Chapter 6
Transport and Logistics

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Abstract The fourth industrial revolution (i4.0) is transforming the workplace in every sector of the economy, including transport and logistics, with many jobs expected to decline over time while creating new jobs and spurring growth in some existing jobs. With changing employment comes the need for new skills. This chapter provides an overview of the impact of i4.0 on the transport and logistics sector worldwide and in Australia. Several case studies from Australia are presented to provide insights on how Australia is coping and expected to manage in the future to meet this technological challenge.

Keywords Connected and automated vehicles · Logistics · Supply chains · Transport

Introduction

Labour markets around the world are undergoing significant changes due to several major disruptions like the fourth industrial revolution, unexpected pandemics, shifts in globalisation and climate change. Any significant disruptions to the economy will create both opportunities and challenges. Although these changes are expected to create millions of new jobs and opportunities, they will also lead to job displacement and a redistribution of income and wealth. It has also changed the nature of work and the skills needed for the new jobs, resulting in significant changes in the skills demanded by the labour market. To prepare for these changes, governments, industry, education institutions, and workers need to have an understanding of how these disruptions will impact the various sectors of the economy.

According to the WEF (2017), the speed at which jobs are changing and the ability of workers to reskill varies across countries. Australia is rated as a country with slower labour market disruption and higher adult skills, implying that Australia should be able to manage the transition more smoothly than other developed

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countries. Nevertheless, 44% of Australian jobs are at high risks due to automation alone (Hajkowicz et al. 2016). Moreover, the disruption and transition are also not uniform across different sectors, with the transport and logistics sector expected to experience more significant challenges.

There are two routes of change in the transport and logistics sector due to i4.0. One route is the indirect impact through changes in the demand for transportation and logistic services. Since much of transport demand is a derived demand, it is highly dependent on the need to travel and move freight, which will be significantly affected by i4.0. For example, there may be an increase in telework in all sectors of the economy, resulting in a reduction in commute trips and demand for passenger or people transport. One the other hand, there may be an increase in trip chaining with greater access to digital mobility services (trip planning, ticketing, payment systems, etc.). On the freight transport side, eCommerce and mCommerce have significantly change the retail shopping sector, resulting in a reduction in in-store shopping and distribution but an increase in automated supply chain and home delivery services. Also, i4.0 will disrupt the supply chain of companies in most sectors of the economy, which will have an impact on the demand for transport and logistic services.

The second route is the direct impact of i4.0 on the transport and logistic sector itself and how businesses in this sector will need to adapt their operations due to advances in technologies, wireless and cloud computing, mobile network and devices, analytics and big data. This chapter will focus mainly on the direct impacts of i4.0 and adjustments needed by the transport and logistics sector, particularly on its impact on the workforce in the transport and logistic sector.

The i4.0 related trends driving industry growth include (WEF 2018):

- Increasing computing power
- Increasing adoption of new technology
- Progress in artificial intelligence
- Expansion of big data
- Progress in mobile internet
- Improvement in cloud technology
- Advances in human-machine interfaces

The above changes are expected to have significant impacts on the composition of the workforce in the transport and logistics sector. As shown in Table 6.1, some of the declining jobs that have a 41% share in 2018 are expected to be reduced to 26% by 2022 while some emerging jobs are expected to increase from 8% to 21% in the same period.

However, identifying the needs of some subdivisions of the transport sector may be more difficult. According to a survey conducted by the WEF (2018), 20% of companies surveyed expect to expand their workforce due to automation, whereas 40% expect to reduce their workforce due to automation. Therefore, the expected impacts are not evenly distributed across the sector.

One of the reasons for the uneven distribution of expectations is the differences in technology readiness. As shown in Fig. 6.1, different firms face different

Table 6.1 Changing workforce in transport and logistics

Jobs with decreasing demand	Jobs with increasing demand
Accountants and auditors	AI and machine learning specialists
Accounting, bookkeeping & payroll clerks	Data analysts and scientists
Administrative and executive secretaries	Innovation professionals
Assembly and factory workers	Process automation specialists
Business services & admin managers	Product managers
Client info and customer service workers	Industrial and production engineers
Data entry clerks	Sales and marketing professionals
General and operations managers	Service and solutions designers
Material-recording and stock-keeping clerks	Software and applications developers and analysts
Transportation attendants and conductors	Supply chain and logistics specialists

Source: WEF (2018)

Fig. 6.1 Technology adoption barriers. (Source: WEF 2018)

perceived barriers to adopt new technology (WEF 2018). 50% of the firms surveyed do not understand the opportunities afforded by modern technology, 26% perceived a lack in investment capital, and 28% lack flexibility in hiring and firing employees. Interestingly, the skills gap in the local market is identified by 59% of the firms surveyed.

Revel et al. (2017) argued that "ensuring that the skills of the graduates match the industry needs is a real challenge for the future: industry needs are difficult to assess, and they are evolving more rapidly than the contents of academic programs. This challenge has been recognized by PEGASUS, and an innovative project, PERSEUS, was launched in 2015–2016 with the support from EU funding, in order to address it."

Industry Overview

The transport and logistic sector is one of the main economic engines of many countries, including Australia. According to the Australian Bureau of Statistics, the transport, postal and warehousing sector comprises 7.2% of the Australian economy and employs about 5.2% of the workforce in 2018 (ABS 2018). The transport industry alone accounts for about 4.6% of the Gross Domestic Product (GDP), with a further 2.7% coming from transport activities in other sectors. Moreover, according to the Australian Logistic Council (2020), the Australian freight logistics industry accounts for 8.6% of GDP, adding $131.6 billion to the Australian economy in 2013, and employs about 1.2 million people. An increase in logistics total factor productivity of 1% is estimated to increase GDP by $2 billion.

Figure 6.2 below represents the complex layout of the sector, which diversely comprises many different but closely related subsectors, including road, rail, air and water transport. They are further sub-sectored into passenger, freight and parcel services.

The sector workforce is equally diverse, although some key occupational groups are specific to the subsectors. For example, drivers, in the road and rail transport, seafarers in the water transport, straddle drivers and crane operators, in port operations, pilots and flight attendants in air transport and pickers in warehouse operations. Behind the scenes, however, are many different occupations which are essential to the sectors' operations, including planners and schedulers, airport

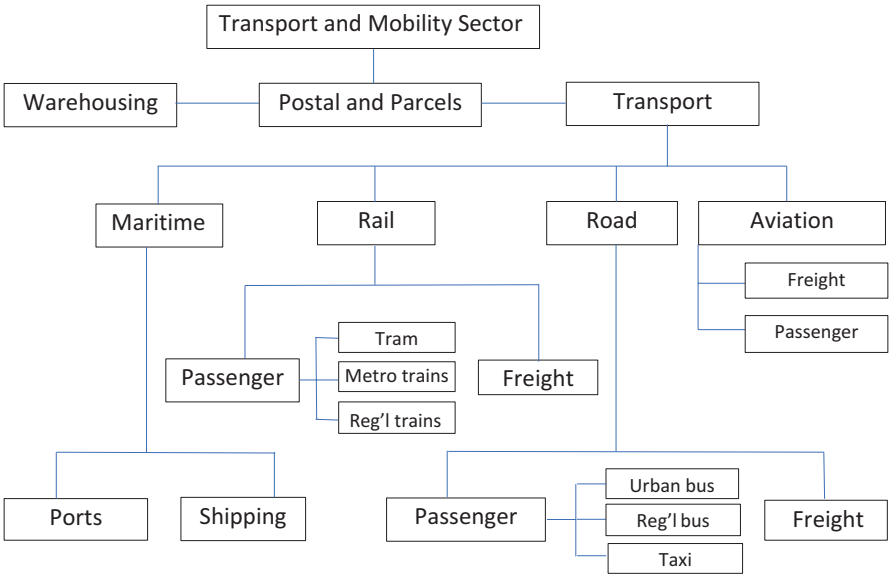

Fig. 6.2 The transport and logistics sector layout

ground crew, train station crews, maintenance personnel as well as many different functional management staff.

The disruptive impact of i4.0 cuts across the majority of the above sub-sectors and occupations. While automation has displaced some jobs in modern advanced warehouses and automated container terminals, associated digitalisation of operations has significantly altered the nature and texture of work in the remaining occupations. Significantly, new occupations have emerged as a result of these disruptive technologies (Gekara and Fairbrother 2013). The conventional work of drivers, for example, has been replaced by the need to possess digital knowledge and competencies to be able to understand and operate highly complex digital dashboards and remote-control systems, as well as digital mobile device enabled data management operations. The challenge for the sector's workforce is that not only is it a sector characterised by an ageing workforce, it also struggles to attract younger workers (Gekara et al. 2015). Furthermore, the technological changes have happened swiftly, in the last 20 years, leaving little room for an effective response from employers and the training establishment.

Without an effective and sustainable response to the skills question in the sector, the entire Australian economy faces significant challenges since efficient transport services are critical to Australia's access to domestic and international markets. Australia's national land freight task is expected to grow by around 75% between 2011 and 2031, with over three-quarters of the non-bulk freight carried on roads (DIRD 2016). Nevertheless, Australia's rail networks carried 1.3 billion tonnes of freight and contributed about $5.1 billion to the Australian economy in 2013–2014. More importantly, automation, such as driverless trains and trucks, is expected to drive future growth in the land freight sector. With regards to maritime transport, automation of stevedoring operations has improved the operational efficiency of major transport and logistic hubs in Australia, such as the Port of Brisbane and Port Botany (DIRD 2016).

Key Technologies and Skills Impact

Technological advances, such as Connected and Automated Vehicles (CAVs), are having a significant impact on the design and operation of Australia's transport systems. Reducing new infrastructure cost, improving road safety, and improving the efficiency of freight transport can be counted as such impacts (DIRD 2016). CAVs are expected to have a significant impact not only on cars and trucks but also on other transport options like freight trains, light rail, taxis and bus services, which will have a drastic effect on the supply chain, especially in first-and-last mile deliveries.

According to the 2019 Transport and Logistics Skills Forecast, advanced computer systems and big data to create 'smart' processes and products are changing the skills requirement of the workforce in the sector (AIS 2019). The impending introduction of CAVs will replace most of the existing drivers with employees with new

skills in cybersecurity and automated systems. The adoption of collaborative electronic platforms will replace many administrative staff with employees with skills in digital literacy, data management, and cybersecurity. This rise of the gig economy will also create a labour market characterised by the prevalence of short-term contracts or freelance work as opposed to permanent jobs (AIS 2019). The internet-of-things and big data will generate a vast flow of information that requires new skills in data management, business analytics, and business systems.

Australian Industry Standards (AIS 2019) lists the top five generic skills required by the transport and logistics sector in order of importance as:

- Design mindset/Thinking critically/ System thinking /Solving problems
- Learning agility / Information literacy/Intellectual autonomy and self-management (adaptability)
- Technology
- Managerial/Leadership
- Communication /Virtual collaboration/Social intelligence

The above list indicates the impacts of big data and technology on the required skills. Competencies in digital technologies, analytical skills, critical thinking, problem-solving or the ability to interpret information to make data-driven decisions are considered as essential skills.

In summary, automation and digital transformation have revamped many facets of the transport and logistics industry. Expertise in robotics, systems and electronics engineering, as well as digital literacy, digital business, business analytics and computer science, are required in the future workforce to meet the requirements of new and emerging jobs.

Australian Case Studies

The Victorian Public Transport Rolling Stock Sector

Young et al. (2020) conducted an industry-funded study to understand the current and future workforce needs in the public transport rolling stock sector in Victoria. The project focused on the strengths, opportunities and challenges facing the sector in overcoming the projected skills and capability crisis in organisations that design, manufacture, maintain and operate rolling stock in trains, trams and buses. The authors concluded that with the emergence of digital and cyber technologies (Industry 4.0), the sector needed to look beyond its current technological focus to the people needed to enable and sustain these changes.

More importantly, the authors conclude that "there is limited literature that offers the insights needed to guide organisations in understanding who their potential future workforce may be, and how they can be recruited most effectively. It is also unclear as to what level of innovation or inclusion exists within the current supply

chain, or the broader social and environmental benefits generated through procurement. As a result, it is not possible to ascertain the current composition of the workforce, where strengths and capabilities exist, or what the most effective economic and social levers are. Since 2006, specific recommendations concerning workforce issues have been periodically raised and repeated, which suggests that deeper systemic issues are yet to be fully understood or addressed" (Young et al. 2020, p. 7).

The study also suggests that "the rolling stock sector exists within an inward and change-resistant culture, which can create barriers to workforce development and retention of younger employees, women, people from different cultural backgrounds, and those with non-standard skills and abilities" (Young et al. 2020, p. 7), "a lack of clarity of the specific training needs related to rolling stock, particularly in relation to delivery of training (p. 8), and "quantified estimates of the economics of skills shortage and training in the rolling stock industry are hard to find in the economic literature" (p. 9).

One of the challenges facing the rolling stock sector is that the major employers of many workers are operators on fixed-term contracts and may not have a strong incentive to reskill workers for future jobs (Shah 2017). Workers in the sector tend to focus on the requirements of current jobs (Shah 2017). In an analysis of the National Workforce Development Fund training in the transport and logistics industry, Shah (2017) found that about two-thirds of all the qualifications were for jobs as machinery operators and drivers (38.3%) or labourers (26.8%), while 10.2% was for clerical and administrative training. Also, the most common reasons given by workers for undertaking training were 'job requirement' and 'to develop extra skills for the current job.' However, the demand for many of these jobs has been forecasted to be decreasing due to the advent of i4.0. Therefore, there appears to be a mismatch between current skills training and the skills required to meet the changing job market. Therefore, industry and/or government leadership to address this market failure is critical to managing a smooth transition.

Australian Container Terminals

The Australian ports industry comprises over 60 ports of all sizes and varying significance. According to Ports Australia trade statistics, 48 of these are considered significant gateways and while all of them handle ranging combinations of bulk commodities, including iron ore, LNG, oil, grains, coal, forestry products, fertiliser, manganese and sugar, only eight include containerised cargo and account for an annual throughput of 8 million TEU. The four key container ports, which account for 90% the total throughput include Port of Melbourne (37.5%), Port Botany (31.3%), Brisbane (16.3%) and Port Adelaide (5%). Technological changes in the industry, particularly container terminal operations can be traced back to the late 1990s when the dominant operator, Patrick Terminals, sought to transform its operations to enhance efficiency and productivity while reducing operating costs. An additional but crucial driving factor was also the need to reduce the power of the

Maritime Union of Australia workers union (MUA). These led to the historical waterfront dispute of 1998/9; the outcome of which reaffirmed the right of the terminal operator(s) to implement a wide range of cost-saving strategies targeting labour reduction (Griffin and Svensen 1998; Dabscheck 2000; McConville 2000). The following 20 years were characterised with rapid technology and digital transformation, which have placed Australia at the top of the advanced container terminal technology league (Gekara and Nguyen 2018).

Gekara and Nguyen (2018) have examined the technological developments at Australian ports and the implications for work, workforce skills and employment. This study builds on earlier research by Gekara and Fairbrother (2013), which focused more on the employment and union organising capacity. These studies conclude that the digital and automation changes taking place have significantly altered both the nature and texture of work.

> Apart from the increasing displacement of the last few remaining jobs by the robotic equipment, digitalisation of the entire process also means that those that remain have undergone significant change, particularly with regard to the tasks performed and the skills required (Gekara and Nguyen 2018).

The adoption and implementation of new technologies in the container terminal industry is mainly driven by the dominant global container terminal operators. The capability and specific interests of each operator ultimately shape the types of technologies adopted and the extent of implementation. Thus, around the world, the extent of technology adoption ranges on a scale of manual, through partial, to full automation.

In Australia these developments are driven by four competing operators – Patrick Terminals, Dubai Ports World (DP-World) and Victoria International Container Terminal (VICT) and Hutchinson, which handle the entire national container throughput. Of the three, Patrick is the most dominant (43.5%), followed by DP-World (39%), then Hutchinson (6.6%) and VICT (5.3%) (ACCC 2019). VICT, is also the youngest of all the operators, having been launched in 2017. Patrick has also been the most influential concerning the development and implementation of automation and digital technologies. There are three discernible models and levels of technology adopts, which we loosely label as the Patrick model, the DPW model and the VICT model.

The Patrick Model

Patrick Container Terminals is the largest operator in Australia. It is also unique in that, unlike the other two global operators, it is an Australian domestic company both in operations and location. Out of the nine major container terminals, Patrick operates four of them in Melbourne, Brisbane, Sydney and Fremantle and handles

43.5% of the total container throughput (ACCC 2019[1]). Not only is Patrick the largest, but it has also been leading in the advancement of terminal operating technologies. It has developed one of the most advanced systems called AutoStrad, based on automated straddles (see Gekara and Nguyen 2018 for more details). However, Patrick has only rolled out the AutoStrad system in its Sydney and Brisbane terminals, surprisingly maintaining manual operations at the Melbourne terminal, which handles the largest proportion of its containers.

Furthermore, while 90% of the AutoStrad terminals are automated, the quay cranes remain manual. This is, however, not likely to stay for long since the automated quay crane technology is readily available. Overall, including the digitalisation of processes, Patrick is one of the few highly automated terminals in the world, with roughly 80% of all operations automated. Across all its terminals, Patrick employs a staff of about 1000 workers.

As observed in Gekara and Nguyen (2018), the implication on work and workforce skills is significant. Not only has it resulted in a considerable reduction in the number of workers physically on-site, it has also transformed the nature of work and job roles. The large majority of the workers at the Autostrad terminals in Brisbane and Sydney occupy desk-top based monitoring and data analysis roles as opposed to previously where the bulk of the work was container yard-based. The few surviving yard-based positions are found in repair and maintenance as well as a new role created to assist in the first and last-point container truck grid operations where lifting off and loading onto the truck bed requires manual assistance. These are called tele-ops (Gekara and Nguyen 2018).

Consequently, the skills composition of the remaining jobs has also changed. While container yard workers' core skills included equipment operation, e.g. straddle, crane and truck driving, the tele-ops supposedly assisting in 'manual' first and final truck grid operations require digital skills as they use miniature yard control consoles. The work of a "Terminal Technical Engineer" for example is no longer hands-on as the designation suggests but instead involves remote desktop monitoring of the operations of the automated straddles and intervening where needed, e.g., in cases of malfunction, breakdown and emergency. The "Terminal Production Manager", on the other hand, monitors productivity statistics and adjust speed and rates of equipment operations as necessary. Consequently, Gekara and Nguyen (2018) observe that

> for most of the remaining workers, it is no longer about pushing buttons and shifting levers; it requires understanding and use of complex computer systems through both mobile and fixed digital devises and touch-pads.

[1] ACCC (2019) Container Stevedoring Monitoring Report, https://www.accc.gov.au/system/files/Container%20Stevedoring%20Monitoring%20Report%20-%202018-19.pdf

The DP-World Australia Model

Unlike Patrick, DP World Australia is a global terminal operator and is part of the DP World global group of companies and a leading provider of container terminal services internationally. In Australia, it is the second-largest operator, and like Patrick, it operates four terminals located at the Brisbane, Fremantle, Melbourne and Sydney ports. It handles about 39% of the total throughput in Australia (ACCC 2019) and employs about 1800 workers.

Interestingly, however, DP World Australia has taken a different approach towards its technology adoption. On a scale of minimal to full automation, DP World Australia may be located in the semi-automated category. Although they have implemented highly advanced Information and Communication Technologies and automated management processes (Gekara and Fairbrother 2013), yard operations still remain predominantly manual.

A number of explanations may be presented for the deliberate decision not to advance the technology to the level of their key competition – Patrick. First, there is no significant value add in terms of operational efficiency and productivity, labour savings and overall profitability. The narrow difference in annual throughput between Patrick and DP World terminals implies that any additional productivity gains might not sufficiently justify the huge extra investment in full automation. The second explanation relates to the second move advantage. A delay in adopting the technologies would allow for first movers, in this case Patrick, to advance and test the technology so that by the time DP World decides to automate, it will be highly advanced, adequately tried and tested and possibly cheaper. Should this be the case, it is highly likely that DP World will begin automating its yard operations very soon.

The implications for the workforce, especially concerning skills and job roles, is not very different from the Patrick case. Although they continue to employ a comparatively large workforce, the nature and functions of jobs and work have changed significantly as a result of the extensive digitalisation of operations. Like in Patrick, digital skills have become an essential part of workforce competency across all job roles, including those that have been traditionally viewed as physical and manual.

The VICT Model

The Victoria International Container Terminal was formally opened in 2017 as a subsidiary of the International Container Terminal Services Incorporated (ICTSI). It currently operates only at Melbourne port and has a capacity of 1 million TEU although, as per the 2018/19 throughput, it now handles approximately 423,000 TEU, which represents 5.3% of the country's total throughput. On the scale of minimal to full automation, VICT is at the fully automated end with more than 90% of its operations automated. Consequently, with a total workforce size of about 54 employees, it has the least number of workers when considering workforce size per terminal (see Dagge 2016; VCIT 2020; ACCC 2019). Gekara and Nguyen (2018) observe that

> …[it] stands out as one of the very few fully automated terminals in the world—from the terminal gate to the ships rail… the entire terminal cargo process is both paperless as well as with minimal and peripheral ground human intervention.

Like the Patrick AutoStrad terminals at Brisbane and Sydney, VICT's workforce is both lean and highly digitalised in terms of the skills they require to perform their roles.

Discussion

The fourth industrial revolution (i4.0) has changed the way firms operate in every sector of the economy. The uptake of technologies has changed the production and delivery methods and processes. These disruptions have a significant impact on the labour force. The transition in the transport and logistics sector in Australia has been disparate, with some industries better prepared to adapt than others. The impact of industry 4.0 workforce in the transport and logistics sector, is not merely new technologies and job replacements. It is instead a more complex scenario of workforce displacement, job reconfiguration and the emergence of new job roles. Automation and digital transformation have revamped many facets of the transport and logistics industry. Expertise in robotics, systems and electronics engineering, as well as digital literacy, digital business, business analytics and computer science, are required in the future workforce to meet the requirements of new and emerging jobs. Skills such as critical thinking, problem-solving, data-driven decisions, leadership, and information literacy have become the generic skills required in this sector. These changes are continuous and transformative. The presence of competitive pressures, as well as industry and/or government leadership, is critical to managing a smooth transition.

The need for government leadership is evident is the Victorian rolling stock sector. Specific recommendations in relation to workforce issues have been periodically raised and repeated in the industry forums. This suggests the presence of deeper systemic issues. One possible reason is the change-resistant culture of both the firms and their employees in the sector, and a lack of clarity on training needs and the delivery of training. Also, due to the nature of fixed-term contracts in sector for operators, firms may not have a strong incentive to reskill workers for future jobs, and workers in the sector tend to focus on the requirements of current jobs, many of which are expected to decrease over time due to advent of 1.40. Therefore, the market has not functioned efficiently, and more government leadership and incentives are needed to ensure a smoother transition.

The cases of the three major port operators, for example, Patrick Terminals, Dubai Ports World and the newly introduced Victoria International Container Terminal (VICT), lead to the conclusion that the use of technology in various processes and operations has significantly impacted the workforce. There has been a significant reduction in workforce sizes across different terminals which occurred

as a result of increasing automation in the past two decades induced by high operating costs and the need for operations efficiency and consistent productivity. The increased use of automated mobile-yard equipment such as straddles and cranes, where the largest proportion of the workforce was, hitherto, located explains the large reduction in the overall terminal workforce.

The impacts are not limited to number reduction. It has changed the required skills and expertise needed in port operations. Traditionally, the port operations required a largely unskilled workforce with little requirement for qualifications or any specific skills. Now, however, terminal operations require a workforce with highly defined skills, including digital literacy and competence. Most of the work has shifted from the yard to the office and involves remote equipment monitoring, control, intervention and data analysis, all of which need highly specialised computer and digital skills. Even employees engaged in the operations of the few remaining non- or semi-automated mobile yard equipment are required to be equipped with the skills to understand and operate the sophisticated systems that integrate their work, which often involves digital control and input, to the overall production process.

To develop these skills, terminal operators have adopted various strategies for training and workforce development, which complement any specific formal training and qualifications that workers may have acquired. These include mostly on-the-job training programs and strategies, with some terminals operators also running formally accredited training under the national vocational education and training system, as enterprise training organisations, to ensure that they equip their workers with the necessary skills but also effectively respond to continuous skills upgrade needs as technologies and systems change (Gekara and Fairbrother 2013).

Conclusion

The case studies in this chapter provide snapshots of the impacts of the fourth industrial revolution (i4.0) on the Australian transport and logistics sector. It can be concluded that the sector has undergone a complex transformation in its workforce skills requirement. The sector requires new job configurations, new skills and workforce development and training to be able to address the requirements of i4.0. However, as recent research indicates, employer response to the changing skills needs is varied, with the majority of organisations making little effort and investment in training (Gekara et al. 2019). Because of the rapid changes in skills requirement and considering that it is employers driving the technology change for enhanced productivity, the more significant burden for training rests with employers. While a comprehensive government policy on workforce digital transformation in Australia is lacking (Gekara et al. 2020), employers must not only implement extensive in-house re-and up-skilling for their workers but also actively participate in developing a sustainable pool of workers for the emerging i4.0.

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