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IoT and the Future Workforce: Potential Implications

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IoT and the Future Workforce: Potential Implications

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Introduction

1. It is increasingly recognised that the disruptive impacts of technology are amplified by their interconnectedness in the so-called Fourth Industrial Revolution (Industry 4.0 or i4.0). Collectively, this has important implications for employment, education and training. The focus of this input paper is to provide insights into the potential implications for the future workforce of the Internet of Things (IoT), one of the top five 'disruptive technologies' associated with i4.0 (WEF, 2016), with IoT in recent times being referred to as the "heart" of i4.0 (IOTAA, 2019).

2. As i4.0 envisages technologies interacting with each other, there may be considerable overlap between IoT and related technologies that have been investigated in other related ACOLA research (e.g. AI, see Walsh *et al.* (2019)). The complex and interwoven nature of these issues means that there is a need for increased collaboration between industry, educators and governments to improve the responsiveness and flexibility in delivering skills—from formal qualifications to micro-credentials or non-formal education—to reflect the needs of rapidly changing IoT and related technologies (Evensen *et al.*, 2019; Seet *et al.*, 2019a; Seet *et al.*, 2019c).

3. In addition, the extent of technology penetration varies in different parts of Australia, which could lead to less positive impact in Rural, Regional or Remote (RRR) parts of the country. The difficulties of IoT related technology adoption then exacerbate the current digital-divide between Australian cities and RRR areas.

Job evolution

• ***What is the likely impact that IoT is expected to have on jobs/employment models in Australia (at a megatrend level with appropriate examples)?***

4. There is a lack of agreement about the exact nature of the impact of IoT and related technologies. While some see the full range of existing disruptive technologies offering limitless new opportunities, others argue they will lead to significant loss of jobs and/or tasks within jobs (AlphaBeta, 2017; Chartered Accountants Australia and New Zealand *et al.*, 2016; Department of Industry Innovation and Science, 2017; Dolphin, 2015; Frey *et al.*, 2013). Even after using new research methodology like Strategic Foresights, the CSIRO, working with BCG, developed 4 quite different scenarios of how such technologies and other 'megatrends' would impact future jobs and employment (Hajkowicz *et al.*, 2016). The inter-connected nature of these i4.0 technologies (e.g. automated systems working with each other using IoT networks) can lead to multiplier effects, thereby impacting jobs more significantly than just independent uses of these technologies.

• ***What sort of jobs will evolve due to IoT? How?***

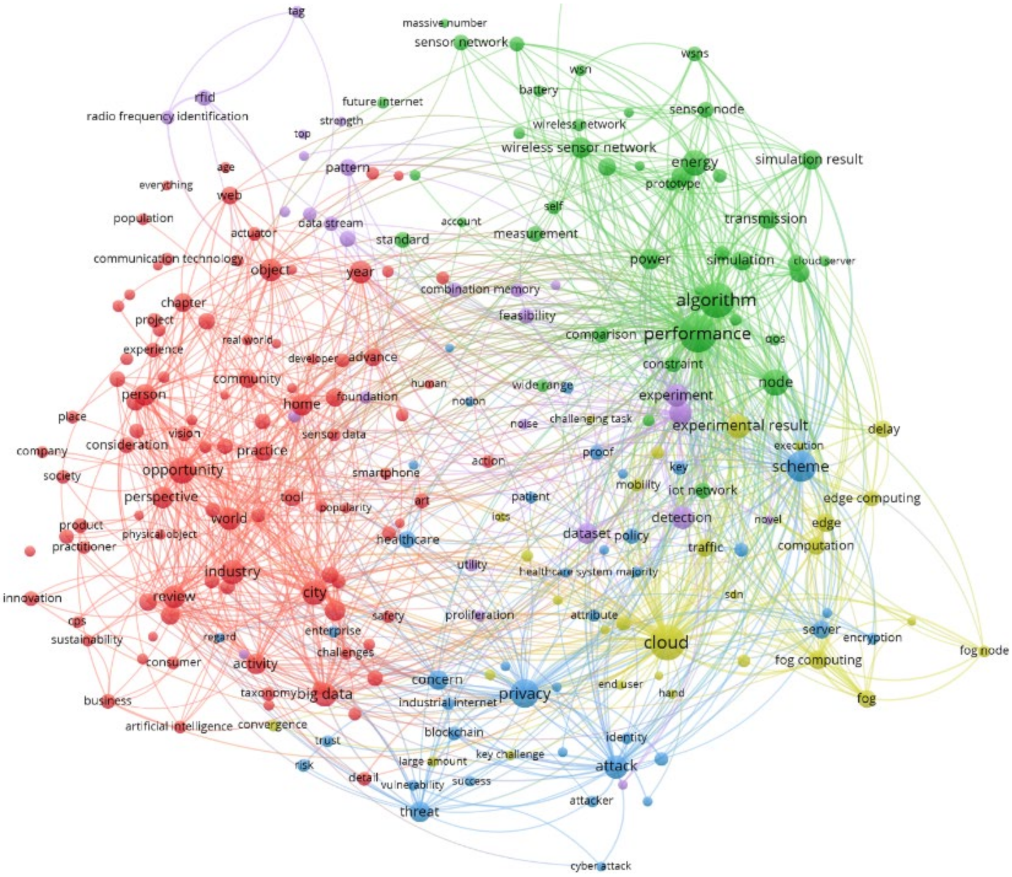

Figure 1: IoT and Related Skills/ Training Representation in Academic Publications in the last 6 months (May-October 2019) (Klarin *et al.*, Work-in-Progress)

5. Research using science mapping through bibliometric analysis of literature has a capability of presenting data from a birds-eye view on the state-of-the-art of a particular field (Korom, 2019; van Eck *et al.*, 2009; van Eck *et al.*, 2014). The state-of-the-art of recent Scopus-indexed publications envisages 4 potential major areas of future jobs in an IoT-permeated economy (see Figure 1 above):

(1) **Network design, planning and implementation for IoT**. A holistic, emergent and open systems view of networks is required in the planning and implementation of IoT to enhance innovation ecosystems (Suseno *et al.*, 2018). Jobs will be created to help ensure that the network infrastructures are robust, reliable and scalable. First movers in Australia in this area include the 'Big 4' professional services firms that have re-skilled and transformed many of their digital strategy consultants to take on IoT consultancy roles. For example, KPMG Australia started an IoT practice in 2016 covering three core sectors: smart cities, precincts and campuses; smart food and fibre; and smart energy and natural resources. In the absence of sufficient internal experience in this emerging technology, KPMG focussed on external hiring of individuals with relevant IoT industry knowledge, expecting to grow its IoT consulting headcount by 50% within a year (KPMG, 2018). As seen in Figure 1, a large part of this planning involves jobs within network- or tele-communications. Most of the underlying IoT connection technology, both in Australia and globally, is predominantly developed by large multinationals (e.g., Cisco, GE, Intel, Ericsson, Siemens). As all major mobile operators in Australia have deployed narrowband IoT technology and are also rolling out 5G, there will be opportunities for local jobs in the integration and delivery of these new technologies in Australia (PwC, 2018). In addition, given the challenges of the Australian context—long distances and lack of fibre and mobile broadband across many parts of RRR Australia, opportunities exist for innovators and entrepreneurs to develop creative solutions. For example, Morse Micro, an Australian start-up based at Cisco's Sydney Innovation Centre, has developed a Wi-Fi chip that is cheaper, more powerful and five times smaller than conventional IoT Wi-Fi design chips that may help in better high-speed Internet coverage in RRR areas (Morse Micro, 2019).

(2) **Security skills for IoT.** While the cyber-security aspects of IoT have been acknowledged in Australia (e.g. through the establishment of the AustCyber CRC), from an IoT facilitating perspective, there will be jobs that capitalise on the ability of IoT to enable smarter surveillance platforms to create more intelligent and safer communities in smart cities. For example, Vi internet Dimensions based in Singapore, is developing machine-learning based platforms that use the enormous data generated by IoT to provide more reliable security for cities and enterprises. In addition to general IT jobs, specialised jobs in computer vision, object recognition, facial recognition, target tracking, sensor fusion, localisation and mapping, machine translation and deep learning are also required (Vi Dimensions, 2019). buildings

(3) **Energy and IoT.** In the energy sector, the IoT's interrelated features will require products and services that facilitate the deployment and management of 'smart grids', with concomitant implications for smart workers. For instance, with a smart grid, remote monitoring and management of secondary substations are feasible, with more interconnection with primary substations for a more stable distribution grid. For energy distributors, the smart grid supports smart field workers (Intel, 2019). Thus instead of working through layers of bureaucracy, operations and maintenance personnel can use devices to gain real-time access to central systems, technical manuals and even instruction videos enhanced by augmented reality to solve technical field problems without having to wait for appropriately trained personnel. The US Energy Department, for instance, has developed a Smart Grid workforce development program in collaboration with educational institutions and industry (Office of Electricity Delivery and Energy Reliability, 2019). As part of this, the National Electrical Manufacturer's Association (NEMA), together with George Mason University and Northern Virginia Community College jointly developed a series of videos dubbed "Vids4Grids" that overview the range of new technologies in the energy industry and presents insights into Smart Grid careers at all levels in the energy industry (Office of Electricity, 2011).

(4) **Monitoring, analysis, and management for IoT.** Given the number of devices and systems connecting to each other and the significant amount of data generated, jobs requiring data analytics skills to monitor, analyse and manage IoT are growing in number. Analysis by PwC indicates that monitoring and tracking will form at least half of the major generic IoT use cases, as a consequence of sensor systems integration (PwC, 2018). In a recent job advertisement for IoT Engineers (Operations), the main task of the IoT Engineer was to "work with teams to develop Industrial IoT (IIoT) solutions for smart manufacturing in cross-sector industrial applications deploying applications such as Digital Performance Management systems, asset tracking and condition monitoring" (McKinsey, 2019).

• How can IoT support more engaging and highly skilled work?

6. **IoT at the Firm-level.** It is at the firm level that IoT can be seen to be supporting more engaging and highly skilled work. An example can be found in the case study of REDARC, a South Australian-based company specialising in the research, design, development and manufacture of electronic products, in particular for automotive applications (see Seet *et al.* (2018a, p.29)). IoT has allowed REDARC to achieve maximum transparency and seamless contact with customers "right throughout the business so they can actually see into the business, see their stock, their product going through the process, understand their lead-times, be able to put their schedules into our systems". Customers are provided with maintenance and fault analysis service data in near real-time, and understand when and where problems are occurring and how to get these fixed. This has led to improved productivity and reduced labour content as a function of:

(1) Machines talking to operators and vice versa (via computer programs), providing real-time information about the process, quality, performance ratings etc.;

(2) Software design capabilities making products instantly;

(3) Configurable and self-analysis of products in real-time;

(4) Rapid prototype tooling using 3D printing has reduced the process from three weeks to 24 hours.

7. **IOT and meaningful work.** IoT has supported the following changes to make work more meaningful at REDARC, but also in non-manufacturing organisations like professional services firms (Lynch, 2016):

(1) Knowledge sharing as teams coming together that "look at how the product is assembled, look at all the different processes and look at seconds and how we can reduce that by smart design concepts. So products that clip together, software and testing and everything has been incorporated without the operator touching or doing anything" (Seet *et al.*, 2018a, p.29);

(2) Social collaboration and breaking down barriers, achieving seamless working between different departments, e.g. engineering and sales, manufacturing and engineering, manufacturing and quality (Seet *et al.*, 2018b);

(3) Sustained engagement post-release of products; there is a continuous improvement process, and continued service and relationship with the customer over the life of the product.

The future workforce

• ***How can Australia prepare the future workforce?***

8. **IoT skills gaps.** International and Australian evidence highlights challenges in terms of finding workers, particularly graduates who are trained—and indeed, familiar with—IoT technologies in the industrial usage context (Turcu *et al.*, 2018). This is largely a consequence of the complexity and newness of these dynamic technologies, which are constantly evolving (Probst *et al.*, 2019).

9. **Australian university efforts**. However, some Australian universities have taken some initial steps to address this gap. For example, at the undergraduate level, James Cook University (JCU) offers an Electronic Systems and Internet of Things engineering degree, which combines Information Technology, electronic engineering and data analytics. Students also benefit from being able to access the Narrowband-IoT (NB-IoT) research facility, a partnership between JCU and telecommunications giant, Huawei. Consisting of research labs and workshops, the NB-IoT research facility enables students to develop solutions to real-world problems using the NB-IoT standard. The University of Sydney offers an IoT major for their Bachelor of Engineering degrees (University of Sydney, 2019). From 2020, La Trobe University will also offer a two-year master's level program that integrates technical knowledge with practical learning opportunities. While based in a new IoT teaching lab in Bendigo, students will use Bendigo city as a "living lab", working with industry partners to produce and implement IoT solutions and systems.

10. **Upskilling the current workforce.** To reduce the skills gap, education and training—and moreover, continuous learning—is needed to skill, re-skill and up-skill individual workers in order to keep pace with changing technology. Gartner (2019) has identified that the IoT will pose challenges for the integration of existing and new Internet-based technologies. This is similar to dealing with the Y2K 'bug' where there is a demand of people with both hardware and software modelling skills to assess and address issues (Mancl *et al.*, 2015). Individual workers need to be trained to enable the transition of systems and data handling of legacy systems as part of the transition to IoT. Beyond that, workplaces will be required to train and retrain existing workforces, which is made more complex by the different training preferences of multigenerational forces (Griffith, 2018). A number of short courses and certifications are available from international companies including IBM, CISCO, Hewlett Packard, and Coursera, and some universities. For example, Curtin University's micro-credential course delivered on the EdX platform, the MicroMasters Program in IoT, comprises six graduate level courses that aim to equip professionals from any field to design IoT solutions relevant to their area of expertise (CurtinX, 2019). Students participate in live discussions with instructors, with remote access to real laboratory equipment for practical sessions. Students who successfully complete all the six courses can use this towards Curtin's two Electrical Engineering major programs for the Master of Professional Engineering. UTS also runs short 'Prepare your IOT future' courses as part of its masterclasses (UTS, 2019).

11. **International efforts.** In the international context, universities are partnering with technology companies that develop IoT solutions (Probst *et al.*, 2019). By integrating online courses from technology companies into the curriculum of a university course, students are able to access the latest in technology, whilst universities are able to keep abreast of rapidly changing technologies. An

example is NASDAQ listed PTC's IOTU.com platform that offers courses on becoming an IoT developer, in which students can learn about IoT and then build apps using PTC's IoT solution ThingWorx (PTC, 2019). In this case, university students are able to access the latest technology, and learn alongside industry professionals and developers, gaining hands-on experience with PTC's IoT solution ThingWorx in a highly scaffolded environment. Another example is the IIoT-focussed Connected Systems Institute at University of Wisconsin-Milwaukee with industry partners Rockwell Automation, Microsoft, and Wisconsin Economic Development Corporation (UW-Milwaukee, 2019).

• What training and skills will be required to support an IoT permeated economy?

12. **Shortage of qualified training providers in Australia.** Providing the required education and training for IoT is not straightforward, as a consequence of challenges in sourcing qualified trainers with the requisite experience (Seet *et al.*, 2018a) . As a result of a shortage of training providers in Australia, Australian enterprises such as REDARC have partnered with offshore institutions such as the German-based Fraunhofer IAO (one of the German-based Fraunhofer Institutes focussed on disruptive technologies) to run dedicated sessions on i4.0 capability building, along with sending staff to conferences and engineers to Japan to study lean manufacturing and i4.0 compatible machine lines. In REDARC's case, IoT is underpinned by a workforce skilled in computer systems, electronics, mechanical/mechatronics, materials skills (how to optimise/reduce weight, advanced processes to protect electronics in harsh environments) and chemical engineering. Employees need strong STEM skills, the ability to analyse data and statistics, and to make decisions based on graphical output. IT literacy is important as operators need to interact with and fix machines using connected computers.

13. **Challenges for SMEs.** However, partnering with international education and training institutions is not always feasible, especially amongst smaller firms, as they may not have sufficient resources, particularly in traditional 'trade' sectors. Thus disruptive technologies like IoT may have a more significant impact on skills development among small to medium enterprises (SMEs), especially compared to larger ones (Seet *et al.*, 2018a). While larger firms can implement in-house training or even partner with other organisations to help fill skill gaps, smaller firms prefer to hire workers with the requisite skill set, rather than develop them internally.

14. **European initiatives.** To address this issue in the European context, the European Commission initiated the IoT4SMEs project to facilitate the development of Vocational Education and Training (VET)-based qualifications that will underpin the digital transformation of the European SMEs seeking to adopt the IoT technology (IoT4SMEs, 2019). Thus there is a role for government programs, collaboration among leading businesses and high-performance cases studies (noting that the CSIRO and government departments are doing some of this work already), that builds awareness both in industry and among training and education providers of the potential for IoT 4.0 technologies and service-based approaches, to prepare firms particularly SMEs to be ready in embracing and adapting to IoT.

15. **Hard vs Soft Skills.** Much of the recent debate related to digital disruption has focused on the dichotomy between the importance of hard or technical skills (such as IoT engineering and data science) and soft or non-technical skills (such as creativity, design and teamwork). This divide is driven by modelling based on a technology-centred (automation) scenario. However, it ignores two other important scenarios, as reported by German i4.0 researchers: the hybrid and specialisation scenarios (Buhr, 2015; Hirsch-Kreinsen, 2016).

(1) **Specialisation scenario.** Under this scenario, people use cyber-physical systems to aid decision-making. Cyber-physical systems are technologies that enable bringing the virtual and material dimensions together to produce a fully networked domain in which intelligent objects interact with each other. For example, in new smart production systems, there will be fewer need for employees with administrative, production and monitoring competencies. But there will be a growing need for qualified and ultra-specialised employees with IT competencies, in particular those who can integrate them with production—technical competencies. Given the 4 broad areas of IoT jobs mentioned above and the complexity of IoT technology, there will be teams of people with deep specialised skills as industry envisages very few individuals can have expertise across many of these boundaries (Heuss, 2014). And to manage these teams, that new boundary-spanning skills will be required. Some examples include "Distributed

Architecture", "OS and Embedded systems", "Communications, Networks and Protocols" and "Mobile Computing" (Assante *et al.*, 2018).

(2) **Hybrid scenario.** Unlike specialisation, the distribution of tasks between people and technologies is based on the relative strengths and weaknesses of workers versus machines. In this case, employees will face an increased demand to be highly flexible. Control tasks will still need to be performed through technologies that require the ability of the workforce in monitoring and directing. Employees with technical skills will need to broaden their outlook to consider the implications of what they design, on the basis that they will likely oversee the implementation of the IoT project that they build (Griffith, 2018). In this sense, the ability to lead, manage and communicate is becoming more critical in the networked economy. The implementation of IoT solutions typically involves significant modification in terms of work content, processes, and environment (Assante *et al.*, 2019). This underscores the importance of soft skills, in particular, problem solving, critical thinking, team working, creative thinking and emotional intelligence. Equipping students and workers with these capabilities is paramount to their ability to manage in an environment that is constantly evolving (Turcu *et al.*, 2018).

• What are some of the infrastructure considerations required to support this? (academic staff and researches, industry placement, global knowledge sharing)

16. **Education-Industry infrastructure partnerships.** For VET providers and universities to support the development of skills needed in the industrial IoT context, educational institutions need to develop the requisite curriculum and courses, underpinned by faculty (e.g., instructors and support technicians) with IoT skill sets and knowledge (Probst *et al.*, 2019). It is recommended for educational institutions to partner with technology providers (e.g. JCU-Huawei), or if they do not, they will need to develop and maintain an IoT server with the capability to connect to diverse data sources and sensors whilst providing easy access to students (Probst *et al.*, 2019). A supporting cloud and network infrastructure will also need to be enhanced in order to protect data, manage devices and perform data analytics.

17. **Education-Industry-Employer collaborations.** In the area of skills and training, several such initiatives have started that are related to, but not necessarily specifically focussed on IoT, and these should be developed further. One of these examples is the partnership between Swinburne University's Advanced Manufacturing and Design Centre (AMDC) with Siemens to access leading-edge technology using Swinburne's Factory of the Future as a key platform for developing and teaching about Industry 4.0 technologies (Seet *et al.*, 2018a). This Swinburne-Siemens collaboration has extended to include employer organisation Ai Group to develop the Industry 4.0 Higher Apprenticeship Program (AiGroup, 2018). Training is provided in cutting edge manufacturing technologies including 3D metal printing, machine vision, and virtual reality applications, many of which are relevant to IoT. These skills are necessary for graduates to be able to respond to disruptive technologies in all industries as part of a unified skills strategy for i4.0 (Northeastern University *et al.*, 2019).

18. **Challenges for RRR areas.** The reliance of IoT on fast and stable data connections is expected to pose problems especially in RRR areas of Australia where Internet connectivity is unreliable and broadband access limited, and it is likely to exacerbate the digital divide between cities and RRR areas as identified in various reviews (e.g. Halsey (2018), RTIRC (2018)), particularly in the following two aspects.

(1) **Lack of qualified trainers.** Even if the emerging IoT technologies were able to be deployed in RRR areas, it is important to have teachers in the VET sector with current industry knowledge. However, many VET providers reported to the Expert Review of Australia's VET System or the Joyce Review (Joyce, 2019) that they found it increasingly difficult to recruit experienced trainers with relevant industry experience, especially in RRR areas and in particular specialities. This will be important for the expansion of RRR-focused IoT technologies that are currently being trialled e.g. smart off-grid power solutions in remote WA (Western Power, 2019). Even for universities that have experience in delivering courses in RRR areas, more specialised IoT qualifications may be difficult to provide. For example, although many of JCU's undergraduate degrees are flexible enough to be delivered in RRR

areas in Queensland, there is no clear mention that the IoT engineering degree offers that flexibility.

(2) **Challenges for Indigenous Australians.** In various reviews, there is a recognition that Indigenous Australians, especially those who live in RRR areas, generally enrol in lower level qualifications due to lower language, literacy, numeracy and digital (LLND) skills (Seet *et al.*, 2019b). As the Joyce review observed, these lower-level qualifications are often a necessary passport to more employment-enhancing qualifications but do not provide a strong pathway into jobs on their own.

To address some of these issues, the Joyce Review noted that flexible and innovative delivery models need to be considered for these areas (Seet *et al.*, 2019a). It recommended that consideration be given to expanding or adopting the regional study hub model, which provides infrastructure and academic support for students studying via distance at partner universities. However, it notes that for this to happen, institution-wide commitment and collaboration between VET providers, universities, external agencies and community networks will be needed in order to achieve high levels of participation and completion for regional and rural students.

Conclusion

19. In looking at the implications of emerging IoT technologies, there is a need to focus on not only the so-called 'hard' infrastructure but also the 'soft' infrastructure. In addition to looking at the micro-issues around skills and training required to support IoT development in Australia, we believe that the following macro aspects are important to be considered. Firstly, attention should be given to implement the recommendations from different policy reviews to address the digital connectivity issues in RRR parts of the country. Secondly, given the inter-connected nature of IoT products and services, and the disruptive nature of the technology across sectors, closer industry-government-education collaborations in delivering education, skills and training to support the transition to an IoT permeated economy, are needed. Some collaborative experiments have begun and these point to a willingness in stakeholders to take the initiative to meet future needs (Seet *et al.*, 2019c).

References

AiGroup. 2018. Industry 4.0 Higher Apprenticeships Program. https://cdn.aigroup.com.au/Reports/2018/Industry_4_Higher_Apprenticeship_Program_July_2018.pdf (22 Oct 2019).
AlphaBeta. 2017. The Automation Advantage, AlphaBeta: Sydney.
Assante D, Caforio A, Flamini M, Romano E. 2019. Smart Education in the context of Industry 4.0. Paper presented at the 2019 IEEE Global Engineering Education Conference (EDUCON), Dubai, United Arab Emirates.
Assante D, Romano E, Flamini M, Castro M, Martin S, Lavirotte S, Rey G, Leisenberg M, Migliori MO, Bagdoniene I, Gallo RT, Pascoal A, Spatafora M. Year. Internet of Things education: Labor market training needs and national policies. In Proceedings of the 2018 IEEE Global Engineering Education Conference (EDUCON).
Buhr D. 2015. Industry 4.0–New Tasks for Innovation Policy. http://library.fes.de/pdf-files/wiso/11480.pdf (24 Oct 2019).
Chartered Accountants Australia and New Zealand, Deloitte Access Economics. 2016. The Future of Work. In *future[inc].* White L (ed.): Sydney.
CurtinX. 2019. MicroMasters Program in Internet of Things (IoT). https://www.edx.org/micromasters/curtinx-internet-of-things-iot (23 Oct 2019).
Department of Industry Innovation and Science. 2017. The Digital Economy: Opening up the conversation, Commonwealth of Australia: Canberra.
Dolphin T (ed.). 2015. *Technology, globalisation and the future of work in Europe: Essays on employment in a digitised economy* Institute for Public Policy Research: London.
Evensen H, Gribb M, Nasiri. 2019. Internet of Things Curriculum Workshop: An Interdisciplinary, Cross-Institutional Effort for Education in an Expanding Field. Paper presented at the 2019 ASEE Annual Conference & Exposition, Tampa, FL.
Frey C, Osborne M. 2013. The Future of Employment: How Susceptible Are Jobs to Computerisation? In *Oxford Martin School Working Paper Series.* University of Oxford.
Griffith C. 2018. The different ways we learn pose a challenge in the age of AI. In *The Australian.* News Corp: Sydney.
Hajkowicz S, Reeson A, Rudd L, Bratanova A, Hodgers L, Mason C, Boughen N. 2016. Tomorrow's Digitally Enabled Workforce, CSIRO: Canberra.
Halsey J. 2018. *Independent review into regional, rural and remote education*. Department of Education and Training: Canberra.
Heuss K. 2014. Is IoT the new Y2K? https://www.zdnet.com/article/is-iot-the-new-y2k/ (24 Oct 2019).
Hirsch-Kreinsen H. 2016. Digitization of industrial work: development paths and prospects. *Journal for Labour Market Research* **49**(1): 1-14.
Intel. 2019. Intel in Energy. https://www.intel.com.au/content/www/au/en/energy/energy-overview.html (22 Oct 2019).
IoT4SMEs. 2019. Internet of Things for European Small and Medium Enterprises. https://www.iot4smes.eu/en/default.aspx (20 Oct 2019).
IOTAA. 2019. IoTAA & KPMG 'State of Nation' Briefing Report. https://www.iotimpact.com.au/iot-state-of-the-nation/ (21 Oct 2019).
Joyce S. 2019. Strengthening Skills: Expert Review of Australia's Vocational Education and Training System, Commonwealth of Australia, Department of the Prime Minister and Cabinet: Canberra.
Klarin A, Seet P-S, Suseno Y. Work-in-Progress. The Internet of Things: Mapping the intellectual structure and charting future directions, ECU: Perth.
Korom P. 2019. A bibliometric visualization of the economics and sociology of wealth inequality: a world apart? *Scientometrics* **118**(3): 849-868.
KPMG. 2018. KPMG to boost headcount by 50% in Australia's leading IoT consulting practice. https://news.efinancialcareers.com/au-en/308174/kpmg-australia-internet-of-things-jobs-sc (22 Oct 2019).
Lynch C. 2016. How The Internet Of Things Can Foster Social Collaboration And Knowledge Sharing In Professional Services Firms. https://www.digitalistmag.com/iot/2016/12/19/internet-of-things-foster-social-collaboration-knowledge-sharing-in-professional-services-firms-04773335 (21 Oct 2019).
Mancl D, Fraser SD, Opdyke B. 2015. Workshop Summary of the 2015 Workshop on Smart Software Strategies: 15 Years after Y2K Everything Old Is New Again (SMART 2015). Paper presented at the 2015 ACM SIGPLAN International Conference on Systems, Programming, Languages and Applications: Software for Humanity.
McKinsey. 2019. IOT Engineer - Operations. https://www.mckinsey.com/careers/search-jobs/jobs/iotengineer-operations-22671 (10 Oct 2019).
Morse Micro. 2019. Morse Micro. https://www.morsemicro.com/ (19 Oct 2019).

Northeastern University, Gallup Education. 2019. Facing the Future: U.S., U.K. and Canadian citizens call for a unified skills strategy for the AI age. https://www.gallup.com/education/259514/northeastern-gallup-perceptions-preparing-to-meet-ai.aspx (18 Oct 2019).
Office of Electricity. 2011. Power Jobs: The Smart Grid Workforce. https://www.energy.gov/articles/power-jobs-smart-grid-workforce (12 Oct 2019).
Office of Electricity Delivery and Energy Reliability. 2019. Smart Grid Workforce Training and Development. https://www.smartgrid.gov/recovery_act/overview/workforce_training.html (23 Oct 2019).
Probst A, Ebner M, Cox J. 2019. Introducing Augmented Reality and Internet of Things at Austrian Secondary Colleges of Engineering. Paper presented at the 21th International Conference on Interactive Collaborative Learning, Kos, Greece.
PTC. 2019. ThingWorx Platform Product Brief. https://www.ptc.com/en/resources/iiot/product-brief/thingworx-platform (19 Oct 2019).
PwC. 2018. Australia's IoT Opportunity: Driving Future Growth. https://www.pwc.com.au/consulting/assets/publications/acs-pwc-iot-report-web.pdf (23/10/2019.
RTIRC. 2018. *2018 Regional Telecommunications Review: Getting it right out there*. Department of Regional Services, Sport, Local Government and Decentralisation: Canberra.
Seet P-S, Jones JT. 2019a. The government keeps talking about revamping VET – but is it actually doing it? In *The Conversation.* https://theconversation.com/the-government-keeps-talking-about-revamping-vet-but-is-it-actually-doing-it-117743: Parkville, VIC.
Seet P-S, Jones JT. 2019b. Indigenous Art Centres that sustain remote communities are at risk. The VET sector can help. In *The Conversation.* http://theconversation.com/indigenous-art-centres-that-sustain-remote-communities-are-at-risk-the-vet-sector-can-help-121179: Parkville, VIC.
Seet P-S, Jones JT, Spoehr J, Hordacre A-L. 2018a. The Fourth Industrial Revolution: the implications of technological disruption for Australian VET, NCVER: Adelaide.
Seet P-S, Jones JT, Spoehr J, Hordacre A-L. 2019c. Jobs are changing, and fast. Here's what the VET sector (and employers) need to do to keep up. In *The Conversation.* https://theconversation.com/jobs-are-changing-and-fast-heres-what-the-vet-sector-and-employers-need-to-do-to-keep-up-118524: Parkville, VIC.
Seet PS, Jones J, Oppelaar L, Corral de Zubielqui G. 2018b. Beyond 'know-what' and 'know-how' to 'know-who': enhancing human capital with social capital in an Australian start-up accelerator. *Asia Pacific Business Review* **24**(2): 233-260.
Suseno Y, Standing C. 2018. The Systems Perspective of National Innovation Ecosystems. *Systems Research and Behavioral Science* **35**(3): 282-307.
Turcu CO, Turcu CE. 2018. Industrial Internet of Things as a Challenge for Higher Education. *International Journal of Advanced Computer Science and Applications* **9**(11): 55-60.
University of Sydney. 2019. Internet of Things major. https://sydney.edu.au/courses/subject-areas/major/internet-of-things0.html (24 Oct 2019).
UTS. 2019. Prepare your IoT future masterclass. https://www.uts.edu.au/about/faculty-engineering-and-information-technology/short-courses/key-trends-2019/prepare-your-iot (18 Oct 2019).
UW-Milwaukee. 2019. Connected Systems Institute. https://uwm.edu/csi/ (17 Oct 2019).
van Eck N, Waltman L. 2009. Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics* **84**(2): 523-538.
van Eck NJ, Waltman L. 2014. Visualizing Bibliometric Networks. In *Measuring Scholarly Impact: Methods and Practice.* Ding Y, Rousseau R, Wolfram D (eds.), Springer International Publishing: Cham.
Vi Dimensions. 2019. Vi Dimensions. https://vidimensions.com (16 Oct 2019).
Walsh T, Levy N, Bell G, Elliott A, Maclaurin J, Mareels I, Wood F. 2019. The effective and ethical development of arfificial intelligence: An opportunity to improve our wellbeing, ACOLA: Melbourne.
WEF. 2016. The Future of Jobs, World Economic Forum,: Cologny, Switzerland.
Western Power. 2019. Empowering regional communities with SPS. https://westernpower.com.au/energy-solutions/grid-technology/stand-alone-power-system/?gclid=Cj0KCQjw0brtBRDOARIsANMDykbfoNY45vXqrmNCLBmOy2Nbxb78gdJqCeansMH0ELkt6yIREsEg9BEaAtb8EALw_wcB (18 Oct 2019).