and Warehousing
7. Information Media and Telecommunications
8. Financial and Insurance Services
9. Local Government
10. Higher Education
11. Health Care

The chapters identify the key 4IR technologies impacting each sector. The application and impact of the 4IR technologies is present across all sectors. Moreover, there is a 'within sector impact', where the introduction of these technologies leads to the restructuring of production and work within the sector. Sectoral boundaries are also eroded by the 4IR technologies as the divisions that were present in the past are blurred as cloud technologies, big data, new energy sources, and the internet of things transforms production, processes, employment, and skills across all sectors and generates new skill demands and new products and processes.

Chapter Summaries The first of the industry focused chapters by Cameron and Rana explores three major industries: agriculture, mining, and construction. The authors explore the major technological developments and adoptions, how they are impacting work, and those occupations most affected. They also identify how jobs are changing and the related future skills that are likely to be needed to meet these trends, the major technologies impacting each sector with key stakeholder views covered and the related policy implications. All three industry sectors have varying rates of 4IR technology uptake and adoption for reasons that are explored further in the chapter. Although the Australian and New Zealand Standard Industrial Classification (ANZSIC) includes eighteen industry sub-sectors, agriculture, mining and construction were selected as the focus for this chapter as they represent the major employers. However, the authors also provide an overview of the key trends and workforce impacts for the other fifteen industry sub-sectors in this category.

The next chapter by Rainnie and Dean addresses Australian manufacturing. The authors refer to the concept of a 'resources curse', and the implications of global 'financialisation' before examining the potential consequences of the 4IR for the sector. The authors argue that the positive implications of the 4IR are reinforced by the ramifications of deglobalisation in general and COVID-19 in particular. For example, the authors question whether the conventional wisdom which suggests that 4IR technologies (such as 3D-printing) are in fact going to help support a revival of re-shored manufacturing. Consequently, Rainnie and Dean cast doubt on just how realistic the anticipated outcomes of the 4IR are for the Australian manufacturing sector.

Chapter 3 focuses on the impact of artificial intelligence and associated technological changes on work and jobs in Australia's utility sector – electricity, gas, water

and waste services. The analysis mainly concentrates on disruptive technology in a broad context which incorporates the collective effects of AI and machine learning, big data, and blockchain. The authors, Cheng, Ganganath, Lee and Fok, identify eight fundamental research gaps and business opportunities. Specifically, they conclude that the utility sector is highly applicable for digitalisation as it involves extensive physical assets that continuously generate valuable data. Further, the authors maintain that Utility 4.0 technologies can shape a utility company to become more lean and agile, which is essential for it to maintain its competitiveness for the post-pandemic era and the challenging future. However, apart from direct data usage in production control in the upstream, such as power plants and oil refineries, and in fault detections in the midstream, which cover the transmission and distribution networks, it is argued that there is a current lack of business cases that involve the massive volume of end-users. Thus, although AI can be used more extensively under human supervision to process big data collected from utility assets and therefore support improved decision making, privacy and ethical issues must be addressed whenever personal data is involved.

In Chap. 5, Larkin and Nankervis investigate the retail sector. They point out that, although retail is the largest employer in Australia, the prevalence of part-time work, casualisation and precarious work are common, as are the related low wages and low union representation. Unlike most other sectors, many retail players benefitted from the COVID-19 crisis, with the Australian Bureau of Statistics (ABS) data illustrating record increases in sales. Despite this, artificial intelligence and automation generally have had significant negative impacts on employment within the industry, particularly in relation to supply chain and distribution. The authors place emphasis on the Food Retailing and Other Store-based Retailing areas from both small-medium-enterprises (SMEs) and large business perspectives. They found that, while some predicted transformations (especially those in the lower-skilled entry level positions) did not bode well for future employment, there were some positive predictions offered by employers and unions, especially where future service-based leadership models are being adopted and supported by industry and government. Tourism is considered in the next chapter by Dhakal which focuses on the accommodation and food services [AFS] sector - considered to be one of the main drivers of economic growth in Australia. Specifically, tourism industries collectively contributed over $100 billion to Australia's GDP, employing nearly one million people in 2019. An emergent issue associated with tourism industries is the 4IR and the impacts of transformative digital technologies. These have advanced rapidly in recent years and are considered to be game-changers for the sector. That said, Dhakal maintains that, although the business-centric view of digital opportunities associated with the 4IR has received significant attention, the policy-centric examination of the 4IR and tourism nexus remains under the radar in Australia. The chapter aims to respond to this gap, drawing on the three pillars of the Automation Readiness Index (EIU 2018) - innovation, education and employment policy landscapes - to explore the challenges and a potential way forward for the AFS sector.

In Chap. 6, Dethridge outlines how AI is used in Australian media which includes advertising, journalism, publishing, film, and TV production. AI use covers (among

other areas) data analytics in advertising and journalism and the automation of roles previously performed by people in screen, literary and arts production. As a result, it is predicted that the increased use of AI and automation will lead to concurrent job loss and job creation in the sector. AI currently constitutes a production tool which has led stakeholders to propose that, in future, media production companies may work in collaboration with software and interface designers to ensure that a sustainable, human-centred approach is taken when using technology. In this way AI may augment the creative, knowledge-based work undertaken by higher-skilled workers in media industries, improving their productivity and subsequently the demand for such workers. The Australian Consumer and Competition Commission (ACCC) emphasised the need for transparency in its 2020 inquiry into the impact of Google and Facebook and their use of AI and user data for commercial purposes. Dethridge proposes that similar investigations will highlight the use of AI and data analytics in the Australian and global media industries, particularly with regard to the supply of news and the implications for media content providers, advertisers and consumers.

The next chapter provides an overview of the impact of the 4IR on the transport and logistics sector in Australia. Tay, Gekara and Ghalebeigi use several case studies to provide insights into how Australia is addressing these technological challenges. The authors conclude that the sector has undergone a complex transformation in its workforce skills requirement such that it now requires new job configurations, new skills and workforce development and training to be able to address the requirements of the 4IR. Notably, the authors argue that employer responses to the changing skill needs of the sector has been varied to date, with the majority of organisations making little effort and investment in training. That said, they argue that the greater burden for training currently rests with employers, largely because the push to drive technological changes for enhanced productivity is mainly coming from that stakeholder group. Consequently, while a comprehensive government policy on workforce digital transformation in Australia is lacking, it is proposed that employers need to not only implement extensive in-house re-skilling and up-skilling for their workers but they also need to actively participate in developing a sustainable pool of workers for the sector due to the 4IR.

As in other chapters, Australia's Financial and Insurance Services sector is explored in relation to the impact of artificial intelligence and associated technological changes on work and jobs. Montague, Svanberg, Maisano, & Fernandes examine the cumulative effects of AI, incorporating machine learning, big data, blockchain, chatbots and financial technology (fintech). The chapter primarily focuses on disruptive technology in a relatively broad context, leading the authors to offer three main conclusions. First, that jobs will most likely be substantially impacted with 15–30% of employment in the risk zone. Losses are predicted not only in relation to repetitive jobs but also in analytical and decision-making jobs that may currently be well-paid and highly regarded. Second, the authors propose that most of the potential for AI in banks and insurance companies is in places where it is invisible, leading them to assert that the myriad of tasks that are relegated to the "back-office" are more at risk of being automated than those that are not. Such tasks include lending decisions, insurance policy agreements, deposits and

payments and those related to internal controls such as loss prevention and fraud detection. The authors' third point concerns the Hayne (2019) Royal Commission into Misconduct in the Banking, Superannuation and Financial Services Industry which, following the malpractices uncovered due to the relentless quest for profit and bonuses, requires a culture change in the sector.

The Australian public sector incorporates federal, state, and local government agencies and is one of the largest employment sectors in the economy incorporating a range of different occupations. However, this chapter by Burgess and Shaikh specifically examines AI and technological developments in local government, as the public sector as a whole is too large and diverse to capture comprehensively. Technology is key to the development of many areas of the public sector with for example, defence, being driven by technological developments in hardware and software. In common with much of the public sector, local government has been subject to the reforms and pressures of new public sector management to improve service delivery and achieve cost reductions and efficiencies. The authors point out that, while Information Technology (IT) and automation have the potential to support both the quality and efficiency objectives of local government, there are challenges related to the impact of structural and technological change on employment, especially in the regions. The chapter considers a range of these challenges, including the potential impact of COVID-19 on finances and the demand for services which it is proposed is likely to increase the demand for technological solutions and skills development.

Next, Connell and Malik explore the impact and influence of the 4IR and artificial intelligence applications on the Australian Higher Education (HE) sector. The chapter focus is on the potential impact of new technologies and their anticipated effects on the sector, its educators, and students. The authors set out to provide a broad understanding of the potential challenges and changes within the context of the recent coronavirus global pandemic. They point out that the restructuring of employment caused by technological disruption and the 4IR followed by COVID-19 brought some areas of HE to a grinding halt. This in turn has led to huge downturns in student enrolments and job losses in the sector. Consequently, the challenges due to both the technological and health crises for the Australian and global HE sector are explored from early 2020. The authors conclude that the role of HE in society and the economy will have to transform to offer best practices in online teaching and high-quality online materials and access appropriate for all student contexts.

The final concluding chapter, by the editors, summarises the key comparative findings across the eleven sectors included in the book. A brief sector overview of the new technologies and the related impact on jobs and workers, as well as the potential challenges and opportunities is provided. With regard to the implications for government, industry, employers and unions it is pointed out that, although there is not yet a dedicated national AI strategy, the government did recently publish Australia's Tech Future, the implications of which are outlined. The editors also refer to the current Prime Minister, Scott Morrison's roadmap for Australian manufacturing which is intended to drive the uptake of digital technologies across

businesses and subsequently lead to increases in productivity and innovation. As yet, the effectiveness of such strategies is, of course, unknown.

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