



Asian and Pacific Centre for Transfer of Technology

Contextualizing Transformation of Healthcare Sector in Asia-Pacific in the Post-COVID-19 Era

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ABBREVIATIONS

4IR	Fourth Industrial Revolution
AI	Artificial Intelligence
AR	Augmented Reality
B2B	Business-to-business
B2P	Business-to-patient
HPC	High Power Computing
ICT	Information and Communication Technology
ICU	Intensive Care Unit
LEAP	Licensing Experimentation and Adaptation Programme
MBS	Medicare Benefits Schedule
MNO	Mobile Network Operator
mRNA	Messenger ribonucleic acid
M-TIBA	Mobile Health Financing Technology Platform
LMIC	Low- and Middle-Income Countries
OECD	Organisation for Economic Co-operation and Development
R&D	Research and Development
VR	Virtual Reality
WHO	World Health Organisation

1. What is the Fourth Industrial Revolution?

INTRODUCTION

There is no standard definition for the Fourth Industrial Revolution (4IR). However, broadly, it refers to the ongoing societal transformations driven by digital and emerging technologies – such as drones, Artificial Intelligence (AI), blockchain, big data, High Performance Computing (HPC), mobile platforms, etc. – and, more importantly, their fusion which has blurred the lines between the physical, digital, and biological spheres¹.

It is called a “revolution” because these technologies represent fundamental changes in economies and our lives, from the way we live, connect, work, and give and receive education to how we manufacture and build sustainable economies. In a recent paper, the authors suggested that COVID-19 has turbo-charged this revolution – The 4IR is a new endless frontier (Kalenzi et al., 2020)) For instance, in the healthcare sector, 4IR technologies are at the forefront in the battle against COVID-19 for returning the global economy to some form of normalcy.

For example, AI and big data have recently been used in a range of measures against COVID-19, like fast-tracking vaccine development, repurposing drugs to treat patients, detection and containment of COVID-19 clusters, diagnosis, and treatment, etc. Moreover, blockchain technologies are being implemented to develop and launch contact tracing and vaccine passes that enable economies to open, as people return to office, schools, go to the gym, and watch movies. Telemedicine

applications are revolutionizing healthcare delivery – enabling healthcare service providers to treat and monitor patients from the comfort of their homes (Wosik et al., 2020). Many believe that the full scaling of telemedicine potential is a game changer in the fight against COVID-19 and future pandemics, including the much-feared Disease X² (Kalenzi, 2020).

However, it is not just the healthcare sector that is witnessing this transformation. There has been a transformation in the movement of people and good, supply chains, and manufacturing. In the education sector, digital tools, online/virtual platforms, AI, and big data saved the day when schools and universities were shut to control the spread of COVID-19 (Kalenzi et al., 2020). In short, every sector of our economies in rich or emerging countries is undergoing this transformation driven by 4IR technologies.

1.1 How is the 4IR reshaping the national innovation policy landscape?

Although this paper is about 4IR and healthcare, it is necessary to briefly review the changing policy landscape due to the ongoing digital revolution to give policy leaderships, especially in “catch-up countries”, a sense of urgency to rethink their innovation policies (OECD, 2019b). In a recent paper, the authors proposed that ongoing changes required nothing short of the “4IR New Deal”, that is, a systemic national reform that would enable countries to develop the 4IR technology capabilities needed to build more robust, resilient,

¹ See: Klaus Schwab “The Fourth Industrial Revolution: what it means, how to respond”, January 14, 2016, <https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/>

² “Disease X represents the knowledge that a serious international epidemic could be caused by a pathogen currently unknown to cause human disease. The R&D Blueprint explicitly seeks to enable early cross-cutting R&D preparedness that is also relevant for an unknown “Disease X”. Global.”

and sustainable healthcare systems and economies (Kalenzi et al., 2020).

However, this requires bold investments to upgrade and scale the digital (broadband networks, software platforms, devices, innovation ecosystems including education and training, etc) and power infrastructures at a national level, . Since the publication of the paper, many major countries have been pursuing “the great reset” of their digital and 4IR capabilities to build more resilient digital infrastructures for enabling better healthcare and economies. For example, the United States (US) just passed a 1.2 trillion-dollar infrastructure spending bill, part of which is for revamping their high-speed internet infrastructure, bridging the digital divide and providing low-cost access to the internet for millions of US citizens. This will provide better access to healthcare through telemedicine, education through online learning, e-commerce and supply chain systems, work from home infrastructure, and so on, to millions (Lobosco & Luhby, 2021).

Moreover, the bill follows another bipartisan 250-billion-dollar investment” to fund the “new endless frontier”. It includes massive investments and subsidies for the 4IR technologies, including 52 billion-dollars for semiconductors and other investments in technology research and development (R&D), subsidies to AI, robots, quantum computing, and training of a high-calibre workforce for the 4IR era (Ip, 2021).

Few other Asia-Pacific countries have recently pursued similar paths toward 4IR-powered economies. In 2020, the Republic of Korea launched a Digital New Deal to fund digital healthcare, AI, digital technologies, big data, and 5G networks, and provide support to other emerging technologies. The government is also

pursuing laws and standards to streamline, standardize, and open up all data to build an AI and big data driven economy.

Similarly, China is also pursuing 4IR agenda. In the words of President Xi, “In recent years, the internet, big data, cloud computing, artificial intelligence, blockchain and other technologies have accelerated their innovation and are increasingly integrated into the entire economy and society”. China needs to make its digital economy stronger and better to align the once-in-a-century transformation with the national priority of rejuvenating the country, he added³. (Time, 2020)

Other similar policies in the Asia Pacific include India’s Digital India programme for a 1 trillion-dollar digital economy by 2025, Singapore’s SG digital (Digitalising Singapore), and Australia’s Digital Transformation Strategy worth 1.2 billion Australian dollars⁴ for 2021.

Outside the Asia Pacific, Europe’s NextGenerationEU worth €806.9 billion will fund next generation digital infrastructure in Europe and create standards for sharing data and accelerate the development of AI and digital technologies. Another 2 billion Euros has been approved for the Digital Europe Programme⁵ to be invested in artificial intelligence (AI), cloud and data spaces, quantum communication infrastructure, advanced digital skills, and the wide use of digital technologies across the economy and society, by the end of 2022. Alongside this main work programme, the European Commission has published two specific work programmes: one on funding cybersecurity, with a budget of €269 million until the end of 2022; and the other on the setting up and operation of the network of European Digital Innovation Hubs, with a budget

³ See: <https://time.com/6108481/china-digital-economy-technology/>

⁴ See: <https://www.adnews.com.au/news/federal-budget-the-1-2-billion-digital-economy-strategy>

⁵ See: European Commission Press release, “Commission to invest nearly €2 billion from the Digital Europe Programme to advance on the digital transition”, https://ec.europa.eu/commission/presscorner/detail/en/ip_21_5863

of €329 million until the end of 2023". Additionally, Canada will also launch a Digital Government Strategy worth 2.5 billion Canadian dollars⁶ in 2021.

The great pivot towards the new industrial policy suggests that countries now view investments in the 4IR as a choice between building competitive and resilient economies in the "post-COVID-19 era" (Ip, 2021) or remaining in the lower ranks of global value chains. Despite these initiatives, mostly from developed economies of the Asia-Pacific, it still unclear whether developing countries, whose economies have been severely affected by COVID-19, can marshal such ambitious policies.

A brief review of the emerging 4IR policy landscape only serves to emphasize the ongoing changes, and a thorough analysis is beyond the scope of this paper. The authors' focus is on reimagining healthcare in the Asia-Pacific region using 4IR technologies. We recognize that countries in the Asia-Pacific are at different stages of digital development in terms of digital infrastructure, innovation ecosystems, human resources, and the supply of innovators and innovations. Hence, they have different capabilities for taking advantage of the 4IR technologies to build resilient healthcare systems. Simply put, some are advanced (4IR-ready countries) while others are 3IR countries along with a group that is hovering between 2IR-1IR stages.

Taking these asymmetries and differences into account, we dive into how COVID-19 and 4IR

must provide the impetus to shift to "hybridtact" healthcare systems in both advanced and emerging countries. The hybridtact healthcare systems are defined as resilient national healthcare systems that combine traditional (physical/contact) systems (such as hospitals), and digital healthcare systems (online/untact) (such as telemedicine, contact tracing, and pandemic passes) to provide citizens with better and accessible healthcare services. This paper proposes that all countries, advanced or not, must consider moving to hybridtact healthcare models. It is hard to imagine how countries can survive in the "living with COVID-19" era, without building more resilient healthcare systems that can withstand COVID-19 and future pandemics.

The concept of hybridtact healthcare is relatively new. Figure 7 lays out a more detailed description of various ways such healthcare system can be realized, including: 1) augmented healthcare systems i.e., adding technology pillars to healthcare systems to build resilience, e.g., contact tracing, vaccine pass, AI-chat bots, AI-diagnostics. 2) Fully Hybridtact model, where digital innovations are fully integrated in all healthcare services offerings, and finally 3) Online healthcare, where patients are given the option to receive healthcare in the comfort of their homes. Variations of hybridtact model is emerging in countries such as China for example Ping An (see detailed description in section 2.3).

In the next sections, the paper elaborates on the aforementioned issues in the healthcare and digital contexts of Asia-Pacific countries.

⁶ See: <https://www.newswire.ca/news-releases/minister-murray-releases-canada-s-digital-government-strategy-832885474.html>

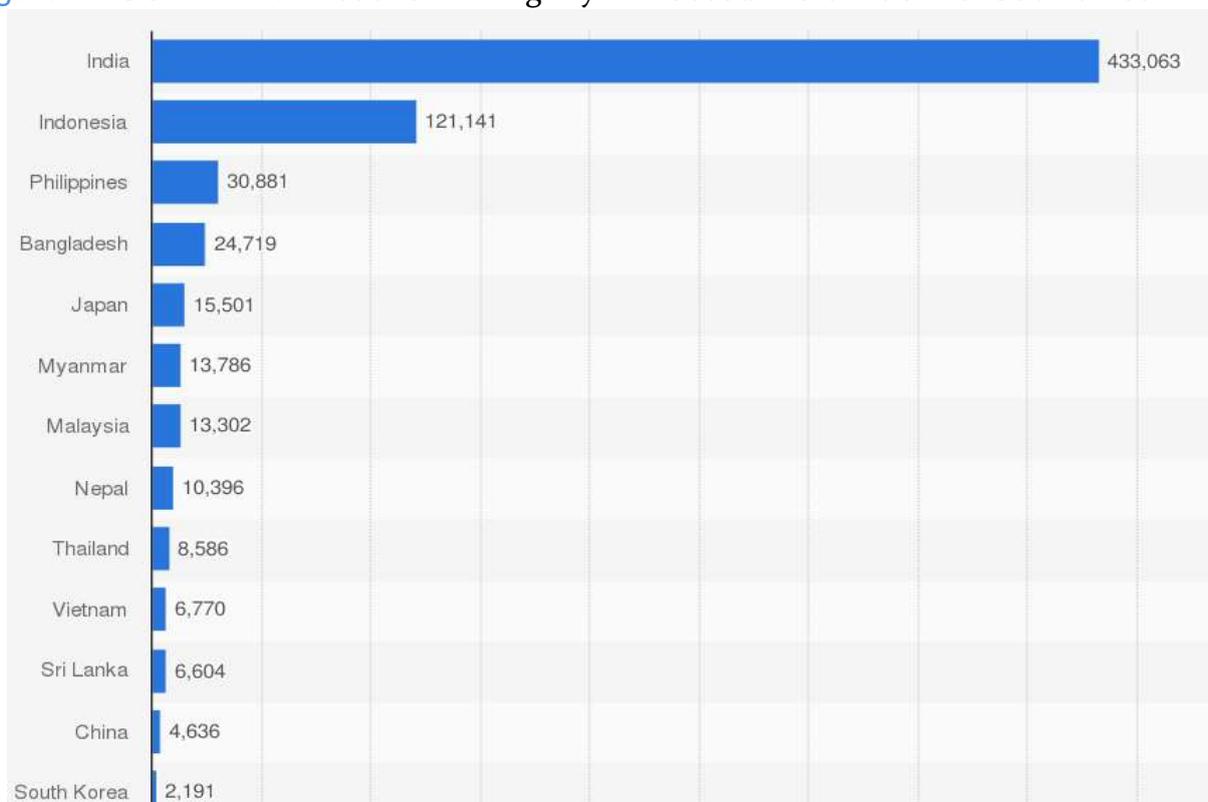
2.COVID-19, 4IR, and the great reset of healthcare in the Asia-Pacific

2.1 COVID-19 AND HEALTHCARE IN THE ASIA-PACIFIC

The ongoing pandemic is disproportionately damaging the Asia-Pacific region with precarious effects on the region's healthcare systems. The numbers paint a disturbing picture of what the region has been enduring for the past two years. As of August 2021, more than 81,413,000 people were infected, out of which more than 1,202,000

unfortunately lost their lives (Figure 1). This is, by far, the most affected region in the world. Across countries, there are painful images of near collapsed ICUs and healthcare systems, overwhelmed doctors and nurses making painful choices about who lives and who dies. Hospitals, overwhelmed by an influx of COVID-19 patients, and running out of oxygen were common sights in the countries.

Figure 1: COVID-19 Deaths in Highly Affected Asia Pacific Countries



Source: Statista 2021, data based on surveys conducted by <https://www.worldometers.info/coronavirus/>

Figure 2: COVID-19 Infection in Highly Affected Asia Pacific Countries as of August, 2021



Source: Statista 2021, data based on surveys conducted by <https://www.worldometers.info/coronavirus/>

Although countries are still in the midst of the pandemic, there are few fundamental lessons that should give policymakers and healthcare sector stakeholders' reasons to rethink and reimagine healthcare systems in their respective countries.

COVID-19 has exposed the flaws and inadequacies in existing traditional healthcare systems. Although the system has been relatively resilient since the Spanish flu in 1920s, and the recent SARS and Corona pandemics, the experiences of the past two years with COVID-19 have proven that any highly infectious disease will make many people sick, quickly overrun hospitals and lead to the collapse of the system. This is the case in both developed and developing countries. For example, the world witnessed COVID-19 pummeling Italy, Japan, and Europe's systems, which are the best worldwide. Hence, many governments imposed strict and economically crippling lockdowns and

implemented unpopular but necessary social distancing and quarantine measures. Thus, it is clear that the healthcare systems in their present conditions are not able to withstand the pandemic. Before the pandemic, developed countries had five hospital beds per 100,000, one doctor per 1000, and one ICU per 100,000. (OECD/WHO, 2020). A brief review of the situation in developing countries provides even more terrifying scenarios. For example, some countries, such as Pakistan, Cambodia, and India have one doctor and one bed per 1,000. In Figures 3-5 (reproduced from the latest OECD report: "Health at Glance in Asia-Pacific), we highlight a number of healthcare indicators that shows the dire conditions of the healthcare systems across a number of APAC countries (OECD/WHO, 2020).

Why is the traditional healthcare system vulnerable to COVID-19 in both developed and developing countries? Experts have varying reasons, but the simple truth is that it is expensive

to build, equip, and maintain national healthcare infrastructures that can provide universal coverage to all citizens. In other words, sustainable and quality healthcare coverage can only be achieved in environments with optimal demand and supply. For example, rich countries (except the United States of America) can afford to have quality healthcare systems because the markets can afford it. Thus, in a typical developing country, the best healthcare infrastructure is typically found in “rich” urban areas leaving a majority of the “poorer” population in rural areas vulnerable or with substandard healthcare services. It is also very expensive to train, hire, and retain doctors and nurses in most developing countries. For example, in the case of countries such as India and the Philippines, around 60,000 of their best healthcare workers live and work in advanced countries, while their countries suffer shortages (OECD/WHO, 2020).

However, the fact that the traditional system is expensive does not absolve governments and healthcare sector stakeholders from the responsibility of providing quality healthcare systems. Now, how can countries build more strong resilient healthcare systems for this “living with COVID-19” era, one that is capable of withstanding pandemics? How can technologies be part of these efforts?

2.2 Post-COVID-19 vs living with COVID-19 and everything in between

Biotechnology companies in countries such as the United States, Germany, and the United Kingdom have relied on advancements in biotechnology such as messenger RNA (mRNA) technologies (Pardi et al., 2018) and 4IR technologies such as

AI⁷ in the past two years; and in fast-tracked the development (Keshavarzi Arshadi et al., 2020) and roll-out of COVID-19 vaccines. In turn, this has led to an increased optimism about the post-COVID-19 world, wherein different and divergent scenarios are being debated. Some argue that we should go back to the old norms, such as the old way of healthcare delivery. Others argue for a new normal that incorporates our lessons, such as digital innovation, to our old ways, and while some are calling for reforms and transitions. This paper argues that it may be too early to talk about the post-COVID-19 era for several reasons. First, there are glaring inequalities and inequities in the access and distribution of vaccine between rich and developing countries in the Asia-Pacific. Those that have sufficiently passed the vaccination thresholds (an average of 70 ~ 80 per cent of the population) may re-open, but for the majority of developing countries in the Asia Pacific, the vaccination rate is around 30-50 per cent, which implies that they are still in for the long COVID-19 fight. The World Health Organisation (WHO) projects that the struggle will continue till at least 2024.

Second, a resurgence of COVID-19 is being witnessed in many countries, even those that have achieved high vaccination rates, such as those in Europe and the United States, due to new COVID-19 variants and vaccine hesitancy. This resurgence is now dampening hopes for the post-COVID-19 world as many have begun to wonder what is likely to happen to the majority of Asia Pacific nations with lower vaccination rates.

Finally, scientists now believe that it may be difficult to completely eradicate COVID-19 in the foreseeable future. Hence, some Asia-Pacific

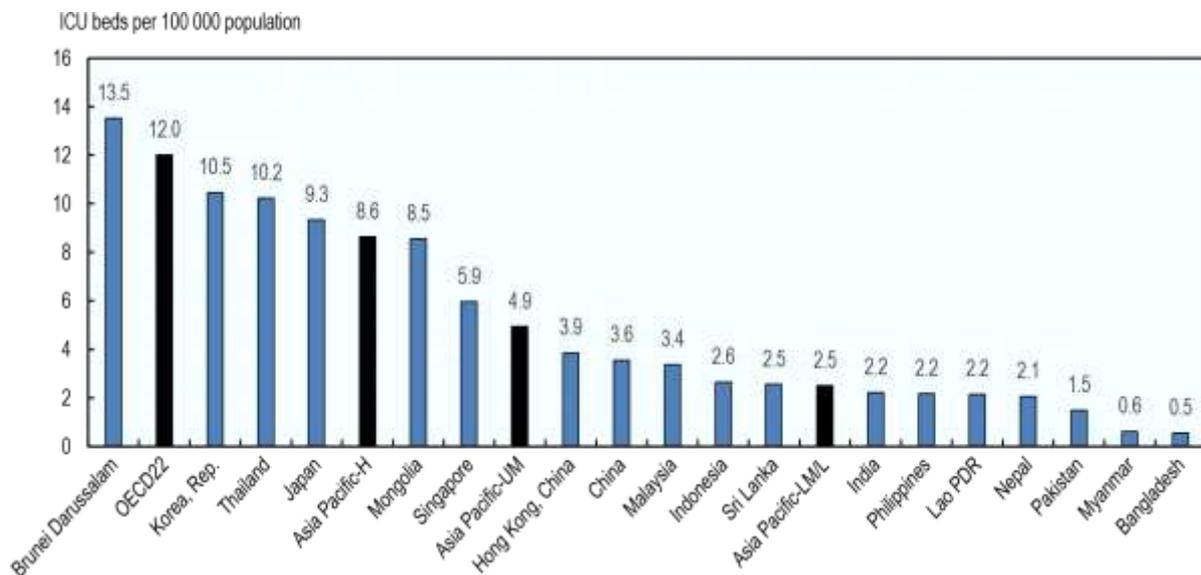
⁷ See, “AI and the COVID-19 Vaccine: Moderna’s Dave Johnson”, MIT Sloan Management Review, July 13, 2021, <https://sloanreview.mit.edu/audio/ai-and-the-covid-19-vaccine-modernas-dave-johnson/>

countries, such as the Republic of Korea and Singapore, are now switching to the “living with the COVID-19” strategy. This essentially acknowledges that COVID-19 is here to stay (at least for the foreseeable future). Thus, once you achieve sufficient numbers of vaccinated population (to reduce hospitalization and fatalities), the next logical step is to reduce the suffering of people and businesses, whose lives have collapsed, by at least opening up the economy and limiting restrictions and social distancing measures. However, the emerging situation in many advanced countries, including those with high vaccination rates, such as the Republic of Korea, Singapore, Israel, and Europe, suggests that the reality of “living with COVID-19” strategy is difficult to achieve without more ambitious steps to build resilience in the

healthcare system. In all these countries, there is one common thread: within weeks to a couple of months, infections spike up to a new wave, ICUs get overwhelmed, casualties and death rates increase, which lead to new restrictions and lockdowns!

To be fair to policymakers who are under extreme pressure, there are no easy and simplistic solutions to these predicaments. Moreover, no one has all answers to the crisis. However, the lessons being learned in real time must not be lost in the chaos of the moment, especially because it may be too early to talk about the “living with COVID-19” strategy if a country has not reimagined and restructured their traditional healthcare systems which must involve digital innovations.

Figure 3. ICU beds per 100 000 population, around 2017

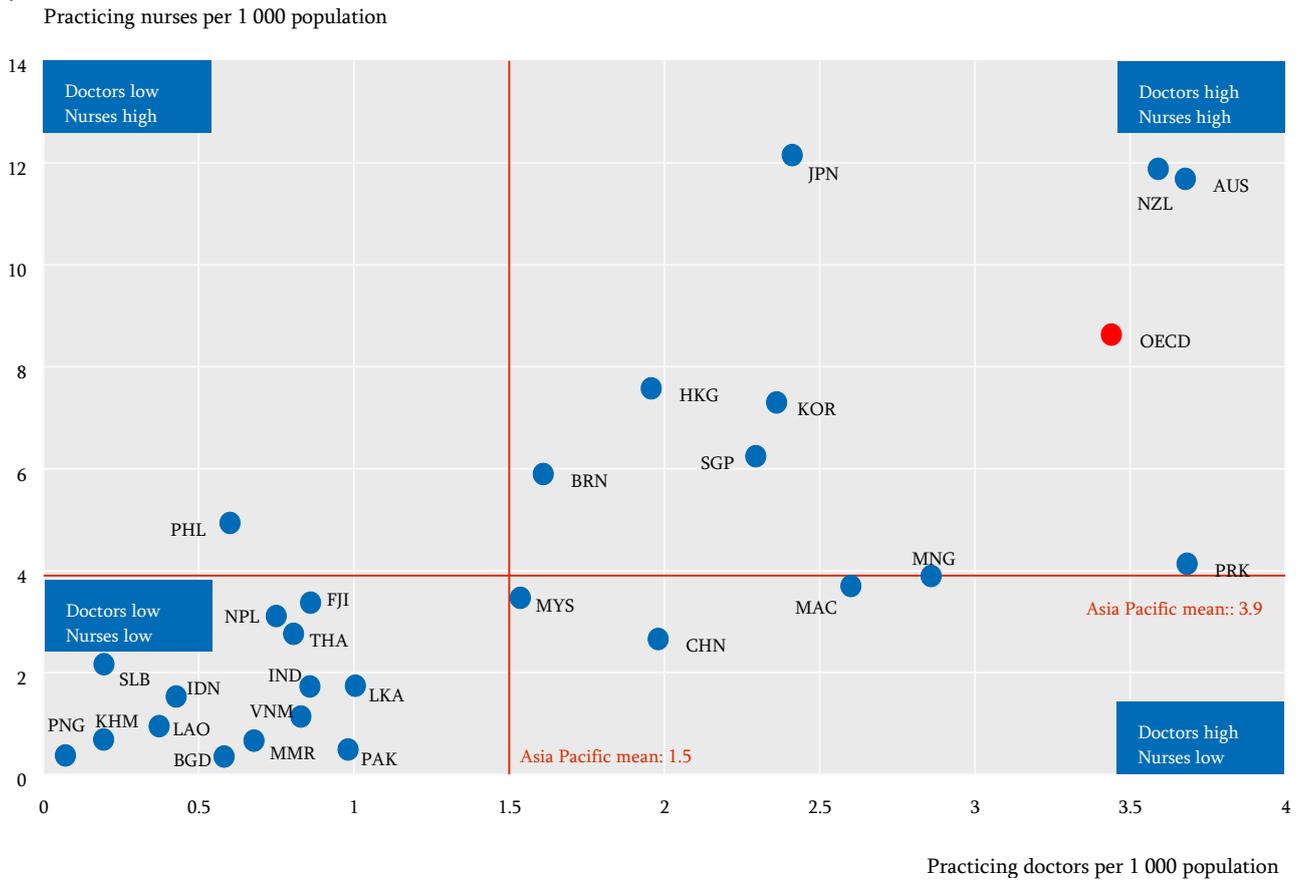


Source: OECD, 2020, (reproduced from latest *Health at a Glance: Asia/Pacific 2020* OECD report)

Note: Paediatric and neonatal ICU beds are excluded. High-care units/beds are excluded too.

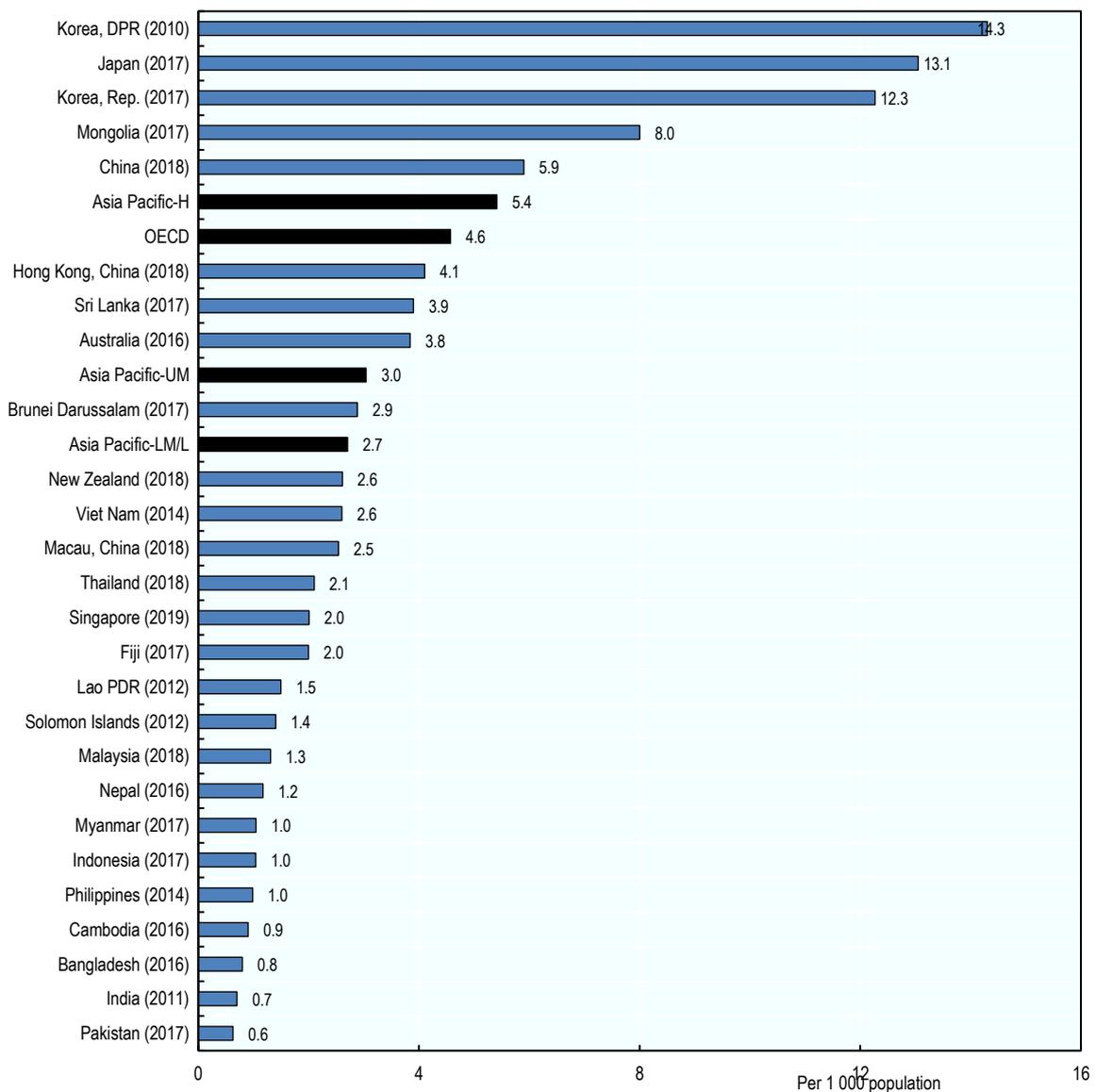
Source: Phua et al. (2020[10]) “Critical Care Bed Capacity in Asian Countries and Regions”, <http://dx.doi.org/10.1097/ccm.0000000000004222>. The figure for Japan is from the Ministry of Health, Labour and Welfare official data.

Figure 4. Number of practicing doctors and nurses per 1000 population, latest year available



Note: The red labels relate to the lines, and the intersection of the two lines is the equivalent of the mean for the Asia-Pacific countries. The OECD dot is the mean for all OECD countries. Source: WHO Global Health Observatory, 2020; OECD Health Statistics, 2020.

Figure 5. Hospital beds per 1000 population, latest year available



Source: OECD Health Statistics 2020; WHO GHO 2020.
StatLink <https://stat.link/0id9wh>

Another key message is that since COVID-19 may be here for a while, although there is news that new drugs may reduce hospitalization, healthcare planners and policy makers must think about strengthening healthcare systems to cope with the “living with COVID-19” era.

2.3 COVID-19 and the Fourth Healthcare Revolution in the Asia Pacific

Amidst all the chaos mentioned above, there is a silver lining, namely, that COVID-19 has

triggered a great pivot towards the use of digital technologies, AI, and big data in health industries across the Asia-Pacific region, and the world. For instance, the world has witnessed how AI, big data, and digital innovations play a critical role in fighting this deadly pandemic. According to a recent OECD report, "AI tools, Big data, and digital applications are deployed in almost every front to stop coronavirus. From fast tracking medical research and treatment to better understanding of coronavirus; from detecting and

diagnosing the virus to predicting its evolution (OECD 2020; World Economic Forum, 2020). These innovations are also critical in prevention, monitoring and slowing the spread of diseases through disease surveillance and contact tracing; responding to health crisis through personalized information and learning and monitoring the recovery and improving early warning systems”. It is clear that these technologies will continue to mature and play even greater roles in transforming the industry. Thus, policymakers and stakeholders across the Asia Pacific must start designing and orchestrating an ecosystem that brings different players, including the healthcare industry and start-ups, academia, investors, manufacturers, etc., to leverage these new technologies and take the healthcare sector to new levels. This requires bold policies, investments, and institutional reforms. Furthermore, realizing the full potential of AI, big data, and related digital innovations requires the creation of new platforms for sharing medical, molecular, and scientific data to enable the health industry to make effective health innovations.

Similarly, new digital innovations such as telemedicine (Kalenzi, 2020), AI-powered wearable devices, contact tracing applications and services, blockchain-powered vaccine passports, and others are now at the forefront of the battle against COVID-19, and without a doubt, will increasingly play major roles in re-engineering the healthcare industry in Asia-Pacific and the world. Their emergence has enabled policymakers to imagine the era of the “hybridtact” healthcare industry, where the traditional “contact” hospital and healthcare systems are “married” with digital and online systems (untact healthcare) to revolutionize how bio-health and healthcare services are delivered.

Furthermore, these digital innovations and their integration with bio-health will play prominent roles in the detection, control of dangerous diseases, and management of healthcare systems. However, realizing their full potential does not happen without efforts to rethink existing innovation ecosystems, including human resource development, promotion of bio-health innovators and start-ups, R&D institutions, academia, and governments, and more importantly, their smooth coordination to revitalize bio-health systems. There is clearly a need to rethink the transition from the traditional healthcare industry to a new era driven by AI, data, and digital innovations.

As previously mentioned, many factors have converged to challenge the healthcare sector in every country to its core: COVID-19 and structural weakness within traditional healthcare systems, including expensive infrastructures, ageing population, etc. This means that an increase in patients leads to the stretching of healthcare systems beyond their capabilities, and hence the need for painful and costly lockdowns, social distancing, and other restrictions. However, these come at a time when technologies such as, AI, blockchain, big data platforms, mobile computing, Augmented Reality (AR) and Virtual Reality (VR) precision medicine, etc., are fully developed, which implies that we can now develop more scalable, less costly, accessible, and resilient healthcare systems. Moreover, the ongoing adoption of such technologies in different countries is breaking the pre-existing technology and innovation inertia, which has long been prevalent in healthcare systems worldwide.

Therefore, it is time for all countries in the Asia Pacific to rethink, reimagine, and revamp their

healthcare systems. It is not a question of whether countries should do so, but of how and who should oversee the implementation of the different pillars of resilient healthcare systems.

When these questions are posed to the architects of traditional healthcare systems, they might have solutions such as: building more hospitals, training more healthcare providers, reducing overburdening of our healthcare systems, and equipping these hospitals with technologies and personal protective equipment (PPEs). They are right, but is this enough? The learnings in the past two years show that it is difficult to provide full healthcare coverage even in rich countries. Earlier, we showed that such a route is extremely expensive for many countries and explains why healthcare systems are largely inaccessible and, on the line, when faced with deadly challenges such as COVID-19.

When the same question is posed to innovators and the “Silicon Valley” kind of thinkers, one might get answers such as: implement online/noncontact digital healthcare innovations including AI, big data, telemedicine, digital

contact tracing, etc. They would argue that these are critical in a pandemic to protect both patients and healthcare workers from contagion and the society from pandemics. They are also right on many levels, but this approach does not provide the full picture. The answer lies somewhere in between, that is, hybridtact healthcare, because healthcare inherently involves both the physical and personal. Thus, the trick is to combine the best of both worlds – traditional healthcare with new 4IR innovations!

This paper intends to lay out a strategic framework for stakeholders in healthcare to comprehend some of these issues for implementing hybridtact healthcare and highlight how these innovations are already pointing us in that direction in the Asia-Pacific countries. Table 1 below highlights 4IR innovations that have emerged across APAC in the last couple of years.

Table 1: 4IR innovations for Hybridtact Healthcare in Asia Pacific

Category of 4IR technology	Country	Examples
<p>Pandemic Communication and Information management</p> <p>*Technologies for sharing, safeguarding and transmitting of factual information to fight the pandemic.</p> <p>E.g. Interactive maps, screening tools, mass communication tools, etc.</p>	<p>Republic of Korea, Singapore, Viet Nam, China</p>	<p>Republic of Korea extensively relies on the Cellular Broadcasting Service to transmit emergency alerts in each region, communicating how many people have been infected to the public and alerts of possible clusters. Republic of Korea also relies on real-time interactive maps that show routes of infected persons, thereby giving the general public a timely information on places to avoid.</p> <p>Viet Nam has successfully relied on traditional communication channels including TV and grassroots communications using speaker mounted bikes and cars to share COVID-19 information with the public.</p>
<p>Detection and Containment</p> <p>*Technologies and interventions that support advanced detection of the virus and containment through non-pharmaceutical interventions</p> <p>E.g. contact tracing technologies, mobile payments to reduce physical contact, etc.</p> <p>Notable examples include TraceTogether, Alipay health code, Kakao, and the Republic of Korea’s recent vaccine pass.</p>	<p>Singapore, Republic of Korea, India, Viet Nam, Mongolia, Pakistan, China</p>	<p>Singapore developed the TraceTogether digital system that enables the government to quickly identify persons who may have come in close contact with infected persons.</p> <p>Mongolia also developed a contact tracing mobile app that alerts the populations to possible COVID-19 exposure.</p> <p>Republic of Korea collaborated with private companies including platform providers such as Kakao, Naver, and Telco such as KT to roll out a country-wide contact tracing digital system that enables the identification of people that are likely exposed to COVID-19. The country has also recently rolled out</p>

		Blockchain-based Vaccine Pass that grants access permissions to vaccinated populations to public places, including restaurants, cafes, gyms, movie theatres, etc.
<p>Healthcare Provider enablement</p> <p>*Includes technologies, tools, and capabilities that frontline workers can use to fight pandemics and infectious diseases</p> <p>E.g. AI-assisted diagnosis, telemedicine, videoconferencing, and SMS management for hospitals</p> <p>drone healthcare delivery</p>	<p>Australia, Republic of Korea, Cambodia, Singapore, Japan, China, India,</p>	<p>Singapore: The Ministry of Health⁸ is working with private telemedicine providers such as ManaDr, MyDoc, Speedoc, and Raffles Medical to ease pressure on hospitals. Such tools enable providers to treat patients in the comfort of their homes⁹.</p> <p>Cambodia launched the MyCLNQ mobile app that enables cross-border healthcare service provision, i.e., doctors in The Republic of Korea or Singapore can treat patients in Cambodia.¹⁰</p> <p>In China, Huawei launched AI-Assisted Automatic and Quick Diagnosis of COVID-19¹¹. Another powerful innovation is the Ping An Good Doctor, which launched commercial operation of One-minute Clinics in China¹².</p> <p>In Australia, the government added a number of temporary Medicare items to help healthcare practitioners deliver telehealth services via phone or video conferencing¹³.</p>

⁸ Ministry of Health, Singapore

⁹ See, Shabana Begum and Tay Hong Yi, "Telemedicine providers stretched thin as more people go into home recovery for Covid-19", THE STRAITS TIMES, Sep 28, 2021, <https://www.straitstimes.com/singapore/health/home-recovery-telemedicine-providers-stretched-thin-but-working-round-the-clock-to>

See: <https://www.moh.gov.sg/licensing-and-regulation/telemedicine>

¹⁰ See: <https://pethyoeung.com/press-release/9>

¹¹ See: Huawei Launches AI-Assisted Automatic and Quick Diagnosis for COVID-19,

https://consumer.huawei.com/en/community/details/Huawei-Launches-AI-Assisted-Automatic-and-Quick-Diagnosis-for-COVID-19/topicid_78103/

¹² See: Ping An Good Doctor launches commercial operation of One-minute Clinics in China,

<https://www.mobihealthnews.com/news/asia/ping-good-doctor-launches-commercial-operation-one-minute-clinics-china>

¹³ See: Providing health care remotely during COVID-19, <https://www.health.gov.au/news/health-alerts/novel-coronavirus-2019-ncov-health-alert/coronavirus-covid-19-advice-for-the-health-and-disability-sector/providing-health-care-remotely-during-covid-19>

<p>Treatment acceleration</p> <p>*Technologies and efforts that support businesses and organizations working on drug and vaccine discovery through big data and healthcare research.</p> <p>E.g. Huawei: AI-assisted drug screening</p>	<p>China, Singapore, Republic of Korea</p>	<p>In China, Huawei launched EIHealth – powered by the advantages of AI and big data technologies from HUAWEI CLOUD, EIHealth provides a professional AI R&D platform to accelerate AI research and applications in genomics, drug discovery, and medical imaging.</p> <p>Republic of Korea: Platforms such as KaiPharm¹⁴, Standigm¹⁵, KISSDD 2.0 (by EnsolBio Science)¹⁶ utilize AI and big data in healthcare for drug screening and drug discovery. Such approaches cut the time and the processes of drug screening and repurposing, far better than traditional approaches.</p>
<p>Healthcare and Economic resilience tools</p> <p>*Technologies, tools, and efforts that enable support/provision of critical infrastructure support, business enablement for SMEs, data driven policy making, resilience, and continuity.</p> <p>E.g. 5G-aided smart construction and unmanned distribution, donation platform for health equipment, access to digital sourcing platform, network bandwidth management</p>	<p>USA, Republic of Korea, Japan, China, Vietnam</p>	<p>In the USA, companies including Telcos and tech firms collaborated with local governments to maintain and expand networks and increase bandwidth to enable use of 4IR innovations in healthcare and education.</p> <p>Across Asia-Pacific countries like The Republic of Korea, China, Singapore, the tech firms have collaborated with governments to scale networks to enable access to distant learning solutions.</p> <p>In Thailand, the Digital Council of Thailand partnered with other players to introduce Helpital, which is a</p>

¹⁴ See: Mining the transcriptome: using big data and AI to drive drug discovery the smart way, <https://www.nature.com/articles/d43747-021-00035-9>

¹⁵ See: Standigm Files PCT Patent Application of AI-driven Repurposed Drugs for Primary Mitochondrial Disease, <https://www.prnewswire.com/news-releases/standigm-files-pct-patent-application-of-ai-driven-repurposed-drugs-for-primary-mitochondrial-disease-301414922.html>

¹⁶ See: KISSDD 2.0 First-in-class Drug Discovery Platform by Bio Big Data and AI, <http://www.ensolbio.co.kr/eng/index.html>

		central donation platform for collection of donated health equipment for distribution to hospitals that required support.
<p>Economic, healthcare, and business continuity</p> <p>*Technologies, tools, and efforts to enable continuity of business during pandemic times.</p> <p>E.g. video conferencing tools, smart work tools, cyber security innovations, payment innovations, supply chain management, remittances etc.</p>	<p>Australia, Bangladesh, Brunei Darussalam, Cambodia, China, Fiji, Hong Kong, China, India, Indonesia, Japan, Republic of Korea, Lao People's Democratic Republic, Malaysia, Mongolia, Myanmar, Nepal, New Zealand, Pakistan, Papua New Guinea, Philippines, Singapore, Sri Lanka, USA</p>	<p>Virtually all countries in the Asia Pacific are relying on some key 4IR innovations to enable continuity in healthcare, economic activities, business, etc. E.g. digital innovations in remittances are enabling the diaspora communities of countries like Philippines and India to stay connected to their families in the home country and support them via money transfers. Smart work video conferencing tools are enabling continuity in business for many sectors across the Asia Pacific. In The Republic of Korea and Singapore such tools are critical when stay at home orders and quarantine rules are implemented.</p>
<p>Social Cohesion</p> <p>*Tools and innovations that support communication and cohesion among individuals, corporations, and institutions.</p> <p>E.g. social media and mental health innovations; promote vaccination</p>	<p>All of Asia-Pacific</p>	<p>In the Asia Pacific, many 4IR innovations including social media platforms such as WhatsApp, Facebook, Tiktok are now critical in supporting mental health, keeping people connected during social isolation, promoting vaccinations, etc.</p> <p>Similarly, community help platforms enable individuals across the Asia-Pacific countries to request and offer assistances in their communities.</p>

Source: Author's compilations based on multiple official sources including government publications

*Note: The category definitions are adapted from the World Economic Forum, and cases are sourced from various sources, including the Ministry of Health of countries and credible news sources.

As Table 1 demonstrates, digital and hybrid healthcare innovations are emerging in the Asia Pacific region. In fact, Table 1 is only a snapshot of thousands of innovations emerging across the region and in each country, regardless of the economic status. It is not the intention of this paper to provide an exhaustive list, but rather to setting set the scene for a broader discussion on

setting up enabling environments that will consolidate and improve on these digital innovations to enable an inclusive and more resilient hybrid healthcare system across Asia. The next section will discuss emerging business models in the region.

Box 1: How telemedicine services are helping Singapore to “live with COVID-19”

Telemedicine refers to the use of ICT tools including apps for video conferencing, phone calls, emails, etc., by healthcare providers to provide remote healthcare services. It is one of the 4IR innovations that has the potential to be game changer in the fight against COVID-19 and other pandemics, and is a critical pillar in establishing “resilient hybrid healthcare systems”.

For instance, in the case of COVID-19, in the past two years, we have learned that while COVID-19 is highly infectious, not every infected person has to be hospitalized. Some non-critical patients can alternatively receive treatment in the comfort of their homes. It is feasible now that innovations including home testing, AI-self test apps, e-prescriptions, and remote monitoring are widely available. Their full implementations means that hospitals will have more room to take care of critical COVID-19 patients and those suffering from other diseases including terminal cancer, AIDS, etc. (these have been largely ignored in the Asia Pacific with very serious consequences, whose cost is yet to be counted). However, national policy support for telemedicine is a controversial, even taboo topic in some Asia-Pacific countries despite its obvious benefits during pandemics

and potential for supporting resilient healthcare systems.

Singapore is one of the handful of Asia-Pacific countries taking bold step to allow telemedicine for the “live with COVID-19 strategy.” Singapore took time to learn how to implement telemedicine through a regulatory sandbox “Licensing Experimentation and Adaptation Programme” (LEAP). This allowed digital healthcare innovations to flourish and when COVID-19 hit just a year later, the country already had providers such as MaNaDr, MyDoc, Speedoc, and Raffles Medical among others who are supporting Singapore’s healthcare system deal with COVID-19. Such innovations are supporting Singaporean healthcare systems in several ways: patients get treatment during lockdowns “circuit breaker”, enabling remote monitoring, patients staying in contact with their doctors, increasing access to cheaper and convenient healthcare services, among others.

Following the success and lessons learned from the regulatory sandbox, Singapore now is updating the regulation to license telemedicine service under the upcoming Healthcare Services Act (HCSA) 2020.

Source: Ministry of Health, Singapore, “Listing of Direct Telemedicine Providers: Transition Approach Prior to Licensing Under the Healthcare Services Act (HCSA).”

Australia is another country making important strides in enabling telemedicine services. The provision of remote healthcare began in March 2021 at the height of COVID-19 and subsequent lockdowns. The temporary measure is designed to enable temporary online Medical Benefits Schedule (MBS), reduce community transmissions, and protect patients and healthcare providers¹⁷. The government has also issued guidelines for telemedicine services in Australia. Such steps have opened the healthcare sector to innovations that will enable the country to move to more resilient hybridtact models of healthcare delivery. At the time of writing of this paper, digital innovators including tappON, Egal health, Swiftdoc, Dokotela, Vleep, Maslow, Rosemary Health, and Healthdirect Australia are mushrooming¹⁸ across the country, supporting the Australian war against COVID-19, helping the country to return to normalcy by enabling continuity in healthcare delivery and contributing to resilient healthcare ecosystems.

It is therefore clear from the ongoing healthcare transformations in APAC, that now is the time to revamp, realign or restructure existing systems including regulatory ones, to promote 4IR technology adoption in the healthcare systems across the region.

Admittedly, transitioning from traditional healthcare to hybridtact healthcare where telemedicine, digital innovations including AI, blockchain, etc., are some of the core pillars to the systems is not easy and will take time. This is especially so because of existing rules and

regulations around data sharing, reimbursements, and the integration of technology in healthcare services have to be renegotiated by key players that make up the healthcare ecosystem. The delays and squabbling in these negotiations, and the creation of shared rules and standards, coupled with technology inertia, and lack of training of both healthcare providers and the general public, means that a number of countries will have to wait to enjoy the full benefits of hybridtact healthcare systems.

An illustrative example of the complexity of this transition is the Republic of Korea, where they have had incredible success in rolling out digital innovations, including contact tracing technologies, AI, big data innovations, and vibrant innovations in telemedicine among others. The country also boasts of one of the best IT infrastructures worldwide, with nearly 100 per cent nationwide fixed and mobile broadband coverage, 99 per cent smartphone ownership, and a receptive population. With such a digital ecosystem, the country is ready to transition to hybridtact healthcare. However, regulatory issues and disagreements around telemedicine are yet to be resolved (Soo-youn, 2021). The result is that because of this regulatory uncertainty, which inhibits the telemedicine provider's ability to innovate, even the Republic of Korea's healthcare system is burdened by the COVID-19 pandemic.

¹⁷ See: Australian Government Department of Health, "Providing health care remotely during COVID-19", <https://www.health.gov.au/news/health-alerts/novel-coronavirus-2019-ncov-health-alert/coronavirus-covid-19-advice-for-the-health-and-disability-sector/providing-health-care-remotely-during-covid-19>

¹⁸ See: Telehealth Providers in Australia, <https://www.talkinghealthtech.com/australia/new-south-wales/healthcare-providers/telehealth-providers>

On the other side of the border, private sector players in China, such as Ping An Good Doctor,¹⁹ might have cracked the code to resolve the complexity of providing telemedicine and hybridtact healthcare services. In China, behemoth insurance and healthcare providers are championing the realization of hybridtact healthcare. The company heavily invested in AI, blockchain, and cloud infrastructure, which has enabled remote healthcare services to be provided to more than 370 registered users across China. The success of this model is premised on the seamless integration of digital technologies with traditional offline healthcare networks that bring 2200 in house medical staff and roughly 21,000

contractual experts on board. Such a resilient healthcare system is further built on successful collaboration with over 3700 hospitals across the country (for a complete description, please see the details in FT²⁰ and McKinsey²¹). Such a model enables the integration of digital technologies, including AI and telemedicine, with insurance and payments, as well as big data analytics, which solves some of the big bottlenecks in realizing hybridtact healthcare.

Similar models have been successfully launched and are revolutionizing the United States of America²².

Figure 6: Ping An’s AI and telemedicine service offering



Source: Financial Times

In the emerging countries category, Viet Nam has been lauded for its handling of the COVID-19 pandemic using digital technologies. Such tools

support the country’s strong measures to swiftly contain the pandemic, limit transmissions, and official reports indicate that Viet Nam is one of the

¹⁹ See: Financial Times, “Bridges to health for China’s people”, <https://www.ft.com/partnercontent/ping-an-insurance/bridges-to-health-for-chinas-people.html>

²⁰ See: Financial Times, “Bridges to health for China’s people”, <https://www.ft.com/partnercontent/ping-an-insurance/bridges-to-health-for-chinas-people.html>

²¹ See: McKinsey Interview with co-CEO of Ping An, “Using ecosystems to reach higher: An interview with the co-CEO of Ping An”, <https://www.mckinsey.com/featured-insights/asia-pacific/using-ecosystems-to-reach-higher-an-interview-with-the-co-ceo-of-ping-an>

²² See: McKinsey, “Telehealth: A quarter-trillion-dollar post-COVID-19 reality?”, <https://www.mckinsey.com/industries/healthcare-systems-and-services/our-insights/telehealth-a-quarter-trillion-dollar-post-covid-19-reality>

few countries in the Asia-Pacific region with the fewest infections and deaths due to COVID-19.

In box 1.2, we highlight Viet Nam's case in implementing digital technologies to combat COVID-19. This case offers great insights into LMICs in the Asia-Pacific region, because unlike Singapore or the Republic of Korea, Viet Nam's digital infrastructure, including fixed and mobile broadband, is in a range similar to other countries in the same income bracket, such as the

Philippines. Yet Viet Nam's "for now" successful strategy might mean that the country had fewer infections and casualties.

Viet Nam's case of using digital technologies will help the country in establishing resilient hybrid-tact healthcare systems. Other emerging countries with similar levels of development and digital infrastructure may have to benchmark Viet Nam's use of digital innovation in the fight against COVID-19 and beyond.

Box 1.2: How Viet Nam is using Digital Innovations to fight the COVID-19 pandemic

A number of high-profile publications including those from the IMF and Brookings have shown how Viet Nam offers a template for developing countries to fight COVID-19. This success is largely attributed to several factors including a strong centralized government leadership that has mobilized across the country to respond to the pandemic, the country's earlier experiences with SARS, and robust tracing systems (see OECD report).

The other arsenal in Viet Nam's COVID-19 combat "playbook" has been the successful leveraging of digital innovation and mobilizing partnerships including the private sector to quickly develop, launch and scale such innovations. For instance, Viet Nam's Ministry of communication and Ministry of Health collaborated to launch the NCOVI and the Viet Nam healthcare Declaration app in March 2020. A month later, another digital innovation, Bluezone was launched to activate contact tracing and alert users on whether they came in close contact with confirmed COVID-19 cases. Within a year, the Bluezone app had 30 million downloads in the country.

Viet Nam has now taken the path to

hybrid-tact healthcare by launching a super app that combines functionalities of earlier versions such as contact tracing, QR codes, and registration of vaccination status with telemedicine capabilities. This digital platform points to the successful collaboration the advanced International Joint Stock Company (AIG Group) and Electronic Health Administration-Ministry of Health of Viet Nam.

Its key features include: AI-powered Virtual Medical Assistant (Chatbot), board-certified specialist consultation, interactive maps to alert users of places to avoid, COVID-19 live updates, GPS guidance to patients on where to find facilities including nearby hospitals, pharmacies, and COVID-19 cases, etc. (for a complete guide, see Google Apps)



2.3.1 Innovative and emerging approaches of hybridtact healthcare

As shown above, there are hundreds (even thousands) of digital innovations mushrooming in different countries and are either already changing the healthcare systems or on the cusp of doing so, depending on the country's capability to utilize the technologies. Given the diversity and number of technologies with different applications that focus on key points of healthcare value chains (see Table 1), each of these requires different business models, partnerships, and, most importantly, solid public and private sector leadership to navigate complex relationships to accelerate their adoption in healthcare.

This paper discusses some examples to illustrate emerging mechanisms and models that can enable more resilient hybridtact healthcare

systems. At their core, technologies like AI and digital power, telemedicine, AI chatbots, contact tracing, and vaccine passes enable different capabilities which build stronger systems when harnessed. Therefore, stakeholders must explore innovative models that incorporate these technologies within healthcare systems. At least three possible and realistic scenarios of how to actualize such resilient systems can be highlighted.

Figure 7. Reimagining healthcare for the post-COVID-19 Era



Technology powered-traditional/"contact"/face-2-face healthcare systems

Contrary to popular myths that 4IR technologies replace traditional systems, including healthcare, the past two years of battling COVID-19 in the ICUs and hospital wards has proved how invaluable traditional contact or sometimes “face-2-face” healthcare systems are. Here, patients get to interact with their doctors and nurses and receive that emotional human support that an AI-powered robot doctor can never master (at least not in the near future). Even though some primary healthcare services such as diagnosis, treatment, prescription, and post-treatment monitoring can be provided online, there are many aspects in a patient journey that have not been automated yet. Even if AI and digital innovations achieved some degree of accuracy, a majority of patients would trust their doctors and nurses to conduct surgeries, therapies, counselling, birth deliveries, and intubating more

than AI robots or chatbots. However, for all its advantages, COVID-19 has exposed structural weakness in traditional healthcare systems, including cost, accessibility, coverage, and the nationwide cost of maintenance.

Now that Asia-Pacific countries have become benchmarks of digital innovation and have accumulated considerable experience in implementing these innovations in the past few years, healthcare planners, policymakers, and stakeholders should be asking the following questions:

- How can 4IR innovations be incorporated to enable more resilient and accessible face-2-face healthcare systems? Asia-Pacific countries may have to consider how such innovations like contact tracing, telemedicine, vaccine pass, etc., are integral to traditional healthcare, and are quickly activated when needed, instead of the current “temporary thinking”

measures designed to mitigate the effects of COVID-19.

- How can we ensure that face-2-face healthcare is made available and open to patients that need it most and ease pressure on such systems due to surges in patients? How can technology help?
- How can we rethink/simplify patient journey and provide alternative routes to receiving healthcare services by different kinds of patients, and ensure that the public is sufficiently educated about these alternatives?

Hybridtact healthcare delivery

As many Asia-Pacific countries turn to digital and 4IR innovations to fight the pandemic, this experience gives them valuable insights regarding the areas of healthcare services value chains that can be shifted online and what touch points need to be strengthened using digital innovations and which are the areas that 4IR innovations cannot replace. Armed with such insights, planners and policymakers have to explore how and which patients access contact/face-2-face healthcare systems or see practitioners via telemedicine and cloud systems, and how to enable both face-2-face and online healthcare systems to work seamlessly. The basic premise of the hybridtact healthcare system is to take the best of both traditional and digital worlds to make healthcare systems more accessible and convenient and less costly to different patient profiles. Consider the example of millions of asymptomatic COVID-19 patients who may not need to visit hospitals and can receive treatment and monitoring from the comfort of their homes instead. The same might apply to those who want to buy Viagra, birth control pills, headaches, simple colds/flu, etc.

The examples we have given for Singapore,

Australia, and other Asia-Pacific countries above proves that such capabilities are not only feasible but also enable a country to provide free hospital and healthcare systems, ease pressure, ensure that critical patients who require hospitalization are catered to, and healthcare systems are more resilient during pandemic times. Therefore, planners must ask some key questions, including:

Which healthcare service offering can be delivered via contact/face-2-face, or via online, or both (hybridtact)? Answering such questions with the lessons learned in the past two years will ensure that both the traditional and online models are properly optimized to deliver the best healthcare outcomes for patients.

How to reimburse doctors and healthcare providers based on working online or through hybridtact services? What is the optimal fee? Does a healthcare service provider charge the same fee or different fees for the services provided in either model?

Fully-online healthcare

Similarly, the fast adoption of AI and big data systems including telemedicine, cloud-based healthcare services, and more importantly, the fusion of such technologies testifies to the viability of the model to stand on its own to augment the current healthcare systems. The aforementioned case of asymptomatic patients receiving healthcare services from the comfort of their homes is instructive in the pandemic times. That withstanding, the healthcare system leans heavily on robust diagnostics and testing capabilities, of which face-2-face is best situated. However, the emergence of hundreds of innovations, including AI-chat bots, symptom checkers, and wearable devices that monitor patient's health 24/7, means that viable alternatives for some health issues exist and

should be promoted within the current healthcare environment. Some key issues in this model that planners and stakeholders must resolve are:

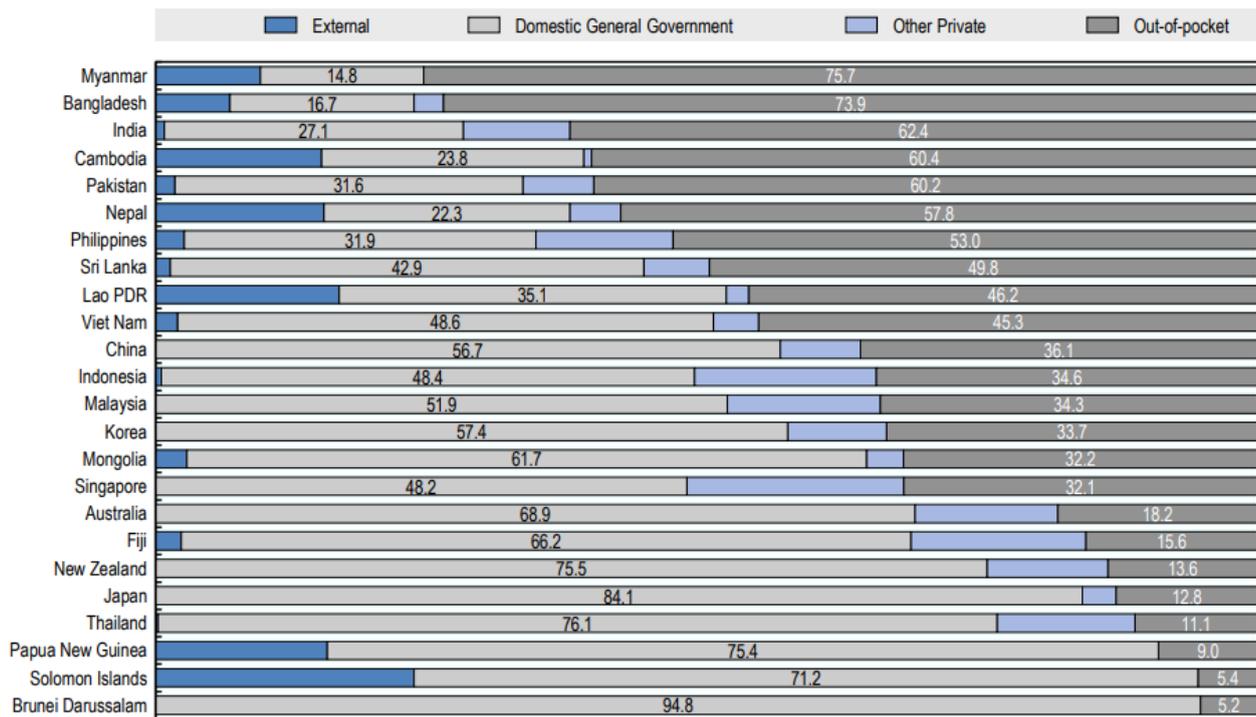
- How to enable fully-online healthcare models that are scalable and increase access to less-costly healthcare services?
- How to manage tensions and allay fears of traditional service providers who resist online and telemedicine healthcare because they fear for their bottom line, even though such a system makes life easier and safer (especially during pandemics)? In some Asia-Pacific countries, such tensions and disagreements are the main reason why fully-online healthcare innovations have stagnated despite these countries having advanced ICT infrastructures to enable such innovations.
- Finally, planners must determine how to revise regulations and standards, especially pertaining to patient data sharing, digital innovation approval and process, and safety

and quality assurance, etc.

2.3.2 Business models, financial mechanism, and incentives to facilitate 4IR innovations in healthcare

Along with providing healthcare through traditional face-2-face models, hybrid/tact models, or fully-online models, one of the central questions is how to pay for healthcare services? This is especially critical in several low-income emerging countries where the prevalent method of payments includes low-level healthcare spending, which is heavily reliant on out-of-pocket expenditures. See Figure 8 below. In such environments, it is difficult to incentivize 4IR innovators to invest in digital innovations that can transform and build resilient healthcare systems. In Figure 5, we see a complex picture of healthcare financing in Asia-Pacific countries that have a mixture of government/public, individual/out-of-pocket, and external sources. It also highlights the fact that in the majority of low and middle income countries (LMICs) in Asia-Pacific, the prevalent model is out-of-pocket.

Figure 8. Percent share of current healthcare spending by financing source, 2017



Source: WHO Global Health Expenditure Dataset, 2020.

Source: OECD, 2020, reproduced from latest *Health at a Glance: Asia/Pacific 2020 OECD report* (OECD/WHO, 2020)

Therefore, digital innovators and policy planners must consider which financing mechanisms and incentives can work in such markets to meet both the supply and demand of 4IR innovations in healthcare. It is critical to develop feasible value propositions and sustainable business strategies that meet the needs of the market to facilitate the adoption of digital innovations in the healthcare sector.

In most developing countries like Cambodia and Bangladesh, where digital innovations for hybridtact healthcare, such as telemedicine are mushrooming, such innovations rely on several revenue streams to incentivize the market. These 4IR innovations link patients to doctors and healthcare service providers and are mostly done by start-ups. They rely on B2P models, which

may be subscription-based or pay-as-go models. Examples of such models include Singapore, Thailand, and Malaysia. The other revenue model includes B2B, where healthcare services may be billed to insurance service providers or employers, as in the case of Ping An in China.

Other Asia-Pacific countries, including Bangladesh, China, India, and Indonesia²³, are implementing micro-insurance schemes that allow the participation of tech companies (especially Telcos) to provide low-cost insurance to millions of subscribers so they can pay for their healthcare services. In Bangladesh, micro-insurance providers use the agent model to reach subscribers, especially in urban centres. Mobile Network Operators (MNOs), including Robi Axiata and Garmeenphone, provide insurance to

²³ See Asia Micro insurance Supply-side study, <https://www.milliman.com/en/insight/Asia-Microinsurance-Supply-side-Study>

millions in Bangladesh. In China, tech companies, including Ant Financial, Baidu, and Tencent, rely on digital-powered micro-insurance schemes that enable many people in rural China to pay and access healthcare services. China also has mass market insurance schemes, such as online mutual aid platforms, which are programmes where participants pool their wealth through a series of small payments. These collective pools make payments to members who have healthcare-related claims. For example, the Xiang Hu Bao (“mutual protection”) by Alipay, which had more than 100 million subscribers in 2018, was reported to make healthcare more inclusive and accessible to its subscribers in China.

In advanced markets such as Australia and Singapore, digital innovations raise a lot of issues in handling existing payment regimes that balance the interests of different healthcare providers, including hospitals and insurance companies on the one side and governments, patients, and the public on the other. To address these complexities, Singapore initiated a regulatory sandbox, which among other things allowed digital healthcare providers to receive reimbursements and payments from special insurance schemes. Similarly, Australia developed guidelines and new temporary rules that allow innovators to be paid for their services through special schemes such as MBS in Australia.

Admittedly, it is a complex issue in several countries and countries such as the United States and even those in Europe are just beginning to address this complexity by, for example, relaxing rules on whether doctors can receive payments regardless of providing services online, hybrid, or offline. Therefore, there is a need for cross-country learning and deep exploration of regulatory sandboxes that have been permitted in countries such as Singapore and Australia.

2.4 Challenges and hard realities of implementing 4IR in Healthcare

This paper highlights the potential of 4IR innovations to enable strong and resilient healthcare systems. It is not claimed that 4IR is a panacea to all healthcare problems but without ambitious plans to leverage such technologies, it is hard to comprehend how Asia-Pacific nations can navigate the “living with COVID-19 era”. It is important to note that all 4IR innovations, including AI and digital innovations, raise critical ethical and governance issues that are being debated vigorously across jurisdictions (OECD, 2019a). Such raging debates cover topics on privacy issues, safety and liability issues, (Floridi et al., 2018) medical ethics, new standards, laws, and regulations (Pagallo, 2018) that must be addressed for such innovations to take hold (Winfield & Jirotko, 2018). Such issues pose important challenges to implementing 4IR in healthcare, and are currently getting vigorous attention across stakeholders in the academia, NGOs, public, and private sectors (Pagallo, 2018).

Other challenges regarding the Asia-Pacific region include disparities within and across countries in the access to digital infrastructures, wide disparities in human resource capabilities, leadership and governance, and lack of adequate investments. These hinder the implementation of reforms and innovations in healthcare. Based on the review of current healthcare and digital environments and healthcare strategies across regions and scanning through different regional datasets, this paper provides some preliminary suggestions for addressing such challenges. However, challenges notwithstanding, policymakers, stakeholders, and healthcare planners across the region should not ignore the urgent need to rethink healthcare systems as we have articulated above.

3. Scaling 4IR innovations and hybridtact healthcare

This paper has shown how the 4IR innovations are transforming the healthcare sectors. From contact tracing and disease surveillance tools in Viet nam and telemedicine in Singapore, Australia, etc., to digital-enabled micro-insurance platforms, AI and big data in healthcare, and 5G transformation in China, innovations are mushrooming everywhere, although in a fragmented fashion. In addition, in the last section, the paper maps possible scenarios and models for realizing hybridtact healthcare systems, including but not limited to models that augment traditional healthcare systems, purely hybridtact models, and purely online modes, and how to incentivize such systems.

To take advantage of this COVID-19 inspired transformation, policymakers across the Asia-Pacific region must ask how they can build on the momentum to scale such innovations to build more resilient healthcare systems. Within the broad 4IR context, resilience can be achieved by incorporating digital innovations into traditional systems, as articulated earlier. Planners and policymakers need to understand that some of these technologies, such as telemedicine, AI tools, digital micro-insurance, and blockchain applications can be used to strengthen healthcare from within. Furthermore, other powerful technologies such as contact tracing and disease surveillance, vaccine passes, can be the “great wall” that protects the healthcare systems from outside. For example, by creating mechanisms to identify who encountered infected persons and which patients should go to hospital and which

patients can receive treatment from the comfort of their homes. These can be activated as and when needed, such as, for example, in the “living with the pandemics” era, and heightened/lowered in normal times. Such measures, when fully operational, can build stronger healthcare systems across the region.

Moreover, COVID-19 and the “living with COVID” era have shown that when it comes to healthcare, failure to invest in stronger healthcare is catastrophic. In other words, planners have a simple choice. Invest in strong healthcare systems or you will painfully witness your systems and economies crumble during times of pandemics.

The rather simple and straightforward answer to the question of scaling such innovations is that all countries (depending on available resources, capabilities, and priorities) must pursue 4IR New Deal for hybridtact healthcare. This is defined as an ambitious investment and reform agenda to strengthen or transform or leapfrog traditional healthcare systems through the increased use of 4IR technologies. How this will look in practice depends on the country’s level of ambition.

In fact, as Table 2 below shows, different countries across the region have proposed or are in the process of implementing some form of digital transformation agenda for healthcare, with varying levels of ambition. Some are ambitious while others are lukewarm and fail in providing the level of investments needed to build stronger healthcare systems that can withstand the “living with COVID-19” era and future pandemics.

Table 2: Digital healthcare strategies in the Asia Pacific

COUNTRIES	Digitalization Initiatives and Policy Strategies in Asia-Pacific region
AUSTRALIA	National Digital Health Strategy, My Health Record, telehealth, electronic prescriptions, workforce education, an extensive community engagement programme 79 million Australian dollars ²⁴
BANGLADESH	e-health, telemedicine, automated patient management protocol, interoperability, cross-border data security, proper use of information ²⁵
BRUNEI DARUSSALAM	Comprehensive Health Information System (such as Bru-HIMS) ²⁶
CAMBODIA	MyCLNQ telehealth consulting services - Through this collaboration, patients in Cambodia can access cross-border health consulting services, especially overseas doctors consulting from Singapore, India, and other Asian countries. This AI-enabled ecosystem can provide medication services from doctors for patients wherever they are and they can also choose to select local or overseas affordable healthcare services. ²⁷
CHINA	"Healthy China 2030" strategy - Reform of the Medical Security System integrating different ecosystem players from the medical, pharmaceutical, and health insurance fields. The government aims to resolve the mismatch between medical and health demand and supply, and provide cost-effective medical and health services to people. Genetic, diagnostic, behavioural, and health service consumption data. Online medicine purchase, insurance direct billing, and online prescription medicine consultation are the main needs of consumers in digital medication services. ²⁸
FIJI	HIS-CIS Strategy - Appropriate technical infrastructure, patient administration system, birth and mortality data systems, clinical information systems, surveillance systems and registries, routine health information systems, human and organizational development, data analysis and presentation, and data quality and coding improvement ²⁹
HONGKONG Special Administrative Region of China	Book and check appointments, pay hospital authority bills and drug charges, view medication and dispensing records for the past two years, and access multi-media rehabilitation games and videos. ³⁰

²⁴ See: <https://nationalstrategy.digitalhealth.gov.au/>

²⁵ See: <https://www.who.int/bangladesh/news/detail/03-01-2021-advancing-digital-health-strategy-in-bangladesh> and <https://dghs.gov.bd/index.php/en/publications/other-publication/ehealth>

²⁶ See: <http://www.moh.gov.bn/SitePages/Healthcare%20Technology.aspx>

²⁷ See: <https://m.phnompenhpost.com/business/digital-healthcare-venture-struck>

²⁸ See: <https://www2.deloitte.com/cn/en/pages/technology/articles/deloitte-and-axa-digital-health-whitepaper.html>

²⁹ See: <https://www.health.gov.fj/wp-content/uploads/2018/03/HIS-CIS-Strategy-2016-2020.pdf>

³⁰ See: <https://www.lexology.com/library/detail.aspx?q=71ab8300-31ba-4327-a3a9-01a6cc497349> and <https://www.legco.gov.hk/research-publications/english/essentials-2021ise14-development-of-telehealth-services.htm>

INDIA	National Digital Health Mission unique digital health ID, mission will enable access and exchange of longitudinal health records of citizens with their consent, Healthcare Professionals Registry (HPR) and Healthcare Facilities Registries (HFR), PM-DHM Sandbox. Interoperability within the digital health ecosystem, similar to the role played by the Unified Payments Interface in revolutionizing payments. Rs. 1,182,000 so far ³¹
INDONESIA	Indonesia has allocated 3.5 billion American dollars of its 2021 budget to fund its universal healthcare coverage. e-pharmacy, online consultation and appointment booking, and healthcare IT solutions ³²
JAPAN	In the healthcare field, the government will dedicate specific funds to the promotion of digitization of data in the long-term care (3.6 billion yen) and in the disability fields, set up a system for digital prescriptions (6.1 billion yen) and the digitization of welfare services. Telemedicine, telepharmacy, medical apps, devices, medical data, AI hospitals, and insurance reimbursement, Personal Health Records (PHR) ³³
REPUBLIC OF KOREA	Contact tracing, vaccine pass, telemedicine, mass SMS, updating of privacy law, funding and public call for start-up and tech companies to participate in technology development and roll out. 5G-powered hospital Yonsei, electronic health record system. In 2021, the national research and development budget on digital health was 850 million American dollars ³⁴ .
LAO PEOPLE'S DEMOCRATIC REPUBLIC	Digital information systems, e-health processes, and distance learning ³⁵
MALAYSIA	Mobile diagnostics, M2M Remote Patient Monitoring, Biosensor tattoos, 3D printing ³⁶
MONGOLIA	e-Health, telemedicine, UpToDate App ³⁷
MYANMAR	e-health, m-health, my doctor, telemedicine, HOPE telecare ³⁸
NEPAL	Health Net telemedicine, Hello Health, digital health information management system DHIS2 (electronic or e-reporting), and the IMIS digital software

³¹ See: <https://www.forbes.com/sites/enriquedans/2020/08/17/how-indias-national-digital-health-mission-is-set-to-revolutionize-healthcare/?sh=42fc50781147>

³² <https://www.thejakartapost.com/news/2021/09/07/potential-and-challenges-of-telemedicine-in-indonesia.html>

³³ <https://languagewise.com/going-digital-the-future-of-healthcare-in-japan/> and <https://cosmopr.co.jp/en/the-1st-cosmo-innovation-seminar-en/>

³⁴ See: <https://blogs.bmj.com/bmj/2021/09/24/south-koreas-my-healthway-a-digital-highway-of-personal-health-records-but-to-where/>

³⁵ See: <https://www.thestar.com.my/aseanplus/aseanplus-news/2021/04/01/laos-seeks-to-improve-healthcare-with-better-digital-information-systems>

³⁶ See: https://www.moh.gov.my/moh/resources/Penerbitan/02-Future_of_Digital_Healthcare-Malini.pdf

³⁷ See: <http://ehp.mn/eng/>

³⁸ See: http://www.mohs.gov.mm/ckfinder/connector?command=Proxy&lang=en&type=Main¤tFolder=/Publications/Power+Point_2018/64th+MMA+Power+Point_2018/&hash=a6a1c319429b7abc0a8e21dc137ab33930842cf5&fileName=Digital+Healthcare.pdf

	platform for managing Nepal's social health insurance. ³⁹
NEW ZEALAND	National Health Information Platform, e medicine, telehealth, patient portal ⁴⁰
PAKISTAN	E-Vaccs, d-Health clinic, a digital library, TeleHealth clinic, Disease Surveillance System (DSS), Health Watch ⁴¹
PAPUA NEW GUINEA	mSupply ⁴²
PHILIPPINES	Telemedicine, electronic medical records, Kira Kontra COVID chatbot, unified enterprise architecture, remote care ⁴³
SINGAPORE	Digital platforms for scheduling appointments and checking lab results, IHiS's focus would be to look at how to improve the patient service journey. Community care management/post discharge care management, interoperability between systems, telehealth, m-health, mindlinE ⁴⁴
SRI LANKA	<p>To increase the electronic medical records coverage of the selected hospitals up to 80 per cent for the total number of patients who access the health services</p> <p>To ensure availability of updated and accurate information for patient care and planning of health services.</p> <p>To improve quality and efficiency in service delivery, governance, accountability, and effective use of resources of the government hospitals</p> <p>To improve the capacity of health authorities to detect emerging and re-emerging diseases and take necessary preventive actions.⁴⁵</p>
THAILAND	<p>Health 4.0</p> <ul style="list-style-type: none"> • Strategy 1: Establish a central organization for eHealth management and cooperation. • Strategy 2: Develop and improve enterprise architecture and infrastructure that are available to support eHealth services to the public. • Strategy 3: Establish standards of Health Information System, effective data integration, and interoperability. • Strategy 4: Promote and develop eHealth innovation, services, and applications which provide benefits to health care delivery system and patients and consumer protection including licensing regimes.

³⁹ See: https://www.mohp.gov.np/attachments/article/368/Nepal_e_health_strategy_Eng.pdf

⁴⁰ See: <https://www.health.govt.nz/our-work/digital-health/digital-health-strategic-framework>

⁴¹ See: <http://digitalpakistan.pk/pdf/d-health.pdf>

⁴² See: <https://reliefweb.int/report/papua-new-guinea/papua-new-guinea-2020-digital-health-factsheet>

⁴³ See: <https://www.bworldonline.com/digital-acceleration-in-philippine-healthcare>

⁴⁴ See: <https://www.moht.com.sg>

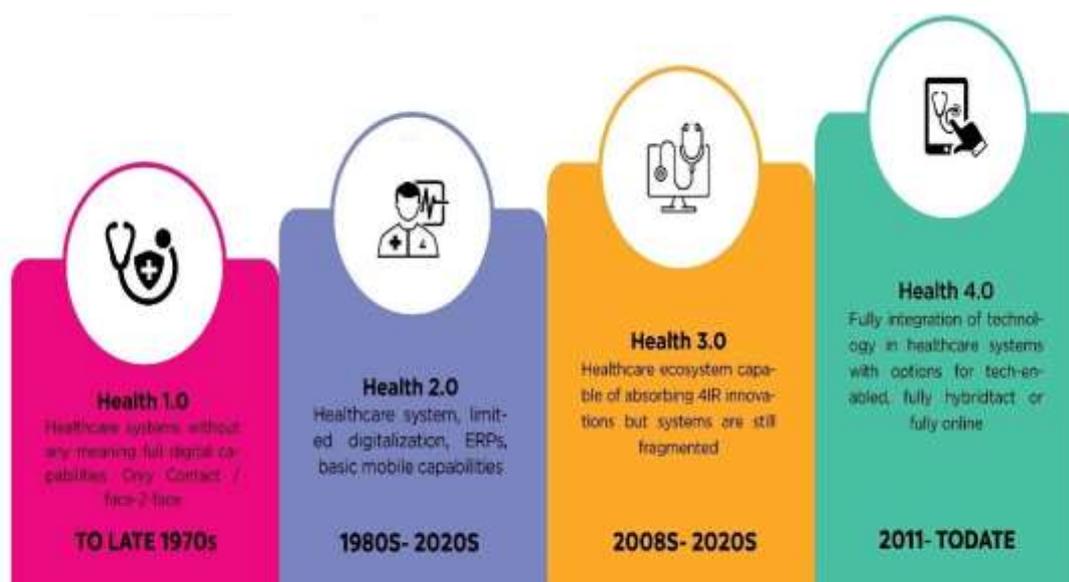
⁴⁵ See: <https://www.icta.lk/projects/digital-health/>

	<ul style="list-style-type: none"> • Strategy 5: Establish laws, regulations, compliances, and standards of ICT in healthcare. • Strategy 6: Develop human capital in eHealth and ICT knowledge management in healthcare⁴⁶
VIET NAM	Doctor Anywhere, JioHealth, Mydoc, VieVie, Healthcare BuyMed ⁴⁷

3.1. Defining the Digital Context for 4IR enabled Healthcare in the Asia Pacific

It is necessary to recognize the diverse capabilities of each country and across the Asia-Pacific region to implement hybridtact healthcare systems. Simply put, the less the country's digital capabilities, the more ambitious investments required, but that also means more opportunity to leapfrog traditional healthcare systems. To illustrate further, this paper presents a preliminary and admittedly imprecise (somewhat biased) but important model, in which countries across the region can use to gauge their present capabilities.

Figure 9. The Fourth Healthcare Revolution



Source: Author's estimates based on historical trends of ICT in healthcare

⁴⁶ See: https://ict.moph.go.th/upload_file/files/eHealth_Strategy_ENG_141117.pdf

⁴⁷ See: <https://assets.kpmg/content/dam/kpmg/vn/pdf/publication/2021/digital-health-vietnam-2020-twopage.pdf>

As Figure 9 shows, there are at least four stages in the development of hybrid-tact healthcare system. As depicted, the first is Health 1.0, which is defined as the stage where traditional healthcare systems are without any digital capabilities. All countries in the Asia Pacific have passed this stage as even the least developed ones are likely to have basic computing and traditional electronic resource planning (ERP) capabilities by now.

The next stage is Healthcare 2.0, which is the stage where traditional healthcare systems have basic digital capabilities, including basic ERPs, and some mobile capabilities such as simple micro-insurance schemes, text-based healthcare services, and fragmented pockets of fragmented digital innovations, but nothing on a national scale. Healthcare 2.0 is typically found in countries with insufficient fixed and mobile broadband infrastructure, limited digital innovation capabilities, limited meaningful connectivity (defined as availability of 4G connections, access to smart phones, availability of data, and regular internet use), limited human resources capabilities to take advantage of innovations, and low rural-urban migrations. Many low-income countries are at this stage in their healthcare journeys. This also means that there is massive room to leapfrog traditional systems – provided countries have ambitions to reimagine their healthcare systems.

Health 3.0 is the stage where healthcare ecosystems advance and absorb 4IR innovations in their value chain, including various healthcare touch points, and end-to-end integrations. Such ecosystems can be scaled at national-level innovations, such as contact tracing technologies, telemedicine, vaccine passes, and AI-enabled services. Healthcare 3.0, which can be found in countries with near-full meaningful connectivity, such as over 90 per cent 4G coverage, over 90 per cent smartphone ownership, availability of data, and regular internet use. Such ecosystems have strong fixed and mobile broadband networks,

widely available digital innovation capabilities, and high urbanization. Many high-income Asia-Pacific countries are at this stage, while some middle-income countries are hovering between healthcare 2.0 to healthcare 3.0. The sad reality in some advanced countries is that because they also have strong and well-established traditional healthcare systems, there is a lot of resistance to the transformation of such systems from established healthcare actors, including public and private hospitals. However, COVID-19 and “living with COVID-19” should provide reasons for them to rethink their resistance to innovations.

Healthcare 4.0, a stage in which resilient and strong healthcare systems integrate the best of traditional face-2-face healthcare systems with the best of 4IR innovations to provide accessible, interoperable, hybrid-tact healthcare at a national and international scale. With such systems, a nation has the capability to provide nationwide end-to-end healthcare services with options for receiving it from 4IR-augmented providers, hybrid-tact providers, or fully-online providers. Such a country is also able to scale its services across borders. Full interoperability and integration enable cross-border healthcare systems such as sharing of vaccine passes and contact tracing in times of pandemics.

A handful of countries in the Asia-Pacific region are nearing such capabilities, although there remains a lot of work and reforms that need to be taken to realize their potential.

With the aforementioned rough framework, the paper provides some broad and specific suggestions in the next section. Providing high-level recommendations require much deeper studies and understanding of what has been done, and different contexts, for this is not a one-size-fits-all scenario. Therefore, the paper limits to preliminary suggestions that are based on a review

of the current healthcare environments across the region, the ongoing rapid changes across the region, and a review of multiple datasets and strategies pertaining to healthcare in the Asia-Pacific region.

3.2 General Preliminary suggestions

COVID-19 and the era of “living with the pandemic” have provided multiple reasons for stakeholders across the Asia-Pacific region to turn to digital innovations as a means of building resilient healthcare systems. However, to realize the full potential of such innovations, all Asia-Pacific countries must set more ambitious investment and reform agendas. This requires nothing short of a “4IR New Deal for Healthcare”, which was previously defined as systemic reforms and investment plans to restructure and upgrade traditional healthcare systems with the aid of digital technologies. Such ambitious agendas will support countries not only to withstand COVID-19 but also protect them against other highly infectious diseases, including the feared Disease X. The paper argues that without such ambitions and serious level of investments, it is hard to see how the currently severely-affected healthcare systems can withstand waves of COVID-19, take care of other existing diseases, and build resilience within the system.

The second general preliminary recommendation is that such ambitious plans must be accompanied by institutional frameworks and organizational arrangements at the highest level to drive the implementation of such reforms. The level of investments and institutional/organizational arrangements can differ depending on the country’s current capabilities and political priorities. Below, we outline suggestions designed for countries depending on their stage of healthcare system development.

3.3. Specific preliminary suggestions

3.3.1 Countries in Healthcare 2.0 brackets

It is suggested that the broad agenda of such countries in the early stages of digital transformation is to set ambitious plans for leapfrogging traditional systems with digital innovations, including accelerating the provision of higher-quality broadband (fixed and mobile) infrastructures, ensuring that healthcare systems are connected, have access to devices, training programmes, etc. This requires committed leadership and governance to champion, such a vision, in collaboration with private sector innovators. At the very least, this must include (but not limited to) the following:

- **Start with what you have:** All Asia-Pacific countries, including low-income countries, have some building blocks to kick-start the journey towards hybrid digital healthcare systems. For example, they have a wide coverage of 3G and improved levels of 4G networks (refer to appendix data). Some LMICs in the Asia Pacific, including Mongolia, Viet Nam, and Kazakhstan, among others, have a high coverage of mobile infrastructure, improving economic status, which means that populations can afford smart phones, data, etc. Such environments, when coupled with new 4IR innovations, will enable leapfrogging of traditional healthcare systems, especially in cities and urban areas.
- Similarly, now is the time for such countries to improve investments in their digital capabilities, including training for healthcare providers to use such tools. One possible suggestion is to ensure that all medical training schools implement digital and ICT curricula as part of medical training.
- **Unlocking 4IR innovations:** pursue a “by all

means necessary policy” to promote market-oriented innovative players. These innovations, including telemedicine, vaccine passes, and AI-enabled systems, mostly come from start-ups, and countries must start identifying and nurturing start-up ecosystems where such innovations might arise. Since developing countries generally have weak start-up ecosystems due to underdeveloped science and technology education capabilities, there is a need to tap into foreign start-up talents with good incentives. In the early years, such innovations may be limited to urban centres where income levels are relatively high and there is infrastructure to support such innovations. However, how about the poor in rural areas and slums with poor access to resources? In the preliminary stage, the 4IR New Deal for healthcare should prioritize improving access to cheaper connectivity and figuring out how such populations can access smartphones, and user-centred designs.

- **Implement innovative healthcare payment/insurance models,** including technology-driven micro-insurance schemes to reduce dependence on out-of-pocket expenditure on healthcare, and encourage digital-enabled pooling of resources and risks. China’s innovative approaches, such as Xiang Hu Bao (“mutual protection”), provides a good benchmark model for any country with sufficient mobile communications infrastructure. Similar innovations are transforming the health insurance markets in Africa; for example, M-TIBA in Kenya.
- **Unlock data sharing and promotion of interoperability and integration.** The starting place to unlock healthcare data in countries with Health 2.0 systems is to ensure that all citizens have access to

reliable IDs with interoperable capabilities. In other words, an ID that can be shared across different healthcare touch points regarding whether a patient is registered for micro-insurance, visiting a doctor for routine check-up, having their records linked to ID, receiving insurance claims, or collecting data for policy. Many rich Asia-Pacific countries have resolved this issue. However, many of their neighbours have no access to reliable ID systems (Asian Development Bank, 2016), and this must be prioritized at the highest political level, including making decisions on whether to accelerate the implementation of centralized or decentralized digital ID systems.

3.3.2 Countries in Healthcare 3.0 Brackets

Countries in healthcare 3.0 brackets generally have all the building blocks for hybrid healthcare systems in place. For example, they have robust digital readiness, strong technology and innovation capabilities, financial capabilities to invest in transformations and reforms of the healthcare systems, and generally strong and innovative private sectors. The next challenge is to tap these capabilities and the momentum and environments forced on them by COVID-19 to oversee the transition of healthcare systems to stronger and resilient hybrid systems. An ambitious agenda for healthcare transformation in such countries must include (but not limited) the following:

- **Policy to end technology Luddism and inertia in the healthcare sector.** Technology Luddism is the tendency to resist innovations typically in established systems, even though innovations and ecosystems are ready for such innovations. The first and most urgent policy agenda of many advanced Asia-Pacific nations is to fight this tendency at all costs, especially building on COVID-19 and “living with

COVID-19” era momentums/shifts. Basically, policymakers should use everything in their powers to stop this tendency. It makes no sense for such countries to suffer because of COVID-19 when they have innovations that can at the very least ease their healthcare systems’ burdens.

This suggestion may sound strange and counter-intuitive considering how advanced these countries are, but the reality is that there is a lot of resistance to 4IR innovations by established ecosystems who “fear” imagined or real disruption even though such innovations may be need to transform and make the system stronger and more resilient. Thus, we are generally observing the implementation of 4IR innovations around healthcare systems such as contact tracing technologies and vaccine passes, but some countries are afraid of taking bold initiatives to transform the system from within using transformative technologies (e.g., telemedicine).

It is important that such governments establish policy levers to nudge “old ways of thinking” about reforms. In countries like Singapore, regulatory sandboxes appear to be encouraging 4IR innovations in healthcare (however, we do not suggest that Singapore is one of those countries with Luddites). Other bold suggestions may include carrot and stick policies, such as linking strategic funding in healthcare to innovations, that is, governments provide funds on conditions of technology adoption and reforms, mobilize both public and private actors and innovators to work towards reforms, and provide income guarantees to healthcare workers. Other policies may include sticks and stone policies – force technology adoption

within the healthcare systems. The past two years of experience with contact tracing and vaccine pass controversies should provide good templates for achieving this.

Finally, governments may provide technology mergers and acquisition funds to public and private healthcare actors to enable them to acquire innovative start-ups that will help them become innovative and transition to hybrid healthcare systems. This is one of the approaches that big tech firms use to keep innovating, and governments may take some cue to facilitate technology transfers to historically technology-resistant healthcare ecosystems.

- **Promote start-up ecosystems in the healthcare sector.** This can be achieved by leveraging the immense innovative capabilities in rich Asia-Pacific countries, typically thanks to decades of good investments in high-quality science, technology, and entrepreneurship education systems. Now that these countries have innovators, it is time to let these “thousand flowers bloom” in regard to these entrepreneurs. The strategies that have proven successful in several high-income Asia-Pacific countries include providing start-up seed funding, and digital incubation and innovation centres that enable the sharing of entrepreneurship training and support to scale digital innovations. Such incubation centres typically provide free/subsidized high-quality facilities, broadband access, and provide promising engineers and entrepreneurs the space they need to innovate.

The next step is to provide policy and regulatory certainty. Some forward-looking and agile Asia-Pacific countries

like Singapore are achieving this through regulatory roadmaps that assures transitions from regulatory sandboxes to laws that guarantees that innovations that have emerged in the past two years including telemedicine providers, vaccine pass, etc., will have business post-COVID-19 (whenever that will be). Singapore, for example, has a LEAP sandbox system that has allowed such innovations to bloom in the past two years and has a road map to license telemedicine services under the Healthcare Services Act (HCSA) that will be enforced in 2022. Other Asian countries that have no clear plans on what to do with these innovators after their growth in the past few years may consider benchmarking the Singapore model.

- **Promote reform in data sharing regimes, laws and investments:** Data has been dubbed the new “oil” that is driving the 4IR, but it is a very sensitive topic in the healthcare sector and mostly for the right reasons. Healthcare data is by its nature very private and safety-sensitivity and can easily be abused if made available without proper standards. Think of what might happen if insurance providers have access to terminally ill patients that require expensive treatments. Will they easily have incentives to provide insurance coverage to those patients? Another extreme hypothetical example is if AI algorithm-driven-tech companies have access to such sensitive data, all sudden users may be exposed to all sorts of unwarranted healthcare recommendations, as we are already witnessing when searching for normal products.

In short, there are many reasons for applying stringent laws when it comes to such data. However, these regulations limit innovations in the healthcare sector, which

typically require sufficient and unbiased data to prove that they work. AI-driven algorithms in healthcare is an example. For policymakers, the tricky part is to find a balance between laws and standards and promote innovation.

There are no easy answers to this complex issue, but some suggestions may include opening up anonymized data with strict limits on how it can be used in healthcare settings; for example, prohibiting the

selling of such data and ensuring that it is used only for hybridtact healthcare innovations. Another suggestion is to provide R&D funding for data standardization and sharing platforms in healthcare. Finally, governments must encourage research and open discussions on these issues to find lasting solutions, such as funding data institutes to provide lasting technology and policy solutions to this complex issue.

4. Strategies and Recommendations for Regional cooperation

The COVID-19 pandemic is severely pummeling every aspect of human life across the Asia-Pacific and the world. In its path is pain and unbearable suffering in all countries rich and poor. It may as well be the first time in recent memory that the whole world is gripped by one issue at the same time. And throughout this crisis, the region is learning (or should be) some fundamental lessons. One is COVID-19 made it crystal clear that the Fourth Industrial Revolution (4IR) is a new endless frontier: for example, as many countries-imposed lockdowns, digital technologies have stepped in to keep the world running. Throughout the document, we have given examples of how such technologies are at the forefront of fighting the pandemic. But it's not only healthcare; it is every aspect of our economies!

Thus, the reality is that countries that have digital infrastructures and capabilities to leverage 4IR technologies (China, Singapore, and the Republic of Korea –to name but a few) are the ones that have more resilient healthcare systems, and therefore the economy. And they are the ones that are reaping the dividends of such innovations in healthcare, education and to partially or fully opening their economies. But even if they are closed off to the outside, such as in China, they have functioning economies and systems, partly thanks to such technologies.

Therefore, countries have to urgently fight at least on two fronts, 1) fighting and defeating the COVID-19 Pandemic and 2) building/rebuilding resilient healthcare and economic systems on foundations of 4IR-Powered economies. On a side note, Climate change is an important issue but is

hogging more attention than those two critical issues at a multi-lateral level. It's the author's view that this is a mistake!!! Addressing the digital divide and ensuring vaccine inequity (at a multi-lateral level) are equally important as climate change.

Countries cannot fight on one front and leave the other! But while wealthy Asia Pacific nations such as the USA, China, Japan, Singapore, the Republic of Korea, etc., can and are addressing such fronts with full-population vaccination campaigns and ambitious plans to rebuild their infrastructures including the digital infrastructures, For example, 1.2 trillion dollars in infrastructure and broadband spending in the USA, Green and Digital New Deals in the Republic of Korea, Similar, ambitious plans in Japan, Singapore etc. Other poorer Asia-Pacific nations whose economies depended partly/or largely on now suffocated tourism, commodities, and remittances cannot fight on all fronts! So, these severely battered countries may be facing a catastrophic human failure on all fronts. This means more death due to COVID-19, longer delays reopening their economies, and economic inequality and inequities, unlike anything the region experienced before.

But things don't have to be this way, which brings us to another fundamental lesson that the Asia-Pacific region is (or should be) learning from the COVID-19 Pandemic. That the world is one large neighbourhood; Prof. Kishore Mahbubani rightly called it a "concatenated world". For example, when Wuhan caught COVID-19 back in late 2019, the rest of the region and world got infected. Put another way, "when Wuhan is well, then the

region is well". Similarly, when Bangladesh's health, economic and supply chains systems, bulks at a weight of COVID-19, it sends a ripple effect across the region and the world that relies on its hardworking and enterprising people for apparel. Therefore, it is in the interest of every country to collaborate and work together to fight COVID-19 with every available tool, including vaccines, social distancing, and digital innovations. And to collaborate on building more resilient healthcare and economic systems using 4IR innovations as one of core pillars. The following section outlines some preliminary suggestions to promote collaborations on 4IR and the fight against COVID-19 pandemic with more emphasis for developing Asia-Pacific countries.

4.1 Towards a 4IR "NEW DEAL" and MARSHALL PLAN" for healthcare in Asia Pacific

Within the above contexts, this paper argues for a more ambitious regional cooperation agenda to help countries fight the Pandemic and rebuild more resilient healthcare systems. "4IR NEW DEAL" and "4IR MARSHALL PLAN".

At a national level, every country, not just the rich countries will need a "4IR NEW DEAL" agenda for more systemic investment to scale implementation of digital innovations and structural transformation of healthcare systems and resilient economic systems. This was earlier defined as hybridtact transformations. What is puzzling in recent times, following COVID-19, many rich countries have put forward such ambitious digital agendas, even though they already have solid-digital innovation ecosystems while poorer neighbours, who need even more investments to catch up have not mastered coherent and strong digital transformation agenda. Without "hard cash" investments, it's hard to comprehend how they will navigate the "living with COVID-19 eras!

Within the multi-lateral frameworks in Asia-Pacific, there is a great need for a more ambitious

investment agenda to fight COVID-19 and invest in the fourth industrial revolution, and digital transformation agenda's especially in emerging Asia Pacific countries. We define this as "4IR MARSHALL PLAN," drawing inspiration from the post-world 2 Marshall Plan that helped to rebuild Europe's infrastructure and economies following the Second World War. The hard truth is that COVID-19 is suffocating most economies in APAC and across the world. Many countries especially poor countries might not have much room to fight the Pandemic and invest in much-needed infrastructure to build healthcare and economic systems resilience. However, the consequences of inaction cannot be imagined. These countries are facing healthcare and economic systems that may collapse due to the COVID-19- Pandemic.

Beyond healthcare, these countries are looking at millions of children and college-going citizens not able to access education simply because their schools don't have digital capabilities to continue with education during the living with COVID-19 era. These countries are facing economic inequality at an unprecedented scale. For instance, using their robust digital infrastructures and ecosystems, the rich APAC countries have turned on the digital switch to keep the economies running-powered by work-from-home, home shopping, online-banking, and digital supply chains, etc. Their kids and college-aged populations just turned to online learning. Their healthcare systems turned to telemedicine, AI-chat bots, and vaccine passes, contact tracing, etc., to keep everyone safe. And everyday people turned to online systems for mental health and staying connected etc. On the other hand, the "LARGE DIGITAL DIVIDE" and COVID-19 have crippled such services in poorer Asia Pacific countries. Countries and governments and multi-lateral level shouldn't bury their heads in the sand at this enormous crisis. Failure to cooperate in the fight against the COVID-19 Pandemic and mobilize resources for meaningful investment in

infrastructure will not be each nation's failure, and it will be a regional failure and a moral failure across the region.

4.2 Preliminary suggestions

• **Focus on vaccinations equality to reduce pressure on the healthcare systems**

We don't yet know the full scope and investments needed for such ambitious agendas. However, fast and urgent support is needed to improve vaccination rates across the Asia-Pacific region. Much progress has been made in advanced Asia-Pacific to get their people vaccinated against COVID-19. For example, the vaccination rates in advanced economies such as The Republic of Korea, China, Japan, and Singapore is over 80 percent of total population. In contrast, developing countries such as Nepal, Myanmar, Bangladesh has very low vaccination rates. This ongoing inequity and inequality in accessing the COVID-19 vaccines between "advanced Asia Pacific Countries" and the "developing Asia Pacific countries is morally reprehensible. Because as we have seen this past year, the rolling out of vaccination in rich countries has provided some signs of recovery in all aspects (health, economy, and every aspect of life "back to normal"). In contrast, some developing Asia Pacific countries will have to wait "indefinitely" especially considering the new rush to give booster shots, which meaning more death, and more severe blows to these already battered economies. Worse still, the rise of new variants including the recent Omicron are showing the dangers of leaving large parts of developing worlds without equitable access to vaccines. Fixing this urgent problem along with non-pharmaceutical interventions such as social distancing and masks will help ease on pressure on the healthcare systems across the region. It remains to be seen if Asia's Asia Pacific Vaccine Access Facility, (APVAX) and COVAX—a partnership between the World Health Organization (WHO) and two international groups – the Gavi vaccine alliance and the

Coalition for Epidemic Preparedness Innovations (CEPI) – which aims to send vaccines to developing countries. —is enough to master the required investment for this enormous challenge.

• **Providing economic relief (especially) to developing APAC.**

Secondly, focus should be on how to provide increased economic relief to the most afflicted Asia Pacific countries. Such hard cash investments are urgently needed to keep many economies afloat, and support populations and businesses in these precarious times. In rich APAC countries, they simply opened the financial stimulus taps. In other words, went on spending spree and thanks to those unhinged financial interventions, they kept their populations and businesses cushioned against the worst of the COVID-19 Pandemic. They can afford lockdowns and less pressures on their healthcare systems. But how about rest of developing APAC countries some of which hosts 60 percent of world's slum population, without hard cash stimulus, how you can keep such population under strict quarantine rule? It's nearly impossible since many urban poor and slums must work to survive, meaning compromised social distancing measures, which results in more sick people, more broken healthcare systems and more deaths. Therefore, within the current multi-lateral frameworks and organisations such as Asia Development Bank (ADB), WORLD BANK, and IMF among others, there is need to provide more relief funding to developing countries to protect people and economies from the worst of COVID-19 and ease pressure on crumbling healthcare systems across the region.

• **Mobilizing investments for recovery and reform of healthcare systems in APAC**

Third, many APAC require financial support to implement hybrid-tact transformations in healthcare and economies through "digital-green innovations". Therefore, the various multi-lateral

frameworks and organisations in the Asia-Pacific, should consider mobilizing large scale investments for digital and energy infrastructure financing which will support countries especially APAC countries in early stages of digital development to upgrade or revamp their digital and power infrastructures. These two go together, because digital technologies in healthcare and economy-wide work well in places with sufficient power infrastructure. For example, it is not feasible to implement telemedicine, vaccine passes or contact tracings technologies on a national scale if a country does not have full coverage of the digital and power infrastructures. Yet such technologies are best utilized when used by large parts of the population. Therefore, such investments will support countries to upgrade their digital and power infrastructures (connecting and expanding of broadband and powerlines), digital capacity developments, support for digital technology development and adoption in healthcare and economy wide by public and private sector institutions, and the public/consumers and bridge the digital divide in APAC. Furthermore, such funding is critical to improve national innovation ecosystems including, building, and expanding healthcare and education ecosystems, capability, and capacity building in healthcare and other sectors to be able to innovate, adopt and use 4IR technologies in their value chains, development, and integration of ICT solutions in healthcare and other sectors, support of start-ups among others.

4.2.1 Preliminary suggestions for bilateral cooperation

- **Bi-lateral & multi-lateral technology cooperation**

There is need for technology cooperation for both knowledge and technology sharing across the region. In the past decade and especially the last two years, the region as emerged as a bastion of digital innovation in healthcare, but this knowledge and technology knowhow is still fragmented, kept within each country's borders and mostly found in advanced APAC countries. For example, the amazing digital transformation in, the Republic of Korea, Singapore, China, Japan, and Viet Nam on areas such as contact tracing, vaccine passes, and telemedicine among others. It is the author's informed view that such knowledge and potential is within reach for every country provided they have a bold vision to transform their healthcare. In this regard such interested countries may pursue bilateral relations for country-to-country technology learning and transfers, through MOUs, support to develop 4IR national transformation master plans, and bilateral project financing.

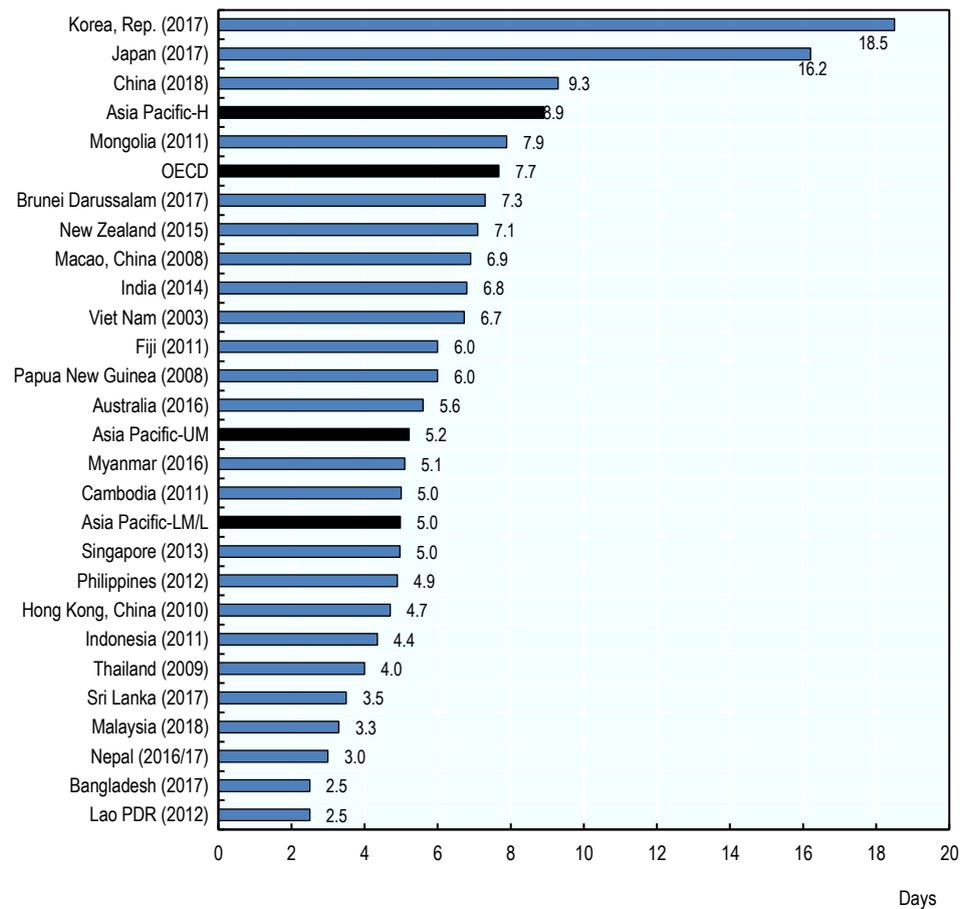
- **Technology bubbles**

Relatedly, there is need to establish "technology bubbles" which like the new travel bubbles, will be means for countries in Asia-Pacific region to share digital technology standards and data standards to enable transfer and mutual recognition of each country's healthcare data. For example, data on vaccination status can be shared through mutual bilateral and multi-lateral technology bubbles to enable movement of vaccinated travellers as is the recent case with Singapore, Korea, Malaysia among others.

ANNEX A

Additional information and data on selected healthcare infrastructure indicators in the Asia Pacific region

Figure 10. Average length of stays for acute care in hospitals, latest year available



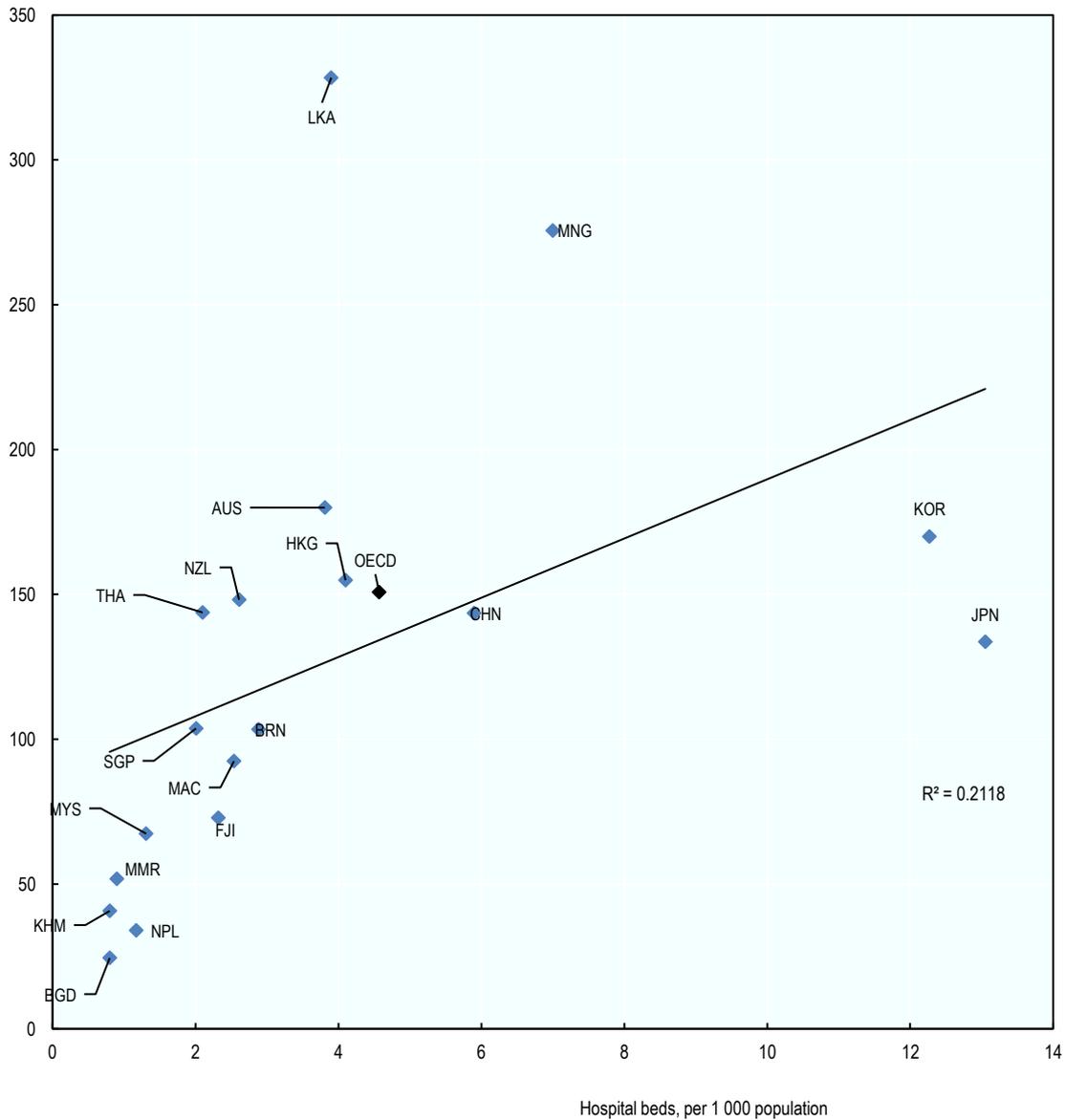
Source: OECD Health Statistics 2020; National data sources

[StatLink https://stat.link/nrod5i](https://stat.link/nrod5i)

Source: OECD, 2020, reproduced from latest Health at a Glance: Asia/Pacific 2020 OECD report (OECD/WHO, 2020)

Figure 11. Hospital beds per 1 000 population and hospital discharges per 1 000 population, latest year available

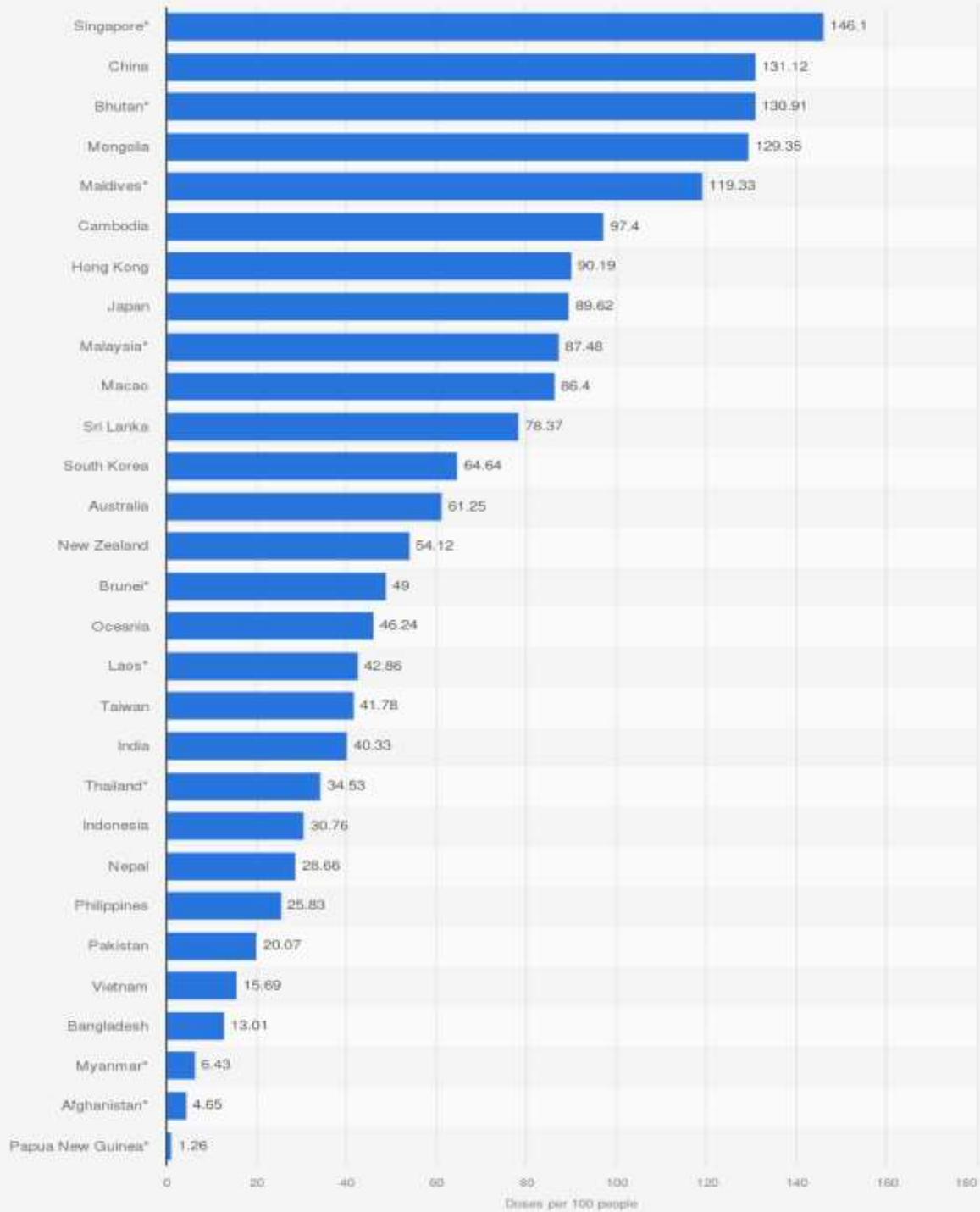
Hospital discharges, per 1 000 population



Source: OECD Health Statistics 2020; WHO GHO 2020.
StatLink <https://stat.link/vwayh1>

Source: OECD, 2020, reproduced from latest Health at a Glance: Asia/Pacific 2020 OECD report (OECD/WHO, 2020)

Coronavirus (COVID-19) vaccination rate in Asia-Pacific as of August 17, 2021 (in doses per 100 people)



Source:
OWID
© Statista 2021

Additional Information:
APAC; as of August 17, 2021

Table 3. Dashboard on healthcare resources in Asia Pacific

▲ Higher than ● Close to ▼ Lower than central tendency

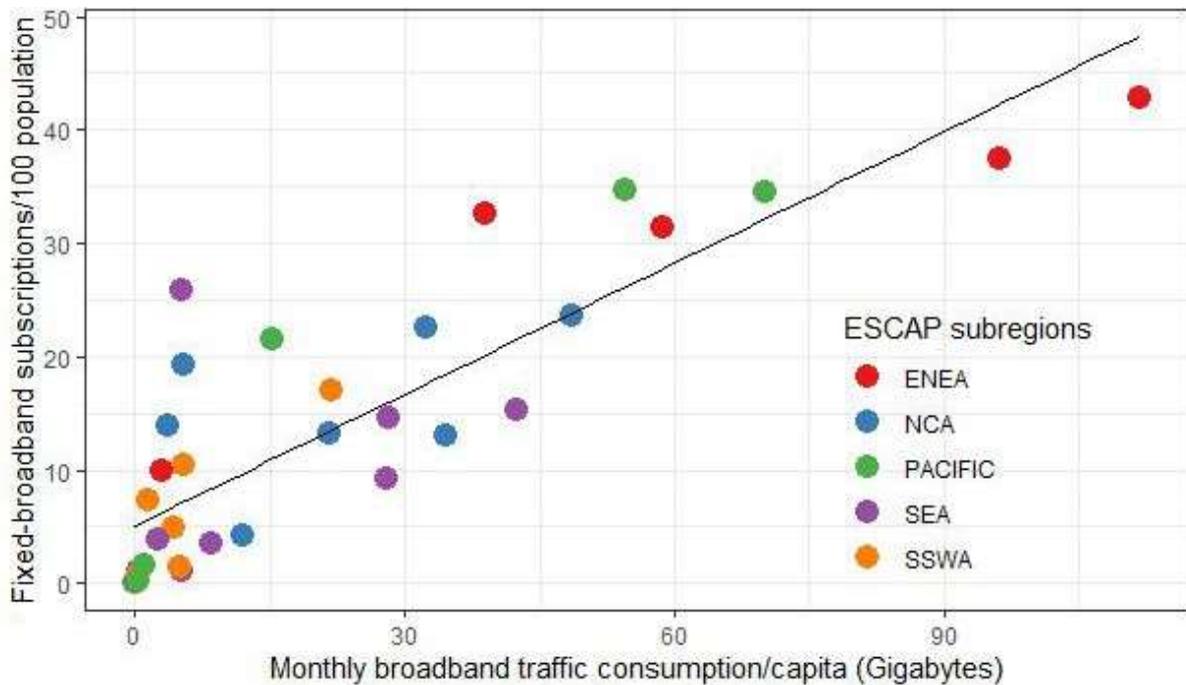
Country	Health spending	OOP spending	Doctors per 1 000 population	Nurses per 1 000 population	Hospital beds per 1 000 population
	USD international per capita	Share of health spending	Number	Number	Number
High income	4018.8	15.9	2.4	7.4	3.4
Australia	4816.2 ▲	18.2 ●	3.7 ▲	11.7 ▲	3.8 ●
Brunei Darussalam	1875 ▼	5.2 ▼	1.6 ▼	5.9 ●	2.9 ●
Hong Kong, China			2.0 ●	7.6 ●	4.1 ●
Japan	4563.5 ●	12.8 ●	2.4 ●	12.2 ▲	13.1 ▲
Korea, Rep.	2980.2 ▼	33.7 ▲	2.4 ●	7.3 ●	12.3 ▲
Macau, China			2.6 ●	3.7 ▼	2.5 ●
New Zealand	3767.5 ●	13.6 ●	3.6 ▲	11.9 ▲	2.6 ●
Singapore	4270 ●	32.1 ▲	2.3 ●	6.2 ●	2.0 ●
Upper-middle income	670.9	36.1	1.0	2.8	2.1
China	841.1 ●	36.1 ●	2.0 ▲	2.7 ●	5.9 ▲
Fiji	322.8 ▼	15.6 ▼	0.9 ●	3.4 ▲	2.0 ●
Malaysia	1139 ▲	37.9 ●	1.5 ▲	3.5 ▲	1.3 ●
Sri Lanka	503.6 ●	49.8 ▲	1.0 ●	1.7 ▼	3.9 ▲
Thailand	670.9 ●	11.1 ▼	0.8 ●	2.8 ●	2.1 ●
Lower-middle and low income	238.2	53.0	0.6	1.3	1.0
Bangladesh	94.3 ▼	73.9 ▲	0.6 ●	0.4 ●	0.8 ●
Cambodia	238.2 ●	60.4 ●	0.2 ●	0.7 ●	0.9 ●
India	253.3 ●	62.4 ●	0.9 ●	1.7 ●	0.7 ●
Indonesia	367.9 ▲	34.1 ▼	0.4 ●	1.5 ●	1.0 ●
Korea, DPR			3.7 ▲	4.1 ▲	14.3 ▲
Lao PDR	177.9 ●	46.2 ●	0.4 ●	1.0 ●	1.5 ●
Mongolia	518.1 ▲	32.2 ▼	2.9 ▲	3.9 ▲	8.0 ▲
Myanmar	287.6 ●	76.2 ▲	0.7 ●	0.7 ●	1.0 ●
Nepal	150.1 ●	57.8 ●	0.7 ●	3.1 ▲	1.2 ●
Pakistan	160.6 ●	60.2 ●	1.0 ●	0.5 ●	0.6 ●
Papua New Guinea	103.9 ▼	9.0 ▼	0.1 ●	0.4 ●	
Philippines	371.7 ▲	53.0 ●	0.6 ●	4.9 ▲	1.0 ●
Solomon Islands	115.2 ▼	5.4 ▼	0.2 ●	2.2 ●	1.4 ●
Viet Nam	375.6 ▲	45.3 ●	0.8 ●	1.1 ●	2.6 ●

Source: OECD, 2020, reproduced from latest *Health at a Glance: Asia/Pacific 2020 OECD report* (OECD/WHO, 2020)

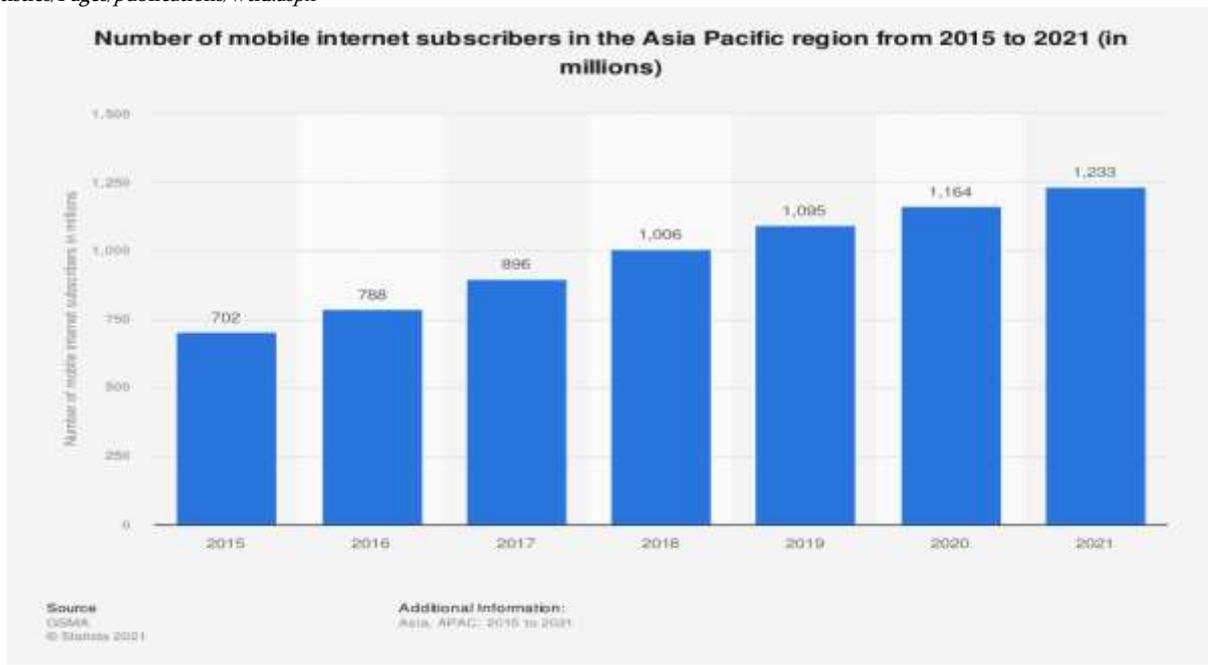
ANNEX B

Additional information and data on selected digital infrastructure indicators in APAC

Figure 12: Fixed-broadband subscriptions and Internet traffic consumption in ESCAP sub regions



Source: ITU, “World Telecommunication/ICT Indicators Database 2020 (24th Edition/December 2020)”. Available at <https://www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx>



References

- Asian Development Bank. (2016). *Identity for Development in Asia and the Pacific*. Retrieved from www.adb.org
- Cornelius Kalenzi, Lee, S. Y., & So Young Kim. (2020). *The Fourth Industrial Revolution: A New Endless Frontier*. Retrieved from <https://www.apcct.org/techmonitor/technological-innovations-control-covid-19-pandemic>
- Floridi, L., Cows, J., Beltrametti, M., Chatila, R., Chazerand, P., Dignum, V., ... Vayena, E. (2018). AI4People—An Ethical Framework for a Good AI Society: Opportunities, Risks, Principles, and Recommendations. *Minds and Machines*. <https://doi.org/10.1007/s11023-018-9482-5>
- ICT COVID-19 Response: Partnering with Technology Companies to Combat COVID-19*. (2020). (April). Retrieved from www.weforum.org
- Ip, G. (2021). 'Industrial Policy' Is Back: The West Dusts Off Old Idea to Counter China An Archipelago Solves for Clean Energy. 1–11.
- Kalenzi, C. (2020). Telemedicine can be a COVID-19 game-changer. Here's how. *World Economic Forum*, 1–5. Retrieved from <https://www.weforum.org/agenda/2020/05/telemedicine-covid-19-game-changer/>
- Kalenzi, Cornelius, Back, D., & Yim, M. (2020). Lessons from South Korea on the future of online education. *World Economic Forum*, 1–9. Retrieved from <https://www.weforum.org/agenda/2020/11/lessons-from-south-korea-on-the-future-of-online-education/>
- Keshavarzi Arshadi, A., Webb, J., Salem, M., Cruz, E., Calad-Thomson, S., Ghadirian, N., ... Yuan, J. S. (2020). Artificial Intelligence for COVID-19 Drug Discovery and Vaccine Development. *Frontiers in Artificial Intelligence*, 3(August), 1–13. <https://doi.org/10.3389/frai.2020.00065>
- Lobosco, B. K., & Luhby, T. (2021). *Here's what's in the bipartisan infrastructure package*. 7–11.
- OECD/WHO. (2020). Health at a glance. In *Tuberculosis* (Vol. 6011).
- OECD. (2019a). OECD Principles on Artificial Intelligence - Organisation for Economic Co-operation and Development.
- OECD. (2019b). The digital innovation policy landscape in 2019. *Technology and Industry Policy Papers*.
- Pagallo, U. (2018). Apples, oranges, robots: Four misunderstandings in today's debate on the legal status of AI systems. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*. <https://doi.org/10.1098/rsta.2018.0168>
- Pardi, N., Hogan, M. J., Porter, F. W., & Weissman, D. (2018). mRNA vaccines—a new era in vaccinology. *Nature Reviews Drug Discovery*, 17(4), 261–279. <https://doi.org/10.1038/nrd.2017.243>

- Soo-youn, S. (2021). *Advanced telemedicine techs limited by laws , regulations.*
- Winfield, A. F. T., & Jirotko, M. (2018). Ethical governance is essential to building trust in robotics and artificial intelligence systems. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*. <https://doi.org/10.1098/rsta.2018.0085>
- Wosik, J., Fudim, M., Cameron, B., Gellad, Z. F., Cho, A., Phinney, D., ... Tchong, J. (2020). Telehealth transformation: COVID-19 and the rise of virtual care. *Journal of the American Medical Informatics Association*. <https://doi.org/10.1093/jamia/ocaa067>