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Innovation, Transfer and Diffusion of Fourth Industrial Revolution (4IR) Technologies to Catalyze Sustainable Development in Asia-Pacific

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List of Abbreviations

4G	Fourth-generation
4IR	Fourth Industrial Revolution
ACCMSME	ASEAN Coordinating Committee on Micro, Small, and Medium Enterprises
AI	Artificial Intelligence
ASEAN	Association of Southeast Asian Nations
B2B	Business-to-Business
B2C	Business-to-Consumer
CAGR	Compound Annual Growth Rate
COVID-19	Coronavirus Pandemic
DEA	Digital Economy Agreement
DEIC	Digital Education and Innovation Centre
DFAT	Department of Foreign Affairs and Trade
DPRI	Digital Platform Restrictiveness Index
DTA	Digital Trade Agreement
ENEA	East and North-East Asia
FDI	Foreign Direct Investment
G2B	Government- to-Business
G2G	Government-to-Government
GDP	Gross Domestic Product
GDPR	General Data Protection Regulation
HUST	Hanoi University of Science and Technology
IMD	Institute for Management Development
IOM	International Organization for Migration
IoT	Internet of Things
IPR	intellectual property rights
LDCs	Least Developed Countries
MAS	Monetary Authority of Singapore
Mbps	Megabits Per Second
MoUs	Memorandum of Understanding
MTCP	Malaysia Technical Cooperation Programme
NCA	North Central Asia
NRI	Network Readiness Index
OASIS	Overall Assistance for Start-up Immigration System
PSDA	Public Service Delivery Agency
PTAs	Preferential Trade Agreements
R&D	Research and Development
RCEP	Regional Comprehensive Economic Partnership
ROK	Republic of Korea
S&T	Science and Technology
SDGs	Sustainable Development Goals
SEA	South-East Asia
SEZs	Special Economic Zones
SMEs	Small And Medium Enterprises
SSN4PSI	South-South Network for Public Service Innovation
SSWA	South and South-West Asia
START	Start-ups from Advanced Research and Technology
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme

UNIDO	United Nations Industrial Development Organisation
UNOSSC	UN Office for South-South Cooperation
USA	United States of America
WEF	World Economic Forum
WIPO	World Intellectual Property Organization

Abstract

Countries in the Asia-Pacific region are fast embracing the fourth industrial revolution (4IR) technologies and the coronavirus pandemic has fast-tracked the adoption of such technologies. At the same time, the pandemic has adversely impacted the advancements towards achieving the 2030 Sustainable Development Goals (SDGs). While many developed and some developing countries are harnessing the benefits of 4IR technologies to achieve their SDGs, there is a risk that many developing and least developed countries (LDCs) could be left behind.

Given this situation, this paper presents an overview of the status, opportunities and challenges related to 4IR technologies for sustainable development in the Asia-Pacific and draws some lessons for regional cooperation. It presents a comparison of the countries with respect to adaptation of 4IR, their strengths and the opportunities that they bring to the countries in the region. It presents cross-country examples of enabling policy mechanisms to promote 4IR technology, innovation and its applications for sustainable development; both at the national level and at the regional level. It outlines select initiatives related to facilitating innovation; 4IR-based partnerships/collaborations and transfer of technology. The paper then presents the key challenges related to innovation, development and transfer of 4IR technologies. These include low research and development spending, digital infrastructure and access gap, regulation and policy gaps, and skill and education gaps. These gaps are more prominent for the developing countries and the LDCs and are accentuated by the barriers related to cross-border technology transfer, investment and trade. To overcome these challenges, the paper makes recommendations on (a) how countries in the region can jointly harness the benefits of 4IR (b) work together to address their common concerns (c) learn from each other's best practices (d) work together to reduce the digital divide and achieve SDGs and (e) how the Asia-Pacific region can utilize the platforms of South-South cooperation and Triangular cooperation for accelerating the adoption of 4IR technologies. The paper presents a 'regional roadmap' to accelerate innovation and transfer of 4IR technologies in Asia-Pacific to achieve SDGs by 2030.

Keywords: Technology Transfer, 4IR, Sustainable Development

1. Introduction

TECHNOLOGY TODAY IS EVOLVING AT AN UNPRECEDENTED RATE LEADING TO FUNDAMENTAL CHANGES IN MANUFACTURING, SERVICES DELIVERY, TRADE, INVESTMENT AND EMPLOYMENT [UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION (UNIDO), 2019]. The fourth industrial revolution (4IR), which is a fusion of advances in multiple technologies is changing every aspect of human lives. The World Economic Forum (WEF) (2018) identified the core 4IR technologies as Internet of Things (IoT), Artificial Intelligence (AI) and Industrial Artificial Intelligence, Advanced Robotics, Enterprise Wearables, and 3D printing. The rapid shift from the physical to the digital world is reshaping industries and leading to emergence of new business models, where innovation is the key to growth (Tohanean and Toma, 2018).

The 4IR market globally, is expected to grow at a compound annual growth rate (CAGR) of 20.6 per cent from 2021 to 2026 (Markets and Markets, 2021). Contribution of AI to the global economy is estimated to be around USD 15.7 trillion by 2030, which is more than the combined gross domestic product (GDP) of China and India (PwC, 2021). Globally, the United States of America (USA), China, Japan and Singapore are taking the lead. The USA and China are projected to gain around 70 per cent of the USD 15.7 trillion windfall that AI is expected to contribute to the global economy by 2030 (Hass and Balin, 2019). China is a key player in IoT and Big Data, being a frontrunner in Big Data R&D [United Nations Conference on Trade and Development (UNCTAD)(a), 2021]. Other key markets are Japan and Republic of Korea. These three countries are also major players in the region in 3D printing and nanotechnology. In Blockchain, Asia-Pacific is predicted to grow at a CAGR of 54.4 per cent from 2021 to 2027 (Research and Markets, 2021). The IoT market in the Asia-Pacific region is estimated to reach USD 436.77 billion by 2026; with one-third of the market comprising of expenditure on smart cities (Birch, 2021). The region has two of the world's top producers of robotic systems (Japan and Republic of Korea), with global market shares of 52 and 12 per cent, respectively (Karr, Loh and Andreas, 2020).

Focusing on regional groups in Asia-Pacific, in the Association of Southeast Asian Nations (ASEAN), 35-40 per cent of manufacturing value added is expected to be enhanced through embracing of 4IR technologies (AT Kearney, 2018). AI adoption is predicted to improve employee productivity in the middle-income economies of the ASEAN region between 46 and 52 per cent, specifically in the Philippines, Malaysia, and Indonesia (Asia Foundation, 2020).

4IR has led to innovation with firms, both large and small, increasingly spending on innovation and technology. Innovation has triggered the growth of start-ups and e-commerce. A number of world's technology-based companies are headquartered in the region, with majority being in China (around 20), Japan, Republic of Korea (ROK) and India. The region also has some of the vibrant start-up ecosystems with emergence of many new start-up hubs in countries such as Philippines, Indonesia, and Vietnam. E-commerce is growing rapidly, with e-commerce market in Asia-Pacific predicted to grow at a CAGR of 18.5 per cent from 2019 to 2025 (Research and Markets, 2020). Rise in disposable incomes, growth in internet penetration, and emerging cross-border e-commerce markets are the key factors.

While some countries in Asia-Pacific such as China, Japan and Australia are embracing

technology at a fast rate, there is a risk that a number of least developed countries (LDCs), especially in South and Southwest Asia (Bhutan, Afghanistan, Maldives, etc.), North Central Asia (Azerbaijan, Kyrgyzstan, Tajikistan, etc.) and the Pacific (Fiji, Kiribati, Palau, Nauru, etc.) could be left behind. There are wide variations among the countries in the region - countries such as China have emerged as major exporters and countries such as India, Indonesia, Turkey, etc., are among the top importers of digital technology (products and services). India is also a key exporter of IT/ITes services to the world. Further, the 4IR is gradually changing geopolitical relations and the economic flows across countries in the Asia-Pacific region.

A number of countries in the region were adversely impacted by the coronavirus pandemic (COVID-19), which led to loss of human lives and livelihood and disruption of supply chains. 4IR technologies have played an important role to fight COVID-19 in many of the Asia-Pacific economies; for example, in Republic of Korea, use of AI algorithms helped in creating an effective COVID-19 test kit within two weeks. The COVID-19 pandemic has accelerated the transition towards a digital economy in the Asia Pacific. The social distancing protocols and strict lockdowns have hastened the adoption of technologies of the 4IR, which have enabled working from home, online learning, telemedicine, among others. As countries recover from the pandemic, it is now important for them to understand how the 4IR technologies can be harnessed to tackle the decline in growth, environmental and social challenges and reach the 2030 Sustainable Development Goals (SDGs).

The 4IR technologies can support inclusive growth and development and at the same time can be disruptive. For example, use of such technology in sector like agriculture can improve productivity and reduce wastages. 4IR has the potential to improve productivity, efficiency, raise income and improve the quality of life (PwC, 2018). For example, it has been projected that use of IoT in China's manufacturing processes can add up to USD 736 billion to the country's GDP by 2030[1]. A number of SDGs can be achieved through use of digitalisation and technology. In this regard, countries such as Republic of Korea, Singapore and China are seriously investing in creating AI ecosystems for innovative businesses to grow. Demand for IoT solutions (for example, smart traffic management systems and power grids) is increasing in the Asia-Pacific region, with increased focus of the governments on creating smart cities[2]. In the Republic of Korea, the smart city of Songdo is built around IoT to reduce traffic pollution, save energy and water, and create a cleaner environment.

At the same time, technology can lead to job losses due to automation. It is estimated that more than 800 million workers may be displaced by 2030 as a result of automation (McKinsey, 2017). There are concerns related to data security and privacy. There are concerns related to uneven access to technology and capabilities of countries to adapt and implement it. Nevertheless, the gains are manifolds if the technology is correctly used, supported by appropriate regulations and policies and can be accessed by all countries and the vulnerable groups like small and medium enterprises (SMEs), women or small farmers in the Asia-Pacific region.

The rapid evolution of technology is making it difficult for policymakers, especially in developing and LDCs, to regulate it. Policymakers are realising the benefits of technology as well as its threats and are keen to harness the benefits through right policies. A number of Asia-Pacific countries have come up with high-technology zones and some

1 https://iotintl.com/the-size-of-the-iot-market-in-china/ (last accessed November 20, 2021)

2 https://www.frost.com/news/press-releases/smart-cities-to-fuel-growth-of-asia-pacifics-internet-of-things-market/ (last accessed November 20, 2021)

have implemented start-up visas to attract foreign entrepreneurs to invest in their markets. Countries have come up with policies such as digital policy, AI strategy, e-commerce policy and start-up policy, to support 4IR. However, there is need for more collaboration for the diffusion of technology especially among the LDCs in Asia-Pacific. Collaborations with the leading countries and South-South collaborations can help in 4IR technology transfer and the region can as a whole harness the benefits of 4IR technologies to meet the SDGs.

1.1 Objective

Given this background, this paper presents how countries in the Asia-Pacific region are using the 4IR technologies to achieve their sustainable development goals. It presents a cross-country comparison highlighting the difference across countries in terms of policies, infrastructure, and access.

It also presents the strengths and the opportunities that 4IR technologies brings to countries in the region. The paper presents the challenges related to innovation, development and transfer of 4IR technologies and makes recommendations on how countries in the region can jointly harness the benefits of 4IR by working together to address their common concerns and by learning from each other's best practices. It also presents a 'regional roadmap' to accelerate innovation and transfer of 4IR technologies to achieve SDGs by 2030 and how platforms like South-South cooperation and Triangular cooperation can be used to accelerate the adoption of 4IR technologies.

2. METHODOLOGY

The paper is based on secondary information and data analysis. The cross-country comparative data has been sourced from sources such as the World Digital Competitiveness Index by Institute for Management Development (IMD), Network Readiness Index by the Portulans Institute, and Global Innovation Index by World Intellectual Property Organization (WIPO). Asia-Pacific has a total of 53 member countries and 9 associate member countries located in five major sub-regions [United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), 2019] – East and North-East Asia (ENEA)[3], North Central Asia (NCA)[4], the Pacific[5], South-East Asia (SEA)[6], and South and South-West Asia (SSWA)[7]. We have selected some representative countries across these regions based on availability of data to make the cross -country comparisons. The USA is a leader in 4IR technology and plays a lead role in diffusion of technology in the Asia-Pacific region. We have added the USA to present the comparison.

The paper specifically focuses on two SDGs – SDG 9: Industry, Innovation and Infrastructure, and SDG 17: Partnerships for the Goals, with the aim to focus on innovation, partnerships and regional cooperation to promote 4IR technologies in the Asia-Pacific. Some earlier studies (for example, UNESCAP (a), 2021; UNESCAP, 2018; World Economic Forum, 2018) have confirmed that innovation and technological progress can help to address a number of economic and social challenges in the Asia-Pacific; and there are examples of cross-country and multi-stakeholder partnership initiatives in this respect in the region. This paper builds upon those existing studies and initiatives to suggest a way forward. The next section presents cross-country comparisons across Asia-Pacific in select indicators related to digital competitiveness, innovation and ICT readiness.

3 China, Japan, Mongolia, Republic of Korea, Hong Kong SAR, Democratic Republic of Korea, and Macao
4 Kazakhstan, Russian Federation, Armenia, Azerbaijan, Georgia, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan
5 Australia, New Zealand, Fiji, Kiribati, Marshall Islands (the), Micronesia (Federated States of), Nauru, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu, American Samoa, Cook Islands, French Polynesia, Guam, New Caledonia, Niue, Northern Mariana Islands
6 Indonesia, Malaysia, Philippines (the), Singapore, Thailand, Brunei Darussalam, Cambodia, Myanmar, Timor-Leste, Vietnam
7 Afghanistan, India, Turkey, Bangladesh, Bhutan, Iran (Islamic Republic of), Maldives, Nepal, Pakistan, Sri Lanka

3. 4IR in the Asia-Pacific: Cross-Country Comparisons

ASIA-PACIFIC REGION ACCOUNTS FOR ALMOST HALF OF THE GLOBAL POPULATION, ONE-FIFTH OF THE GLOBAL ECONOMY, AND IS EXPECTED TO CONTRIBUTE AROUND 60 PER CENT TO GLOBAL GROWTH IN THE NEXT DECADE. The region encompasses countries at different stages of development with varied characteristics such as – low income and large population (e.g., India, China, Indonesia, Pakistan. Thailand, Vietnam, Malaysia); high income and large population (e.g., Japan, Republic of Korea); low income and small population (e.g., Mongolia, Tuvalu); and high income and small population (e.g., Australia, Singapore, New Zealand). Ranging from countries such as Japan, which is a leader in ICT adoption and robotics to countries such as Bhutan and Nauru, which are still at lower stages of technology integration, the technology gap across countries is likely to widen and adversely impact the SDGs target unless there is more collaboration and cooperation. For many countries such as Indonesia, and the Pacific islands such as Fiji, Kiribati, Papua New Guinea, 4IR technologies can be instrumental to overcome geographic isolation and remoteness.

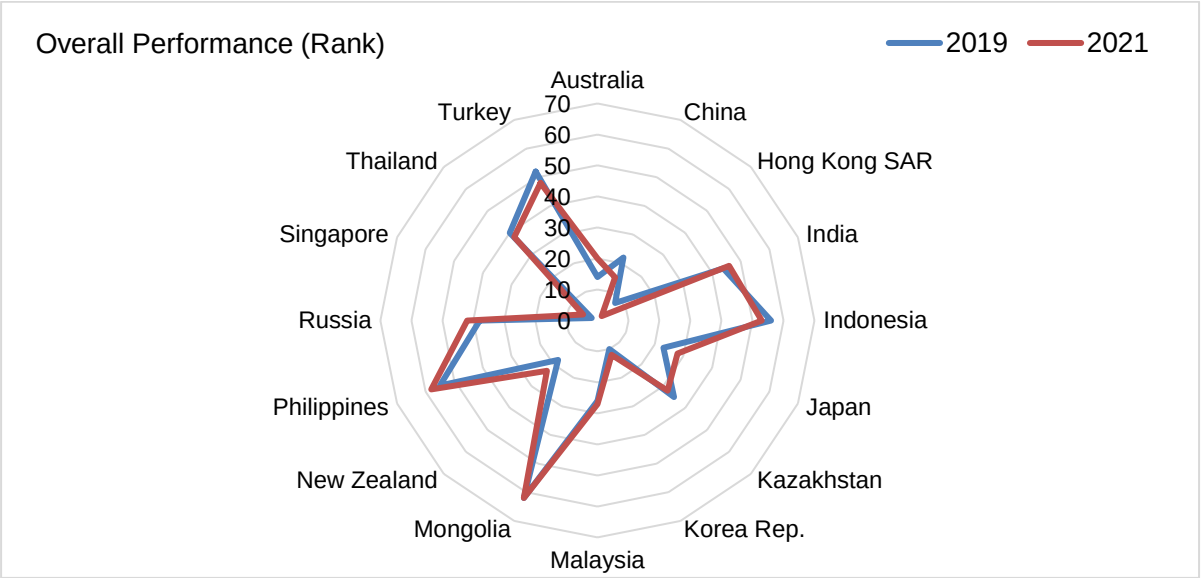
3.1 Digital Competitiveness

The IMD's World Digital Competitiveness Ranking presents cross-country comparisons in three sub-categories - knowledge, technology and future readiness, for 63 economies [IMD World Competitiveness Centre, 2021]. A sub-set of Asia-Pacific countries is selected from this index, for the analysis (see Figure 1).

Hong Kong Special Administrative Region of the People's Republic of China (SAR)[8] (2nd), Singapore (5th), and Republic of Korea (12th) were the top performers in the overall index. These economies were the top performers within Asia-Pacific in 2019 as well; however, Hong Kong SAR stepped forward from 8th to 2nd, while Singapore's position slipped to 5th from 2nd. The rankings show huge disparities among the countries in the region, with countries in ENEA such as Mongolia acquiring second bottom rank of 62 in both 2021 and 2019. Other countries in the bottom include SEA countries such as Indonesia and the Philippines and from SSWA such as Turkey (see Figure 1). Comparing the ranks for 2021 with that for the year 2019, China has made the largest improvement by 7 places from the rank of 22nd in 2019 to 15th in 2021. The USA has been the top performer in the overall rankings consecutively for the fourth time since 2018.

[8] Hong Kong Special Administrative Region of the People's Republic of China (SAR) would be referred as Hong Kong SAR consequently in the paper.

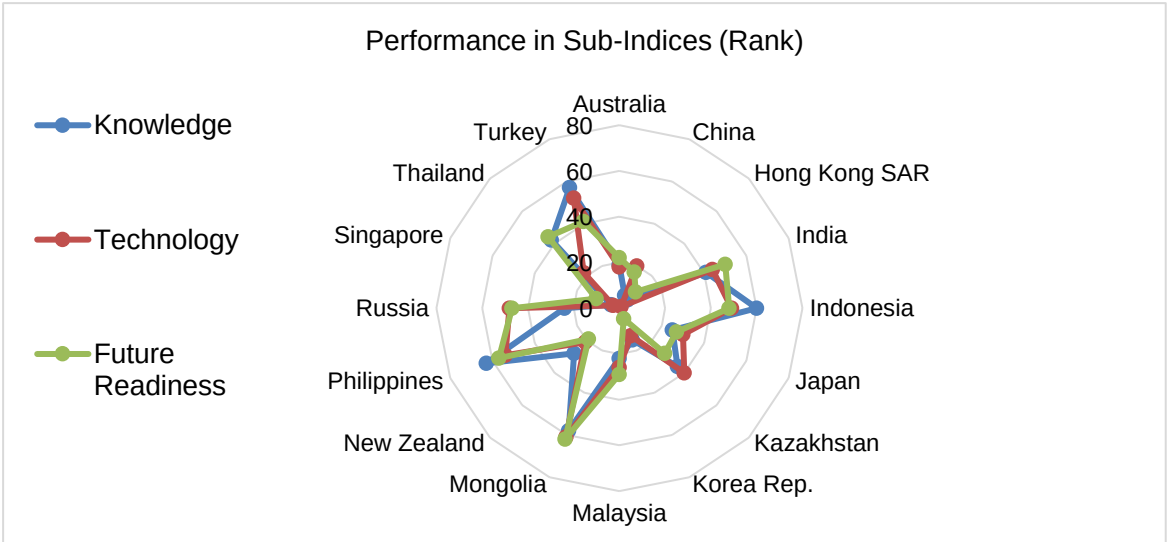
Figure 1: Cross-Country Comparisons of Select Asia-Pacific Countries in Digital Competitiveness (2019 and 2021)



Source: Extracted from https://www.imd.org/globalassets/wcc/docs/release-2021/digital_2021.pdf (last accessed November 20, 2021)

Within Asia-Pacific, Singapore, was the top performer in the 'knowledge' sub category; Hong Kong SAR was the top performer in the 'technology' sub-category', while Republic of Korea was the top performer in the 'future readiness' sub-category (see Figure 2). Countries such as Mongolia and Philippines performed poorly across all the three sub-indices. China have improved its rank significantly across the three indices from 2019 to 2021, with most improvement seen in 'knowledge' sub-category of 12 positions (from 18th to 6th). Thailand have also improved its rank between 2019 and 2021 across all the sub-indices.

Figure 2: Performance in Digital Competitiveness Across Sub-Indices (2021)



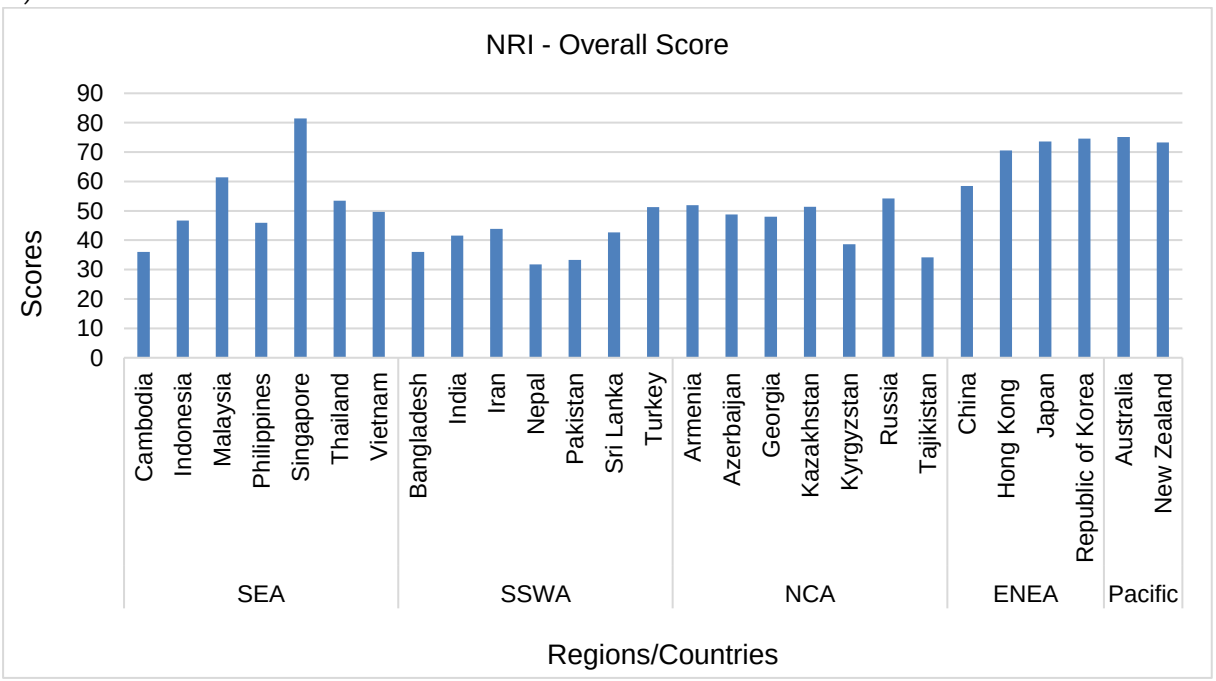
Source: Extracted from https://www.imd.org/globalassets/wcc/docs/release-2021/digital_2021.pdf (last accessed November 20, 2021)

3.2 Network Readiness

The Network Readiness Index (NRI) 2020 of the Portulans Institute (earlier given by the World Economic Forum) measures the performance of 134 countries[9] in terms of possessing the necessary drivers for digital technology adoption and impact of these technologies on the economy and society. It has four pillars – technology (access, content, future technologies), people (individuals, businesses, governments), governance (trust, regulation, inclusion), and impact (economy, quality of life, SDG contribution).

Among the Asia-Pacific countries, Singapore is the top performer with 3rd rank and is the only Asia-Pacific country in top 10. The other countries in top 15 include Australia (ranked 12th) and Republic of Korea (14th). The performance of these countries does not differ much when it comes to broad access to ICTs or regulatory provisions. Differences are mostly on account of aspects such as investment in and adoption of 4IR technologies (e.g., AI, IoT, Robotics, etc.). Wide variations can be seen across the region (see Figure 3), with the Pacific region and the ENEA region showing the best performance. In the SEA region, apart from Singapore, Malaysia has performed well (ranked 34th), being the top performer among upper-middle income countries. the SSWA region has performed poorly, with Nepal (ranked 113th) and Pakistan (111th) among countries ranked at the bottom. Countries such as China (40th) and India (88th), while have some of the advanced and innovative businesses, have ranked comparatively low in this index. This is partly on account of challenges with respect to extending ICT access and skills to the general population.

Figure 3: Cross-Country Scores on Network Readiness Index for Select Asia-Pacific Countries (2020)



Source: Extracted from https://networkreadinessindex.org/nri-2020-countries/ (last accessed November 20, 2021)

[9] For details, see https://networkreadinessindex.org/nri-2020-countries/ (last accessed November 20, 2021)

3.3 Innovation

The Global Innovation Index (2021) captured the innovation ecosystem performance of 132 countries, based on 7 key areas and 81 different indicators (WIPO, 2021). Among the countries in the Asia-Pacific region, two countries feature among top 10 – ROK (5th) and Singapore (8th).

Among sub-regions, the ENEA region shows the least disparity with all the countries featuring among top 15 – China (12th), Japan (13th) and Hong Kong SAR (14th) (see Figure 4, which shows variation in innovation levels across select sub-regions within Asia-Pacific). Highest disparity is seen among the countries of the SEA region – with Singapore ranked 8th and Myanmar ranked 127th, where it ranked 2nd from the bottom in the sub-pillar of creative outputs. Pacific countries such as Australia and New Zealand have performed remarkably ranking 25th and 26th, respectively.

In the sub-indices' ranking, the USA topped the 'innovation input' index ranking while China topped the 'innovation output' index. Countries such as Myanmar (127th), Bangladesh (116th), Nepal (111th) ranked at the bottom of the index, indicating lower levels of innovation. The USA attained the 3rd position in the overall index, with being the top performer in 13 of the 81 indicators used. Within Asia-Pacific, Hong Kong SAR performed the best in sub-categories such as new businesses, high-tech imports and global brand value. Singapore attained the top rank in sub-indicator of regulatory quality. China and the ROK ranked among the top countries in sub-indicators such as high-tech exports and researchers, among other indicators. Japan performed well in areas such as patent families, production and export complexity. Among the middle-income countries, China is the only country to be among top 30. Turkey (41st), Thailand (43rd), Vietnam (44th), Russia (45th) and India (46th) were in the top 50. However, India performed poorly in sub-indicators such as ICT access (111th) and ICT use (110th), which is a cause for concern for this developing country with a large population.

The top 100 science and technology (S&T) clusters were seen to be hosted by 26 economies, including those from Asia-Pacific (such as China, Japan, Iran, Turkey, and Russia). Cities such as Istanbul (Turkey) and Delhi, Mumbai (India) are seen to have high growth. Some countries have performed really well in some sub-indicators, although their overall rankings are lower[10]. Examples include those from SEA region – Thailand and Vietnam in 'market sophistication', countries in SSWA region such as Turkey in 'human capital and research' (26th), countries in NCA region such as Uzbekistan in 'market sophistication', and countries in ENEA region such as Mongolia in 'creative outputs' sub-category.

3.4 Performance in E-commerce

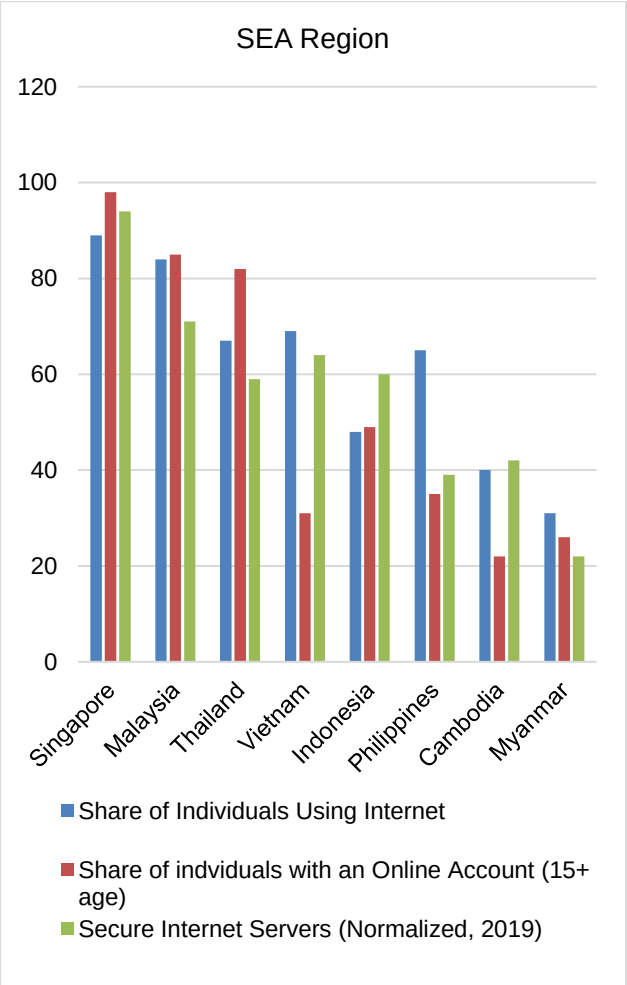
Emergence of 4IR technologies have led to new modes of services delivery and growth of e-commerce. However, there is wide diversity among the Asia-Pacific countries in terms of e-commerce development. The Global Business-to-Consumer (B2C) E-commerce Index measures a country's readiness in supporting online commerce, where factors such as ICT development and internet penetration play an important role. Figure 5 shows wide disparities across regions and countries within a region of Asia-Pacific in e-commerce development according to the B2C E-commerce Index, 2020 [United Nations Conference on Trade and Development (UNCTAD)(b), 2021]. For example, while ROK, New Zealand and Hong Kong SAR has high internet penetration rates of 96, 95, and 92 per cent, respectively; countries from the SSWA region such as Nepal, Bangladesh, and Afghanistan rank have very low rates of 34, 13, and 18 per cent, respectively (see Figure 5). Within

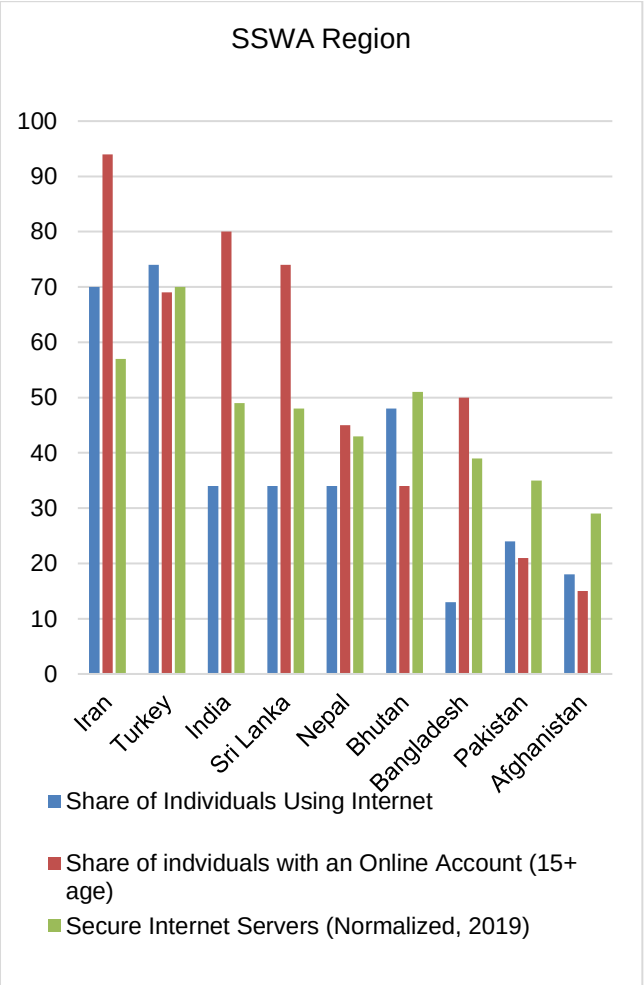
10 While overall rankings indicate level of innovation, the sub-indices such as 'institution', 'human capital and research', 'knowledge and technology outputs', etc., refer to specific parameters related to innovation.

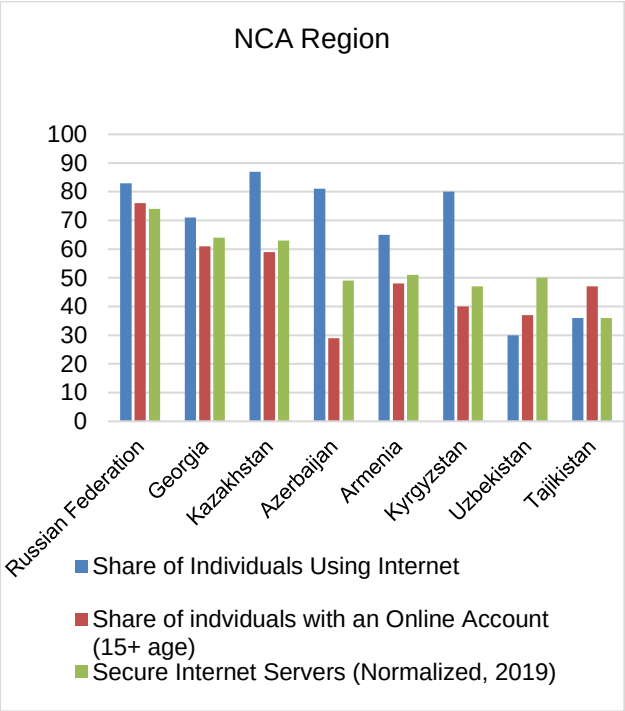
Asia-Pacific, Singapore and Hong Kong SAR feature among the top 10 in 2020, ranking 4th and 10th, respectively. Tajikistan (121st), Myanmar (130th) and Afghanistan (143rd) were ranked at the bottom. While China and the USA are known as the world's largest B2C markets, they are ranked 12th and 55th respectively in the index.

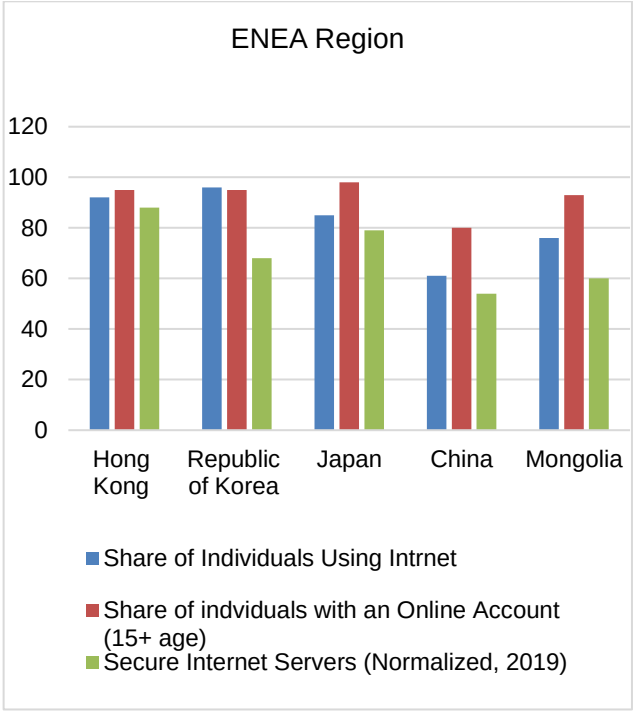
Overall, the cross-country comparisons across different indicators show that there are wide dispersions among the countries in terms of ICT adoption and internet penetration, digital competitiveness, innovation and growth of e-commerce. However, on the positive side, a number of Southeast Asian countries and South Asian countries, including India, are focusing on digitalisation which is expected to lower the digital divide and are now becoming major start-up hubs.

Figure 5: Performance of Asia-Pacific Countries in B2C E-Commerce Index (2020)









Source: Extracted from https://unctad.org/system/files/official-document/tn_unctad_ict4d17_en.pdf (last accessed November 20, 2021)

3.5 Adoption of 4IR Technologies Through SDG Target Year 2030

While some Asia-Pacific countries have taken policy initiatives to digitalise at a fast pace and adopt 4IR technologies, there are variations across countries. Some countries, especially developing countries and LDCs, are yet to implement policies in crucial areas like data protection and data sharing and are facing challenges with respect to skill mismatches and availability of finance for implementing 4IR technologies. There is apprehension that some of them may not be able to meet their 2030 SDGs if there is no prompt action. With respect to SDG Goal 9, while sub-regions such as Southeast Asia has made relatively good progress, but a number of countries (especially the Pacific Island countries such as Kiribati, Fiji, Tuvalu, etc., which have not been included in most indices on innovation, digital competitiveness, among others), have a long way to go. In countries which are almost on track, most of the progress has been made in terms of provision of access to mobile networks (see Section 3.4). While the region shows a mixed picture with respect to progress on achieving the SDG targets by 2030, greater collaboration and technology/knowledge transfer can help accelerate adoption of 4IR across the countries. Investment in R&D needs to be enhanced (see Section 7.6) and focus should be on increasing the share of manufacturing value-addition in medium and high-technology industries.

To achieve SDG targets, while each country has the primary responsibility to implement its SDGs, mobilization of financial resources as well as capacity-building and the transfer of technologies to developing/LDCs countries on favourable terms, including on concessional and preferential terms, will support them in implementing their SDGs. There is need for greater multi-stakeholders' engagements in the Asia-Pacific region in this regard. There is need for more partnerships in capacity building, strengthening data collection and well-defined numerical targets. Greater North-South, South-South, triangular, regional and international cooperation; access to science, technology and innovation and enhanced knowledge sharing on mutually agreed terms, and through a global technology facilitation mechanism will help to attain the SDGs.

The concerns related to the performance of the region and key countries in adoption of 4IR technologies to meet the SDGs by 2030 is presented in Section 6 and Section 7 suggests how to mitigate the issues and move towards meeting the target of 2030.

4. Policy Initiatives for 4IR in the Asia-Pacific Region

THE ASIA-PACIFIC COUNTRIES HAVE WIDE DIFFERENCES IN SOCIO-ECONOMIC PRIORITIES AND IN THEIR POLITICAL AND GOVERNANCE STRUCTURE, WHICH IS ALSO REFLECTED IN THEIR POLICY REGIMES WITH RESPECT TO 4IR. Rapid growth of technology has emerged as a regulatory challenge for the policymakers and, at the same time, a number of countries have come up with policies to support 4IR. This section attempts to map the similarities and differences across countries in terms of policies related to 4IR, with a specific focus on digital policy, AI strategy, e-commerce policy, and data privacy policy. In addition, indicators such as start-up visas and high technology zones/special economic zones (SEZs) are used to map the receptiveness of countries to foreign investors and professionals in 4IR.

4.1 Digital/ICT Policies

Most of the countries in this region have initiated digital/ICT policies. In some countries, such as Australia, and Cambodia, there are digital vision/master plans to develop a comprehensive roadmap to drive economic growth, productivity and improve living standards by harnessing technology. Australia aims to be one of the top three digital governments in the world by 2025 through its 'Digital Transformation Vision 2025'. In countries such as Papua New Guinea, there are digital strategic plans to serve as a blueprint for ICT infrastructure, innovation and cyber security.

Singapore has launched the 'Digital Government Blueprint', which is a five-year plan building on previous e-government master plans to harness digital technology in order to build stakeholder centric services. Bangladesh government had laid down the 'Strategic Priorities of Digital Bangladesh in 2011' with a vision to leverage ICTs as a pro-poor tool to eradicate poverty and establish good governance to empower Bangladesh to become a middle-income country by 2021. In Iran, the Ministry of ICT has set goals in the sub-sectors of IT, other information services, and telecommunications to promote productivity and national output in the service sector, but there is no integrated policy document. Bhutan has multiple policies related to ICT, including the National ICT Policy, ICT Master Plan, IT Strategy and select sectoral ICT policies. In Kyrgyzstan, the government has come up with an initiative 'Sanarip Kyrgyzstan' (Digital Kyrgyzstan) in 2018, that aims to build a knowledge-based economy. Overall, in a number of countries there is strong government support for digitalisation.

At sub-regional level, ASEAN has been at the forefront in introducing policy frameworks related to ICT/Digitalization. Some of the initiatives undertaken include - ICT: ASEAN Framework on Digital Data Governance and the ASEAN Digital Integration Framework Action Plan (2019-2025), which had identified five key policy areas to overcome barriers to digital integration - digital connectivity and affordable access, financial ecosystem, commerce and trade, workforce transformation, and business ecosystem.

- **Adoption of 4IR Technologies for Public Service Delivery**

The adoption of 4IR for public service delivery can help in reducing leakages, and in understanding the

needs of the citizens. A number of countries in Asia-Pacific have come up with policies to promote 4IR and digital technologies for delivering services to the most vulnerable groups of the society. For example, India launched the 'Digital India Initiative' in 2015, which is an umbrella programme focusing on three core components that facilitate the growth of digital finance –the development of secure and stable digital infrastructure, delivering government services digitally, and universal digital literacy. The Digital India Initiative along with two other national level policies, the 'Pradhan Mantri Jan Dhan Yojana (PMJDY)' (which is a drive to provide all Indians with a bank account) and 'Aadhar' (the provision of a unique digital ID for every citizen) collectively, referred to as the Jan Dhan, Aadhaar, and Mobile (JAM) is enabling the government to do direct benefit transfer to the most vulnerable groups. Australia's Digital Transformation Vision, 2025, looks to promote digital welfare payments (G2P), digital tax payments, etc. Pakistan's government launched the 'Ehsaas' programme that aims at creating a 'welfare state' through use of data and technology. This programme primarily uses data analytics tools to identify gaps and causes of social issues and develop solutions for mitigating them.

4.2 Data Privacy and Security Regulations

With respect to data privacy and security, countries have regulations in the form of laws, acts and additional decrees, which are at different stages of implementation (see Table 1). In some countries the Acts have been implemented. For example, New Zealand's 'Privacy Act 1993',[11] China's 'Cyber Security Law 2016', Turkey's 'Personal Data Protection Law, 2016' and ROK's 'Personal Information Protection Act', 2011. In countries such as the USA, there is no single law but there are multiple legislations at the state and federal levels to protect personal data of the USA residents. Along with these there are various sector-specific legislations.

In many countries, legislations on data privacy and protection are yet to be operationalised. For example, the 'Personal Data Protection Bill 2018' in India is in process of being approved by the Parliament. In Cambodia, Myanmar and Indonesia specific data protection policies are not available, but there are certain sector-specific regulations (see Table 1). Countries such as New Zealand and Japan's data protection laws align with EU's General Data Protection Regulation (GDPR), while some such as Singapore and Russia's data protection laws are partially aligned with GDPR with some differences related to terminologies and definitions.

11 https://www.data.govt.nz/manage-data/privacy-and-security/what-is-personal-identifiable-information-and-the-privacy-act/ (last accessed November 20, 2021)

Table 1: Examples of Status of Data Protection and Privacy Policies in Asia-Pacific (as of November 2020)

Countries	Legislation in Draft/Bill format	Data Protection Regulation/Act/Law present in some form	Type of Regulation (Comprehensive - ✓; Not Comprehensive – X)
Australia		✓	✓
New Zealand		✓	✓
China		✓	✓
Japan		✓	✓
Republic of Korea		✓	✓
Russia		✓	✓
Papua New Guinea		X	X (Information Security Law)
India	✓		X (Information Technology Law)
Sri Lanka		X	X (Cyber Security Law)
Pakistan	✓		X
Bangladesh		✓	X (Cyber Security Law)
Brunei		X	X (Sectoral Law)
Cambodia		X	X (Sectoral Law)
Malaysia		✓	✓
Myanmar		X	X (Sectoral Law)
Philippines		✓	✓
Indonesia		X	X (Electronic Information Law)
Singapore		✓	✓
Thailand		✓	✓
Turkey		✓	✓
Vietnam	✓		X (Cyber Security Law)

Source: Compiled from different government websites

4.3 AI Strategies and Initiatives

Countries such as China, Japan and ROK have developed strategies and initiatives for AI, while some countries like Malaysia are in the process of formulating national documents for AI. The government is developing a 'National Artificial Intelligence Framework 2019' and establishing digital transformation labs as an expansion of the 'National Big Data Analytics Framework 2015'. China has the 'New Generation Artificial Development Plan (2017)'[12] while Japan has an 'AI Technology Strategy (2018)' with a three-phase plan to develop an AI ecosystem. ROK has formulated the 'Intelligent Information Development Strategy (2016)' to support the development of AI start-ups and small and medium enterprises (SMEs)[13]. Countries such as Russia and Singapore have launched their national AI strategies, known as the 'National AI strategy (2019)' and the 'AI Singapore' program (2017), respectively. The Government of Malaysia is in the process of developing a National Artificial Intelligence Framework and establishing Digital Transformation Labs to promote innovation in the

12 https://futureoflife.org/ai-policy-china/ (last accessed November 20, 2021)

13 https://english.msit.go.kr/english/msipContents/contentsView.do?cateId=msse44&artId=129620 3 (last accessed November 20, 2021)

country. In India, the government have come up with an AI strategy in 2018 through a working paper titled 'National Strategy for Artificial Intelligence'. The paper identifies five key areas for AI development – education, agriculture, healthcare, urban-/smart-city infrastructure, transportation and mobility. In Australia, the government has a specific annual budget to promote development of AI.

4.4 E-commerce Policies

Most countries in the Asia-Pacific region have laws, Acts or guidelines governing the use of e-commerce. These can be in the legislations at the national and federal levels, or as a part/component of the overarching digital policies of the country. Some regulations include China's 'E-commerce Law of the People's Republic of China (2019)',[14] and ROK's Act on Consumer Protection in Electronic Commerce (2016)'[15]. The Malaysia's e-commerce and online businesses are regulated by the 'Electronic Commerce Act 2006' (for the private sector) and the 'Electronic Government Activities Act 2007' (for the public sector)[16]. Australia has issued the 'Guidelines for Electronic Commerce (2006)'(Commonwealth of Australia, 2006).

In the USA, there are legislations related to e-commerce both at the federal and provincial level, in areas such as enforcement of online contracts and e-signatures, consumer protection and privacy, anti-spam, etc. [17]

India had come out with a Draft National E-commerce Policy in February 2019, to facilitate a regulatory environment for e-commerce at the national level and to empower domestic entrepreneurs. However, the policy had received certain criticisms and is under review as of January 15, 2020. In August 2019, the government had come with the Consumer Protection Act, 2019, which aims to enhance consumer rights in a digital economy. Under this Act, Consumer Protection (E-commerce) Rules, 2019 (Department of Consumer Affairs, 2019) was released on November 11, 2019, which had established conditions regarding the governing set-up, operations of e-commerce businesses, their liability for non-compliance, etc. Bangladesh and Pakistan have national policies on e-commerce. Bangladesh passed its National Digital Commerce Policy in July, 2018, with the goal of expanding trade and commerce into the digital space and creating opportunities for small and medium enterprises[18]. Pakistan came up with a National E-commerce Policy in 2019, with the aim of providing a regulatory framework for online businesses (Government of Pakistan, 2019). Many Pacific Island countries, such as Kiribati, Tuvalu, Timor-Leste, etc., do not have a national policy framework for facilitation of e-commerce.

Overall, regulations with respect to data protection, consumer privacy and e-commerce, are still evolving in many countries. For example, in India, which is an information technology hub in Asia-Pacific, the data protection and e-commerce policies are still at a draft stage.

Taking an example of a sub-region, Table 2 gives status of select policies across the South Asian countries with respect to e-commerce, IT, start-ups, etc.

14 https://www.izvoznookno.si/Dokumenti/E-commerce%20Law%20of%20the%20People%E2%80%99s%20Republic%20of%20China.pdf (last accessed November 20, 2021)

15 https://wilmap.law.stanford.edu/entries/act-consumer-protection-electronic-commerce-etc-last-amended-act-no-11461-english-version (last accessed November 20, 2021)

16 https://www.ecinsider.my/2014/07/understanding-ecommerce-legislation-malaysia.html (last accessed November 20, 2021)

17 https://www.justia.com/business-operations/managing-your-business/e-commerce/ (last accessed November 20, 2021)

18 https://www.bangladeshinfo.com/article/1988/National-Digital-Commerce-Policy-2018-passed (last accessed November 20, 2021)

Table 2: Select Policies Across South Asian Economies (as of December 2020)

Countries	Start-Ups	E-Commerce	E-Governance	Digitalisation	IT Policy
India	Yes	Under Consideration	Yes	Yes	Yes
Pakistan	Not available	Under Consideration	Yes	Yes	Yes
Afghanistan	Not available	Not available	Yes	Not available	Yes
Bangladesh	Yes	Yes	Yes	Yes	Yes
Sri Lanka	Not available	Yes	Yes	Yes	Yes
Nepal	Not available	Under Consideration	Yes	Yes	Yes
Bhutan	Yes	Not available	Yes	Not available	Yes
Maldives	Not available	Not available	Yes	Not available	Not available

Source: Compiled from various country-specific websites

4.5 Technology Start-up Policies

A number of countries in the Asia-Pacific region have sought to strengthen the entrepreneurship ecosystem by initiating start-up policies, specifically to promote technology-based start-ups. While countries such as Philippines have start-up specific Acts, some such as Singapore have start-up programmes and initiatives (see Table 2). These policies/programmes can provide both fiscal and non-fiscal incentives.

The Government of China is emphasizing 'mass entrepreneurship' as the next stage of the country's growth with various policies which seek to improve institutional mechanisms and improve financing and incentives for entrepreneurs[19]. The country aims to increase the total number of domestic incubators, makerspaces and accelerators to more than 10,000 by 2020[20]. Malaysia has enabled funding for start-ups through various government agencies and has introduced tax breaks to encourage private investment[21]. In Indonesia, the Ministry of Communication and Information Technology had a strategic partnership with Kibar, a technology start-up ecosystem facilitator with an aim of encouraging 1000 Startups by 2020, which is known as the '1000 Startups Movement'.

In North and Central Asian economies, there are wide differences with respect to growth in the start-up ecosystems. For example, in Kazakhstan, start-up culture is growing and the government is actively involved in creating an innovative technological environment through initiatives such as Digital Kazakhstan Programme (launched in 2018), to create local technology hubs to support technology firms. However, in countries such as Turkmenistan, the entrepreneurial environment is often faced with a number of bureaucratic hurdles[22]. In West Asia, Turkey is emerging as a vibrant start-up economy, although there is no consolidated start-up policy at the national level. The country, however, has various provisions to enable the growth of start-ups – grants, venture capital funding program, accreditation of angel investors, etc. In Turkey, the number of technology parks have grown significantly in the last decade – from 27 in 2010, it has now risen to 68 in 2021, and 16 more are in the process of formation (Startups Watch, 2021).

To give a boost to the start-up environment, some cross-country initiatives have come up. For example, the Indo-Russian Innovation Bridge connects investors, incubators, start-ups, and aspiring entrepreneurs of both the countries and help them in accessing capital, knowledge and

19 https://press.covestro.com/news.nsf/id/2018-177-EN/$file/KAIROS_ENG.pdf (last accessed November 20, 2021)
20 http://english.www.gov.cn/state_council/ministries/2017/12/08/content_281475969117324.htm (last accessed November 20, 2021)
21 https://www.thestar.com.my/news/community/2014/11/19/govt-incentives-for-startups (last accessed November 20, 2021)
22 https://startupjedi.vc/content/startup-ecosystems-central-asia-kazakhstan (last accessed November 20, 2021)

technology transfer. Some countries such as Sri Lanka and Mongolia have no start-up policy in place. External funding and lower access to online payments have been identified as some key barriers hampering the growth of start-ups in Sri Lanka [Startup Sri Lanka, 2016].

Table 3 provides select examples from Asia-Pacific countries on policies focused on start-ups and entrepreneurship.

Table 3: Start-up Specific Acts, Programmes, Initiatives and Policies in Select Asia-Pacific Countries

Countries	Examples of Acts/Policies/Programs/Guidelines/initiatives to Startups
Australia	• Global Talent Scheme • National Innovation and Science Agenda, Entrepreneur's Program
China	The Torch Program
India	Startup India Initiative
Indonesia	1000 Startups Movement
Japan	• J-Startup Program • Program to Increase Foreign Entrepreneurs • Shido Next Innovator Program • Program for Creating Start-ups from Advanced Research and Technology (START)
New Zealand	Callaghan Innovation
Singapore	Startup SG & other schemes
Republic of Korea	• Living Innovation Startup Acceleration Program • Overall Assistance for Start-up Immigration System (OASIS) and other schemes
Philippines	The Innovative Startup Act (2019)
Thailand	Startup Thailand

Source: Compiled from various government websites of the countries

4.6 Attracting Foreign High-Skilled Professionals and Investment: Start-up Visas and High Technology Zones

To encourage and facilitate entry of foreign start-ups and high skilled personnel, some countries have come up with start-up/entrepreneur visas to bring in new technologies and innovation to fast track the growth of 4IR. A growing number of Asia-Pacific countries are of the view that partnership with foreign start-ups will help domestic start-ups to grow and explore global markets. In an era of protectionism and barriers to labour mobility, a number of countries are, therefore, initiating start-up visa or entrepreneurship to facilitate the mobility of skills for high-technology companies (see Table 3). Countries in the Pacific region (except New Zealand and Australia) have no policies specific to start-ups or start-up visa or the information may not be available online.

A number of countries in the Asia-Pacific have other special provisions for foreign start-ups apart from visas. For example, in China, foreign companies are provided a break on provisional income tax on profits[23]. India has joint Start-up

[23] https://www.reuters.com/article/us-china-economy-investment-tax/china-temporarily-exemptsforeign-firms-from-taxes-for-

hubs/programmes with countries such as ROK, USA, Japan and Singapore. These hubs/programmes/partnerships aim to enable joint innovation and start-ups exchange, market access and funding programmes. However, India does not have any start-up visas.

Majority of the Asia-Pacific countries have high-technology zones or special economic zones (SEZs), electronic parks/technology parks, where tax incentives and other benefits are given to foreign investors to invest in technology (see Table 4).

Table 4: Presence of Start-up Visa/Entrepreneur Visa and High Technology Zones/Special Economic Zones in the Asia-Pacific Region

Country	Start-up Visa/Entrepreneur Visa	High Technology Zones/Special Economic Zones
Australia	✓	✓
New Zealand	✓	✓
China	✓	✓
Japan	✓	✓
Republic of Korea	✓	✓
Russia	X	✓
Iran	✓	✓
Fiji	X	✓
Papua New Guinea	X	Under consideration
India	X	✓
Sri Lanka	X	✓
Pakistan	X	Under consideration
Bangladesh	X	✓
Maldives	X	✓
Brunei	X	✓
Cambodia	X	✓
Malaysia	✓	✓
Myanmar	X	✓
Philippines	✓	✓
Indonesia	✓	✓
Singapore	✓	✓
Thailand	✓	✓
Vietnam	X	✓

Source: Compiled from various government websites of the Asia-Pacific countries

reinvested-profits-idUSKBN1EM0GI (last accessed November 20, 2021)

5. Examples of Initiatives and Partnerships on 4IR among Asia-Pacific Countries

There are several examples of within country and across country partnerships in 4IR technologies in Asia-Pacific which are Government-to-Government (G2G), Government- to-Business (G2B), Business-to-Business (B2B) along with collaborations between academic research organisation, non-government organisations, etc. Some of the best practices are discussed below.

5.1 Country-Wise Initiatives and Partnerships for Attaining SDGs through Technology: Select Examples

Within a country, adaptation of 4IR technologies require collaborations across various government departments/ministries. For example, three ministries of Thailand (Ministry of Digital Economy and Society, Ministry of Science and Technology, and Ministry of Education) had come out with a national-level online course platform called 'MOOC' (Massive Online Open Course) to connect citizens of the country for learning remotely through use of 4IR technologies and fulfilling objectives of 'Thailand 4.0'. Government in many countries are focusing on private-public partnerships. For example, the Research, Innovation and Enterprise 2020 Plan of Singapore has been created to develop private-public partnership platforms to drive technology transfer, technological innovation and adoption across the manufacturing sector and make Singapore an ideal location for developing ground-breaking technologies. The government launched the National Robotics Programme in 2016 to double productivity and lessen the usage of labour in Singapore.

In Vietnam, the Ministry of Industry and Trade have collaborated with Google to launch the 'Accelerate Vietnam Digital 4.0' program to provide new digital and technological skills training to over 500,000 SME employees. Governments themselves are promoting investment in technology. For example, in the Philippines, to encourage development of 3D Printing/Additive Manufacturing, the Department of Science and Technology has come up with two research facilities to improve the productivity and quality of the country's aerospace, defence, biomedical, healthcare, and automotive industries.

Governments and regulators are one of the largest users of technology and many governments are using technology to collect and analysis data for better policy making and monitoring. For example, the Commonwealth Bank of Australia have adopted advanced predictive analytics for predicting likelihood of fraud activity in its transactions, which shows results within 40 milliseconds of initiation of transaction.

5.2 Examples of Cross-Country Initiatives and Partnerships for Attaining SDGs through Technology

At cross-country level, there are examples of North-South, South-South and Triangular collaboration. Most of these have taken place at inter-governmental level. For example, a partnership between Indonesia and Australia and funded by the Department of Foreign Affairs and

Trade (DFAT), Australia, MAMPU is an initiative (launched in 2012) that aims at gender equality and women empowerment. It aims at integrating social risks emerging from 4IR in Indonesia, to help improve employment conditions[24]. The governments of North and Central Asian countries such as Tajikistan, Kyrgyzstan, Uzbekistan have come together with a 'Capacity Development and Technology Transfer' initiative to improve generation and use of data and information in supporting monitoring of environmental concerns. It is aimed at creating advanced IT systems to improve access to near real-time environmental information. Indian government is enhancing technology cooperation with countries such as Japan in areas such as AI, Fin-Tech, Critical cyber infrastructure, etc., through memorandum of understanding (MoUs). LDCs such as Cambodia was aided by countries such as ROK and Japan in creating a master plan for developing its ICT framework.

5.3 Examples of South-South and Triangular Cooperation

To improve the status of regional economic cooperation, initiatives in the form of South-South Cooperation and Triangular Development Cooperation have grown across the Asia-Pacific economies. For example, in 2019, Malaysia signed four memorandums of understanding (MoUs) with ROK in the areas of 4IR, transportation and development of smart cities. ROK is a pioneer in the usage of 4IR technologies such as IoT in coming up with innovative smart city solutions such as shared parking, smart street lights, use of IoT sensors, etc. However, the progress is quite slow when it comes to South-South partnerships with respect to 4IR.

Vietnam's Hanoi University of Science and Technology (HUST) has entered into partnership with ROK's largest internet company called 'Naver Group', to create SEA's first AI research centre in Vietnam. Other SEA economies such as Singapore is engaged in providing third country training and capacity building initiatives (Triangular cooperation) in ICT and other related areas with other Asia-Pacific economies such as Australia, New Zealand, India, Japan, ROK, Thailand, etc.(Kumar, 2008). China is one of the leaders in ICT and 4IR in the region, and is engaged in developing ICT infrastructure in many countries in Central Asia, Mongolia, etc.

In Bangladesh, China is setting up manufacturing industries in SEZs to help facilitate transfer of technology and experience. The Government of Bangladesh is working towards achieving a vision of a Digital Bangladesh by 2021 and a Developed Bangladesh by 2041. Bangladesh and the UN Office for South-South Cooperation (UNOSSC) established the South-South Network for Public Service Innovation (SSN4PSI), a global collaborative platform that has been working since November 2017 to promote and facilitate adaptation of public service innovations on a global scale, ensure effective and useful replication of good practice/initiatives among countries and organizations through matchmaking workshops and learning from field visits[25].

In line with SDG 17, countries such as Turkey are exploring various capacity building initiatives to facilitate exchange of knowledge on effective health-related response actions, through application of technology to LDCs and developing countries, through the channel of South-South Cooperation.

At a regional level, in June 2021, the ASEAN Coordinating Committee on Micro, Small, and Medium Enterprises (ACCMSME) launched the ASEAN Access, a one-stop business information gateway for international-oriented businesses to expand their market outreach within the ASEAN

24 http://mampu.bappenas.go.id/en/about-us/ (last accessed November 20, 2021)
25 https://www.asia-pacific.unsouthsouth.org/2019/03/1068/(last accessed November 20, 2021)

and beyond. The second phase of the ASEAN-Australia Development Cooperation Programme, adopted in 2015 is another regional partnership initiative which explores the potential between both the economies' visions, policies and initiatives related to 4IR.

5.4 Examples of Collaboration with International Organisations

To foster 4IR based technological learning and innovation, the national government in Asia-pacific in collaboration with the United Nations Industrial Development Organisation (UNIDO), have come up with a Digital Education and Innovation Centre (DEIC), which will provide training and raise awareness on opportunities and challenges related to 4IR for innovation, entrepreneurship and competitiveness. The United Nations Development Programme (UNDP) along with the UK government have collaborated with Georgia's Public Service Delivery Agency (PSDA) to analyse and protect electronic data and make cyber-crime prevention systems more resilient. It also aims at developing data collection and management standards. In Turkey, the government in collaboration with the International Organization for Migration (IOM), have come up with the 'Resilience Innovation Facility', to empower young people in area of digital and 4IR technological development, so that they can identify potential opportunities and challenges related to it.

In Armenia, the national government in cooperation with the United Nations launched the National SDG Innovation Lab in 2017, which has two main focus areas – utilization of sources for Big Data for evidence-based policy making and development of real-time platform for measuring and visualizing implementation of the SDGs.

Under the Malaysia Technical Cooperation Programme (MTCP), the country collaborates with UN organizations such as the UNDP, UNESCAP and UNIDO, in diverse areas which includes technology. For example, the UNDP has come up with the concept of Accelerator Labs, which is been implemented across a number of countries. Through various collaborative efforts, this initiative suggests policy actions by combining the outputs of people, data and technology. Within Asia-Pacific, in Japan, 7 such labs are collaborating with Japanese companies to develop and design models to address various development problems under the SDG Japan Innovation Challenge. In India, the initiative has been launched with the aim of addressing various challenges such as inequality and climate change. The initiative in India has been operated under the Atal Innovation Mission and works in collaboration with 60 global accelerator labs across 78 nations.

Overall, while there are examples of initiatives at country, cross-country and regional levels to promote 4IR and transfer of technology, South-South cooperation and Triangular cooperation have been comparatively lower than country-level initiatives.

6. Challenges Related to Innovation, Development and Transfer of 4IR Technologies

THE RAPID GROWTH IN 4IR TECHNOLOGIES HAS LED TO MULTIPLE CHALLENGES ACROSS COUNTRIES IN ASIA-PACIFIC AS COUNTRIES ARE AT DIFFERENT STAGES OF DEVELOPMENT, THEY HAVE DIFFERENT RESOURCE ENDOWMENTS AND THERE IS INFRASTRUCTURE, REGULATORY AND FINANCE GAPS. Further, developed countries are mostly the exporters of technology while developing and LDCs are dependent on such exports. In a growing protectionist world, there is a fear of data localisation and privacy and security related concerns, which can adversely impact the transfer of 4IR technologies. The pandemic has created new challenges. For example, the pandemic and the need for social distancing has brought to light the gaps in traditional manufacturing processes and lack of automation, especially in developing and LDCs. Further during the pandemic, foreign direct investment (FDI) dropped by 40 per cent in 2020 dropping below USD1 trillion (from USD1.5 trillion in 2019) for the first time since 2005. Some of the challenges are as follows-

6.1 Low Research and Development (R&D) Spending

Globally, investment in R&D as a percentage of GDP has increased from 1.5 per cent in 2000 to 1.7 in 2015 but has remained almost unchanged since then although volume-wise, R&D expenditures have increased, from approximately USD677 billion in 2000 to around USD2.2. trillion in 2019 (Congressional Research Service, 2021). While overall R&D spending has increased, there is huge disparity across countries, which is specifically visible within the Asia-Pacific countries. As evident from sub-indices of the Global Innovation Index of 2021, the top 5 economies in R&D spending include three countries from the ENEA region in Asia-Pacific namely – China, Japan and Korea, with gross R&D spending as percentage of GDP recording at 2.2, 3.2 and 4.6, respectively (WIPO, 2021). At the same time, in countries such as Myanmar and Cambodia, R&D spending is below 1 per cent, at 0.1 per cent in both the countries in 2021. Such lower levels if spending in developing and LDCs leads to lower adoption of technologies and patents. In 2020, patents by origin per USD billion for China was recorded at 53.2 as compared to 2.0 for India, 0.4 for Tajikistan and 1.2 for Sri Lanka.

6.2 Digital Infrastructure and Access Gaps

Digital infrastructure is growing at a fast pace, and it is estimated that in 2020, almost the entire world population lived within range of mobile networks, with 85 per cent covered by a fourth-generation (4G) network (GSMA Intelligence, 2020). However, there issues in terms of usage, only 51 per cent of the global population used the internet in 2019, and around half of the world population or

3.6 billion people were without internet access. In LDCs, only one in five people were online in 2020. In Central and Southern Asia, just over a quarter of the population were connected. The cost of internet access and internet-connected devices, and the lack of related skills, are the highest barriers to access for large parts of the world (UNESCAP (a), 2021).

Data shows that there are wide disparities among countries in the Asia-Pacific in terms of ICT adoption, access and quality (see Figure 5). Countries in South Asia such as Bangladesh and Afghanistan recorded share of internet users as low as 13 and 18 per cent, respectively, in comparison with countries such as ROK, which recorded share in internet users at 96 per cent, in 2020.

Even fast-growing markets are facing challenges and regional disparities in adaptation of technology. For example, India faces challenges with respect to broadband connectivity and call-drops. With a fixed broadband speed of around 20.72 megabits per second (mbps), which is below the world average of 42.71 mbps, the country is facing challenges in 4IR adoption[26].

6.3 Gaps in Domestic Regulations and Policies

Technology is fast evolving, and it is often difficult for policymakers, especially in developing and LDCs to match their regulations with evolving technology. Countries in the Asia-Pacific differ in their regulatory approach towards 4IR technologies and there are wide variations in regulations related to protection of consumer data, privacy, cyber security, etc. (see section 3.2). In a number of countries (see Table 1), the regulations are not comprehensive (for example, in Bangladesh, Indonesia, Papua New Guinea, etc.) and/or not aligned to global best practices such as the GDPR of EU. In many countries, financial data and health sector data are treated as sensitive (e.g., in Australia) and there are sector-specific regulations in some countries (for example, in Myanmar, Mongolia, Cambodia, etc.). While the need to regulate is acknowledged by all countries, there is a difference of opinion related to the form of regulation, what type of data should be regulated, where the data should be stored and the need to "share data with a trust".

Further, not all countries have incentives targeted for start-ups. For instance, India's Start Up India scheme has led to filing of 5,020 patents and 12,264 trademarks in the five years to its launch (January 2016 – December 2020), indicating that targeted schemes can foster research and innovation culture. However, many countries do not have such policies. R&D-linked tax incentives/deductions are offered by only some countries, such as Bangladesh, India, Myanmar, Vietnam, and Singapore.

6.4 Restrictive Domestic Policies

A number of countries have imposed restrictions in terms of online access to information services, which can decrease the positive impact of ICT development in a country. The Digital Platform Restrictiveness Index (DPRI), 2019 measures restrictions imposed by countries which can affect online platforms with a focus on online search, e-commerce and social media [European Centre for International Political Economy (ECIPE), 2019]. The index covers 64 countries, out of which 15 are Asia-Pacific countries. China tops the chart in imposing restrictions in all the sub-indices and also in overall rankings. These include restrictions in terms of taxation of online services, data restrictions, restrictions related to intellectual property rights (IPR) framework, content access restrictions, among others. Thus, while China ranks among the top countries in the Asia-Pacific region in terms of growth in technology and digital adoption, such restrictions may affect the growth of small enterprises and start-ups and impact the country's digital competitiveness. It is a major barrier for China's trading partners such as the USA

[26] https://www.thebetterindia.com/165566/india-trai-airtel-vodafone-jio-fibre-call-drops-news/ (last accessed November 20, 2021)

and has been one of the key issues in trade discussions between the two countries.

Other countries with highest restrictions include Russia, Vietnam and India. Countries with least number of restrictions are Philippines, Australia, New Zealand and Japan. While Brunei ranks among the most restricted countries, it has least number of restrictions in the sub-category of e-commerce. Similarly, in Indonesia and Malaysia, while the overall restrictions on digital platforms are high, the number of restrictions in terms of online search engine is quite less.

6.5 Issues Related to Cross-Border Technology Transfer, Collaboration and Trade

- **IPR Related Issues** - In a world of continuing technological advancements and innovation, the impact of IPR protection on technology diffusion across countries cannot be overstated. Strong IPR protection can aid in technology transfer through the channels of enhanced trade, FDI, joint ventures, technology licensing, among others. However, across Asia-Pacific countries, adoption of strong IPR framework have been low, with few exceptions such as Japan, Singapore, ROK, Australia and China. As per the IP Index report released by the US Chamber of Commerce, various IPR challenges exist across countries with respect to patents, copyrights, trademarks, trade secrets, commercialization of IP assets, enforcement, ratification of international treaties, etc. (Global Innovation Policy Centre, 2021). For example, in Vietnam, there are issues with copyright protection and lack of measures to counter online infringements; in Thailand, there is inadequate protection related to patents and severe patent backlogs is seen; and in in Pakistan, there are major discrepancies between institutionalized IP rights and practical enforcement, and enforcements are often arbitrary in nature resulting in IP thefts. National IP frameworks in Turkey and Russia has increasingly been shaped by broader policy landscapes, which are more focused on localisation. In India, despite strong efforts from the government for robust IP protection and enforcement, there still exist many issues such as patentability requirements which are not as per international standards, barriers related to licensing and technology transfer including stringent registration requirements, limited participation in international treaties, etc.

- **Variations in Technical Standards** - One of the key issues in technology transfer and collaboration in the Asia-Pacific is the wide variations in technical standards, which adversely impact cross-border digital connectivity. The standards of many developing and least developing countries are not aligned with international technical standards and frameworks and there are huge variations in quality, due to which harmonisation of standards across countries become difficult.

- **Domestic Capabilities** - Second, there is lack of domestic manufacturing capabilities of high-technology goods among many developing and LDCs in the region. Hi-tech products are manufactured in a few countries such as China, ROK and Vietnam, and supply chain disruptions led to access issues in others during the COVID-19 pandemic. Most of the South Asian countries are net importers of digital products and lack in domestic manufacturing capabilities. Large import bills are leading to protectionism in countries like India and Indonesia which, in turn, is adversely impacting trade. More recently, countries have started imposing protectionist measures such as high tariffs on imports and rigid data location requirements making it difficult for cross-border data sharing. Lack of cross-border regulatory cooperation and arrangements for data sharing with a trust is also creating problems for technology firms from developed countries to invest developing and LDCs.

- **Less Participation in International Forums Related to 4IR** - To facilitate trade, establishment of global value chains and to ensure transparency and predictability in regulations, countries in the Asia-Pacific region are participating in various multilateral, plurilateral, regional and bilateral forums. However, the range of these engagements varies, from undertaking commitments in the WTO to sharing of best practices. Most often, it has been seen that participation of countries has been limited.

  Among the various trade agreements in force within the Asia-Pacific, around 78 per cent are bilateral preferential trade agreements (PTAs). Between 2018 and 2020, a total of 27 new PTAs were signed with at least one Asia-Pacific member being a part[27]. However, in 2020, newly signed PTAs were less in number (6) due to the COVID-19 pandemic. With emergence of 4IR and technology diffusion, digital trade has been increasingly recognised as an important part of the new trade agreements signed. However, only select countries from the region are a part of such agreements - Singapore, Japan, Australia, New Zealand, and ROK. For example, the Japan signed a Digital Trade Agreement (DTA) with the USA in 2019, while Australia signed a Digital Economy Agreement (DEA) with Singapore in 2020. One of the largest regional trade agreements - Regional Comprehensive Economic Partnership (RCEP), signed on November 2020 excludes key countries such as India. Countries such as India and Indonesia are also not part of multilateral negotiations and agreements such as the WTO plurilateral negotiations on e-commerce (started by 76 members in 2019 and currently increased to 86). Majority of the South Asian economies are not signatories of the Information Technology Agreement (ITA - I and II), except India, which signed part I of the agreement. Further, the engagements of Pacific Island countries of Asia-Pacific have been almost negligible in such agreements.

- **Cross-Border FDI Flows** - Within the Asia-Pacific region, cross-border FDI inflows, especially FDI inflows into technology-based sectors show a wide variation. For example, in China, FDI inflows in 2020 was recorded at USD 149 billion (a growth of 6 per cent from the previous year) which was majorly driven by technology-based industries, R&D and e-commerce [(UNCTAD)(a), 2021)]. FDI inflows into China's high-technology sector grew by 32.1 per cent year-on-year in the first quarter on 2021. However, in other countries of the region such as ROK, Singapore, Indonesia and Vietnam, overall FDI declined in 2020 by 4 per cent, 21 per cent, 22 per cent and 2 per cent, respectively. These countries have been amongst the highest FDI recipients of the region, mainly attracting FDI into technology-intensive sectors. In South Asia, overall FDI increased by 20 per cent in 2020, majorly driven by 27 per cent increase in inflows to India. It has mainly been on account of robust investments in the ICT sector. Major investment announcements were also made by global technology multinationals during the second quarter of 2020-21. However, other countries in South Asia did not see much inflows. This is despite many developing and LDCs offering tax incentives and subsidies to attract FDI in technology. Further, during the pandemic, even with extensive use of digital technology by businesses and consumers, FDI inflows into communications, software and IT services in the Asia-Pacific region has been quite moderate at USD9.8 billion in January-August 2020 as compared to USD19.3 billion for whole of 2019 [UNESCAP (b), 2021].

[27] https://www.unescap.org/kp/2020/preferential-trade-agreements-asia-and-pacific-20202021 (last accessed November 20, 2021)

6.6 Limited South-South and Triangular Cooperation

While many countries within the Asia-Pacific have come up with partnerships across South-South and Triangular Cooperation, it is still very limited with respect to 4IR. Specifically, third party cooperation mechanisms through Triangular cooperation have been observed to be quite less, and it is mostly select countries within ASEAN that are taking up some initiatives related to technology transfer. Further, very few LDCs are covered, and the Pacific Island countries such as Fiji, Tuvalu, Timor-Leste, etc., have not benefitted much from such cooperation initiatives, especially with respect to 4IR.

6.7 Education and Skill Mismatches and Potential Job Losses

With rapid advances in 4IR technology, there are three key issues. First, the education curriculum in the science, technology, engineering and mathematics (STEM) field is not often aligned to the new developments and there is shortage of staff with expertise in 4IR technologies, specifically in developing countries. For example, within the Asia-Pacific region, while entrepreneurs and business entities understand the importance of adopting AI technology, they often face the challenge of finding the right skill-set and talent. Second, a number of low-skilled and repetitive jobs such as assembly line workers are at risk. In India, a report predicts job losses of around 3 million by 2022 in IT companies due to transition to automation[28]. Further, with COVID-19 and a number of companies adapting the work-from-home models/hybrid models, a number of white-collar jobs are at risk[29].

Studies show that with requirements of skills shifting from low-technology jobs to high-technology jobs, countries such as Vietnam, India and Bangladesh, which are developing at a fast pace, may be at risk of losing jobs if requisite skill-sets are not developed, given that these countries have abundant supply of low-skilled and cheap labour. In such countries, majority of the population still rely on labour-intensive industries and there is a mismatch between demand for new advanced and specialised skills and its supply[30]. Specifically there are shortages of AI, machine learning, robotics, cloud computing and analytics, skills. In countries such as India, studies show that the quality of education in technology related fields such as engineering has not able to match the requirements of the rapidly changing IT sector (Sharma, 2018).

6.8 Funding Issues

A number of developing countries and LDCs within the Asia-Pacific region faces issue with respect to getting access to funding various technological initiatives with respect to 4IR. Most often, these countries are not aware of the alternative funding mechanisms or initiatives taken up by international organizations.

28 https://timesofindia.indiatimes.com/business/india-business/it-companies-set-to-slash-3-million-jobs-by-2022-due-to-automation-to-save-100-billion-in-cost-report/articleshow/83575541.cms (last accessed November 20, 2021)

29 https://www.weforum.org/press/2020/10/recession-and-automation-changes-our-future-of-work-but-there-are-jobs-coming-report-says-52c5162fce/ (last accessed November 20, 2021)

30 http://aseantuc.org/2016/10/skill-shortage/ (last accessed November 20, 2021)

7. Roadmap to Accelerate Innovation and Transfer of 4IR Technologies in Asia-Pacific to Achieve SDGs

4IR technologies are at the core of achieving industrial and sustainable development within countries [UNIDO, 2020]. While these technologies are expanding across nations within Asia-Pacific, only a handful of these countries are actually driving the revolution and others are mostly excluded from coming up with technological breakthroughs. In this regard, for faster diffusion of technologies across countries and to attain the objectives of SDGs by 2030, collaboration is the key and is indispensable. Across the Asia-Pacific region, there is diversity in levels of development among countries and this provides immense opportunities for collaboration.

7.1 Creating Consolidated Sub-Regional Strategy

The regions within Asia-Pacific vary as to their approach on how to harness the benefits of 4IR technology to achieve SDGs. For example, while the ASEAN has come out with a specific 4IR based strategy for the region, hardly any discussions on the issue have been brought up in other regions such as the SAARC. The Consolidated Strategy on the 4IR for ASEAN (ASEAN, 2021), which can be a guiding document for other regional groups, is fairly comprehensive and aims to provide policy guidance in building the ASEAN Digital Community. It builds on the initiatives taken by the ASEAN member countries and has three key visions: (a) a digital ASEAN that is open, secure, transparent, and connected while respecting privacy and ethics in line with international best practices; (b) digital ASEAN that harnesses technologies to build a resilient, inclusive, integrated, and globally competitive economy; and (a) a digital ASEAN that embraces innovation in transforming society and contributes to social progress and sustainable development. Similar initiatives can be taken by other regions. At the regional level, efforts can also be built upon UNCTAD's 10-point South-South Digital Cooperation Agenda. There can be a Regional Digital Development Fund to support the LDCs.

There is a need to draw up an Asia-Pacific regional plan/strategy/vision document for 4IR with short (2-3 years) and long term (5 years) targets. After consultations, the road map on how to achieve the targets can be drawn. There is a need to regularly monitor the progress. The vision plan or strategy document can lay down the priority areas for collaboration and Task Force can be put in place at a regional level to monitor the progress. Countries have to put in institutional mechanisms and identify a nodal ministry/body which will be responsible for accelerating innovation and monitoring the progress in use of 4IR for achieving the SDGs. Regular data collection and analysis will help in monitoring. Data will also help to identify the gaps, overlaps, or inconsistencies that might

lead to implementation challenges.

Partnerships can also be developed for deploying technological solutions across different sectors such as agriculture, healthcare, education, among others. For this, Sectoral Working Groups can be created at regional/sub-regional levels and workshops can be conducted to identify issues and priority areas across sectors.

7.2 Need for Greater Collaboration

There is need for greater collaboration within countries and across countries and across regions. Today there is limited South-South collaborations and this needs to be encouraged. Fast growing developing countries such as India, need to support other developing and low-income countries in implementing 4IR technologies. Countries such as ROK, Singapore, Thailand, etc., which are leaders in adoption of 4IR technologies such as 3D printing, can utilize their proximity to LDCs in the region such as Myanmar and Cambodia to transfer knowledge of such technologies through capacity building initiatives, setting up of high-technology zones, etc. Similarly, countries such as Australia and New Zealand can aid the Pacific islands in developing digital infrastructure and advanced technological skills. With regard to technological collaboration on the lines of South-South cooperation, best practices such as that of Turkey to improve health technology (see Section 4.2) can be adopted. Potential of such cooperation have increased in the wake of the COVID-19 and to implement such collaborations, focus should be on creation of Regional R&D Centres of Excellence.

There is need for more MOUs and technology collaboration agreements - South-South and Triangular. Regions can develop Regional Technology Banks, which can be a repository of technological breakthroughs and developments. One area where there is need for greater cooperation is to make technology more affordable and accessible to the LDCs and developing countries. Countries like India, which has already developed a niche for itself in information technology services and is a start-up hub, can support other LDCs in the Asia-Pacific in implementing 4IR technologies. Such South-south cooperation will fast track the diffusion of technology for achieving the SDGs.

7.3 Enhanced Cooperation Across Multiple Stakeholders

For greater cooperation within the region, there is need for engagement of all stakeholders' government, businesses, academics and non-government organisations. At present, there are huge divide in access to technology and there is a fear that some developing and LDCs may be left behind. There is need for capacity building within regions and public and private sector should be pulled in for capacity building. Sharing of information and best practices within the region will be beneficial. It is important to identify certain areas like digital inclusion for SMEs, women, disabled and other vulnerable groups, digital literacy or creating digital infrastructure in remote and inaccessible areas, where most countries will be able to reach a consensus. There can be areas like data protection where there can be domestic regulatory gaps or lack of willingness of some members to enter into agreement to 'share data with a trust'. Given that 4IR technology is data-driven, sharing of data with a trust will help in its percolation. Protection of patent and intellectual property rights will support innovation. Countries have to put in place such framework for greater collaborations. Countries, both at national and regional levels, should explore public-private partnerships to create secure data-sharing initiatives. Co-created data resources can aid the countries in predicting aspects such as technology skills shortage or gaps in training.

There is also scope for SMEs across countries to onboard into e-commerce platforms, giving them wider access to buyers and consumers. However, that will need cross border collaborations and cooperation on e-commerce and digital payments. There is also a need to collaborate to harmonise

policies regarding consumer protection, digital content, cybersecurity, and cross-border payment systems, to name a few. In areas like data protection for national security and consumer protection there is a need to ensure that while regulation is necessary it should not be an unnecessary barrier to trade. Harmonised protection regulations benefit businesses and facilitate cross border data flow with a trust. There is need for regulatory cooperation and learning from international best practices. At the same time, there is need for a comprehensive cybersecurity policy at a country level and strategy at the regional level.

Box 1: Regulatory Cooperation: Sand Box Regulations

To bridge the technological divide among Asia-Pacific countries, innovation centric policies like 'sand box regulations' can be adopted to create flexible regulatory environment for fostering innovations. These regulations are generally set up by a financial sector regulator in a country with the main aim of allowing small scale companies, start-ups, fin-tech players, etc., to experiment with innovative products and services under the supervision of the concerned regulator.

The developed countries of the region can create a fund-of funds to bring together the angel investors, venture capitalists of the region for investing in innovative start-ups across sub-regions. Focus can be on developing regional partnerships for developing an ecosystem for sectoral start-ups, such as fin-tech, edu-tech and health-tech start-ups utilising 4IR technologies. Countries such as Singapore and ROK have implemented or announced regulatory sandboxes involving a number of focus areas, including blockchain and digital assets. For example, the Monetary Authority of Singapore (MAS) fin-tech regulatory sandbox provides various forms of regulatory relief to member organizations that explore financial services innovation.

7.4 Augment Funding for Adoption of 4IR Technologies

Some developing and LDCs face constraints due to lack of government funding and there is need to explore alternative sources like private sector funding and FDI in this respect. Governments can co-invest together with the help of private sector in 4IR technologies. Focus should be on roping in private venture capitalists who can create and manage such funds. The governments should collaborate and support such initiatives through providing fiscal and non-fiscal incentives. The financial institutions of the region should also play a vital role in supporting and extending loans to start-ups and entrepreneurs in developing innovative products and services related to 4IR.

Convergence of the South-South economies with respect to developing financial governance mechanisms can aid in addressing 4IR needs of the LDCs. Provision of financial assistance mechanisms would boost technological adoption across countries to achieve SDGs.

7.5 Promotion of 4IR based Skills and Education

Asia-Pacific member countries have to identify their skill shortages to adopt 4IR based technologies, design suitable educational curriculum and scale up their digital literacy initiatives. In developing countries such as India and Indonesia, which are characterised by large young population with lower wage requirement, development of requisite skills related to technology can be of great advantage. Innovative projects that can support training in technical skills can be promoted. However, governments in developing countries may not have the funding to

do so alone and there is need for greater collaboration and partnerships with the private sector, academia and policymakers for skill development. An Asia-Pacific, multi-stakeholders' forum on 'Future of Work', which maps the skill requirements across countries, training needs etc., will be beneficial to all countries in this region. This forum can focus on future job needs, curriculum designing, modules on skill development, etc. 4IR education and skill development is a key modality to catalyse 4IR development and adoption.

To meet the requirements of the changing skills landscape, the Asia-Pacific region needs to focus on a two-pronged approach - a) upskilling - upgrading of skills of the existing workers and b) reskilling - imparting new skills to the existing and new workers. For this, proactive steps have to be taken to conduct skill gap assessment across sectors and occupations. Along with technical skills such as AI programming and data analytics, other skills such as emotional intelligence, critical thinking, innovation, empathy, leadership, etc., will be crucial in fulfilling the new jobs of the future. The many Asia-Pacific countries who have emerged as leaders under different sub-domains of 4IR (such as AI, Blockchain, etc.) can support the less developed economies of the region through diffusion of best practices for skilling the workforce. The Reskilling Revolution launched by the World Economic Forum can be an apt platform for this. This is a multi-stakeholder forum aimed at imparting better education, skills and work opportunities to people across the globe by 2030. With COVID-19, the demand for 4IR based technological skills have accentuated further, and such platforms can help the workforce in transitioning to new jobs. Some of the reskilling initiatives that can be taken up across countries include developing sector-specific technical and vocational education and training (TVET) programmes targeting 4IR skills and training on industry-wise transformation maps to provide inputs on impact of existing and new technology.

7.6 Invest in R&D

It has been seen that investments in R&D are concentrated in a few developed economies of the region (see Section 5.1), and overall spending of developing and LDCs in technology and innovation is low. Some countries have already realised the need to spend in technology and are promoting start-ups and high technology companies. All countries in the region should focus on R&D, development of accelerators and centre of excellence. There is need for innovative funding strategies for 4IR investment and collaboration across Asia-Pacific. Specifically, developed and fast developing countries can set-up joint centres of excellence in other developing and LDCs through MoUs and joint collaboration of research institutes. It would aid in technology transfer and provide an impetus to these countries to invest in technology. The R&D centres can bring together different stakeholders engaged in the innovation process to create new solutions based on the demands of the specific countries. It will provide a platform to connect innovators, developers, technicians, etc., and can help in developing manufacturing capabilities in innovative products. Further, to mitigate the challenges related to IPR, especially with respect to 4IR, the countries need to collaborate. Specifically, in areas such as IoT, robotics and nanotechnology where IP rights are still developing internationally, countries should come together in addressing the challenges of IPR protection. There should be discussions and dialogue around various collaborative mechanisms for sharing information and know-how, technology transfer, commercialisation of IP, and developing regulations based on international frameworks, among others.

8. Conclusion

IN CONCLUSION, THE DISCUSSION IN THIS PAPER SHOWS THAT ASIA-PACIFIC COUNTRIES ARE AT DIFFERENT LEVELS IN ADAPTATION OF 4IR TECHNOLOGIES AND SUCH TECHNOLOGIES CAN HELP COUNTRIES TO ATTAIN THEIR SDGS. However, at the same time, it is imperative for countries to understand how and where these technologies could be harnessed to tackle some of the world's most pressing environmental, economic, and social challenges. The technology access and regulatory gaps are wider for developing countries and LDCs, and there is a fear that some of them may be left behind. At the same time, with the recent coronavirus pandemic, it is now more important than ever before to use 4IR technologies to come out of the pandemic on a path of sustainable and inclusive growth. Many of these challenges can be resolved through enhanced collaboration and cooperation among countries in the Asia-Pacific region, which will also help countries to attain their SDGs. It is, therefore, crucial for the region to act swiftly through domestic policy changes at the country level, greater stakeholders' engagement, cross-country and cross-regional collaborations, South-South, Triangular, and other collaborations to ensure easy and even transition towards adoption of 4IR technologies across the region. Learning from each other's success stories and best practices will enable countries to move forward. Greater collaboration and cross-border financing for research and innovation will help countries to come out of the pandemic and attain their SDG targets. For this, coordinated efforts need to be put by stakeholders across government, private and academia. Only then, the Asia-Pacific region can achieve the UN agenda of SDG 2030, specifically through adoption of advanced technologies.

References

Asia Foundation. (2020). The Future of Work across ASEAN: Policy Prerequisites for the Fourth Industrial Revolution - Recommendations and Country Studies. Collaboration with Microsoft. Available at 2020, https://asiafoundation.org/wp-content/uploads/2020/02/The-Future-of-Work-Across-ASEAN_full.pdf (last accessed November 23, 2021)

Association of Southeast Asian Nations (ASEAN). (2021). Consolidated Strategy on the Fourth Industrial Revolution for ASEAN. Available at https://asean.org/wp-content/uploads/2021/10/6.-Consolidated-Strategy-on-the-4IR-for-ASEAN.pdf (last accessed November 20, 2021)

AT Kearney. (2018). Accelerating 4IR in ASEAN: An Action Plan for Manufacturers. Available at https://www.es.kearney.com/operations-performance-transformation/article?/a/accelerating-4ir-in-asean-an-action-plan-for-manufacturers (last accessed November 23, 2021)

Birch, K. (2021). Smart Cities to Fuel APAC's IoT Market. Frost & Sullivan, Business Chief, Asia. Available at https://businesschief.asia/technology/frost-and-sullivan-smart-cities-fuel-apacs-iot-market (last accessed November 20, 2021)

Commonwealth of Australia. (2006). The Australian Guidelines for Electronic Commerce. Available at https://treasury.gov.au/publication/the-australian-guidelines-for-electronic-commerce/the-australian-guidelines-for-electronic-commerce (last accessed November 20, 2021)

Congressional Research Service. (2021). Global Research and Development Expenditures: Fact Sheet. Available at https://sgp.fas.org/crs/misc/R44283.pdf (last accessed November 23, 2021)

Department of Consumer Affairs. (2019). Draft Consumer Protection (e-Commerce) Rules, 2019. Available at http://consumeraffairs.nic.in/DraftRule/Draft%20e-commerce%20Rules.docx (last accessed November 20, 2021)

European Centre for International Political Economy (ECIPE). (2019). Patterns of Trade Restrictiveness in Online Platforms: A First Look. Available at https://ecipe.org/wp-content/uploads/2019/01/Patterns-of-Trade-Restrictiveness-in-Online-Platforms-A-first-look-final.pdf (last accessed November 23, 2021)

Global Innovation Policy Centre. (2021). International IP Index: Recovery Through Ingenuity. 2021 Ninth Edition. Available at https://www.theglobalipcenter.com/wp-content/uploads/2021/03/GIPC_IPIndex2021_FullReport_v3.pdf (last accessed November 20, 2021)

Government of Pakistan. (2019). E-Commerce Policy of Pakistan. Commerce Division. Available at https://www.commerce.gov.pk/wp-content/uploads/2019/11/e-Commerce_Policy_of_Pakistan_Web.pdf (last accessed November 20, 2021)

GSMA Intelligence. (2020). The State of Mobile Internet Connectivity 2020. Available at https://www.gsma.com/r/wp-content/uploads/2020/09/GSMA-State-of-Mobile-Internet - Connectivity-Report-2020.pdf (last accessed November 23, 2021)

Hass, R., and Balin, Z. (2019). US-China Relations in the Age of Artificial Intelligence. Brookings A Blueprint for the Future of AI: 2018-2019 Series. Available at

https://www.brookings.edu/research/us-china-relations-in-the-age-of-artificial-intelligence/ (last accessed November 20, 2021)

IMD World Competitiveness Centre. (2021). World Digital Competitiveness Ranking 2021. Available at https://www.imd.org/globalassets/wcc/docs/release-2021/digital_2021.pdf (last accessed November 23, 2021)

Karr, J., Loh, K., and San Andreas, E.A. (2020). COVID-19, 4IR and the Future of Work. Asia-Pacific Economic Cooperation (APEC) Policy Brief No. 34, June. Available at https://www.apec.org/docs/default-source/Publications/2020/6/COVID-19-4IR-and-the-Future-of-Work/220_PSU_Covid-19-4IR-and-the-Future-of-Work.pdf (last accessed November 23, 2021)

Kumar, N. (2008). South-South and Triangular Cooperation in Asia-Pacific: Towards a New Paradigm in Development Cooperations. Research and Information Systems for Developing Countries (RIS). Available at https://www.ris.org.in/south-south-and-triangular-cooperation-asia-pacific-towards-new-paradigm-development-cooperations (last accessed November 20, 2021)

Markets and Markets. (2021). Industry 4.0 Market by Technology (Industrial Robots, Blockchain, Industrial Sensors, Industrial 3D Printing, Machine Vision, HMI, AI in Manufacturing, Digital Twin, AGV's, Machine Condition Monitoring) and Geography - Global Forecast to 2026. Available at https://www.marketsandmarkets.com/Market-Reports/industry-4-market-102536746.html (last accessed November 20, 2021)

McKinsey. (2017). Jobs Lost, Jobs Gained: Workforce Transitions in a Time of Automation. McKinsey Global Institute. Available at https://www.mckinsey.com/~/media/mckinsey/industries/public%20and%20social%20sector/our%20insights/what%20the%20future%20of%20work%20will%20mean%20for%20jobs%20skills%20and%20wages/mgi-jobs-lost-jobs-gained-report-december-6-2017.pdf (last accessed November 20, 2021)

PwC. (2018). Fourth Industrial Revolution for the Earth: Harnessing Artificial Intelligence for the Earth. Available at https://www.pwc.com/gx/en/sustainability/assets/ai-for-the-earth-jan-2018.pdf (last accessed November 23, 2021)

PwC. (2021). Sizing the Prize: What's the Real Value of AI for your Business and How Can You Capitalise? Available at https://www.pwc.com/gx/en/issues/analytics/assets/pwc-ai-analysis-sizing-the-prize-report.pdf (last accessed November 20, 2021)

Research and Markets. (2020). Asia-Pacific E-Commerce Market 2020-2026. Available at https://www.researchandmarkets.com/reports/5240888/asia-pacific-e-commerce-market-2020-2026 (last accessed November 20, 2021)

Research and Markets. (2021). Asia Pacific Blockchain Technology Market by Type, By Component, By Enterprise Size, By Industry Vertical, By Country, Growth Potential, Industry Analysis Report and Forecast, 2021 – 2027. Available at https://www.researchandmarkets.com/reports/5322518/asia-pacific-blockchain-technology-market-by (last accessed November 20, 2021)

Sharma, P. (2018). The Curious Case of India's Skills Gap, and What it Will Take to Close It. YourStory. Available at https://yourstory.com/2018/06/the-curious-case-of-indias-skills-gap/amp (last accessed November 20, 2021)

Startup Sri Lanka. (2016). Country Overview of the Startup Ecosystem in Sri Lanka. Available at

https://slasscom.lk/wp-content/uploads/2019/10/Startup-Sri-Lanka-Report-2016-1.pdf (last accessed November 23, 2021)

Startups Watch. (2021). The State of Turkish Startup Ecosystem: An In-Depth Analysis and Evaluation. Collaboration with Invest in Turkiye. Available at https://www.invest.gov.tr/en/library/publications/lists/investpublications/the-state-of-turkish-startup-ecosystem.pdf (last accessed November 23, 2021)

Tohanean, T., and Toma, S.G. (2018). Innovation, A Key Element of Business Models in the Fourth Industrial Revolution. Network Intelligence Studies, Romanian Foundation for Business Intelligence, Editorial Department, Issue 12, pp. 121-130, December. Available at https://ideas.repec.org/a/cmj/networ/y2018i12p121-130.html (last accessed November 23, 2021)

United Nations Conference on Trade and Development (UNCTAD)(a). (2021). Technology and Innovation Report 2021. Available at https://unctad.org/system/files/official-document/tir2020_en.pdf (last accessed November 23, 2021)

United Nations Conference on Trade and Development (UNCTAD)(b). (2021). The UNCTAD B2C E-Commerce Index 2020. Available at https://unctad.org/system/files/official-document/tn_unctad_ict4d17_en.pdf (last accessed November 23, 2021)

United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP). (a) (2021). Asia and the Pacific SDG Progress Report 2021. Available at https://www.unescap.org/sites/default/d8files/knowledge-products/ESCAP_Asia_and_the_Pacific_SDG_Progress_Report_2021.pdf (last accessed November 23, 2021)

United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) (b). (2021). Asia-Pacific Trade and Investment Trends 2020-2021. Available at https://www.unescap.org/sites/default/d8files/knowledge-products/APTIT%20FDI.pdf (last accessed November 20, 2021)

United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP). (2019). List of Countries in ESCAP Asia-Pacific Region and Sub-Regions. Annex 4. Available at https://www.unescap.org/sites/default/files/Annex4_List_of_countries_Asia-Pacific_SDG_Progress_Report2019.pdf (last accessed November 23, 2021)

United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP). (2018). Frontier Technologies for Sustainable Development in the Asia and the Pacific. Trade, Investment and Innovation Division. Available at https://www.unescap.org/publications/frontier-technologies-sustainable-development-asia-and-pacific (last accessed November 23, 2021)

United Nations Industrial Development Organisation (UNIDO). (2020). Bracing for the New Industrial Revolution: Elements of a Strategic Response. Discussion Paper. Available at https://www.unido.org/sites/default/files/files/2020-06/UNIDO_4IR_Strategy_Discussion_Paper.pdf (last accessed November 23, 2021)

United Nations Industrial Development Organisation (UNIDO). (2019). Unlocking the Potential of Industry 4.0 for Developing Countries. 1st Regional Conference on Industrial Development, Asia-Pacific. Available at https://tii.unido.org/sites/default/files/publications/Unlocking%20the%20Potential%20of%20Industry%204.0%20for%20Developing%20Countries.pdf (last accessed November 23, 2021)

World Economic Forum. (2018). Readiness for the Future of Production Report 2018. Collaboration with AT Kearney. Available at https://www3.weforum.org/docs/FOP_Readiness_Report_2018.pdf (last accessed November 23, 2021)

World Intellectual Property Organization (WIPO). (2021). Global Innovation Index 2021. Partnership with Portulans Institute, 14th Edition. Available at https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2021.pdf (last accessed November 23, 2021)