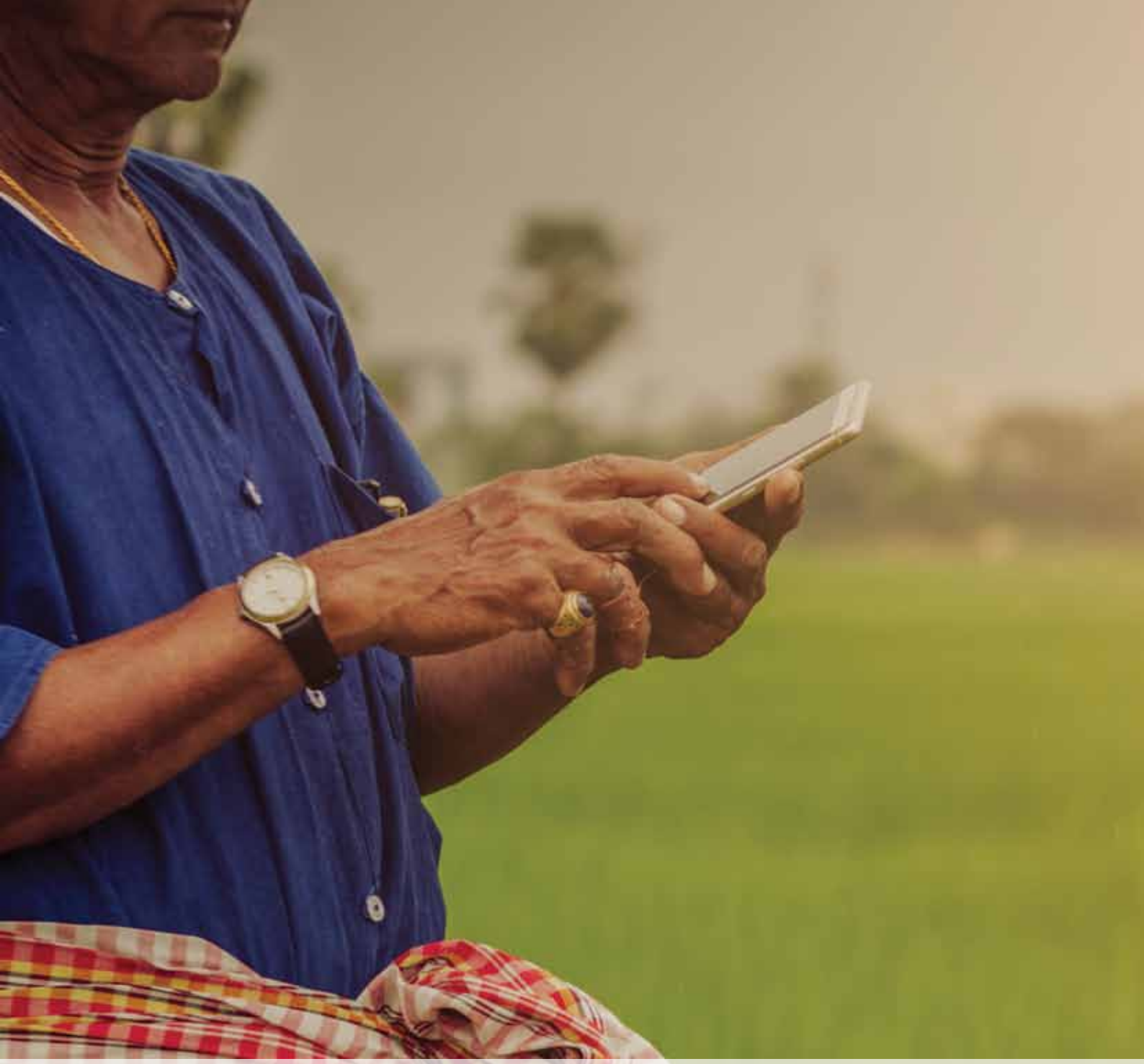

Human Resource Development Challenges and Opportunities Arising from Digital Innovation

Prepared for the APEC Business Advisory Council – Digital and Innovation Working Group by RMIT University

November 2018

ABAC
APEC BUSINESS ADVISORY COUNCIL

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THE AUSTRALIAN APEC STUDY CENTRE

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FOREWORD

The RMIT University Graduate School of Business and Law (RMIT GSBL) are pleased to partner with APEC Business Advisory Council of Papua New Guinea (ABAC PNG) (project sponsor), the PNG APEC Study Centre and Australian APEC Study Centre (AASC) to produce this report on *Human Resource Development (HRD) Challenges and Opportunities Arising from Digital and Innovation* for the APEC Business Advisory Council (ABAC) Digital and Innovation Working Group. The Australian Government through the Department of Foreign Affairs and Trade (DFAT) has provided funding for this report.

This report identifies issues for policy makers to inform endeavours to maximise the benefits of digital innovation in line with APEC's theme for 2018, "Harnessing Inclusive Opportunities, Embracing the Digital Future". HRD is critical for all APEC economies to take full advantage of the rapid technological change and changing workplace needs we are currently experiencing.

A fundamental element of HRD is developing education, training and reskilling options to develop digital skills and knowledge attuned to industry's needs. The education sector itself is being disrupted by digital innovation and the need to update curricula, focus on science, technology, engineering and maths (STEM) subjects is required across all economies to meet the demands of industry 4.0. Further, we are witnessing the shift to innovative teaching methods, such as online learning and micro-credentials.

Significantly, this report highlights those vulnerable groups that are particularly exposed to missing the benefits of the digital revolution. More attention should be given to ensure, women, indigenous, senior and remote/rural economies all have the requisite skills to participate in the digital economy. APEC economies should ensure that these groups have equal opportunity to access the education and skills required to take advantage of the new economy.

The report has been the culmination of research from MBA, EMBA, Masters of International Business Students, researchers, and alumni at RMIT University. I thank the MBA, Executive MBA and MIB researchers selected from RMIT University's for their work on this report. Their findings highlight critical issues around the challenges and opportunities of human resource development across the APEC region. On their behalf, I commend this report to ABAC, and look forward to continued collaboration with the Australian APEC Study Centre.

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INTRODUCTION

As Papua New Guinea (PNG) passes the APEC chair to Chile, RMIT has reviewed research on digital innovation (the application of digital technologies) and associated Human Resource Development (HRD) issues to inform policy development in APEC.

Under PNG's chair, APEC's theme for 2018 has been "Harnessing Inclusive Opportunities, Embracing the Digital Future." APEC Business Advisory Council of PNG (ABAC PNG) adopted the theme "Digitization and Innovation – Advancing Social Harmony" with the following priorities: accelerating regional economic integration; sustaining, developing and deepening inclusive growth opportunities; creating opportunities for MSMEs to prosper; strengthening financial systems to secure stable growth, investment and inclusiveness; and breaking barriers to enrich society by advancing technology.

ABAC PNG co-hosted the inaugural *ABAC Digital Innovation Forum* with ABAC Chinese Taipei, at the Taipei International Convention Centre in July 2018 to discuss all things related to digital innovation, new technologies and digital futures. ABAC PNG recognises that within APEC the digital economy is growing exponentially and continually evolving to creating a surge in disruptive business models in all industries. ABAC PNG is committed to ensuring that PNG can further build on achievements realised during 2018.

Under ABAC, the 2018 Digital and Innovation Working Group (DIWG) established the following priorities: develop business perspectives on frontier digital and innovation challenges; support APEC Internet and Digital Economy Roadmap and E-Commerce Facilitation Framework; promote measures to encourage social absorption of emerging new technologies and entrepreneurship; contribute to the APEC Economic Committee Review of Structural Reforms relevant to digitization and beneficial to business; and support development of a policy framework to upgrade human capital skills and training to adapt to challenges of digitization

In 2019, Chile has indicated that priority issues will include: finding the best paths for regulation of the digital economy and services, boosting widespread regional connectivity, and increasing the participation of women in the economy and international commerce.

Digital innovation is affecting social life, social interaction, work, learning, government and business in all APEC economies and will continue to do so. It is enabling positive transformations on many fronts and APEC recognises the significance of digital innovation for prized economic growth, prosperity and social inclusion. It also delivers deep disruption and needs inclusive, coherent and coordinated policies to thrive in this accelerating digital age.

Across APEC, digital innovation in our social and employment landscapes is occurring at a pace that is challenging policy makers. HRD is a non-negotiable requirement to respond to and manage the ongoing disruption and position economies to benefit from "Industrialisation 4.0", "Digital trade" and "E-commerce". Rapid technological change, shifting workforce needs and new business practices will continue to change how individuals within APEC navigate their lives. The demand for digital skills and new competencies – technical, conceptual and attitudinal – will continue to mount. Digital innovation will continue to offer new options for how the required knowledge, skills and experience can be learnt, taught and delivered. All APEC economies are under pressure to implement progressive HRD regimes to ensure the development of adequate human capital as more digital innovation comes into play.

Digital innovation has unfolded in waves, propelled by advancements in technology. Earlier waves were driven by the advent of web 2.0, smart mobile devices and access to high-speed internet. Chapter 1 reviews the current wave of enabling technology and their implications, including the internet of things (IoT), big data and advanced analytics, 3D printing, blockchain, artificial intelligence (AI) and machine learning.

As the focus pieces and examples in the report show, digital innovation is being absorbed at variable rates within APEC and Chapter Two reviews the impact of digitalisation in the region.

Frontrunner APEC economies, having established the major building blocks of digital maturity, will soon enhance their digital infrastructure with 5G, are strengthening their policy and regulatory frameworks, and are building comprehensive digital eco-systems involving government, business, education and citizens. They have established the impacts of new technology and digitalisation on the world of work and are investing in industry development at the forefront of the 4th Industrial Revolution. Their development of the workforce of the future involves all levels of their education system, based on identified skills gaps, talent development and supply. Their challenge is to continue investment in HRD to stay ahead of the digital innovation curve.

Other adopter APEC members are steadily realising digital potential in their public and private sectors, improving the quality and lowering the cost of their digital infrastructure (4G and cable networks), incentivising business to go digital to boost productivity, and adapting systems to deliver essential STEM, digital and entrepreneurial education, and growing e-commerce. They are embracing initiatives to position their economies to better capture opportunities enabled by automation, AI, big data and analytics. The challenge is to solidify gains achieved to date and increase momentum on key HRD fronts to meet current and future labour market demands on a reliable, sustainable basis.

Some starter members face significant challenges to build their digital eco-systems, striving to establish comprehensive, affordable access to the internet and digital services (health, education, e-commerce, financial etc). Developing human capital under these conditions is challenging. With an emerging digital generation of mainly mobile first-time users, they are assessing ways to raise awareness of digital opportunities, enable digital literacy, and encourage participation in nascent digital economies through partnerships and innovative scalable projects. They are also investigating the potential of emerging technologies to 'leapfrog' these issues. The challenge is to establish solid foundations for digital HRD policies and programs, and to strategically partner on innovative initiatives to close the widening digital gap. Their priority is for urgent capacity building on several fronts to underpin HRD for the next generation and avoid falling behind.

This evident digital divide is a critical issue for APEC and is receiving attention on many fronts as governments put digital first in enterprises, education, entrepreneurs and community. An area of universal interest is the development of fit-for-purpose policies and systems to provide enough and appropriately skilled human resources to meet the challenges of a digital age. Alongside and entwined with the requirement for policies that provide for digital access, privacy and security, members share a common aspiration to develop digital talent for now and the future as a key element to realising social, economic and developmental benefits from digital innovation.

Every APEC economy has an increasingly active digital citizenry – increasingly mobile first - hungry for adequate digital infrastructure and the skills to effectively manage their lives in a digital world. APEC economies variously have businesses embracing digital opportunity: sole traders and micro-businesses using e-commerce gateways to access global markets; incumbent companies, including many SMEs,

enhancing traditional business models and processes with digital technologies; entrepreneurial start-ups developing new products, services, and engagement models; established firms transforming operations through big data and analytics; and companies at the forefront of implementing automation, AI, blockchain, and machine learning. With infrastructure, appropriate education and training programs, investment in skills development, and supportive regulatory and legal frameworks, the business sector will be able to access digitally equipped, entrepreneurial, problem solving, innovative employees, and specialist digital expertise, now and into the future.

HRD involves reskilling existing workers so opportunity exists for all. Chapter 3 investigates social inclusiveness in digital innovation, considering: urban and rural divides; ethnicity; age; gender, and the digital and educational divide between economies. To build sustainable economic growth within APEC, economies should adopt a multi-stakeholder and whole-of-government approach to develop policies to ensure social absorption of emerging technologies so no-one is excluded or left behind.

A key element to HRD is identifying education, training, and development options to deliver the digital skills and knowledge that industry needs, and students want. Furthermore, teachers need to have the ability to teach digital skills courses. There is also an opportunity to meet the challenge by recognising that the way individuals learn is entering new realms through digital innovation.

Chapter 4 investigates ways to enable HRD in APEC to take advantage of digital innovation opportunities in supporting education and training development and delivery. Emerging trends such as blockchain, AI and IoT are providing new ways to deliver content to students and provide solutions that enable more equitable access to education. This chapter investigates the role of government to set frameworks and incentivise these developments, so economies can respond to frontier digital and innovation opportunities that will support social and economic goals.

The digital age brings economic and social opportunity to APEC economies. This paper has been prepared with due regard for the diversity of the economies within APEC to provide key findings and recommendations that might assist APEC policy makers in the future to work together to pursue innovation in HRD to develop a regional digital workforce – to meet today's needs and into the future. This paper was developed through desk research and data collection from a range of research papers, APEC and country reports, presentations and books.

[5] Schwab, K. (2016) 'The Fourth Industrial Revolution: what it means', *The World Economic Forum*

KEY RECOMMENDATIONS

1. *Policy makers should focus on enabling HRD to keep pace with digital innovation and take advantage of opportunities the 4th Industrial Revolution brings.*

2. *APEC economies should maintain efforts to establish enabling environments for the uptake of digital innovation, including: aggressive investment in connectivity infrastructure, and exploring the potential of leapfrog and other innovative technologies to help emerging economies shrink the digital divide.*

3. *Priority should be on social inclusivity policies to lift awareness of digital innovation, uptake and utilisation in life and business across economies.*

4. *Identify measures to ensure vulnerable groups (women, indigenous, elderly, workers in the informal economy and rural and remote populations) have access to digital infrastructure including internet technologies, are aware of digital opportunities and can access STEM and digital education, and innovative on-the-ground projects that foster digital businesses.*

5. *Considering various levels of development amongst APEC economies, efforts should continue to strengthen the capacity for members (in cooperation with partners) to share information and develop joint capacity-building programs, projects and initiatives to promote best practice HRD. This should include focus on innovative approaches in education, training and enterprise-based systems to develop the technical, specialist and soft skills needed in the digital age.*

6. *APEC economies should act to enhance collaboration between government, academia and industry to ensure positive development of appropriate curricula, qualifications, domestic/local/sectoral skills recognition frameworks, and standards.*

7. *APEC economies should continue to focus on targeted demand-driven institutional capacity building to ensure that education, vocational and enterprise-based training systems can apply digital and ICT innovations to deliver education and training, reform curricula to improve technical and soft skills, foster a culture of life-long learning, establish micro credentials and digital badge concepts for targeted accreditation, and introduce campaigns to encourage enrolment in STEM and ICT courses, including by women.*

CHAPTER ONE

DIGITAL TECHNOLOGY TRENDS

FINDINGS

Digital innovation is affecting life, social interaction, work, learning, government and business in all APEC economies and will continue to do so.[1] Digital technologies are affecting the shape and structure of industries around the globe, and the influence on innovation, society and commercial value is well documented.[2] It is enabling positive transformations on many fronts and APEC recognises the significance of digital innovation for prized economic growth, prosperity and social inclusion.

Digital innovation has unfolded in waves, propelled by advancements in technology. Earlier waves were driven firstly by the advent of personal computing and then by the introduction of the web 2.0, smart mobile devices and access to high-speed internet.

The world is now entering the third wave of digital innovation, levelling up out of the internet and connectivity era into what the World Economic Forum has coined the "4th Industrial Revolution". New enabling technologies are providing opportunities for productivity improvements and new revenue streams.

[1] US Department of Commerce 2016
[2] Nylén & Holmström 2015, Chaffey 2016, Taalbi 2017

This chapter reviews the current wave of enabling technology associated with the 4th Industrial Revolution, including the internet of things (IoT), remote sensors, big data and advanced analytics, blockchain, AI and machine learning.

The coming decade will see another revolution in the way things are done. Rapid technological change will shift how individuals navigate their lives. New workforce needs will become clear, driving demand for further new digital skills and competencies – technical, conceptual and attitudinal. The way human resources are developed will need to respond. APEC needs to think now about the future learning, teaching and delivery of digital knowledge, skills and delivery.[3] The risk is to not act and so miss out on the economic value that digital innovation offers including increased productivity and new revenue streams.

Within APEC some economies are already benefiting from breakthrough innovations in medicine, education, commerce and the environment. 3D printing is being used to train doctors, create implants and other prosthetics. In education, machine learning allows educators to understand how their students are applying concepts. In commerce, wireless mesh networks have transformed supply chain networks, tracking people, products and transportation assets.[4] This rise in innovation and creativity has been stimulated by digital technologies, and relies on skilled workers from local, regional or global sources.[5]

In the future, digital innovation will involve the convergence of increasing computing power, big data and machine learning.[6] It will bring forth increased automation, data processing and communication, changing the way businesses access their markets, process transactions and manage their supply chains.[7] Several emerging digital technologies are currently driving innovation. The most impactful digital technologies include machine learning and AI, IoT, blockchain, and virtual and augmented reality. These technologies are upending the way we perceive and interact with technology, the way we connect with each other, and the way we work.[8]

Key Trends in Digital Technologies

Machine Learning and Artificial Intelligence (AI)

AI is an umbrella term for a collection of technologies, ranging from machine learning and rules-based systems to natural interfaces including speech, vision and natural language processing. AI is growing at a rapid pace. Bank of America Merrill Lynch predicts revenue in AI related technologies will grow to $127 billion by 2025, with the biggest growth coming from applications of deep learning, cognitive computing and predictive APIs. AI growth has been significantly aided by computing power increases, which have occured by a factor of ten every four years, providing the ability to crunch and analyse large quantities of data.[9]

[3] Halaweh 2013, Rotolo Hicks & Martin 2015
[4] Segars 2018
[5] Huang, Hsieh, He, & Kozlowski 2014
[6] Skilton & Hovsepian 2018
[7] US Department of Commerce 2016, Huawei 2017
[8] Segars 2018, Huang, Hsieh, He, & Kozlowski 2014, US Department of Commerce 2016, Huawei 2017, Lorenz, Rüßmann, Strack, Lueth, & Bolle, 2015,
[9] World Economic Forum 2018c

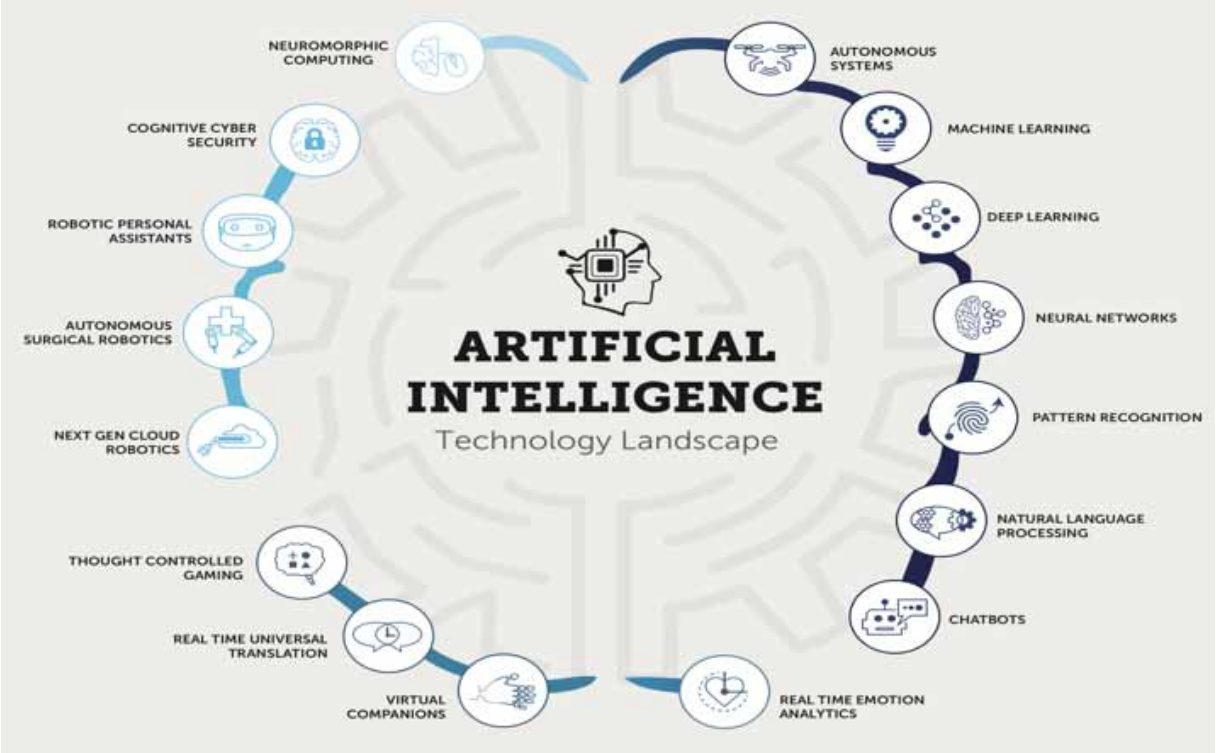


Figure 1.1: AI Technology Landscape.[10]

The U.S. has the largest market for cognitive/AI spending with 2017 revenues totalling nearly $9.7 billion.[11] Europe, the Middle East and Africa (EMEA) is the second largest region but strong spending growth from the Asia Pacific region (including 107% growth in Japan) is expected to move it ahead of EMEA by 2020. Five of the world's six most AI-engaged economies - Japan, Korea, U.S., China and Taiwan - are APEC members, with patents across a variety of industries.[12]

Internet of Things

The Internet of Things (IoT) allows devices on closed private internet connections to communicate with others and the "internet of things" brings these networks together. The internet will be integrated with numerous everyday items, and these devices will be intelligent and context aware.[13] Items such as toasters, wearables, alarm clocks, sensors, smartphones and collars for animals can be connected through IoT to gather information, analyse it and execute relevant actions.[14] There are 23.14 billion IoT connected devices in 2018 ranging from basic consumer electronics to highly complex medical and industrial machines and IoT forecasts vary from 30.73 billion to 50 billion devices by 2020.[15] Worldwide spending on the IoT is forecast to reach $772.5 billion in 2018 and will surpass the $1 trillion mark in 2020 and possibly reach $1.1 trillion in 2021.[16] Predictions that IoT could add $15 trillion to global GDP by 2030 indicate the significant economic impact.[17]

[10] Callaghan Innovation
[11] IDC 2017
[12] OECD 2017b
[13] Panda & Tripathy 2017
[14] Burgess 2018
[15] Panda & Tripathy 2017, Statista 2018b
[16] IDC 2017
[17] Weinberg, Milne, Andonova & Hajjat 2015

IoT disruption is predominately occurring in areas such as industrial manufacturing, transportation and utilities.[18] Manufacturing organisations leading the global implementation of IoT devices are pursuing operator productivity gains; improvement in the accuracy of warehouse management and inventory monitoring; a reduction in non-technical operations losses, and enablement of smart product tracking.[19] Advances in IoT technologies through increased investment and widespread adoption in retail, healthcare and industrial/supply chain industries are expected to generate significant growth and take these industries to the next level.[20] The IoT will connect global supply chains from end to end, enabling pervasive visibility, proactive replenishment and predictive maintenance.[21]

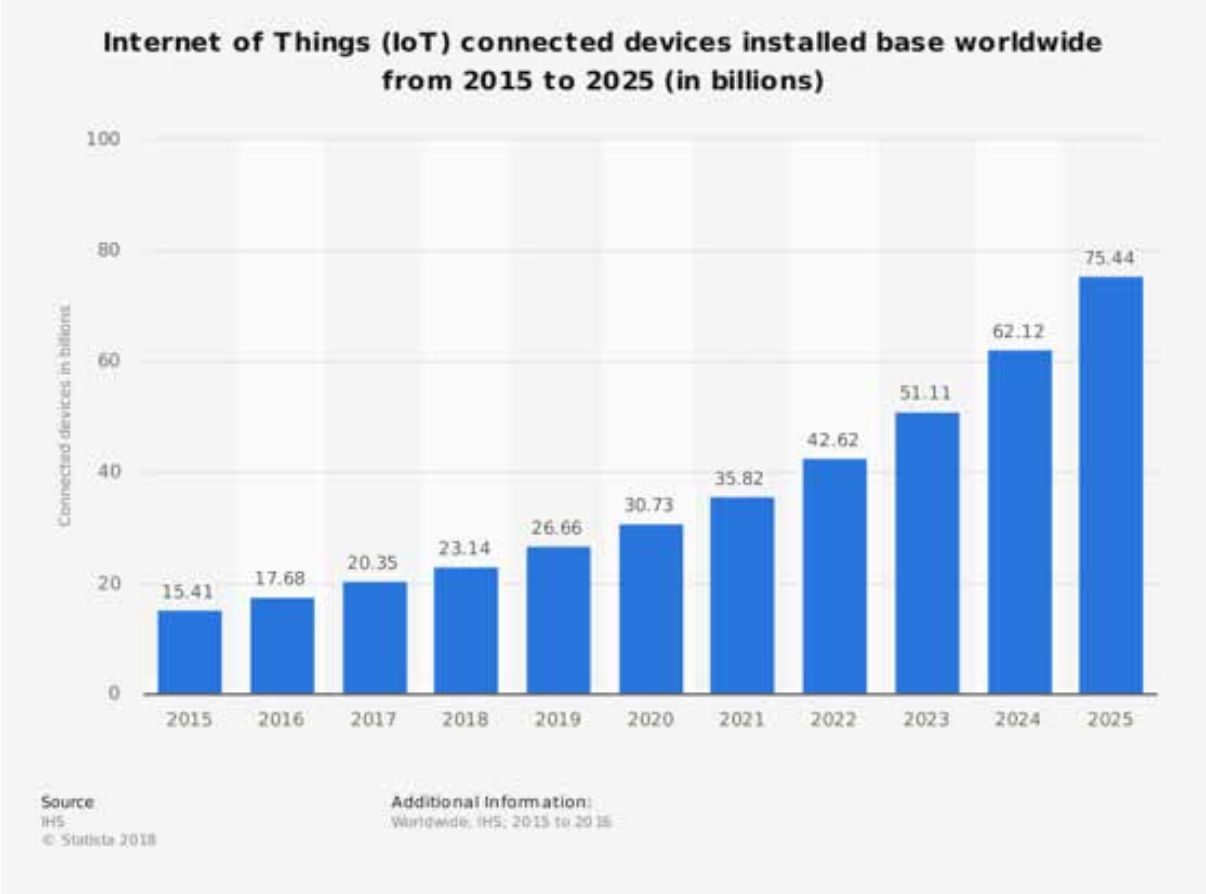


Figure 1.2: Global IoT connected devices

In emerging economies, IoT can improve welfare, education and productivity. Essentials such as electricity; water; waste treatment; medical services, and access to food sources can be improved by IoT enabled devices.[22] Developing economies recognise the importance of IoT to facilitate digital and entrepreneurial activities.

[18] Columbus 2018
[19] Ibid.
[20] Newman 2017
[21] Roe 2018
[22] Ibid.

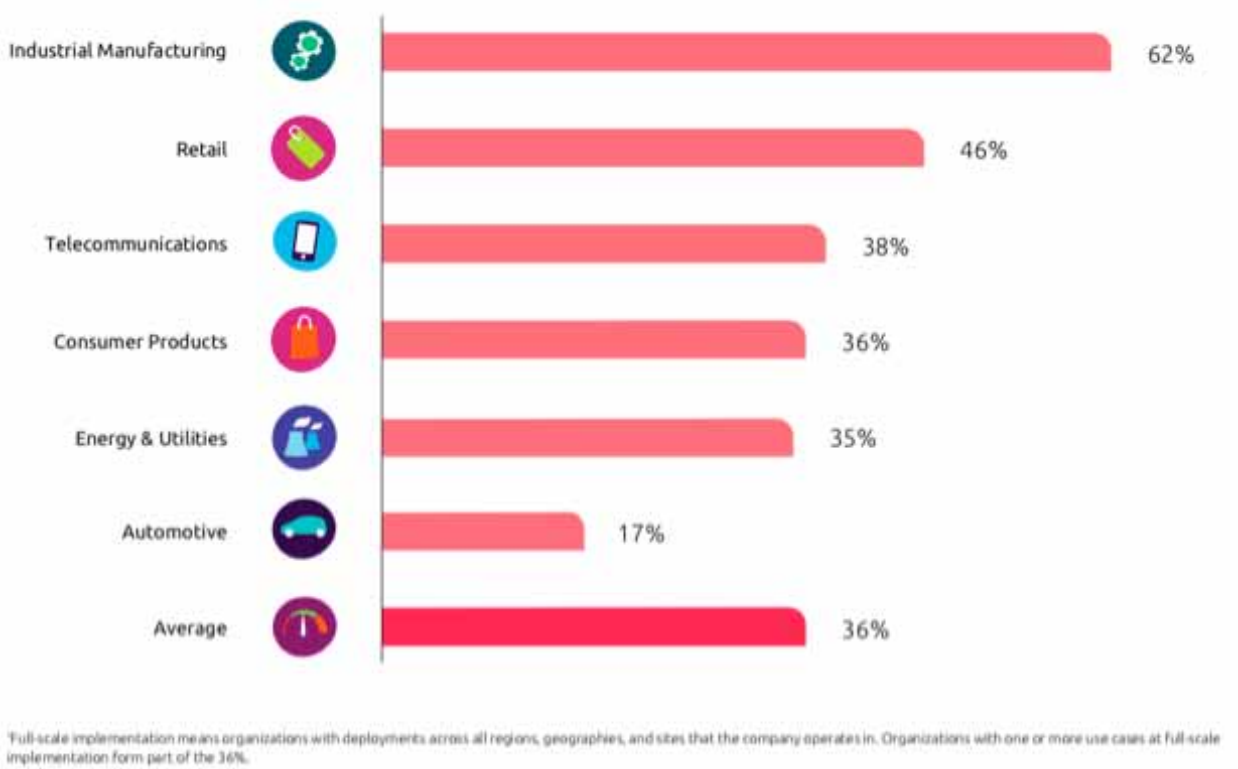


Figure 1.3: Organisations deploying IoT in operations at full scale – by industry.[23]

Blockchain

Blockchain is an electronic shared digital ledger, incorporating a list of transactions that once recorded cannot be changed.[24] Commonly referred to as distributed ledgers, by establishing multiple copies on multiple independent computers within a decentralised network, no single entity controls the ledger. Additionally, blockchain is protected by cryptography which helps to validate the identity of those entering data into the block.[25] These interdependent layers of security make it impossible for a blockchain to be compromised using existing technology. The information recorded in a block can consist of anything from digital media to banking data. By securely enabling the recording of interactions and value transfer (records of ownership) from peer to peer, without the need for a centrally managed coordinating authority, increased efficiency, reliability and resilience are achieved. The decentralised and transparent nature of blockchain increases trust, security, speed, overhead and efficiency of transactions.[26]

[22] Ibid.
[23] Capgemini 2018
[24] Benton & Radziwill 2017
[25] McPhee & Ljutic 2017
[26] World Bank 2018a, Tokareva 2018b

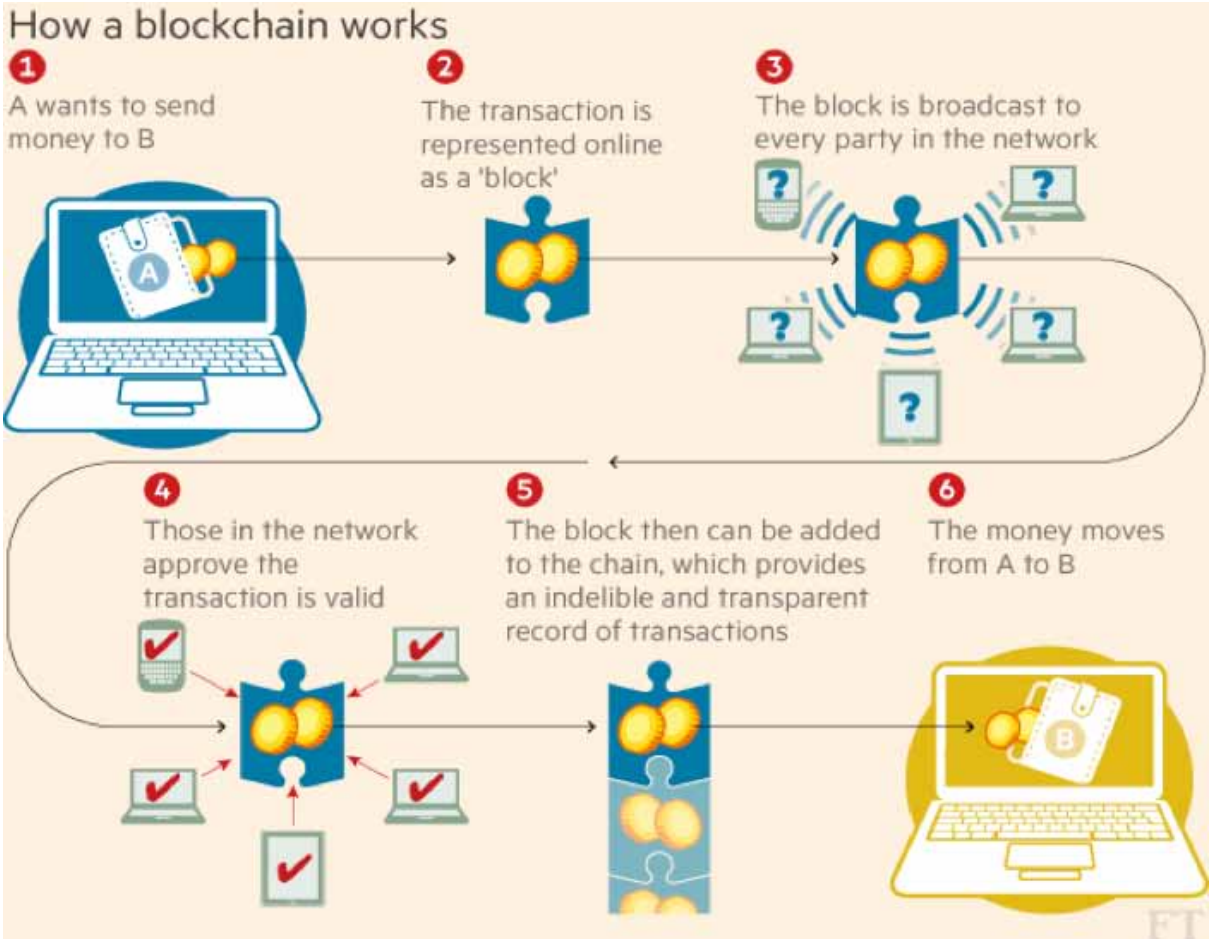


Figure 1.4: Demonstration of a basic blockchain transaction.[27]

Blockchain technology offers process optimisation across any industry that exchanges value or information not only the financial sector. Supply chain assurance and auditing, smart contract-based values exchanges, personal information transfer and secure IoT data exchanges all benefit from the increased efficiency, resilience and reliability that blockchain technology offers.[28]

The economic impact of blockchain is predicted to reach USD176 billion by 2025 and surpass USD3.1 trillion by 2035.[29] At present, blockchain is enabling and affecting digital innovations and value creation in many regions and many sectors.[30] Blockchain technology also enables the development of innovative solutions in conjunction with other emerging technologies. It has been considered the 'transactional platform', supporting the connection of Industry 4.0 technologies such as AI, robots, drones and the IoT.[31] Through the exploitation of its key features and via the specific interplay with other emerging technologies, significant innovations are beginning to emerge. Blockchain is likely to have significant implications for innovation and importantly, the future of work.[32] Entrepreneurs in developing APEC economies recognise blockchain as pivotal to innovation activities in both the government and private sector, ranking it as one of the core facilitators of digital innovation.

[27] Financial Times, November 1 2015
[28] Blockgeeks 2018, World Bank 2018a
[29] Lovelock & Furlonger 2017
[30] Deloitte Insights 2018
[31] McKinsey & Co. 2017a, O'Connor 2017
[32] Australian Government 2017

In focus

China leads the region in adoption of blockchain technologies, issuing its first government approved invoice via blockchain in August 2018.[33] China's Electronic Industry Standards Research Institute is working on national business and application standards, process and method standards and information security standards for the technology to.[34]

Enabling Digital Technologies

The utility of such digital technologies depends on the ability to rapidly store, retrieve and transmit information. Social, mobile, analytics and cloud technologies (SMAC) generate new insights and allow for greater connectivity, faster deployment of innovative ideas and are at the core of current digital trends.[35] To effectively capitalise on the benefits these technologies offer, good quality high speed data infrastructure, big data analytics and cloud computing technology is required.

Fifth Generation (5G) Networks

Key to the adoption and success of these technology trends is the appropriate infrastructure to support them. As emerging digital technologies generate and transmit increasingly large amounts of data, development of infrastructure such as 5G networks that support these increasing payloads and provide reduced latency in data transfers is necessary. Considered a 'step change' from previous generations of mobile technology, 5G technology makes a wider range of applications possible.[36]

5G will comprise the following characteristics:[37]

- Data rates of 1 – 10 Gbps connection to endpoint
- Near zero latency
- 1000 times more bandwidth than current networks
- 10 – 100 times more connected devices
- 99.99% availability and 100% coverage
- 90% reduction in energy usage
- 10yr battery life for low power, machine-type devices

Currently mobile network coverage across the Asia-Pacific region is increasing at an average of 2.5% per year.

[33] Cointelegraph 2018
[34] CCN, 2018
[35] McKendrick 2014
[36] Branch 2016, Bureau of Communication and Arts Research 2018
[37] Australian Communication and Media Authority 2016

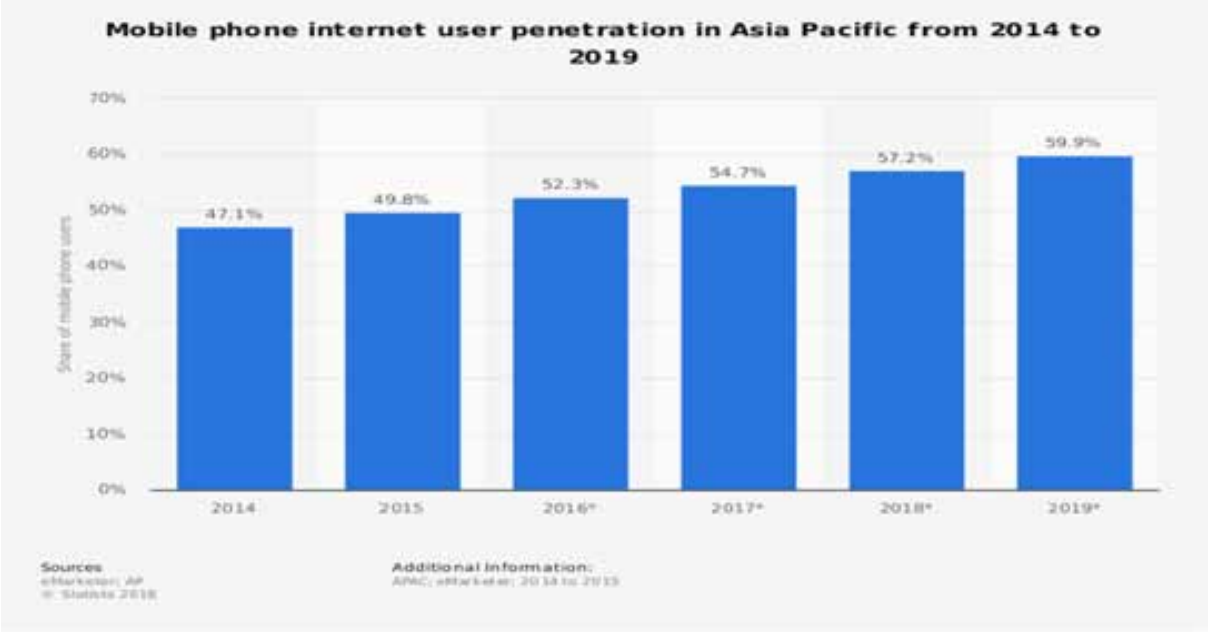


Figure 1.5: Mobile phone internet user penetration in Asia Pacific from 2014 to 2019.[38]

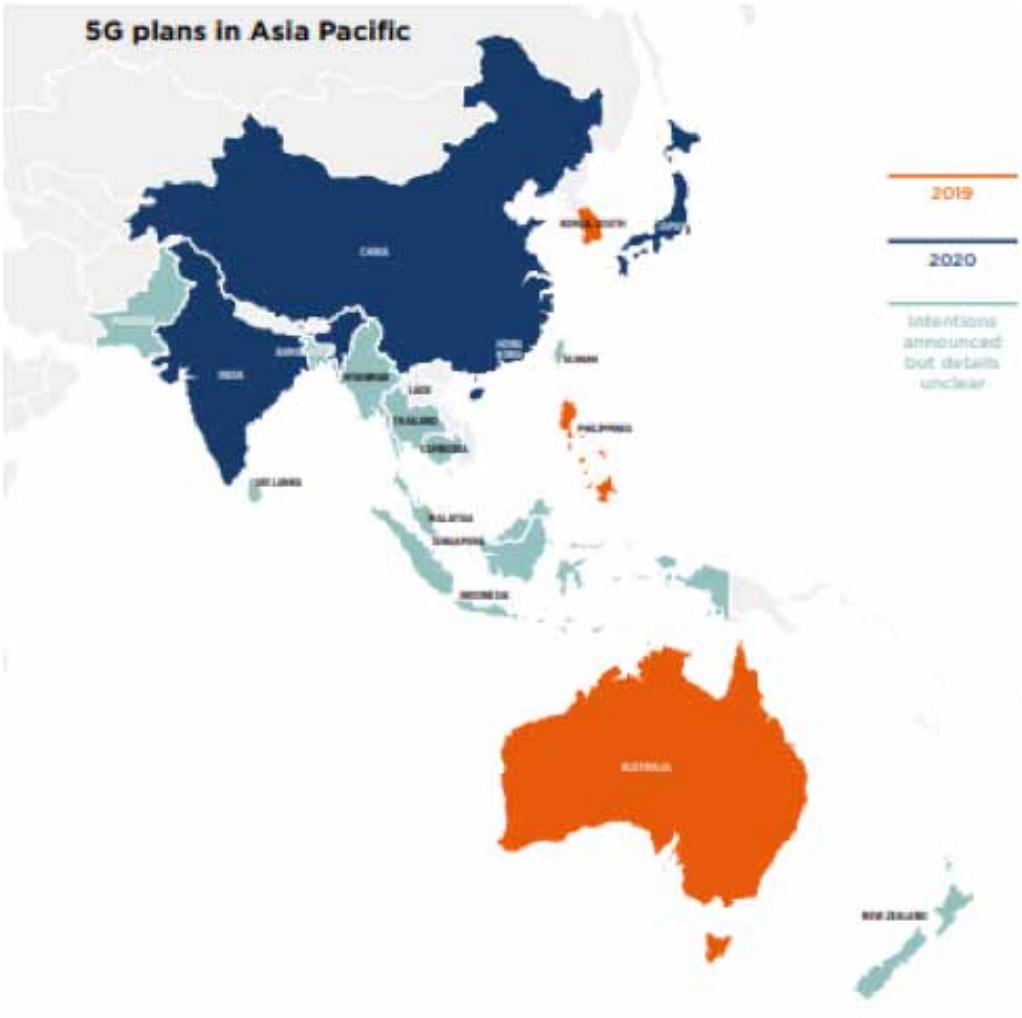


Figure 1.6: 5G plans in Asia Pacific.[39]

[38] Statista 2018a
[39] GSMA 2018

Early-adopters of 5G infrastructure within APEC include Australia, the Philippines and South Korea. South Korea's Ministry of Science and ICT recently announced changes to telecommunications regulations that will require the country's three mobile operators to participate in the co-deployment of network infrastructure and opening of facilities for infrastructure sharing, with the specific goal of supporting the early commercialisation and take up of 5G technology, whilst reducing costs. Potential savings are estimated at $40 million in annual deployment costs and $1 billion in capex over the next 10 years.[40] In Australia, 5G is predicted to improve multifactor productivity growth across the economy and is estimated to add an additional $1,300 - $2,000 in GDP per person within ten years of rollout.[41]

Given the potential economic growth that is predicted, continued investment in 5G infrastructure remains a priority for APEC economies. Initiatives such as those undertaken by South Korea should be investigated across all economies planning future 5G implementation, to enable cost effective rollout of the technology.

Big Data & Analytics

Data is exploding, digital platforms generate large amounts of raw or "big data". Mobile technologies allow for the digital connectivity of individuals in almost any location. However, data without context, has limited utility. It is the ability to analyse this data which makes it particularly useful, as analytics allows for the discovery of patterns and other useful information. This analysis requires complex algorithms, computational power and analytical techniques to yield actionable insights.[42] Data from activities conducted on mobile devices can be fed back to be analysed allowing organisations near real-time statistics to help guide their decision making.[43]

- 90% of all data was created in the last 2yrs – 2.5 quintillion bytes per day.[44]
- More than 50% of web searches done on a mobile.[45]
- Google now processes more than 40,000 searches every second - 3.5 billion searches per day.[46]
- 77% of searches are conducted on Google, - worldwide there are 5 billion searches a day.[47]

[40] Ibid.
[41] Bureau of Communication and Arts Research 2018
[42] Oppitz & Tomsu 2017
[43] McKendrick 2014
[44] Domo 2017
[45] Tech Startups 2018
[46] Ibid.
[47] Ibid.

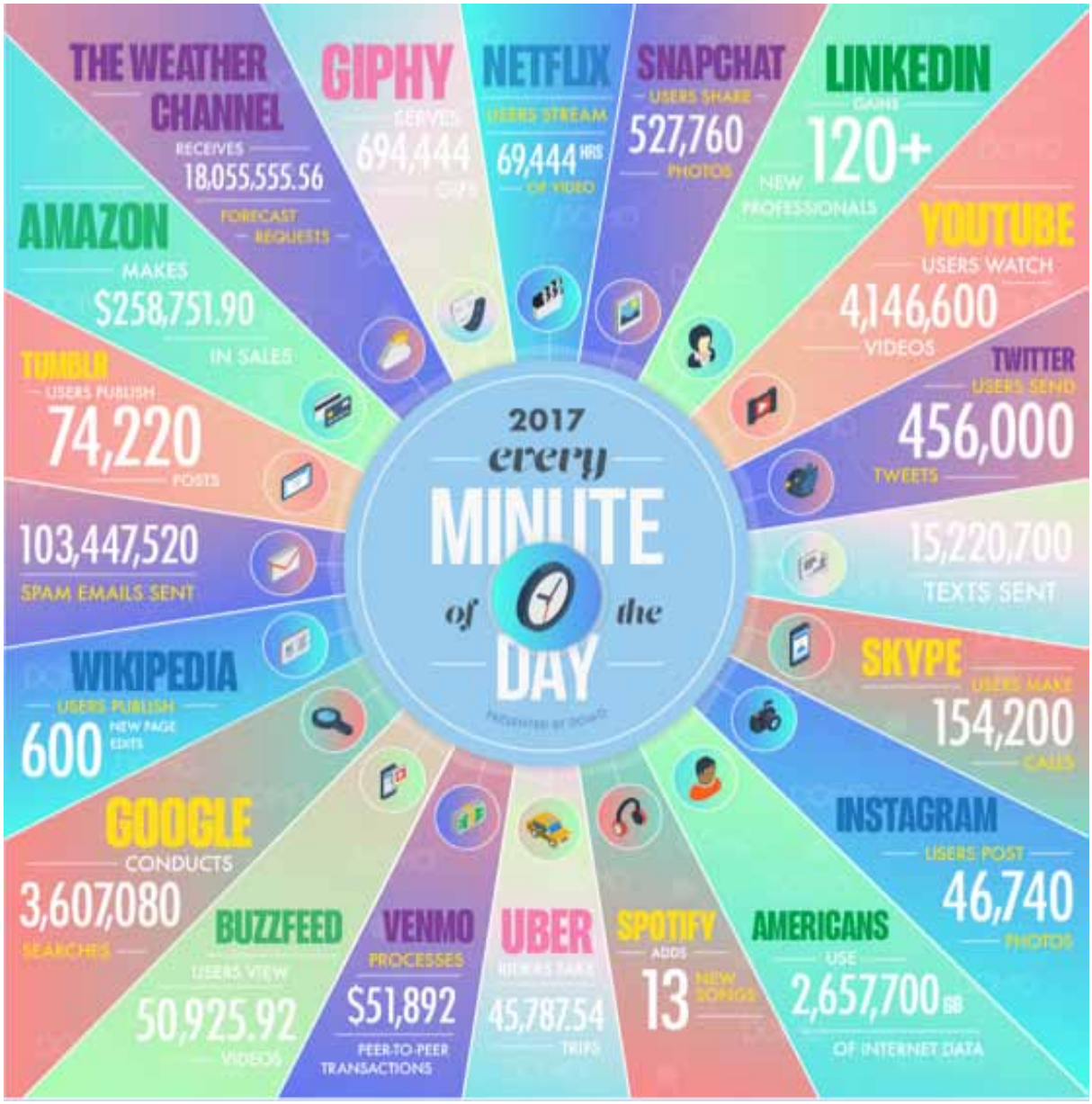


Figure 1.7: Data created every second in 2017.[48]

[48] Domo 2017

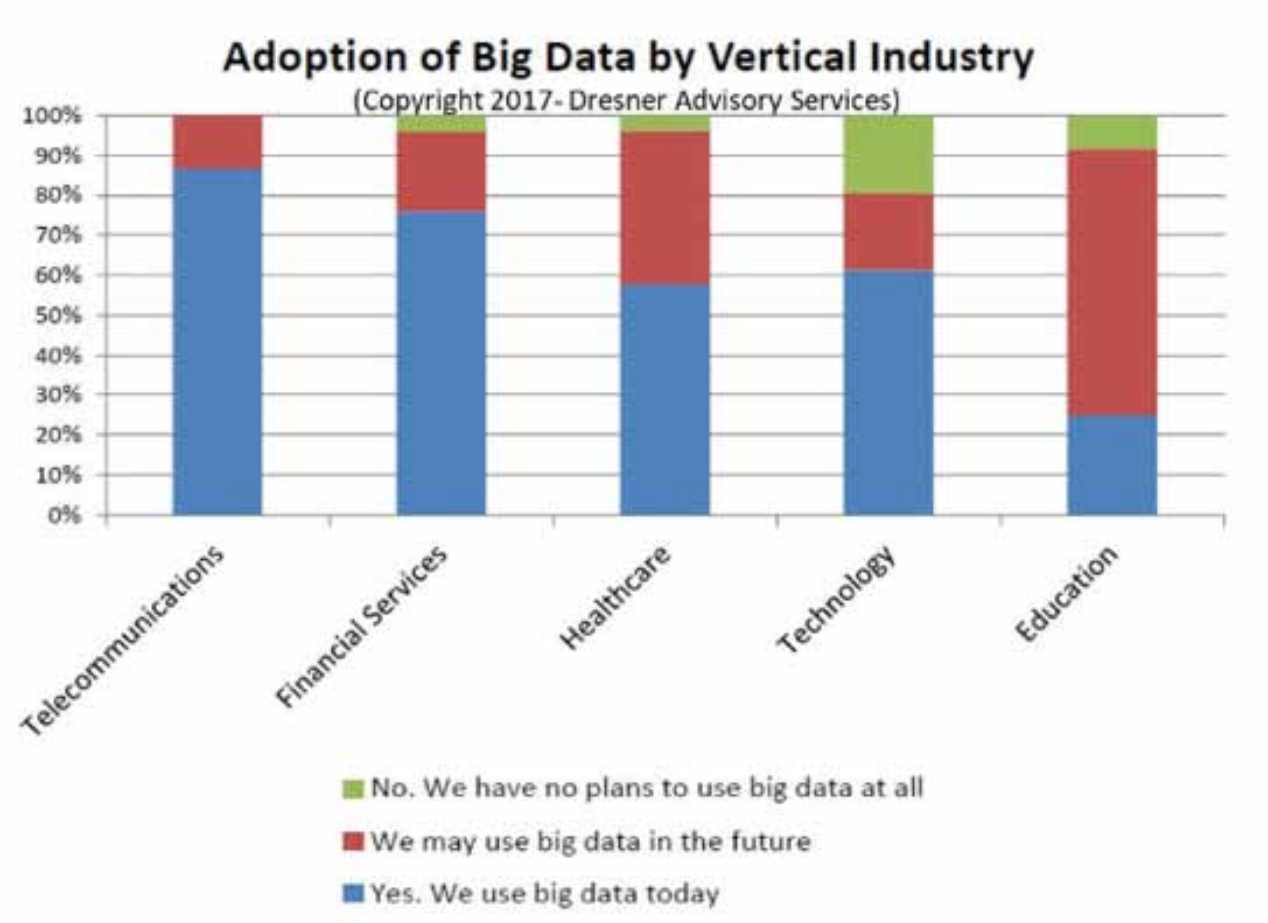


Figure 1.8: Big Data Analytics Market Study.[49]

Whilst the commercial benefits of innovations which leverage data are highest in the most developed economies, big data also has a role to play in developing economies, both from a social and a commercial perspective.[50] There are many activities in the big data lifecycle which can be leveraged to create value (Figure 1.8). Technological innovation is the impetus for developing economies to benefit from big data; satellites, sensors and cloud-based storage are ways for developing economies to leapfrog from traditional methods of data generation to big data, without having to go through the same evolution as developed economies.

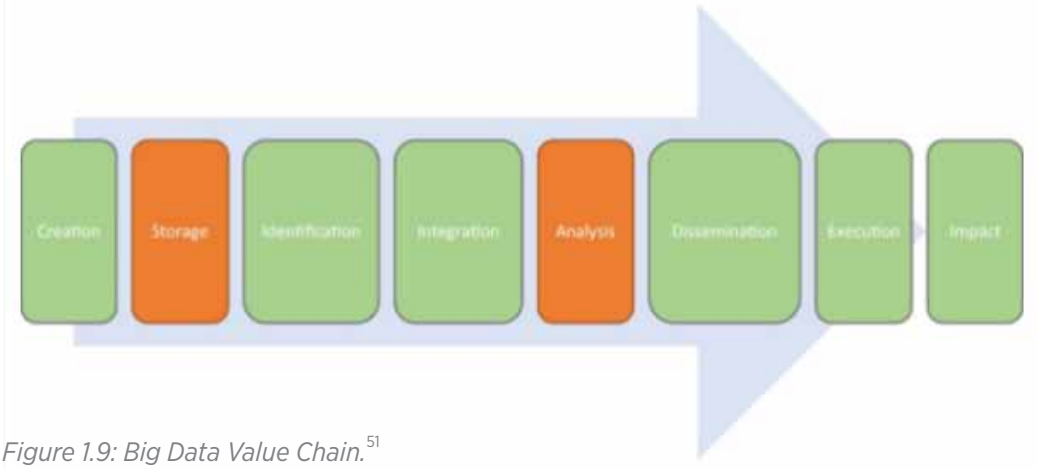


Figure 1.9: Big Data Value Chain.[51]

[49] Columbus 2017, Dresner Advisory Services 2017
[50] Chandy, Hassan & Mukherji 2017
[51] Chandy, Hassan & Mukherji 2017

Cloud Computing

With the explosive growth of data being generated comes the challenge of how to handle and store this large amount of information. Cloud-based technology has assisted as it allows for the storage and rapid deployment of server and processing infrastructure, providing greater scalability of pooled resources, on demand provisioning and self-service pay as you go features. The ability to hold vast amounts of data means cloud computing is integral to development and use of IoT, big data & analytics. Organisations are seeing the benefits of moving digital infrastructure away from local installations to centralised cloud-computing services. This enables them the ability to access the technology they need, as and when they need it without the necessity to invest up-front capital to source their own infrastructure.[52]

[52] Yang, Huang, Li, Liu & Hu 2017

CHAPTER TWO

IMPACT OF DIGITAL INNOVATION ON APEC ECONOMIES

FINDINGS

APEC's theme for 2018 is "Harnessing Inclusive Opportunities, Embracing the Digital Future". Digital innovation is driving structural adjustment in the labour market and raising the requirement for effective HRD to prepare coming generations for work of the future in the digital age, upskill existing workers to ensure they can participate and are not displaced, and act to ensure that vulnerable groups are not left behind.

Findings from the research highlighted the vital importance of digital capability and skills development. All APEC economies are finding rapid digital innovation challenging in terms of providing policies that support labour market adaptability, employment, life-long learning and workforce participation.

There is a widening digital and educational divide within APEC that is obstructing the achievement of APEC objective of sustainable and inclusive growth in the region.

As demand for digital skills grows many economies aren't keeping pace with development of capability to support digital innovation, now nor in the future. In many economies within APEC digital literacy is lagging and increased awareness of the benefit digital technology brings is needed to increase societies uptake.

Meeting the challenges of digital innovation is a cross-sectional issue requiring policies around labour market adaptability, employment, life-long learning and workforce participation.

HRD is key and is an evident priority in existing Statements, Strategies, Agendas, Blueprints, Frameworks, Sub-Fora and Working Groups on HRD, Education, Structural Reform, Employment, and Entrepreneurship.

This chapter reviews the impact of digitalisation across the region. As the many examples and the case studies in this report confirm, digital innovation is being absorbed at varying paces and with varying levels of success across APEC. All members are clear that opportunity abounds because of digital innovation. Barriers which have hindered adoption of advancing enabling technologies by economies, organisations and individuals are eroding.[53]

In this accelerating third wave of digital innovation, the differing rates and capacities of APEC economies to manage disruption and develop inclusive, coherent and well-coordinated policies to capture the full potential is a critical issue for the forum to consider. Figure 2.1 shows the variability of digital transformation in a range of global economies, including numerous APEC economies.

Figure 2.1: The Digital Transformation Journey of Global Economies.[54]

[53] Morabito 2016
[54] *Huawei 2017*

Inclusive Internet Index **Overall ranks**

Rank		Score /100	Rank		Score /100	Rank		Score /100
=1	Singapore	90.3	26	Colombia	71.9	51	Kenya	55.2
=1	Sweden	90.3	27	South Africa	71.0	52	Algeria	53.0
3	United States	88.2	28	Saudi Arabia	70.6	53	Pakistan	50.7
4	United Kingdom	88.0	29	China	69.7	54	Myanmar	50.6
5	Japan	87.9	30	Mexico	69.6	55	Cambodia	50.2
6	South Korea	86.9	31	Turkey	68.3	56	Nepal	49.1
7	France	86.6	32	Vietnam	67.9	57	Tanzania	48.5
=8	Canada	85.2	33	Peru	66.3	58	Senegal	46.7
=8	Netherlands	85.2	34	Morocco	65.6	59	Angola	46.3
10	Italy	84.7	35	Indonesia	65.4	60	Côte d'Ivoire	45.9
11	Australia	83.9	36	India	64.4	61	Cameroon	45.6
12	Germany	83.8	37	Egypt	64.3	62	Sudan	45.0
13	Poland	82.7	38	Iran	63.9	63	Rwanda	44.3
14	Spain	81.1	39	Mongolia	63.6	64	Uganda	43.8
15	Russia	80.2	40	El Salvador	63.4	65	Mozambique	43.3
16	Taiwan	79.7	41	Sri Lanka	62.5	66	Yemen	42.0
17	Romania	79.4	42	Venezuela	60.7	67	Burkina Faso	40.2
18	Brazil	78.0	43	Philippines	59.8	68	Zambia	39.4
19	Chile	77.6	44	Maldives	59.7	69	Ethiopia	37.2
20	Argentina	76.2	45	Nigeria	59.4	70	Malawi	32.3
21	Malaysia	75.8	46	Bangladesh	57.8	71	Madagascar	30.7
22	Ukraine	73.8	47	Uzbekistan	56.7	72	Mali	29.7
23	Thailand	72.6	48	Seychelles	56.2	73	Liberia	28.8
24	Oman	72.3	49	Ghana	56.1	74	Niger	26.9
25	Kazakhstan	72.2	50	Guatemala	55.3	75	Congo (DRC)	24.1

Figure 2.2: Inclusivity Factors.[55]

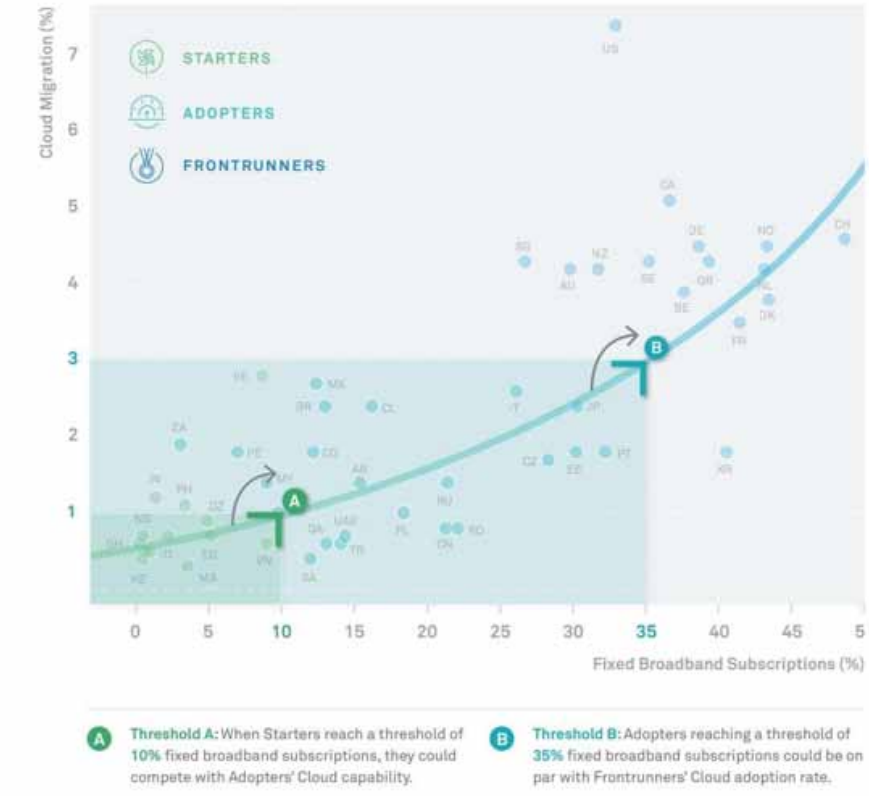


Figure 2.3: Increasing Fixed Broadband Subscriptions encourages Cloud Adoption.[56]

[55] Economist Intelligence Unit 2017
[56] Huawei 2017

Globally, and within APEC, economies must grapple with the reality of a steadily widening digital divide with the advent of the third and current wave of digital technology.

Globally only 15% of the world has access to high speed internet, and approx. 2 billion people aren't using a mobile (Figure 2.4).[57] Within APEC, many regions still lack fixed-line infrastructure, and in some access to the internet is scarce, unaffordable, too slow or completely unavailable (Figure 2.3).[58] In many developing economies mobile networks are being deployed to compensate for lack of infrastructure and this has been particularly successful in the Asia-Pacific region.[59]

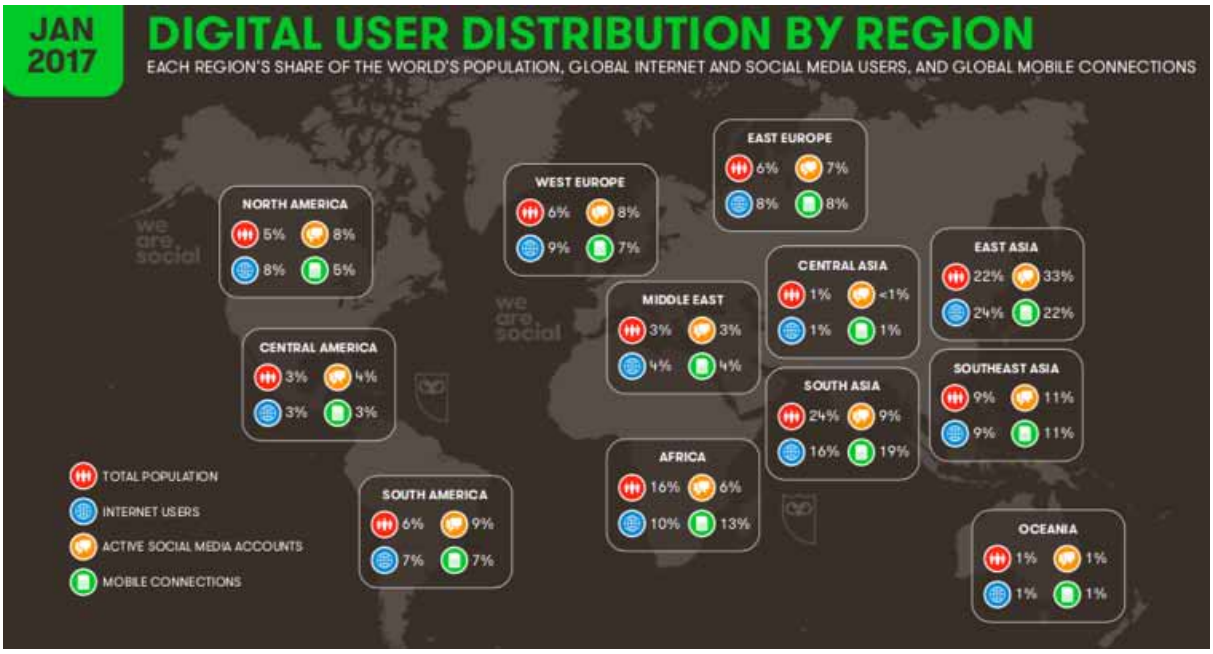


Figure 2.4: Regional Digital User Distribution.[60]

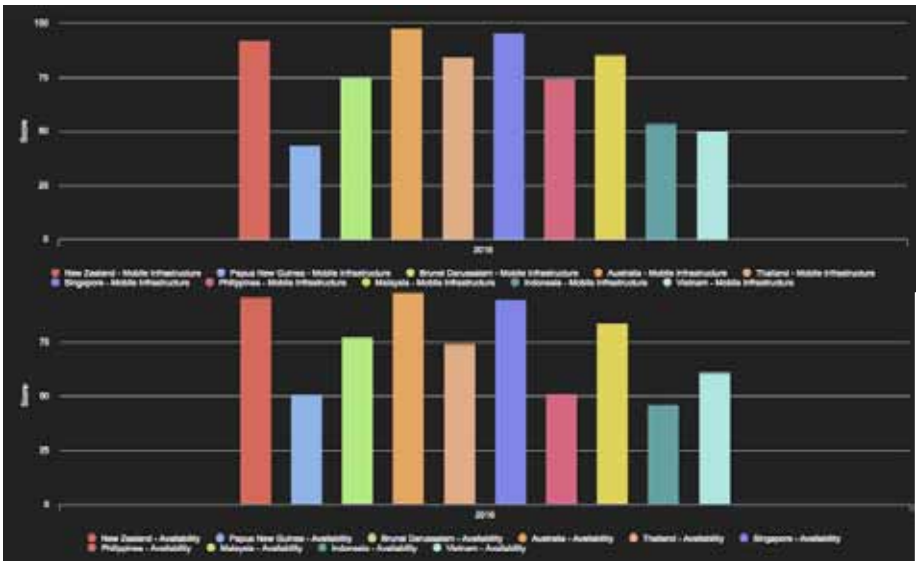


Figure 2.5: Comparison of Mobile Infrastructure (Top) and Digital Availability (Bottom) – Oceania & SE-Asia.[61]

[57] United Nations 2016
[58] World Economic Forum 2016a
[59] Economist Intelligence Unit 2017
[60] Hootsuite 2017
[61] GSMA 2016

This divide emerged during the earlier waves of digital innovation. Whilst developed economies at the forefront of digital innovation, were able to invest to set up the foundations of a digital eco-system, including national broadband and mobile connectivity, digital literacy, and support for digital adoption by large, SMEs and start-up enterprises, developing economies divided into two camps with lower levels of adoption of the vital enabling technologies and critical initiatives to leverage it. Having established the major building blocks of digital maturity, they are well placed to enhance their digital infrastructure with 5G, are strengthening their policy and regulatory frameworks, and are building comprehensive digital eco-systems involving government, business, education and citizens. They have established the impacts of new technology and digitalisation on the world of work and are investing in industry development at the forefront of the 4th Industrial Revolution. Their development of the workforce of the future involves all levels of the education system, based on measured skills gaps, talent development and supply. Their challenge is to continue investment in HRD to stay ahead of the digital innovation curve.

The first group of other economies recognised and identified in the Global Index for Connectivity, as 'adopter' economies, have moved more slowly to implement digital innovations. Due to constraints and competing priorities for resources, they have steadily but at a lesser pace realised digital potential in the public and private sectors. They have established and are now consolidating the quality affordability of their digital infrastructure (4G and cable networks), incentivising business to go digital to boost productivity, and adapting systems to deliver essential STEM, digital and entrepreneurial education, and growing e-commerce. They are seeking to enable their economies to better capture opportunities enabled by automation, AI, big data and analytics. The challenge is to solidify gains achieved to date and increase momentum on key HRD fronts to meet current and future labour market demands on a reliable, sustainable basis.

The second group of economies, identified as 'starter' economies have and continue to face significant challenges to build their digital eco-system, striving to establish comprehensive, affordable access to the internet and digital services (health, education, e-commerce, financial etc). Developing human capital under these conditions is a challenge - improve their capacity to handle and overcome the structural barriers that are blocking the effective development of human resources in their respective economies.

With an emerging digital generation of mainly mobile first-time users, they are assessing ways to raise awareness of digital opportunities, enable digital literacy, and encourage participation in nascent digital economies through partnerships and innovative scalable projects. They are also investigating the potential of emerging technologies to 'leapfrog' these intransient issues. The challenge is to establish solid foundations for digital HRD policies and program, and to strategically partner on innovative initiatives to close the widening digital gap. Their priority is for urgent capacity building on several fronts to underpin HRD for the next generation and avoid falling behind.

This evident digital divide is a critical issue for APEC and is receiving attention on many fronts as governments put digital first in enterprises, education, entrepreneurs and community. An area of universal interest is the development of fit-for-purpose policies and systems to provide enough and appropriately skilled human resources to meet the challenges of a digital age. Alongside and entwined with the requirement for policies that provide for digital access, privacy and security, members share a common aspiration to develop digital talent for now and the future as a key element to realising social, economic and developmental benefits from digital innovation.

Privacy and Security

Due to the increase in the volume of data and the number of connected devices outlined in Chapter 1, there is growing concern about the security of personal information and individual privacy.[62] Connected technologies such as IoT are heavily dependent on data and provide more entry points for hackers and cyber criminals.[63] Currently connected device technology has minimal regulation, and as the volume of data increases, so too does the threat of cyber-attacks. Malware, for example, a purposeful malicious discharge of software that is intended to reduce or destroy the efficiency and productivity of individuals and businesses is growing exponentially in the U.S., Asia and Europe.[64]

The costs caused by security violations are estimated at between US$300 billion and US$500 billion per year and the categories of cyber-attacks range from fraud and embezzlement to theft of intellectual property and blackmail (Figure 2.6).[65] Cybersecurity risk will increase exponentially as people, processes and organisations continue to connect every part of peoples' lives, as well as economies.[66]

Figure 2.6: Most Common IT security events 2016.[67]

Digital technology trends of the future come with significant concerns around breaches of personal information and security, highlighting the increasing importance of adequate security measures and policies ensure data and devices aren't exposed or susceptible to data theft, breach of privacy, fraud or cyber-attack.[68]

The Business Sector (Private Sector Challenges & Opportunities)

Impact on the Business Sector

Organisations leading the world in innovation activities are heavily investing in digital endeavours with big data analytics, mobile products and capabilities, digital design and aggressive adoption of new technologies being key focus areas (Figure 2.7). Conversely a declining focus on technology

[62] Meola 2016
[63] Weinberg, Milne, Andonova & Hajjat 2015
[64] Morabito 2016
[65] Oppitz & Tomsu 2017
[66] Roe 2018
[67] Oppitz & Tomsu 2017
[68] Smith 2018

platforms indicates the fundamentals of digital innovation (the platforms) are now established for these organisations.[69] The increasing importance placed on digital technology has afforded many organisations within APEC the ability to tailor new business models and has led to significant competitive advantages. Expansion into other geographical sectors has provided new market opportunities that would have otherwise been impossible without digital technologies.[70]

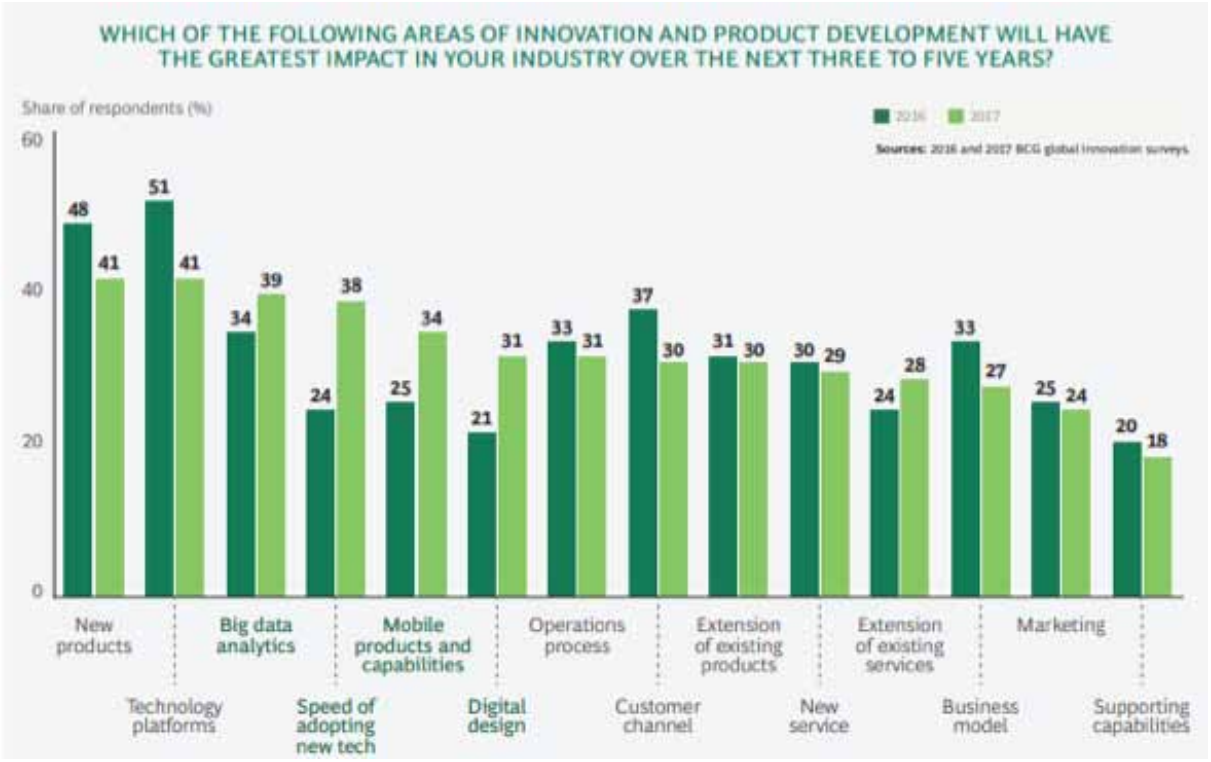


Figure 2.7: Digital Innovations – Biggest Increases in Expectations[71]

The implications of digital technology vary across APEC economies and the industries within. The opportunities presented by AI alone will lead to automation of many manual repetitive tasks carried out across industries. This change in turn influences the skills required for workforces. Digital transformation for any organisation can be disruptive but for incumbent businesses it can have a significant impact on job roles as new technology makes existing roles redundant.

Traditional organisations that have built their business models based on a non-digital landscape struggle to find additional investment or allocate already scarce resources to develop new technologies. In addition, psychological resistance from existing management and employees often prevent digital transformation within organisations as they attempt to retain that which is familiar, rather than embracing change.[72]

If digital technologies are implemented without careful consideration, there could be a significant impact on organisations and subsequently economies, as workforces attempt to adjust.

[69] BCG 2018
[70] OECD 2017c
[71] Ibid.
[72] Ibid.

"If we can break barriers and position more businesses to benefit from regional growth drivers using digital advances, it could be the next revolution. That could integrate remote areas, more women in businesses and more informal firms into the new economy". Dr Bollard, Executive Director of the APEC Secretariat.[73]

Understanding the Benefits of Digital Innovation

Fear of change is a common barrier that organisations face in responding to frontier digital innovations; as is finding talent; and staying competitively relevant. Digital innovation requires a cultural transformation which should be driven from the upper levels of organisations. The necessity to understand the benefits of linking organisational strategy with digital innovation and technology initiatives is vital. These synergies can provide organisations with enablers that provide new revenue streams; allow them to be more agile and respond to the changing business landscape.[74]

For many organisations 'digital innovation' in the form of 'digital transformation' is considered no more than a buzzword. It is often difficult to determine where and how the impact will result in tangible business value. Instead a cultural shift must be achieved to maintain a competitive advantage as value through the delivery of technological platforms for innovation is introduced.[75]

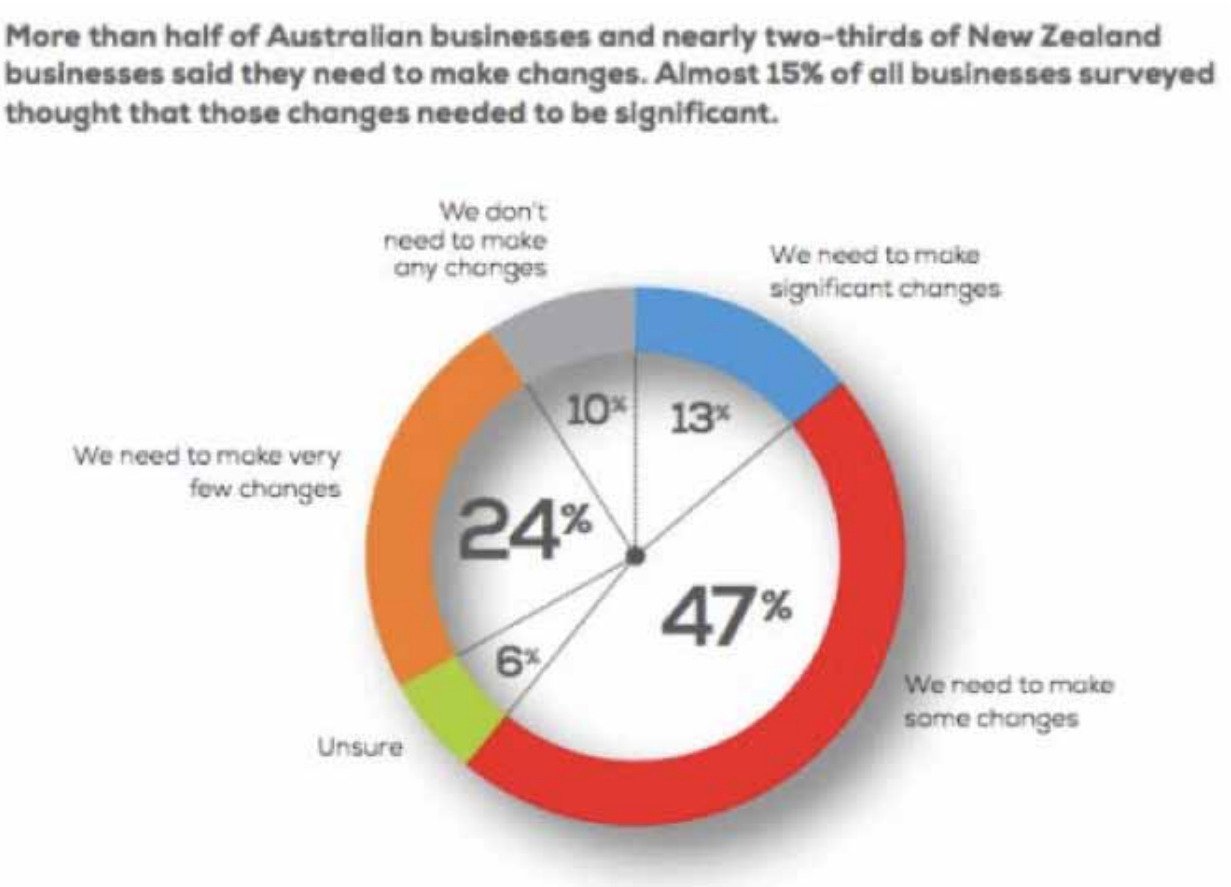


Figure 2.8: The extent in which organisations need to change to prepare for the future of work.[76]

[73] APEC 2018a
[74] Capgemini 2016
[75] Ibid.
[76] Capgemini 2016

Which of the following technology related issues has your business experienced in the last 12 months?

High cost of IT with a low or unknown return on investment	39.2%
Project overrun	16.1%
Security breach	13.2%
Privacy breach	1.8%
Disconnect between technology and business strategies	26.9%
Not enough IT staff	24.6%
Inadequate disaster recovery or business continuity measures	9.1%
Lack of agility	15.5%
Lack of inovation	17.0%
Serious IT operation incidents	9.1%
Issue related to cloud computing	16.7%
Issue related to mobile device security	4.1%
Issue related to outsourcing / technology service providers	22.5%
Issue related to employees using personal devices for work activities	12.9%

Figure 2.9: Technology related issues affecting businesses.[77]

Impact on Jobs and Employment

Any major technology development will mean some change and adjustment in the economy. The effect of digital technology on jobs and employment is twofold, the changing nature of work is resulting in a skills gap brought about by new technologies, and also the threat to traditional types of work brought about by technologies that render this work redundant.[78] Similar to the industrial revolution, the digital age brings innovation solutions which will increase productivity but also the potential to negatively impact jobs. As production lines in the industrial revolution created jobs for factory workers, the digital economy will reduce the need for manual labour as repetitive tasks are replaced by software algorithms and robotics. Conversely, these changes are benefiting many, as goods and services are being produced faster, at lower cost and are delivered rapidly.[79]

Creating Future Jobs

As workplaces become more digitised, efficiencies such as robotics and AI will be introduced that change the way work is performed. The way people work and the skills that are essential in today's labour market is a landscape that is quickly changing. The challenges presented are driven by technological innovation, demographics, shifting business models and the evolution of today's business requirements. Because of these advancements the future of work will be vastly different from what it is today. Consequently, future generations are expected to undertake many different jobs throughout their lifetime and due to technological evolution, many of these roles don't currently exist (Figure 2.10).[80]

[77] Qld Chamber of Commerce 2016
[78] Roos 2017
[79] Frey & Osbourne 2017
[80] Khan & Forshaw 2017, McKinsey & Co 2017b, OECD 2016c

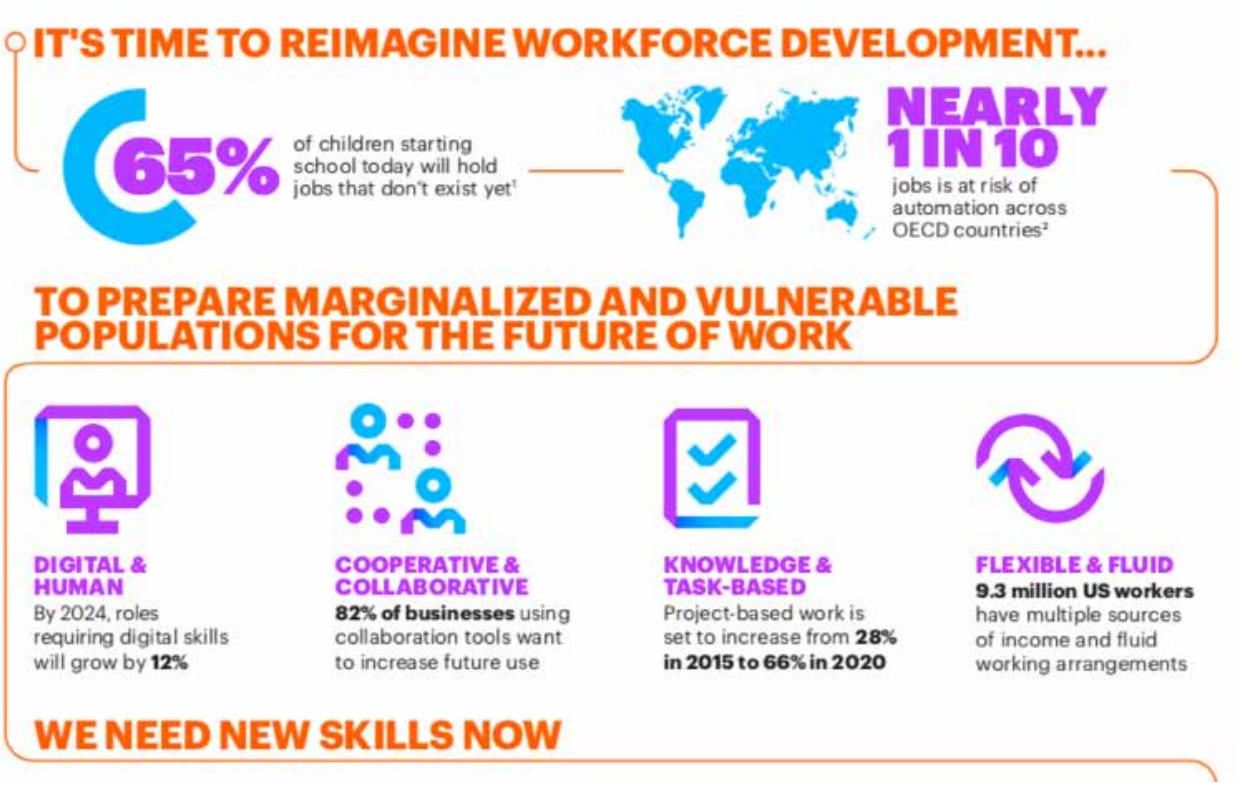


Figure 2.10: Accenture – Future Skills Now.[81]

It is estimated that within the next fifteen years, one in ten jobs are at risk of being automated.[82] But most jobs that will be automated are predominantly performed by workers with lower levels of education, and typically lower digital skills. As a result, mid-career job training and re-deployment of labour will be necessary.[83] This is likely to exclude these individuals if barriers to re-training aren't addressed.[84]

[81] Khan & Forshaw 2017
[82] OECD 2016c
[83] McKinsey & Co 2017b
[84] Khan & Forshaw 2017

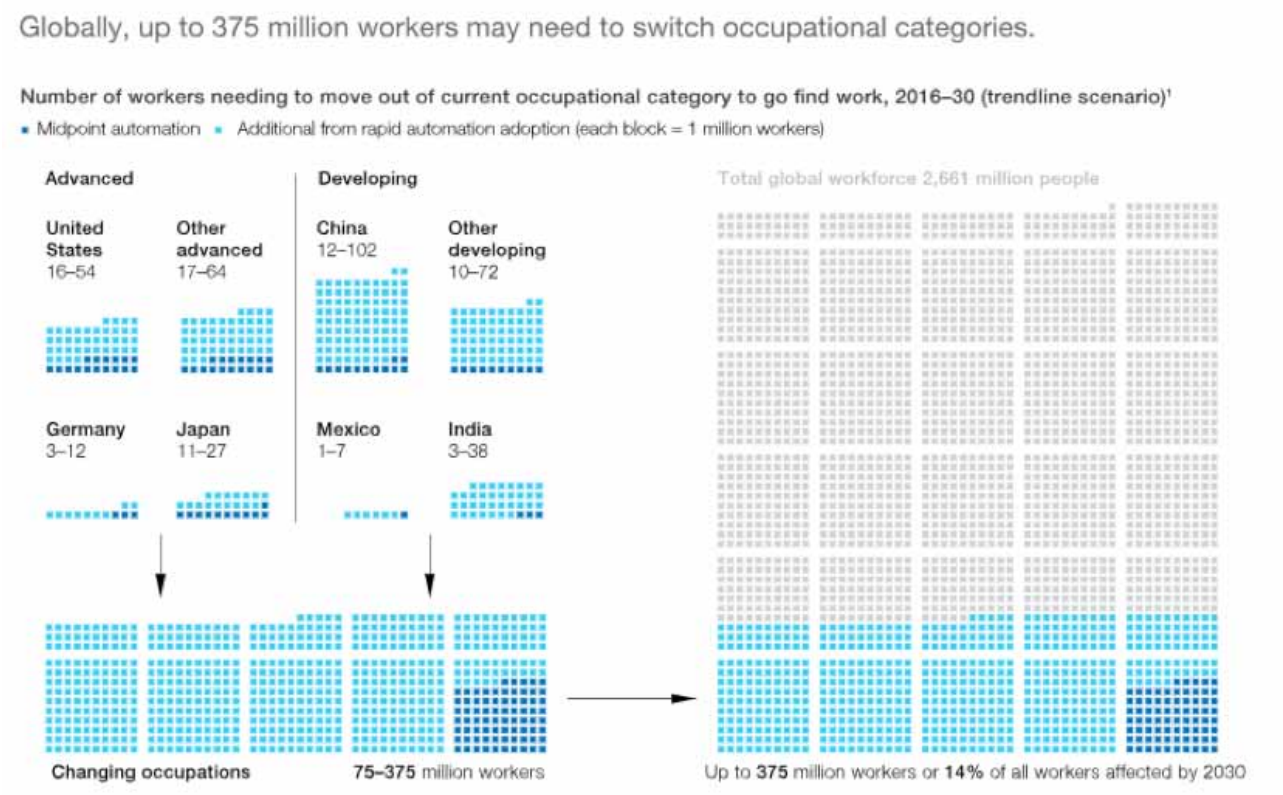


Figure 2.11: Occupational Changes.[85]

Technology such as blockchain has the potential to be an enabler of work, improving functionality and addressing challenges in the labour markets, by providing a platform to ensure equal pay, accurate measurement of workers productivity and by facilitating faster payments. Blockchain and smart contracts have the potential to fuel growth in freelance workforce and address issues such as managing transaction-based processes and contractual arrangements, to make them fairer and more transparent.[86]

While many jobs will become obsolete, demand for some roles will increase along with their skills in both technical and non-technical terms. Jobs related to blockchain have already increased six-fold since 2015 and this has increased demand for writers, traders, marketers and lawyers. 400 of the 800 people currently employed by Deloitte across various blockchain projects are in non-technical roles.[87] IoT technology is increasing the demand for digital skills in industries adopting IoT strategies. In addition, new products, services and industries will be created because of these technology trends generating more jobs. The number of new jobs will outweigh the number of lost jobs as technology such as IoT is expected to create a US$10-$20 trillion market by 2020.[88]

[85] McKinsey & Co. 2017a
[86] Tate, Johnstone & Fielt 2017
[87] del Castillo 2017
[88] Seeds 2015

Digital Skills

Digital skills are sought after in both developing and developed economies. As technological capabilities are introduced, labour markets require more digital capabilities to support these advances.[89] Developing economies are more affected by skills shortages. Research shows that over 50% of workers don't have the skills to participate in a 'technology rich environment'.[90] The lack of good quality digital skills poses a potential risk for all economies, as a shortage of talent can impact the ability for businesses to invest in new technology, which provides productivity and efficiency increases, leading to increased economic growth and social prosperity for the entire economy.[91]

Both developed and developing economies need to deal with the challenge of developing workers existing digital skills to meet the demands of the digital environment and ensure that the population without digital skills are provided with the necessary training and support to take advantage of the digital world and the opportunities that exist.[92]

A 2016 OECD survey assessed the relationship between a person's current skills and the qualifications required for their current jobs. They confirmed a substantial gap currently and projected that approx. 35% of the skills for jobs needed across generic industries would significantly change by 2020.[93]

Digital literacy is seen as important as traditional literacy and numeracy skills and it needs to be similarly taught from an early age and reinforced throughout childhood education.

Digital Talent Gap Evidence

Capgemini studies have found that globally 55% of organisations consider a digital talent gap exists, varying significantly on a geographical basis (Figure 2.13).[94]

Figure 2.12: Organisations perceived Digital Talent Gap by Geography.[95]

[89] Capgemini 2017, Khan & Forshaw 2017, NZ Digital Skills Forum 2017, OECD 2016c, Thomas, Barraket, Wilson, Ewing, MacDonald, Tucker & Rennie 2017, CEDA 2018
[90] OECD 2018d
[91] Büchi, Just & Latzer 2016, Khan & Forshaw 2017, NZ Digital Skills Forum 2017
[92] World Economic Forum 2016
[93] OECD 2016c
[94] Capgemini 2017
[95] Capgemini 2017

British Chamber of Commerce surveys indicated that over 75% of organisations believe they lack needed workforce skills (Figure 2.14); and data collected by the NZ Government highlights the increasing demand for digital skills and the lower level of digital skills available (Figure 2.15).[96]

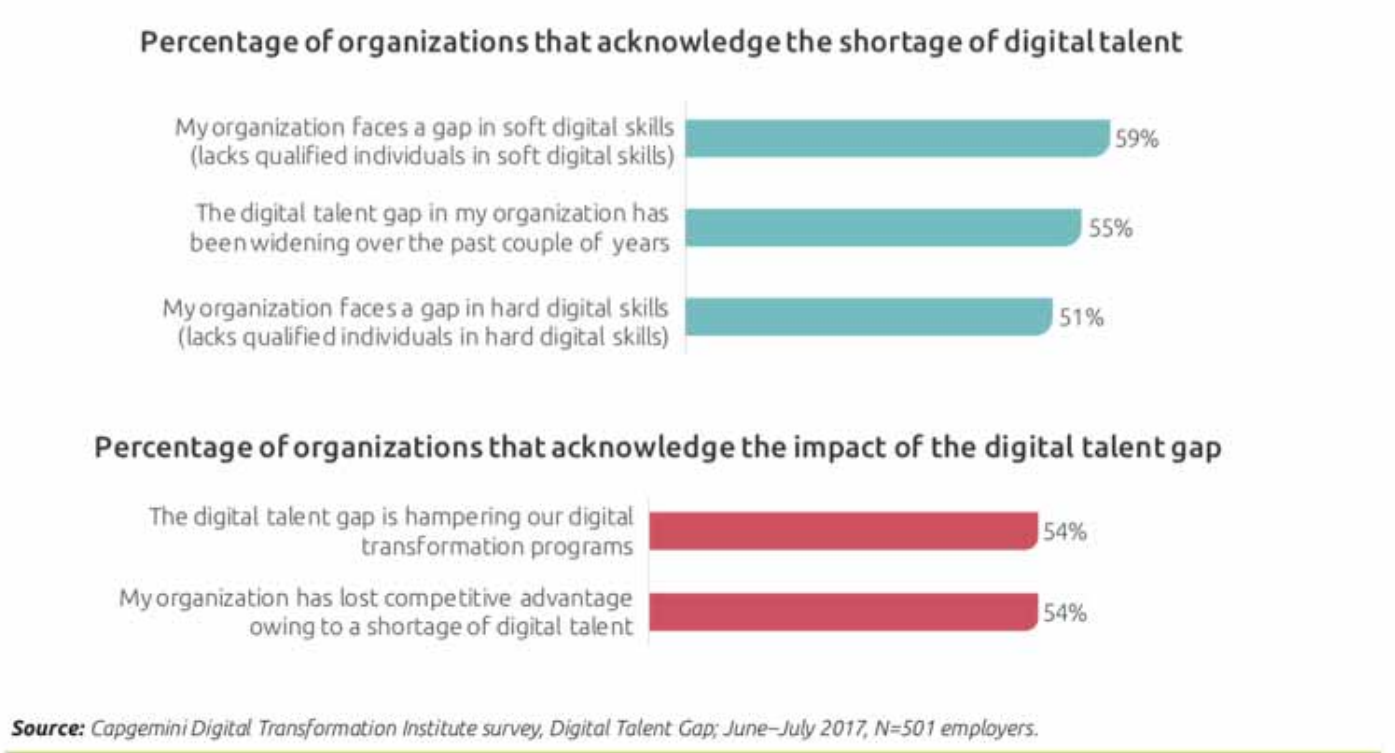


Figure 2.13: Digital Skills Shortages.[97]

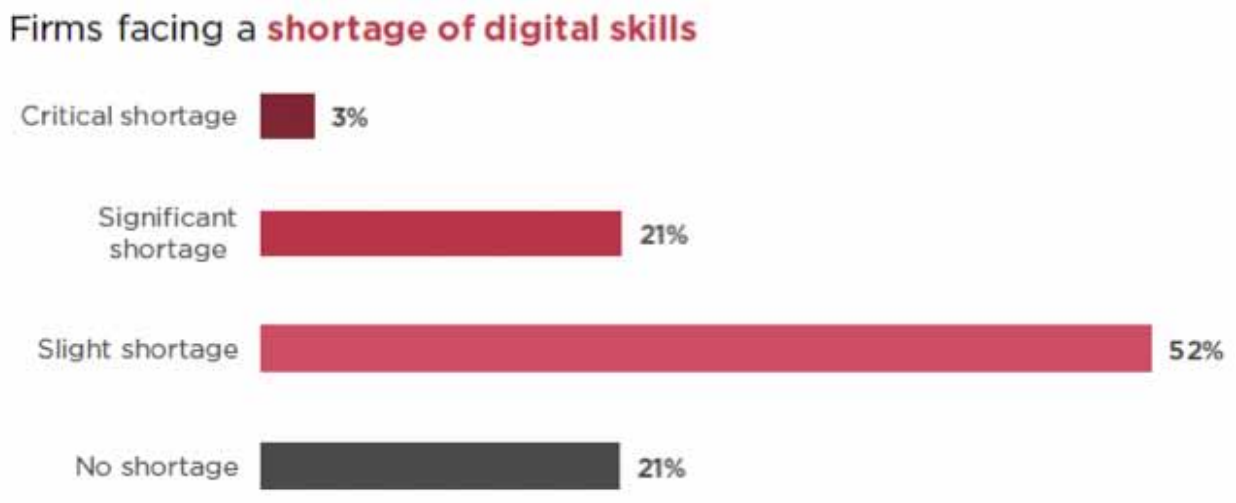


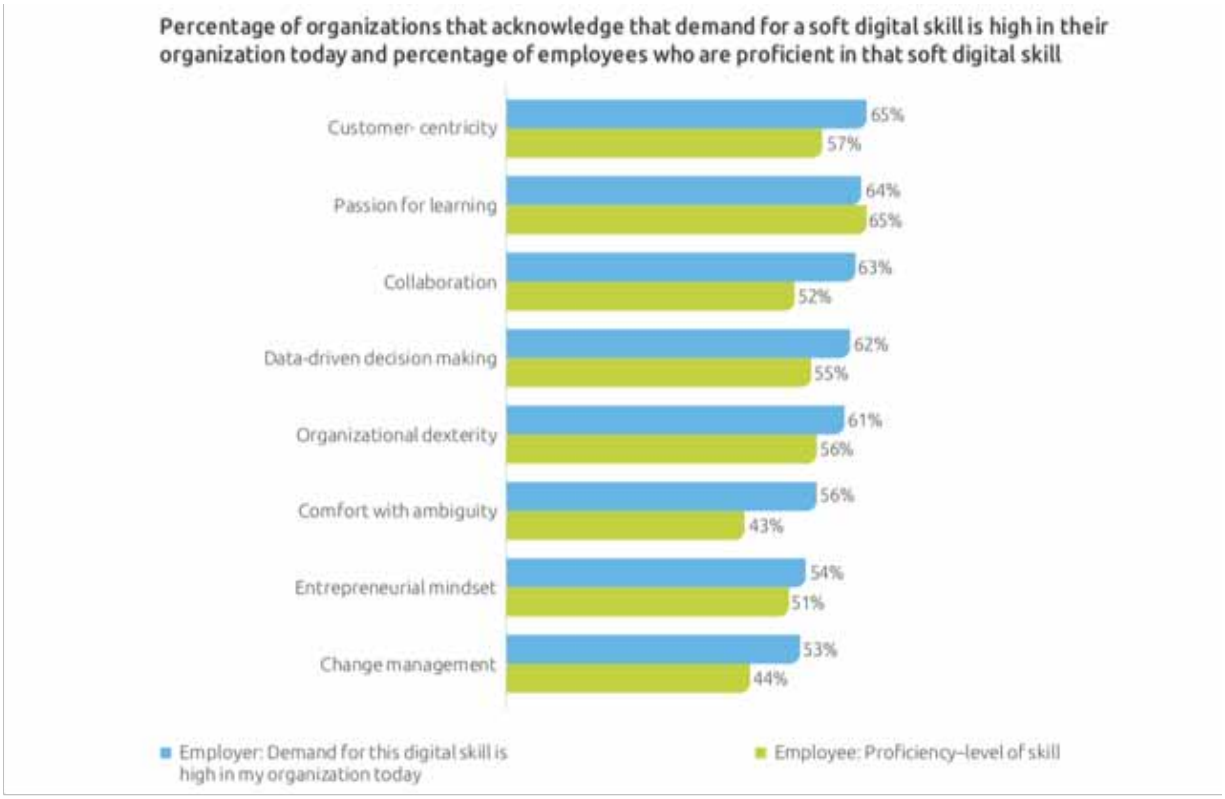
Figure 2.14: Firms facing a shortage of digital skills.[98]

[96] Marshall 2017, NZ Digital Skills Forum 2017
[97] Capgemini 2017
[98] Marshall 2017

Figure 2.15: New Zealand (NZ) Digital Skills Forum Survey – NZ Skills Gap.[99]

Organisations challenged to secure employees with adequate digital skills. Capgemini found organisations view the workforce capability for both hard and soft digital skills falls well short of their requirements. (Figure 2.16). PWC studies found that digital soft skills are becoming more important than hard skills (Figure 2.17).[100]

[99] NZ Digital Skills Forum 2017
[100] Capgemini 2017, PWC 2018b



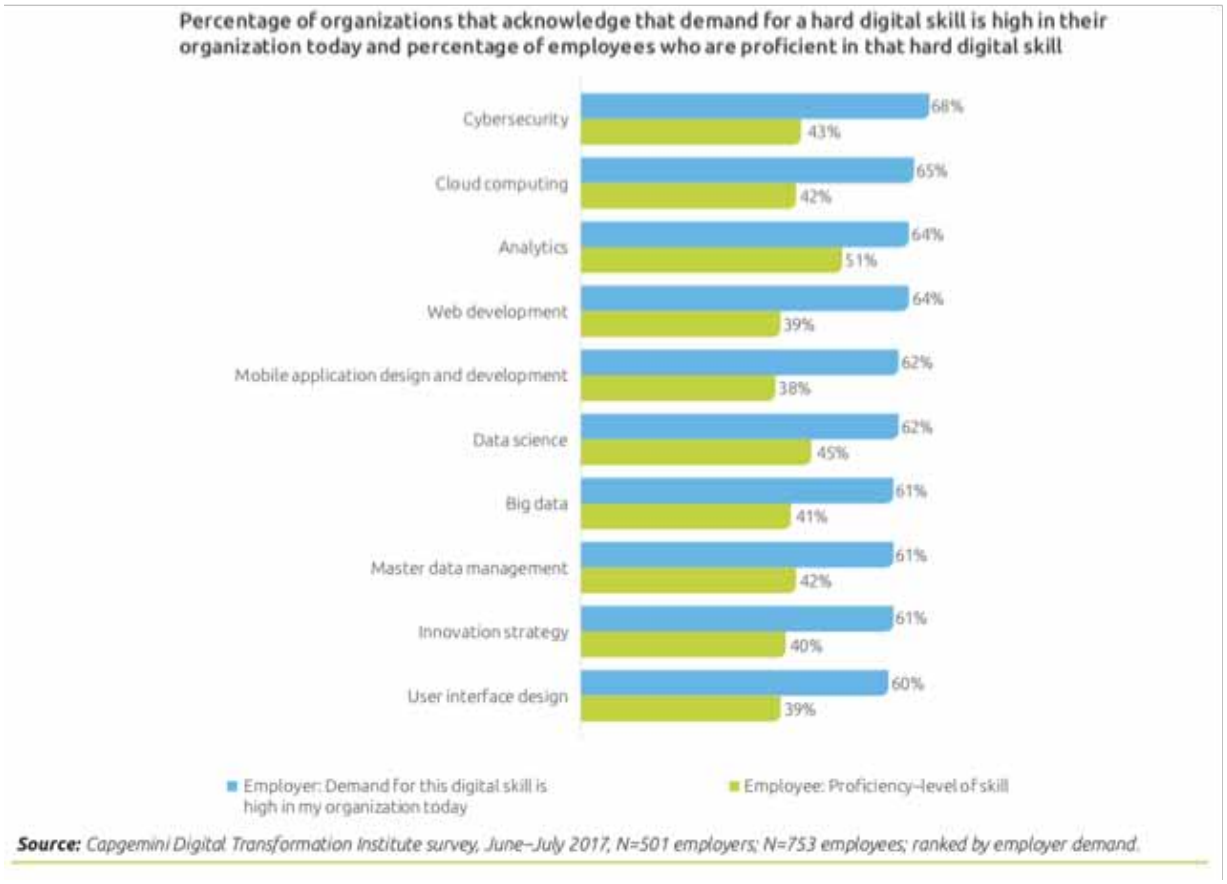


Figure 2.16: Soft and Hard Skills Gap that exists between organisations needs and employees' capabilities.[101]

[101] Capgemini 2017

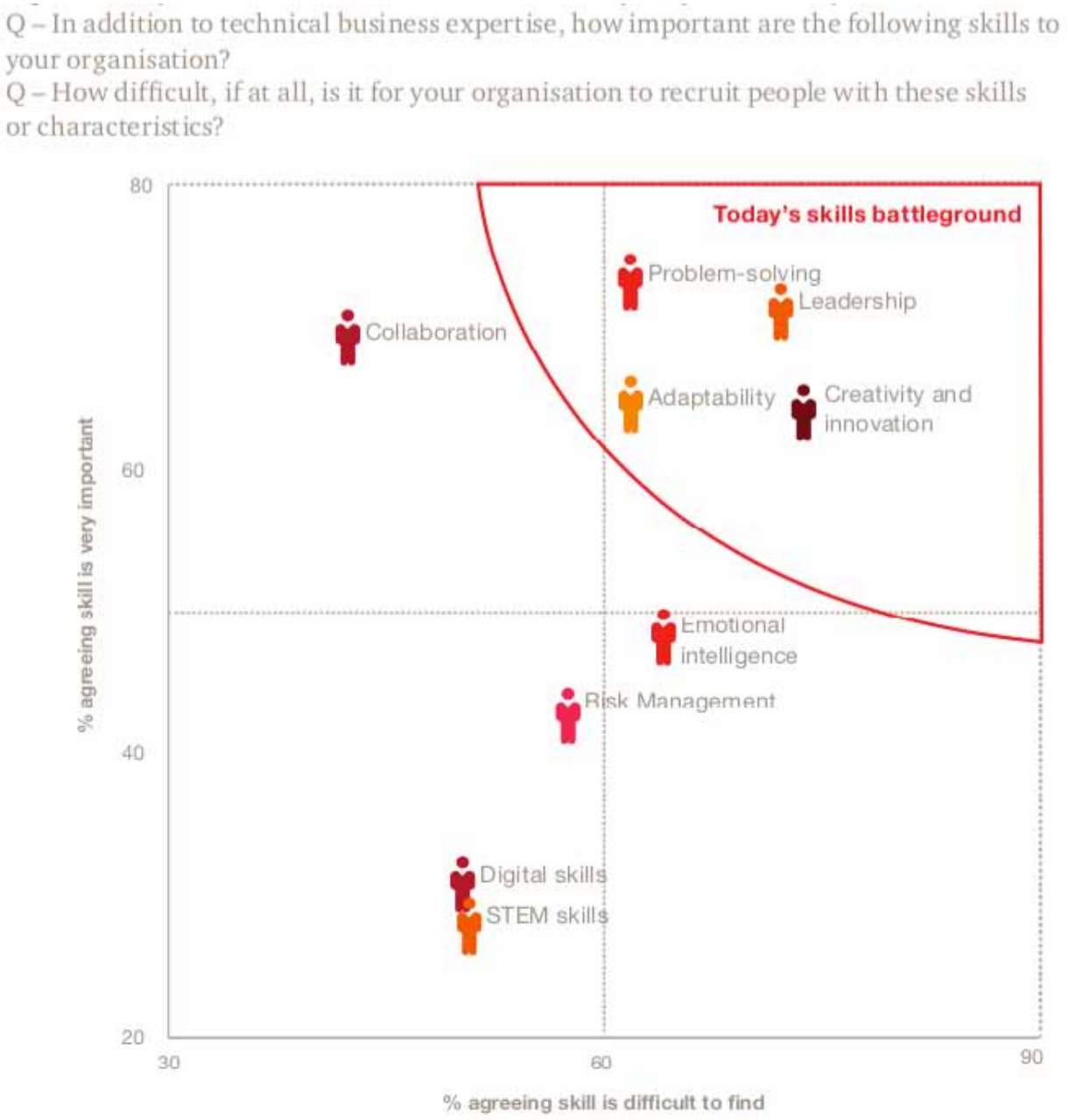


Figure 2.17: PWC Future of Work - Soft Skills are in demand and are hard to find.[102]

Attracting and Retaining Talent

Talent retention becomes vital when demand outstrips supply of scare skills.[103] Organisations need to attend to the need to enhance the digital skills and capacities of their employees and the shelf life of employees with current digital skills so that they stay current. This investment will benefit the organisation and assist in retention of employees with digital and other sought-after skills.

[102] PWC 2018b
[103] Capgemini 2017

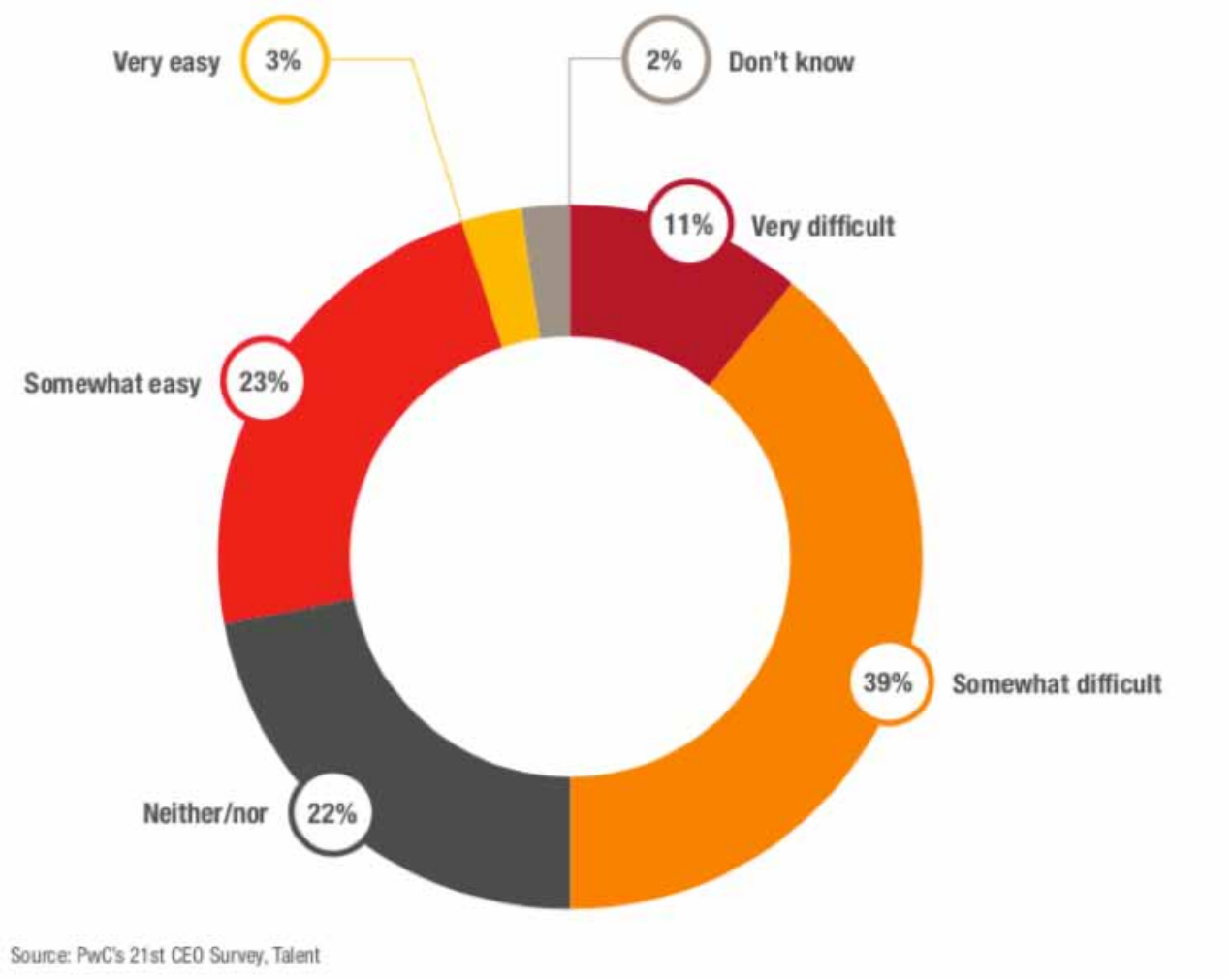


Figure 2.18: PWC CEO Survey 2018 - Attracting Digital Talent - How easy or difficult is it?[104]

Organisations need to create an opportunity to build and sustain motivation within their workforce to embark on additional learning, upskilling or reskilling of their core competencies.[105] Aspiring managers need to understand the nature of the transformations taking place as a direct result of the digital economy trends, what is driving those trends and the ability to predict the future possibilities. Without these skills, management will struggle to meet the demand of the digital economy and may fail to build and lead successful ventures.[106] It can be expected in the modern digital economy, that every business professional possesses the opportunity to become a digital innovator given the impact digital technologies have on building successful businesses.[107] Organisations that aren't engaging in digital skills training aren't only preventing their employees from developing but hampering the digital transformation of their business.[108]

[104] PWC 2018a
[105] World Economic Forum 2017c
[106] Morabito 2016
[107] Ibid.
[108] Information Today 2018

"Upskilling our global workforce is critical to ensure they have the skills they need to accelerate performance, and everyone has access to the opportunities on offer. The best organizations know this, which is why we've seen a marked rise in the number of businesses focusing on training and development to fill talent gaps. We expect to see this number grow." Jonas Prising, ManpowerGroup Chairman & CEO.[109]

Individuals in the workforce will need resilience and adaptability to navigate this changing environment. They will also need to focus on continual education and growth, with education systems designed to support them in developing these skills.[110] Educational programs and curricula need to focus on lifelong learning to support individuals as they require new skills.[111] As a result there is a pressing need for education institutions to provide appropriate grounding in information technology related skills and the ability to innovate in a digital environment.

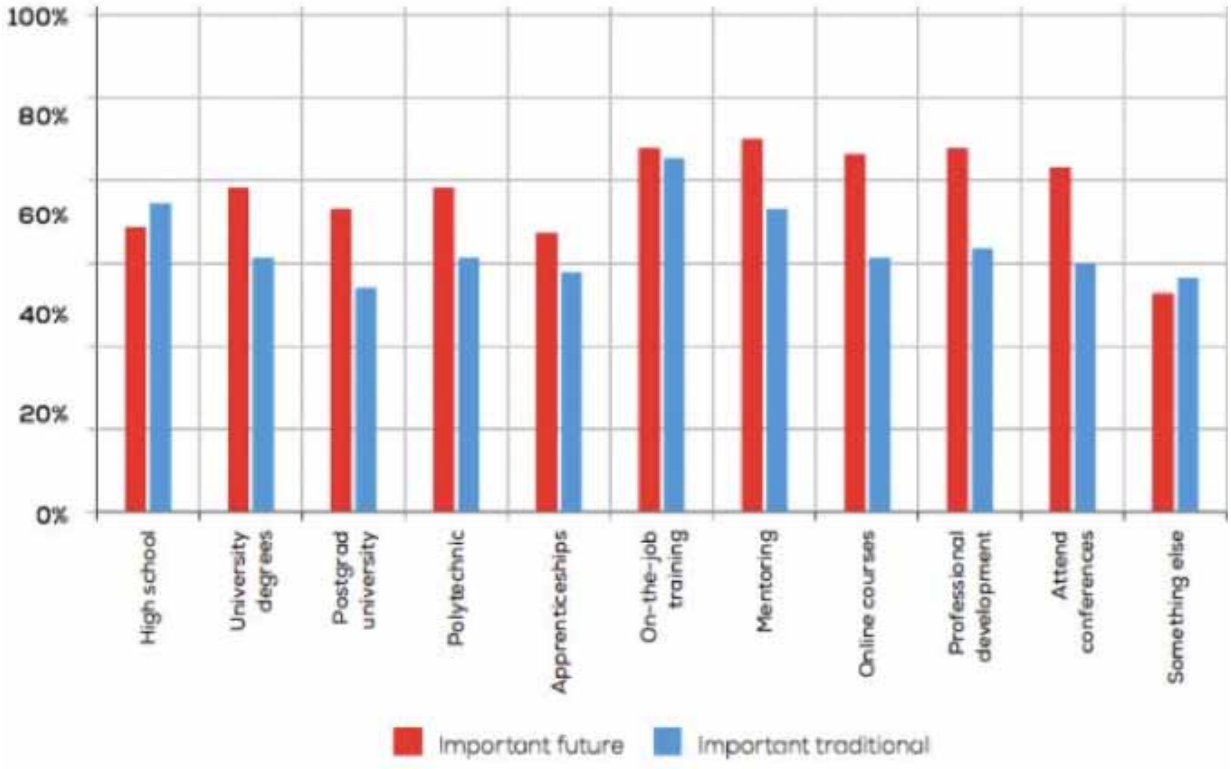


Figure 2.19: Usefulness of sources for developing new and traditional skills.[112]

Impact on Developing Economies

Emerging economies face the same challenges as the developed world but magnified in respect to digital technology trends and the implications for employment, education, privacy and security.[113] Digital innovation can be particularly difficult in developing economies where isolation, lack of existing technology, cultural limitations, poor education, inadequate access to capital, inadequate government structures for long term planning and monitoring all contribute to poor implementation of innovations.[114]

[109] Future inc, 2017
[110] Khan & Forshaw 2017
[111] Ibid., NZ Digital Skills Forum 2017, OECD 2016c
[112] Future Inc. 2017
[113] World Bank 2017
[114] Chaminade & Padilla-Pérez 2017

It can take up to six years for the full benefit of greater digital presence to be realised, so long term planning is vital to success.[115]

The gap between economies adopting technology appears to be widening (Figure 2.20) and will cement inequality between economies, particularly regarding education, employment, privacy and security.[116]

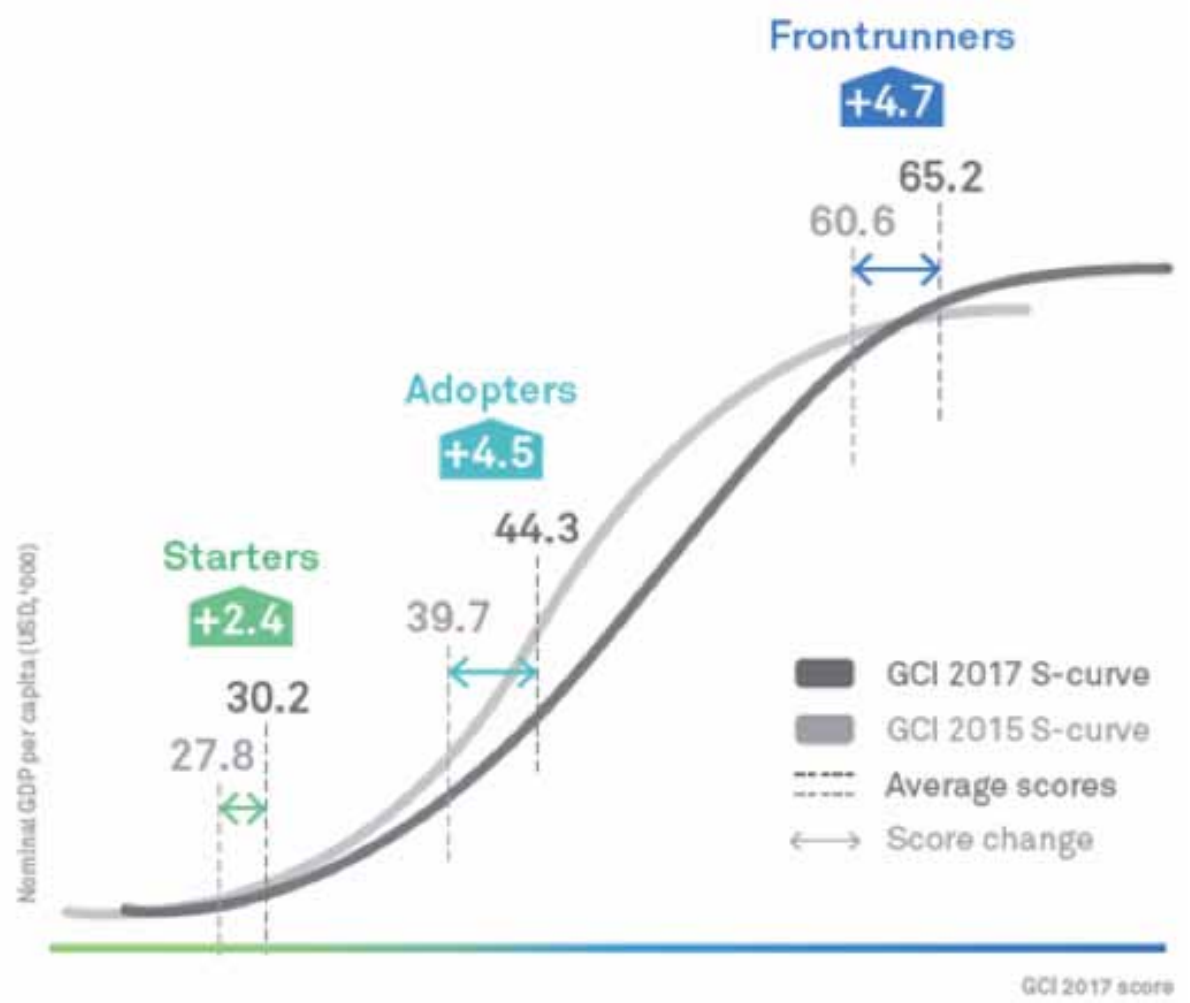


Figure 2.20: The widening Digital Divide between Economies.[117]

Rapid innovation is reshaping the way goods and services are produced and consumed, with profound implications for productivity, jobs, trade and investment. Developing economies face challenges to the traditional development path but may have opportunities to 'leapfrog' technology milestones if governments are willing to scale up technology adoption and invest in building the necessary talent pool and the associated digital infrastructure.

A prime example of 'leapfrogging' technology milestones is the adoption of wireless data networks over traditional 'fixed' landline systems. Figure 2.21 shows a marginal figure of 9.3% for fixed broadband subscription in Asia-Pacific in 2017. Conversely, Figure 2.22 shows a significantly higher mobile internet penetration of 51%. This highlights the technology leap that the Asia-Pacific region has made with respect to internet access using mobile technology.[118]

[115] Accenture 2018, Warschauer 2003, Huawei 2017
[116] Ibid.
[117] Huawei 2017
[118] OCED 2018c

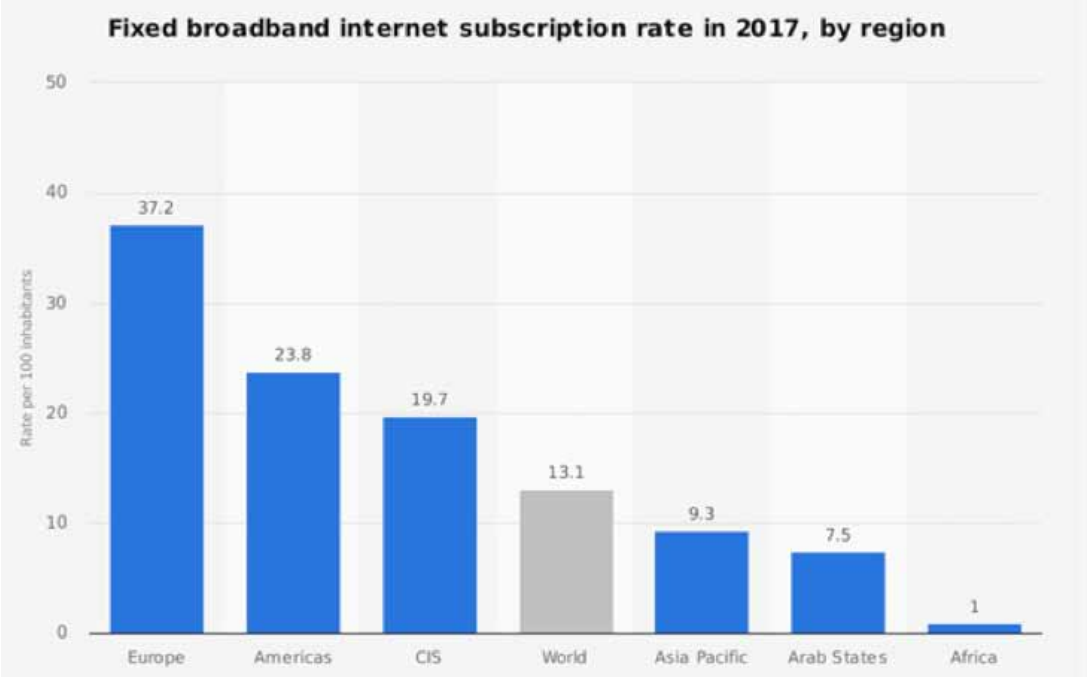


Figure 2.21: Global fixed broadband internet subscription rate 2017.[119]

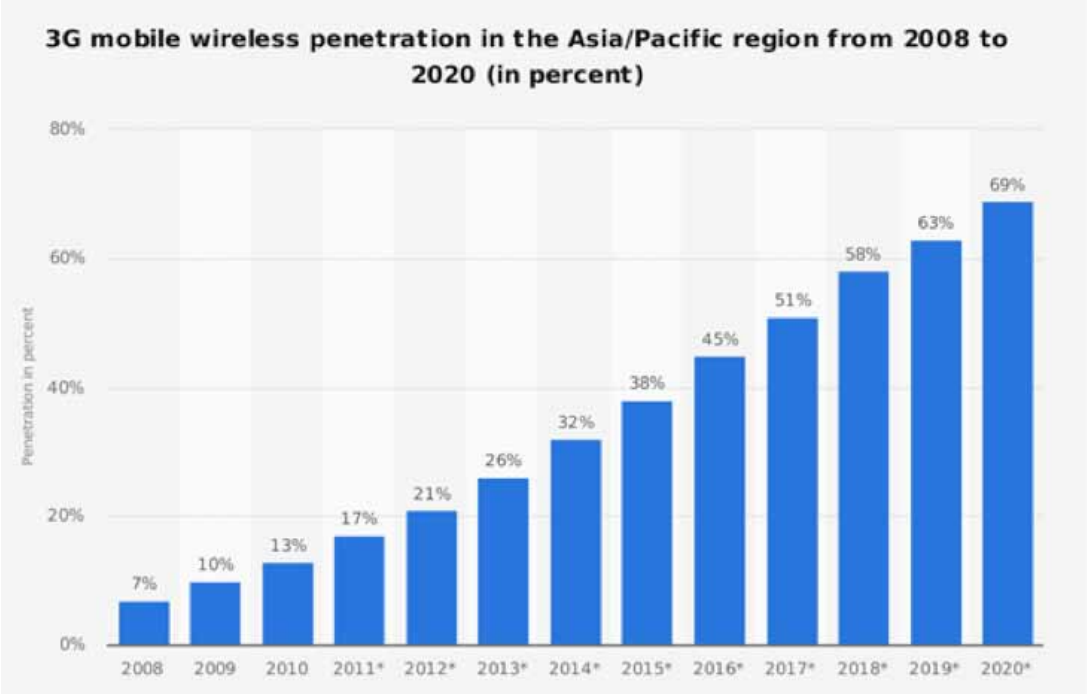


Figure 2.22: 3G mobile internet penetration in Asia-Pacific region from 2008 to 2020.[120]

To ensure effective implementation of technological innovations in developing economies, structural support for innovation on a public policy level aligned with a national development agenda is required.[121] Access to education and technology as well as the knowledge and experience of developed economies are also key. With six billion people globally without access to high speed internet and four billion without internet access at all, connectivity is key to bridging the digital divide.[122]

[119] Statista 2018c
[120] Ibid.
[121] Chaminade & Padilla- Pérez 2017
[122] World Economic Forum 2017a

In focus

PNG Entrepreneurs Development Program 2018

Entrepreneurship is increasingly being recognised as a positive and empowering force in making a difference in people's lives and fostering people-to-people linkages and should be further developed in PNG, and in collaboration with other APEC members. One such program was the 2018 HRD initiative to link PNG entrepreneurs with Australian start-ups in a development program to help them develop the resources, expertise and international connectedness they need to build large, globally significant and sustainable companies. (See details on page).

In 2018, PNG and Australia have collaborated, under the Australia's Department of Foreign Affairs and Trade (DFAT) Cyber Cooperation Program, to support the development of PNG's entrepreneurial ecosystem, initiating several ground-breaking projects to bring PNG start-up founders together with their Australian counterparts to further develop their skills. In July, six entrepreneurs from PNG travelled to Melbourne to attend a joint PNG-Australian Entrepreneurial Bootcamp at RMIT University with local Melbourne local start-ups.

Together the founders undertook a program of HRD and business development to foster effective communication, building resilience, and introducing lean validation techniques in their business. The program opened up new opportunities for founders to grow and accelerate their business ventures including:

- Nou Vada and Rex Paura: Co-founders of blockchain startup Coin-sure, an insurance product to protect cryptocurrency wallets currently being finalised for market testing.
- Yivan Gabut: Founder of Runway Buy, which lets users view and buy original designer fashion direct from the runway in real-time using AI powered image recognition and Bluetooth technology.
- Winifred Amini: Co-founder of Win-IT Consultancy and e-commerce entrepreneur working with the Digital Commerce Association on blockchain-powered solutions for identity and supply chain validation.
- David Valentine: Co-founder of Refer Tech, a fit-for-purpose electronic records management system to simplify tuberculosis case management and improve patient compliance.
- Emmanuel Narokobi: Founder of Blackspace, an online platform that links small traders in the Highlands with empty space in logistics services to help get their goods to market.

It aimed to help them better understand their role and contribution towards economic development and their local start-up ecosystem. Contributors to the program included the Australian APEC Study Centre, RMIT's Activator, and Blockchain Innovation Hub as well as PNG's APEC Business Advisory Council.

In working toward closing the skill gap and ensuring emerging economies can respond to human resource training needs in support of social and economic goals, emphasis will need to be placed on industries and educators working together to ensure workers and students are suitably skilled for jobs of the future and facilitate lifelong learning. The challenge will be enabling HRD in emerging economies to take advantage of digital innovations.

RECOMMENDATIONS

1. *APEC policy makers should focus on enabling HRD to keep pace with digital innovation and take advantage of the opportunities the 4th Industrial Revolution brings.*

2. *APEC economies should maintain efforts to establish comprehensive enabling environments for uptake of digital innovation, including:*
   a. *aggressive investment in connectivity and ICT infrastructure preferably 5G to enable high quality, fast access to SMAC technologies (smart, mobile, analytics and cloud);*
   b. *exploring the potential of leapfrog and other innovative technologies to help emerging economies shrink the digital divide.*
   c. *placing priority on supporting a competitive environment for ICT uptake, including drafting and enacting data privacy and protection laws to stop the lack of trust in technology and online safety.*

CHAPTER THREE

ENABLING SOCIAL INCLUSIVENESS IN DIGITAL INNOVATION

FINDINGS

APEC Governments are facing pressure to provide adequate systems to provide the educational qualifications, skills and competencies for existing and future workers to meet the needs of industries adopting emerging technologies and digitalisation.

The demand for digital skills is growing and many economies are not adequately equipped to support business needs now and in the future. Greater support is needed for all levels of society to support individuals already in the workforce in developing digital skills.

- *Not enough attention is given to lifelong learning.*
- *Digital literacy needs to be a fundamental part of all education curricula and introduced at an early age.*
- *Teachers aren't always equipped with adequate digital skills to support needs.*
- *Lack of awareness of how digital technology can assist is limited at an individual level, most notably in developing and rural economies.*
- *Private initiatives to support educational programs for disadvantaged or disconnected communities are making a difference.*

How Digital Technologies Enable Social Inclusiveness

Digital innovation is widely recognised as a catalyst for economic growth and increased social welfare. The potential to improve society through increased productivity; better government services; access to improved healthcare and broader markets; is recognised by APEC economies as being vital to sustainable economic growth. As such APEC priorities have been developed with significant focus placed on ensuring the benefit of digital technology positively impacts all of society, to ensure no one is left behind.

The digital revolution has lifted economies by facilitating substantial advances in transportation, communication services, health care, production and agricultural processes.[123] But as the world embraces digital technology and innovation; people, organisations, industries and economies are evolving at different rates.[124] A lack of access to readily available information through technology and infrastructure significantly affects even the most developed economies opportunities for growth, as digital innovation has enormous potential to improve people's lives through better access to information; better government services; access to healthcare; improved productivity; broader markets; better connectivity and job creation.[125] Economies need to plan and invest in making technology available to the population to reduce potential inequalities and ensure development is equitable.[126]

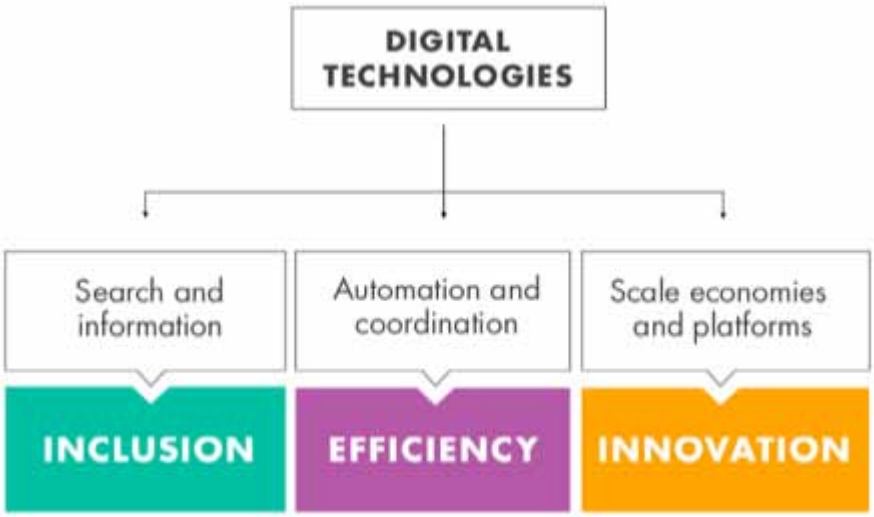


Figure 3.1: Development Mechanisms provided by Digital Technology.[127]

But inequalities in access to infrastructure, education and support are increasing the divide between those that are able to access and take advantage of these resources and those that aren't.[128] It's commonly agreed that being left behind not only hampers economies economic development but also individuals in the workplace.[129] This makes everyday life difficult as society becomes more digitised and services are more commonly being delivered via digital means.[130]

[123] United Nations 2016
[124] CEDA 2018, OECE 2016c, OECE 2016c
[125] United Nations 2016, Zamani 2018
[126] CEDA 2018, OECD 2016a, World Economic Forum 2016a
[127] World Bank 2016
[128] Mariën & Prodnik 2014, Thomas, Barraket, Wilson, Ewing, MacDonald, Tucker & Rennie 2017
[129] Robinson, Cotten, Ono, Quan-Haase, Mesch, Chen, Schulz, Hale, & Stern 2015
[130] Mariën & Prodnik 2014, Robinson et al, 2015, Thomas, Barraket, Wilson, Ewing, MacDonald, Tucker & Rennie 2017

Access to digital infrastructure isn't always a guarantee of a reduction in digital exclusion, as other social factors may also impact the ability for individuals to be involved in the digital ecosystem and may even reinforce some inequalities that already exist.[131] Rapid advancements in technology will change the nature of economies, jobs and productivity, creating global opportunities as well as challenges for societies.[132] As digital technology is adopted more rapidly by industries and organisations, the need for advanced digital literacy for the entire population is increasingly needed for participation in and to support these advancements.[133]

Enabling Social Inclusiveness in Rural Areas

Rural or remote areas have unique challenges that create an environment that excludes entire communities from digital participation and the opportunities that come as a result of being connected.[134] The World Economic Forum (WEF) found the urban/rural divide to be large, with rural areas accounting for 64% of offline populations with some studies suggesting that this is increasing rather than declining in some parts of the world.[135] Challenges such as inadequate infrastructure, lack of digital skills, high implementation and usage costs, and exclusion from digital services hampers regional development and reduces economic and social benefits.[136]

In many regions a lack of reliable and affordable infrastructure prevents rural communities from benefiting from digital technology (Figure 3.2 for current household adoption of internet use comparing urban and rural locations). In addition, a lack of understanding, negative attitudes to adoption and security concerns are also significant. Addressing these issues are fundamental to getting people online in rural regions where the digital divide is significant and, in some cases growing.

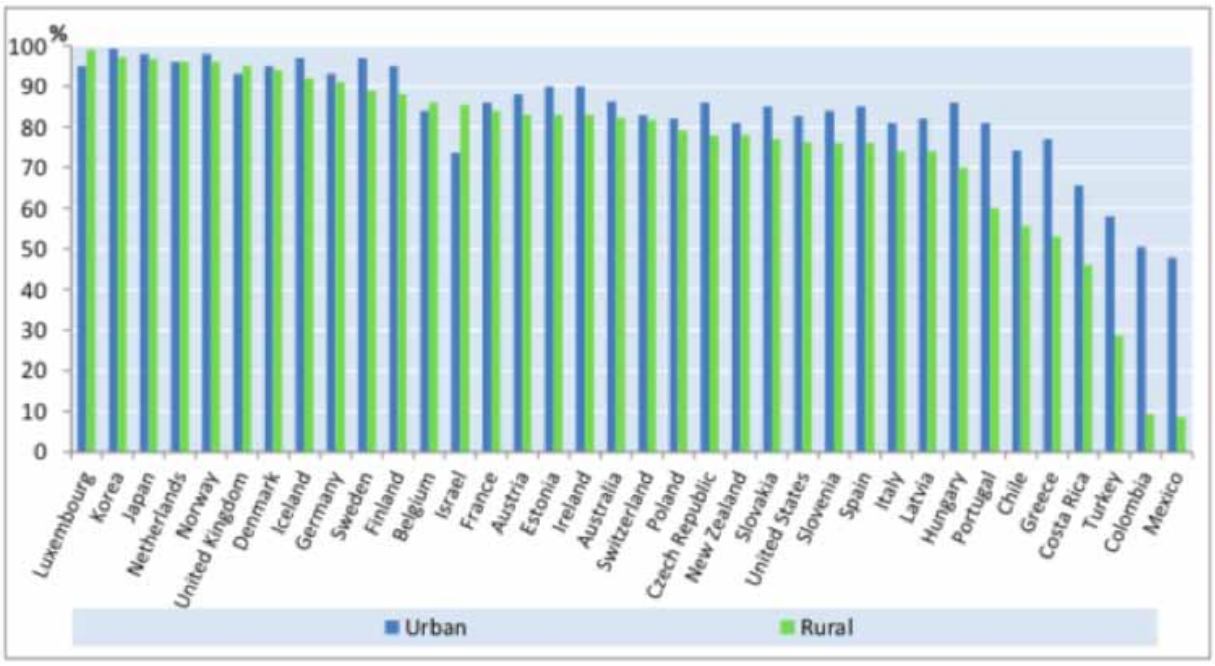


Figure 3.2: Household Adoption of Internet – Rural/Urban OECD Economies.[137]

[131] Büchi, Just & Latzer 2016
[132] Khan & Forshaw 2017, OECD 2016c
[133] Khan & Forshaw 2017, NZ Digital Skills Forum 2017, OECD 2016c, Reisdorf & Groselj 2017
[134] OECD 2018a
[135] World Economic Forum 2015
[136] OECD 2018a
[137] Ibid.

Infrastructure

Investment in infrastructure is a significant factor in providing access to rural areas as population density is often far lower than urban areas, as such private companies are more reluctant to build infrastructure due to lack of sufficient returns on Investment.[138] In some regions additional challenges occur due to difficult terrain, long distances and lack of electricity services or roads making installation of services more difficult. In some environments, alternative options such as mobile or satellite technology have been considered and implemented to address these issues.[139] Successful examples of satellite infrastructure deployments have been achieved in remote locations on Easter Island in Chile, Greenland and in Canada. These implementations have played an important role in keeping these remote communities connected. Some economies have also attempted to reduce the cost to low income and rural regions to encourage connection by subsidies to service providers.[140]

In focus

Computer Sciences for Children in Inuit Communities

Many regions in APEC suffer from extremely large land mass and limited connectivity which poses access problems for the local populations which result in difficulties in providing adequate digital education for children in these regions.

Nunavut a remote region of Canada suffers from these challenges, with a land size equivalent to Western Europe and a population of 36,000 people the communities are very remote and underserviced. Unreliable internet connections and lack of computer equipment made it difficult in the region to provide adequate education in computer sciences and as a result these skills were not on the curriculum in 2012.

An organisation called Pinnguaq, established as a response to address this gap through games, apps and other tools. Weekly 'Nunavut Code Clubs' were developed which aimed to teach programming to children between the ages of 5 and 19. These were extremely popular and successful in incorporating local Inuit culture with technology, so children had a better understanding and appreciation of what they were learning and subsequently wanted to learn more. The program was so successful that the founder has extended this to design a computer science curriculum that can be run offline via USB sticks to address the connectively issues. Pinnguaq aims to reach all remote communities in the region within the next five years.[141]

> "An average kid in Nunavut is doing the same thing an average kid anywhere is doing, but in Nunavut, there's no system set up to say that computer science is also a career. Now it's just another door open." Ryan Oliver – founder of Pinnguaq. [142]

[138] Mariën & Prodnik 2014
[139] World Economic Forum 2015
[140] OECD 2018a
[141] Laidlaw 2017
[142] Ibid.

Awareness and Understanding

A challenge with digital uptake in some rural areas, especially in developing economies is the lack of understanding of what the internet and digital technology provides and the benefits that can be realised through its use.[143]

> "People don't understand that they can use the internet to find out, for example, what kinds of pesticides they can use on their crops, and where to buy them from. Women don't realise that they can use the internet to sell whatever small products they have, such as embroidery, for thousands of dollars rather than the fraction of it that they often get." Maria Umar, founder and president - Women's Digital League Pakistan.[144]

In focus

Mobile Telephone Assisting Rural Fishing Businesses

A study undertaken on sardine fishermen in India in 2009 highlights the dramatic reduction in price dispersion once mobile phones were introduced. The fishermen operated in a market where limited infrastructure and high search costs led to lack of access to information on market needs and pricing. By providing access to mobile technology, pricing became more regular (Figure 3.3) and as a result levels of stock waste also declined.[145]

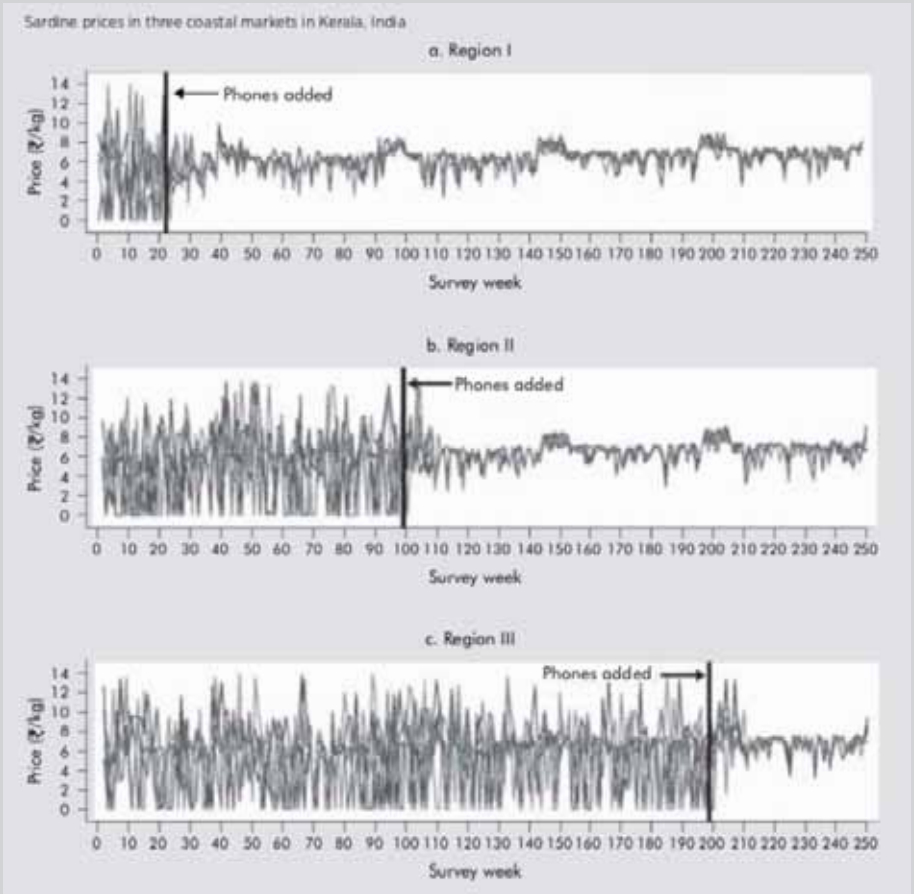


Figure 3.3: Use of Mobile Phones – Reduction in Price Dispersion – India.[146]

[143] Economist Intelligence Unit 2017
[144] Ibid.
[145] World Bank 2016
[146] World Bank 2016

Ethnicity

An all too persistent gap in economic opportunity and outcomes exists across the world when ethnicity is considered. Education is widely considered the necessary path to improve an individuals' economic outcomes. However, research has shown that additional education and experience can explain one third of the wage variation in individuals, even after necessary qualifications are attained there are still large differences in economic outcomes across ethnicity.[147]

The US Federal reserve gathered earnings data across two cohorts of adult workers aged between 25-34, one generation apart. Those in this age bracket have limited work experience but most have completed their education, therefore focusing on this age bracket allowed researchers to isolate the effect that education would have on the influence of other variables, including experience. This data confirms a lack of progress for disadvantaged groups and highlights the gaps in economic outcomes over the past 25 years.[148]

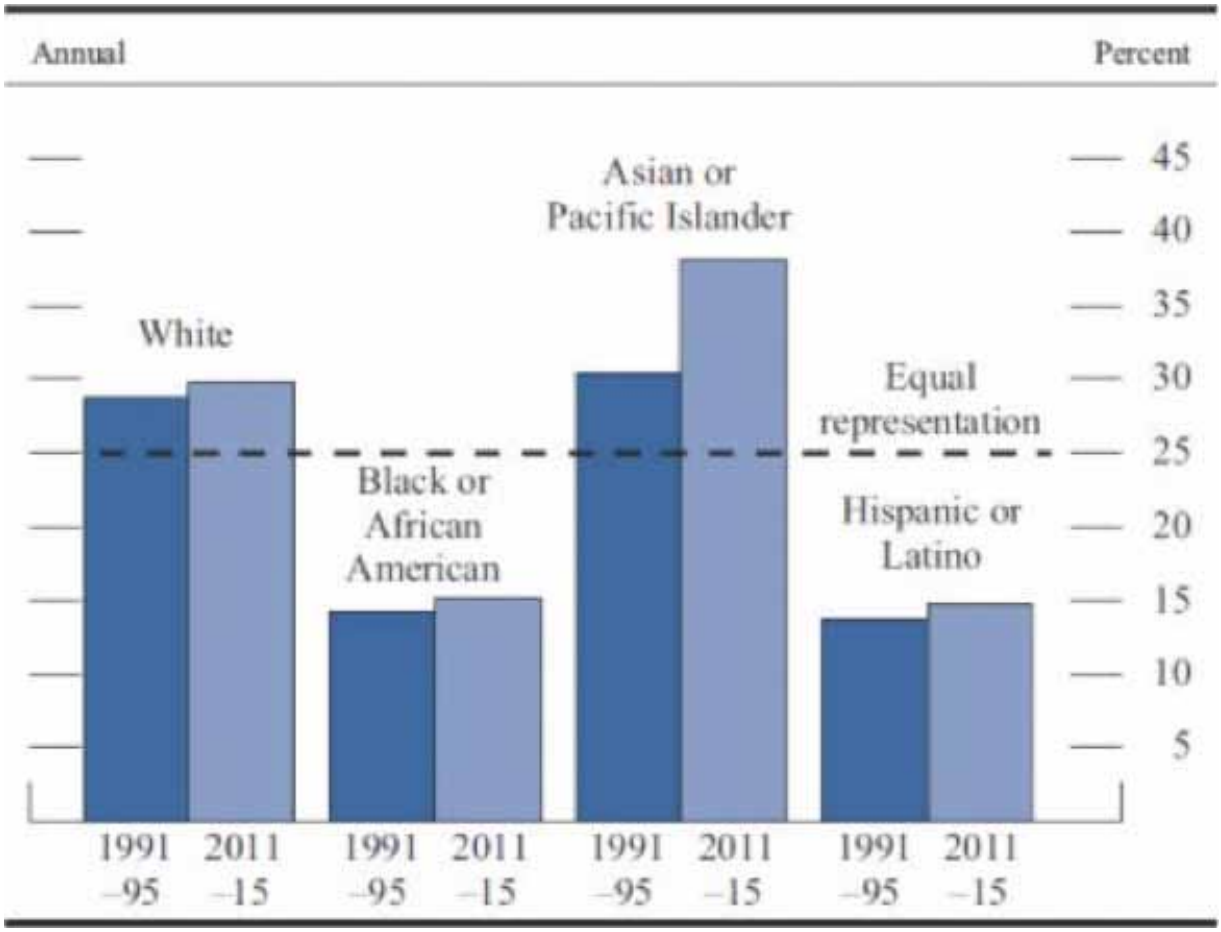


Figure 3.4: Percent of workers in top quartile of earnings among all young adults – comparting 2 generations.[149]

[147] US Federal Reserve 2017
[148] US Federal Reserve 2017
[149] Ibid.

Age

The United Nations predicts that the number of people over 60yrs will be greater than those under 5yrs by 2020, and that the world's population of over 60s will double to 22% between 2015 and 2050.[150] Studies have shown that working age adults and young adults are equally as likely to use digital technology.[151] But significant differences exist in older people's use with less than 49% of 65-74yr olds using the internet compared to 95% of those aged under 24yrs.[152] Over 75yrs+ are even less likely than 'younger' old people to use the internet and older women less likely than older men.[153]

The level of education attained appears to be a more significant factor for older generations in digital technology uptake than for younger generations.[154] The differences are also more marked in developing economies where older generations often have lower levels or no education.[155] Older generations often lack experience and familiarity with digital technology and are reluctant to use it due to a lack of confidence in their ability to learn basic computing and internet literacy skills.[156] These barriers are reinforced by the necessity to re-learn skills due to the fast pace of technological change and concerns that technology is too complex.[157]

Evidence has shown that retirement age in most developed economies has increased and many older individuals are increasingly remaining in the workforce or will move into part time roles rather than leave entirely.[158] This is commonly resulting in up to four generations working together. The differences in digital skills between these generations with younger being more technologically competent could create potential generational divides.[159]

[150] United Nations 2016
[1501] Hodge, Carson, Newman & Garrett 2017, OECD 2016b
[152] OECD 2016b
[153] Hodge, Carson, Newman & Garrett 2017
[154] Ibid., OECD 2016b, World Economic Forum 2015
[155] World Economic Forum 2015, OECD 2016b
[156] Hodge, Carson, Newman & Garrett 2017
[157] Van Volkom, Stapley & Amaturo 2014
[158] Khan & Forshaw 2017, Van Volkom, Stapley & Amaturo 2014
[159] Ferrara, Mohammadi, Taylor & Javernick-Will 2016

Gender Challenges

Globally there are 250M less women online than men. This digital divide between the genders exists in both developing and developed economies primarily due to access issues, affordability as well as socio-cultural perceptions and stereotypes.[160] Considering females represent half the world's population, and inequalities substantially impact economies potential for growth and progress, it's important to recognise the barriers that exist for women in order to find ways to address these and increase female participation and inclusion.[161]

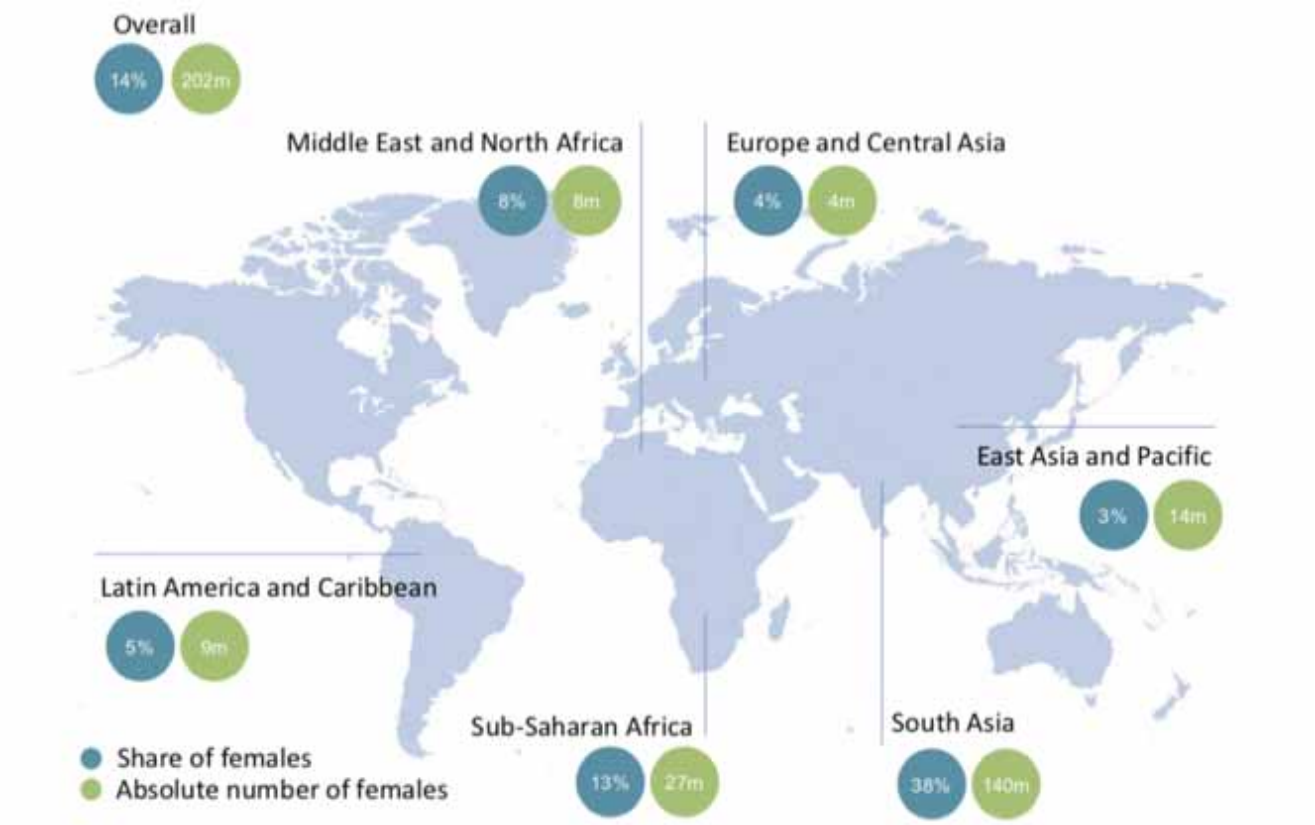


Figure 3.5: Mobile Phone Ownership by Region

Female STEM Education and Involvement

Globally underrepresentation of women in Science Technology and Maths (STEM) affects the likelihood of gender equality in digital innovation.[162] With women accounting for less than 20% of ICT graduates, they are significantly underrepresented.[163] These percentages decrease further when considering women working in ICT roles, as significant gaps exist in female representation.[164] Representation widens further in software development and leadership or senior technology positions that have a significant influence on innovation.[165] This level of underrepresentation is concerning considering the substantial amount of evidence showing diversity benefiting innovation, problem solving and creativity. Evidence from USA studies shows that non-white women have even lower representation (Figure 3.6).[166]

[160] OECD 2018b
[161] United Nations 2016
[162] OECD 2018b, GEM 2017a
[163] OECD 2018b, World Bank 2016
[164] OECD 2018b, Ashcraft, Mclain & Eger 2016, UNESCO 2015
[165] Ashcraft, Mclain & Eger 2016, Brush, Greene, Balachandra & Davis 2017
[166] Ashcraft, Mclain & Eger 2016

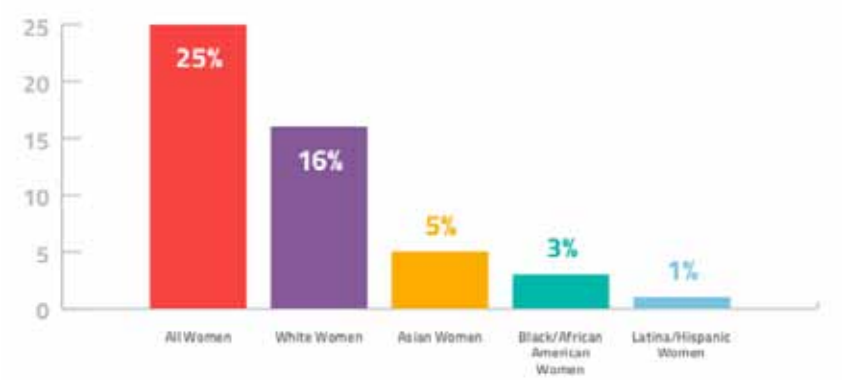


Figure 3.6: ICT Occupations held by Women – USA.[167]

Another concern is the significant number of women that commence in ICT roles but leave over time, further reducing female participation. Studies in the USA have shown an average of 25% of women entered ICT occupations in 2016 which has declined from a peak of 36% in 1991, but currently a staggering 56% of them leave (Figure 3.7). The underutilisation of these skills is a concern for economies, considering the loss of the financial and social investment in training.[168] Gender stereotypes, inadequate facilities for childcare, non-family friendly workplace practices all contributed to the challenges presented to women in the STEM fields.[169] Although research has shown that the reasons women are leaving these roles is primarily due to conditions they experience in the workplace such as lack of access to creative roles and lack of training resulting in a state of inertia in their careers.[170]

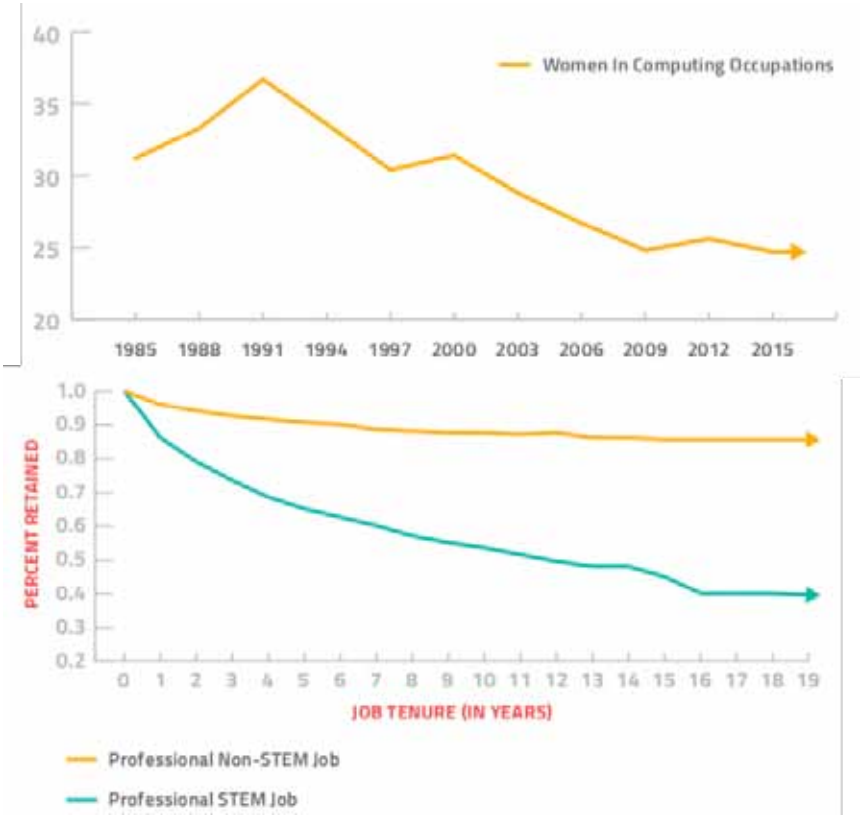


Figure 3.7: Women in Computing Occupations (Top) Women existing professional occupations (Bottom) – USA.[171]

[167] Ashcraft, Mclain & Eger 2016
[168] OECD 2015
[169] Ibid.
[170] Ashcraft, Mclain & Eger 2016
[171] Ashcraft, Mclain & Eger 2016

The World Bank considers that investing in girls to close the education gap with boys will lead to lifetime earnings increases equivalent to an increase in annual GDP growth rates of approx. 1.5%.[172] Policy makers have attempted to address gender issues in STEM through a range of initiatives such as introducing units for women in science ministries; targets; quotas; networks; mentoring; equal opportunity legislation and policies on maternity and paternity leave.

In focus

Good Practice – Spotlight on Latin America

Laboratoria, a Peruvian digital business found it was impossible to source female programmers and developers to grow their business. To support their own needs, they created a training program and trained up enough females in technical and coding to support their business. They recognised that other businesses had the same challenges. They also recognised the untapped potential of women in Peru, many unable to afford a formal education. To address these challenges, they extended their program to provide an opportunity to help develop these skills, assist other businesses and underprivileged women. Their training program focusses on recognition of women with potential who they intensively train over a six-month period in web development and UX design. Once they complete their boot camp, Laboratoria assists them in finding work. The program won a US Aid award for the Innovation into Action Challenge and as a result have been able to expand into three additional economies, Brazil, Mexico and Chile. Their vision is to train more than 5000 women in the region and be the largest source of technical talent in Latin America.[173]

Female Innovation

The gender gap in entrepreneurship is "striking and persistent", with men being nearly twice as likely as women to be self-employed and three times more likely than women to own a business with employees.[174] Despite women entrepreneurs owning approx. 8-10 million small-medium enterprises (SMEs) in developing economies, the average growth rate of these enterprises is significantly lower than those operated by men, with access to finance a major obstacle.[175]

Funding for female led entrepreneurial activities is significantly low, with studies showing 90% of funding for start-ups involved in innovation related activities going to male led businesses.[176] The reasons for this are complex and varied across economies but gender bias in lending practices is commonly cited as a significant barrier with financial institutions considering women's ventures smaller and the women themselves less experienced than men.[177]

The technology itself is also providing opportunities for women. Platforms allow women to more easily access new product markets which can result in e-commerce innovations. Mobile telephones can also assist closing the digital divide for women, by facilitating access to information and markets. Mobile money, making financial transactions sim card to sim card, is another way to close the gender gap by enabling a financial history which in turn assists when seeking finance for entrepreneurial pursuits.[178]

[172] Albrectsen 2015
[173] Green 2018
[174] OECD 2018b
[175] Ahmad 2015
[176] Brush, Greene, Balachandra & Davis 2017, OECD 2018b
[177] Brush, Greene, Balachandra & Davis 2014
[178] OECD 2018b

A supportive legal and regulatory framework and the provision of incentives for the procurement from women-owned enterprises are considered as just some of the ways to improve women's access to finance to build their entrepreneurial businesses.[179] By addressing gender specific constraints APEC economies can maximise entrepreneurial potential.[180]

Digital Providing New Advantages for Women

The digital environment has also provided some advantages to women, providing them with access to digital technology and tools that allow them greater access to information, markets and the ability to participate in the labour market in a more flexible way. Digital tools have provided women in developing economies leapfrog opportunity and empowerment that they previously haven't been able to access.[181] Brunei Darussalam is a good example of an APEC economy that has provided a supportive environment for females to enter STEM fields. It currently leads Asia-Pacific as the third highest Muslim economy in the world for female STEM graduates.[182] Overall Muslim economies are leading the way in encouraging women to enter STEM education and females are accessing new opportunities historically not available to them (Figure 3.8).

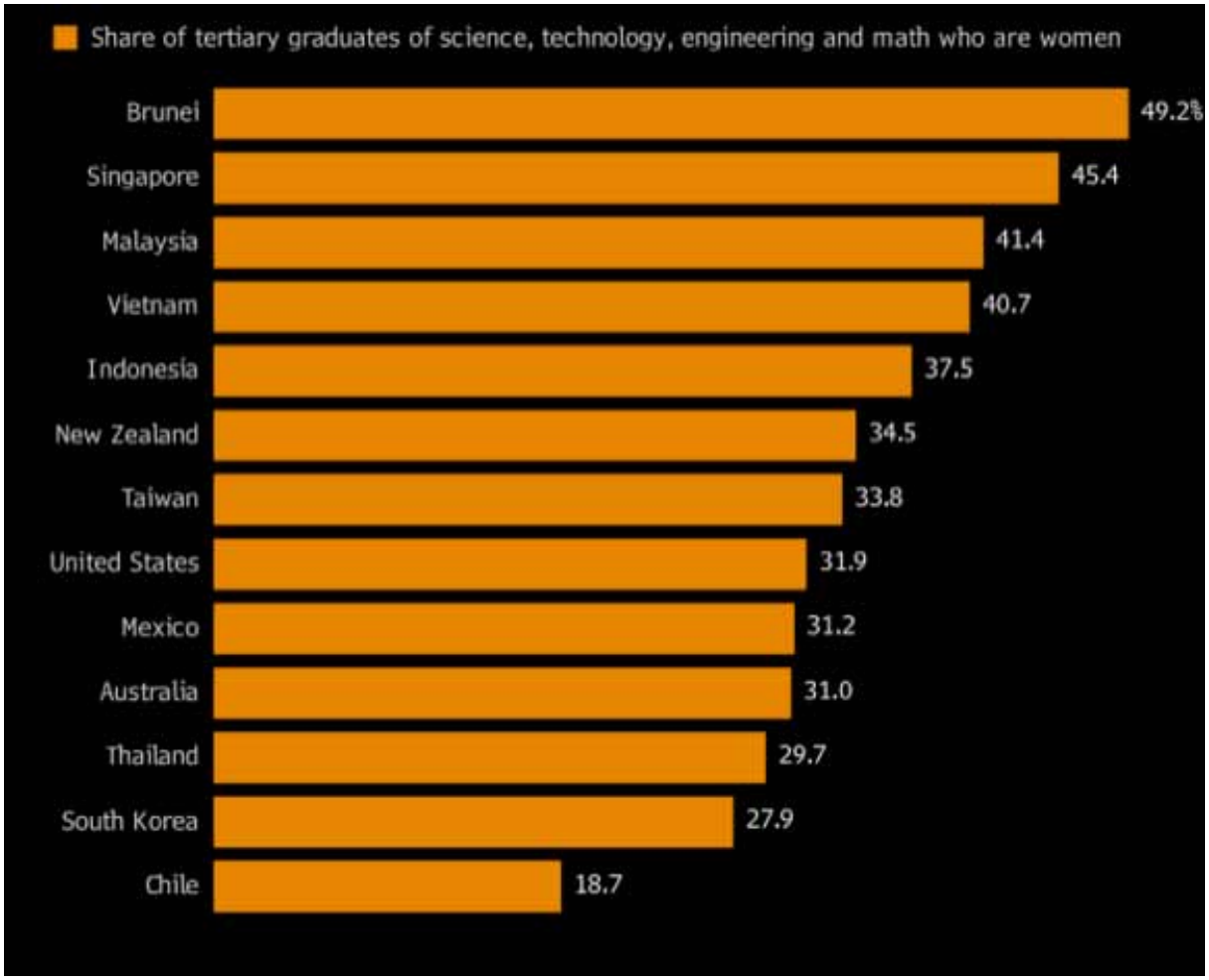


Figure 3.8: Women in STEM – APEC.[183]

[179] Ahmad & Afida 2015
[180] OECD 2018b
[181] Ibid., Zahidi 2018
[182] Jamrisko 2017
[183] Jamrisko 2017

In focus

Pakistan

Outside APEC, one such venture in Pakistan, doctHERS, uses digital consultants to provide housewives who are also qualified doctors to rural communities, providing opportunities for women they may not have had without the flexibility technology provides them.[184]

Socio-Economic Barriers

Socio-Economic barriers represent one of the most significant factors preventing women from participating equally in digital innovation in Asia Pacific and more frequently in developing economies.[185] Data shows that economies with the lowest levels of inclusion for female internet access are lower-middle and low-income economies. In these regions, women are the poorest citizens in society and often lack adequate education, literacy and additional challenges in being primarily responsible for child care. These barriers are even greater in rural areas where access to infrastructure is more difficult and, in some cases, not available at all as digital mobile networks are also limited and don't cover some areas of rural Asia.[186]

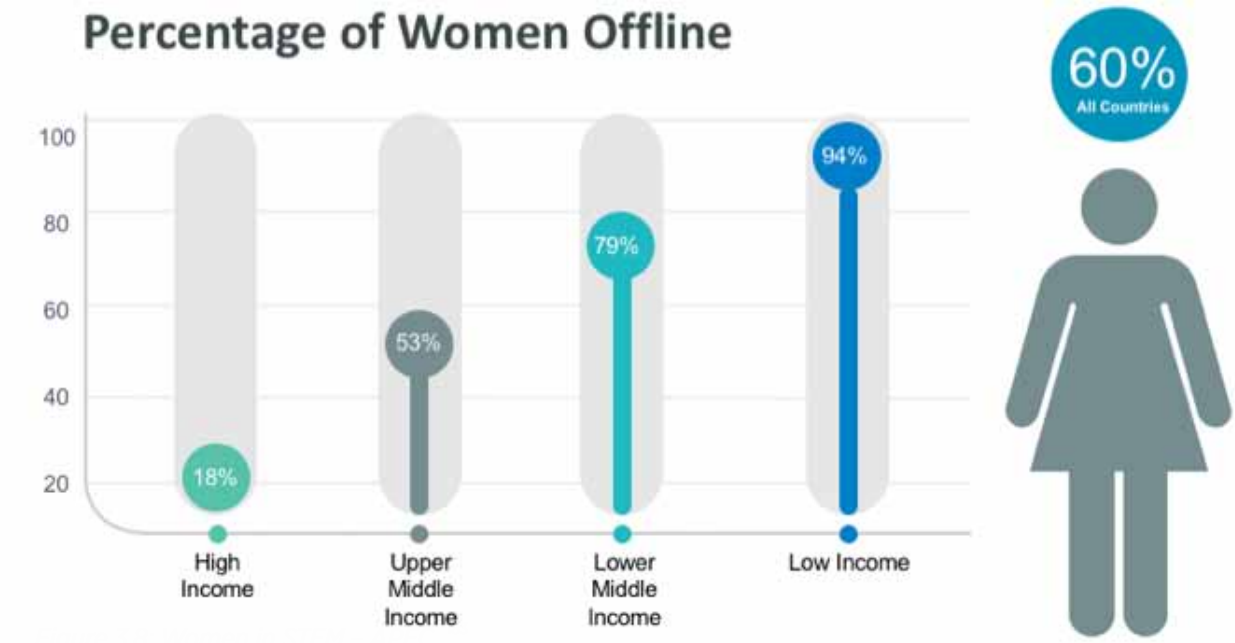


Figure 3.9: Average % of women offline.[187]

Cultural Barriers

Barriers for women in some regions are also due to prevailing cultures that exist in society, that discourage or prevent them from participating or using digital technology, most notably developing economies. Concerns over the appropriateness of women using the internet or mobile phones, safety concerns and highly patriarchal cultures create environments that make it difficult for women.[188]

A 2016 World Bank survey found 12% of women didn't consider it appropriate to access the internet and 8% were concerned about family and friends' approval. These barriers are challenging to address and require targeted programs such as the programs implemented by the Women's Digital League in

[184] Zahidi 2018
[185] Economist Intelligence Unit 2017, World Bank 2016
[186] Economist Intelligence Unit 2017
[187] Economist Intelligence Unit 2017
[188] Ibid., World Bank 2016

Pakistan with funding from the World Bank which trained rural women, often in regions characterised by strongly traditional and conservative communities, to use digital technology, to find new markets to sell their products, source work and use technology to improve their conditions.[189]

Negative cultural norms also need to be addressed to ensure the internet is a safe environment for women. It is necessary to provided women with adequate training to keep themselves safe from online harassment and negative reactions from communities. There is also a strong argument for involving men in the development of training programs for women in these regions. The power of the patriarchal society is strong and to create an environment that is sustainable, men's attitudes also need to be shifted.[190]

In focus

Case Study - PNG

PNG faces many challenges in providing equitable digital inclusion for its citizens. One significant challenge is the heavily patriarchal society which affects attitudes to women's use of technology. Research has shown that providing women with economic empowerment assists them with escaping domestic violence and boosts GDP, income per capita and increases competitiveness for economies.[191]

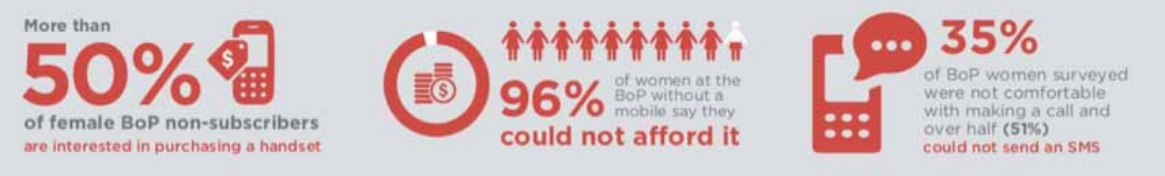


Figure 3.10: PNG Women at the base of the pyramid – Mobile attitudes.[192]

To provide PNG women entrepreneurs with support and skills to assist them in building their businesses, the Center for International Private Enterprise (CIPE) established the Women's Business Resource Center. Since it was established in 2016 with the assistance of the state department, the initiative has assisted hundreds of PNG women in developing their businesses. This has been achieved through access to free training, support systems and childcare services, all provided in a safe environment.[193]

> "Stronger women mean stronger families and a stronger PNG. Economic empowerment is enabling women to start and manage their own businesses, escape gender-based violence, and break through cultural and socioeconomic barriers". Eli Webb, CIPE's Country Director - PNG.[194]

Other initiatives undertaken in PNG to assist women in the use of digital technology include the Connected Women's 'Mobile Skills' toolkit, for mobile operators, NGOs and other institutions or organisations to use to train women. It provides visual and audio training material to overcome literacy issues and assist them in the understanding of SMS, mobile money and bill payment technology.[195]

To capitalise effectively on the talent pool available, economies should ensure equality exists in employment opportunities for not only ethnicity, but also gender, such equality will increase a nation's ability to contribute to digital innovation.[196]

[189] Economist Intelligence Unit 2017
[190] Economist Intelligence Unit 2017
[191] Yun 2017
[192] GSMA 2015
[193] Yun 2017
[194] Ibid.
[195] GSMA 2015
[196] GSMA 2015

RECOMMENDATIONS

1. *Considering various levels of development amongst APEC economies, efforts should continue to strengthen the capacity for members (in cooperation with partners) to share information and develop joint capacity-building programs, projects and initiatives to promote best practice HRD. This should include focus on innovative approaches in education, training and enterprise-based systems to develop the technical, specialist and soft skills needed in the digital age.*

2. *Facilitate policy-relevant discussion among Ministers responsible for HRD to identify innovative approaches to ensure learning, teaching and training systems befit the digital age and to ensure mutual benefits among APEC economies on human resources development in the digital age.*

3. *Consult with business and industry to understand their skills and capability requirements and incentivise firms to invest in enterprise training and education and collaborate with education and research institutions.*

4. *APEC economies should act to enhance collaboration between government, academia and industry to ensure positive development of appropriate curricula, qualifications, domestic/local/sectoral skills recognition frameworks, and standards.*

5. *APEC economies should continue to focus on targeted demand-driven institutional capacity building to ensure that education, vocational and enterprise-based training systems can apply digital and ICT innovations to deliver education and training, reform curricula to improve technical and soft skills, foster a culture of life-long learning, establish micro credentials and digital badge concepts for targeted accreditation, and introduce campaigns to encourage enrolment in STEM and ICT courses, including by women.*

6. *In developing policies to support and encourage the application of ICT and digital innovation to strengthen the capacity of existing education, vocational training and enterprise-based systems to deliver flexible and innovative programs that develop digital skills in an inclusive way, consider:*
   a. *Utilising ICT to improve the teaching of STEM, digital and critical thinking.*
   b. *Implementing micro credentials and digital badge concepts into secondary and tertiary education to address the need for rapid learning and accreditation.*
   c. *Improve problem-based learning curricula to improve the critical thinking skills.*
   d. *Invest in training for teachers to better educate students in ICT.*
   e. *Build campaigns to encourage students to study STEM subjects.*

CHAPTER FOUR

ENABLING HUMAN RESOURCE DEVELOPMENT (HRD) IN APEC TO TAKE ADVANTAGE OF DIGITAL INNOVATION

FINDINGS

APEC Governments are facing pressure to build systems that provide the qualifications, skills and competencies for workers to meet industry needs. The demand for digital skills is growing. Greater support is needed to reskill. Lifelong learning should be fostered. Digital literacy needs to be a fundamental part of all education curricula and introduced at an early age. Teachers aren't always equipped with adequate digital skills to support needs. Awareness of how digital technology can assist teachers is limited, most notably in developing and rural economies. Private initiatives to support educational programs for disadvantaged or disconnected communities are making a difference.

Digital innovation is driven by the actions of the private sector but Government is key to providing an enabling environment, foster public/private partnerships for collaboration, financial assistance and access to complimentary skills and capabilities in the public sector. The digital environment is dynamic, and the exponential rate of change requires policy and regulation development that is agile, considers the whole of society and involves key stakeholders in development. Evidence has shown that a competitive economic environment is beneficial to digital adoption, highlighting the need for policy makers to consider how tariffs and taxes are used, as protectionism and revenue generation in the short term is detrimental to longer term innovation and subsequent economic development.

- *Access to STEM training is a top priority of business, entrepreneurs and government in developed and developing APEC economies.*
- *Access to STEM in education continues to be a challenge for women, particularly in developing economies.*
- *Access to finance is considered a top priority of young entrepreneurs, business and government in the digital economy.*
- *Immature debt markets continue to create barriers to finance.*
- *Women are disadvantaged when it comes to access to finance for entrepreneurial pursuits.*
- *Partnerships between government, educational institutions and private industry, both locally and cross border, can support and encourage digital entrepreneurship.*

The previous chapters have outlined the trends in digital technologies, and the impact they have on people, organisations and economies. Digital innovation is a foundation for future economic wealth for APEC, increasing the competitiveness of businesses within the region and overall productivity of its economies.[197] This chapter considers ways to enable HRD to take advantage of digital innovation and use it as a driver for change. Digital innovation offers opportunities to improve quality of life and economic conditions and profoundly change the way business is conducted, enabling efficiency gains in productivity and supply.

The Role of Government

Government is a key facilitator of digital innovation. The capacity to innovate and bring innovation successfully to market is crucial in enabling economies to achieve increased productivity and competitiveness. Evidence suggests innovation-led growth economies have had a large degree of government support from actions such as grant programs, tax incentives and research and development initiatives.[198] Governments within APEC will need to be agile and possess the ability to adapt in the face of rapid changes to remain relevant. Looking ahead to position their economies to respond to the disruptive nature of the digital transformation will see them thrive and grow in the new digital economy.[199]

STEM and Digital Skills Policies

STEM is a key facilitator of digital innovation. The introduction of the Sustainable Development Goals (SDGs) in 2015 reinforced the need for economies globally to strengthen their STEM capabilities and highlighted the importance of government policy aimed at strengthening innovation skills through STEM education. Successful policies aimed at increasing overall participation in STEM have been undertaken by other economies (Table 4.1, part A). A commitment to STEM from early education and an overarching national framework are vital for support and enablement of a STEM curriculum. For example, frameworks and policies in Australia illustrate the economy's commitment to STEM: Australia's National Science Statement, the National Innovation and Science Agenda, and the National STEM school education strategy,[200] recognise the value of and demand for STEM-skilled employees, and associated need, to ensure the education system provides the foundation STEM skills required for the future workforce.

In focus

Talent and skills – Australia

The Australian Government considers STEM skills critical to prepare students to perform the jobs of the future. To set the right environment for skills development, they have an agenda to support all Australians in gaining STEM and digital skills, adjusting curricula to include coding and computing in schools, and develop the problem solving and critical reasoning skills considered critical for higher wage jobs in the future. This will support citizens to adjust to new jobs in existing and developing industries because of the digital economy.[201]

[197] OECD 2016b, Chaffey 2016, World Bank 2016
[198] Chopra 2015
[199] NZ Digital Skills Forum 2017, Australian Government 2015
[200] Commonwealth of Australia 2017, Commonwealth of Australia 2015, Education Council 2015
[201] Australian Government 2015

In focus

Australia Spotlight on women in STEM

Curious Minds is a program aimed at girls in Years 9 and 10 who have an interest in STEM. The six-month program combines two residential camps and a coaching program and aims to improve representation of women in high level research roles.[202]

In focus

USA & China

President Trump's initiative in spending $2 million per year to make coding a priority in US schools will give way to an increased focus on STEM and coding in schools. In China, the government is committed to building new makerspaces in schools, with more than 5,000 new makerspaces opening in schools in 2017 alone.[203]

It is also important to ensure that the broader economy is technically competent in the use of digital technology. It is suggested that government policy and curricula development also address minimum literacy levels, the ability to problem solve, collaboration, critical thinking and entrepreneurial behaviours, to build a better innovation culture.[204] Different approaches have been taken by different economies in their approach to education policies (Table 4.2-part B).

Part A: Policy Approaches aimed at Increasing STEM Education	
Policy Approach	*Economy*
Budget increases to boost STEM Education	*Belgium, Croatia, Latvia, South Africa and USA*
Initiatives to make STEM Subjects more interesting to future the young	*Ireland, NZ and Portugal*
New teacher training programs and recruitment criteria	*Croatia, Korea, Ireland, Norway and Sweden*
New teaching methods and tools	*Czech Republic, Ireland, Lithuania, Portugal and Spain*

Part B: Policy Approaches aimed at Increasing Generic Skills for ICT Education and Adoption	
Policy Approach	*Economy*
Development of Generic IT Skills	*Spain*
Problem Solving Capacity	*Korea*
Entrepreneurial Behaviours	*Croatia, Ireland, Russia, Finland and Turkey*

Table 4.1: Policy Approaches – Building Innovation Culture.[205]

[202] Commonwealth of Australia 2017
[203] Ye 2017
[204] OECD 2016c
[205] OECD 2016c

Security and Privacy within Education

An important factor for educational programs which use digital technologies to deliver education are the issues of privacy and security of data. Educational technologies need to comply with privacy laws that target educational data in addition to abiding by standard legal requirements that apply to all tech products.[206]

Since digitally delivered course enable organisations to track student metrics, aggregate data and analyse results, there needs to be transparency, security protocols and policies.[207] Regulatory safeguards are vital to the protection of individuals' privacy and policy makers need to consider this in conjunction with educational programs.[208] Risks around the use of big data for the development of digital innovations were highlighted in 2013 when scholarships.com in the USA shared student data with an affiliate.

In focus

European Union Privacy Laws

The European Union has recently introduced new legislation which will require that any entity that processes personal data for E.U residents honour the right of individuals to have their information removed. The new law also requires that companies obtain explicit consent from users before sharing data. Universities will fall subject to the new laws if an academic is interacting with a university management system or when a prospective student in Europe applies for admission to a university in another country. This could potentially be an issue for universities hosting learning platforms such as massive open online courses (MOOCs) which host digital courses for millions of learners around the globe.[209]

Supporting Financing and Investment in Digital Innovation

The existence of and access to finance is an essential piece of the puzzle in enabling a successful digital innovation ecosystem within APEC economies. Particularly in developing economies significant benefits can be derived from the digital economy.

Public Investment

Public investment is a critical service in a thriving economy, as it provides funding and development for the construction of new schools, public housing, hospitals and other social infrastructure. In addition, public funding can connect citizens to economic opportunities as it builds necessary economic infrastructure hubs such as networks to provide advanced telecommunications, sea ports to allow transportation of goods, and improved airports.[210] By making overseas markets more accessible for exports, domestic organisations have a greater ability to link to global value chains.[211] Because of increased public spending in these areas of social and economic infrastructure, economic growth is given an opportunity to flourish. Evidence corroborates the positive relationships between public investment strategies that build high quality infrastructure and economic growth.[212]

[206] Barrett, 2018
[207] Kurshan 2017
[208] Kurshan 2016
[209] Johnson 2018
[210] IMF 2018
[211] UNCTAD 2017
[212] IMF 2018

Participation and increased access to the digital economy will offer improved wellbeing for APEC economies that take advantage of increased innovation and growth. Appropriate policy action is required to preserve open access to the internet, healthy competition and address privacy and security concerns as well as new investments into enabling infrastructure.[213] To capitalise on the opportunities available because of the digital economy, policy makers and organisations need to act now. Financial investments and appropriate public spending will be required to make a real impact on GDP across economies.[214]

Investment in Infrastructure

Investment in infrastructure continues to be a key focus for APEC economies. New technologies will generate immense amounts of data, which will put pressure on the Internet and make it necessary to find more efficient ways to transmit and store data.[215] The expected explosion in data traffic on already congested networks is going to have a significant impact on existing infrastructure.[216] The next generation of 5G wireless networks will be a great leap forward in terms of data throughput, scalability and decreased latency.[217]

Evidence suggests that projects financed with debt rather than through tax increases or cutting government spending yield a larger expansionary result.[218] It has been shown that economies which have clearly identified infrastructure requirements, enough economic slack, and monetary accommodation have a strong case in support of increasing the investment in public infrastructure. Such debt-financed investments have proven to boost aggregate demand and expand productivity in the long run, whilst not having an adverse effect on the debt-to-GDP ratio.[219]

As economies mature and plans to rollout 5G in the region are realised, the need will rise for initiatives - entrepreneurship, education, access to funding and robust government support - to ensure all members of society are able to participate in the digital economy.

Educational Infrastructure

Structures, learning spaces and schools' infrastructure are crucial elements of stimulating learning in schools and universities. There is strong evidence to support that high-quality infrastructure facilitates and higher quality learning environments improve student outcomes and increases retention rates. Studies have found that both environmental and design elements of school infrastructure are directly related to a 16% variation in students' results and progress. The research found that the design of the education infrastructure affected the degree of the students' learning through interrelated factors including individualisation and flexibility of the learning space.[220] However, schools also need to be able to adapt to the evolution of teaching and the requirement for skills that are important for the future of jobs. Most schools were built decades ago, meaning that classrooms are outdated and haven't been built for change, which has become a problem globally as education, curricula and teaching continues to evolve at a rapid pace.[221]

[213] OECD 2015
[214] Mićić 2017
[215] Meola 2016
[216] Smith 2018
[217] Smith 2018
[218] Abiad, Furceri & Topalova 2016
[219] Ibid.
[220] Barrett, Davies, Zhang & Barrett 2016
[221] World Bank 2018b

In focus

Australia

The Victorian Government is one example of a government committed to improving the infrastructure of schools and training facilities to drive a more positive outcome for both students and teachers. One of the main drivers is to bring schools into the 21st century by building futuristic classrooms and creating integrated community hubs, which have proven to be a more positive environment to learn in.[222]

Supporting Private Sector Investment

APEC economies need to create an environment that supports private sector investment.[223] Policies to provide grants, subsidies and loans or equity funding that support innovation is necessary to build business confidence in the private sector and foster investments in R&D and Innovation. Fiscal policies and incentives also enable indirect support that further encourage investment, such as R&D tax incentives. Governments possess the opportunity to provide direct funding into areas of the economy that will yield the greatest economic and social returns and are therefore powerful instruments in kickstarting incremental innovations for firms that have found the digital economy is disrupting their existing business operations.[224]

The shift from technology absorption to innovation means access to finance is vital. Innovative firms especially face considerable barriers for accessing finance because their projects are inherently risky with uncertain outcomes.[225] Research has found that private investment in highly efficient public investment economies increases as a share of GDP as a side effect of public investment injections, however when public investment is low, private investment as a share of GDP in these economies falls.[226]

In addition, it has been found that as investment in ICT research increases, economic growth ensues, and vice-versa. ICT R&D investment has also been shown to have a greater impact on economic growth, which

[222] Victorian Government 2018
[223] Help 2018
[224] OECD 2015
[225] Chopra 2015
[226] Abiad, Furceri & Topalova 2016

is also fuelled by an increase in public investment in efficient economies. Once again, private investment increases because public investment increase, and its private investment which has the greater impact on economic growth for economies, yielding higher tax revenues which enable further public investment.[227]

Education and Training Challenges

Digital transformation along with advancement in automation are changing the skills needed in the workforce and deeply affecting labour market conditions.[228] Future anticipated demand for digital skills is predicated to far outweigh the current supply within the labour market and education institutions.[229] These anticipated shortages highlight the necessity for economies to implement policies and regulations addressing education and skills development for current and future workforces, adjustments to curricula and development of suitably qualified educators.[230] To meet the needs of the future digital economy, education systems will need to provide higher levels of non-routine cognitive skills, complex problem solving, creativity, as well as foster stronger socio-emotional skills.[231] Due to the rate of change digital technology brings, governments need to continually focus on ensuring policy initiatives and regulations are relevant to the needs of the economy.[232]

Graduate Readiness

Many employers are expressing their dissatisfaction with the quantity and quality of ICT graduates. They find that new entrants to the workforce lack practical and soft skills such as teamwork and problem solving that are vital in the workplace. This is especially true for young entrepreneurs. At a recent panel of industry leaders on the Future of Work, all panel members concluded that it is the combination of technical and enterprise skills that will be required to cope with the changing nature of work through digital innovation.[233]

Low engagement in ICT skills in schools has led to an unsatisfactory pipeline of ICT skills into the workforce. The perception of ICT careers is a key driver for change, and reform is required to boost and enhance these perceptions. Such enhancements will be geared to increase the availability and preparedness for ICT graduates that will allow economies to capitalise on the digital economy's opportunities.[234]

Figure 4.4: The Most Important Digital and IT Skills.[235]

[227] Hong 2017
[228] OECD 2018d
[229] OECD 2016c
[230] Khan & Forshaw 2017, OECD 2016c, Thomas, Barraket, Wilson, Ewing, MacDonald, Tucker & Rennie 2017, World Bank 2016
[231] OECD 2018d
[232] World Bank 2016
[233] RMIT 2018
[234] Australian Government 2013
[235] Marshall 2017

Figure 4.3: Enterprise Skills have been found to accelerate the transition to full time employment.[236]

A 2015 study of employers' perspectives of the current and future value of graduate skills, placed the greatest priority on adaptability and flexibility for future employees, to be able to adjust to the rapidly changing workplaces due to the growing digital economy. Employers who employ STEM graduates still value the contribution that universities make towards the skills of graduates but would like to see the infusion of higher order thinking and more relevant discipline knowledge into the curriculum. It also considered that integration of authentic Work Integrated Learning (WIL) tasks into the curriculum would enrich the value already offered by university education programs.[237]

Lifelong Learning

To support the rapid advancement of economies because of digital innovation, promoting social cohesion and economic resilience is necessary to ensure workforces can adjust to changes in demand for skills. Workers will need to continually update their skills and often this will need to happen outside of formal education. APEC Governments need to consider how individuals and businesses can be supported to promote lifelong learning.[238]

To do this, learning opportunities need to be more equitable. Recent analysis conducted by the OECD[239] highlights that individuals most likely to receive training are already highly proficient in numeracy and literacy with approximately 25% of workers receiving training, having low skills. In addition, workers that perform work that is more likely to be automated are less likely to be trained. When comparisons are made between male and female workers, males in the same roles as females receive systematically more hours of training and family responsibilities are considered a major barrier for female participation in training programs.[240] APEC Governments need to consider how training programs can be promoted and developed to better target vulnerable individuals and groups within their economies.[241]

In a survey of Australia job seekers 25% felt they were not fully prepared for the reality of today's workforce while 52% wanted access to more internships and apprenticeships.[242]

[236] Foundation for Young Australians 2018
[237] Rayner & Papakonstantinou 2015
[238] Khan & Forshaw 2017, OECD 2016c, OECD 2016c, World Bank 2016
[239] OECD 2018e
[240] Ibid.
[241] OECD 2018e
[242] Anson & Baker 2018

Underinvestment in Training

Government research in NZ found public and private sector organisations were not investing at effective levels to develop their staff for the technology sector because of difficulties in finding the time and prioritising training over business activities. Government and private sector organisations engaging in innovation activities need to co-invest in their workforces' education, and to work together to better align course curriculum with the future demands of ICT.[243]

Technology and the Aim of Education

Education systems need to match or outpace technology innovation to deliver skilled domestic human capital to support growth and an inclusive economic system leading to economic prosperity. Investment in education should be directed to reduce skills shortages to a level that will allow the system to keep pace with technological advancements (Figure 4.4).[244]

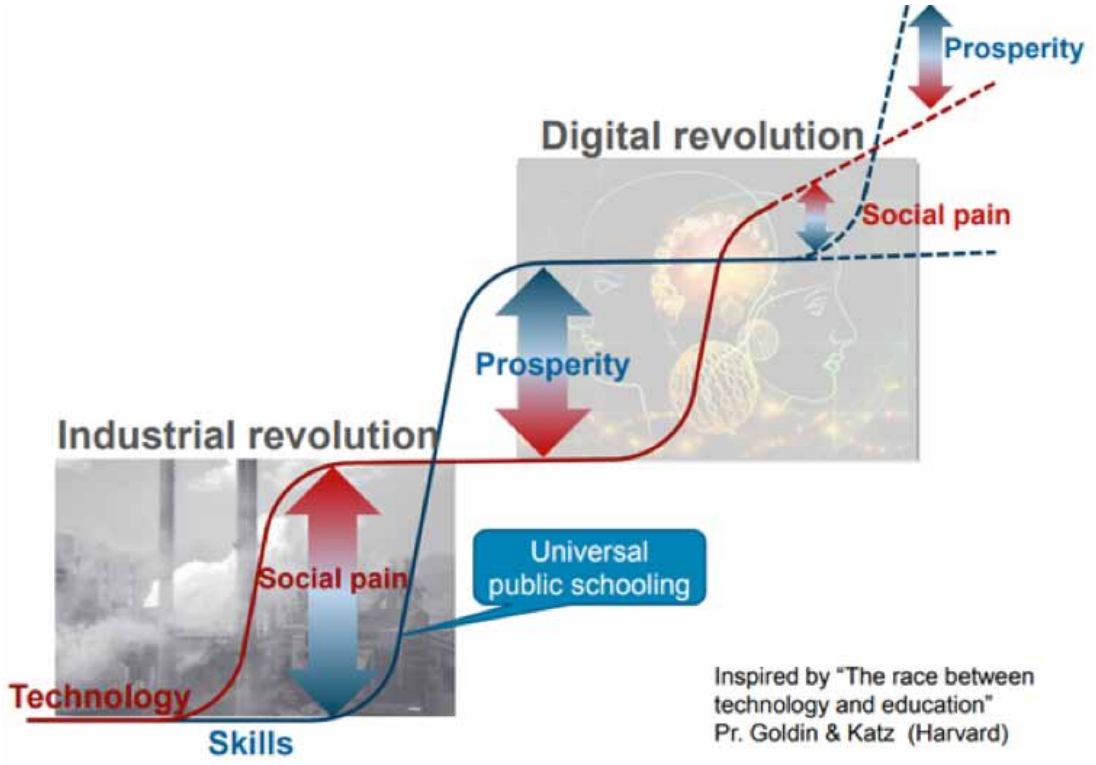


Figure 4.4: Technology and Education development.[245]

One of the most commonly held reasons for the digital divide is inequalities in education due to the disparity that exists between those that have the ability to develop digital skills through technology usage and those that don't.[246] Education plays a critical role in adoption of technology and individuals that have a higher education level are found to be more capable of flexibility, enabling them to overcome complexity constraints.

Adjustments to education and training systems are required to support digital learning.[247] Teachers and on-the-job workers need to be provided with the specialist skills required to meet these changes in

[243] NZ Digital Skills Forum 2017
[244] Schliecher 2016
[245] Schliecher 2016
[246] Cruz-Jesus, Vicente, Bacao & Oliveira 2016, Iivari, Kinnula, Molin-Juustila & Kuure 2018
[247] McKinsey & Co 2017b, OECD 2016c

education requirements. It is also essential that children are educated to provide them with the skills they need to design, make and build digital technology, in addition to in-depth use of digital technology.[248]

> "schools have some catching up to do if they are to prepare young people for the world they are going to grow up in... Just as the tech companies have an agile approach to innovation where they trial and evaluate, iterate, and then go again, we need that approach in education as well." Mark Scott - Head of the New South Wales State Department of Education in Australia.[249]

Delivery of Education

The effect of digital technology on education is twofold, it will change not only what is taught in education institutions, but also offers opportunities in how education is delivered. Figure 4.5.

Figure 4.5: Digital Transformation Trends in Education.[250]

[248] Iivari, Kinnula, Molin-Juustila & Kuure 2018
[249] Future inc, 2017
[250] Forbes 2017, Newman 2017

Innovation in education can involve a new pedagogic theory, methodological approach, teaching technique, instructional tools, learning process, or institutional structure that, when implemented, produces a significant change in teaching and learning.[251]

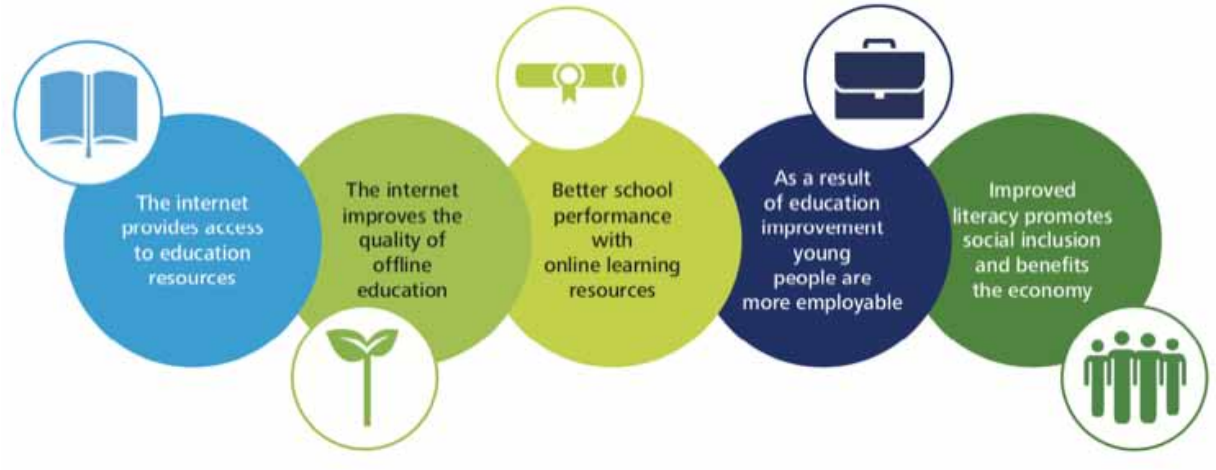


Figure 4.6: Educations impact on Economic Development and Social Inclusion.[252]

Digital innovation in education is impacting how individuals want to learn. Educational technologies such as virtual classrooms, mobile devices, digital readers, on-demand video and cloud-based LMSs have fed a market that has been and continues to be hungry for innovation. Innovations such as the connected campus, will enable students to use their mobile devices as a 'remote control' for their entire university experience.

Advances in data analytics and AI will require the formation of new education methods including via virtual reality, online and use of robots, changing everything from pre-admissions to the experience in the classroom.[253] IoT devices can be used for delivering and assessing exams; Blockchains for data collection and distribution; and AI for data analysis and trend identification. In addition, predictive tools that model big data to analyse individual students' probability of success in both their chosen course, and possible alternative courses to which they may be more suited can improve educational outcomes.

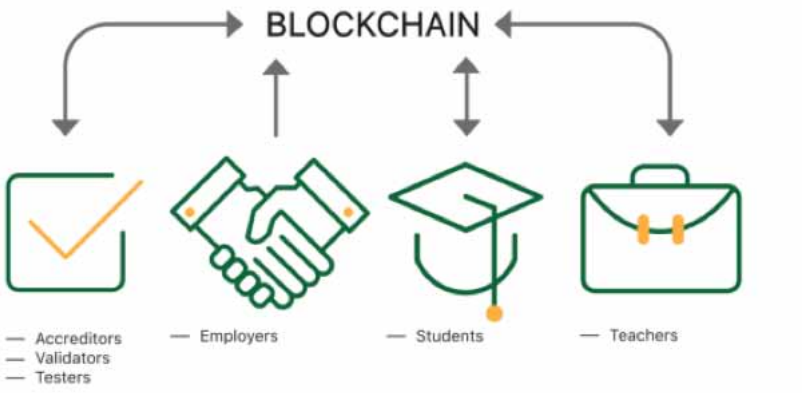


Figure 4.7: Educational Stakeholders with an interest in Blockchain.[254]

[251] Serdyukov 2017
[252] Deloitte 2014
[253] Ibid.
[254] Grech & Camilleri 2017

The use of augmented and virtual reality is changing how students interact with their teachers as they layer virtual content onto printed materials to enhance understanding and inspiration. The ability to easily and economically convert existing platforms such as mobile phones into VR enabled devices has fuelled an explosion of low-cost education solutions such as Google Cardboard and Samsung's Gear.[255]

Along with extant digital learning techniques such as online courses, assessments and management, there has been significant groundwork around the creation of systems and standards to facilitate the collection of student data for intervention and retention purposes across APEC.[256]

Historically, education technology was focused on the higher education market, but more recently, the boundaries are being expanded to beyond higher education and on to corporate training.[257] The lesson to be learnt in today's evolving digital innovation world is that there needs to be a focus on speed and how to make learning efficient and effective.[258]

Innovation will be essential to bring about qualitative changes in education, as opposed to the quantitative expansion seen so far. These changes are needed to increase efficiency and improve the quality and equity of learning opportunities.[259] APEC economies should focus investment on education, including initiatives to enhance digital skill sets required for future work. As connectivity increases across Asia-Pacific, so does the opportunity for economies to take advantage of digital innovation.

In focus

Korea Spotlight on Education Delivery

The core concepts of science are taught with a close relation to learners' experiences, and students are provided with opportunities to apply science-related knowledge and inquiry skills for problem solving in society and daily life.[260]

Technology Based Education

Technology supported learning can improve students' learning outcomes.[261] Collaboration through technology as a learning method may improve flexibility of learning, cultural diversity, student interaction and engagement and student thinking skills.[262] Teaching models based on gaming, virtual laboratories, international collaborative projects, real-time assessment and skills-based assessment are examples that have been successfully developed to date.

Historically, education has been 'spatially fixed and geographically limited'.[263] Traditionally, schools are in fixed locations, meaning that students must either live close to or at the educational institution. Delivery of education is via a broadcast, 'one-to-many' model. Digital technologies liberate students and educators from these limitations and facilitate a non-broadcast model of teaching and learning.[264]

[255] TechRadar 2018, Accenture 2018, Education Technology Solutions 2018
[256] TechRadar 2018
[257] Newman 2017
[258] Ibid.
[259] OECD 2016e
[260] Khine, 2015
[261] Kärkkäinen & Vincent-Lancrin 2013
[262] OECD 2016e
[263] Balkin & Sonnevend 2016
[264] Ibid.

Whilst there will still be a need for intensive one-on-one teacher student interaction, and virtual schools cannot fully substitute physical schools, hybrid models of education can be applied.[265] Through digital technologies, education is made accessible to students who previously had no access, and affordable to those who may have not been able to afford it in the past. This is particularly relevant in developing economies, where isolation due to location has prohibited citizens from participating in learning.

In focus

Blockchain Skills and Education

Current reports suggest there is an extreme shortage of blockchain talent. One report suggests an estimated 75% of all blockchain jobs result from reskilling and cross-training existing employees, thus creating roles for educators and in-house trainers.[266] Meeting the demand for workers with appropriate digital, technical and enterprising skills will therefore require immediate and on-going investment in education and training. Current examples of APEC economies addressing this issue includes:

- Singapore - Skills Future has been established to enable people to upgrade their skills by using credits provided by the government.[267]
- Malaysia - have included digital skills in the school curriculum through its Digital.Tech@Schools initiative.[268]

A recent example of this investment in education investigated the fundamental impact that investment has on educational prosperity.[269] The study identified the key aspects of the broader educational strategy implemented by the regional government in Shanghai, China. This strategy resulted in a world class education system that was based on inclusiveness and prosperity. Notably, the key points that have a digital relevance include:

- Efficient assessment systems for all grade levels,
- Shanghai closely monitoring the school management environment and teaching and learning outcomes. The municipality collects school and district data annually.

Data from these assessments are used to inform teaching, learning and future assessment.

Blockchain applications are still in their infancy but institutions have been quick to exploit opportunities, even allowing students studying digital currency to pay for tuition using bitcoin, to gain a qualification on a pay as you go remittance not usually offered by traditional universities.[270] Universities are, such as RMIT and the University of Melbourne adopting Blockchain technology to record student credentials, allowing graduates to share verified copies of their qualifications with future employees and relevant third parties in a tamper proof environment.[271]

[265] UNCTAD 2017
[266] del Castillo 2017
[267] Gonzales, Hernando & San Andres 2016
[268] MDEC 2018
[269] World Bank 2018b
[270] Grech, Camilleri & Inamorato Dos Santos 2017
[271] AFR 2017

Alternative Learning Platforms

There are currently a range of emerging types of learning platforms growing in popularity including: Micro learning, Micro credentials, Virtual Exchange Programs, Flipped Classrooms, Gamified Learning and Massive Open Online Course (MOOC's).

Micro-credentials and Micro-learning

Micro-credentials are designed to make authenticated learning recognised in both formal and informal situations. Once a new skill or knowledge is achieved the student/learner receives a stamp or badge of credibility that is recognised as a qualification. Micro-credentialing is any approach that confirms and authenticates schooling that falls outside of traditional certification or qualification processes. Digital badges are a primary example of micro-credentials with their main benefit being that they are less complex and time consuming to achieve than traditional certifications and degrees.

Micro-credentials have been developed in direct response to the changing workforce landscape, requiring work ready graduates and the need to upskill adults with more flexible accreditations quickly. They are one of the most popular alternative learning platforms and are expected to continue to increase as they grow in popularity due to the increasing importance for individuals to demonstrate their commitment to lifelong learning (Figure 4.8). Micro-credentials are closely linked to micro-learnings in that a credential is a stamp of credibility toward a qualification or certification whereas with micro-learning an individual partakes in an unvalidated learning achievement.[272]

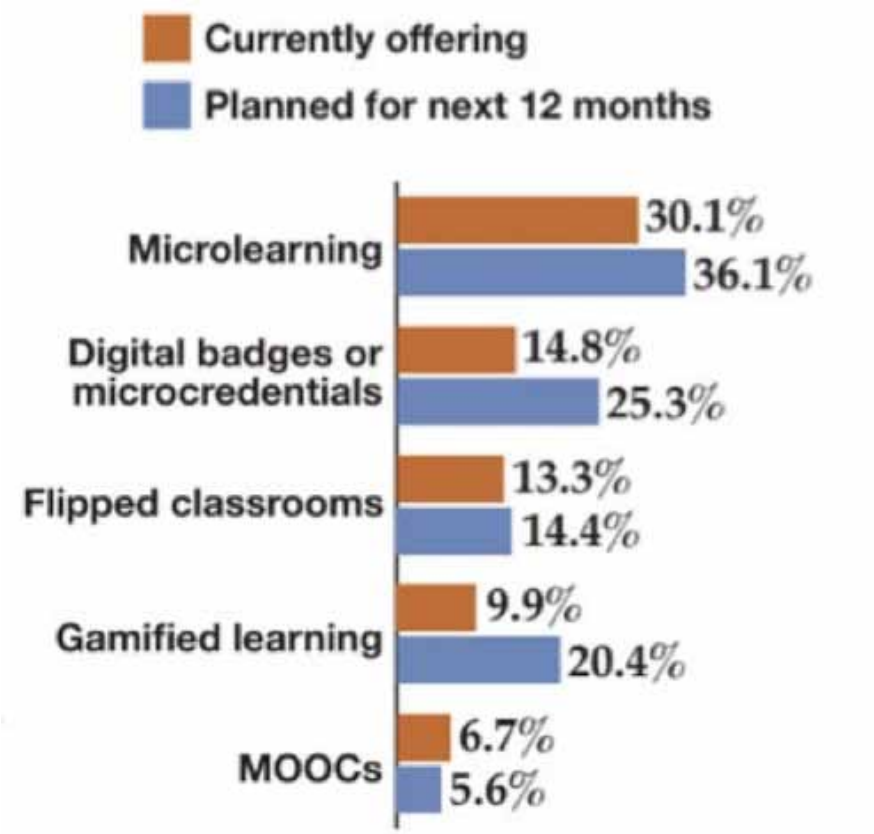


Figure 4.8: Learning platforms offered or planned.[273]

[272] Steel & Cobb 2017
[273] Steel & Cobb 2017

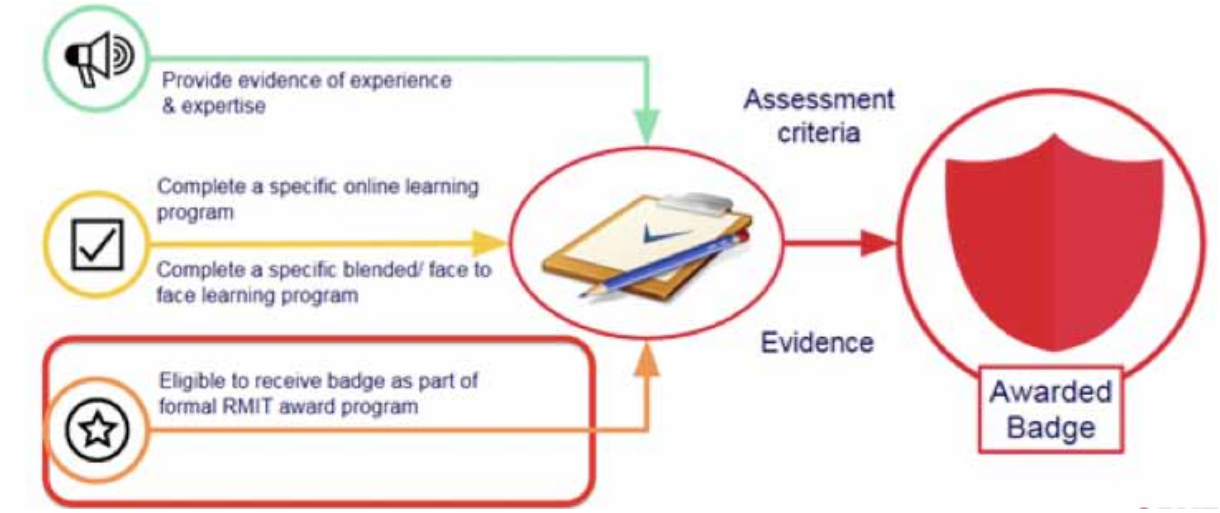


Figure 4.9: RMIT University's Process for earning Micro-credentials.[274]

Virtual Exchange Programs

Virtual exchange programs operate in a similar way to standard exchange programs offered by Universities; however, they are completely online. At the end of 2017, 8 high-ranked universities signed an agreement for a virtual exchange whereby they offer their students the opportunity to take online elective courses and gain credits for their bachelor or master's degrees.[275]

Massive Open Online Courses (MOOC)

Massive Open Online Courses (MOOCs) are providing popular for post-secondary education, providing distance learning that is accessible from any device, and often provided free of charge. The advantages of being online and free broadens participation, but they require existing digital skills, high speed internet connections and the individual needs to be self-motivated to learn. Although despite these challenges they offer solutions for individuals in the workforce to acquire new skills in a flexible way that is a benefit to workers and organisations. These courses can also provide access for individuals in economies where education systems don't yet support advanced ICT skills to gain formal qualifications.[276]

There are currently more than 800 universities around the world that have launched at least one MOOC. The number of MOOCs available today stands at 9,400, which is up from 6,850 in 2017. The total potential revenue just from students currently enrolled in online degrees and programs offered by major MOOC platforms is now exceeding $65 million. Online graduate degrees are a lucrative monetisation opportunity for MOOC providers. Coursea is planning to launch 15-20 degrees by 2019, while FutureLearn has announced that they will be launching 50 degrees.

Although MOOCs have not disrupted universities, they have changed how working professionals access continued learning and career-advancement opportunities. [277]

[274] Molden 2018
[275] Van Valkenburg 2017
[276] World Bank 2016
[277] Shah 2018

Figure 4.10: Growth of MOOCs.[278]

The top five MOOC providers by registered users are:

1.	Coursea	30 Million users
2.	edX	14 million users
3.	XuetangX	9.3 million users
4.	Udacity	8.0 million users
5.	FutureLearn	7.1 million users

Although there is still clearly a role for traditional and formal educational institutions such as tertiary and university, these traditional schools are viewed as less valuable for developing future skills when compared with on the job training, online courses and professional development courses.[279]

A recent report commissioned by the European Commission, explores the feasibility, benefits and challenges of decentralised technology in education. Some of the main challenges needing to be addressed include how to continuously re-skill workers and the need for continuous professional development. How to recognise non-formal learnings, particularly for open learners and migrants, and how to standardise credentialing, such as micro-credentials, in a recognised way that can be access by third parties.[280]

More work needs to be undertaken to better align the educational experience and the needs of individuals and organisations both now and in the future.[281]

[278] Shah 2018
[279] Future Inc. 2017
[280] Grech, Camilleri & Inamorato Dos Santos 2017
[281] Future Inc. 2017

In focus

Australia / NZ Case Study - The Tertiary Sector Respond[282]

Responding to feedback from employers and students alike, in an environment of reducing rates of graduate employment, leading universities in NZ and Australia are introducing new courses, curriculums and entry criteria with a view to better preparing students for the workforce of the future.

They have approach this in various ways. The first is through the introductions of new entry tests to identify applicants with strong communication, problem solving and critical analysis skills and the introduction of courses that teach these skills in a traditional setting. These skills have become essential skills for employability that have been identified as skills graduates often don't possess.

The University of Auckland (UOA) have identified that work ready graduates for the future world of work should be skilled digitally, be business savvy, creative and possess skills to assist in digital strategy. The UOA business school has introduced changes to their curriculum, data analytics, digital marketing, change management and innovation. They are focusing on preparing students for an ambiguous future of work where jobs are forever evolving, changing and uncertain. Additionally, lectures are moving away from traditional methods of teaching, focusing more on team-based learnings, experimentation and the introduction of technology in the form of online teaching and learning.

Professional Development of Teachers

With the focus on STEM curriculum, as well as the new and innovative ways to deliver teaching discussed earlier in this chapter, there comes a need to reform teacher education. Most teachers are not adequately prepared to teach STEM,[283] and will need a 'new and interdisciplinary content knowledge base'.[284] The complex and multidisciplinary nature of STEM subjects have made teachers' professional development challenging. One emerging approach is the creation of professional development programs is to support the development of teacher networks, both formal and informal.[285]

Overarching frameworks, like the Technological Pedagogical Content Knowledge (TPACK) are helping to create a best practice body of knowledge to assist educators. TPACK captures some of the essential qualities of teacher knowledge required for technology integration in teaching.[286] Programs like HP's Catalyst initiative offer opportunities in cross border collaboration which serve as Communities of Practice for professional development of teachers in the teaching and delivery of STEM education via the use of technology.[287]

Impact of Digital Innovation on Education

Many APEC economies can do more to invest in innovative digital solutions to drive social impact, and investment in education is fundamental. Nowhere more so than within the education sector, is the impact of digital innovation able to provide high value opportunities for people especially in developing economies. Making education affordable, accessible, and relevant will empower disadvantaged

[282] Ibid.
[283] Stohlmann, Moore & Roehrig 2012
[284] Baker-Doyle and Yoon 2011
[285] Ibid.
[286] Hsu & Hsu 2015
[287] Ibid.

populations and prepare them for the 21st century economy. Education is a key factor in supporting the growth and prosperity of a community, and digital technologies are now a key enabler to education. The Digital Readiness Index (Figure 4.11) measures each APEC economy's digital readiness and ability to skill their population through education. The lower the readiness index score the more the nation is equipped and utilises digital technologies.

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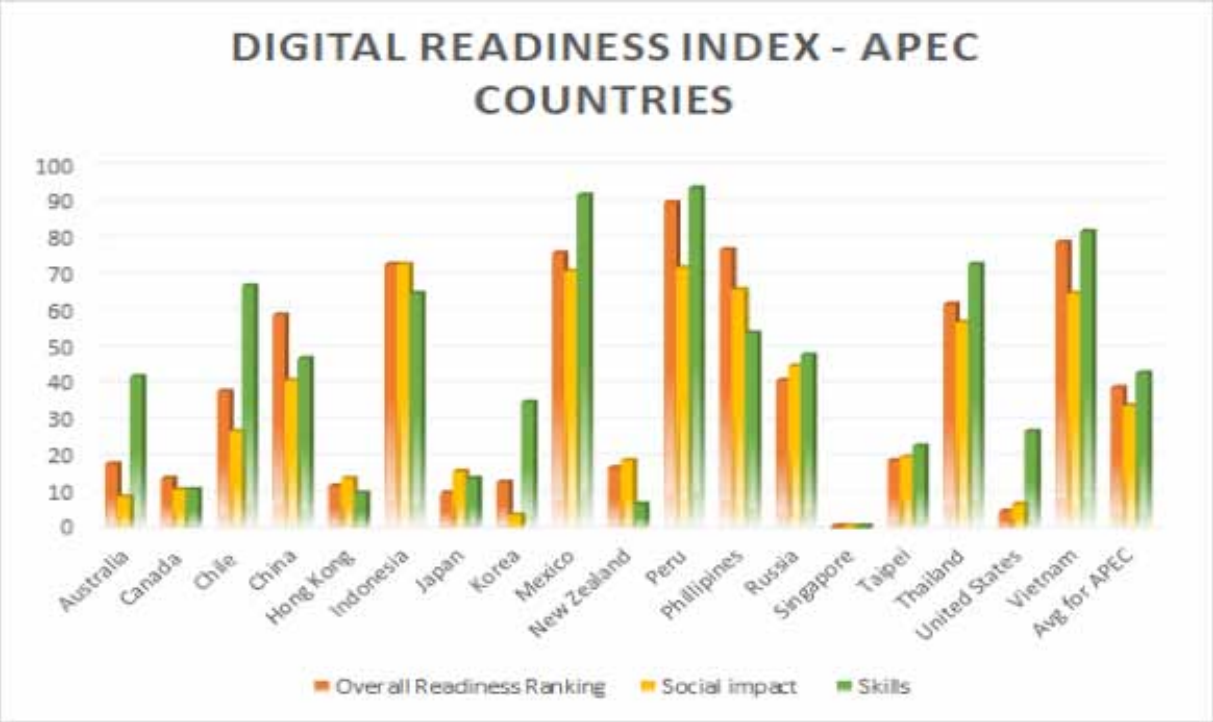


Figure 4.11: Digital Readiness Rankings 2016.[288]

Traditional education programs are becoming more irrelevant to the future landscape of jobs and therefore the quality and quantity of skills is affected. This coupled with inequalities in economic and social conditions that exist globally raise the need for urgent attention to these issues.[289] Organisations need to become part of the solution to tackle the shortage in digital skills, and business leaders need to be aware that if they fail to address these shortages, their revenues will suffer stagnation or decline. To do this they should engage with training providers to help address their digital needs and support is needed from policy makers in development of effective migration policies to source talent from overseas, allowing organisations to fill key skills gaps.[290]

It is apparent that an opportunity exists to create educational systems relevant to today's learning challenges that could resolve current barriers and create a more sustainable model that is not only relevant to the future dynamic and evolving workforce but also works toward enhancing social cohesion and equality amongst society.[291]

[288] World Economic Forum 2017b
[289] World Economic Forum 2017b
[290] Marshall 2017
[291] World Economic Forum 2017b

RECOMMENDATIONS

1. *Considering various levels of development amongst APEC economies, efforts should continue to strengthen the capacity for members (in cooperation with partners) to share information and develop joint capacity-building programs, projects and initiatives to promote best practice HRD. This should include focus on innovative approaches in education, training and enterprise-based systems to develop the technical, specialist and soft skills needed in the digital age.*

2. *Facilitate policy-relevant discussion among Ministers responsible for HRD to identify innovative approaches to ensure learning, teaching and training systems befit the digital age and to ensure mutual benefits among APEC economies on human resources development in the digital age.*

3. *Consult with business to understand their skills and capability requirements and incentivise businesses to invest in training, educate within their firms and collaborate with education and research institutions.*

4. *APEC economies should act to enhance collaboration between government, academia and industry to ensure positive development of appropriate curricula, qualifications, domestic/local/sectoral skills recognition frameworks, and standards.*

5. *APEC economies should continue to focus on targeted demand-driven institutional capacity building to ensure that education, vocational and enterprise-based training systems can apply digital and ICT innovations to deliver education and training, reform curricula to improve technical and soft skills, foster a culture of life-long learning, establish micro credentials and digital badge concepts for targeted accreditation, and introduce campaigns to encourage enrolment in STEM and ICT courses, including by women.*

6. *In developing policies to support and encourage the application of ICT and digital innovation to strengthen the capacity of existing education, vocational training and enterprise-based systems to deliver flexible and innovative programs that develop digital skills in an inclusive way, consider:*
   a. *Utilising ICT to improve the teaching of STEM, digital and critical thinking.*
   b. *Implementing Micro credentials and digital badge concepts into secondary and tertiary education to address the need for rapid learning and accreditation.*
   c. *Improve problem-based learning curricula to improve the critical thinking skills.*
   d. *Invest in training for teachers to better educate students in ICT.*
   e. *Build campaigns to encourage students to study STEM subjects.*

CASE STUDY: PAPUA NEW GUINEA

In November 2018, Papua New Guinea leads and hosts APEC Summit discussions on the theme of "Harnessing inclusive opportunities and embracing the digital future". This will include focus on three policy priorities: improving digital connectivity and deepening regional economic integration; promoting inclusive and sustainable growth; and strengthening inclusive growth through structural reforms.

This historic meeting and the activities under ABAC PNG, and through the APEC PNG Study Centre will raise PNG's profile within and outside of APEC as its youngest developing economy member, showcasing its cultural diversity and traditions, the nation's economic potential, and need for further aid and investment to strengthen PNG's political, economic and social development.

> "All digital innovation depends ultimately on cheap quality access to internet" (PNG entrepreneur, 2018).

The PNG APEC Study Centre was established in February 2017 through a memorandum of understanding between the PNG Government and PNG National Research Institute (PNG NRI). PNG ASC is supported by Australia through the PNG-Australia Partnership. Its first conference with The APEC Study Centre Consortium Conference (ASCCC) was in May 2018, with the topic 'Inclusive growth opportunities in an increasingly connected region'. It focused on improving understanding of how to enable digital innovation in a PNG context. It will support applied multi-disciplinary research that advances policy 'across a range of economic, regional trade and investment issues' with a focus on innovation, technology and digitalisation.

The Centre will focus efforts to bring together researchers, practitioners from industry and the development sector, and policymakers to focus on issues such as:

- How to increase access to mobile technology in rural communities
- Cacao producers in PNG using technology to share price data and processing techniques to ensure better returns for their cacao.
- How can blockchain track the condition of perishable goods and improve supply chains in PNG.
- How do we ensure growth is inclusive for all groups including: Women and minorities?
- How blockchain has the potential to improve trading, ledgers and supply chain for a range of goods and services.

Located between East Asia and Australia, PNG is well positioned to take advantage of this regional growth but is by no means alone in facing significant challenges to establish a comprehensive local digital eco-system and move across the digital divide from 'starter' to 'adopter' status.[292] Entrepreneurship is increasingly being recognised as a positive and empowering force in making a difference in people's lives and fostering people-to-people linkages and should be further developed in PNG, and in collaboration with other APEC members. One such program was the 2018 HRD initiative to link PNG entrepreneurs with Australian start-ups in a development program to help them develop the resources, expertise and international connectedness they need to build large, globally significant and sustainable companies. (See details on page 40).

Like some APEC and Pacific Island neighbours, PNG continues to focus efforts on fundamental infrastructure development, improving fixed and mobile broadband access, affordability of plans, connecting citizens and increasing online participation, raising awareness of digital benefits, expanding online service delivery (including digital government) and content development, and building an IT-based business infrastructure to stimulate the digital economy.

PNG's infrastructure has long been hampered by its diverse and challenging geography and lack of financing. Its steep hills and rugged terrain make transport and internet access difficult to provide and this, in turn, complicates the provision of electricity, water and other infrastructure. Fixed internet penetration remains very low in PNG, due to exorbitant prices and difficult to access terrain. In 2013 broadband prices were 665 times higher than in Singapore. While 4G LTE mobile coverage is available to residents of Port Moresby and Lae, and 3G is available in most regional centres, the rest have access to 2G or no access at all, making it difficult for users to benefit from the full capabilities of their devices (Figure 5.1). Recent infrastructure developments should improve access to fixed broadband. In July 2018, the leaders of Australia and PNG signed an agreement to deliver a project to lay an undersea internet cable that will significantly improve internet access and speed to PNG.[293]

More Papua New Guineans who access the internet rely on mobile broadband rather than laptops or other devices. Currently nearly 40% of Papua New Guineans own a mobile phone, but it's estimated that only half of these are smart phones. Prominent futurist, Mark Pesce, in addressing the Business Advantage PNG Investment Conference in Sydney last year, suggested that a policy to drive up the rates of smart phone ownership, potentially aiming for 85% smart ownership by 2022, would be instrumental in PNG's economic development.[294]

[292] Deloitte 2017
[293] ABC 2018
[294] James 2017

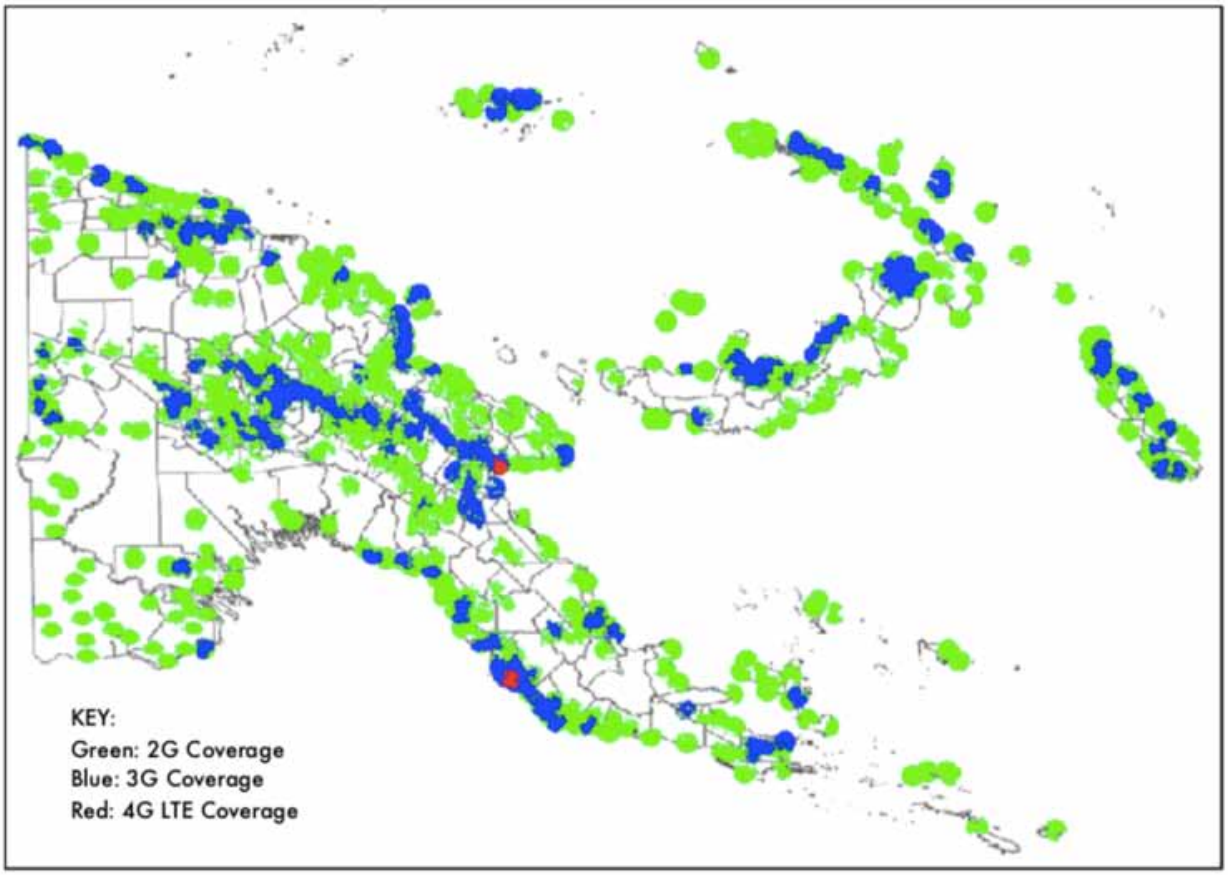


Figure 5.1: Mobile Broadband Coverage in PNG.[295]

HRD - and capacity building in HRD - is a clear strategic priority for Government, alongside aid and investment for PNG. The key challenges in the full development of human resources in PNG to meet the opportunities presented by digital innovation are to implement an approach to make the best of limited resources, foster a culture of continuous improvement, and utilises external aid, investment and expertise, to build the capacity of local institutions, educators and trainers to deliver appropriate digital education, training and experience to foster digital literacy, skills and innovation. This should continue to be combined with initiatives to include historically disadvantaged groups, particularly women, rural and remote communities.

An Oceanian archipelago nation north of Australia and west of Indonesia, PNG's population consists of several thousand separate tribal communities, most with only several hundred people, each with their own language and traditions.[296] PNG's population of 8,440,282 is the 56th largest in the world, but is one of the least densely populated, with 15 people per square kilometre.[297] In this population, over 40% are under the age of 15 and will expect to enter the labour market in some form (be it formal or informal) within the next decade.

82% of PNG's population live outside of urban areas, with a low rate of urbanisation at 2.52%. Port Moresby, with a population of 310,000 in 2018, is the only city with over 100,000 people. Lae, Arawa, Mt Hagen, Popondetta, Madang, Kokopo and Mendi are key regional centres with populations between 25,000 and 100,000.[298] Papua New Guineans speak 832 living languages, 12% of the world's languages, making it one of the most linguistically diverse places on earth. Most of these languages have less than 1000 speakers and

[295] Digicel 2018
[296] CIA 2018
[297] CIA 2018, World Population Review 2018
[298] World Population Review 2018

are preserved by close-knit tribal systems. Tok Pisin, PNG's official language alongside English, is the most widely spoken language, with 80% of the population fluent in it. In contrast, only 1-2% of the population speak English, posing barriers to the use of internet and digital tools, which predominantly use English.[299] PNG society is largely traditional, and a core value of most Papua New Guineans is 'wantok loyalty', loyalty to village and language groups over personal or national loyalty. 'Wantok' means "someone who speaks my language" in Tok Pisin. Within wantoks, responsibilities and wealth are shared, providing a sense of belonging and security.[300]

For most of the population, subsistence-based agriculture and informal employment is the predominant activity. PNG's formal economy is nascent and largely tied to the agricultural and resources industries.[301] This creates great potential. Deloitte reports an estimated 2.5 million people work in the informal economy, compared to around 500,000 in the formal sector. Transferring even a modest share of those in the informal sector to the formal sector would create considerable economic gains, in terms of productivity and tax revenue.[302] However, PNG face many of the same challenges as other economies within the region with significant difficulties in finding suitably qualified people.

The same report highlighted the impact of this issue showing 83% of businesses surveyed stated that skills shortages impede hiring and were the primary factor affecting recruitment in the wholesale, hospitality and retail sectors with 93% of businesses citing this as being more of a challenge than broader economic factors. This trend was exacerbated outside Port Moresby, Lae and Madang in regional and remote areas. [303] These skills include digital skills, hard and soft skills.

Figure 5.2: Behind general economic conditions, skills shortages are the single biggest factor that impedes hiring.[304]

[299] CIA 2018, AV 2017, World Population Review 2018
[300] Moffatt 2012
[301] Deloitte 2017
[302] Ibid.
[303] Ibid.
[304] Deloitte 2017

PNG's education systems face considerable challenges to deliver quality services that meets the needs of its population. Education, including tertiary education since 2012, is free in PNG but provision and access is not yet universal. The Ministry of Higher Education, Research, Science and Technology is striving to expand capacity within the education sector to meet demand but ongoing substantial investment in essential educational infrastructure is still required to allow access for all Papua New Guineans to education.[305] The quality of education is as important as the quantity of education provided, at primary, secondary and tertiary levels, and PNG institutions require support to ensure systems and providers have required courses, competencies and confidence to deliver lifelong digital learning. This requires an approach to education systems, training of teachers and a change of mindset that introduces innovation into education and training to deliver foundational literacy and numeracy for students in schools and digital, training and vocational skills geared to market needs.[306]

The system should provide for early digital learning to ensure the next generation have the technical and conceptual skills to participate in the digital age – as employees, as teachers, as entrepreneurs and as innovators. All economies face challenges in ensuring children are equipped with foundational skills that now include digital literacy, and that they not only acquire knowledge but have learning to learn competencies, so they are able to increase their capacity to learn. These skills are fundamental to equipping and motivating them to undertake lifelong learning to develop the new skills and competencies they will need to navigate the future of work.

The system should also educate and equip secondary and tertiary students with digital skills to meet current demands. There are opportunities for PNG to consider a more flexible and open approach when undertaking educational reforms.[307] For example, there may be dividends in moving away from theoretical acquisition of knowledge towards more practical applied experimental learning that encourage students to interact and collaborate through projects. The teaching role in education delivery can evolve to be a facilitator to guide students, encourage them to explore and learn from different sources more creatively.

Digital inclusion and education in PNG are hampered by geographical and technical barriers, safety issues, financial issues, education and gender. Two identified groups of disadvantaged people in PNG are those who live rurally and women. It calls for a coordinated framework to advance connectivity, digital literacy, and promotion of digital opportunities.

[305] Oxford Business Group 2015
[306] UNCTAD 2018
[307] UNESCO 2015

Rural and remote communities have less access to the internet and digital services including education, banking and business opportunities and being offline hampers regional development of digital skills.[308] It is estimated that up to 85% of PNG's rural-based population remain unconnected. The often-hilly terrain, makes mobile and broadband receptivity unreliable, or unavailable and travel to urban centres is difficult.

A priority for PNG is to maintain focus on improving connectivity for communities in remote and rural areas, promoting both household and business use (encouraging the development of enterprises in the informal economy including agriculture) and lifting awareness about potential digital benefits. Improvements in connectivity and skillsets also have implications for micro enterprises and the ability for anyone with a mobile phone to connect with buyers and sellers in other markets, build and showcase their brand, and even take advantage of intellectual property protections. For example: producers of Wosera bilums, Sepik River masks and highlands coffee could expand their market reach in Port Moresby and link up with supply chain partners to reach customer bases in places such as Australia, China, Japan and the US. Eco-tourism providers in Kokopo, along the Kokoda Trail and elsewhere in PNG could with digital training attract a new wave of visitors through digital channels and show them all that the "land of the unexpected" has to offer.[309]

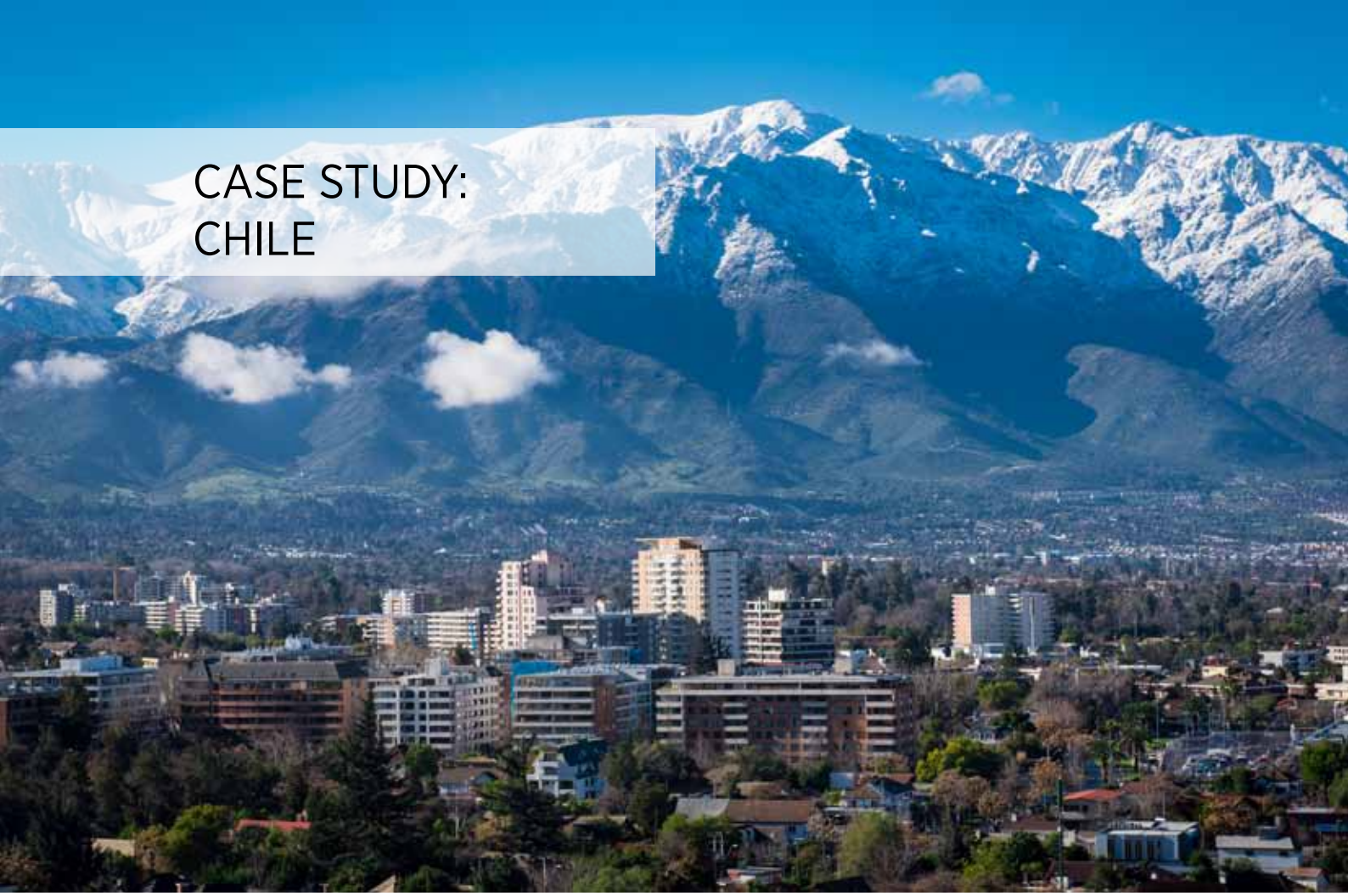
This is also linked to the focus on ensuring the availability of education across the country, including to disadvantaged rural and remote areas and consider innovations such as remote interactive teaching (mobile and broadband compatible) or solutions that require less data and speed or catering for offline modes to make online learning more accessible to remote users.

Women are the poorest, least educated and digitally literate members of PNG society, with limited time to spend on education and career development in the face of pressing family responsibilities. Attitudes around appropriateness of women accessing digital content and online safety, drawn from cultural taboos, further impede women's access to digital tools and digital literacy. Incidence of domestic and community violence makes travel insecure and can also limit women's access to education and career opportunities and hamper participation.[310] In the 2011 PNG census, only 27% of women participated in the labour force and formal employment – in economic terms, women represent an underutilised source of labour and potential productivity.[311] The ongoing exclusion of many women financially and educationally hinders the development of skills, particularly digital skills that would support the development of female digital entrepreneurship.

APEC will continue to offer PNG valuable opportunities to bridge the widening digital divide evident in the region. PNG is well placed to benefit from the diversity that exists in digital and related HRD terms across APEC's 21-member economies and draw on the resources and experience of larger developed economies in APEC such as the US, Australia, Japan and Korea to better adapt to the emerging technologies in the changing world of the digital age. PNG can benefit from external, expert and trusted advice on how to make improvements to policy and practice to solve some of its HRD challenges and realise digital innovation benefits.

Port Moresby has a small but thriving entrepreneurial community and the government has expressed its support for the use of new technologies including blockchain and mobile money. To make the most of digital innovation opportunities, PNG and APEC officials should continue to look for opportunities to plug education and skills gaps vital to empowering people to work and thrive in the modern, digital economy. This will complement strong GDP growth, positive infrastructure developments that are improving both fixed and mobile internet access, and the increasing penetration of mobile and even smart phones to further encourage the development of digital activity.

[308] RMIT 2017
[309] Bollard A (https://postcourier.com.pg/png-apecs-digital-development/)
[310] Nixon 2018
[311] Deloitte 2017



CASE STUDY: CHILE

In 2019, Chile takes the APEC Chair and has indicated as the APEC host that priority issues for consideration will include: finding the best paths for regulation of the digital economy and services, boosting widespread regional connectivity, and increasing the participation of women in the economy and international commerce. Recognised as one of Latin America's most prosperous, economically and socially stable nations, with a high-income economy and high living standards, Chile's economy has grown at an average rate of 4% per annum since 2000.[312] However Chile's recorded GDP was 1.6% in 2016, down from 6.1% in 2011, predominantly due to declining copper prices.[313]

Chile is a leading 'adopter' economy in digital terms. In the past two decades, Chile has had substantial success in implementing policies, actions, and national practices to drive infrastructure and material access to the internet and ICT. In quantitative terms, Chile has realised substantial increases in growth due to ICT and infrastructure investments.[314] Chile ranks 19th in the *Inclusive Internet Index*[315] with;

- 77% Internet penetration and annual growth of 8% or 1 million internet users.[316]
- Cellular Data internet speeds ranging from 15 Mbps up to 19 Mbps.[317]
- 162% increase in 4G data subscriptions - 80% of Chilean internet access.[318]
- Mobile subscribers of around 64% of the Chilean population.[319]

[312] OECD 2018c
[313] Oxford Economics 2018
[314] GSMA 2017
[315] OECD 2018e
[316] CONICYT 2018
[317] OECD 2018f
[318] Ibid.
[319] Ibid.

The progress in providing information and connectivity technology has established a solid foundation for a digital economy. Chile has a tranche of policies with concrete goals and commitments to expand the access nationally, increase awareness about safe use of ICT, and ensure Chile sustains its technological leadership in the region, including: The National Digital Agenda, and the Productivity and the Innovation and Growth Agenda and National Cybersecurity Policy.

One priority is to expand ICT infrastructure to underserved territories with high speeds and at reasonable prices. Chile's digital agenda is to double the internet penetration to 80% in 2020, while lowering the average price of ICT services. Other important objectives include providing free public Wi-Fi to 100% of communities, increasing high speed connections, lowering piracy, increasing ICT sales as a proportion of GDP, integrating ICT technology in all areas of education and encouraging the digitization of public services as well as e-commerce in SMEs.[320]

The strong progress has enabled wider interest in adopting technologies for data management and storage, particularly cloud adoption, which are critical to allow Chilean industries to tap into the economic benefits of IoT and big data. Chile is lifting the levels of fixed broadband subscriptions and 4G coverage towards the levels that foster competition with frontrunner economies in these areas. Currently at 20%, Chile's fixed broadband subscription is moving forward towards the threshold level of 35% and whilst 4G coverage is nudging 30%, with strong MBB subscription and smartphone penetration rates, it is predicted that by 2020, 4G LTE will make up over 60% of all mobile connections in the country and total nearly 15 million connections, nudging the 75% coverage is required to compete with frontrunners economies.[321]

Chilean industry, notably in the resourcing and services sectors, is beginning to implement Cloud to enable the use of big data and analytics, automation, AI and the Internet of Things (IoT) to increase efficiency, productivity and global competitiveness. Chile's industry structure has traditionally been dominated by mineral resources, agricultural raw materials, and forestry. The economy is still led by copper refining, nitrate products, iron smelting and steel production, oil refining, cement, chemicals, timber and pulp, furniture, and various wood products. There is also a large textile, clothing, and leather industry concentrated in the urban centres. However, Chile's service sector is growing at rates that will outpace that of goods, the country´s traditional stronghold.

Digital progress and access have also made Chile an attractive base for local technology start-ups and ICT solutions providers.[322] The Chilean Ministry of Economy and the Production Development Corporation, established Start-Up Chile in 2010 to create a supportive environment for entrepreneurial innovation.[323] The program has been recognised as one of the leading accelerator programs in the world and by the World Economic Forum for being "the most innovative country for early stage entrepreneurs".[324] Chile is ranked as one of the top 10 countries with the highest percentage of adults who are either starting a business or have run one for less than 3½ years.[325] It has the 3rd largest number of start-ups in Latin America, 80% of which are registered in the capital, Santiago.[326] The development of human capital with the requisite hard and soft skills is critical.

[320] Huawei 2017
[321] Ibid.
[322] Ibid.
[323] GEM 2017b
[324] Ibid.
[325] Ibid.
[326] OECD 2016d

Meanwhile, Chile's SMEs, predominantly micro-enterprises, represent over 95% of all enterprises nationally and employ 57% of the business sector labour force. These start-ups and SMEs require suitably skilled employees to take full advantage of unfolding digital opportunities.

Chile is poised to realise substantial benefits from digital transformation but there are signs of barriers to industry taking advantage of the fourth wave of the industrial revolution.[327] One recognised limiting factor is the supply of digital and other relevant skills in the labour force, aligned with the capacity of the education system to respond to this challenge. The gap between the demand for digitally proficient employees is also growing faster than the supply of qualified workers, and the current digital skills gap is predicted to widen unless action is taken. Only 48% of Chilean employees have adequate training and skills for technology development in their workplace and only 39% have access to the latest technology.[328]

Lack of digital skills was also the primary factor cited as an impediment to digital inclusion in Chile, ahead of safety and privacy.[329] Chile has recognised the requirement for ambitious HRD to meet the challenges of digitalisation.

With the rapid advancement in technology, there is a need to prepare the current workforce for the change in skills needed to undertake the jobs of the future once mining moves toward automation and jobs are lost.[330] Preparing for the current and upcoming digital era, the Chilean government has invested in efforts to improve human capital development within the labour market.[331] With large reliance on the mining industry, Chile faces potential job shortages in the future as automation is introduced.[332] Labour market currently ranked 23rd globally. [333] CONICYT acting as an implementing agency has allocated over US$205.8 million to finance training of advanced human capital and research.[334]

[327] OECD 2018c
[328] Oxford Economics 2018
[329] GSMA 2017
[330] OECD 2018e
[331] CONICYT 2018
[332] OECD 2018f
[333] Ibid.
[334] Ibid.

Chile has been at the forefront of education reform in Latin America over the past two decades, undertaking successive reforms to lift access and relevance of education, including with subsidies, scholarships, vouchers and credits to allow access to disadvantaged groups. Chile has increased education coverage through innovative allocation of resources, policies, regulations and service support. Access across K-12 and in tertiary and vocational education courses has been positive. Chile's numeracy and literacy rankings have steadily improved to lead Latin America. Enrolment rates in higher education in Chile increased by 17.5% between 2012 to 2015 and the gap between this and GDP is also increasing and expected to continue to do so (Figure 6.1).[335]

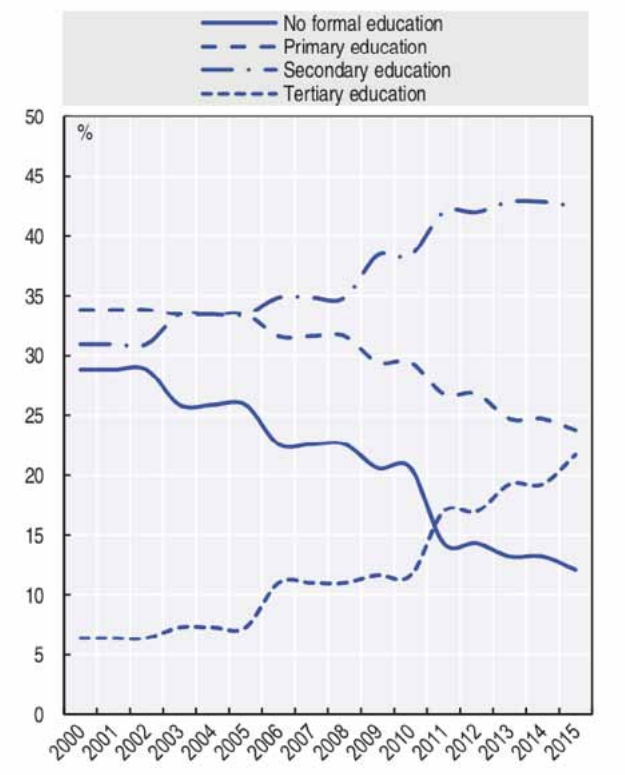


Figure 6.1: Chile – Evolution of Labour Force by Education Level up to 2015.[336]

More recently, Chile has committed further education initiatives to lifting quality of education provided and to support digital adoption and innovation, recognising indicators that programs were not aligned with the emerging skills requirements for the future workforce.[337] Reports showed that only 3% of graduates had the skills to take up ICT fields, with a dire 1% entering STEM fields.[338] Chile's student population are currently pursuing degrees that are not in areas that target skills requirements for future competitiveness substantial talent gaps are predicated.[339] This skills gap hampers the capacity for the business sector to take advantage of digitisation and uptake of new technologies allowing innovation and connection to global production systems.

In 2018, the Government has emphasised the teaching of computing and digital skills to Chile's students, so the country can be a future digital leader. In July 2018 the Ministry of Education launched the National Digital Language Plan. Emphasis has been placed on lifting awareness of digital opportunity and interest in digital education opportunities. Announcements included: the investment of 140 million U.S. dollars to expand Google's Chilean data centre, the only one of its kind in Latin America; the linking of some 2,000 Chilean schools and half a million students with the 'The Hour of Code', an initiative by the U.S. foundation, Code.org.

[335] OECD 2017a
[336] OECD 2018f
[337] Ibid.
[338] Ibid.
[339] OECD 2018e

and the announcement by the Chilean Ministry of Education (MINEDUC) has launched a new partnership with Discovery Education, the leading provider of digital content and professional learning for Primary and Secondary classrooms, supporting the new Me Conecto para Aprender (I Connect to Learn) initiative to use technology to create digital learning.

Policies and programs have also been emphasised to train the teachers and trainers. A major concern for the Chilean government is the implementation of policies and initiatives to address the capabilities and quality of teachers. Currently many teachers lack the necessary skills and knowledge required to deliver to the national curriculum. There is a pressing need to focus on improving teacher's capability in mastering theory and practical skills to keep pace with the digital environment.[340] Initiatives to assist teachers in development of skills for ICT to prepare teachers for educating the workforce of the future include.

- The Centre for Innovation and Teacher Development - Universidad Católica de la Santísima Concepcion program has been established to provide training, research and the capacity to assimilate and generate new information.[341]
- Enlaces Program was launched by Ministry of Education to align pedagogical practices such as nurturing relationships, curriculum decision-making, teaching and learning with the enhanced use of ICT as a tool for skills development for teachers and students. Using digital technologies and training tools Enlaces enables teachers to apply digital technologies in the class room. Webquest uses active communication through web-logs; automatic generation of selection tests; creation of virtual communities and formation and publication of websites.[342]
- Innovative Teaching for Deeper Learning Program to make education stakeholders aware of new technologies and provide them with the skills to incorporate technology in the learning process, improving the quality of teaching and education. Currently in use at the Diego Portales University the program is being used to exchange information, reflections and questions about education practices, through interactive seminars on specific topics. The program offers support to technology using training tools, learning modules, competency maps to incorporate technology into the process of learning.[343]

Chile faces three challenges in delivering equitable digital education to citizens; [344]

1) Policy to guide education providers to improve learning outcomes for vulnerable students from poor families;
2) Lack of monitoring of academic learning outcomes and achievement for socio-economically disadvantage students at regional and provincial levels; and
3) Ensuring disadvantaged students are gaining access to government funds available.

Chile is now in a strong position to build on the foundations laid through implementation of policies that have driven infrastructure development and material access to the internet and ICT. The introduction of entrepreneurial support programs within Chile have benefitted private sector growth and facilitated new innovations. However, to further support this emerging digital landscape, development of human capital is now critical to ensure the gap between supply and demand for digitally proficient and qualified workers is reduced. This is vital to ensure the private sector has access to an adequate supply of digital and other relevant skills in the labour force to support innovation activities. To achieve this, collaboration between policy makers, the private sector and educational institutions in defining relevant human resource skill requirements is needed to meet the challenge of digitisation and ensure Chile's education policies are better aligned with private sector needs and aid Chile's ongoing digital development.

[340] ODI 2014
[341] OECD 2018f
[342] Ministry of Education 2015
[343] Ministry of Education 2015
[344] OECD 2018f

CONCLUSION

Digital innovation is affecting life, social interaction, work, learning, government and business in all APEC economies and will continue to do so. It is enabling positive transformations on many fronts and APEC recognises the significance of digital innovation for prized economic growth, prosperity and social inclusion. However, APEC Governments are facing pressure to provide adequate systems to provide the educational qualifications, skills and competencies for existing and future workers to meet the needs of industries adopting emerging technologies and digitalisation.

Findings from the research highlighted the vital importance of digital capability and skills development. All APEC economies are finding rapid digital innovation challenging in terms of providing policies that support labour market adaptability, employment, life-long learning and workforce participation. However, there is a widening digital and educational divide within APEC that is obstructing the achievement of APEC objective of sustainable and inclusive growth in the region.

As demand for digital skills grows many economies aren't keeping pace with development of capability to support digital innovation, now nor in the future. In many economies within APEC digital literacy is lagging and increased awareness of the benefit digital technology brings is needed to increase societies uptake. Digital literacy needs to be a fundamental part of all education curricula and introduced at an early age and adequate training should be provided to teachers who are not always equipped with adequate digital skills to support needs.

The need for social inclusion has been recognised by governments throughout APEC including measures to remove many of the barriers to social inclusiveness in digital innovation particularly for women, indigenous groups, the elderly, workers in the informal economy, rural and remote populations. A strong focus needs to be placed on developing programs that meet the needs of the target community by involving them in the development of solutions.

This report has identified trends and findings, sought to highlight the challenges and opportunities for human resource development arising from digital innovation and provide recommendations based on these findings throughout the report. Detailed below are the key recommendations that have been selected from this report:informal economy and rural and remote populations) can access the internet, are aware of digital opportunities and can access STEM and digital education, and innovative on-the-ground projects that foster digital businesses.

KEY RECOMMENDATIONS

1. *Policy makers should focus on enabling HRD to keep pace with digital innovation and take advantage of opportunities the 4th Industrial Revolution brings.*

2. *APEC economies should maintain efforts to establish enabling environments for the uptake of digital innovation, including: aggressive investment in connectivity infrastructure, and exploring the potential of leapfrog and other innovative technologies to help emerging economies shrink the digital divide.*

3. *Priority should be on social inclusivity policies to lift awareness of digital innovation, uptake and utilisation in life and business across economies.*

4. *Identify measures to ensure vulnerable groups (women, indigenous, elderly, workers in the informal economy and rural and remote populations) have access to digital infrastructure including internet technologies, are aware of digital opportunities and can access STEM and digital education, and innovative on-the-ground projects that foster digital businesses.*

5. *Considering various levels of development amongst APEC economies, efforts should continue to strengthen the capacity for members (in cooperation with partners) to share information and develop joint capacity-building programs, projects and initiatives to promote best practice HRD. This should include focus on innovative approaches in education, training and enterprise-based systems to develop the technical, specialist and soft skills needed in the digital age.*

6. *APEC economies should act to enhance collaboration between government, academia and industry to ensure positive development of appropriate curricula, qualifications, domestic/local/sectoral skills recognition frameworks, and standards.*

7. *APEC economies should continue to focus on targeted demand-driven institutional capacity building to ensure that education, vocational and enterprise-based training systems can apply digital and ICT innovations to deliver education and training, reform curricula to improve technical and soft skills, foster a culture of life-long learning, establish micro credentials and digital badge concepts for targeted accreditation, and introduce campaigns to encourage enrolment in STEM and ICT courses, including by women.*

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