Challenge 9
Making the Best Use of Digital Technology **to Improve People's Quality of Life**

Titik Anas and Bambang Irawan

Presisi Indonesia

Introduction: Digital Technology and Our Lives

Digital technology allows a large amount of information and data to be stored in a virtual space, which can be accessed and shared in a quick and effortless manner at a relatively low cost. These developments have led to a relatively low adaptation cost of digitisation, which in turn has revolutionised our way of communicating in integrated connection networks. Digitisation has structurally transformed our economy and society (ITU, 2017).

Based on a study by the Asian Development Bank and the World Economic Forum (2017), Industrial Revolution 4.0 is shaped by the technological advancement in artificial intelligence (AI), robotics, biotechnology, block chains, quantum computing, and 3D printing. In this regard, AI is the cornerstone of most underlying digital technologies, especially robotics. The development of AI, supported by interconnectivity from the Internet of Things (IoT), will allow the production process to be automated using intelligent machines coupled with self-learning features (machine learning). This improvement will allow manufacturers to produce highly complex products or improve the quality of existing products. Meanwhile, biotechnology offers improvements to products that are related to or use living organisms in their construction, such as medicines, foods and beverages, biofuels, and other related products. 3D printing has been widely incorporated into the product design process, although its mass production capability is still far from adequate. In addition, quantum computing serves as a new tool for running new types of algorithms that are more powerful and holistic relative to previous technology. Quantum computing is expected to bring further breakthroughs in the development of new technologies, systems, and AI. On the other hand, blockchain technology has been recently utilised to integrate records and information storage into secure networks. These developments are still being rapidly improved, thus revolutionising the whole business process.

Several studies have evidenced the apparent benefit of the adoption of digital technologies. A report by the World Economic Forum (WEF) in 2018 shows that investment in digital technologies (i.e. robotics, mobile and social media, IoT, and cognitive technologies) generates an increase in the earnings of industries. Qu, Simes, and O'Mahony (2017) estimated the contribution of digital technology (i.e. mobile phone and Internet usage) to gross domestic product (GDP) from 2000 to 2014. Although their results vary between countries, they show conclusive evidence that mobile phone usage proliferation contributes to between a 1% and 4.1% increase in GDP per capita growth, while Internet usage proliferation contributes to between a 0.9% and 9.9% increase in GDP per capita growth. In the specific case of Indonesia, Pangestu and Dewi (2017) also estimated the effect of mobile and Internet penetration as a digitalisation proxy for labour productivity in Indonesia.

Despite the advantages, the digital revolution has structurally changed the labour market composition, and some types of jobs may cease to exist because of automation or other labour-displacing technologies. An extensive amount of studies has shown that digital technology adoption, especially automation, diminishes the role of routine and manual tasks and enhances the function of non-routine and specialised tasks (Autor and Dorn, 2013; Autor, Dorn, and Hanson, 2015; Autor, Levy, and Murnane, 2003; Acemoglu and Autor, 2010). There is strong evidence of the changes in the labour market structure in both developed countries and developing countries, such as the United States (Autor and Dorn, 2013; Firpo, Fortin, and Lemieux, 2011; Autor, Katz, and Kearney, 2006), France (Harrigan, Reshef, and Toubal, 2016), Egypt (Helmy, 2015), India (Berman, Somanathan, and Tan, 2005), and other countries (Berman and Machin, 2000; Autor and Solomons, 2018; Goos, Manning, and Solomons, 2009).

Further evidence has shown a germane conclusion to the latter studies. Frey and Osborne (2017) estimated the probability of being replaced by computerisation or automation. They observed that the least susceptible jobs to automation are mostly jobs related to specialised, personalised, and complex tasks, while the most susceptible jobs are mostly jobs related to routine, manual, and simple tasks. However, the labour-destroying effect will be balanced by emerging new jobs because of technology adoption. Acemoglu and Restrepo (2018) proposed the theory that in the long run new occupations with new tasks related to digital technology adoption will emerge and replace obsolete occupations. This theory is also further evidenced by several studies, especially for developed countries (Autor and Solomons, 2018).

In other cases, digital technology adoption also improves the livelihood of society. The widespread use of mobile phones and the Internet has contributed to a major improvement in agriculture, fisheries, tourism, education, and healthcare. The adoption of mobile phones in agriculture has shortened the supply chain by giving direct linkages from farmers to consumers, yielding higher profits for farmers and lower costs for consumers. The increased connection has enabled information sharing between fishermen and farmers alike, which creates the sharing of information related to the prices of products, market shortages, and other market information. This improves efficiency and provides a solution to the longstanding problems of market failure in the agricultural and fisheries sector. The tourism sector has also started to utilise information and communications technology (ICT) to provide real-time information about tourist destinations. Hotels and restaurants can also advertise with the addition of digital platforms related to tourism activities. Digital technology has been further utilised in healthcare as telemedicine, collaboration with offshoring doctors or medical specialists, and improvements in drugs. As for education, digital technology has gained a pivotal role in increasing the credibility and usefulness of distance learning, where distance learning can be utilised more to provide access to quality education in obscure and developing regions.

It is difficult to predict the future movement of digital technology towards 2045 as it is currently still rapidly developed and will indubitably be developed further in the future. However, there is a definite trend of increasing integration of digital technology in all elements of livelihood in society. Nevertheless, Indonesia and Japan should be more prepared and deepen their cooperation to seize the opportunities presented by digital technology adoption. Both countries also need to brace for the structural change in the labour market as a result of digital technology adoption. Robust labour market policies, retraining programmes, and education policies will be critical in managing the changes and smoothing the impacts on the labour market.

The next section presents in detail digital technology in Japan and Indonesia and both governments' plans to develop and integrate digital technology into all aspects of society. Subsequently, we will discuss the application of digital technology in higher education. This chapter concludes with ideas on how both countries can cooperate to gain further benefits from digital technology.

Japan and Digital Technology

Current Readiness

Japan is one of the most developed countries in terms of ICT infrastructure and is even relatively higher than other developed countries. In terms of mobile broadband subscriptions, Japan led amongst other Group of Seven (G7) countries in 2017 with 157.4 subscriptions per 100 inhabitants, significantly higher than the Organisation for Economic Co-operation and Development (OECD) average of 101.8 subscriptions per 100 inhabitants. In terms of fixed broadband subscriptions, Japan is relatively comparable with other OECD countries with 30.8 subscriptions for every 100 inhabitants. Japan also has a robust infrastructure for Internet servers, with around 5,980 secure Internet servers per 1 million people in 2017, around 71% higher than the world average of 3,528 servers per 1 million people, although the figure is low compared to the OECD average. Considering the numbers, it is quite certain that Japan's ICT infrastructure is mature enough and well prepared to develop the digital economy.

However, in terms of utilisation, Japan is quite lacking relative to other developed countries, especially compared to OECD countries. While broadband subscriptions in Japan are significantly high relative to other developed countries, the access for households and individuals is significantly lagging. In 2009, only 67% of inhabitants in Japan had access to the Internet. This was far below the level of several developed countries, most notably the Republic of Korea (hereafter, Korea), which had around 94% Internet access, and some European countries, such as Ireland, the Netherlands, Sweden, Norway, and Denmark, all with over 80% Internet coverage. On a side note, however, Japan has an increasing trend for Internet access, with around a 3% increase on average from 2005 to 2009. In 2010, households with broadband access in Japan were also significantly lower than several OECD countries, such as Korea (which had the highest level of access at 97.5%), Iceland, Norway, Sweden, the Netherlands, Denmark, and the United States (US). This result is peculiar since the share of broadband subscriptions in Japan is one of the highest amongst developed countries by a significant gap. Meanwhile, access to computers from home in Japan decreased from 2009. In 2016, access to computers from home decreased to 73% coverage, which was below most OECD countries. However, there was probably a substitution effect regarding computer usage since mobile subscriptions are increasing. There is an increasing tendency for people to use mobile devices rather than using personal computers due to accessibility issues. In general, even though Japan has high ICT utilisation, it is still lacking when compared to other developed countries.

On human capital readiness, Japan is also prominent. In 2016, around 50.5% of adults aged 25–64 years had completed tertiary education. This percentage is undoubtedly high even compared to other developed countries. Amongst OECD countries, Japan ranks second in terms of its adult education level, surpassed only by Canada. For adult education, around 60% of young people (aged 25–34 years old) in Japan have a tertiary education level, a share which is surpassed by Canada and Korea. Japan has also relatively educated elders, and only around a 20% gap persists between the education levels of youngsters and elders (aged 55–64), where 40% of elderly people in Japan have tertiary education. The high level of education is also accompanied by a high rank in STEM according to the PISA ranking, effectively making Japan one of the most prepared in facing the digital economy era. Japan's demographic issues are unlikely to hinder the development of digital technology given the large share of educated elders.

Given the robust development of infrastructure and human capital, we can expect to find that the level of research is significantly higher than in other developed countries. By looking at gross domestic spending on research and development (R&D) relative to GDP, Japan has a share of 3.1% of GDP as R&D spending, which is significantly higher than the OECD average of 2.35%. The number of researchers in Japan is also relatively higher than the OECD average, with 9.95 researchers per 1,000 people in 2016. Moreover, Japan's innovation output remains strong. Looking at patent data for 2015, Japan accounted for 17,361 patented innovations. This level of patents is the highest in the world and the country is the largest contributor of patents amongst OECD members. To summarise, Japan ranks highly in research and patents.

With its high level of innovation, Japan remains technologically competitive compared to the rest of the world.

Challenges for Japan

Although Japan has excellent readiness and implementation of the digital economy, there are still several challenges, most notably in AI development and productivity issues that stem from the ageing population.

Japan's AI development has been lacking relative to other developed countries and even China and India. In terms of AI innovation, only 2% of research papers in AI come from Japan. Most of them come from developed countries (the US and the European Union) and China (Lundin and Eriksson, 2016), although Japan has one of the highest innovation levels. Moreover, Japanese companies have been relatively sluggish in taking advantage of AI. This fact is also reinforced by the lack of Japanese corporations at the forefront of innovation in the AI field. Based on a list of 100 leading companies in AI by Fortune, most innovation in AI comes from foreign companies, mostly US companies, with only two firms on the list originating from Japan.

This issue is exacerbated by the low IoT utilisation by Japanese companies. IoT utilisation in Japanese companies only reaches around 20%, which is relatively low when compared to the US with a utilisation rate of around 40%.[4]

Japan's issue presents a unique case since Japan is one of the leading countries in robotics development, yet this has not been accompanied by the development of AI.

In addition, productivity has become a crucial issue in Japan due to the ageing population. Japan has a clear labour shortage problem in its economy since the growth of productive workers has diminished. Based on research by the McKinsey Global Institute (2015), Japan's working age population will decline from 79 million in 2012 to 71 million in 2025, and its dependency ratio will increase from 0.60 to 0.73 over the same period. Furthermore,

---

[4] Referenced from https://mainichi.jp/english/articles/20180803/p2g/00m/0bu/047000c.

Japan's labour productivity growth has stagnated below 2% for the past two decades, compounded with the decline in capital productivity (the return on investment of listed non-financial companies in Japan is 23% below that of US companies). In this case, Japan needs to devise a solution for increasing its productivity and finding a new catalyst for economic growth. This problem raises urgency for the Japanese government in accelerating the development of AI to reinforce its labour productivity.

How Can Japan Catch Up?

Japan's outstanding ICT infrastructure is pivotal to the foundation of the country's digital technology reform. As shown in the previous section, Japan's ICT infrastructure is mature and on par with other OECD and developed countries and complemented with a high education level. These advantages are also coupled with low digital trade restrictiveness (Lee–Makiyama, 2018) since at least half of all trade in services is supplied via the Internet. All these aspects have led Japan to have a robust position in the digital economy.

Japan has also successfully managed to secure a major role in the digital technology business. Even with modest development in AI, Japan has managed to become one of the world's leaders in robotics development. In addition, the EU–Japan Centre for Industrial Cooperation (2015) has also noted the maturity of the use of digital technology in the business sector. The Internet usage rate amongst enterprises in Japan reached 99.9% in 2013, and e-commerce consumers reached 77 million with a market size of around €104.29 billion in 2014, accompanied by 7.1% growth between 2013 and 2014. Japan's e-commerce has also reached a noteworthy share of overseas transactions, with 10.2% of Japanese online consumers from overseas websites, mostly from the US and China. Japanese companies such as NTT DoCoMo and SoftBank have also committed to developing IoT and integrating IoT applications into their businesses.

The Japanese government has carried out several initiatives during this momentous revolution. One of the most thorough initiatives from the Japanese government is their plan for AI development. Realising the struggle with the AI development, the government has initiated a roadmap for the development and commercialisation of AI and established a Strategic Council for AI Technologies in 2016 (MIC, 2017). The development is divided into three phases. The first phase is the utilisation and application of data-driven AI in various domains. The second phase, which is planned to start in 2020, is to propel the public use of AI and data developed across various domains. Lastly, the second phase, which is planned to start between around 2025 and 2030, is to build an ecosystem by connecting multiplying domains. The roadmap also prioritises on productivity, healthcare and welfare, and mobility as the industrialisation plan to prepare for Industrial Revolution 4.0. Another notable initiative by the Japanese government is Society 5.0, in which the government has prepared a plan to converge cyberspace and physical space to solve social issues and promote economic development. In addition, the government also plans to increase its science and innovation budget by ¥900 billion by 2020.

The growth of the AI market potential in Japan is promising. The Ministry of International Affairs and Communication of Japan has forecasted that the economic impact of AI in Japan is predicted to be ¥121 trillion in 2045 (Harris, 2017). In addition, the E&Y Institute has predicted that the AI market will grow to ¥23 trillion in 2020 and ¥87 trillion in 2030 (Lundin and Eriksson, 2016), with the largest contribution to the transportation sector followed by the wholesale and retail and manufacturing sectors. On the other hand, Japan also has globally competitive market players in AI and has been able to attract several major global AI companies to invest in Japan. Amongst the notable Japanese companies are NEC in public safety-related AI development; Fujitsu and Toshiba in manufacturing-related AI; Hitachi in machine learning; Mitsubishi and Sharp in robotics and AI; and Sony, NTT Group, SoftBank, and many more. Meanwhile, foreign companies that are active in AI development in Japan include Zen Robotics, IBM, and YouAppi.

Society 5.0 is another extensive and long-term Japanese government initiative targeted at the convergence of cyberspace and physical space.[5] It aims to improve lives by utilising the function of AI in cyberspace, which will be expected to surpass human capabilities, to give high value-added information, proposals, machine instructions, and production processes. Different from the usual common practice, which is to store information that is then utilised by people, Society 5.0 aims to create a 'super-smart' society that lets people deliver information to virtual space to be processed, following which cyberspace sends instructions and analyses or gives suggestions to machines and people. Society 5.0 will be

[5] Referenced from http://www8.cao.go.jp/cstp/english/society5_0/index.html.

focused on healthcare, mobility, infrastructure, and financial technology. The seamless integration of processing is expected to bring efficiency and solve social problems.

Indonesia and Digital Technology

Current Readiness

In facing the digital economy, Indonesia has challenges but also untapped potential at the same time. The biggest challenges for Indonesia are ICT infrastructure and human capital. These are further exacerbated by the fact that Indonesia's R&D expenditure and R&D development have remained stagnant over several years. Compounding these problems, there is also a huge digital divide in Indonesia, especially when comparing regions and diverse demographic elements. Meanwhile, Indonesia has the aptitude to adapt to new technologies and untapped potential in the form of a large and rapidly growing domestic market, especially in e-commerce, and an emerging start-up environment.

Internet access in Indonesia is far below the world average. Only around 25% of the population had access to the Internet in 2016, much lower than the global average of 45% and even lower than the other ASEAN Member States. However, Internet access has grown rapidly since 2004 and is expected to still grow in the future.

Meanwhile, mobile cellular subscriptions in Indonesia have seen remarkable growth since 2000 and passed the world average by 2008 at 59 subscriptions per 100 people. In 2016, mobile cellular subscriptions in Indonesia accounted for 149 subscriptions per 100 people, which is significantly higher than the world average of 102 subscriptions. Mobile subscriptions in Indonesia are comparable to developed countries, and even surpassed those of Japan from 2012. We will see later that the high level of mobile subscriptions influences Indonesia's development in the digital economy.

Despite the encouraging level of mobile subscriptions, Indonesia's rate of fixed broadband subscriptions is still very low. The level of fixed broadband subscriptions remained below 2 subscriptions per 100 people from 1998 to 2016. This level is much lower than the world average of 12.47 subscriptions per 100 people. In addition, the growth rate of Indonesia's subscriptions has stagnated for two decades, while other countries have significantly higher growth rates in broadband subscriptions, even relative to other comparable countries like

Thailand and Malaysia. Furthermore, there is an enormous gap in the level of subscriptions between Japan and Indonesia, where Japan is much more prominent.

Indonesia is also experiencing a digital divide, where most of the access to the Internet and ICT infrastructure is concentrated in specific areas, especially in Java's urban areas. Nevertheless, even with low ICT infrastructure, Indonesia has fast adaptation and high savviness regarding digital technology, especially on the consumer side. This has resulted in a robust start-up environment in the big cities. E-commerce and the sharing economy are growing at a fast pace in Indonesia, mostly due to the high adoption of mobile phones and consumers' savviness with technology. Several start-ups have become competitive market players regionally in ASEAN, such as Go-Jek, which has started to expand its business to other ASEAN countries, such as Viet Nam; Bukalapak and Tokopedia, which are major players in ASEAN; and Traveloka.

Box 9-1. E-commerce

Indonesia's recent developments in the digital economy are defined by the e-commerce sector. Based on a report by McKinsey & Company (2018), Indonesia's e-commerce gross merchandise value in 2017 reached above US$8 billion, and the growth has been astoundingly high since 2015, at around 100% annually. Most shares of e-commerce sales were generated from e-tailing, which includes all transactions from online marketplaces, amounting to around US$5 billion. Meanwhile, transactions from social commerce, such as Facebook, Instagram, Line, and WhatsApp, also contribute to large e-commerce activities worth over US$3 billion. However, e-tailing's contribution to total GDP is still low, with only a 0.5% contribution in 2017.

E-commerce activities in Indonesia are also extremely vibrant, especially in Southeast Asia, as consumers are increasingly comfortable with utilising online marketplaces. Based on an iPrice Insights (2017) report on e-commerce in Southeast Asia, Indonesia has a significantly high usage share of mobile traffic for e-commerce activities. It had a staggering 87% share of mobile traffic in 2017, followed by Thailand and the Philippines.

People in Indonesia are also more willing to buy products after visiting a website or platform from an online marketplace relative to other ASEAN countries. Indonesia ranks second in conversion between accessing websites to purchasing products, surpassed only by Viet Nam.

The Digital Divide: A Major Concern for Indonesia's Digital Technology Adoption

Despite the vigorous state of e-commerce, Indonesia is plagued by the digital divide. To begin with, by observing the regional 2016 ICT Development Index, we can see there is a huge gap between Java and the eastern Indonesian regions. Papua and Maluku generally receive significantly lower scores relative to regions in Java, such as DKI Jakarta, DI Yogyakarta, Bali, and Banten. However, other regions outside Java are also found to have higher than average scores, such as several regions in Kalimantan. As the ICT Development Index is measured by access and infrastructure, ICT usage, and skill, it is obvious that ICT development is bogged down by the huge gaps in infrastructure development and education levels.

Uneven Internet coverage and download bitrate capacity further reinforce Indonesia's digital divide. Internet coverage is still concentrated much more in Java Island than in the other islands. Significant areas in Papua, Kalimantan, Maluku, Sulawesi, and Sumatera do not even have access to 2G. Meanwhile, 4G and 4G+ access is still highly limited, and 4G+ is only accessible in several urbanised regions in Java. On the other hand, the download bitrate capacity in Indonesia is extremely low, except for several regions in Java. In all areas in Papua, the download bitrate is still lower than 5 megabytes per second.

There is a massive challenge for Indonesia's digital technology development. The current ICT infrastructures have shown to be extremely inadequate, and the problem is coupled with a lack of education to prepare human resources to deepen the integration of digital technology. In short, the Indonesian government has a huge task in preparing its country to avoid getting left behind in the huge global digitisation wave. In its current condition, digital technology will only be utilised by a few groups of people, especially in the highly urbanised and developed areas of Java, and the development of digital technology in Indonesia will stagnate without extreme measures for improvement. Indonesia needs to focus on increasing its investment in ICT infrastructure (including electricity), address the regulatory impediments to ICT development, and increase investment in human capital, especially for digital skills.

Digital Technology in Higher Education

The role of ICT in higher education has been well documented. A study by the OECD (2016) shows how new innovations have influenced how lessons are delivered in higher education institutions. It describes how ICT technologies have allowed for greater learning experiences for both students and lecturers through the development of online (virtual) laboratories, greater collaboration amongst international participants in research and learning, and more interactive discussions and monitoring by the lecturers of the students' development, which have opened greater access to women and people with disabilities.

Indonesia established the Open University (Universitas Terbuka, UT) in 1984. It is arguably the first institution in Indonesia to offer distance education services and has become the leading institution in Indonesia providing education for people who cannot dedicate their time to attend traditional classes at the university level or for people living far from a physical university. Currently, more than half of the total students (62%) attend the faculty of teaching and education (FKIP), and the same percentage of them are actually teachers by profession. In the early stages, the UT packaged its learning materials in the form of printed modules for students to learn independently, supported by TV and radio programmes. With the advancement of technology, particularly ICT, the tutorials can take place online using the Internet, allowing for more interactive discussions between students and lecturers, and the materials are available in digital form. In addition, the UT now has its own YouTube channel, an online UT radio, and an Internet-based TV channel.

Given this development, the Indonesian government, through the Ministry of Research, Technology and Higher Education (Kemenristekdikti), has encouraged more institutions to develop their online degree programmes. Currently, there are 51 higher education institutions that are permitted to offer online programmes (19 public institutions and 32 private). Consumers will have more to choose from, access for everyone will become greater, and women and people with disabilities will benefit from higher enrolment rates.

Digital Technology in the Health Sector

Digital technology has also changed the way health services are delivered. E-health has improved the efficiency and effectiveness of health care provision (Kristianto, 2013). Electronic Health Records (HER) for example, have mostly been implemented in developed markets. However, the adoption of these digital records is costly.[6] PWC (2016) shows that the adoption of traditional EHR is still low in emerging markets, and Indonesia is amongst the lowest of the emerging countries. Apart from the cost, resistance from users is also an issue in developing countries. Jember Pulmonary Hospital in Indonesia, for example, implemented a computer-based digital system in 2005. However, it was not successful as the participation rate was too low. In 2013, the hospital modified its digital system using tablets and called the digitisation programme Hospital in Tablet (HoT) to increase the willingness of doctors to fill in the electronic medical records correctly, completely, and on time.

Nugraha and Aknuranda (2017) show the evolution of IT used in the health sector from satellite-based health services in the early years of digital health to mobile and Internet-based services, such as teleconsultation, telediagnosis, telecoordination, tele-education, drug databases, tele-biomicroscopy, and tele-education. Ariani et al. (2017) shows how m-health, defined as the use of portable devices (short messages or text messages, voice calling, and wireless data transmission) are used in delivering medical and public health services with the enormous potential to reduce costs, advance health information exchange, and improve healthcare access (Betjeman et al., 2013; Wittet, 2012). Although the use of digital technology in Indonesia has increased over time, as PWC (2016) describes, the adoption in general remains low.

In contrast, Japan has one of the highest levels of adoption of digital technology in healthcare services. The Japan Medical Association (2017) indicates that Japan adopted electronic medical records (EMR) in 1999. In 2001, the Japanese government allowed health institutions to use EMR without producing printed records at all. In 2006, ICT became the priority for the structural reform of healthcare policy. Japan has a national health database, including EMR data, insurance claims, and health check-up data. The World Health Organization (2018) indicates that Japan will implement an integrated community care system by 2025. The system will be basically a comprehensive system at

[6] The United States Congressional Budget Office (CBO) reports that, on average, EHR implementation costs for hospitals amount to approximately US$14,500 per bed with annual operating costs of US$2,700 per bed per year.

the community level that integrates prevention, medical services, and long-term care while also providing living arrangements and social care. The introduction of robots in the health sector is also reported by Deloitte (2017). Japan's Toyohashi University of Technology has developed Terapio, a robot that can carry out routine hospital tasks, such as making hospital rounds, delivering medications and other items, and collecting records. For now, the robot follows a nurse or other medical staff.

How Is Indonesia Catching Up?

The Indonesian government has initiated several plans to tackle the seemingly insurmountable issues. One of the most momentous plans by the government is the Palapa Ring initiative, which serves as a major improvement for ICT infrastructure, specifically in fibre optic extension.

The Palapa Ring initiative targets the construction of 36,000 kilometres (km) of fibre optic cables that connect all major Indonesian islands and integrate with existing networks. The initiative aims to cover 440 cities and municipals in Indonesia. Specifically, the Palapa Ring initiative also aims to build a fibre optic network in the eastern part of Indonesia (under the Palapa Ring-East plan) and integrate it with the existing networks in other parts of Indonesia in 2019. Palapa Ring-East will consist of 3,850 km of submarine cable and 600 km of land cable to cover 21 cities and municipals.

Outside of the Palapa Ring initiative, the Indonesian government has also made an effort to extend the fibre optic network through Telkom Indonesia, a state-owned enterprise in the ICT sector. In 2015, additional fibre optic cables in eastern Indonesia were built by Telkom Indonesia to connect Sulawesi, Maluku, and Papua under SMPCS Packet-1, and all around Papua, including the surrounding islands, under SMPCS Packet-2. In May 2018, Telkom Indonesia finished building a fibre optic cable network as a joint project with international and ASEAN consortia. The network connects Java, Bali, Sumatra, Singapore, Eastern Kalimantan, and Sulawesi under one network called the Indonesia Global Gateway system.

The broadband development efforts by the government will be crucial in preparing Indonesia for the adoption of digital technology as broadband infrastructure is still used as a pivotal foundation for the underlying development of all digital technologies. The improvement in broadband coverage to include all of Indonesia, coupled with the government's plan to reinforce education and skills, will allow Indonesia to join the global digitisation wave.

Japan–Indonesia Cooperation

Digital technology is a new hope for Indonesia to accelerate the process of more equitable development as it will help narrow the development gaps between the more and less advanced parts of Indonesia. However, Indonesia is currently lacking the digital technology success factors: infrastructure and human capital. To address these issues, large investments are required, both in ICT infrastructure and human capital.

Based on the analysis in this study, we suggest that Japan and Indonesia can strengthen cooperation in several areas. First, Japan's overseas investment and development assistance can be channelled into ICT infrastructure development to allow Indonesia to close the digital divide more quickly. This will mutually benefit both countries – Indonesia can increase its ICT infrastructure capacity, and Japan can channel its investment into a fast-growing digital economy.

Second, Japan and Indonesia can work together to improve Indonesia's human capital, particularly improving the skills required to work with advanced technology and develop future technology, which are currently relatively scarce in Indonesia. Regarding higher education, drawing on one of the case studies we highlighted in this study, we recommend cooperation in improving Indonesia's quality of distance learning services. Distance learning has been and will be an important way of providing better access to education for people living in Indonesia's less developed regions. Specifically, we recommend cooperation with Japan for the content development of online courses. For vocational education, cooperation with Japan is also important. Learning about and potentially adopting the Japanese curricula might increase Indonesia's vocational training compatibility with industries' needs, particularly Japanese manufacturing in Indonesia.

Third, Indonesia should cooperate with Japan to learn from the country's advanced adoption of digital technology in healthcare services, such as integrated healthcare information systems. The integrated healthcare information system in Japan has improved the efficiency and effectiveness of healthcare services. In this study, we showed that some hospitals in Indonesia have implemented digital technology to improve the efficiency and effectiveness of their services. However, digital technology adoption is still rather limited. Cooperation with Japan would allow Indonesia to accelerate the establishment of an integrated system.

Last but not least, we recommend cooperation in R&D. With Japan's R&D in advanced ICT future technologies, collaborative and joint research projects between Indonesia and Japan's research institutions and universities will contribute to the greater involvement of Indonesia's research in future technology.

Taking into account Indonesia's digital divide, we also recommend that the cooperation between Indonesia and Japan should not only focus on the advanced regions of Indonesia, such as in Java Island, but also on the less developed regions.

References

Acemoglu, D. and D. Autor (2010), 'Skills, Tasks, and Technologies: Implications for Employment and Earnings', *Handbook of Labor Economics*.

Acemoglu, D. and P. Restrepo (2018), 'The Race between Man and Machine: Implications of Technology for Growth, Factor Shares, and Employment', *American Economic Review*.

Ariani, A., A. P. Koesoema, and S. Soegijoko (2017), 'Innovative Healthcare Applications of ICT for Developing Countries', *Innovative Healthcare Systems for the 21st Century*, pp. 15–70.

Autor, D. and D. Dorn (2013), 'The Growth of Low-skill Service Jobs and the Polarization of the US Labor Market', *American Economic Review*.

Autor, D., D. Dorn, and G.H. Hanson (2015), 'Untangling Trade and Technology: Evidence from Local Labour Markets', *The Economic Journal*, pp. 621–646.

Autor, D., L. F. Katz, and M. Kearney (2006), 'Measuring and Interpreting Trends in Economic Inequality', *AEA Papers and Proceedings*, 96(2).

Autor, D., F. Levy, and R. Murnane (2003), 'The Skill Content of Recent Technological Change: An Empirical Exploration', *Quarterly Journal of Economics*.

Autor, D. and A. Solomons (2018), 'Is Automation Labor-displacing? Productivity Growth, Employment, and the Labor Share', *NBER Working Paper*.

Berman, E. and S. Machin (2000), 'Skill-biased Technology Transfer around the World', *Oxford Review of Economic Policy*.

Berman, E., R. Somanathan, and H. Tan (2005), 'Is Skill-biased Technological Change Here Yet? Evidence from Indian Manufacturing in the 1990s', *World Bank Policy Research Working Paper*.

Betjeman, T.J., S.E. Soghoian, and M.P. Foran (2013), 'mHealth in Sub-Saharan Africa." *International Journal of Telemedicine and Applications*, pp. 1–7.

Deloitte (2017), 'The Hospital of the Future: How Digital Technologies can Changes Hospitals Globally', *Deloitte Center for Health Solutions*. https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Life-Sciences-Health-Care/us-lshc-hospital-of-the-future.pdf (accessed 1 September 2018).

EU–Japan Centre for Industrial Cooperation (2015), *Japan ICT Market Entry and Business Development Guide.* EU–Japan Centre for Industrial Cooperation.

Firpo, S., N. Fortin, and T. Lemieux (2011), 'Occupational Tasks and Changes in the Wage Structure', *IZA Discussion Paper*.

Frey, C.B., and M. Osborne (2017), 'The Future of Employment: How Susceptible Are Jobs to Computerisation?', *Technology Forecasting and Social Change*, pp. 254–280.

Gatra (2015), *Manajemen Rumah Sakit Tablet.* 11 August. http://arsip.gatra.com/2015-08-11/majalah/artikel.php?pil=23&id=159947 (accessed 9 November 2018).

Goos, M., A. Manning, and A. Solomons (2009), 'Job Polarization in Europe', *American Economic Review: Papers and Proceedings*.

Harrigan, J., A. Reshef, and F. Toubal (2016), 'The March of The Techies: Technology, Trade, and Job Polarization in France, 1994–2007', *NBER Working Paper*.

Harris, P. (2017), *Developments in Artificial Intelligence (AI) in Japan and Implications for Australia.* Tokyo: Australian Embassy, Tokyo.

Helmy, O. (2015), 'Skill Demand Polarization in Egypt', *Middle East Development Journal*.

Irawan, Y.S. and S. Soegijoko (2015), 'Sahabat Bundaku (My Mom's Best Friend): A Mobile Based Integrated System for Mother & Child Healthcare', The IEEE Region 10 Humanitarian Technology Conference (R10-HTC).

ITU (2017), *'Social and Economic Impact of Digital Transformation on the Economy', GSR-17 Discussion Paper, International Communications Union.*

Japan Medical Association (JMA) (2017), 'International Conference on Current Situation and Challenges of Health Database in Each Country: Security, Protection of Personal Data, and Utilizing of Data' Japan Medical Association.

Kristianto, E. (2013), 'E-Health di Indonesia', *Jurnal Universitas Kristen Krida Wacana*.

Lee-Makiyama, H. (2018), *Regulatory Assessment & FDI Review: The Digital Economy in Japan.* London: LSE Consulting.

Lundin, M. and S. Eriksson (2016), *Artificial Intelligence in Japan (R&D, Market and Industry Analysis).* Tokyo: EU-Japan Centre for Industrial Cooperation.

McKinsey & Company (2018), 'The Digital Archipelago: How Online Commerce is Driving Indonesia's Economic Development'. Jakarta.

McKinsey Global Institute (2015), *The Future of Japan: Reigniting Productivity and Growth.* Executive Summary, McKinsey & Company.

Ministry of Internal Affairs and Communications (MIC), Japan (2017), *AI Strategy and Related Activities in Japan (Overview).* Ministry of Internal Affairs and Communications.

Nugraha, D.C.A. and I. Aknuranda (2017), 'An Overview of e-Health in Indonesia: Past and Present Applications', *International Journal of Electrical and Computer Engineering (IJECE)*, 7(5), pp. 2441–2450.

Pangestu, M. and D. Grace (2017), 'Indonesia and the Digital Economy: Creative Destruction, Opportunities and Challenges', in *Digital Indonesia: Connectivity and Divergence*, pp. 227.

PricewaterhouseCoopers (PwC) (2016), *The Digital Healthcare Leap.* PricewaterhouseCoopers.

Qu, J., R. Simes, and J. O'Mahony (2017), 'How Do Digital Technologies Drive Economic Growth?', *Economic Record*, pp. 57–69.

Soegijoko, S, I.M Puspitasari, I.D Jani, and S. Suparno (2011), 'Implementation Experience of e-Prescription System in Developing Country: An Indonesian Community Health Renter Case', *The Electronic Proceedings of Med-e-Tel*, pp. 551–554.

World Economic Forum (WEF) (2017), *Digital Transformation Initiative in Collaboration with Accenture: Unlocking $100 Trillion for Business and Society from Digital Transformation,* Executive Summary. World Economic Forum.

World Economic Forum (WEF) and the Asian Development Bank (ADB) (2017), *ASEAN*

4.0: What Does the Fourth Industrial Revolution Mean for Regional Economic Integration, white paper. World Economic Forum.

World Health Organization (WHO) (2018), *Japan Health System Review.* World Health Organization.

Wittet, S. (2012), 'eHealth mHealth Reproductive Health', *Outlook*, 29(2), p. 8.