INFORMATION AND COMMUNICATIONS TECHNOLOGY
AND DISASTER RISK REDUCTION DIVISION

Digital Transformation Landscape in Asia and the Pacific: Aggravated Digital Divide and Widening Growth Gap

Seunghwa Jun
Jongsur Park
Jeong Yoon Kim

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About the authors: Dr. Seunghwa Jun is a senior information and communications technology (ICT) consultant with 18 years of strategy development and market analysis experience in the ICT industry and 4 years of teaching experience in digital economics and strategic management at Korea University. She is the author of the book, "Phono Sapiens Economics: The New Human-Centered Digital Economy", and writes columns about the Fourth Industrial Revolution.

Dr. Jongsur Park is a Professor of Econometrics in the Economics Department at Sunmoon University, Republic of Korea. Prior to his professorship, he conducted research in the field of telecommunications demand prediction at the Korea Telecom Economic Management Research Institute and established a big data policy in the local government of the Republic of Korea.

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Abstract

The COVID-19 pandemic has accelerated mass digital adoption and expedited tech adoption across industries, advancing digital transformation at an unprecedented speed and scale. At the same time, the pandemic has widened and deepened the digital divide between and within countries, reinforcing a vicious cycle of economic inequalities.

As the benefits of digital transformation are not equally distributed, the widening digital gap between businesses and industries is magnified at country levels, worsening global development gaps and imbalances. Thus, there is an urgent need to create a country-level analytical model that goes beyond business-level analysis to understand the current digital transformation landscape and diagnose existing digital transformation gaps among member States of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP).

This working paper discusses a study that reviewed existing ICT-related analytical frameworks and indicators, and proposed 105 indicators used by international organizations to formulate a digital transformation framework and Digital Transformation Index (DTI version 1) to measure and analyse the status of country-level digital transformation.

Based on an in-depth pilot analysis of the DTI results, the study found that the Asia-Pacific region is the most digitally divided among five regions, showing the conspicuous digital transformation divides within and among the regions. The study also revealed the critical role of the government and business sectors in initiating and enhancing digital innovations.

This working paper suggests that the ESCAP member States take a more active role in narrowing the digital transformation gaps between advanced countries and late comers to achieve an inclusive digital future.

Keywords: Digital Transformation, Digital Transformation Index (DTI), Digital Divides

1. INTRODUCTION

An assessment framework has been developed to better understand the current digital transformation landscape in the Asia-Pacific region and diagnose existing digital transformation gaps among the member States of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) in order to progress towards an inclusive digital economy and society.

The COVID-19 pandemic has transformed socioeconomic activities around the globe at an unprecedented speed and scale. According to Accenture, companies have adopted innovative technologies, such as fifth-generation (5G) mobile network, artificial intelligence (AI), big data, cloud computing, Internet of Things (IoT), robotics, augmented reality (AR), virtual reality (VR) and extended reality, faster during the pandemic. This has widened the gap between leaders and laggards in business since the benefits of digital transformation have not been equally distributed.[i] Although many parts of the world are now recovering from the pandemic, the recovery path seems to bifurcate in two directions, creating a "K-shaped recovery curve".[ii]

The United Nations recently named the digital divide the new face of inequality in the COVID-19 era[iii] because digitally-connected and well-prepared countries, industries, companies and individuals are thriving, while the poorest and those most vulnerable are hit hardest. As digital technology plays a critical role in how we live, learn, work and participate in the economy, the scope of the digital divide has extended from access and usage to capacity and socioeconomic outcomes. With more devices and systems relying on Internet connectivity emerging, those without reliable Internet and necessary digital skills will be further excluded from access to the benefits and opportunities of the digital economy in the future.[iv]

Thus, a country-level analytical model is urgently needed to understand the current digital transformation landscape and diagnose digital transformation gaps among ESCAP member States. This working paper proposes 105 indicators for measuring country-level digital transformation and presents a framework for the Digital Transformation Index (DTI). Leveraging macroeconomic analysis tools such as the political, economic, social, technological, environmental and legal (PESTEL) analysis and the circular flow model, the DTI framework incorporates five pillars – Network / Infrastructure, Government, Business, People and Ecosystem. Additionally, to reflect the evolutionary dynamics of digital transformation, three stages are proposed – Foundation, Adoption and Acceleration – thus, creating 15 separate domains for investigation.

The DTI framework has been applied to better understand the current digital transformation landscape in the Asia-Pacific region and diagnose existing and emerging gaps among ESCAP member States. The key findings are presented in this working paper. This paper identifies the key factors driving high levels of digital transformation and examines the digital

transformation divides between leaders and laggards. This paper also attempts to derive meaningful implications that can be utilized for establishing national digital transformation strategies by selecting benchmarking countries in each income level group. With the in-depth analysis of the DTI results, the paper is expected to guide countries included in the study to understand their level of digital transformation achievements and develop plans to further accelerate digital transformation.

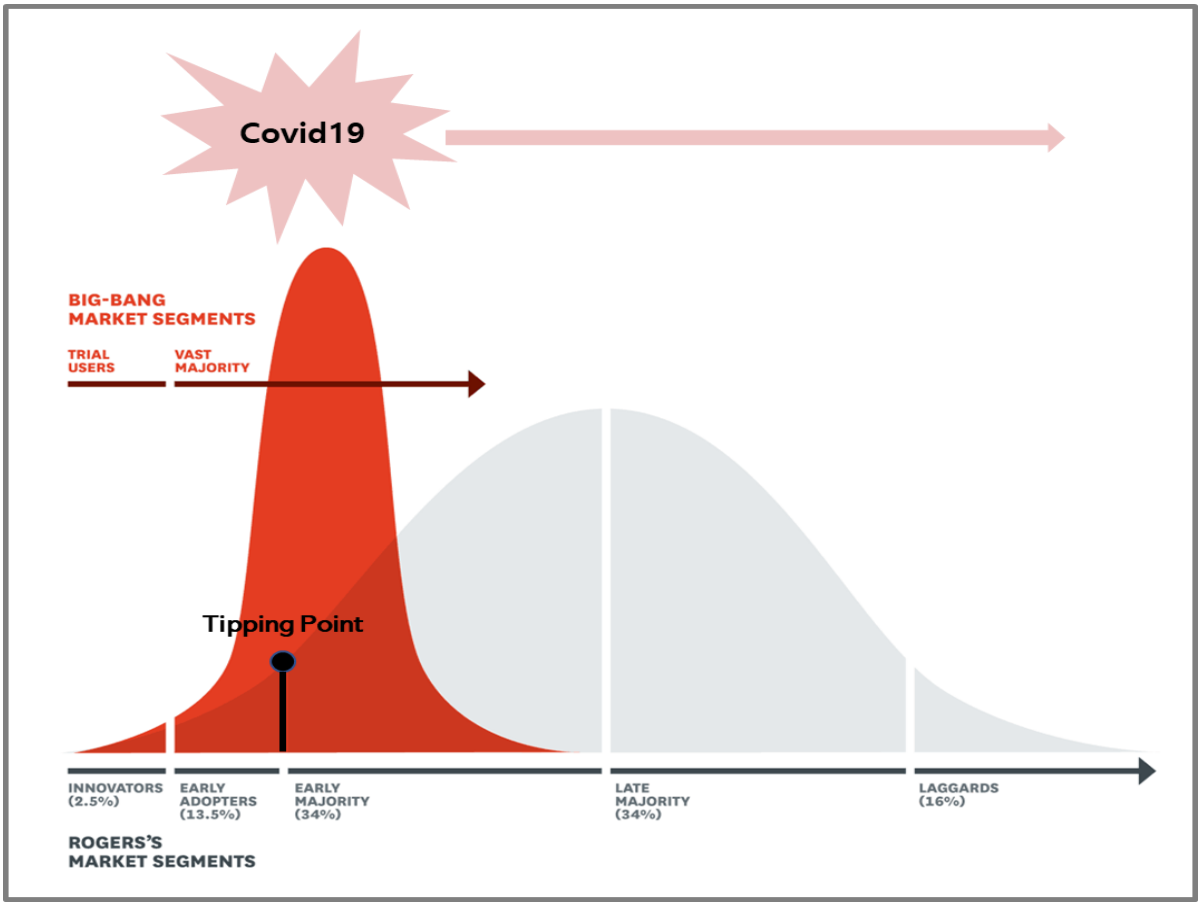
2. COVID-19 AND THE NEW DIGITAL DIVIDE

The COVID-19 pandemic has advanced the role of digital technologies and accelerated mass digital adoption in every socioeconomic aspects. However, the uneven capacity for accelerating digital transformation has widened digital divide, reinforced existing social and digital inequality, and thus, deepened the vicious economic inequality cycle.

2.1 Big-bang Digital Adoption: Accelerating towards Contactless Society

The march towards contactless services – Since the outbreak of COVID-19, countries around the world have implemented strong containment and mitigation measures to minimize direct human interactions. For most people, even among the "digitally-resistant" ones, "contactless" digital services such as online shopping, remote working, video conferencing and distance learning have become a necessity (Table 1).[v]

Figure 1: Big-bang disruption during the COVID-19 pandemic



Source: Downes, L., and Nunes, P. (2013). Big-Bang Disruption. Harvard Business Review. Available at https://hbr.org/2013/03/big-bang-disruption, modified by the authors.

Big-bang digital adoption – COVID-19 has pushed people over the technology tipping point, and digital adoption has taken a quantum leap in a brief period of time. Unlike the usual sequential pattern of technology diffusion, digital adoption during the pandemic occurred in a much more accelerated way. Figure 1 illustrates the striking difference between Everett Rogers' classic bell curve with five distinct customer segments (shown in grey) and Downes and Nunes' taller and compressed "big-bang disruption" model with only two market segments (shown in red).[vi]

Table 1: Contactless services and key digital technologies

Category	Service	Key Digital Technology
Non-face-to-face Service	Video Conferencing	Cloud, Software-as-a-Service (SaaS)
	Telehealth	Cloud, Big Data, AI, AR, VR
	Distance Learning	IoT
	Online Shopping	Cloud, SaaS
	Online Gaming	Payment Solutions, AR, VR, AI, Cloud
	Video Streaming	AI, Cloud, Big Data
	Social Media	Big Data, AI, Cloud, AR, VR, Blockchain
	Smart Factory	Industrial IoT, Big Data, AI, Cloud, AR, VR
	FinTech	Big Data, AI, Blockchain, Cloud
	ProTech	Big Data, AI, Blockchain, Cloud, AR, VR
Autonomous Service	Unattended Store	Sensor, Payment Solutions, AI, Real-time Locating Systems, Cloud, Big Data
	Robotic Barista	Robotics, AI, IoT
	Drone Delivery	Drone, AI, IoT, Cloud, Big Data
	Self-driving Car	AI, IoT, Connected and Autonomous Vehicle, Cloud, Big Data

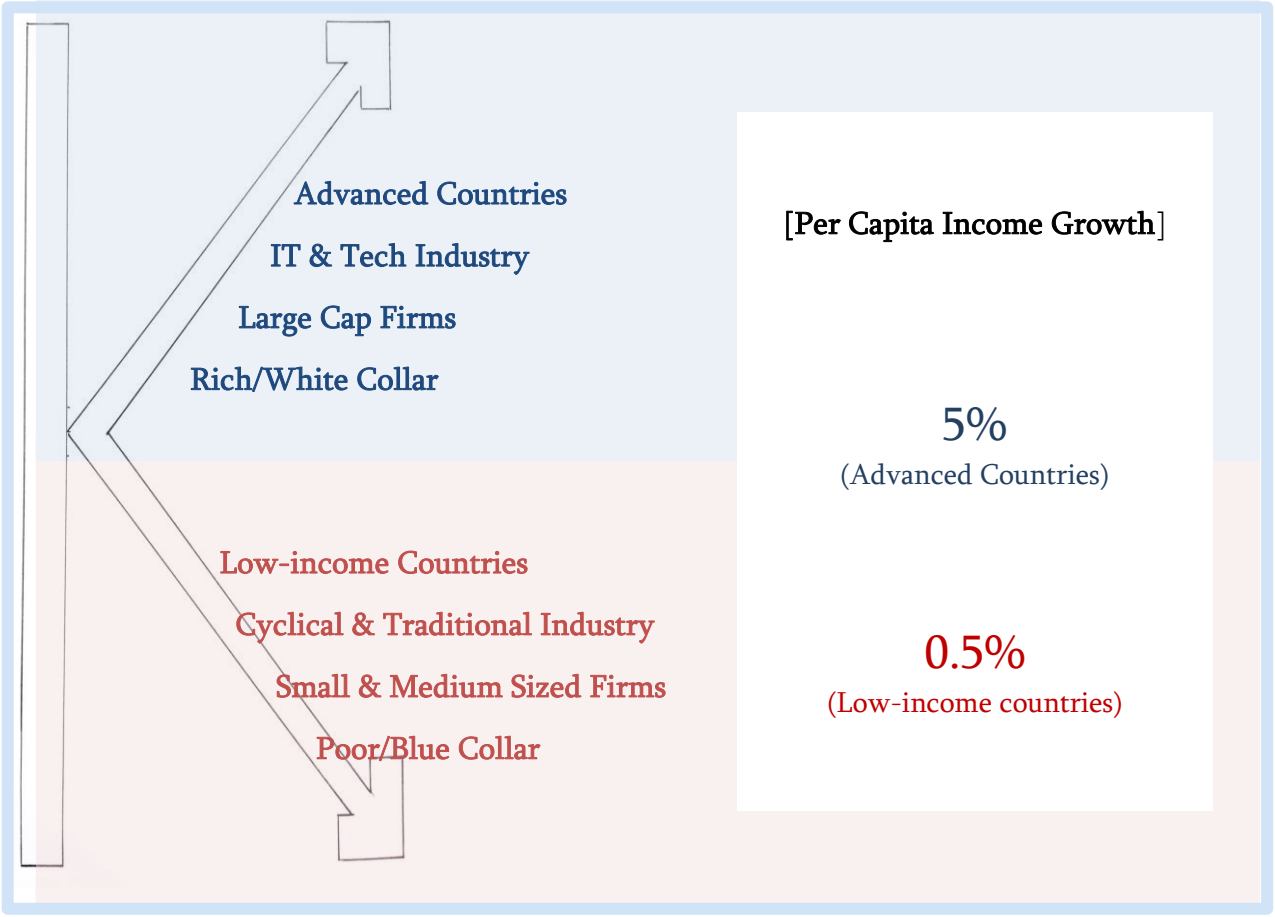
Source: Jun, S., and Kim, J. (2020). Theoretical Background and Prospects for the Untact Industry. Journal of New Industry and Business, vol. 38, no. 1, pp. 96-116. Available at https://doi.org/10.30753/EMR.2020.38.1.005.

2.2 The Inequality Virus: Widening Gaps Between and Within Countries

K-shaped recovery – Although many parts of the world are recovering from the pandemic, the recovery path seems to bifurcate in two directions, creating a K-shaped recovery curve.[vii] The term "K-shaped recovery" refers to the different rates of economic recovery across the world from the COVID-19 pandemic. Unlike typical economic recoveries that are V, W, Z, U and L-shaped, a K-shaped recovery is characterized by two contradictory trends – a rapid rebound for some groups and a persistent lag for others. The wildly uneven recovery has worsened existing socioeconomic inequalities. The phenomenon of "the rich get richer and the poor get poorer" is aggravated between countries, regions, industries, companies, classes and individuals.

Inequality between countries – The dramatically uneven economic recovery across countries is exacerbating inequality around the world. According to the World Bank, per capita income in advanced economies is growing nearly 5 per cent in 2021, compared to only 0.5 per cent in low-income countries. [viii] In addition, although the average aggregate growth of emerging market and developing economies is estimated at 5 per cent in 2021 and 4.2 per cent in 2022, these optimistic figures depend on a strong expected rebound of China. The pace of economic recovery is diverging within the emerging market and developing economies as their anticipated average recovery (excluding China) is only 3.5 per cent – much more subdued than including China.[ix]

Figure 2: K-shaped recovery from the COVID-19 pandemic (1)

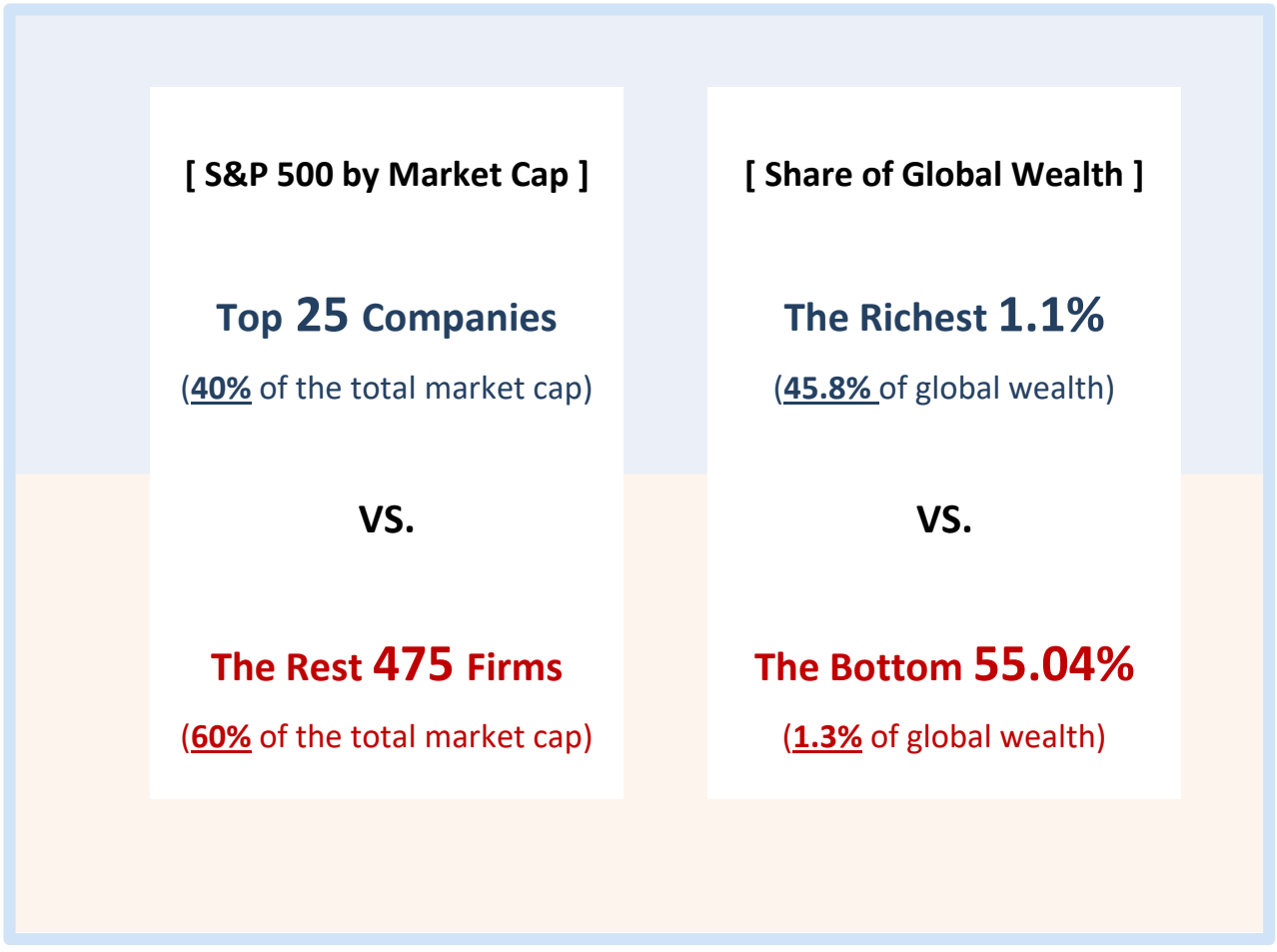


Sources: Modified by the authors based on references from World Economic Forum, J.P. Morgan, World Bank and Investopedia.

Inequality within society – Since February 2020, when the pandemic triggered a freefall in share prices, the stock market revealed the impact of accelerating digital trends, with growing gaps between winners and the rest, and a flow of value to mega-players.[x] As of October 2021, the 25 largest companies made up approximately 40 per cent of the total combined market cap of the 500 companies in the S&P 500. As of April 2022, nine places out of the top 10 biggest companies were taken by tech giants such as Apple (7.14 per cent), Microsoft (6.1 per cent), Amazon (3.8 per cent), Tesla (2.5 per cent), Alphabet Class A (2.2 per cent), Alphabet Class C (2.1 per cent), NVIDIA Corporation (1.8 per cent) and Meta (1.4 per cent).[xi] Moreover, while just 1.1 per cent of the world's population holds 45.8 per cent of global wealth, 55 per cent of the population owns only 1.3 per cent of global wealth.[xii]

To be or not be digital – This unprecedented K-shaped recovery can largely be explained by the digital transformation that has rapidly accelerated during the pandemic. For example, Satya Nadella, the Chief Executive Officer of Microsoft stated: "Microsoft has seen two years' worth of digital transformation in two months. From remote teamwork and learning, to sales and customer service, to critical cloud infrastructure and security."[xiii] As the digital innovations that could have taken place over the next 10-20 years have been compressed into the past two years, those who have led the digital transformation or have promptly switched to digital systems are clearly distinguished from those who have not. The digital divide amplified by the butterfly effect of the pandemic has further accentuated digital and social inequalities.

Figure 3: K-shaped recovery from the COVID-19 pandemic (2)

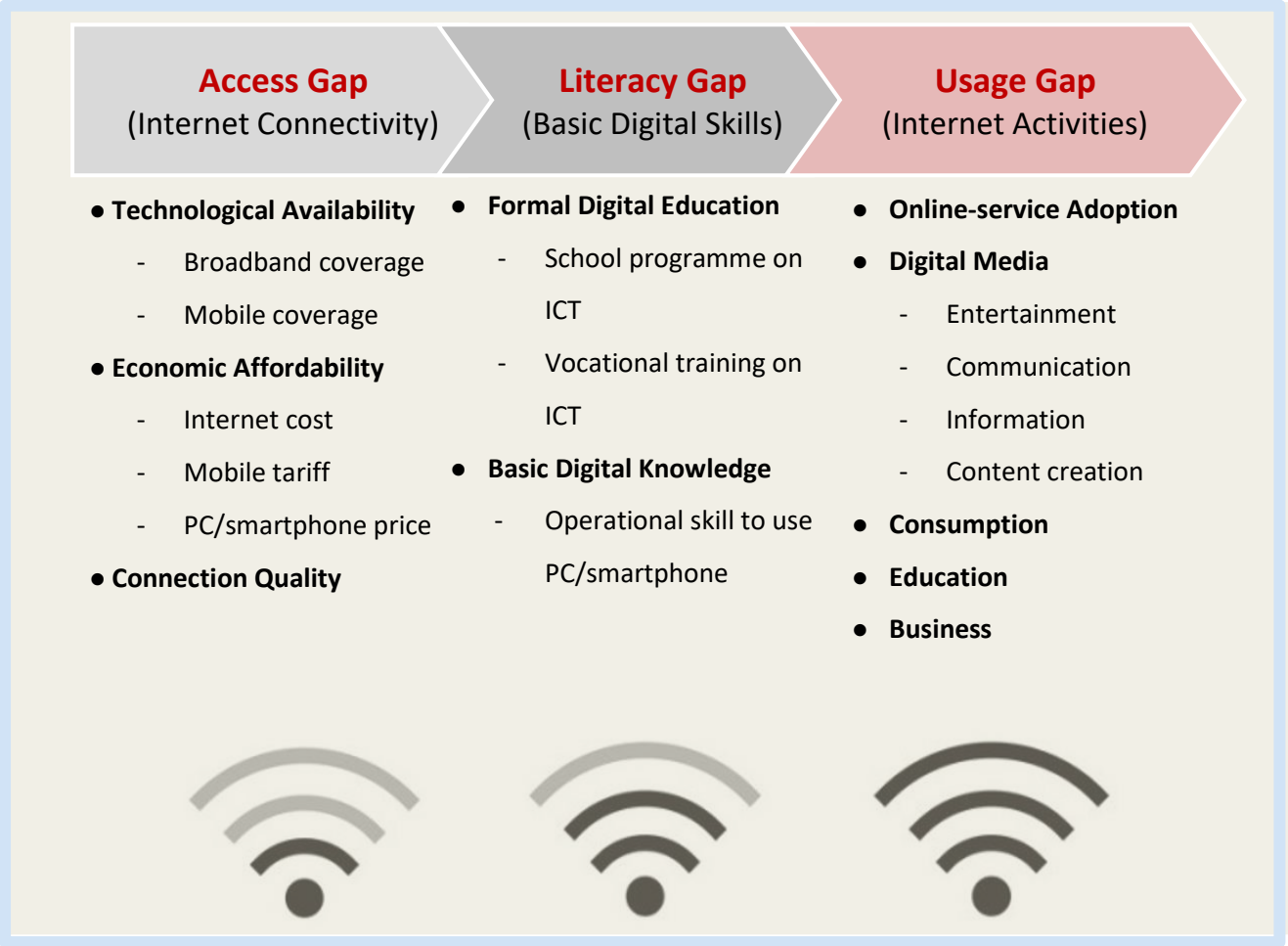


Sources: Modified by the authors based on references from World Economic Forum, J.P. Morgan, World Bank and Investopedia.

2.3 The New Digital Divide: Reinforcing a Vicious Cycle of Inequality

The digital divide – The term "digital divide" generally refers to the gap between individuals, households, businesses and geographic areas at different socioeconomic levels regarding both their opportunities to access information and communications technologies (ICTs) and their use of the Internet for a wide variety of activities.[xiv] Based on van Dijk (2020), this paper defines six factors of the extended digital divide after the COVID-19 pandemic: (1) access gap; (2) literacy gap; (3) usage gap; (4) capacity gap; (5) participation gap; and (6) outcome gap. The access gap refers to the Internet connectivity that encompasses technological availability, economic affordability and connection quality. The literacy gap means the different level of basic digital skills such as formal digital education and basic digital knowledge. The usage gap results from the varying degree of Internet activities such as online service adoption, digital media, consumption, education and business. While Internet coverage and physical access gaps have slowly narrowed, the gaps in digital literacy and usage have been widening. For example, people with high education tend to learn digital skills faster and better, and those in higher social class tend to use the Internet more for education, work, career and business, while people with low education and social class primarily use the Internet for entertainment, chat or simple communication and e-shopping.[xv]

Figure 4: New digital divide after the COVID-19 pandemic (1)



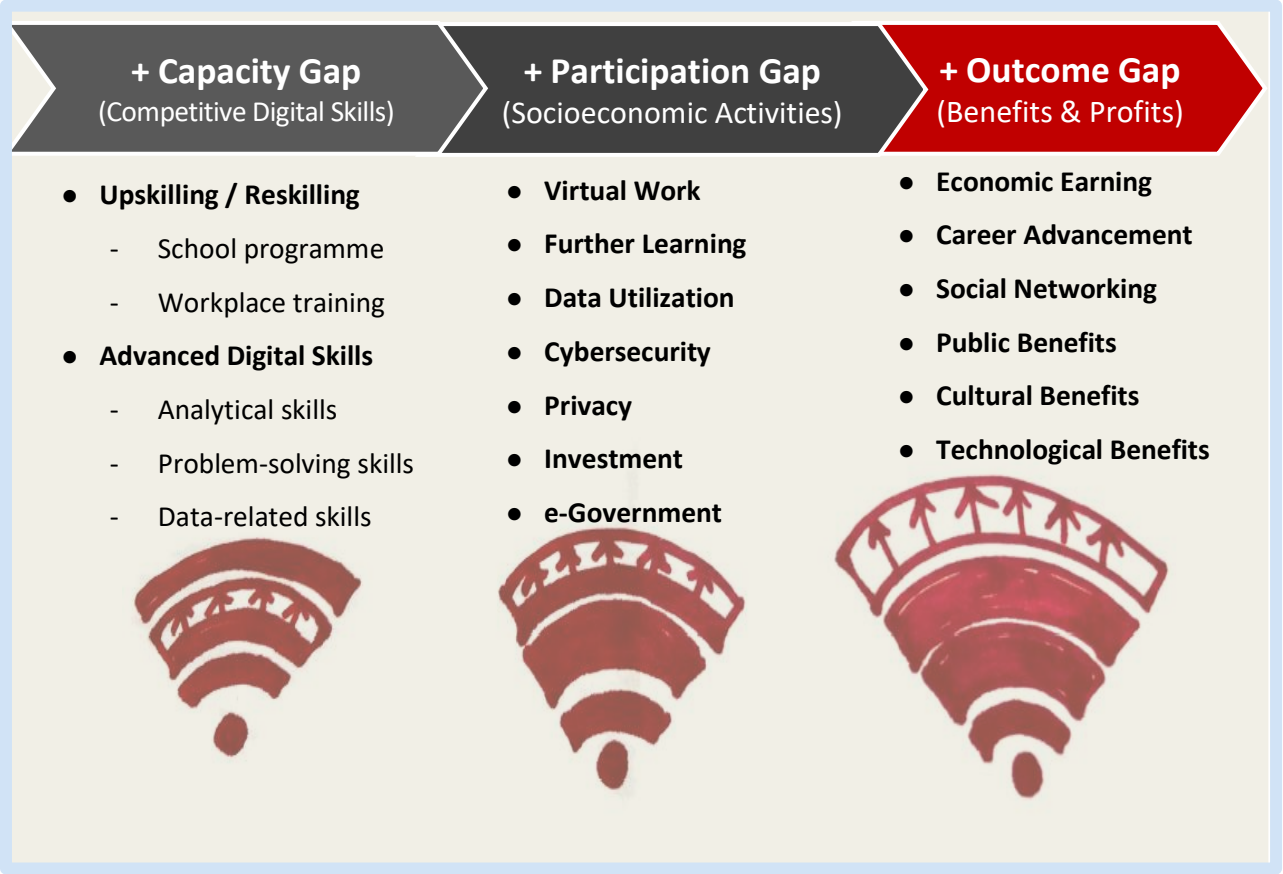
Source: Elaborated by the authors, based on van Dijk, J. (2020). Closing the Digital Divide: The role of digital technologies on social development, well-being of all and the approach of the Covid-19 pandemic. Available at https://www.un.org/development/desa/dspd/wp-content/uploads/sites/22/2020/07/Closing-the-Digital-Divide-by-Jan-A.G.M-van-Dijk-.pdf.

The capacity gap describes competitive digital skills consisting of upskilling and reskilling through school programmes and workplace training in advanced skills such as analytical skills, problem-solving skills and data-related skills. The participation gap indicates the gaps related to socioeconomic activities such as virtual work, further learning, data utilization, cybersecurity, privacy, investment and e-government. The differences in benefits and profits are referred to as the outcome gap, which involves economic earning, career advancement, social networking, and public, cultural and technological benefits.

Reinforcing inequality – Since digital inequality between those who are digitally connected and those who are not is severely exacerbated, the United Nations recently named the digital divide as the new face of inequality in the COVID-19 era.[xvi] While digitally connected and well-prepared countries, industries, companies or individuals thrive, the poorest and most vulnerable are the hardest hit by the crisis. The pandemic has widened and deepened existing social and digital inequalities, reinforcing the vicious cycle of economic inequality.

Growing impact – As digital technology plays a critical role in how we live, learn, work and participate in the economy, the scope of the digital divide has extended from access and usage to capacity and socioeconomic outcomes. In addition, as more devices and systems relying on Internet connectivity emerge, those without reliable Internet and necessary digital skills will be further denied access to the benefits and opportunities of the digital economy in the future.[xvii]

Figure 5: New digital divide after the COVID-19 pandemic (2)



Source: Elaborated by the authors, based on van Dijk, J. (2020). Closing the Digital Divide: The role of digital technologies on social development, well-being of all and the approach of the Covid-19 pandemic. Available at https://www.un.org/development/desa/dspd/wp-content/uploads/sites/22/2020/07/Closing-the-Digital-Divide-by-Jan-A.G.M-van-Dijk-.pdf.

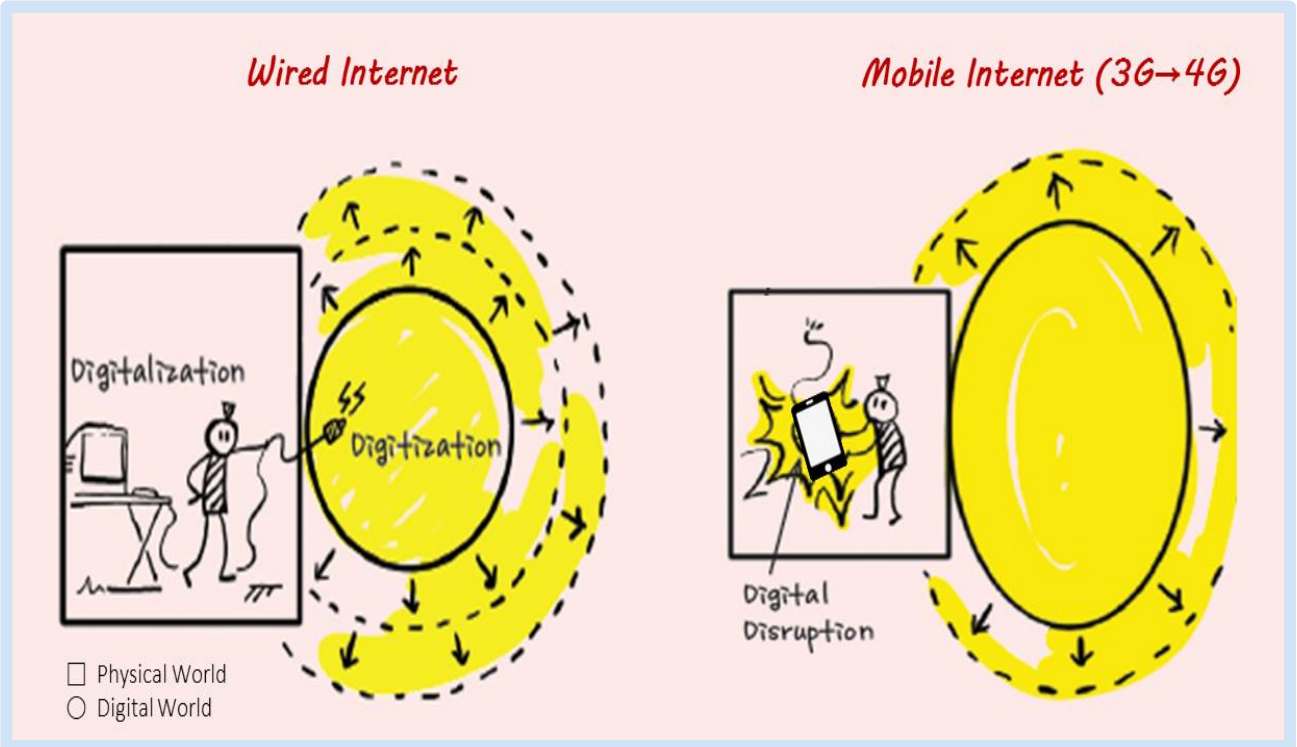
3. DIGITAL TRANSFORMATION LANDSCAPE IN ASIA AND THE PACIFIC

As the benefits of digital transformation are not equally distributed, the widening growth gap between businesses and industries is magnified at the country level. To understand the status and gaps of digital transformation, a pilot analysis conducted using the DTI framework (version 1), provided many insightful findings and directions towards an inclusive digital society. However, the lack of sufficient data in less developed countries prevented analysis of these countries.

3.1 The Inevitable Journey of Digital Transformation: Internet leads to the Fourth Industrial Revolution

Advent of the Internet – The pre-Internet era was mainly a physical world, which is depicted as a square in Figure 6. Later, the development of digital technologies and the Internet paved the way for digitization and digitalization and this digital world is illustrated as an expanding circle. Although digitization and digitalization are often used interchangeably, digitization refers to creating a digital representation of physical objects or attributes and converting existing data and processes to a digital format, whereas digitalization embraces the use of digital technologies as well as digitized data.

Figure 6: Journey of digital transformation (1)



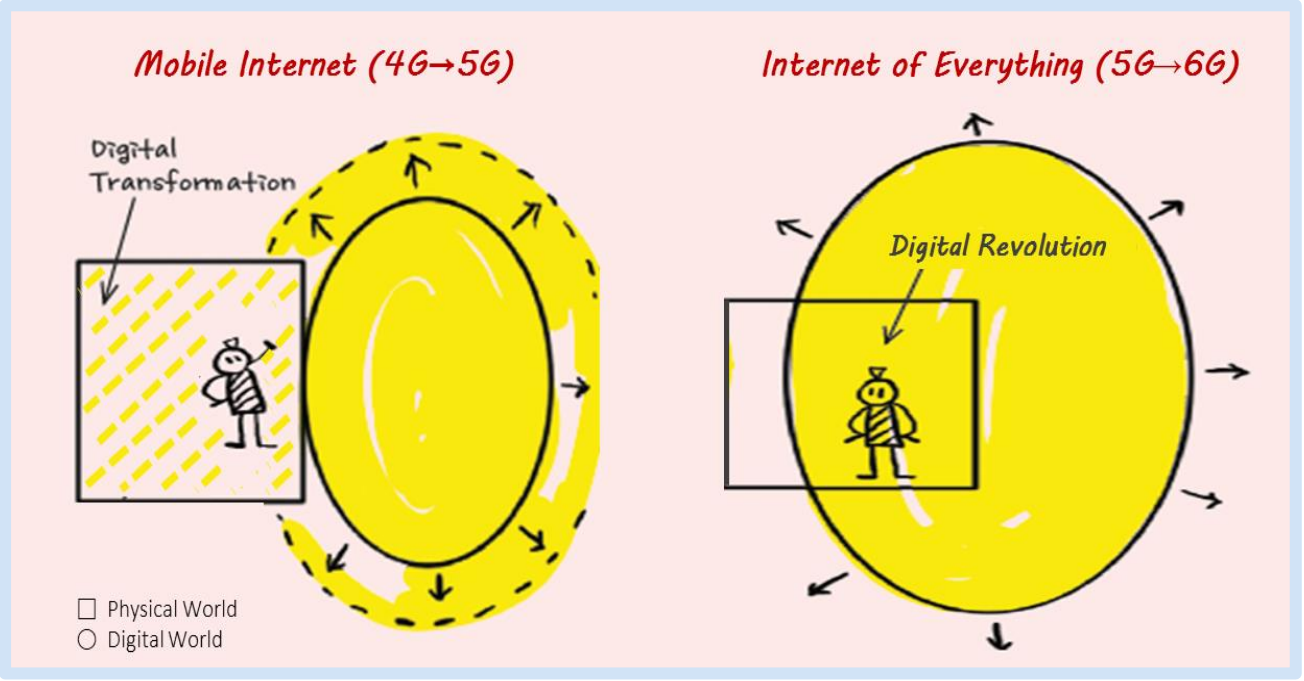
Source: Jun, S. (2019). Phono Sapiens Economics: The New Human-Centered Digital Economy. Mega Study Books.

The disruptor vs. the disrupted – The development of the mobile Internet and smartphones introduced various mobile digital platforms, expanding "digital disruption". Digital disruption can be described as an effect that changes the fundamental expectations and behaviours in a culture, market, industry or process that is caused by emerging digital technologies and business models. [xviii] Digital disruption has brought about radical changes in our lives, destroying not only offline but online competitors. In this stage, there always exist the "disruptor" and the "disrupted".

Digital transformation and the Fourth Industrial Revolution – Digitalization has already significantly impacted our lives, and no industry is immune to digital disruption. Nowadays, organizations leverage digital technologies to generate values and innovate themselves in all areas of business, and this process of integrating digital technologies is called "digital transformation". Digital transformation has been increasingly affecting our lives, the economy, society and politics. Thus, digital transformation inevitably leads to the era of the Fourth Industrial Revolution, which represents a fundamental change in the way we live, work and relate to one another, and refers to the advances of merging the physical, digital and biological worlds.[xix]

The COVID-19 pandemic and accelerated digital transformation – The pandemic has been transforming socioeconomic activities around the world at an unprecedented speed and scale, and accelerating the digital transformation of the economy. The World Economic Forum estimated that about 70 per cent of new economic value will be created over the next ten years on digitally-enabled platforms,[xx] and by 2022 over 60 per cent of global gross domestic product (GDP) will be digitized. [xxi] Moreover, many countries are extending 5G coverage, initiating the era of Internet of Everything by integrating IoT, big data, AI and other frontier technologies into our daily lives. As the advancement of digital technology occurs at an exponential rate, the physical and digital worlds will be merged at an unprecedented pace, consolidating the Fourth Industrial Revolution.

Figure 7: Journey of digital transformation (2)

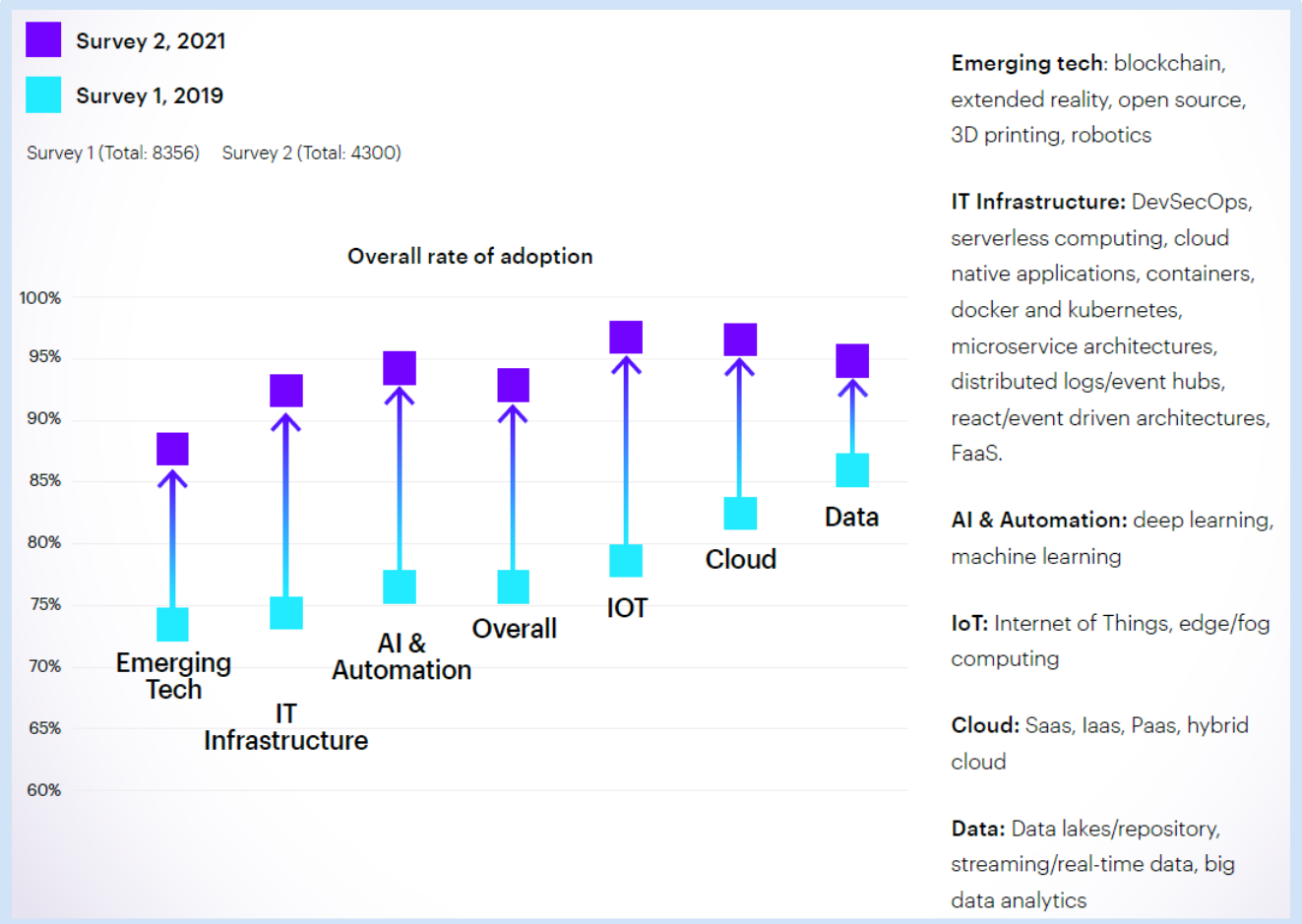


Source: Jun, S. (2019). Phono Sapiens Economics: The New Human-Centered Digital Economy. Mega Study Books.

3.2 Accelerated Digital Transformation and Widening Growth Gap

Accelerated tech adoption during the pandemic – The COVID-19 pandemic is transforming socioeconomic activities around the world at an unprecedented speed and scale. The pandemic has expedited the tech adoption rate and has compressed the digital transformation time frame. To understand the digital transformation landscape, Accenture surveyed more than 8,300 global executives in 2019 and 4,300 in 2021 to see the investment and the value creation of enterprise information technology systems. The comparison of the results of the two surveys reveals that COVID-19 has contributed to compressing transformation. The rate of technology adoption has accelerated but not equally. [xxii] Accenture defined technology adoption as: "The extent of technology adoption across organizational processes, and organizational and cultural readiness for tech-enabled innovation." The overall rate of technology adoption has increased from approximately 75 per cent in 2019 to almost 95 per cent in 2021. [xxiii] According to the surveys, companies adopted emerging technologies, information technology (IT) infrastructure, AI and automation, IoT, cloud and data (Figure 8).[xxiv]

Figure 8: Accelerated rate of tech adoption during the COVID-19 pandemic



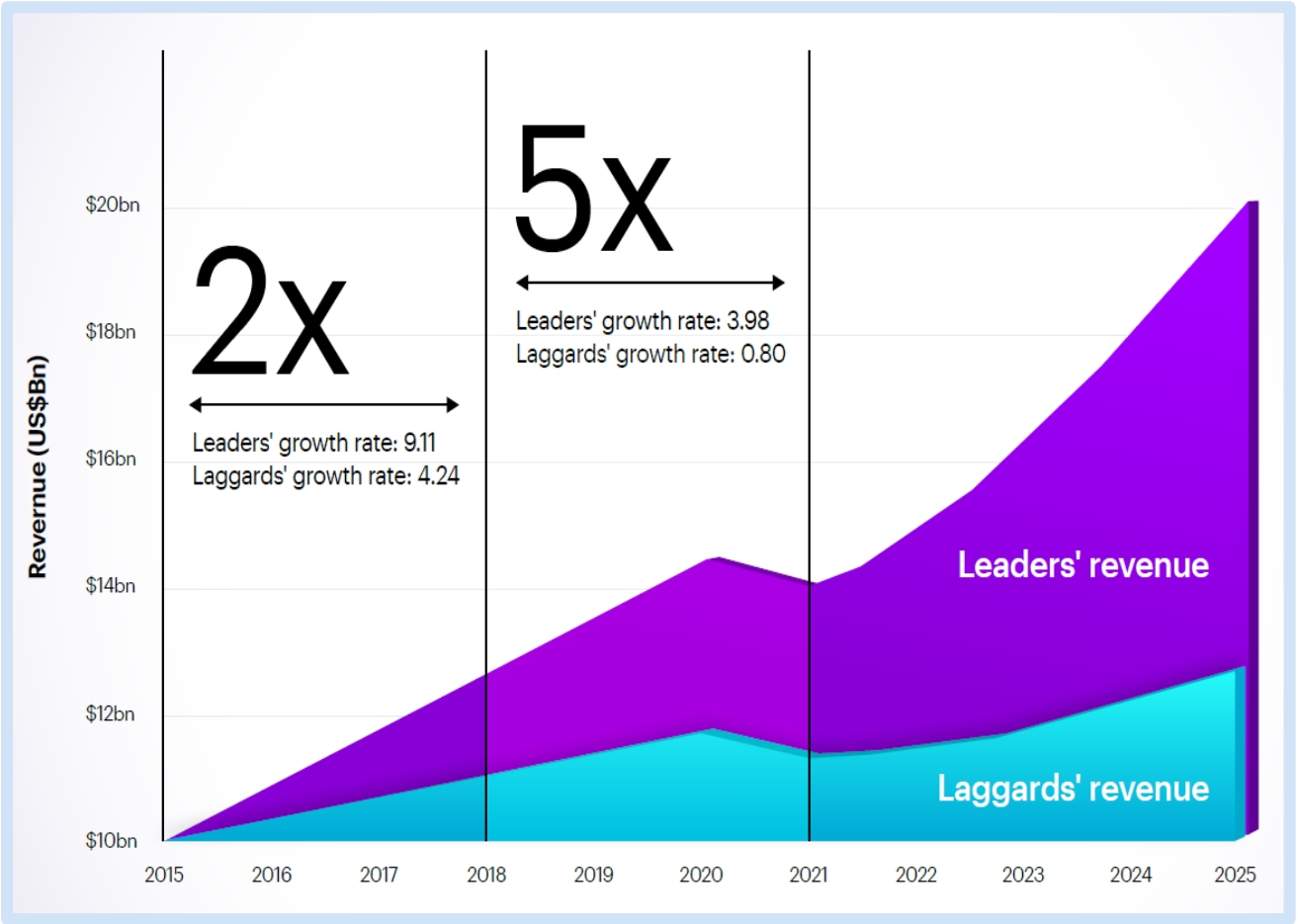
Notes: FaaS = Function-as-a-Service; SaaS = Software-as-a-Service; IaaS = Infrastructure-as-a-Service; and PaaS = Platform-as-a-Service.

Source: Accenture (2021). Make the Leap, Take the Lead. Available at https://www.accenture.com/_acnmedia/PDF-153/Accenture-Make-The-Leap-Take-The-Lead-Report.pdf.

Widening growth gap – COVID-19 has widened the gap between leaders and laggards in businesses because the benefits of digital transformation are not equally distributed despite the accelerated tech adoption rate during the pandemic. For example, the financial analysis from Accenture on its global survey of companies in 2019 and 2021 shows that leaders (the top 10 per cent) have extended their advantages over laggards (the bottom 25 per cent) during the pandemic. While leaders were growing revenues at twice the rate of laggards in 2019, according to its 2021 survey, leaders are now growing five times faster than laggards.[xxv]

As big tech companies and digital technologies continue to grow, corporate inequalities and industry inequalities also rise due to the disproportionate increase in sales and market values across businesses and industries. The rise in the growth gap between businesses and industries is magnified at the country level, exacerbating global imbalances, and worse, this digital transformation divide is expected to become even greater as the global economy picks up after the COVID-19 pandemic.

Figure 9: Revenue growth gap between leaders and laggards



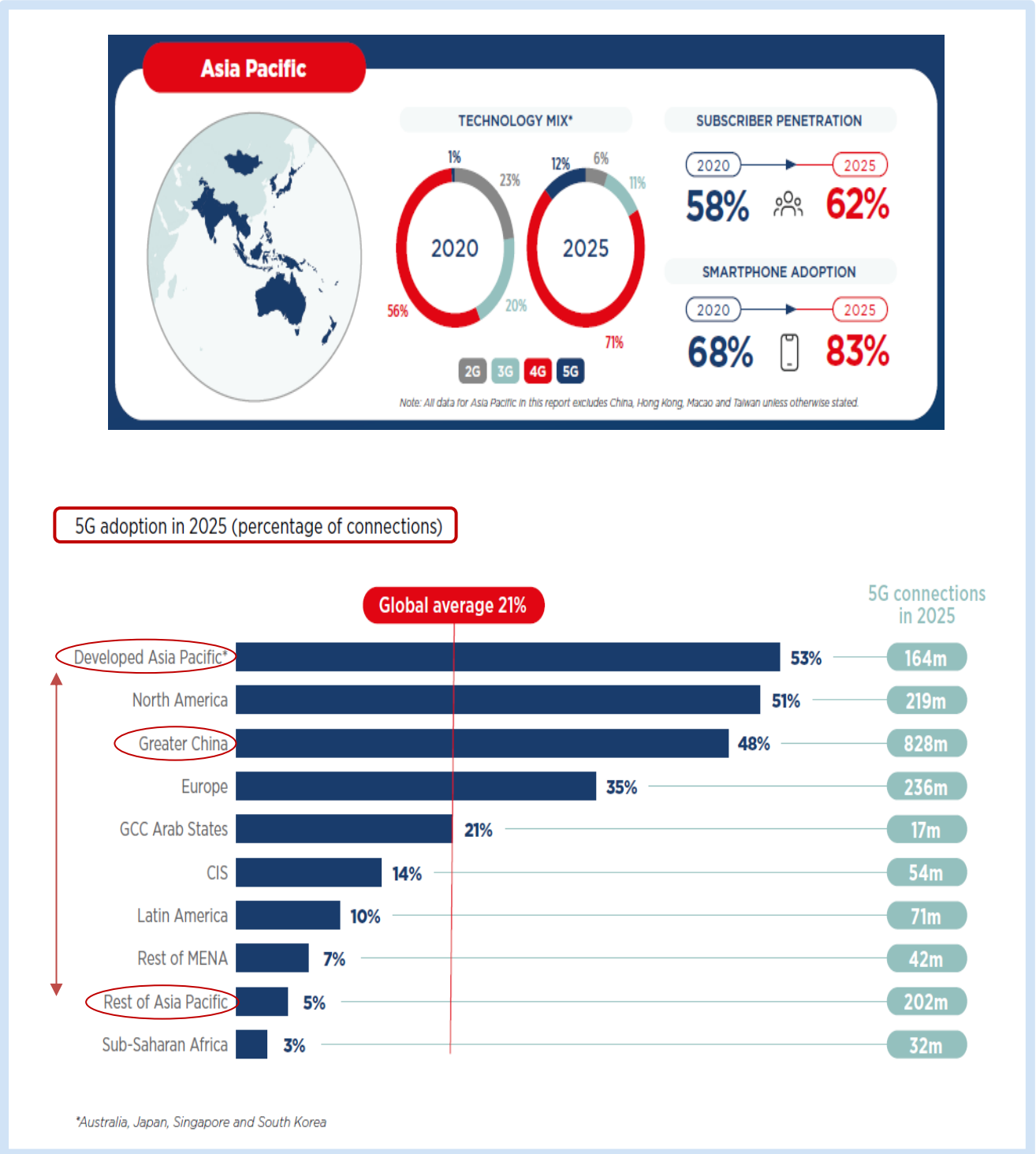
Note: Revenue growth drop during the COVID-19 pandemic for leaders was 55 per cent while it was 80 per cent for laggards. The model was based on two companies, one leader and one non-leader, with USD10 billion revenue at the end of 2014 and with average revenue growth rates from a global survey for the two groups. For realized values, the most recent survey responses of 2019 and 2021 were used. For projections, executives were asked when they expect to return to pre-pandemic level revenue growth, applying the five-year compound annual growth rate (2015-2019) as the pre-pandemic revenue growth. A linear increase in revenue growth was assumed during the recovery period.

Source: Accenture (2021). Make the Leap, Take the Lead. Available at https://www.accenture.com/_acnmedia/PDF-153/Accenture-Make-The-Leap-Take-The-Lead-Report.pdf. (2021).

5G divide in Asia and the Pacific – The COVID-19 pandemic has widened and deepened the digital divide both between and within countries. Whereas some developed countries are leading 5G connections and investing in frontier technologies, half of the Asia-Pacific population does not even have an Internet connection.

As 5G is generally characterized by ultra-high speed (20 Gbps), ultra-low latency (1 msec) and hyper-connectivity (connecting 1 million devices within 1km²), 5G will evolve into an "intelligent network" integrating IoT, big data, AI and other frontier technologies. As shown in Figure 10, by 2025, the Asia-Pacific region will be the most digitally divided area in the world.

Figure 10: Internet connection in the Asia-Pacific region in 2025



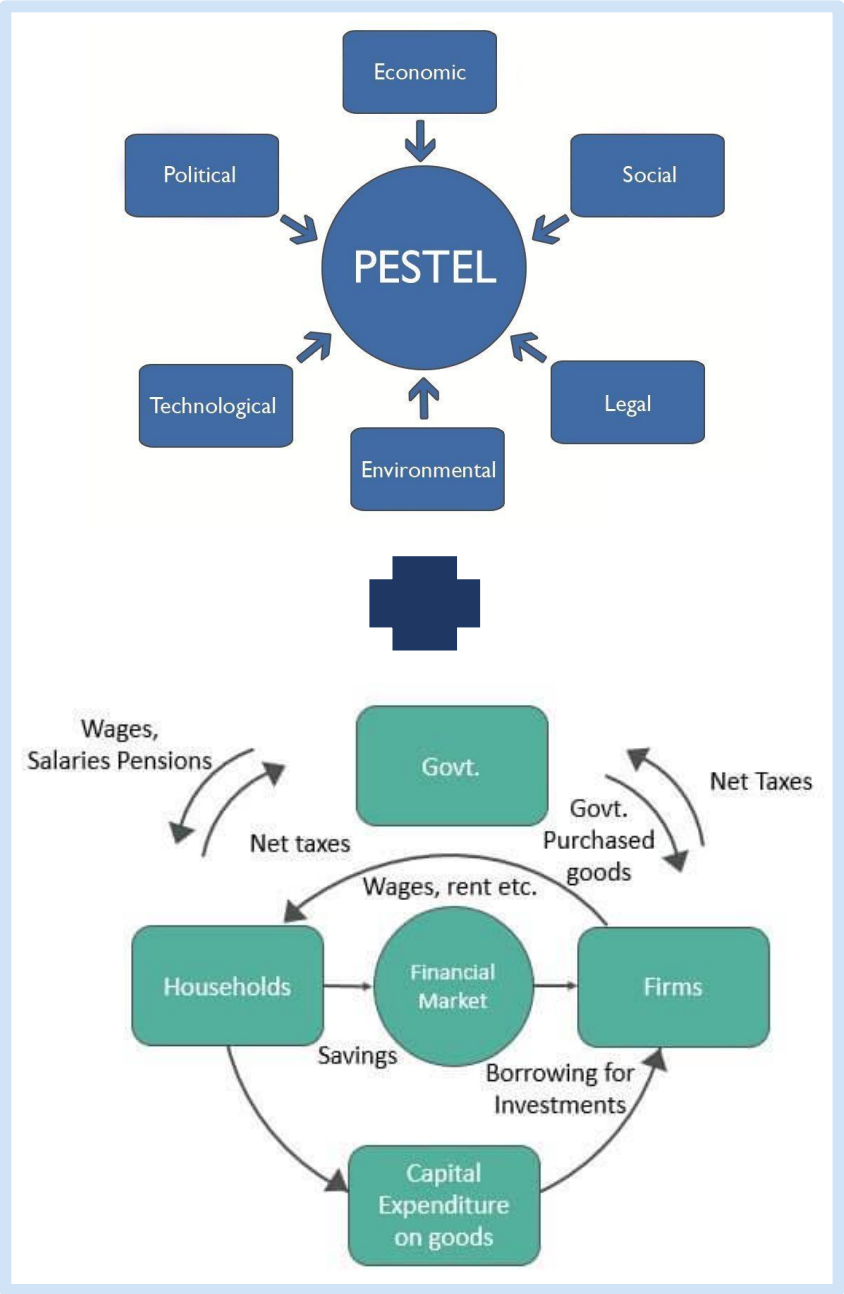
Source: Global System for Mobile Communications Association (2021). The Mobile Economy 2021. Available at https://www.gsma.com/mobileeconomy/wp-content/uploads/2021/07/GSMA_MobileEconomy2021_3.pdf.

3.3 Developing the DTI Framework

The need for national-level digital transformation diagnosis – Considering the deeply unequal global digital landscape, the DTI framework was developed to diagnose country-level digital transformation.

Developing the DTI framework – The DTI framework aims to capture the dynamics of digital transformation over time by dividing digital transformation into three stages – Foundation, Adoption and Acceleration. Morever, considering that digital transformation is a comprehensive process across a country's economy, society and industry, the DTI framework comprises five pillars – Network / Infrastructure, Government, Business, People and Ecosystem based on PESTEL analysis and the circular flow model.

Figure 11: Macroeconomic analysis tools (PESTEL + circular flow)



A comprehensive analytical tool was created to understand the current digital transformation landscape in the Asia-Pacific region and diagnose existing and emerging digital gaps among ESCAP member States.

A volume of secondary sources related to digital transformation was rigorously reviewed, and some of the most recent and significant reports were selected and analysed. All the indicators used in the DTI framework are from existing indicators of other sources such as Cisco, Economist, Institute for Management Development, Oxford Insights, Portulans, World Economic Forum and World Intellectual Property Organization (Table 2). The original intentions of the indicators were critically assessed when constructing the DTI.

Table 2: Main references used in the study

Report	Source	Factors	Weight
Digital Readiness Index (2019)	Cisco	• Number of indicators: 25 • 7 pillars: Basic Needs, Business and Government Investment, Ease of Doing Business, Human Capital, Startup Environment, Technology Adoption, Technology Infrastructure	Total score from 0 to 25
Network Readiness Index (2020)	Portulans	• Number of indicators: 60 • 4 pillars: Technology, People, Governance, Impact • 3 subpillars under each pillar	Each pillar is given a weight of 25%
World Digital Competitiveness Rankings (2020)	Institute for Management Development	• Number of indicators: 52 • 3 pillars: Knowledge, Technology, Future Readiness • 3 subpillars under each pillar	Hard data represents a weight of 2/3 in the overall ranking whereas soft survey data represents a weight of 1/3
Government Artificial Intelligence Readiness (2020)	Oxford Insights	• Number of indicators: 33 • 3 pillars: Government, Technology Sector, Data and Infrastructure	All indicators, dimensions and pillars are weighted equally
The Inclusive Internet Index (2021)	Economist	• Number of indicators: 83 (59 + 24 background indicators) • 4 pillars: Availability, Affordability, Relevance, Readiness	Availability (40%) Affordability (30%) Relevance (20%) Readiness (10%)
Global Competitiveness Index (2019)	World Economic Forum	• Number of indicators: 103 • 4 areas: Enabling Environment, Human Capital, Markets, Innovation Ecosystem • 12 pillars: Institutions, Infrastructure, ICT Adoption, Macroeconomic Stability, Health, Skills, Product Market, Labour Market, Financial System, Market Size, Business Dynamism, Innovation Capability	Each pillar is given a weight of 8.3%
Global Innovation Index (2021)	World Intellectual Property Organization	• Number of indicators: 81 • 7 pillars: Institution, Human Capital and Research, Infrastructure, Market Sophistication, Business Sophistication, Knowledge and Technology Outputs, Creative Outputs	

The DTI comprises a total of 105 indicators (see Appendix) and follows the ESCAP country groupings. [1] It incorporates data from 107 different countries worldwide, among which 25 are member States of ESCAP with relevant data available.[2]

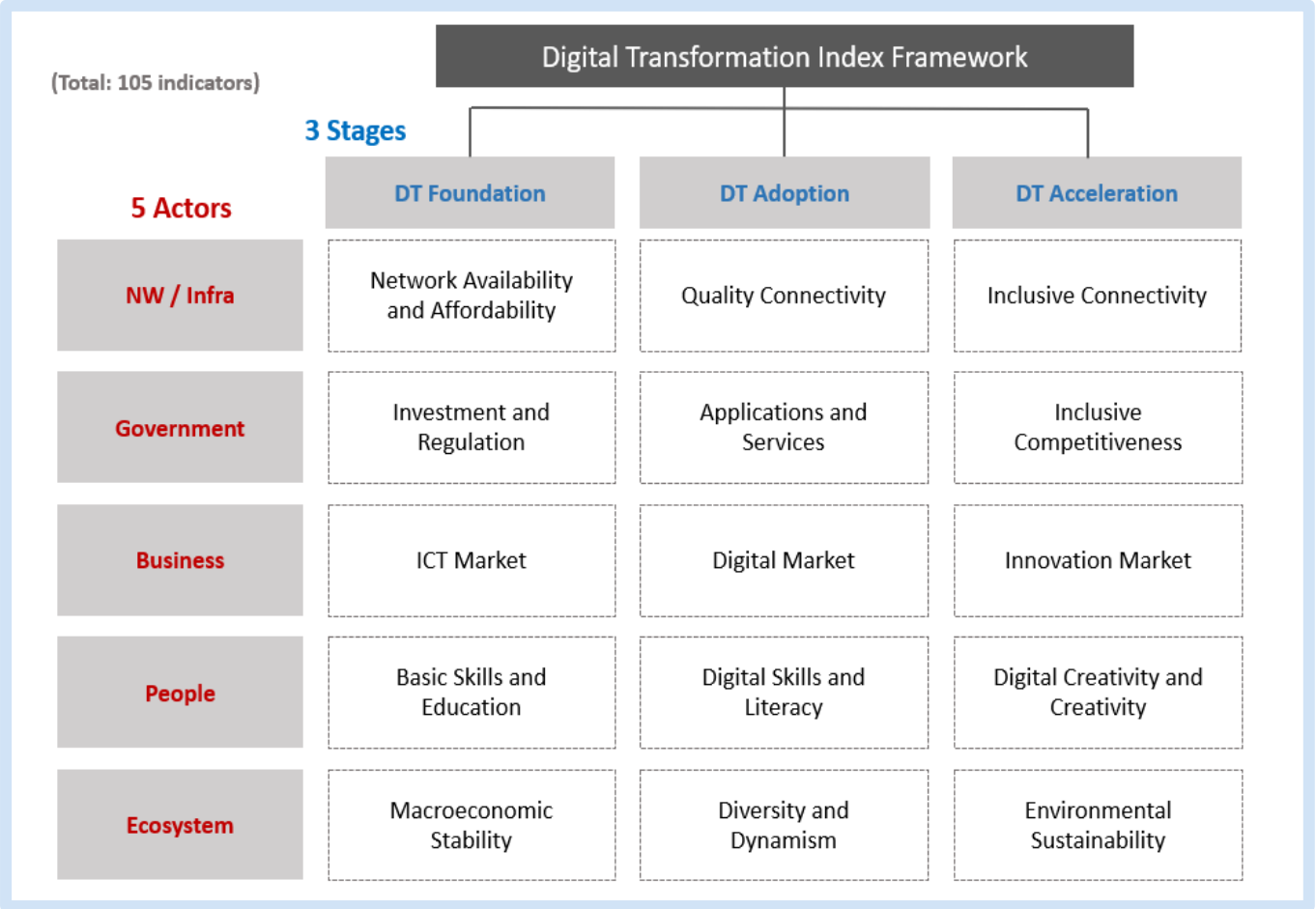
The study tried to include as many countries as possible in the DTI for comparative analysis among countries and regions, but countries with insufficient data to diagnose their digital transformation status were inevitably excluded from the DTI.

The three stages and five pillars of the DTI constitute a total of 15 domains. Each domain has different indicators that best represent the theme, and the level of importance of each domain is primarily reflected through the number of indicators.

The DTI contains 34 survey data (32 per cent of the entire dataset) to assess some important features that cannot be measured in numbers. Due to objectivity and reliability issues, however, the weighting for qualitative data is half that of quantitative data.

Figure 12 and Tables 3 and 4 give an overview of the factors and indicators that comprise each stage and pillar of the DTI.

Figure 12: The DTI framework



Notes: DT = Digital Transformation; NW = Network; and Infra = Infrastructure.

Sources: Elaborated by the authors, based on secondary sources such as Cisco, Economist, Institute for Management Development, Global System for Mobile Communications Association, World Bank, World Economic Forum, World Intellectual Property Organization, etc.

[1] ESCAP, "SDG Gateway Asia Pacific: Methodology, definitions and country groupings", 3 November 2020. Available at https://data.unescap.org/stories/escap-database.

[2] Four ESCAP member States – France, Netherlands, United Kingdom and United States of America – were excluded in order to focus the analysis on countries that geographically belong to the Asia-Pacific region.

Table 3: Key characteristics in the DTI

Pillar / Stage	Foundation	Adoption	Acceleration
Network / Infrastructure	Availability Affordability	Usage Quality	Emerging tech Inclusiveness
Government **Business** **People** (Circular Flow)	ICT-comprehensive Fundamental basis for digital transformation	Digital application Effectiveness Competitiveness	Emerging tech Reliability Inclusiveness
Ecosystem (PESTEL)	Economic and political basis	Economic and social dynamism	Technological and environmental

Table 4: Indicators by stage and pillar

Pillar / Stage	Foundation [35]	Adoption [35]	Acceleration [35]
Network / Infrastructure [24]	**Network Availability and Affordability**	**Quality Connectivity**	**Inclusive Connectivity**
	Total electricity access	Smartphone penetration	5G coverage
	Days to get electricity	Average revenue per user	5G deployment
	Mobile subscribers	Average fixed-broadband download speed	Public cloud services spending
	Fixed-line broadband subscribers	Mobile download speed	Gender equality in mobile phone access
	Internet users	Average mobile latency	Gender equality in Internet use
	Mobile tariff affordability	Tablet possession	Government effort to promote 5G
	Fixed-line broadband affordability	4G coverage	Government initiatives to make Wi-Fi available
	Handset prices affordability	Servers per population	Private sector initiatives to make Wi-Fi available
Government [24]	**Investment and Regulation**	**Application and Services**	**Inclusive Competitiveness**
	Ease of doing business	e-Government Index	National AI policies
	Intellectual property protection	e-Participation Index	Publication and use of open data
	ICT regulatory environment	Online Service Index	AI Readiness Index
	Privacy regulation	Legal framework's adaptability to digital business models	Open data policies
	Burden of government regulation	National digital identification system	Trust in online privacy

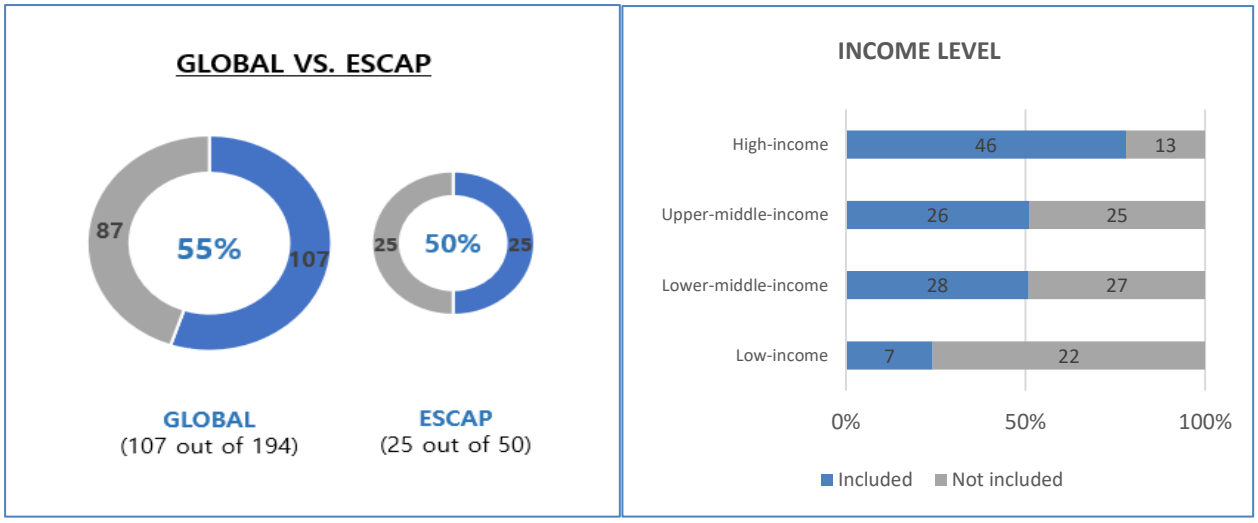
	Business and government investment	Government effectiveness	Trust in government websites and apps
	Research and development expenditure by government and higher education	Government's responsiveness to change	Online security
	Government promotion of investment in emerging technologies	e-Commerce legislation	Future orientation of government
Business [21]	**ICT Market**	**Digital Market**	**Innovation Market**
	Foreign direct investment net flow	Computer software spending	Startup environment
	Research and development expenditures by business	Venture capital availability	Robot density
	Business environment	Mobile apps development	Use of big data analytics
	High-tech exports	Digital content (news) in local languages	Innovation capability
	Medium- and high-tech industry	e-Government services in local languages	Adoption of emerging technologies
	Labour productivity per employee	Business use of digital tools	Number of tech unicorns
People [18]	**Basic Skills and Education**	**Digital Skills and Literacy**	**Digital Capacity and Creativity**
	Labour force participation	Digital skills among active population	Critical thinking in teaching
	Adult literacy	Quality of vocational training	Pupil to teacher ratio in primary education
	Harmonized test score	Ease of finding skilled employees	Harmonized test score
	Public expenditure on education	Support for digital literacy	Female digital skills training
	Basic skills	Schools with Internet access	Female Science, Technology, Engineering and Mathematics education
	Mean years of schooling	Skills of current workforce	Skills of future workforce
Ecosystem [18]	**Macroeconomic Stability**	**Diversity and Dynamism**	**Environmental Sustainability**
	Nominal GDP	Flexibility in labour market	Energy efficiency regulation
	Gross national income per capita	Diversity of workforce	Renewable energy regulation
	Democracy Index	International co-inventions	Environmental treaties
	Corruption Perceptions Index	Multi-stakeholder collaboration	SDG 11 (Sustainable Cities and Communities)
	Price stability	Cluster development and depth	GDP per unit of energy use
	Debt dynamics	Joint venture and strategic alliance deals	Environmental performance

Note: [] = Number of indicators.

3.4 Results and Analysis of the DTI

Data availability matters – One of the most conspicuous findings from the DTI is that most of the low-income countries do not have sufficient data to diagnose their digital transformation status, leaving them excluded from the DTI. Surprisingly, more than 40 per cent of the middle-income countries also do not have sufficient data for the 105 indicators related to digital transformation. On the contrary, 86 per cent of high-income countries have sufficient data to examine their digital transformation status.

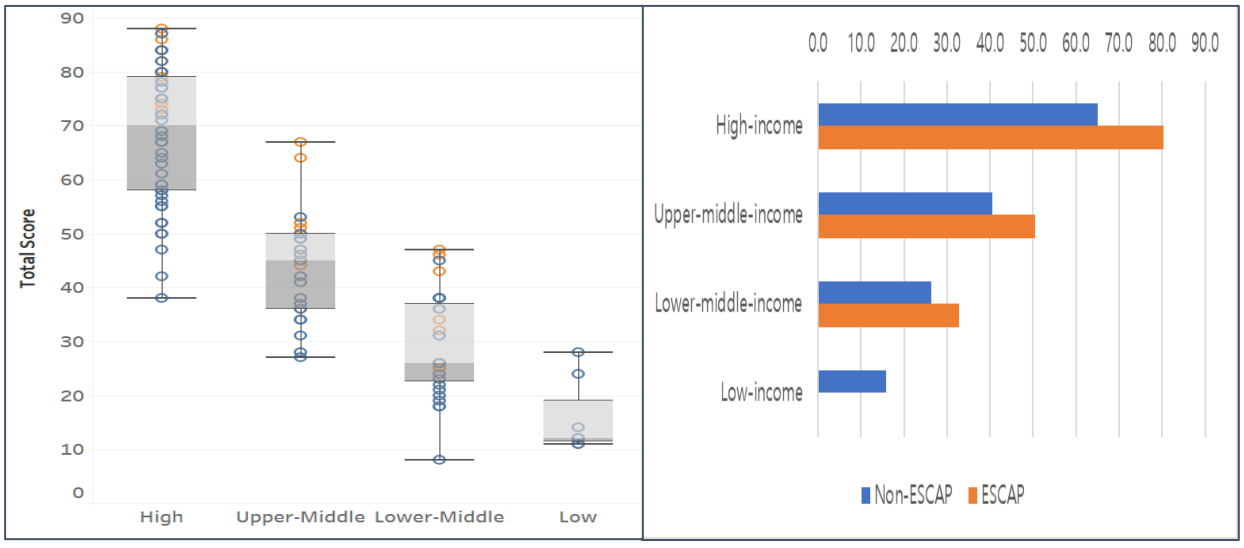
Figure 13: Characteristics of countries included in the DTI



Source: Analysed by the authors.

Income level matters – The DTI ranks the 107 countries included in the analysis by scoring them from 0 to 100. When categorized by their income level, the boxplot distribution demonstrates a high correlation as shown in Figure 14. Whereas 67 per cent of the high-income countries score higher than 60, 71 per cent of the low-income countries score lower than 20.

Figure 14: DTI score distribution and average score by income level

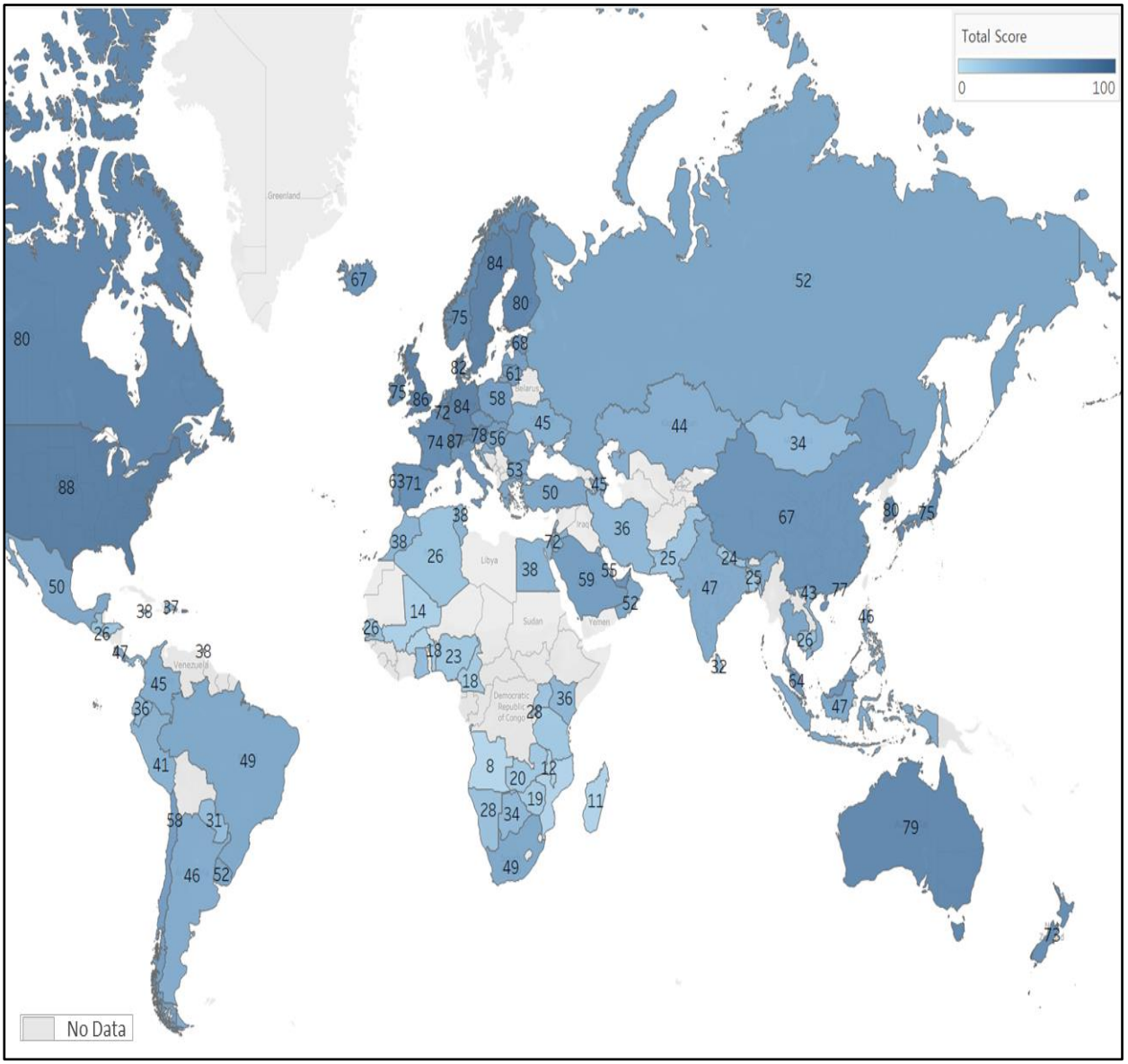


Source: Analysed by the authors.

Global landscape of the DTI – The global landscape of current digital transformation at the national level is illustrated in the map in Figure 15. Countries in North America and Europe have the highest score while African countries are among those with the lowest score.

The United States of America, Switzerland, United Kingdom, Singapore, Germany, Sweden, Denmark, Netherlands, Republic of Korea, Finland and Canada all scored above 80. One of the noticeable results is that the top eleven countries, except Singapore and the Republic Korea, are located in either North America or Europe.

Figure 15: The world map of DTI 2022



Source: Analysed by the authors.

DTI ranking and grade levels by country – The final results, including the rankings and total scores for the 107 countries in 2022, are shown in Table 5. A country's total DTI score is the sum of weighted scores of each stage and pillar. Based on their total DTI score, the countries are grouped into five grades – S (above 80), A (above 60), B (above 40), C (above 20) and D (below 20). Only eleven countries are graded as S and 22 countries as A. Most of the countries analysed are either Grade B or Grade C, each with 33 and 32 countries, respectively. Grade D has the least number of countries of nine.

Table 5: DTI rankings and grade levels by country

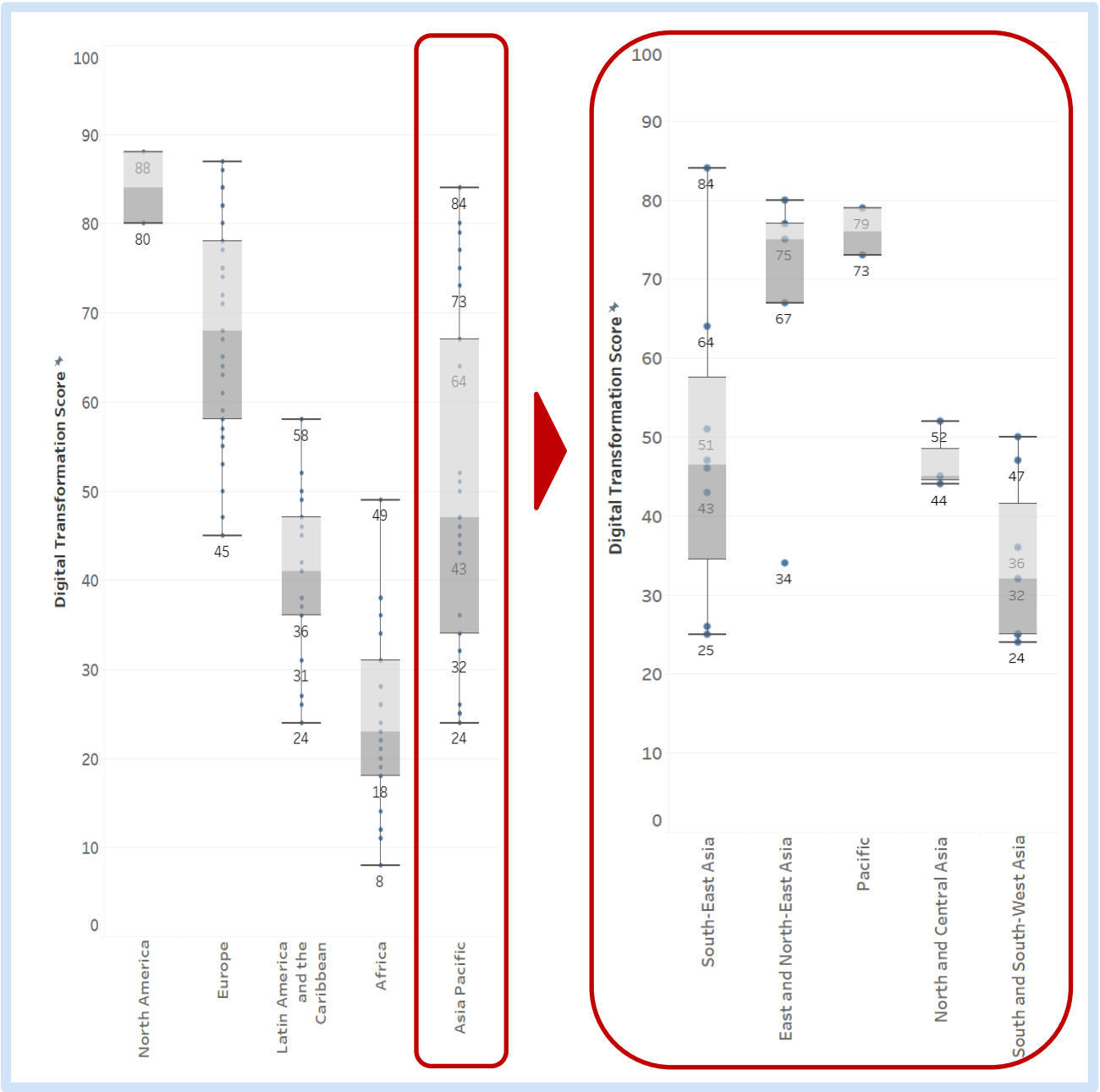
Rank	Country	Grade	Rank	Country	Grade
1	United States of America	S	21	Israel	A
2	Switzerland	S	22	Belgium	A
3	United Kingdom	S	23	Spain	A
4	Singapore	S	24	United Arab Emirates	A
5	Germany	S	25	Estonia	A
6	Sweden	S	26	Qatar	A
7	Denmark	S	27	Iceland	A
8	Netherlands	S	28	China	A
9	Republic of Korea	S	29	Italy	A
10	Finland	S	30	Czech Republic	A
11	Canada	S	31	Malaysia	A
12	Australia	A	32	Portugal	A
13	Austria	A	33	Lithuania	A
14	Hong Kong, China	A	34	Slovakia	B
15	Luxembourg	A	35	Saudi Arabia	B
16	Ireland	A	36	Poland	B
17	Japan	A	37	Chile	B
18	Norway	A	38	Latvia	B
19	France	A	39	Hungary	B
20	New Zealand	A	40	Romania	B

Rank	Country	Grade	Rank	Country	Grade
41	Bahrain	B	75	Ecuador	C
42	Bulgaria	B	76	Lebanon	C
43	Russian Federation	B	77	Botswana	C
44	Uruguay	B	78	Mongolia	C
45	Oman	B	79	Sri Lanka	C
46	Thailand	B	80	Paraguay	C
47	Mexico	B	81	Ghana	C
48	Greece	B	82	Namibia	C
49	Turkey	B	83	Rwanda	C
50	Kuwait	B	84	Guatemala	C
51	Brazil	B	85	Senegal	C
52	South Africa	B	86	Algeria	C
53	Costa Rica	B	87	El Salvador	C
54	Indonesia	B	88	Cambodia	C
55	Croatia	B	89	Lao PDR	C
56	India	B	90	Bangladesh	C
57	Argentina	B	91	Pakistan	C
58	Philippines	B	92	Honduras	C
59	Ukraine	B	93	Uganda	C
60	Colombia	B	94	Nepal	C
61	Azerbaijan	B	95	Nigeria	C
62	Kazakhstan	B	96	Côte d'Ivoire	C
63	Viet Nam	B	97	Tanzania	C
64	Panama	B	98	Zambia	C
65	Jordan	B	99	Zimbabwe	D
66	Peru	B	100	Cameroon	D
67	Jamaica	C	101	Benin	D
68	Morocco	C	102	Mali	D
69	Trinidad and Tobago	C	103	Malawi	D
70	Egypt	C	104	Burkina Faso	D
71	Tunisia	C	105	Madagascar	D
72	Dominican Republic	C	106	Mozambique	D
73	Iran	C	107	Angola	D
74	Kenya	C			

DTI score distribution across regions – The box-and-whisker plots in Figure 16 display the distribution of the DTI scores along an axis, with each box indicating the middle 50 per cent of the data and each whisker representing all points within 1.5 times the interquartile range. The boxplots in the figure illustrate the distribution of the scores across regions, exhibiting notable divides within and among regions.

The readiness of Asia-Pacific countries for digital transformation shows wide disparity (width of boxplot) between countries. While some Asia-Pacific countries have accelerated digital transformation, many other Asia-Pacific developing countries are alarmingly lagging behind. Within the Asia-Pacific region, South-East Asia shows widest disparity.

Figure 16: DTI score distribution by region and Asia-Pacific subregion



Note: Pacific includes Australia and New Zealand only. The analysis for Pacific developing countries is not available due to the lack of data.

Source: Analysed by the authors.

4. IMPLICATIONS OF THE DTI

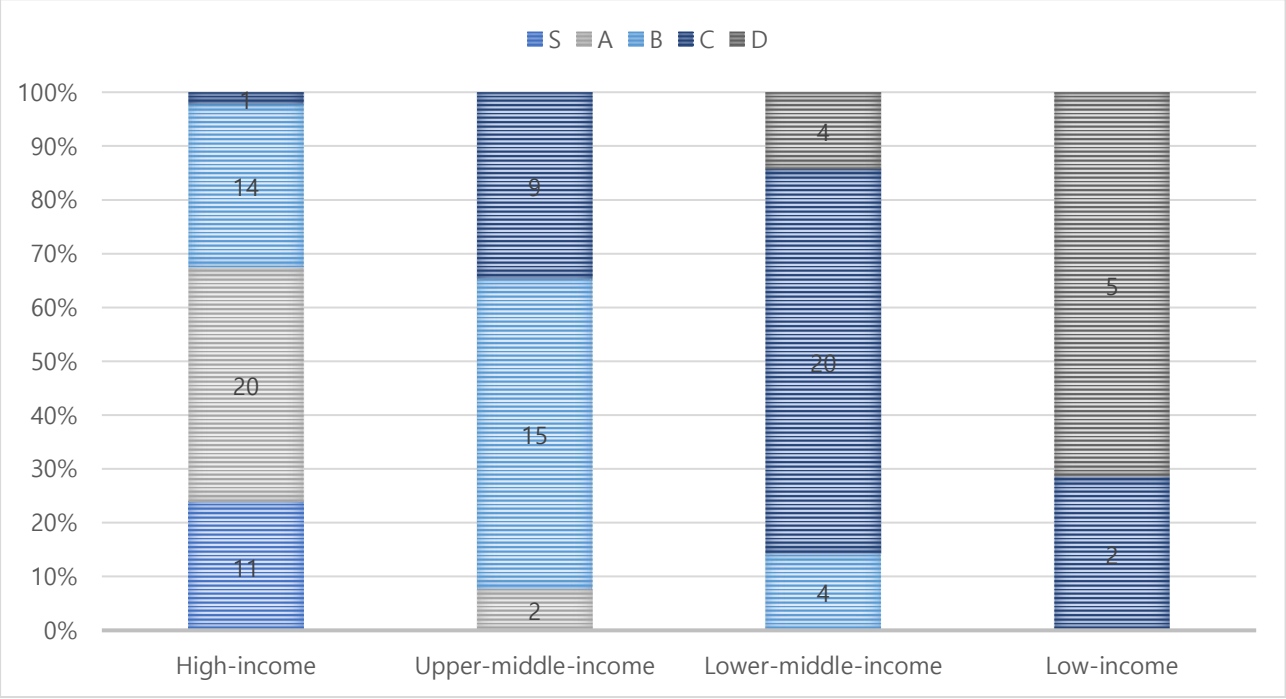
The comparative analysis of the DTI identifies benchmarking countries along with key factors that drive digital transformation, and underscores the significance of regional cooperation in advancing digital transformation as well as in bridging digital divides in Asia and the Pacific.

4.1 Key Drivers of Digital Transformation and Widening Gaps between Leaders and Laggards

Distribution and dispersion of DTI grade levels – To better analyse the results of the DTI and identify key factors for digital transformation, the DTI classifies 107 countries into five grades based on their DTI scores – S (80-100), A (60-79), B (40-59), C (20-39) and D (0-19).

Whereas 67 per cent of high-income countries are categorized as either S (80-100) or A (60-79), 71 per cent of low-income countries are graded as D (0-19). In other words, out of 46 countries in the high-income group, 11 countries and 20 countries are classified as Grade S and Grade A, respectively, while the five countries out of seven in the low-income group are denoted as Grade D. In addition, a majority of countries in the upper-middle-income group are categorized as Grade B, whereas most of the countries in the lower-middle-income group are Grade C.

Figure 17: DTI score distribution by grade level



Source: Analysed by the authors.

More specifically, only eleven countries out of 107 are classified as Grade S, including United States of America, Switzerland, United Kingdom, Singapore, Germany, Sweden, Denmark, Netherlands, Republic of Korea, Finland and Canada. Except for Singapore and the Republic of Korea, all countries in Grade S are located in North America, Western Europe or Northern Europe.

While 57 per cent of upper-middle-income countries such as the Russian Federation and Thailand are classified as B, 71 per cent of lower-middle-income countries including Bangladesh, Cambodia, Lao PDR and Mongolia are graded C.

Unlike Grade S whose countries are concentrated in certain geographic areas, the countries in Grade A are dispersed across wide swathes of geographic regions from Australia and New Zealand, Western Europe, Northern Europe and Southern Europe, to East and North-East Asia, Western Asia, and South-East Asia. Moreover, the countries in Grade C are more dispersed than those in Grade B, as it even includes South America, Central America and Southern Africa. The countries graded as C are mostly concentrated in Africa, along with the Caribbean, South America, South and South-Western Asia, and East and North-East Asia, whereas countries in Grade D are only located in the African region.

In addition, it is worth noting that the Asia-Pacific region is the most digitally divided, with the presence of countries in all grades from S to C. Within the Asia-Pacific region, the South-East Asia subregion is the most digitally divided, also with countries of all grades except D.

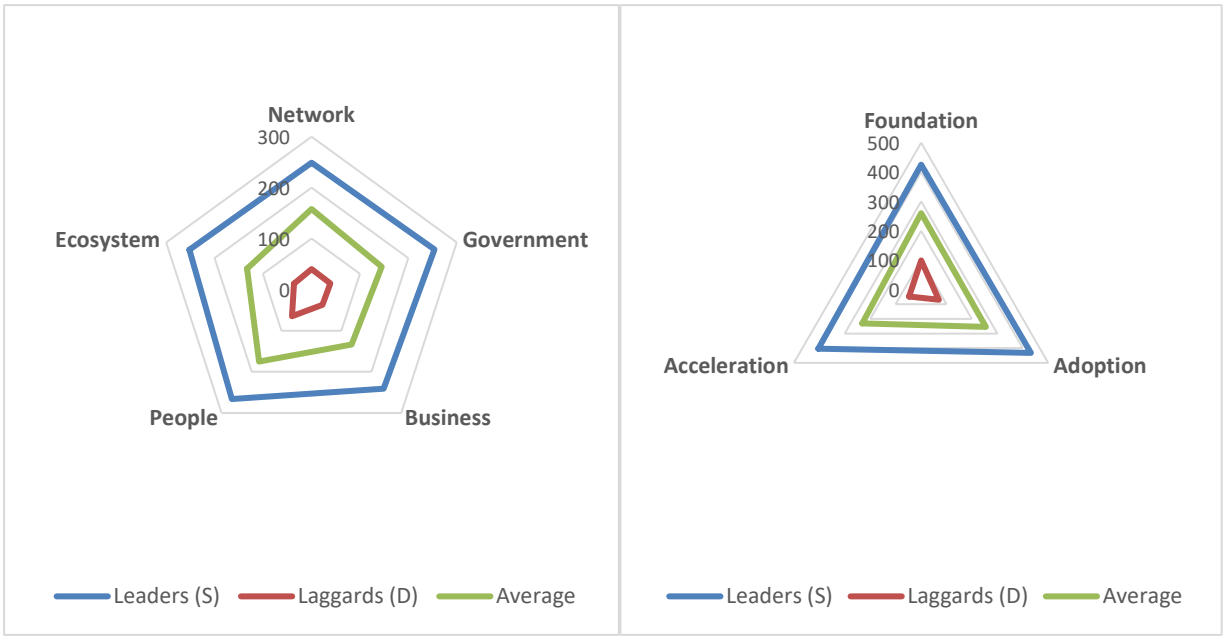
Figure 18: DTI dispersion map by grade level

Source: Analysed by the authors.

Digital transformation gaps between leaders and laggards – As the DTI framework consists of three stages depending on digital maturity (Foundation, Adoption and Acceleration) and five pillars (Network / Infrastructure, Government, Business, People and Ecosystem), examining the gaps between the leaders (countries in Grade S) and the laggards (countries in Grade D) shows striking divides in digital transformation as well as its implications.

With a maximum score for each pillar being 300, the average scores of the leaders are consistently high at around 250 across the pillars while the laggards score below 40 in most pillars, demonstrating a significant gap in every pillar with differences ranging from 201 to 216. In addition, when the highest score of each stage is 500, the leaders score above 400 whereas the laggards score below 100 in all stages. In particular, the difference between the leaders and the laggards is significantly higher in the Adaption and Acceleration stages than in the Foundation stage.

Figure 19: Gaps between leaders and laggards across pillars and stages



Grade Level	Pillar					Stage		
	NW	GOV	BIZ	PEO	ECO	FD	AD	AC
Leaders (S)	249	254	241	266	252	425	432	404
A	223	212	192	237	198	359	361	342
B	174	141	128	185	110	249	254	234
C	105	77	75	124	69	165	157	128
Laggards (D)	40	39	37	65	36	99	70	47
Average	158	145	134	175	133	260	255	231
Score Gap (S vs. D)	**209**	**215**	**204**	**201**	**216**	**326**	**362**	**357**

Notes: NW = Network; GOV = Government; BIZ = Business; PEO = People; ECO = Ecosystem; FD = Foundation; AD = Adoption; and AC = Acceleration.

Source: Analysed by the authors.

Factors affecting the digital transformation divide – The correlation coefficients analysis between the total DTI scores and each stage (Foundation, Adoption and Acceleration) reveals that the Acceleration stage is the most correlated stage among the three stages. Among the pillars, the Business pillar has the highest correlation coefficient with DTI scores.

Further analyses on correlations between the total DTI score of each stage and the scores of the pillars within that stage find that the pillars with the highest correlation within the Foundation stage are the Ecosystem and Business pillars, while the Network and Government pillars have relatively low correlations. The pillars with the highest correlation coefficient with total DTI score in the Adoption stage are the Network and Business pillars, whereas the pillars with the highest correlation coefficient with total DTI score in the Acceleration stage are the Business and Government pillars. The Business pillar has the highest correlations across all stages.

Figure 20: Correlation coefficients between total DTI score and pillars / stages

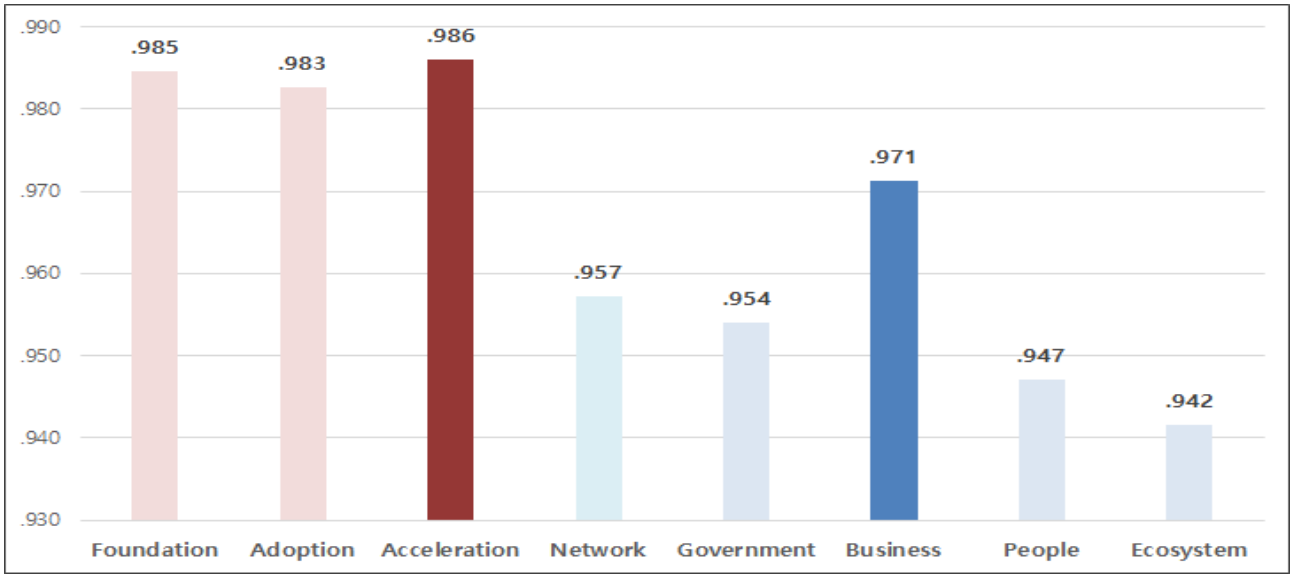
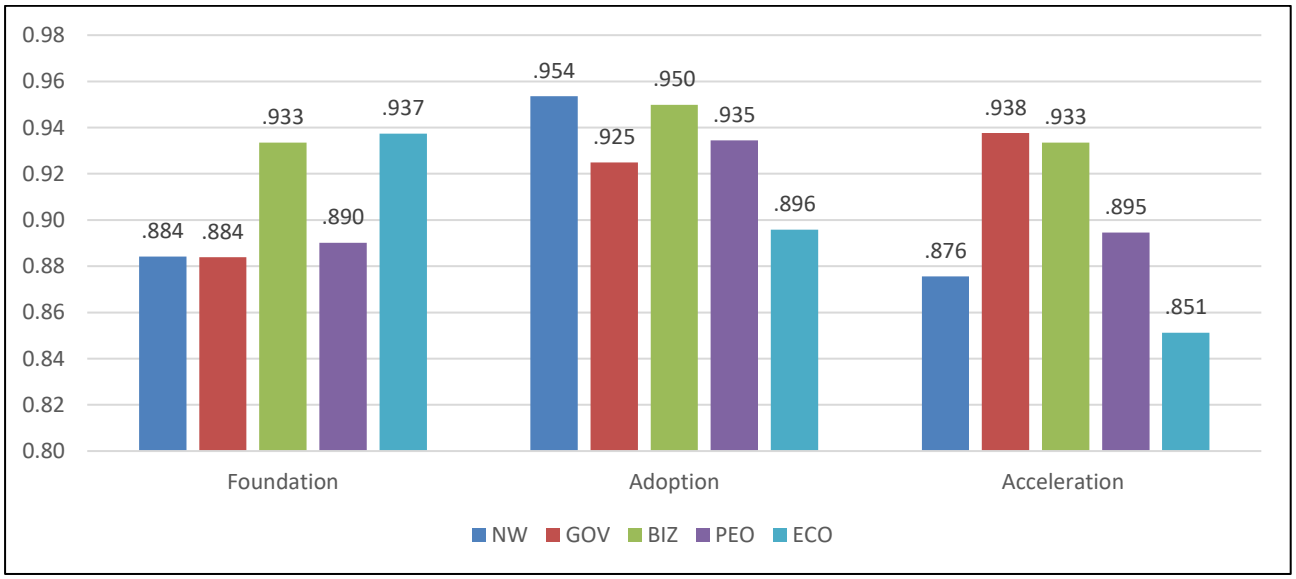


Figure 21: Correlation coefficients of pillars within stages



Notes: NW = Network; GOV = Government; BIZ = Business; PEO = People; and ECO = Ecosystem.

The analysis on the correlation coefficients of all 105 indicators with the DTI scores discovers that the most critical pillars and stages in the DTI are the Business and Government pillars and the Adoption and Acceleration stages. Moreover, indicators with correlation coefficients of above 0.85 are identified as key indicators, which totals 22 indicators as listed in Table 6. It is found that the Government Artificial Intelligence Readiness Index has the highest correlation coefficient of 0.97, followed by innovation capability, adoption of emerging technologies, e-Government Index, government effectiveness and mobile apps development. Another finding shows that the indicators in the Business and Government pillars and in the Adoption and Acceleration stages have higher correlation coefficients than indicators in the other pillars and stages. It can be inferred that the adoption and utilization of digital technologies, including emerging technologies are more related to the higher level of digital transformation.

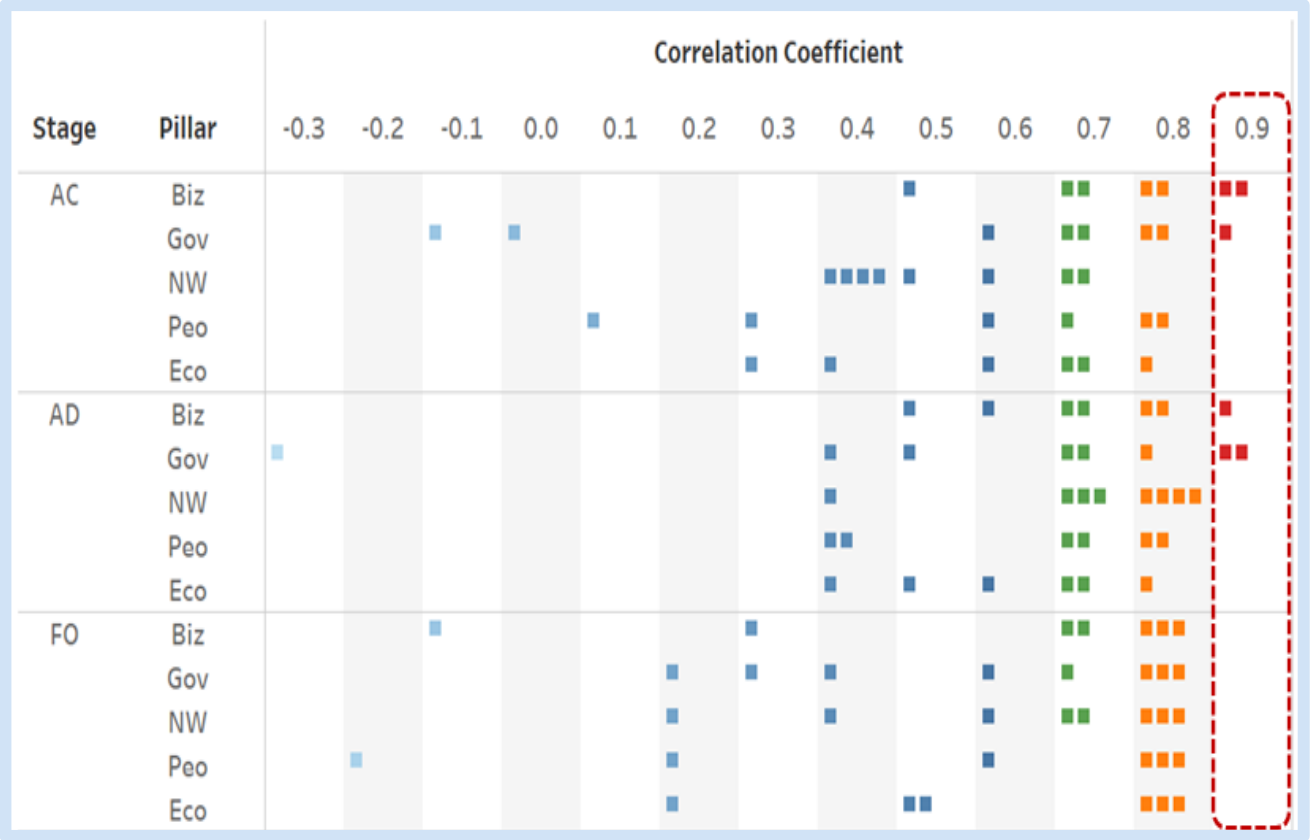
Table 6: Highly correlated indicators (above 0.85 correlation coefficients)

Rank	Indicator	Pillar	Stage	Correlation Coefficient
1	Government AI Readiness Index	Government	Acceleration	0.967
2	Innovation Capability	Business	Acceleration	0.935
3	Adoption of Emerging Technologies	Business	Acceleration	0.930
4	e-Government Index	Government	Adoption	0.929
5	Government Effectiveness	Government	Adoption	0.924
6	Mobile Apps Development	Business	Adoption	0.918
7	Business Environment	Business	Foundation	0.899
8	Labour Productivity per Employee	Business	Foundation	0.895
9	Fixed-line Broadband Subscribers	Network	Foundation	0.888
10	Servers per Population	Network	Adoption	0.884
11	Tablet Possession	Network	Adoption	0.879
12	ICT-enabled Organizational Model Creation	Business	Adoption	0.878
13	Gross National Income per Capita	Ecosystem	Foundation	0.875
14	Business Use of Digital Tools	Business	Adoption	0.870
15	Environmental Performance	Ecosystem	Acceleration	0.869
16	Handset Prices Affordability	Network	Foundation	0.863
17	Mobile Download Speed	Network	Adoption	0.863
18	Skills of Future Workforce	People	Acceleration	0.862
19	International Co-inventions	Ecosystem	Adoption	0.859
20	Ease of Doing Business	Government	Foundation	0.854
21	Basic Skills	People	Foundation	0.854
22	Corruption Perceptions Index	Ecosystem	Foundation	0.853

In particular, six indicators with above 0.9 correlation coefficient show substantial gaps among the grade levels (S, A, B, C and D). Each Business and Government pillar has three indicators above 0.9 correlation coefficient value respectively, whereas other pillars have none.

Only the Business and Government pillars have indicators whose correlation coefficients are above 0.9 in both Adoption and Acceleration stages. Further examination of the indicators with high correlation coefficients above 0.9 reveals significant differences in the average scores of those indicators among the grade levels. In particular, the differences between the leaders (Grade S) and the laggards (Grade D) are too wide to catch up in a short period of time.

Figure 22: DTI indicator dispersion by correlation coefficients



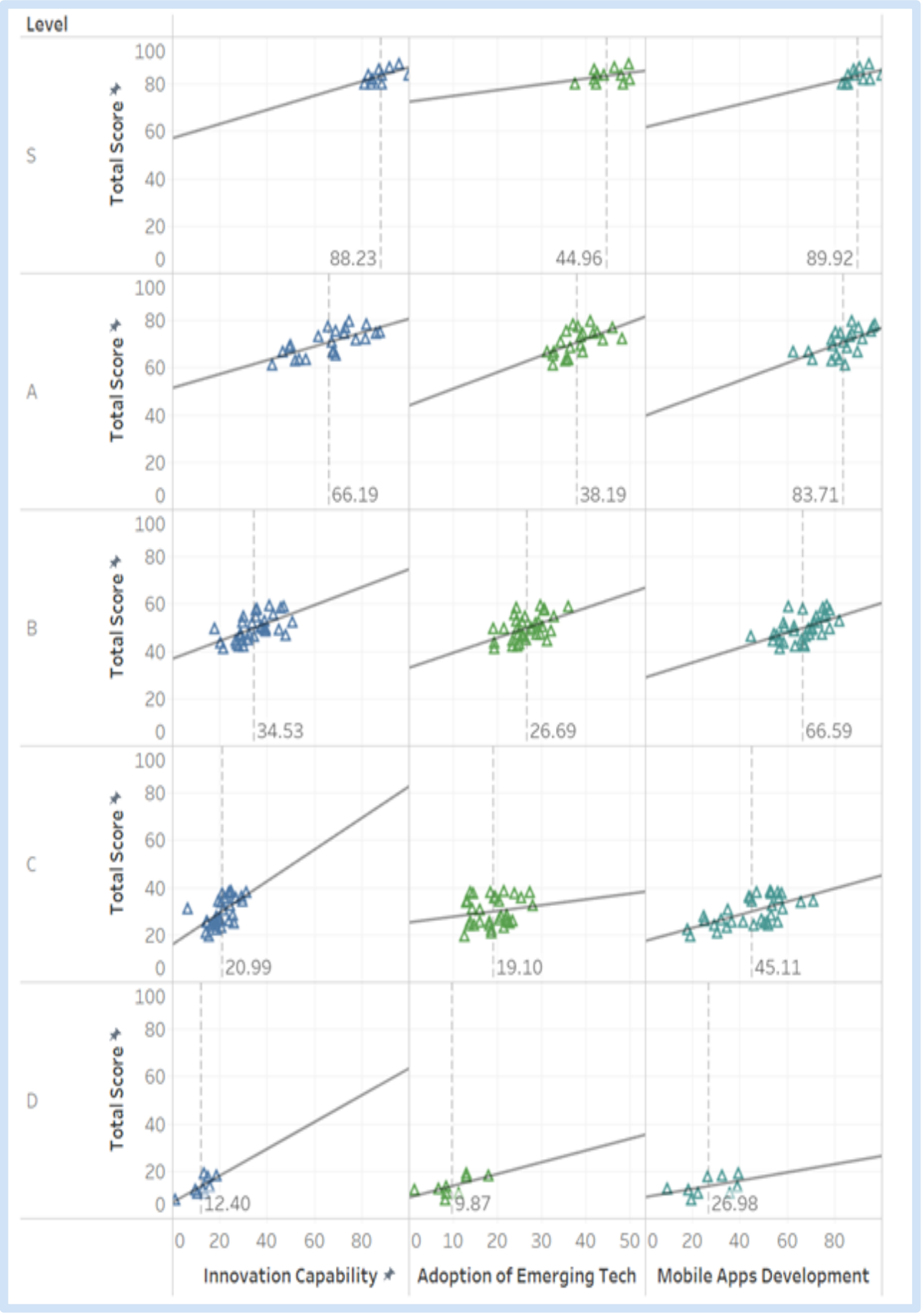
Notes: AC = Acceleration; AD = Adoption; FO = Foundation; Biz = Business; Gov = Government; NW = Network; Peo = People; and Eco = Ecosystem.

Source: Analysed by the authors.

As shown in Figures 23 and 24, three indicators with highest correlation coefficients in the Business pillar are innovation capability, adoption of emerging technologies and mobile apps development, and those in the Government pillar are the Government Artificial Intelligence Readiness Index, e-Government Index and government effectiveness.

It is worth noting that the higher correlation coefficient of the indicator, the wider differences in the average score of that indicator between the leaders and the laggards. For instance, the difference in the average score of innovation capability between Grade S and Grade D is 75.83, adoption of emerging technology is 70.16 and mobile apps development is 62.94. A similar pattern is discovered in the Government pillar, with the difference in the average score of the Government Artificial Intelligence Readiness Index between the leaders and the laggards being 74.59, e-Government Index 60.82 and government effectiveness 55.5.

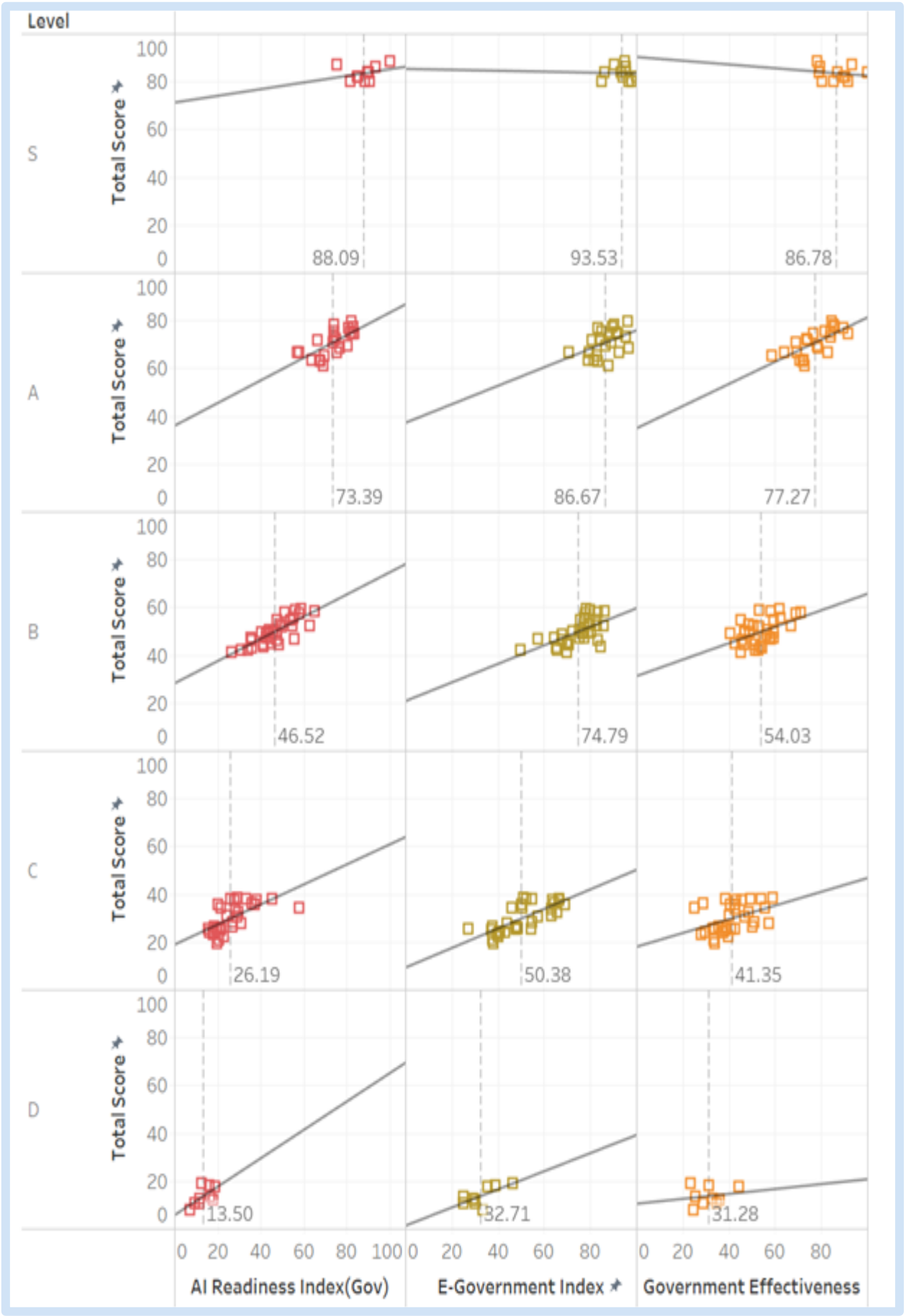
Figure 23: Gaps among grade levels in top three indicators in Business pillar (with highest correlation coefficients above 0.9)



Note: ---- denotes the average score of indicators in each level.

Source: Analysed by the authors.

Figure 24: Gaps among grade levels in top three indicators in Government pillar (with highest correlation coefficients above 0.9)



Note: ---- denotes the average score of indicators in each level.

Source: Analysed by the authors.

4.2 Benchmarking Countries and Their Key Driving Factors

Benchmarking countries in each income group – From the comparison of income level and grade level, so-called leading countries that have been graded higher than their peers have been identified in each income group. As shown in Table 7, the countries in the blue-shaded area are the benchmarking countries whose grade level is higher than their peers in the same income group.

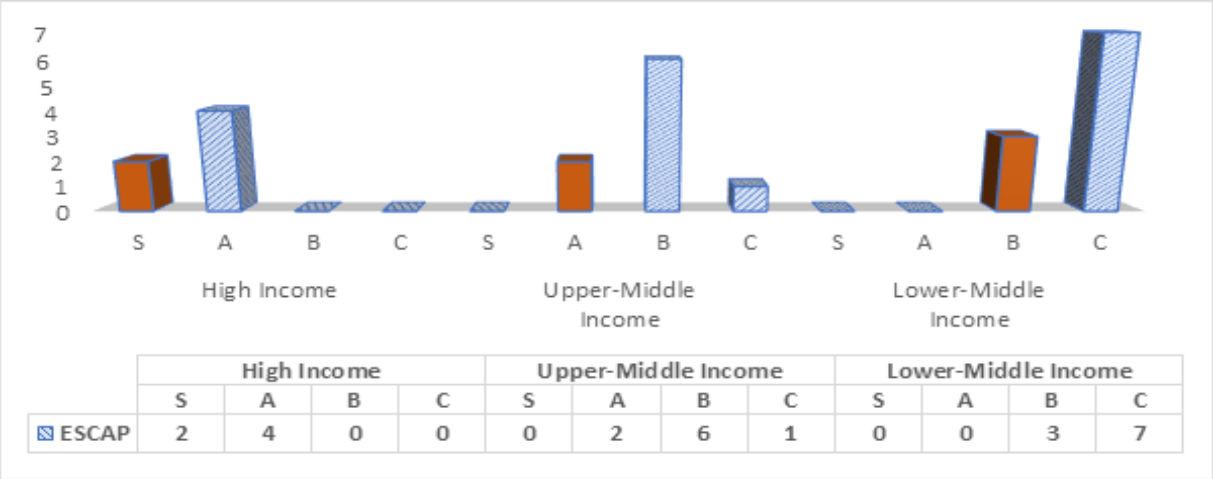
Table 7: Countries by income and grade level

	High	Upper Middle	Lower Middle	Low
S	**USA, Switzerland, UK, Singapore, Germany, Sweden, Denmark, Netherlands, Republic of Korea, Finland, Canada**			
A	Australia, Austria, Hong Kong, Luxembourg, Ireland, Japan, Norway, France, New Zealand, Israel, Belgium, Spain, United Arab Emirates, Estonia, Qatar, Iceland, Italy, Czech Republic, Portugal, Lithuania	**China, Malaysia**		
B	Slovakia, Saudi Arabia, Poland, Chile, Latvia, Hungary, Romania, Bahrain, Uruguay, Oman, Greece, Kuwait, Croatia, Panama	Bulgaria, Russian Federation, Thailand, Mexico, Turkey, Brazil, South Africa, Costa Rica, Indonesia, Argentina, Colombia, Azerbaijan, Kazakhstan, Jordan, Peru	**India, Philippines, Ukraine, Viet Nam**	
C	Trinidad and Tobago	Jamaica, Dominican Republic, Iran, Ecuador, Lebanon, Botswana, Paraguay, Namibia, Guatemala	Morocco, Egypt, Tunisia, Kenya, Mongolia, Sri Lanka, Ghana, Senegal, Algeria, El Salvador, Cambodia, Lao PDR, Bangladesh, Pakistan, Honduras, Nepal, Nigeria, Cote d'Ivoire, United Republic of Tanzania, Zambia	**Rwanda, Uganda**
D			Zimbabwe, Cameroon, Benin, Angola	Mali, Malawi, Burkina Faso, Madagascar, Mozambique

Note: ESCAP member States selected as the benchmarking countries are in red font.

Figure 25 shows the leading countries that are graded higher than their peers in each income group within the Asia-Pacific region. Among six high-income countries, only Singapore and the Republic of Korea are graded S. China and Malaysia are categorized into the higher grade of A than their peers in the same income group of upper-middle income. While a majority of countries in the lower-middle income group are graded C, only three countries – India, the Philippines and Viet Nam – are classified into the higher grade of B. Table 8 exhibits the benchmarking countries and their key success factors.

Figure 25: Grade distribution by income level in the Asia-Pacific region



	High Income				Upper-Middle Income				Lower-Middle Income			
	S	A	B	C	S	A	B	C	S	A	B	C
ESCAP	2	4	0	0	0	2	6	1	0	0	3	7

Table 8: Benchmarking countries in the Asia-Pacific region

Country	Grade	ESCAP rank	Pillar rank					Key success factors driving higher ranks
			Network	Government	Business	People	Ecosystem	
Singapore	**S**	3	6	1	2	6	5	**Government** • Business and government investment • Government effectiveness
Republic of Korea	**S**	5	3	4	4	7	10	**Network** • Days to get electricity • Internet users • Smartphone penetration
China	**A**	11	11	12	8	13	12	**Business** • High-tech exports • Number of tech unicorns
Malaysia	**A**	12	12	10	12	9	11	**People** • Pupil-to-teacher ratio in primary education • Skills of future workforce
India	**B**	17	23	13	13	23	13	**Business** • Number of tech unicorns **Ecosystem** • Renewable energy regulation • Environmental treaties in force
Philippines	**B**	18	22	20	18	14	14	**People** • Ease of finding skilled employees **Ecosystem** • GDP per unit of energy use
Viet Nam	**B**	21	18	21	19	20	19	**Network** • Average mobile latency • Fixed-line broadband affordability

Source: Analysed by the authors.

4.3 Towards an Inclusive Digital Future

One of the most conspicuous findings from the DTI analysis is that 45 per cent of the countries in the world and 50 per cent of ESCAP member States do not have sufficient data to diagnose their digital transformation status, leaving them excluded from the analysis.

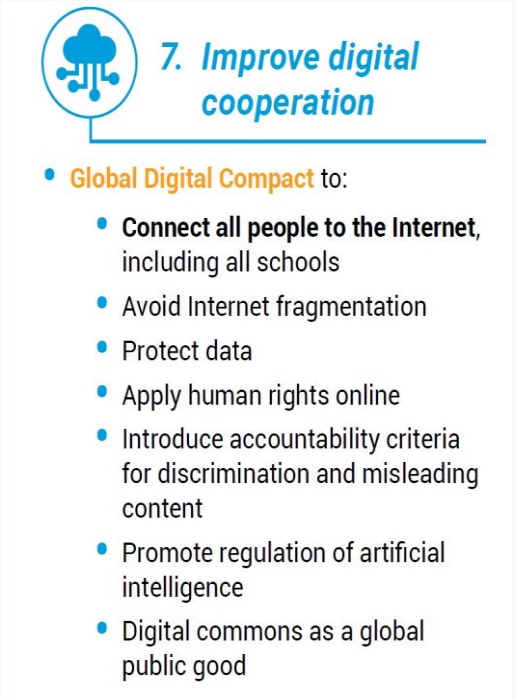
Considering the essential role of digital transformation in shaping the digital future of a country, it is indispensable to develop national digital strategies and initiatives for accelerating digital transformation. The lack of reliable data in half of ESCAP member States poses a significant obstacle to not only assess the current level of digital transformation but establish digital visions and formulate timely and proactive digital policies to maximize the benefits of digital innovations.

In addition, the COVID-19 pandemic highlighted the growing importance of digital technologies in our societies, while seriously affecting every corner of the world. Although countries are recovering from the crisis, an uneven global economic recovery only aggravates pre-existing inequalities and widens divide. As a result, building back better through concerted national policies and coordinated digital cooperation has become one of the most important agendas.

Digital cooperation among member States to bridge the digital divide and address common challenges has been discussed through numerous United Nations global initiatives and programmes, such as the Sustainable Development Goals 4, 5, 9 and 17,[xxvi] the World Summit on the Information Society Action Lines,[xxvii] the United Nations Secretary-General's Strategy on New Technologies, [xxviii] the United Nations Secretary-General's Roadmap for Digital Cooperation[xxix] and the 12 Commitments for Our Common Agenda, including Commitment 7 on Improving Digital Cooperation (Figure 26).

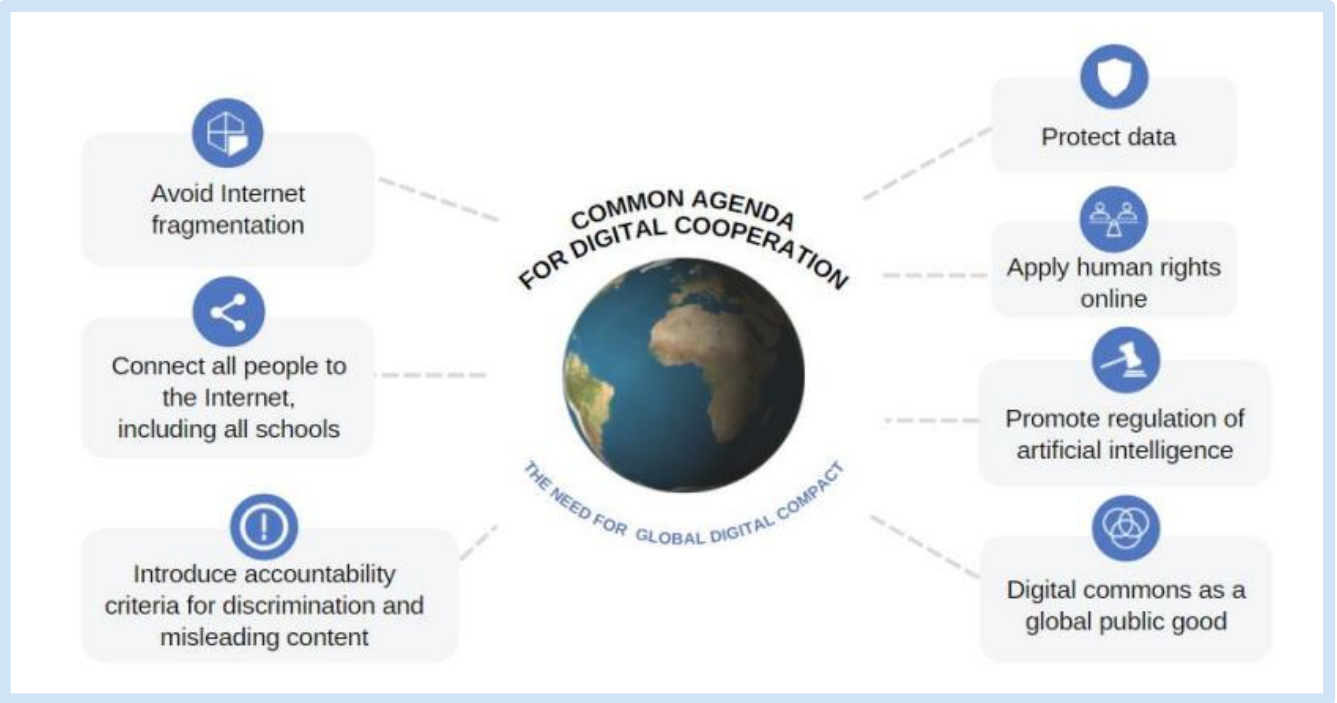
Figure 26: Twelve commitments for Our Common Agenda

1. Leave no one behind
2. Protect our planet
3. Promote peace and prevent conflict
4. Abide by international law and ensure justice
5. Place women and girls at the centre
6. Build trust
7. Improve digital cooperation
8. Upgrade the United Nations
9. Ensure sustainable financing
10. Boost partnerships
11. Listen to and work with youth
12. Be prepared



Source: United Nations (2021). Our Common Agenda – Report of the Secretary-General. Available at https://www.un.org/en/content/common-agenda-report/.

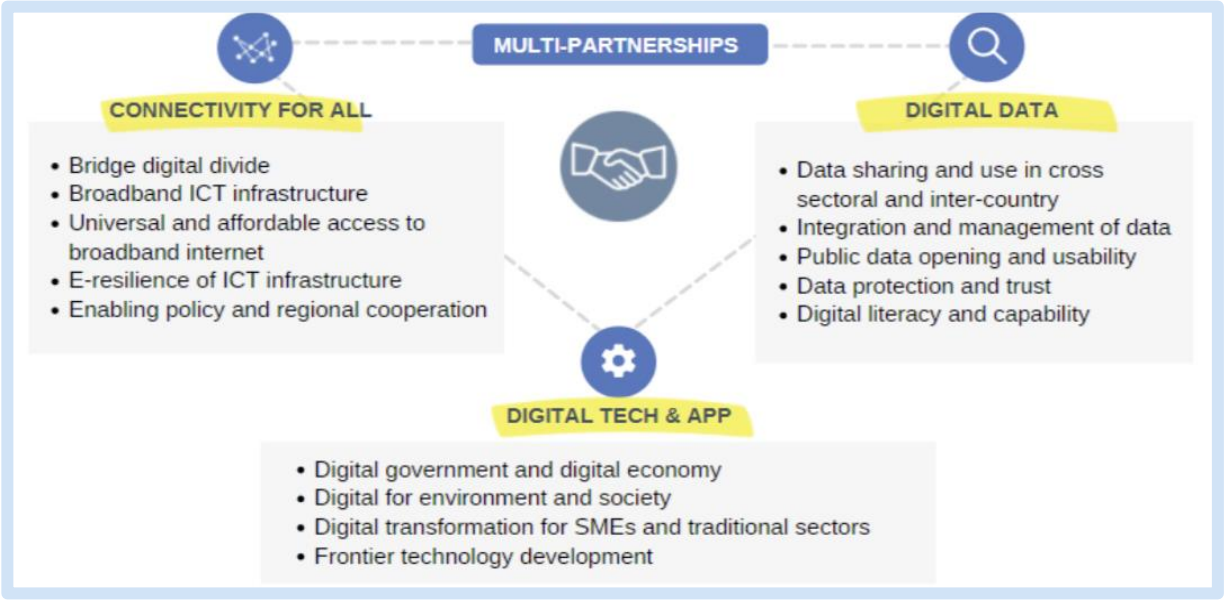
Figure 27: The Common Agenda for Digital Cooperation



Source: Elaborated by Chang Yong Son based on United Nations (2021). Our Common Agenda – Report of the Secretary-General. Available at https://www.un.org/en/content/common-agenda-report/.

The ESCAP secretariat has continued to support ICT development in the region to mitigate the adverse impacts of COVID-19, build back better in the Asia-Pacific region, and advance digital transformation towards an inclusive digital economy and society. Recognizing the need to promote regional cooperation on ICT and the digital agenda, the ESCAP secretariat has been implementing the Asia Pacific Information Superhighway (AP-IS) initiative as a region-wide intergovernmental cooperative platform to accelerate digital transformation and bridge the digital gap through promoting digital connectivity, digital technologies and data use in the region.

Figure 28: The AP-IS (2022-2026) and its three pillars



Source: ESCAP (2021).

As digital transformation is having wide-ranging impacts on society, it is crucial to develop proactive and whole-of-government digital policy responses through collaborative discussions and consultations among various stakeholders, including across diverse sectors. Moreover, taking the rapid pace of technological change in consideration, policymakers and regulatory bodies need to adopt a flexible and adjustable approach to embrace digital advances and meet the public needs in a prompt and comprehensive manner.

At a regional level, it is highly important for the ESCAP secretariat to support member States in engaging in intergovernmental dialogues to build a regional consensus on ICT and digital development agendas. In this regard, the "Asia Pacific Digital Ministerial Conference 2022 and the Asia Pacific Digital Transformation Forum" will be held in the Republic of Korea on 9-10 November 2022. Furthermore, ESCAP as a primary regional hub will continue its role in providing integrated programmes, frameworks and tools such as capacity building and action plans to enhance regional cooperation and create synergic effects towards bridging digital divides and accelerating digital transformation in Asia and the Pacific.

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Appendix: DTI Indicators

A. Network Pillar

1.1 Foundation Stage

1.1.1 Total electricity access (per cent of population)

The percentage of population with access to electricity. Electrification data is collected from industry, national surveys and international sources.

Source: World Bank Global Electrification Database

1.1.2 Days to get electricity

The number of days to obtain a permanent electricity connection. This indicator captures the median duration that the electricity utility and experts indicate is necessary in practice, rather than required by law, to complete a procedure.

Sources: World Bank and Doing Business Project

1.1.3 Mobile subscribers (per 100 inhabitants)

The sum of active handset-based and computer-based mobile-broadband subscriptions to the public Internet, where users have accessed the Internet in the last three months. It covers actual subscribers, not potential subscribers, even though the latter may have broadband-enabled handsets.

Source: International Telecommunication Union

1.1.4 Fixed-line broadband subscribers

Fixed-line broadband subscriptions per 100 inhabitants. The higher the number of subscriptions, the greater the level of Internet connectivity.

Source: International Telecommunication Union

1.1.5 Internet users (per cent of household)

The number of people who have used the Internet in the past 12 months. A higher number of people using the Internet indicates greater connectivity.

Source: International Telecommunication Union

1.1.6 Mobile tariff affordability

This indicator is based on the Mobile Tariffs Subindex that is included in the Affordability pillar of the Mobile Connectivity Index published by the Global System for Mobile Communications Association (GSMA). The subindex relates to the cost of three different basket profiles (100MB, 500MB and 1GB) that are partly distinguished by monthly usage allowance. The tariffs are given as a percentage of monthly gross domestic product (GDP) per capita. The main source for the data is Tarifica (https://tarifica.com/).

Source: GSMA Mobile Connectivity Index 2019

1.1.7 Fixed-line broadband affordability (per cent of monthly gross national income (GNI) per capita)

The price of fixed-line monthly broadband to the consumer as a percentage of monthly income. Generally, the lower the broadband cost, the higher the adoption rates. There is a cap on fixed-line monthly broadband cost as per cent of monthly GNI per capita at 350. All countries that exceed this value receive a score of 0.

Sources: International Telecommunication Union and World Bank

1.1.8 Handset prices affordability (per cent of monthly GDP per capita)

This indicator is based on the Affordability pillar of the Mobile Connectivity Index published by the GSMA. It relates to the cheapest smartphone or feature phone that allows users access to the Internet. The main source for the data is Tarifica (https://tarifica.com/).

Source: GSMA Mobile Connectivity Index 2019

1.2 Adoption Stage

1.2.1 Smartphone penetration (per 100 inhabitants)

The number of mobile-broadband subscriptions per 100 inhabitants. Mobile-broadband subscriptions refer to subscriptions to mobile cellular networks with access to data communications (e.g., the Internet) at broadband speeds, irrespective of the device used to access the Internet.

Source: International Telecommunication Union

1.2.2 Average revenue per user (USD)

The annual average revenue per user (ARPU) calculated over the given period (12 months for annual data). ARPU is used to measure consumer spending on mobile services. This measure of ARPU is "blended", which means that both pre-paid and post-paid subscribers are being counted in the metric. The metric includes data and voice.

Source: Telegeography

1.2.3 Average fixed-broadband download speed (Mbps)

Fixed-broadband download speed averages for all years are based on Ookla's analysis of Speedtest data collected between 1 October and 30 September of each calendar year. A faster speed is a positive indicator for better performance.

Source: Ookla

1.2.4 Average mobile download speed (Mbps)

Mobile download speed averages are based on Ookla's analysis of Speedtest data. A faster speed is a positive indicator for better performance.

Source: Ookla

1.2.5 Average mobile download latency (Ms)

This measures average mobile latency (or how long it takes for data to travel between its source and destination). Averages are based on Ookla's

analysis of Speedtest data.

Source: Ookla

1.2.6 Tablet possession (per cent of household)

The percentage of households having at least one item of portable, usually battery-powered, and very thin personal computer with a touchscreen panel.

Source: Euromonitor International 2021

1.2.7 4G coverage (per cent of population)

Percentage of the population covered by at least an LTE / WiMAX mobile network refers to the percentage of inhabitants that live within range of LTE / LTE-Advanced, mobile WiMAX / WirelessMAN or other more advanced mobile-cellular networks, irrespective of whether or not they are subscribers.

Source: International Telecommunication Union

1.2.8 Servers per population (per 1 million people)

The number of distinct, publicly trusted TLS / SSL certificates found in the Netcraft Secure Server Survey.

Source: World Bank

1.3 Acceleration Stage

1.3.1 5G coverage (per cent of population)

The percentage of population covered by 5G networks.

Source: GSMA Intelligence

1.3.2 5G deployment

This indicator assesses whether operators have implemented 5G New Radio technology in the country, including as part of a trial or a fuller commercial deployment. Limited availability refers to a 5G network that is present but where devices are limited to select users, usually in a testing environment. Commercial availability refers to a 5G network where any consumer can purchase a device for use on this network.

Source: Ookla

1.3.3 Public cloud services spending (per cent of worldwide)

Information technology spending on public cloud services as a percentage of the worldwide total.

Source: Gartner

1.3.4 Gender equality in mobile phone access (per cent of difference)

The Economist Intelligence Unit calculated the gender gap ratio according to the following formula: (male access – female access) / male access. In the second and third editions of the index, the Economist Intelligence Unit calculated the gender gap ratio with female access as the denominator: (male access – female access) / female access. Scores for these editions have been updated to reflect this change. To calculate the equality index, an absolute value was taken from the raw data, and the lower the number, the higher the equality index was assigned.

Source: International Telecommunication Union

1.3.5 Gender equality in Internet use (per cent of difference)

The Economist Intelligence Unit calculated the gender gap ratio according to the following formula: (male access – female access) / male access. In the second and third editions of the index, the Economist Intelligence Unit calculated the gender gap ratio with female access as the denominator: (male access – female access) / female access. Scores for these editions have been updated to reflect this change. To calculate the equality index, an absolute value was taken from the raw data, and the lower the number, the higher the equality index was assigned.

Source: International Telecommunication Union

1.3.6 Government effort to promote 5G (survey)

This indicator assesses whether the country has developed a strategy or initiatives to promote 5G. Countries receive a higher score if the policy or strategy recognizes multiple use cases of 5G. Multiple use cases may include the following: fixed wireless access, enhanced mobile broadband, massive machine-type communications, Internet of Things or ultra-reliable low-latency communications. Other use cases or applications may also apply if specifically mentioned (e.g., 5G for precision agriculture, smart city / home applications, autonomous vehicle applications). Note that policies, strategies or initiatives may be embodied across a number of documents (e.g., policy or strategy documents, government committee notes).

Source: Economist Intelligence Unit country research

1.3.7 Government initiatives to make Wi-Fi available

This indicator assesses whether the Wi-Fi network is free to join or not. “Public” means that the Wi-Fi network and associated hotspot(s) must be accessible in a public park, library, public building, airport, train or ferry terminal. “Largest city” means largest city in the country by population.

Source: Economist Intelligence Unit country research

1.3.8 Private sector initiatives to make Wi-Fi available

This indicator assesses whether the Wi-Fi network is free to join or not and whether the public Wi-Fi is available to anyone (general population, tourists, etc.) or just to customers of the largest Internet service provider (ISP) in the country. The largest ISP means the largest private-sector run ISP, not state-owned. “Public” means that the Wi-Fi network and associated hotspot(s) must be accessible in a public park, library, public building, airport, train or ferry terminal. “Largest city” means largest city in the country by population.

Source: Economist Intelligence Unit country research

2. Government Pillar

2.1 Foundation Stage

2.1.1 Ease of doing business

The Ease of Doing Business Index aggregates a country's percentile rankings on 10 topics covered in the World Bank's Doing Business report series. The topics are: starting a business, dealing with construction permits, getting electricity, registering property, getting credit, protecting minority investors, paying taxes, trading across borders, enforcing contracts and resolving insolvency. A high ranking indicates that the regulatory environment is more conducive to setting up a business.

Source: World Bank

2.1.2 Intellectual property protection

The World Economic Forum Executive Opinion Survey is conducted on an annual basis to gather information from business leaders on topics for which hard data sources are scarce or non-existent. It is part of the effort to supplement the Global Competitiveness Report in assessing issues that drive national competitiveness. This indicator measures response to the survey question: In your country, to what extent is intellectual property protected? (the answer ranges from 1 = not at all to 7 = to a great extent). It is based on 2018-2019 weighted average or most recent period available.

Source: World Economic Forum Executive Opinion Survey

2.1.3 ICT regulatory environment

This indicator is based on a composite index – the Information and Communications Technology (ICT) Regulatory Tracker – that provides a measure of the existence and features of ICT legal and regulatory frameworks. The index covers 50 indicators that are distributed across four pillars: Regulatory Authority, Regulatory Mandate, Regulatory Regime and Competition Framework. Scores are standardized to a scale of 0 to 2.

Source: International Telecommunication Union

2.1.4 Privacy regulation

The lack of clear privacy regulations can limit adoption if users feel their data and personal information are not secure online. Therefore, it is important that the country has privacy laws, which enable users to know what is legally acceptable within the country.

Source: Economist Intelligence Unit country research

2.1.5 Burden of government regulation

This indicator measures response to the survey question: In your country, how burdensome is it for companies to comply with public administration's requirements (e.g., permits, regulations, reporting)? (the answer ranges from 1 = extremely burdensome to 7 = not burdensome at all). It is based on 2018-2019 weighted average or most recent

period available.

Source: World Economic Forum Executive Opinion Survey

2.1.6 Business and government investment

Building digital infrastructure and capabilities requires significant investments from both governments and businesses. To measure these investments, the indicator assesses different sources of private and public investment, including foreign direct investment, research and development (R&D) spending, and investment freedom.

Source: Cisco

2.1.7 R&D expenditure by government and higher education (per cent of GDP)

This indicator refers to the combined expenditure by governments and higher education institutions on R&D as a percentage of GDP. The government sector comprises all units of central, regional and municipal government, but excludes public enterprises (which fall under the business enterprise category). Higher education institutions are those that primarily focus on providing formal tertiary education (i.e., levels 5-8 of the International Standard Classification of Education). R&D expenditure is defined as all current expenditure plus gross fixed capital expenditure for R&D performed by governments and higher education institutions, whatever the source of funds.

Source: United Nations Educational, Scientific and Cultural Organization

2.1.8 Government promotion of investment in emerging technologies

The data refers to the simple mean of the average answers to a similarly worded question regarding five different emerging technologies: In your country, to what extent does the government foster investment (public and private) in artificial intelligence and machine learning, robotics, app- and web-enabled markets, big data analytics, and cloud computing? (the answers range from 1 = not at all to 7 = to a great extent).

Source: World Economic Forum Executive Opinion Survey

2.2 Adoption Stage

2.2.1 e-Government Development Index

The e-Government Development Index presents the state of e-government development of the United Nations member States. Along with an assessment of the website development patterns in a country, the index incorporates the access characteristics, such as the infrastructure and educational levels, to reflect how a country is using information technologies to promote access and inclusion of its people. The index is a composite measure of three important dimensions of e-government, namely, provision of online services, telecommunications connectivity and human capacity.

Source: United Nations Department of Economic and Social Affairs

2.2.2 e-Participation Index

The e-Participation Index assesses, on

a 0-to-1 (best) scale, the quality, relevance and usefulness of government websites in providing online information and participatory tools and services to their citizens.

Source: United Nations Department of Economic and Social Affairs

2.2.3 Online Service Index

The Online Service Index assesses the quality of government's delivery of online services on a 0-to-1 (best) scale. It measures the evolution of e-government services (smart services) in terms of availability, quality, connectivity and diversity of channels, and the use by the public of these services. The index is based on data collected from an independent Online Service Questionnaire conducted by the United Nations Department of Economic and Social Affairs, which assesses the national online presence of all 193 United Nations member States, complemented by a Member State Questionnaire.

Source: United Nations Department of Economic and Social Affairs

2.2.4 Legal framework's adaptability to digital business

This indicator measures response to the survey question: How fast is the legal framework of your country adapting to digital business models (e.g., e-commerce, sharing economy, fintech, etc.)? (the answer ranges from 1 = not fast at all to 7 = very fast). It is based on 2018-2019 weighted average or most recent period available.

Source: World Economic Forum Executive Opinion Survey

2.2.5 National digital identification system

This indicator assesses whether the country has a national digital identification system. It measures response to the survey question: Does the country have a national digital identification system to be used online to access government services?

Source: World Bank

2.2.6 Effectiveness of government

This indicator assesses the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.

Source: World Bank

2.2.7 Government's responsiveness to change

This indicator measures response to the survey question: In your country, to what extent does the government respond effectively to change (e.g., technological changes, societal and demographic trends, security and economic challenges)? (the answer ranges from 1 = not at all to 7 = to a great extent). It is based on 2018-2019 weighted average or most recent period available.

Source: World Economic Forum Executive Opinion Survey (various editions)

2.2.8 e-Commerce legislation

This indicator refers to countries' adoption of e-commerce legislation. The Global Cyberlaw Tracker provides information on whether a country has adopted legislation (or has a draft law pending adoption) in four areas: electronic transactions, consumer protection, privacy and data protection, and cybercrime. Scores range from 0 (no legislation) to 4 (adopted legislation in all four areas).

Source: United Nations Conference on Trade and Development

2.3 Acceleration Stage

2.3.1 Cloud regulation

The cloud regulation segment comprises three parameters: Privacy, Government Regulatory Environment and Intellectual Property Protection. The data for each of the three parameters was normalized to a 10-point scale and then aggregated to provide scores out of 30.

Source: ACCA

2.3.2 Publication and use of open data

This indicator refers to the fourth edition of the Open Data Barometer, an index that provides a measure of how governments publish and use open data based on the following three dimensions (weights given in parentheses): Readiness (35 per cent), Implementation (35 per cent) and Impact (30 per cent).

Source: World Wide Web Foundation

2.3.3 Government Artificial Intelligence Readiness Index

The index measures governments' readiness to implement artificial intelligence in the delivery of public services to their citizens. It looks at the capabilities and enabling factors required for a government to be ready for artificial intelligence implementation, but it does not measure the implementation itself.

Source: Oxford Insights

2.3.4 Open data policies

This indicator assesses whether the government has a formal open data policy that applies to the public sector (i.e., the government makes public sector data – both public and publicly-funded data – publicly available to the general population), and whether the government has an open data website or platform that centralizes this data.

Source: Economist Intelligence Unit country research

2.3.5 Trust in online privacy

This indicator measures response to the survey question: How confident are you that your activity online is private? It is ranked by responses indicating "somewhat confident" and "very confident".

Source: Economist Intelligence Unit Survey

2.3.6 Trust in government website and apps

This indicator measures response to the survey question: To what extent

do you trust the information you receive from the following sources online? – Government websites / apps. It is ranked by responses indicating "mostly" and "completely".

Source: Economist Intelligence Unit Survey

2.3.7 Online security or cybersecurity

The Global Cybersecurity Index provides a measure of the level of cybersecurity commitment of countries. It is a composite index made up of 25 indicators that are distributed across five main pillars: Legal Measures, Technical Measures, Organizational Measures, Capacity Building Measures and Cooperation measures. Scores are standardized to a scale of 0 to 1.

Source: International Telecommunication Union

2.3.8 Future orientation of government

This indicator is based on the average score of the following four Executive Opinion Survey questions: How fast is the legal framework of your country in adapting to digital business models (e.g., e-commerce, sharing economy, fintech, etc.)? (the answer ranges from 1 = not fast all to 7 = very fast); in your country, to what extent does the government ensure a stable policy environment for doing business?; in your country, to what extent does the government respond effectively to change (e.g., technological changes, societal and demographic trends, security and economic challenges)?; in your country, to what extent does the government have a long-term vision in place? For the last three questions, the answers range from 1 = not at all to 7 = to a great extent.

Source: World Economic Forum Global Competitiveness Index

3. Business Pillar

3.1 Foundation Stage

3.1.1 Foreign direct investment net flow

This indicator is based on data from the International Monetary Fund Balance of Payments Database, supplemented by data from the United Nations Conference on Trade and Development and official national sources.

Source: International Monetary Fund

3.1.2 R&D expenditures by businesses

The expenditures on R&D, expressed as a percentage of GDP (2016 or most recent year available). This indicator covers current and capital expenditures (both public and private) on creative work undertaken systematically to increase knowledge – including knowledge of humanity, culture and society – and the use of knowledge for new applications. R&D covers basic research, applied research and experimental development.

Source: World Bank World Development Indicators Database

3.1.3 Business environment

The Economist Intelligence Unit business environment rankings quantify the attractiveness of the

business environment. The business rankings model examines 10 separate criteria or categories, covering the political environment, macroeconomic environment, market opportunities, policy towards free enterprise and competition, policy towards foreign investment, foreign trade and exchange controls, taxes, financing, the labour market, and infrastructure.

Source: Economist Intelligence Unit Business Environment Rankings

3.1.4 High-tech exports (USD)

High-technology exports are products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments and electrical machinery. Data is in current US dollars. Since industrial sectors specializing in a few high-technology products may also produce low-technology products, the product approach is more appropriate for international trade.

Source: United Nations Comtrade

3.1.5 Medium- and high-tech industry

This indicator refers to the percentage of the value added of medium- and high-tech industry out of the total value added of manufacturing. The manufacturing sector relates to sector D in the International Standard Industrial Classification of all Economic Activities (ISIC) revision 3 (1990) or sector C in ISIC revision 4 (2008). The definition of "medium- and high-tech industry" is based on the R&D intensity of economic activities. See United Nations (2019) or Galindo-Rueda & Verger (2016) for details on the classification.

Source: United Nations Industrial Development Organization

3.1.6 Labour productivity per employee

The Conference Board provides two calculations of its estimates on output, labour and labour productivity: an original version based on official GDP data and an adjusted version based on GDP growth and levels that consider rapidly falling ICT prices. This indicator is based on the estimates of the adjusted version.

Source: The Conference Board Total Economy Database

3.1.7 Scientific publications

The index measures the number of published papers cited in other papers at least h times. The h-index reflects both the number of publications and the number of citations per publication. Only articles, reviews and conference papers are considered. The document universe is defined by those tracked by Scopus, an abstract and citation database of peer-reviewed literature: scientific journals, books and conference proceedings. A log transformation is applied to the raw score before it is normalized to a 0 to 100 scale.

Source: SCImago Journal & Country Rank

3.2 Adoption Stage

3.2.1 Computer software spending

This indicator includes the total value

of purchased or leased packaged software such as operating systems, database systems, programming tools, utilities and applications. It excludes expenditures for internal software development and outsourced custom software development. The data is a combination of actual figures and estimates, and is reported as a percentage of GDP.

Source: World Economic Forum

3.2.2 Venture capital availability

This indicator measures response to the survey question in the new edition of the Executive Opinion Survey, which includes the distribution of venture capital by region: In your country, how easy is it for startup entrepreneurs with innovative but risky projects to obtain equity funding? (the answer ranges from 1 = extremely difficult to 7 = extremely easy).

Source: World Economic Forum

3.2.3 Mobile apps development

This indicator is included in the Mobile Connectivity Index published by GSMA. It is one of four indicators that make up the Local Relevance Subindex, which, in turn, is part of the Content & Services Pillar. The original data is sourced from AppFigures (https://appfigures.com/).

Source: GSMA

3.2.4 Digital content (news) in local languages

This indicator assesses whether there is local news for the largest metropolitan area in local languages, including both official and non-official languages. For countries with more than one official language, the justification covers each of the official languages. Non-official languages may include native, indigenous or minority languages (e.g., immigrant populations) commonly spoken but not recognized as official languages. The availability of online news in non-official languages can help to empower native and minority communities to produce their own culturally and locally relevant online content. Audio or video content may attract different user groups and may be preferred by speakers of non-written languages or users with lower levels of comprehension or literacy. The frequency with which content is updated will also draw users online.

Source: Economist Intelligence Unit country research

3.2.5 e-Government services in local languages

This indicator assesses whether there is a local government website available for the largest city in the country and whether the site offers transactional services that can include: applying for any type of license or permit, registering for programmes / services and paying bills and fees. If the city website provides downloadable applications, but the process is not entirely online, the country scores a 1. In order to score a 2, the entire process must be online.

Source: Economist Intelligence Unit

country research

3.2.6 Business use of digital tools

This indicator measures response to the survey question: In your country, to what extent do businesses make good use of the latest digital tools to sell their goods and services (e.g., e-commerce, digital payment, mobile web stores, social media stores)? (the answer ranges from 1 = not at all to 7 = to a great extent).

Source: World Economic Forum

3.2.7 ICT-enabled organizational model creation

This indicator measures the average answer to the question: In your country, to what extent do ICTs enable new organizational models (e.g., virtual teams, remote working, telecommuting) within companies? (the answer ranges from 1 = not at all to 7 = to a great extent).

Source: World Intellectual Property Organization

3.3 Acceleration Stage

3.3.1 Startup environment

This indicator assesses a country's startup environment, such as its venture capital availability and investment, new business density, and patent and trademark registrations.

Source: Cisco

3.3.2 Robot density

This indicator refers to the estimated number of multipurpose industrial robots per 10,000 persons employed in the manufacturing industry (ISIC revision 4: C). The International Federation of Robotics collects country-level data on operational stock of industrial robots and, for some countries, computes robot densities. The computed robot densities are published in the annual World Robotics Report.

Source: International Federation of Robotics

3.3.3 Use of big data analytics

This indicator assesses the extent to which companies are using big data and analytics to support decision-making.

Source: Institute for Management Development

3.3.4 Innovation capability

This indicator measures response to the survey question: In your country, how widespread are well-developed and deep clusters (geographic concentrations of firms, suppliers, producers of related products and services, and specialized institutions in a particular field)? (the answer ranges from 1 = non-existent to 7 = widespread in many fields). It is based on 2018-2019 weighted average or most recent period available.

Source: World Economic Forum Executive Opinion Survey

3.3.5 Adoption of emerging technologies

The data refers to the simple mean of the average answers to a similarly worded question regarding five different emerging technologies: In

your country, to what extent are companies adopting artificial intelligence, robotics, app- and web-enabled markets, big data analytics, and cloud computing? (the answers range from 1 = not at all to 7 = to a great extent – on par with the most technologically advanced economies).

Source: World Economic Forum Executive Opinion Survey

3.3.6 Number of tech unicorns

A unicorn company is a privately-owned startup that has a current valuation of USD1 billion or over.

Source: CB Insights

3.3.7 Growth of innovative companies

This indicator measures response to the survey question: In your country, to what extent do new companies with innovative ideas grow rapidly? (the answer ranges from 1 = not at all to 7 = to a great extent). It is based on 2018-2019 weighted average or most recent period available.

Source: World Economic Forum Executive Opinion Survey

4. People Pillar

4.1 Foundation Stage

4.1.1 Labour force participation (per cent of total population ages 15-64)

Labour force participation rate is the proportion of the population ages 15-64 that is economically active: all people who supply labour for the production of goods and services during a specified period. The labour force is the supply of labour available for producing goods and services in an economy. It includes people who are currently employed and people who are unemployed but seeking work as well as first-time jobseekers. Not everyone who works is included, however. Unpaid workers, family workers and students are often omitted, and some countries do not count members of the armed forces. Labour force size tends to vary during the year as seasonal workers enter and leave.

Source: International Labour Organization

4.1.2 Adult literacy (per cent of people)

Adult literacy rate is the percentage of people ages 15 and above who can both read and write, and has the ability to understanding a short simple statement about their everyday life.

Source: United Nations Educational, Scientific and Cultural Organization

4.1.3 Harmonized test score

Harmonized test scores from major international student achievement testing programmes. They are measured in equivalent units from the Trends in International Maths and Science Study, where 300 is minimal attainment and 625 is advanced attainment. Most recent estimates are used, and the year of most recent estimate is shown in data notes.

Source: World Bank

4.1.4 Public expenditure on education (per

cent of GDP)

The total general (local, regional and central) government expenditure in educational institutions (current and capital). It excludes transfers to private entities such as subsidies to households and students, but includes expenditure funded by transfers from international sources to government. It includes pre-primary, primary, secondary and tertiary public institutions.

Source: Eurostat

4.1.5 Basic skills

This indicator measures adult literacy (25 per cent) + school life expectancy (25 per cent) + mean years of schooling (25 per cent) + tertiary enrolment (25 per cent).

Sources: United Nations Development Programme and United Nations Educational, Scientific and Cultural Organization

4.1.6 Mean years of schooling

The average number of completed years of education of a country's population aged 25 years and older, excluding years spent repeating individual grades.

Source: United Nations Educational, Scientific and Cultural Organization

4.2 Adoption Stage

4.2.1 Digital skills among active population

This indicator measures response to the survey question: In your country, to what extent does the active population possess sufficient digital skills (e.g., computer skills, basic coding, digital reading)? (the answer ranges from 1 = not all to 7 = to a great extent). It is based on 2018-2019 weighted average or most recent period available.

Source: World Economic Forum Executive Opinion Survey

4.2.2 Quality of vocational training

This indicator measures response to the survey question: In your country, how do you assess the quality of vocational training? (the answer ranges from 1 = extremely poor among the worst in the world to 7 = excellent among the best in the world). It is based on 2018-2019 weighted average or most recent period available.

Source: World Economic Forum Executive Opinion Survey

4.2.3 Ease of finding skilled employees

This indicator measures response to the survey question: In your country, to what extent can companies find people with the skills required to fill their vacancies? (the answer ranges from 1 = not at all to 7 = to a great extent). It is based on 2018-2019 weighted average or most recent period available.

Source: World Economic Forum Executive Opinion Survey

4.2.4 Support for digital literacy

This indicator assesses the existence of a strategy that supports digital literacy whereby the government plan or strategy should include

courses in ICT skills, computer science, programming or other classes where computers are mandatory in the curriculum. The plan or strategy must also include training teachers on ICT skills.

Source: Economist Intelligence Unit country research

4.2.5 Schools with Internet access

The percentage of secondary educational institutions with any type of Internet connection, whereby the Internet is defined as: "Worldwide interconnected networks that enable users to share information in an interactive format – referred to as hypertext – through multiple wired or wireless devices (e.g., personal computers, laptops, personal digital assistants, smartphones, etc.) via broadband and narrowband connections". Where data gaps existed, data on primary educational institutions was collected.

Source: United Nations Educational, Scientific and Cultural Organization

4.2.6 Skills of current workforce

This indicator is based on a composite index that measures the extent of staff training, quality of vocational training, skillset of graduates, digital skills among active population and ease of finding skilled employees.

Source: World Economic Forum

4.3 Acceleration Stage

4.3.1 Critical thinking in teaching

This indicator measures response to the survey question: In your country, how do you assess the style of teaching? (the answer ranges from 1 = frontal, teacher based and focused on memorizing to 7 = encourages creative and critical individual thinking). It is based on 2018-2019 weighted average or most recent period available.

Source: World Economic Forum Executive Opinion Survey

4.3.2 Pupil to teacher ratio in primary education

The average number of pupils per teacher, based on headcounts of both pupils and teachers. It is based on 2017 data or most recent period available.

Source: World Economic Forum

4.3.3 School computers per student

The Programme for International Student Assessment measures the availability and quality of material resources in schools by asking school principals if their school's capacity to provide instruction is hindered by: a lack of educational materials (i.e., textbooks, ICT equipment, library or laboratory material); inadequate or poor-quality educational materials; a lack of physical infrastructure (i.e., building, grounds, heating / cooling systems, lighting and acoustic systems); or inadequate or poor quality physical infrastructure.

Source: Organisation for Economic Co-operation and Development's Programme for International Student Assessment

4.3.4 Female digital skills training

This indicator assesses whether strategies and plans addressing e-inclusion of females and digital skills training for women exist that help reduce the gender digital divides.

Source: Economist Intelligence Unit country research

4.3.5 Female Science, Technology, Engineering and Mathematics (STEM) education

This indicator assesses whether policies or government initiatives exist that encourage women and girls to study STEM.

Source: Economist Intelligence Unit country research

4.3.6 Skills of future workforce

This indicator is based on a composite index that measures critical thinking in teaching and pupil-to-teacher ratio in primary education

Source: World Economic Forum

5. Ecosystem Pillar

5.1 Foundation Stage

5.1.1 Nominal GDP

This indicator measures the total economic value of a country. Countries with higher GDP typically have higher purchasing power for ICT.

Source: Economist Intelligence Unit

5.1.2 GNI per capita

Higher income increases the chances for affordability of access.

Source: World Bank

5.1.3 Democracy Index

This index measures the quality of democracy and the biggest threats to sustaining democracy.

Source: Economist Intelligence Unit

5.1.4 Corruption Perceptions Index

This index measures the perceived levels of public sector corruption worldwide.

Source: Transparency International

5.1.5 Price stability

Inflation is normalized in a U-shaped function to capture the detrimental effects of high inflation and deflation. Countries with inflation rates between 0.5 per cent and 4 per cent receive the highest possible score of 100. Outside this range, scores decrease linearly as the distance between the optimal value and the actual value increases. Due to the special conversion applied to this indicator, the ranking for this indicator is based on progress scores rather than raw values.

Source: International Monetary Fund

5.1.6 Debt dynamics

This indicator is a category-based min-max normalization of the debt change. The debt change is the difference between the 2017 and 2018 expected values of the debt-to-GDP ratio. To transform the debt change value into a 0 to 100 score, each country was assigned to a specific category that determined the value

boundaries.

Source: World Economic Forum

5.2 Adoption Stage

5.2.1 Flexibility in labour market

This indicator is based on a composite index that measures redundancy costs, hiring and firing practices, cooperation in labour-employer relations, flexibility of wage determination, active labour market policies, workers' rights, ease of hiring foreign labour, and internal labour mobility.

Source: World Economic Forum

5.2.2 Diversity of workforce

This indicator measures response to the survey question: In your country, to what extent do companies have a diverse workforce (e.g., in terms of ethnicity, religion, sexual orientation, gender)? (the answer ranges from 1 = not at all to 7 = to a great extent). It is based on 2018-2019 weighted average or most recent period available.

Source: World Economic Forum Executive Opinion Survey

5.2.3 International co-inventions

This indicator computes the sum of the patent family applications with at least one co-inventor located abroad, filed in at least two of the major five intellectual property offices in the world: the European Patent Office, the Japan Patent Office, the Korean Intellectual Property Office, the State Intellectual Property Office of the People's Republic of China, and the United States Patent and Trademark Office. Data was extracted from the PATSTAT database by earliest filing date and inventor country, using fractional counts, and expressed in applications per million population. A log transformation was applied to the raw score before it was normalized to a 0 to 100 scale.

Source: Organisation for Economic Co-operation and Development

5.2.4 Multi-stakeholder collaboration

This indicator is based on the average score of the following three Executive Opinion Survey questions: In your country, to what extent do people collaborate and share ideas within a company? (the answer ranges from 1 = not at all to 7 = to a great extent); in your country, to what extent do companies collaborate in sharing ideas and innovating? (the answer ranges from 1 = not at all to 7 = to a great extent); in your country, to what extent do businesses and universities collaborate on R&D? (the answer ranges from 1 = do not collaborate at all to 7 = collaborate extensively).

Source: World Economic Forum Executive Opinion Survey

5.2.5 Cluster development and depth

This indicator is based on the average answer to the survey question: In your country, how widespread are well-developed and deep clusters (geographic concentrations of firms, suppliers, producers of related products and services, and specialized institutions in a particular field)? (the answer ranges from 1 = non-existent

to 7 = widespread in many fields).

Source: World Economic Forum Executive Opinion Survey

5.2.6 Joint venture / strategic alliance deals

Refinitiv's data on joint venture / strategic alliance deals provides details on the country of origin of partner firms, among others. The data extraction corresponded to a query on joint venture / strategic alliance deals between 1 January 2018 and 31 December 2020. The country of each company participating in a deal (n companies per deal) was allocated, per deal, a score equivalent to 1/n (with the effect that all country scores added up to the total number of deals). The data was reported as GDP based on purchasing power parity.

Source: International Monetary Fund

5.3 Acceleration Stage

5.3.1 Energy efficiency regulation

The score is based on a country's performance in 12 indicators: national energy efficiency planning; energy efficiency entities; information provided to consumers about electricity usage; incentives and mandates for industrial and commercial end users; incentives and mandates for the public sector; incentives and mandates for utilities; financing mechanisms for energy efficiency; minimum energy efficiency performance standards; energy labelling systems; building energy codes; transport; and carbon pricing and monitoring. For more information, see https://rise.worldbank.org/indicators#pillarenergy-efficiency.

Source: World Bank Energy Sector Management Assistance Program

5.3.2 Renewable energy regulation

The score is based on a country's performance in seven indicators: legal framework for renewable energy; planning for renewable energy expansion; incentives and regulatory support for renewable energy; attributes of financial and regulatory incentives; network connection and use; counterparty risk; and carbon pricing and monitoring. For more information, see https://rise.worldbank.org/indicators#pillar-renewable-energy.

Source: World Bank Energy Sector Management Assistance Program

5.3.3 Environmental treaties in force

This indicator measures the total number of international treaties from a set of 29 for which a state is a participant. A state is acknowledged as a participant whenever the status for each treaty appears as ratified, accession or in force.

Source: International Union for Conservation of Nature

5.3.4 Sustainable Development Goal (SDG) 11: Sustainable Cities and Communities

The safety and sustainability of cities is captured by two indicators: urban pollution and road safety. Urban pollution is an official indicator related to SDG 11: Make cities and

human settlements inclusive, safe, resilient and sustainable (indicator 11.6.2), and is measured by annual mean concentrations of fine particulate matter in urban areas that are less than 2.5 microns in diameter. Road safety refers to death rate due to road traffic injuries per 100,000 people. It is an official indicator related to SDG 3: Ensure healthy lives and promote well-being for all at all ages (indicator 3.6.1), but it is also associated with SDG Target 11.2: By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons. The data refers to the simple mean of the reversed normalized scores of the two indicators.

Source: World Health Organization

5.3.5 GDP per unit of energy use

This indicator is reported as GDP based on purchasing power parity (2015) per total energy supply (TES). TES is made up of the cost of production + imports – exports – international marine bunkers – international aviation bunkers +/– stock changes. GDP / TES is an indicator of energy productivity.

Source: International Energy Agency

5.3.6 Environmental performance

The 2020 Environmental Performance Index ranks 180 countries on different categories covering environmental health and ecosystem vitality. These indicators provide a gauge of how close countries are to achieving established environmental policy targets. The index offers a scorecard that highlights leaders and laggards in environmental performance and provides practical guidance for countries that aspire to move towards a sustainable future. The index ranges from 0 to 100, with 100 indicating best performance.

Sources: Yale University and Columbia University, 2020 Environmental Performance Index; and Bourguignon, F., and Morrison, C. (2002).

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