Shaping Our Digital Future

Asia-Pacific Digital Transformation Report 2022

ESCAP 75
MOVING FORWARD TOGETHER

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*The shaded areas of the map indicate ESCAP members and associate members.**

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The ESCAP secretariat supports inclusive, resilient and sustainable development in the region by generating action-oriented knowledge, and by providing technical assistance and capacity-building services in support of national development objectives, regional agreements and the implementation of the 2030 Agenda for Sustainable Development.

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Foreword

Digital technology has steadily taken over more aspects of our lives. In most countries, including those in Asia and the Pacific, many daily activities are now being measured digitally and operated more precisely. Through the arrival of the first digital documents, to super- computers, to the Internet of Things, more and more socio-political and economic systems are now digital by default.

Businesses, some of them now mammoth enterprises, have become key drivers of digital innovation. Governments have also used these new technologies to deliver information and services. And, through social media and elsewhere individuals and groups have become both digital consumers and creators.

The digital transformation was given a further boost in 2020 by the largely unforeseen COVID-19 pandemic which detonated a 'digital big bang' that compressed normal periods of societal adoption of digital technologies from years to months or even weeks.

As with most advances in human development, the digital transformation resulted in a number of benefits, but also opened up new disparities, producing both leaders and followers, and generating business successes and failures. Such complex outcomes have placed new demands on policy planners and regulators, and require more flexible, adaptive and corroborative approaches.

Governments need to keep abreast of these dramatic advances and leverage them for new socioeconomic development. While welcoming technological advances, policymakers can also guide innovation in the most productive directions and steer it away from evident dangers, such as cybercrime, threats to privacy, and the tendency to deepen the divides between the digital haves and have-nots.

This first *Asia-Pacific Digital Transformation Report 2022* aims to deepen our understanding of the digital transformation and help member States respond to its potential rewards and risks. The transformation is inevitably varied and uneven across the Asia-Pacific region which has global digital pioneers, such as Japan, the Republic of Korea, Singapore, and increasingly China, as well as some of the world's poorest countries that struggle to gather sufficient resources to move forward on their digital journeys. Even so, as the United Nations Secretary-General's *Our Common Agenda* indicates, common problems and themes are emerging and it is clear that, in all countries, digital developments need to be tracked, not just in terms of access to the Internet or the use of mobile phones but much more broadly so as to take into account the implications of widespread economic and social transformations, particularly for the poorest and most vulnerable groups.

Building on a data-driven evidence base the *Asia-Pacific Digital Transformation Report 2022* presents an analytical policy framework and a digital transformation index with extensive graphic illustrations. And to help coordinate and guide policy planning, the Report identifies three future pathways, which are aligned with the actions arising from the Asia-Pacific Information Superhighway Action Plan for 2022-2026.

In subsequent editions we will look more closely at the social and political economy implications of the digital transformation. We hope that this new series from ESCAP will provide valuable insights, and look forward to your comments and suggestions for future work.

Armida Salsiah Alisjahbana

Under-Secretary-General of the United Nations and Executive Secretary of ESCAP

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Acronyms

AI	artificial intelligence
AMI	advanced metering infrastructure
AP-IS	Asia-Pacific Information Superhighway
AR	augmented reality
ASEAN	Association of Southeast Asian Nations
capex	capital expenditure
CE	cellular economy
C-ITS	cooperative intelligent transport system
CLVT	Cambodia, Lao People's Democratic Republic, Viet Nam, and Thailand
CODES	Coalition for Digital Environmental Sustainability
DENR	Department of Environment and Natural Resources
DFS	digital financial services
DigiSRII	Digital and Sustainable Regional Integration Index
digital IDs	digital identities
DP-3T	Privacy-Preserving Proximity Tracing
DT	digital transformation
EoU	end of use
EVs	electric vehicles
GB	gigabyte
GDP	gross domestic product
GHGs	greenhouse gases
GNI	gross national income
GSMA	Global System for Mobile Communications Association
ICT	information and communications technology
ILO	International Labour Organization
IoT	Internet of Things
ITU	International Telecommunication Union
IXP	Internet exchange point
KT	Korea Telecom
LTE	long-term evolution
mb/s	megabits per second
MP3	Moving Picture Experts Group Layer-3 Audio
NFA	National Fire Agency
PC	personal computer
pc	per capita
POS	point of service
PPP	public-private partnership
QR	quick response code
RDTII	Regional Digital Trade Integration Index
RTLS	real-time locating systems
SaaS	software as a service
SDGs	Sustainable Development Goals
SMART	Science Monitoring And Reliable Telecommunications
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
UNITAR	United Nations Institute for Training and Research
UNOSAT	United Nations Satellite Centre
UNWOMEN	United Nations Entity for Gender Equality and the Empowerment of Women
UPI	unified payments interface
USAID	United States Agency for International Development
VR	virtual reality
2G	second generation mobile network
3G	third generation mobile network
4G	fourth generation mobile network
5G	fifth generation mobile network

Executive Summary

Shaping our digital future

The COVID-19 pandemic has delivered a global shock to our socioeconomic systems and to the quality of people's life, with millions of lives lost and livelihoods destroyed. The pandemic has also driven member States to accelerate mass digital adoption at an unprecedented speed and scale.

At the same time, the pandemic has widened and deepened the digital divide both between and within countries. This has reinforced a vicious cycle of economic inequalities, and further differentiated leading countries from the lesser developed, since digital dividends were not equally distributed. Consequently, in the United Nations report *Reclaiming our future: A common agenda to advance sustainable development in Asia and the Pacific*, the United Nations has referred to the digital divide as the new face of inequality.

With digital technologies now underpinning all aspects of socioeconomic policy planning and implementation processes, many government and business services are 'digital by default', thus highlighting the urgent need to develop new development paradigms, policy and regulatory frameworks in a more flexible, adaptive, and corroborative way.

At the heart of such new paradigms is the digital transformation process. This is not simply about access to digital connection and applications. Rather, it is a transforming process by which the whole social fabric is disrupted by new technologies with the creation, management, use and distribution of resources. Efficiency gains promote the productivity of industries and the competitiveness of nations thus providing people with improved services and new societal values and demands, within and across countries. In the digitally driven paradigm, people are not just consumers but also creators of previously unheard-of products and services, thus accelerating the transformation of value systems and socioeconomic structures.

In this report digital transformation goes beyond just the digitalization of goods and services. It represents a new development paradigm, reweaving the whole fabric of society, in terms of value creation, management, use and distribution through applications of disruptive technologies, including artificial intelligence (AI), digital data, connectivity and networks. During the pandemic, this transforming process intensified: many choices suddenly became more binary – people had to interact with the rest of world digitally, or not at all.

In the wake of this 'digital big bang', ESCAP has initiated a biennial series of Asia-Pacific Digital Transformation Reports. The central argument of this 2022 edition is that countries should go beyond establishing digital connectivity and deepen their understanding of digital transformations. To enrich understanding of the complex digital transformation landscape in the region, an analytical policy framework and digital transformation index has been developed. To help coordinate and guide policy planning, the report also identifies three pathways for the future, which are aligned with a set of identified actions under the Asia-Pacific Information Superhighway Action Plan for 2022-2026. Subsequent issues of the Report will look more closely at the broader social and political economy shifts triggered by the digital transformation.

Becoming digital by default

Taking stock of the digital transformation is a major undertaking, requiring multidimensional integrated approaches and cooperation. So far, this process has mostly been tracked through the one-dimensional metrics of Internet availability and access. But recently, even the poorest countries have begun to offer basic Internet services. An estimated 96 per cent of the population in Asia and the Pacific is now covered by mobile broadband. Countries therefore need to look beyond connectivity infrastructure. In the new digital-by-default paradigm, the choice is no longer about whether to opting into digital transformation, but rather about how to improve its adoption and performance.

Rewards and risks of digital transformation

Many of the 'digital by default' consequences of digital transformation have been positive. Digital technologies enhance productivity, optimize the use of resources, help reduce greenhouse gas emissions and track the spread of the pandemic. For example, social networks have fostered and diversified communications among people sharing common interests, irrespective of location, thus helping them stay in touch, broaden their experiences and deepen their knowledge.

But there are also serious risks. Social networks have also created social 'echo chambers' and generated torrents of misinformation and hate speech. There is also the risk of speculative financial bubbles, notably in the trading of cryptocurrencies, digital coins, and digital property, as well as cybercrime, which not only increased alarmingly but also assumed prolific variations as digital went default.

Alongside all this is the potential risks for environmental damage. Digital gadgets, the Internet, and the enabling systems that support them are thought to contribute more than 2 per cent to the global carbon footprint. The manufacture of electronic hardware can also exhaust supplies of natural resources, such as rare-earth elements and other precious metals, like cobalt and lithium.

Digital transformation driven by digital finance

This *Asia-Pacific Digital Transformation Report 2022* observes that a key element of the transformation, particularly for business and people, is digital finance. Originally, this largely comprised digital payment systems. For example, digital financial service providers, such as FinTechs and telecommunication companies in the Philippines, pioneered the use of e-wallets that enabled users to send and receive cash through the exchange of text messages. Similar payments services have emerged in Myanmar, Bangladesh and Cambodia. The use of e-wallets has expanded rapidly with increasing access to smart phones and innovative applications, such as the use of QR codes, while the digital transformation is now extending to many other financial services, such as savings, loans and more recently investment. In 2021, the transaction value for the digital payments market in Asia and the Pacific reached $4 trillion, and by 2026 it is projected to reach $6.7 trillion. In 2021, two-thirds of these transactions were in e-commerce. But, in the future, the most dynamic segment is expected to be mobile point-of-service payments.

Steadily smarter infrastructure

Greater coverage, by 5G and other high-speed networks, is also making diverse infrastructure steadily smarter. For example, real-time traffic information, smart logistics, intelligent lighting, and other ICT-enabled solutions can help everyone and everything reach their destinations faster and at reduced cost. Smart transport systems can link modes, such as car sharing, ride sharing, bike sharing, and enable vehicles to communicate with each other and with roadside infrastructure about the state of traffic.

For shipping, smart ports use digital technologies to rationalize, reorganize and streamline maritime activities. Similarly, the Science Monitoring and Reliable Telecommunications (SMART) Subsea Cables of the ITU/WMO/UNESCO-IOC initiative has made progress in deploying pilot projects that aim to integrate environmental sensors into submarine telecommunications cables, with the purpose of supporting climate and ocean observation, and sea-level monitoring, as well as tsunami and earthquake early warnings and hazard quantification. For railways, digital technologies also allow for more accurate monitoring, and help shorten train tracking intervals and reduce operating costs. Countries can also benefit from smart electricity grids. Managing the delivery of electricity more precisely can reduce power losses, increase efficiency and integrate renewable sources, all of which reduce carbon emissions.

In this process, digital infrastructure has thus emerged as a meta-infrastructure; an infrastructure that connects all other types of infrastructure and makes them smarter. Furthermore, evidence abounds that the co-deployment of fibre-optic cables with linear infrastructures, such as highways, railways and

electricity grids, is cost effective and can bring digital connectivity and smart infrastructure to remote, sparsely populated areas where the costs of single sector approaches can be prohibitive.

Governing digitally

Another major driver of digital transformation is e-government; the delivery of national or local government information and services via the Internet or through other digital means. The United Nations DESA *E-Government Survey* notes that e-government has far-reaching potential, not just for improving institutional processes and public service delivery, but also for extending inclusion, participation, accountability and transparency, and for helping to build trust between societies and governments.

E-government is increasingly evident at the local level, but progress has been slow, and if not implemented appropriately can lead to further alienation and exclusion. Most local government city portals do not yet meet emerging best practices on user-friendly design or as global technology standards. Thus, they often rely on readily available social media platforms to interact with the general public. Furthermore, due to over complexity, such portals often remain out of the reach of older generations and the disabled, irrespective of income level. Exclusion can be even worse for the poor, as most have limited education.

A key challenge here is that while government services are increasingly becoming digital by default, the efficiency gains have not been matched by regulatory simplification. If anything, during the pandemic regulations become even more complex. Without concerted efforts among countries, it may take a while to unwind regulations and fully leverage the benefits of going digital for a more inclusive society.

Where governments lack the infrastructure to deliver more efficient services themselves, they can look to public-private partnerships (PPP) that can tap private finance and combine the skills, resources and innovations of the public and private sectors, while sharing risks and responsibilities. This enables governments to delegate day-to-day operations to the private sector and focus on policies, planning, and regulatory reforms.

Benefits to ecosystems and the use of natural resources

Although digital technology applications can be a source of pollution, and exhaust natural resources, they can also offer environmental benefits and solutions – for example, through improved design and digital twin technologies that convert products into services more efficiently. Producers can now monitor, control, analyse and optimize product performance and collect usage data. Verifiable information can also be incorporated in digital codes or passports which carry data about a product's origin, composition, environmental and carbon performance, as well as repair, dismantling and end-of-life handling. With full implementation, this could reduce consumption and the depletion of natural resources and other materials.

Big data generated by enhanced digital connectivity and digital technology applications is enriching our understanding of the natural world and helping us adapt to climate change. High-tech sensors allow for faster and more accurate collection of data through, for example, multi-sensor-equipped smart phones, satellite tags carried by animals, drones and deep-sea smart fibre-optic cables. Now it is possible to have more frequent large-scale monitoring of the natural environment, in finer resolution and even in previously inaccessible or dangerous locations.

Similarly, in Asia and the Pacific, as the most disaster-impacted region of the world, big data analysis has already transformed the accuracy of risk forecasts making them more relevant, and resulting in a major paradigm shift from 'what the weather will be' to 'what the weather will do'. In this regard, ESCAP has developed a methodology for forecasting the impact of extreme events and slow-onset disasters.

The Report also notes the benefits of smart agriculture which can boost yields by 30 per cent, cut food waste by 20 per cent and at the same time reduce the demand for water. Smart solutions could, additionally, cut emissions from the housing sector thereby reducing energy costs and creating revenue opportunities.

Digital divide

From the outset, however, digitalization not yet benefitted everyone equally, with some countries and societies racing ahead to embrace the new technologies, while others, with fewer resources and less capacity, are adapting more slowly to the stream of innovations.

Gaps are evident too within countries, as rapid technological change exposes and exacerbates existing social, economic and geographical divisions. The *Report* identifies five digital divides; age, gender, education, disability and geographic characteristics. As the *Report* indicates, while the technology is available, social and peoples' value systems adapt more slowly. For example, people caught in the digital divide may not be able to afford electricity and digital connectivity, or lack the skills to use digital services, or may believe the new offerings are too difficult to learn, or not relevant to them, or fear that they will be exploited.

Typically, those most comfortable with technological innovations are younger people who have grown up with the Internet as 'digital natives'. Older people may be slower to acquire the necessary skills or suffer declines in aptitude with age. Among all ages, however, there can be a gender divide. In principle, the digital transformation should offer women and girls more opportunities through, for example, remote working or receiving critical information to which they would otherwise have no access. But it can also put them at a disadvantage. In 2020, out of 18 Asia-Pacific countries with available data, 14 countries had more men than women using the Internet. Disabled persons can also face specific barriers; in Asia and the Pacific, only 40 per cent of the governments have indicated that their public websites are considered accessible to persons with disabilities. Even then, the services offered are difficult to use, as digitalization has not reduced regulatory complexity .

Tracking digital transformation through the development of an assessment tool

Such a broad and diverse transformation is inevitably difficult to assess and monitor. ESCAP has constructed a policy analytical framework and a digital transformation index as a pilot. The framework identifies three different stages of the transformation: foundation, adoption and acceleration. These stages are considered across five actors: network infrastructure, government, business, people and ecosystems. This framework is used as a basis for understanding and tracking the digital transformation at the regional and country levels as well as over time.

First, a key finding is that Asia and the Pacific is the most digitally divided region of the world. While some countries in the region, such as China, Japan, the Republic of Korea and Singapore, have advanced digital transformation capacity, many other developing countries notably in South and South-West Asia, are lagging seriously behind . The Pacific small island developing States are believed to be the most digitally divided; indeed insufficient data has prevented even their inclusion in the analysis in the index. Within the subregions, South-East Asia emerged as the most divided with Singapore as its most advanced country and Myanmar lagging far behind.

Second, even in countries with advanced digital transformation, their performance demonstrated different strengths and weaknesses at the three stages of transformation (foundation, adoption and acceleration stages) and across the five actors (network infrastructure, government, business, people and ecosystems). For example, Singapore scores highly for indicators on 'government' effectiveness and investments. The Republic of Korea, which shows a high overall digital transformation score, is strongly driven by 'network infrastructure' indicators. Thus, digital transformation status is driven by varied factors lending support to the need for a multi-pathway, experimental and adaptive approach to digital transformation.

Third, the most significant determinant of digital transformation in all three stages is the 'business' sector. This underlines the central role of businesses on continued investments in digital infrastructure, driving research and development on frontier technologies, and in adopting disruptive technologies for transformation. It also exposes the profound gaps in competitiveness between government and business

sectors. This is of concern as these gaps deter improvements in the universal deployment of digital infrastructure and a technology-centred enabling policy environment for business sector innovation.

Fourth, a country's digital transformation status is strongly correlated with its income level. In this regard, a positive finding is that some Asia-Pacific countries have a digital transformation status that is relatively higher than their income grouping, with a number of lower-middle-income Asian countries, such as India, the Philippines and Viet Nam emerging as advanced digital transformation countries.

Fifth, most of the low-income countries, notably the Pacific small island developing States, do not have sufficient data for meaningful analysis. Urgent action is needed t strengthening and building digital data systems in the Pacific region. Furthermore, more than 40 per cent of the middle-income countries also do not have sufficient data to systematically measure digital transformation and refine the key policy gaps.

Sixth, notwithstanding the improvements in women's access to digital technologies, over the past 25 years, there is still an 'access gap' between women and men. This is particularly evident in terms of on-line work and the use of emerging innovative technology, including AI systems.

Planning with pathways: recommendations

Regional cooperative mechanisms can accelerate digital transformation in the region. In ESCAP resolution 78/1 members and associate members committed to strengthening digital cooperation at all levels including at the ministerial level in closing the digital connectivity divide, ensuring digital skills training, strengthening digital connectivity, and addressing digital trust and security. Consequently, to align with the Action Plan of the Asia-Pacific Information Superhighway (AP-IS) initiative for 2022-2026, the *Report* recommends three pathways (tracks) for action, which are not mutually exclusive.

Pathway 1: Infrastructure networks and connectivity – On the supply side, pathway 1 provides good policy practices for cost-effective development of network infrastructure and for fostering a culture, where policymakers and regulators actively promote investments in next generation infrastructure. Recommendations include to:

- Revisit regulatory complexity and streamline and simplify infrastructure deployment policies and regulations, including through a 'dig once' policy for the co-deployment of fibreoptic cables;
- Promote Internet exchange points (IXPs) in the subregions/region through regional cooperative mechanisms;
- Incentivise investment and research and development through balanced spectrum policies and licensing frameworks;
- Promote government support for expanding connectivity in remote, non-economically viable areas and assess the effectiveness of universal service funds, as well as environmental sensing;
- Promote digital connectivity between rural products and urban markets through building smart villages;
- Enhance awareness and capacity of policymakers on resilient ICT infrastructure development, including the incorporation of the e-resilience component in ICT infrastructure investment and development plan as an essential element.

Pathway 2: Digital technologies and applications – Policymakers must also consider the demand side and, in particular, whether people can afford new digital products and services in capacity and price. Recommendations include to:

- Accelerate investment, by governments, in the capacity and skills of both government officials and end users with a special focus on the digital divides;
- Promote awareness and capacity on digital transforming trends and consequences, including the development of assessing framework and indicators;
- Establish a national/sub-regional digital solutions centre to address unexpected digital challenges that may arise during the process of digital transformation;

- Strengthen regulatory policies for promoting digital innovative businesses in the framework of public-private partnerships (PPPs);
- Promote capacity for digital skills and digital financial services, particularly for women entrepreneurship and empowerment, and for vulnerable groups in countries with special needs;
- Strengthen ICT applications for disaster risk monitoring, management and recovery from disasters;
- Promote policies and digital platforms for small and medium-sized enterprises (SMEs), particularly in countries with special needs.

Pathway 3: Data about data – Digital connectivity and the greater use of digital technology and applications generates data extensively (billions of devices), and intensively (detailed data in real time). At present, few governments can take full advantage of what is being produced. However, all countries need to become more adept at managing data and monitoring the state of their own digital transformations. Recommendations include that governments:

- Strengthen data systems and indicators to respond to digital transformation as an essential component of an inclusive digital society;
- Strengthen the capacity of literacy and skills of government officials for a deeper analysis and understanding of the digital divide and digital transformation process;

- Promote national and regional intelligent data resource management centres as key infrastructure to maximize data use, provide smart services and expedite innovation;
- Promote the system for easy sharing of digital and statistical data among public sector organizations, in particular among ministries;
- Enable everyone to obtain digital identities and easy access to digital data;
- Strengthen the systems and framework for data privacy and protection including the capacity on cybersecurity.
- Strengthen institutional capacity to collect, research, and publish granular data related to the digital transformation.

Drawing from the above discussion, the Asia-Pacific Information Superhighway (AP-IS), and its Action Plan 2022-2026, thus provides a useful regional cooperative platform for promoting policy coordination and partnerships between governments, businesses and social groups at regional and global levels. Only by working together can countries ensure that these technological breakthroughs will work for their economies and societies and the natural environment in an inclusive and sustainable manner..

CHAPTER 1.

The COVID-19 pandemic detonates a digital big bang

Across Asia and the Pacific, digital technology is transforming many aspects of daily life. These changes were already well underway before the COVID-19 pandemic but were given a further boost by the pandemic, as governments, businesses and communities sought greater safety by using contactless digital interactions. In many respects, the outcomes were beneficial, motivating whole societies to adopt digital technologies more rapidly and radically. But this 'big bang' also left many people behind, particularly those without the necessary assets or capacities to take advantage of these new options, thus further accentuating the digital divide.

Human societies are being transformed by a series of disruptive frontier technologies, including artificial intelligence (AI), big data, mobile connectivity and high-capacity electronic networks. This digital transformation is reshaping both social interactions and national economies. In this new development paradigm, people are not just consumers of products and services but also, through their social networks, creating value and developing previously unheard-of products and services. Such development goes beyond the digitalization of goods and services; it represents an irreversible transformation of socioeconomic structures.[1]

To respond to a world rapidly becoming digital by default, member States should focus more deliberately on digital transformations, not just to take stock, but to shape the digital transformation process. To support these efforts, ESCAP has initiated the production of a biennial series of *Asia-Pacific Digital Transformation Reports*. These reports will also offer an information evidence base that will help shape the participation of member States in the Asia-Pacific Information Superhighway initiative and activities contained in its Action Plan for 2022-2026.

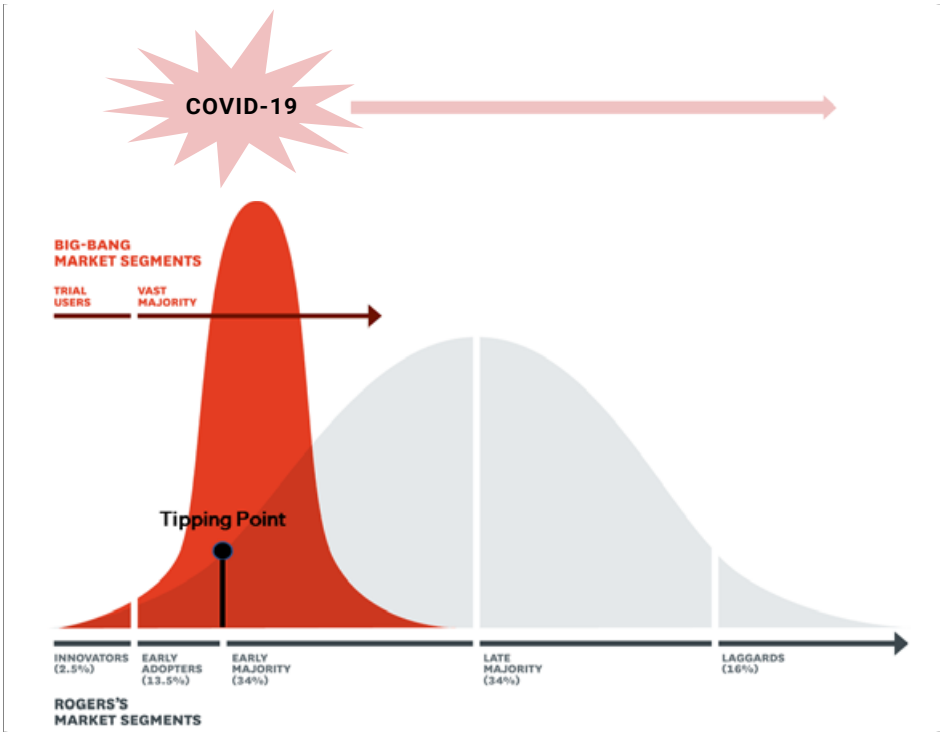
The digital transformation accelerated during the COVID-19 pandemic. Most countries were forced to implement strong containment and mitigation measures, aiming to minimize direct human interaction, and encouraging the use of 'contactless' online digital services. Governments, for example, provided online income support and new digital services for households. Businesses also took greater advantage of online shopping, remote working, video conferencing and distance learning.

Normally, new technology diffuses slowly through consumer segments; from 'early adopters' to 'followers' in a classic bell curve. Instead, the COVID-19 pandemic caused a 'big bang' that suddenly pushed many more people over technology tipping points and compressed the adoption period into two segments; the 'early adopters' and the 'early majority' (Figure 1-1).[2]

1 This report differentiates digitalization and digital transformation. Digitalization is the process of leveraging digital technology and data to improve business processes, model and productivity. For example, it develops the website and converts the sales from off-line to on-line business.

2 Larry Downes and Paul Nunes, "Big-bang disruption", *Harvard Business Review* (March 2013). Available at https://hbr.org/2013/03/big-bang-disruption

Figure 1-1. The big-bang disruption during the COVID-19 pandemic



Source: Adapted by ESCAP from Larry Downes and Paul Nunes, "Big-bang disruption", *Harvard Business Review* (March 2013). Available at https://hbr.org/2013/03/big-bang-disruption

The digital divide in Asia and the Pacific

Rapid technological changes are occurring at a pace that is leaving many people and enterprises in Asia and the Pacific behind, thereby widening the digital divide. As more and more devices and systems rely on the Internet, businesses and people without reliable connections and the necessary digital skills can be denied access to the benefits and opportunities of the digital economy. The types of barriers to connectivity are summarized in Figure 1-2,[3] and six types of resulting gaps are demonstrated in Figure 1-3.[4]

Figure 1-2. Barriers to connectivity

Affordability	Knowledge and digital skills	Relevance	Safety and security	Access
Individuals cannot afford devices, data plans or other service fees.	People are unaware of mobile Internet and its benefits or do not have the necessary skills to use digital technology.	Local digital ecosystems are underdeveloped, and there is a lack of content, products and services that meet user needs and capabilities.	Individuals and communities are concerned about the negative aspects and risks of the Internet, such as harassment, theft, fraud and online security.	Individuals do not have access to networks and enablers, such as electricity and formal IDs, or devices and services are not accessible enough.

Source: Anne Delaporte and Kalvin Bahia, "The State of Mobile Internet Connectivity Report 2021", GSMA, September 2021. Available at https://www.gsma.com/r/somic/

3 Anne Delaporte and Kalvin Bahia, "The State of Mobile Internet Connectivity Report 2021", GSMA, September 2021. Available at https://www.gsma.com/r/somic/

4 John Roese, "Davos Agenda 2021: COVID-19 exposed the digital divide. Here's how we can close it", World Economic Forum (WEF), 27 January 2021. Available at https://www.weforum.org/agenda/2021/01/covid-digital-divide-learning-education/

Figure 1-3. Six digital gaps

Source: Seunghwa Jun, Jongsur Par, and Jeong Yoon Kim, "Digital Transformation Landscape in Asia and the Pacific: Aggravated Digital Divide and Widening Growth Gap", ESCAP Working Paper Series, 13 July 2022. Available at https://www.unescap.org/kp/2022/digital-transformation-landscape-asia-and-pacific-aggravated-digital-divide-and-widening

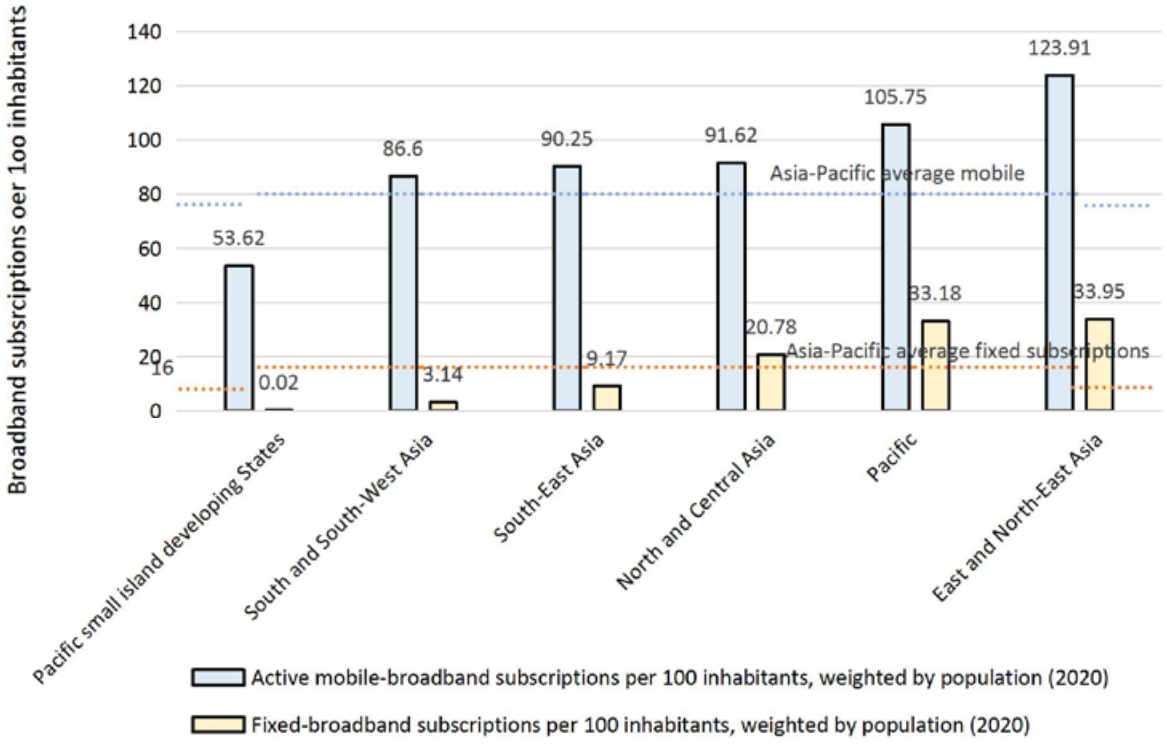
Since the COVID-19 pandemic, mammoth enterprises, such as Google and Amazon, have been able to grow much faster than other companies. One analysis suggests that, in 2019, the top 10 per cent of enterprises were growing twice as fast as the bottom 25 per cent, but by 2021 they were growing five times faster.

These disparities are particularly evident during times of crisis. While digitally connected and well-prepared countries, industries, companies or individuals were better equipped to cope with the pandemic, the weakest organizations and the poorest people living in vulnerable situations were the hardest hit. The pandemic has thus intensified a vicious cycle of economic inequality, and widened development gaps. In the COVID-19 era, the UN recently called the digital divide 'the new face of inequality'.[5]

Significant differences between countries are evident from data on the number of subscriptions per 100 population, for both fixed and mobile Internet connections (Figure 1-4). In Asia and the Pacific, the gaps are widest for fixed broadband; with the lowest access in the Pacific small island developing States, and the greatest access in East and North-East Asia. For mobile subscriptions, overall access is greater, and the gaps are narrower; subscriptions per 100 inhabitants range from 54 per cent in the Pacific small island developing States to 124 per cent in East and North-East Asia.

Even within countries there are notable differences between urban and rural areas, as well as large gender divides, with women in South Asia being 41 per cent less likely than men to use mobile Internet. For example, in Bhutan 71 per cent of the urban population use mobile services compared to 29 per cent in rural areas. There are similar rural-urban gaps in Mongolia (25 and 58 per cent, respectively) and in Samoa (2 and 11 per cent, respectively).

Figure 1-4. **Broadband (fixed and mobile) connections per 100 inhabitants, by subregion**



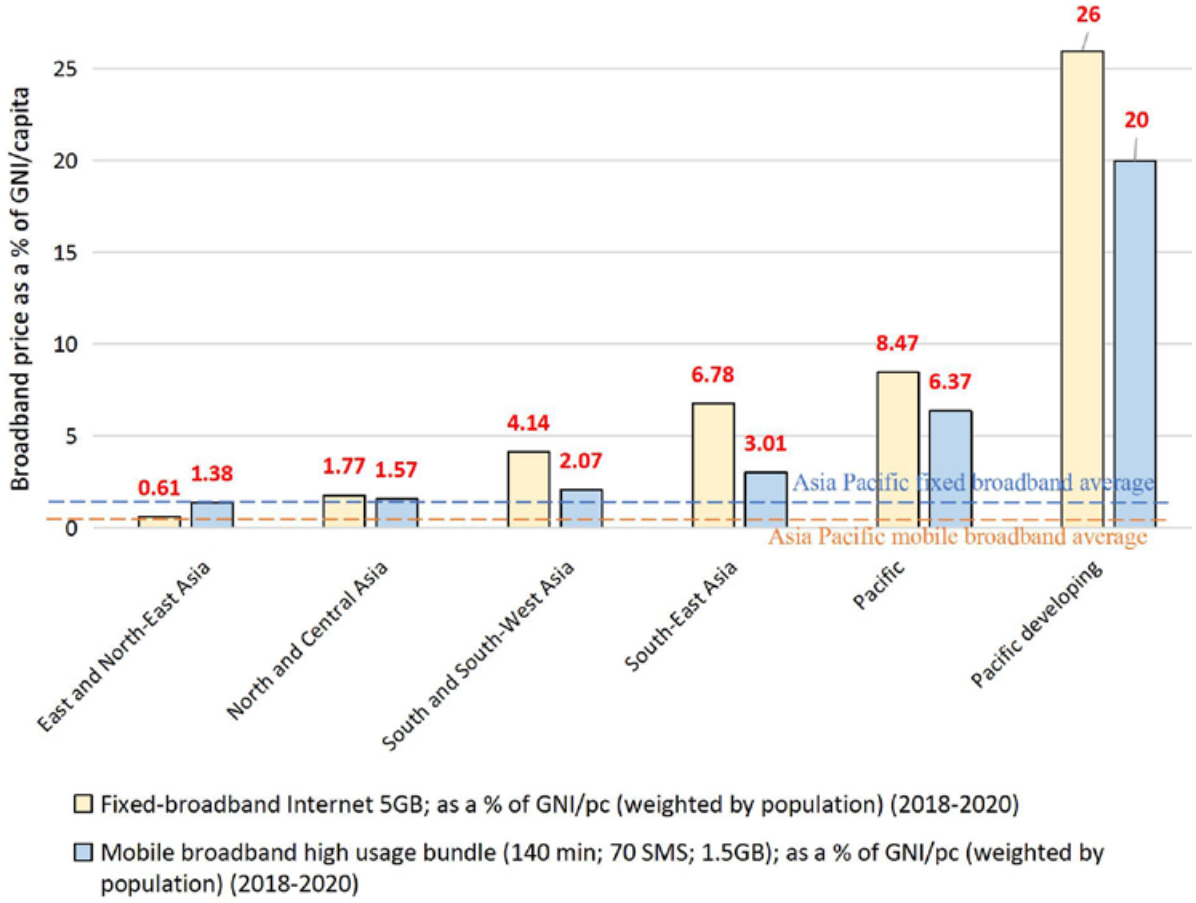
Source: ITU, "World Telecommunication/ICT Indicators Database 2021". Available at https://www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx

Note: The Pacific small island developing States exclude Australia and New Zealand.

Variations between countries in subscription levels correspond to differences in affordability. These are illustrated in Figure 1-5 which shows average subscription prices as a proportion of per capita gross national income (GNI).

5 United Nations, "High-level thematic debate: Digital cooperation and connectivity: Whole-of-society responses to end the digital divide", Summary of the President of the General Assembly, 27 April and 24 May 2021. Available at https://www.un.org/pga/75/wp-content/uploads/sites/100/2021/07/PGA-Letter-Summary-of-HLD-on-Digital-Cooperation-Connectivity.pdf

Figure 1-5. Fixed and mobile prices as a percentage of GNI per capita (2018-2020)



Source: ITU, "World Telecommunication/ICT Indicators Database 2021". Available at https://www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx

Note: The Pacific small island developing States exclude Australia and New Zealand

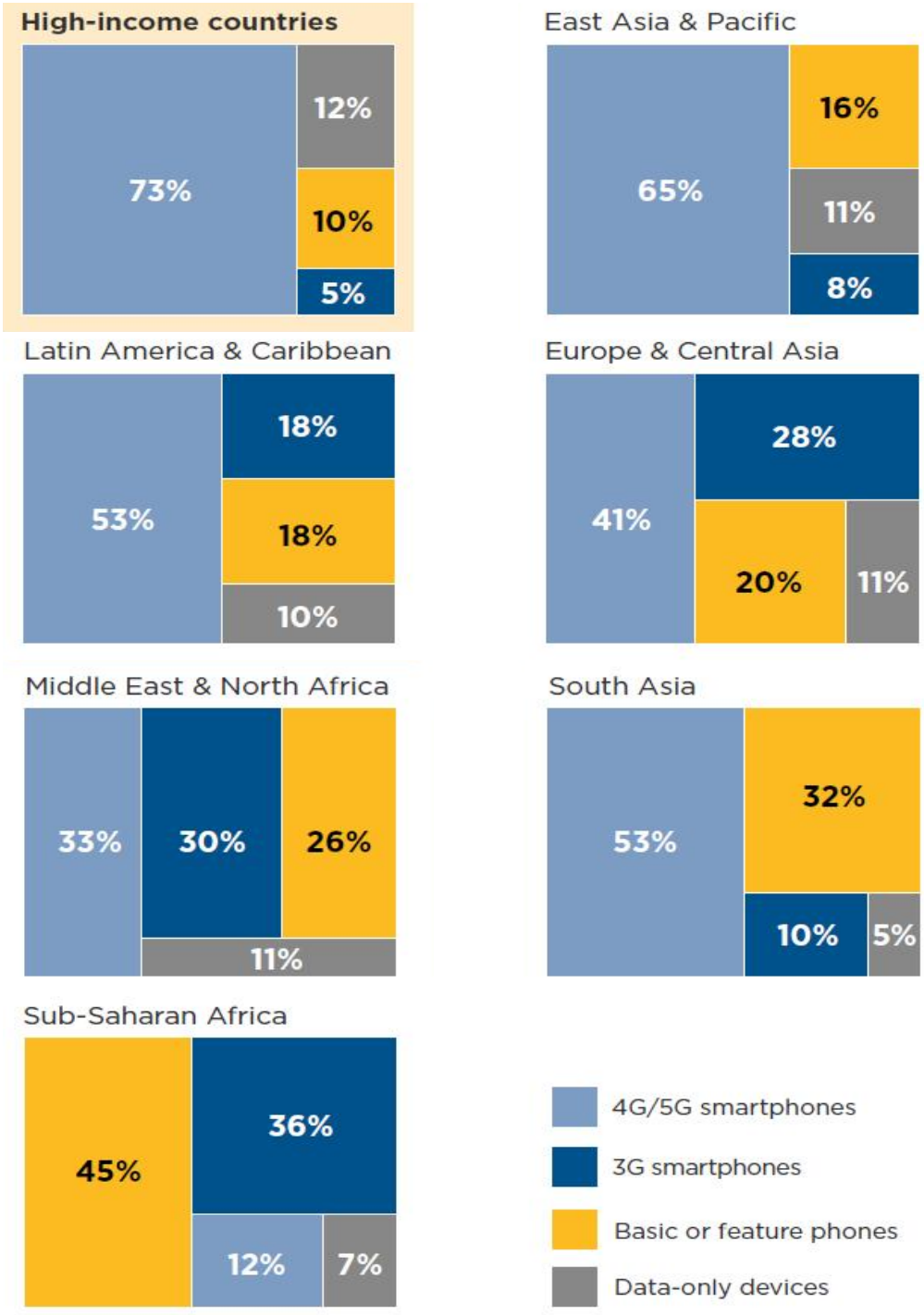
The affordability of Internet-enabled handsets is a key barrier to using the Internet and is of growing concern. The COVID-19 pandemic and the resulting economic fallout caused disposable household income to drop, making handsets less affordable for many. For those with limited income to save or with limited access to credit, access to affordable finance to purchase devices will be a necessary condition to advance digital inclusion.

Upgrading mobile devices is also key to enable digital transformation. Even when people own a mobile device, it may not be possible to use it to access the Internet. For this, a 3G- or 4G-enabled phone is needed, and to benefit from 5G networks newer and more expensive smartphones and other devices are required.

The adoption of Internet-enabled handsets and newer devices also impact on investment decisions in infrastructure. For example, in countries where a significant number of people still depend on 2G handsets there mobile operators have in incentive to keep these networks alive. Conversely, slow adoption of costlier 5G handsets will be taken into account when making investment decisions for the roll-out of supporting networks.

In many countries, people cannot afford Internet-enabled handsets. In South Asia, for example, 32 per cent of subscribers still use basic 2G phones, with a further 10 per cent using 3G devices (Figure 1-6). Over the past few years, now operating systems have enabled the development of handsets that are less costly to manufacture, particularly smart feature phones and ultra-low-cost smartphones. This has narrowed the price differential between a basic 2G phone and a 3G or 4G handset, creating more opportunities for people to go online.

Figure 1-6. State of mobile Internet connectivity, 2021

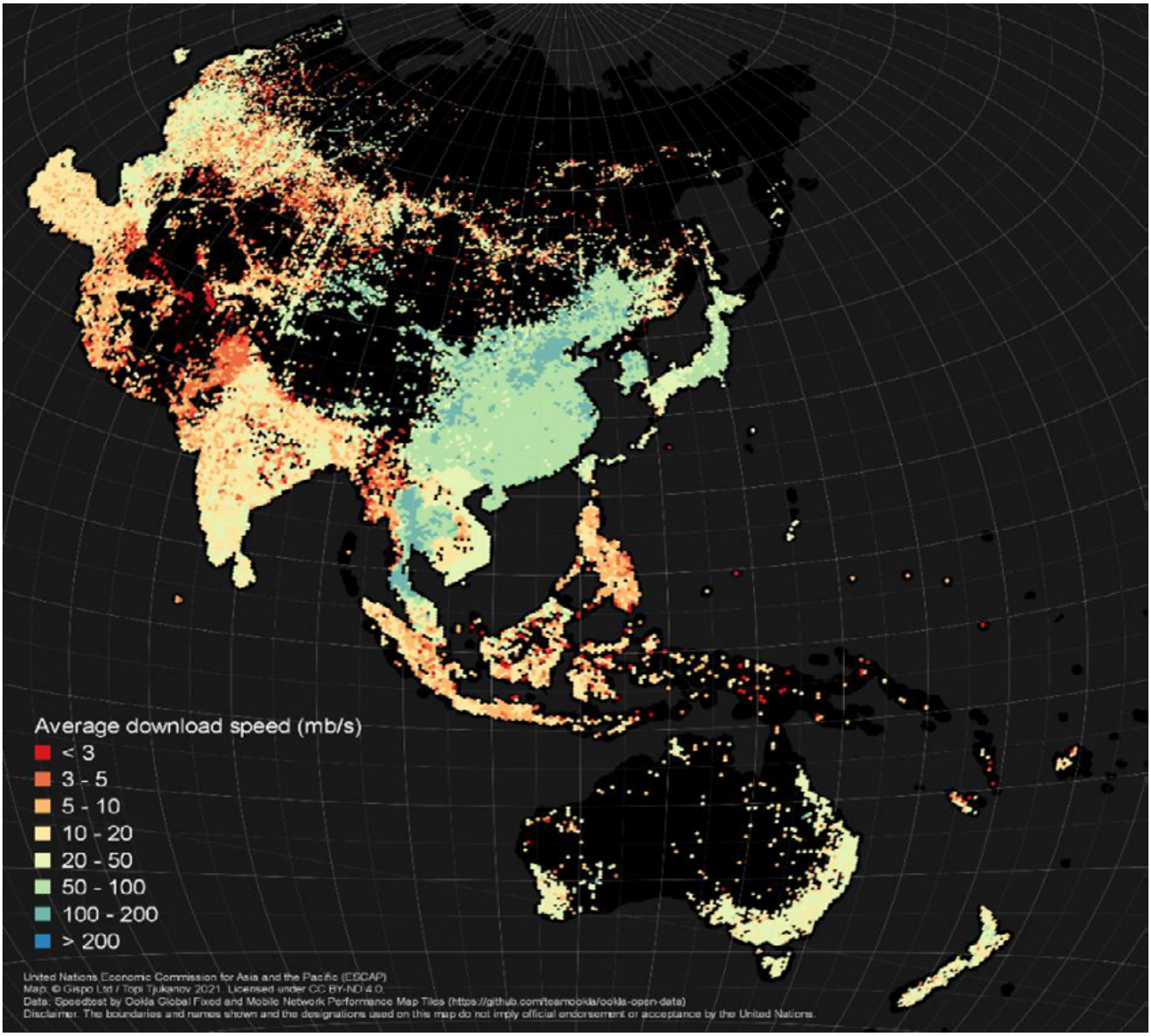


Source: Anne Delaporte and Kalvin Bahia, "The State of Mobile Internet Connectivity Report 2021", GSMA, September 2021. Available at https://www.gsma.com/r/somic/

Regional broadband disparities

An ESCAP study revealed stark gaps between member States in terms of fixed broadband download speeds. Based on aggregated real-time data, this is illustrated in Figure 1-7. Thailand and Viet Nam, for example, have higher average fixed broadband download speeds almost country-wide (green), while the archipelagos of Indonesia and the Philippines have lower speeds ,as do several countries in South and South-West Asia (orange).

Figure 1-7. **Fixed broadband speeds in Asia and the Pacific**

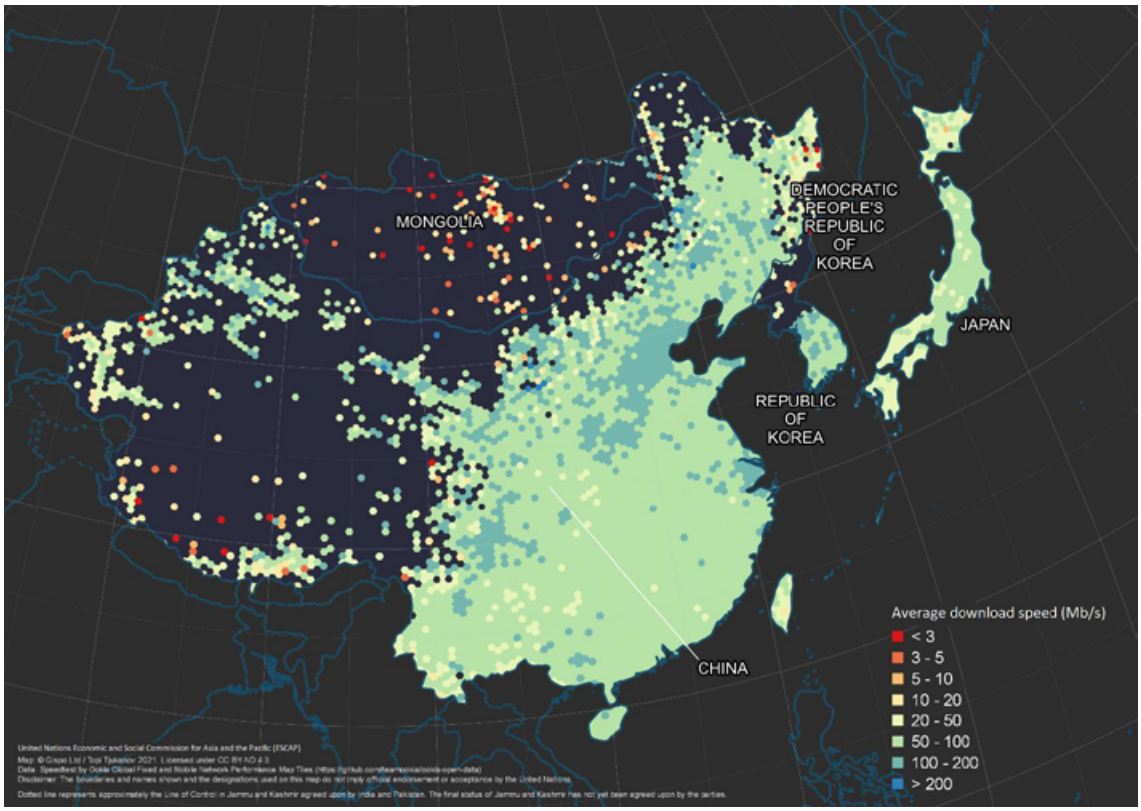


ESCAP research in 2021 found that, among the subregions, the highest fixed broadband download speeds were in East and North-East Asia (Figure 18).[6, 7] The fastest speeds were in Hong Kong, China (125 Mb/s), Macau, China (102 Mb/s), and in the Republic of Korea (103 Mb/s). In Japan, the average speed was lower at 63 Mb/s though evenly distributed between urban and rural areas. China's average speed was similar at 93 Mb/s, but with greater disparities, and lower speeds in Western China. Mongolia (17 Mb/s) experienced the lowest average fixed broadband download speeds and also had notable differences between urban and rural areas.

6 Siope Vakataki 'Ofa and Cristina Bernal Aparicio, "Visualizing Broadband Speeds in Asia and the Pacific", Asia-Pacific Information Superhighway Working Paper No. 02, United Nations ESCAP, ICT and Disaster Risk Reduction Division, 2 May 2021. Available at https://www.unescap.org/kp/2021/visualizing-broadband-speeds-asia-and-pacific-0

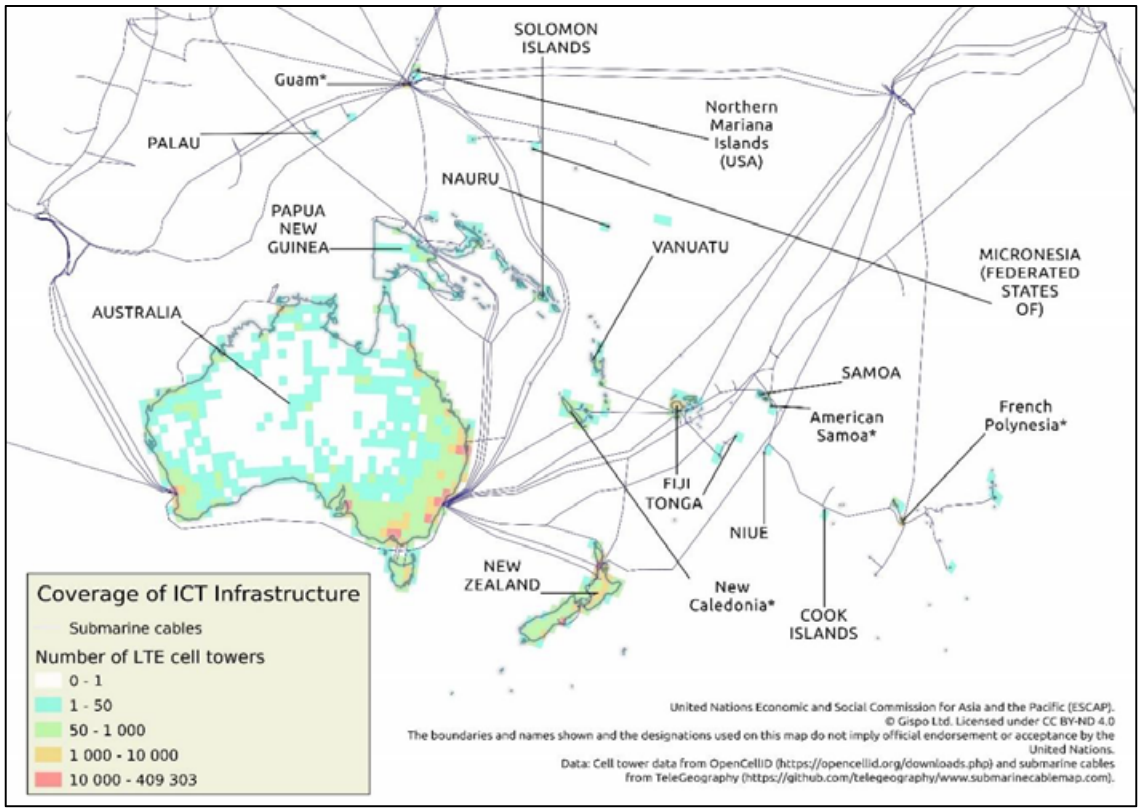
7 The highest fixed broadband downloads speeds for the other Asia-Pacific subregions were 34 Mb/s for the Pacific small island developing States, 44 Mb/s for South-East Asia, 32 Mb/s for North and Central Asia, and 17 Mb/s for South and South-West Asia.

Figure 1-8. Fixed-broadband average download speeds in East and North-East Asia



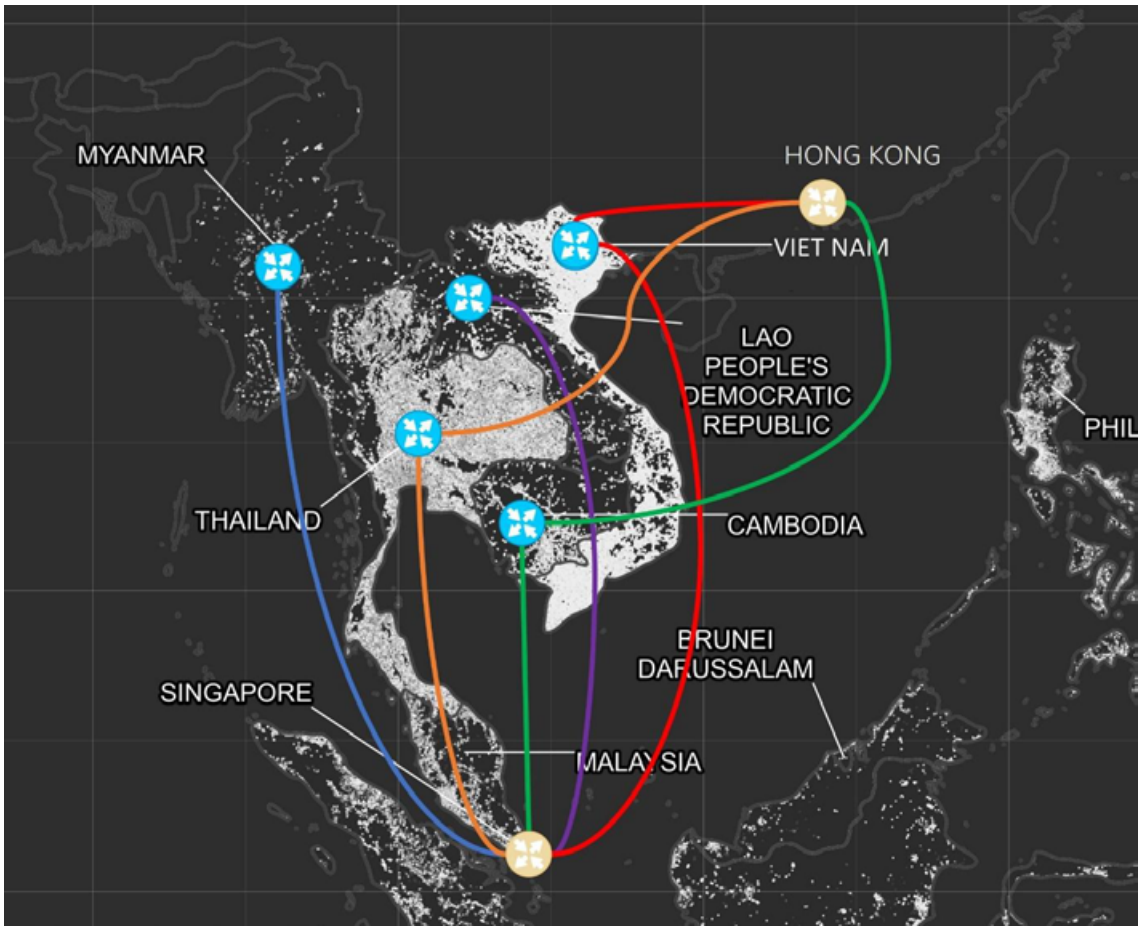
In the Pacific, ICT infrastructure deployment has been made possible through various public-private partnerships (Figure 1-9). Many submarine fibre-optic cables, as with those for Tonga and Samoa, have been funded through agencies, such as the Asian Development Bank and the World Bank. Others, like those for Vanuatu, were financed by private banks. In Australia, the densest concentrations of LTE towers for 4G transmission were seen in urban areas, like Sydney, Canberra, and Melbourne.

Figure 1-9. ICT infrastructure in the Pacific small island developing States



Access and use of the Internet is also affected by the efficiency of traffic management and the number of Internet exchange points (IXPs) that connect traffic between different Internet service providers. South-East Asia has fewer IXPs so Internet traffic between neighbouring countries may be routed via Singapore or Hong Kong, China, over privately leased lines and submarine cables, resulting in high transit costs and latency (Figure 1-10). This in turn affects the affordability and quality of Internet services for end users.

Figure 1-10. Internet connection routes in CLVT countries



Source: Dae Keun Cho and Chang Yong Son, "Promoting ICT Connectivity through Internet Exchange Points in South-East Asia", Asia-Pacific Information Superhighway Working Paper Series, United Nations ESCAP, ICT and Disaster Risk Reduction Division, May 2022. Available at https://www.unescap.org/sites/default/d8files/knowledge-products/Promoting%20ICT%20Connectivity%20through%20Internet%20Exchange%20Points%20in%20South-East%20Asia.pdf

Disclaimer: The boundaries and names shown here and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Widening digital divides

Rapid technological change can expose and exacerbate existing social, economic and geographical divisions. These include those related to age, gender, education, disability and between regions.

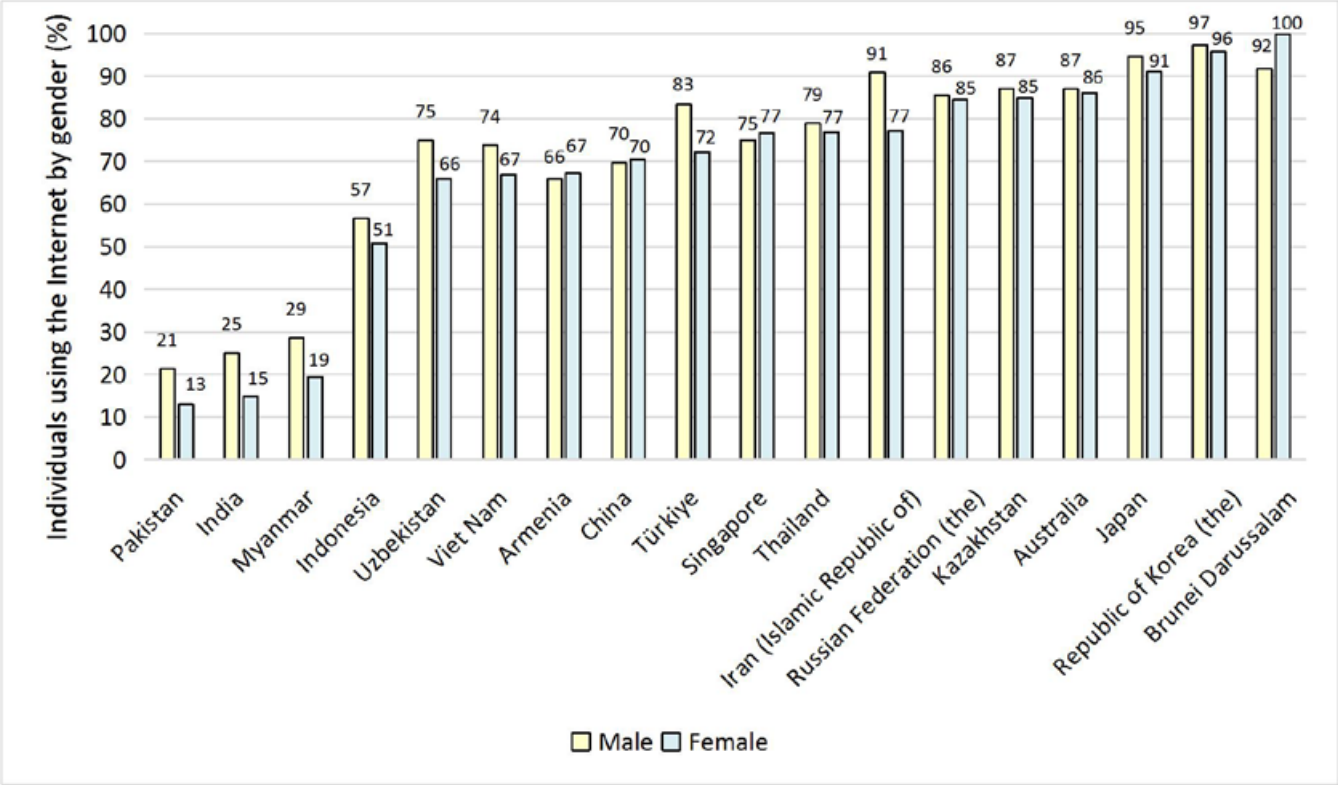
The grey divide

Younger people who have grown up using the Internet can be considered 'digital natives', and are able to pick up digital skills faster. Older people, however, often have far less access to or are limited in their ability to use digital technologies due to a number of reasons. For example, higher costs, the degree of support, lack of ICT skills, self-efficacy or motivation, concern over security, and decline in memory or in spatial orientation due to age. During the COVID-19 pandemic, access to digital services helped some older people overcome the social isolation from lockdowns, but those without access were often excluded even from government and social services.

The gender divide

The digital transformation has offered many benefits to women and girls through, for example, remote working, online medical advice and consultations, social connections, mobile finance services, online education, and online shopping.[8] However, it also resulted in a gender digital divide.[9] Recent data from the GSMA shows that after years of improvement, progress has stalled. Between 2020 and 2021, the gender gap in mobile Internet widened from 15 to 16 per cent.[10] In 2020, out of 18 Asia-Pacific countries with available data, 14 had more men than women using the Internet (Figure 1-11).

Figure 1-11. Use of the Internet by gender, 2020



Source: ITU, "World Telecommunication/ICT Indicators Database 2021". Available at https://www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx

The ILO estimates that women represent only one in three online workers, indicating a gender balance that is particularly skewed in developing countries.[11] These gaps are even wider at higher levels of skill, for example in designing or developing AI and machine-learning systems. In Google's AI workforce, only 10 per cent are women. In Facebook, the proportion is 15 per cent, and in LinkedIn 10 per cent.[12] This reflects gaps

8 Dominica Lindsey, "Why COVID-19 has increased the urgency to reach women with mobile technology", GSMA, 20 April 2020. Available at https://www.gsma.com/mobilefordevelopment/blog/why-COVID-19-has-increased-the-urgency-to-reach-women-with-mobile-technology/

9 This section is a summary of the research commissioned by UN-WOMEN to inform the Secretary General's report on 'Review and appraisal of the implementation of the Beijing Declaration and Platform for Action and the outcomes of the twenty-third special session of the General Assembly,' (E/CN.6/2020/3), and the discussion paper titled, "The digital revolution: Implications for gender equality and women's rights 25 years after Beijing". See, Judy Wajcman, Erin Young and Anna Fitzmaurice, "The digital revolution: Implications for gender equality and women's rights 25 years after Beijing", discussion paper No. 36, August 2020. Available at https://www.unwomen.org/en/digital-library/publications/2020/08/discussion-paper-the-digital-revolution-implications-for-gender-equality-and-womens-rights

10 Matthew Shanahan, "The Mobile Gender Gap Report 2022", GSMA, June 2022. Available at https://www.gsma.com/r/gender-gap/

11 Janine Berg and others, "Digital labour platforms and the future of work: Towards decent work in the online world", International Labour Organization, Geneva, 2018. Available at https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_645337.pdf

12 Judy Wajcman, Erin Young and Anna Fitzmaurice, "The digital revolution: Implications for gender equality and women's rights 25 years after Beijing", discussion paper, No. 36, August 2020. Available at https://www.unwomen.org/en/digital-library/publications/2020/08/discussion-paper-the-digital-revolution-implications-for-gender-equality-and-womens-rights

in skills and education as well as the persistence of traditional gender norms and stereotypes.[13] Lower proportions of women than men graduate in engineering and ICT subjects.

The UNIDO Industrial Development Report 2020 finds that in emerging and developing economies, women workers in manufacturing industries are more exposed than men to the risk that machines will substitute workers. The risk is generally greater in low-technology industries, such as textiles, apparel and leather goods manufacture which have a larger share of female workers. On average, susceptibility to automation is almost 3 per cent higher for women than men.

The education divide

The digital divide has also been widened by education. People with higher levels of education tend to use the Internet more for education, work, career, and business while those with less education are more likely just to use it for entertainment, simple communications or e-shopping.[14]

The disability divide

The Asia-Pacific region is home to the world's largest cohort of persons with disabilities.[15] On average, there is a 17 percentage point gap between persons with and without disabilities in the use of the Internet. During the pandemic, digital technologies enabled those with disabilities to receive essential supplies, information, and services for work, education, and personal assistance. But the pandemic also revealed significant inequalities; many persons with disabilities experienced difficulties in affording or learning to use digital devices and services. Such services also failed to offer accessibility features, such as sign language interpretation, text-to-speech or captioning, or the potential for screen magnification. As a result, many persons with disabilities, including those in developed countries, have been excluded from essential health and safety information and services, as well as from vital social support programmes.

Among government portals of the 193 UN member States, only 32 per cent allowed font and colour adjustment, only 7 per cent enabled website content to be read aloud, and only 4 per cent included videos in sign language. Graphical elements on 63 per cent of the websites lacked descriptive text.[16] Moreover, the accessibility features of mobile phones and services remain underdeveloped.[17]

In Asia and the Pacific, only 40 per cent of the governments participating in the mid-term review of the implementation of the Incheon Strategy to "Make the Right Real for Persons with Disabilities in Asia and the Pacific" indicated that their public websites were accessible to persons with disabilities.[18] In addition, many persons with disabilities, particularly those living in developing countries, cannot afford ICT devices or services, are not aware of the available digital tools, and cannot acquire the necessary skills and knowledge to use them.[19]

13 This section summarizes the research commissioned by UNIDO. See, Alina Sorgner, "The impact of new digital technologies on gender equality in developing countries", Inclusive and Sustainable Industrial Development Working Paper Series, Working Paper 20, UNIDO, 2019. Available at https://www.unido.org/api/opentext/documents/download/16760725/unido-file-16760725

14 Nicole Zillien and Eszter Hargittai, "Digital Distinction: Status-Specific Types of Internet Usage", *Social Science Quarterly*, vol. 90, No. 2 (June 2009), pp. 274-291. Available at doi: 10.1111/j.1540-6237.2009.00617

15 *Disability At A Glance 2019: Investing in Accessibility in Asia and the Pacific*, (United Nations publication, 2019a). Available at https://www.unescap.org/sites/default/d8files/knowledge-products/SDD-DAG-2019.pdf

16 *Disability and Development Report: Realizing the Sustainable Development Goals by, for and with persons with disabilities* (United Nations publication, 2019).

17 Ibid.

18 *Building Disability-Inclusive Societies in Asia and the Pacific: Assessing Progress of the Incheon Strategy* (United Nations publication, 2018b)

19 United Nations High Commissioner for Refugees (UNHCR), "Digital access and inclusion of people with disabilities", Background Note, Geneva, 2021. Available at https://www.gsma.com/mobilefordevelopment/resources/the-digital-lives-of-refugees-and-kenyans-with-disabilities/

The geographic divide

The Asia-Pacific region has the widest digital divides in the world (Figure 1-12) some wide geographic divides within subregions.[20] While some Asia-Pacific countries in East Asia, such as China, Japan and the Republic of Korea, are advanced, the Pacific small island developing States are likely to be the least connected, followed by countries in South and South-West Asia. Among the subregions, ASEAN is the most divided with Singapore being the most advanced, while Myanmar lags significantly behind.

These issues are considered in greater detail in the following chapters.

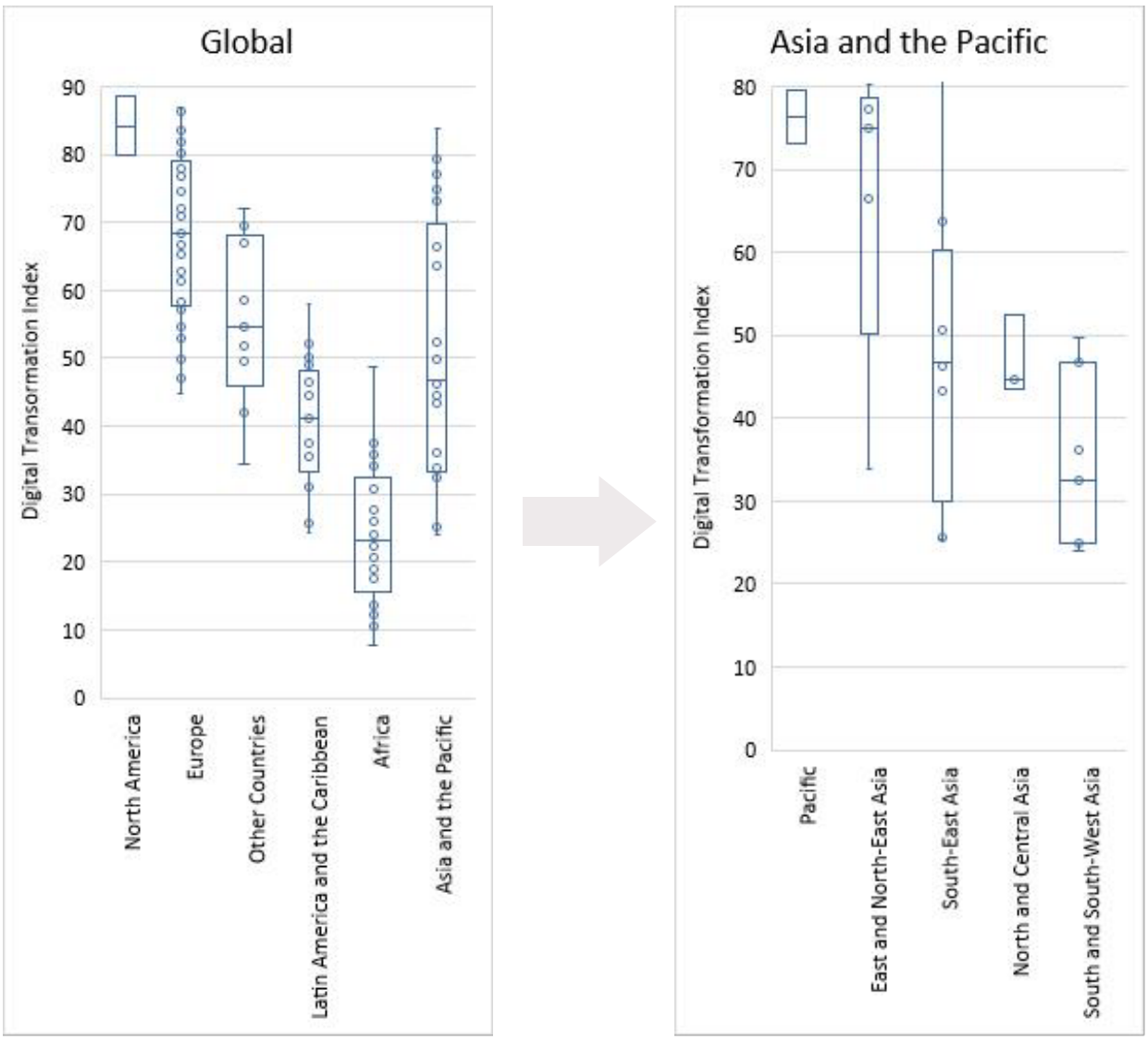
Chapter 2 details the main policy challenges that policymakers should address if they are to guide the digital transformation efficiently and productively, ensuring that digital divides are narrowed and digital dividends are shared equitably, especially among the poorest and most vulnerable groups.

Chapter 3 discusses the far-reaching potential of e-government for improving institutional processes and public service delivery and helping to build trust between societies and governments.

Chapter 4 outlines three of the most effective pathways for digital transformation which corresponding to the Action Plan 2022-2026 for the implementation of the Asia-Pacific Information Superhighway. These are: promoting digital infrastructure connectivity; expanding digital technology applications; and digital data collection, management and use. These pathways aim to lead to fair and positive outcomes for an inclusive digital society.

20 Jongsur Park, Seunghwa Jun and Jeong Yoon Kim, "Methodology for data analysis of digital transformation", ESCAP Working Paper Series, 31 May 2022. Available at https://www.unescap.org/kp/2022/methodology-data-analysis-digital-transformation

Figure 1-12. Digital divides among regions and subregions of Asia and the Pacific



Source: Jongsur Park, Seunghwa Jun and Jeong Yoon Kim, "Methodology for data analysis of digital transformation", ESCAP Working Paper Series, 31 May 2022. Available at https://www.unescap.org/kp/2022/methodology-data-analysis-digital-transformation

Note: The Pacific includes only Australia and New Zealand. The analyses for the Pacific small island developing States are not available because of lack of data.

CHAPTER 2.

The dynamics of digital transformation

The rapid acceleration of digital transformation has led to profound changes across the Asia-Pacific region. While some aspects of this transformation were deliberate and planned, others were spontaneous, resulting in unforeseen impacts for which societies remain largely unprepared. The task for policymakers now is to understand the implications of these dynamic developments so as to foster innovation and enterprise, and guide these transformations in their most efficient, productive and fair directions. Governments should ensure that everyone is included, especially the poorest and most vulnerable groups, so that digital dividends are equitably shared.

The digital transformation that is impacting the world can be considered as part of the fourth industrial revolution. The first industrial revolution was based on metals and steam energy to mechanize production; the second used electrical power for mass production; and the third used electronics and information technology to automate production. This fourth revolution consists of merging the physical, digital, and biological worlds, leading to fundamental changes in the way we live, work, and relate to one another.[21]

Two essential elements of the digital transformation are 'digitization' and 'digitalization'. Digitization is the process of converting analogue information into a digital format so that it can be electronically stored, processed, managed, and transmitted. For example, the conversion of analogue music to MP3 files. On the other hand, digitalization is the process of using digital technology and data to improve business processes, models and productivity. Some of these digital technologies are listed in Table 2-1.

Both digitization and digitalization feed into the broader societal change that is digital transformation. Going beyond just the digitalization of goods and services, the digital transformation means a new development paradigm and its process for the fabric of the whole society, in terms of value creation, management, use and distribution through applications of disruptive technologies, including artificial intelligence (AI), digital data, connectivity and network. New processes of value creation, management, use and distribution are reshaping both social interactions and national economies, and irreversibly transforming socioeconomic structures.

21 World Economic Forum (WEF), "Fourth Industrial Revolution", 2022. Available at https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/

Table 2-1. Contactless services and key digital technologies

Category	Service	Key Digital Technology
Non-face-to-face Services	Video conferencing	Cloud, software as a service (SaaS)
	Telehealth	Cloud, big data, artificial intelligence (AI), augmented reality-virtual reality (AR-VR), Internet of Things (IoT)
	Distance learning	Cloud, SaaS
	Online shopping	Payment solutions, AR-VR, AI, cloud
	Online gaming	Cloud, big data, AI, AR-VR, blockchain
	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
Unmanned Servicesl	Unmanned stores	Sensor, payment solutions, AI, real-time locating systems (RTLS), cloud, big data
	Robotic barista	Robotics, AI, IoT
	Drone delivery	Drone, AI, IoT, cloud, big data
	Self-driving cars	AI, IoT, connected and autonomous vehicles, cloud, big data

Source: Seunghwa Jun, Jongsur Par, and Jeong Yoon Kim, "Digital Transformation Landscape in Asia and the Pacific: Aggravated Digital Divide and Widening Growth Gap", ESCAP Working Paper Series, 13 July 2022. Available at https://www.unescap.org/kp/2022/digital-transformation-landscape-asia-and-pacific-aggravated-digital-divide-and-widening

Rewards and risks of digital transformation

Rapidly spreading across the world, the digital revolution has connected 4.5 billion people who are exchanging ideas through social media, gaming, and chat apps.[22] Many of the consequences of such a revolution are positive; digital technologies enhance productivity, optimize the use of resources, help reduce greenhouse gas emissions, support the monitoring and tracking of health challenges, such as COVID-19, track progress in sustainability, and move societies towards green digital economies. Artificial intelligence (AI) and additive manufacturing, for example, are part of the next wave of climate change solutions. The Internet of Things (IoT), blockchain-based authentication, data-sharing platforms, and gamified applications have helped align participants on common goals for sustainability and foster collaboration across the value chain.

In government administration, 5G capabilities lead to building smarter cities, utilities, and public safety agencies. Central banks are taking advantage of the underlying technologies, including blockchain, and are supporting the use of technology for further innovation. Across all industries, 5G and AI are transforming business models. In the automotive industry, for example, smart and connected vehicles can make travel saver and save human lives, while creating new sources of profit. Moreover, in society as whole, digital connections have offered new ways to support marginalized groups.

22 Simon Kemp, "Digital 2021 October Global Statshot Report", Kepios, 21 October 2021. Available at https://datareportal.com/reports/digital-2021-october-global-statshot

More broadly, digitalization can help achieve global and regional agendas, including the Sustainable Development Goals (SDGs) that are central to the 2030 Agenda. An assessment, conducted in 2020, found that digital technologies can positively impact 10 of the 17 SDGs.[23] The report estimated that 70 per cent of the 169 SDG targets could be furthered by digital technology applications.[24]

But there are also risks. At the social and political level, social networks, while fostering communications, have also heightened the dangers of polarization as algorithms designed to maximize traffic for advertisers have prioritized the more extreme and provocative posts, creating social 'echo chambers' and spreading misinformation.

There is also the risk of speculative bubbles, notably in the trading of cryptocurrencies, digital coins, and digital property in the form of non-fungible tokens. This was demonstrated in 2022 in the crash of two cryptocoins, Terra and Luna. To maintain and protect their consumers and economies, some countries have sought to exert greater control. In 2018, Thailand became one of the first countries in the world to regulate the trade in cryptocurrencies and, in March 2022, banned their use for payments.[25] China has also prohibited the use of cryptocurrencies.

The digital revolution can also lead to environmental damage by expediting the exploitation of resources and creating digital waste. According to some estimates, digital gadgets, the Internet, and the systems that support them contribute to 2.3 per cent of the global carbon footprint, which is roughly the same as that for global air travel.[26, 27] In terms of material demands, globally, the world produces around 50 million tons of electronic e-waste a year, only 20 per cent of which is recycled.[28] The manufacture of electronic hardware also relies on the extraction and potential exhaustion of natural resources, such as rare earth elements and precious metals like cobalt and lithium.[29]

Networks and infrastructure

Over the past five years, global annual investment by the mobile industry in infrastructure, services and other innovations was around $1 trillion, of which over $400 billion was in Asia and the Pacific. As a result, Asia-Pacific countries are more connected to each other and to the rest of the world. At the personal level, this is primarily through mobile devices, particularly in low- and middle-income countries, where 87 per cent of Internet connections are through mobile broadband. In the Asia-Pacific region, as in the world as a whole, 94 per cent of the population is now covered by mobile broadband (Figure 2-1).[30]

23 PwC, "Over two-thirds of Sustainable Development Goals could be bolstered by emerging tech, including AI and blockchain", 17 January 2020. Available at https://www.pwc.com/gx/en/news-room/press-releases/2020/blockchain-sdgs-wef.html (accessed on 14 February 2022).

24 Other assessments have come to similar conclusions for example, the GESI Digital With Purpose Report (2019) found that 103 of the 169 SDG targets are directly influenced by seven digital technologies: digital access, faster internet, cloud, the nternet of things (IoT), cognitive, digital reality, and blockchain. Also see Maria E. Mondejar, "Digitalization to achieve sustainable development goals: Steps towards a Smart Green Planet", *Science of The Total Environment*, vol. 794 (10 November 2021). Available at https://www.sciencedirect.com/science/article/pii/S0048969721036111.

25 Suttinee Yuvejwattana and Thomas Kutty Abraham, "Thailand Bans Use of Cryptocurrencies as a Method of Payment", *Bloomberg Asian Edition*, 23 March 2022. Available at https://www.bloomberg.com/news/articles/2022-03-23/thailand-bars-use-of-cryptocurrencies-as-a-method-of-payment

26 Global e-Sustainability Initiative (GeSI), "#SMARTer2030: ICT Solutions for 21st Century Challenges", Belgium, 2015. Available at https://smarter2030.gesi.org/downloads/Full_report.pdf

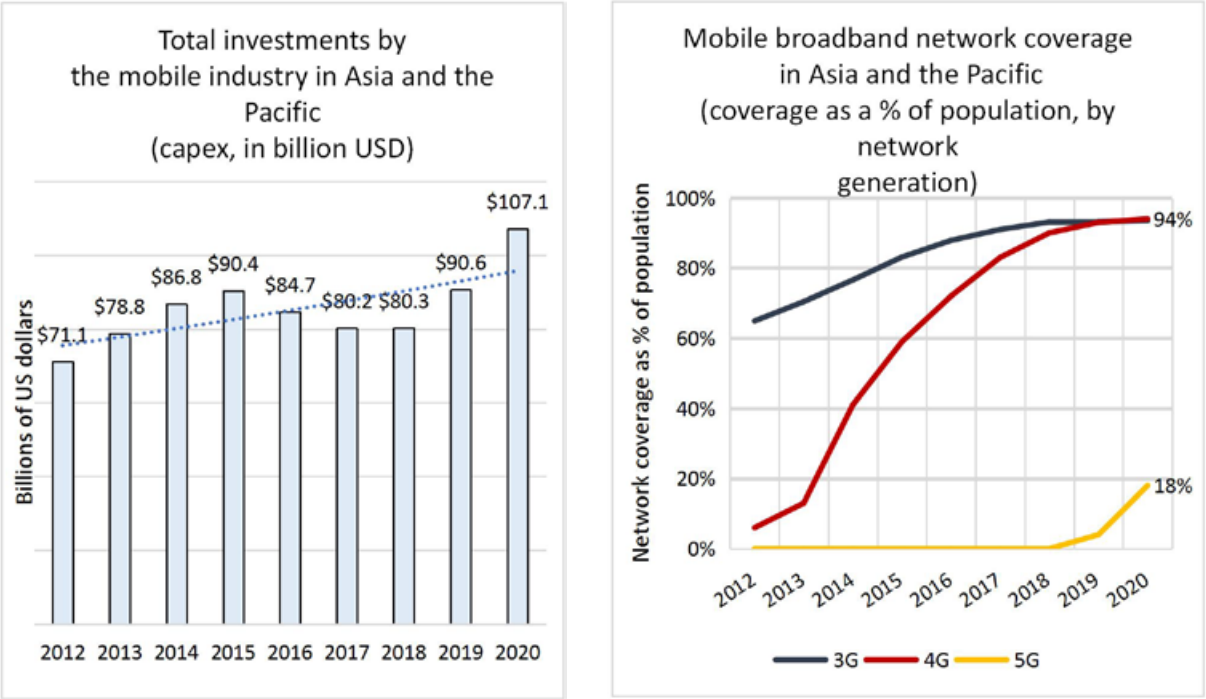
27 Brandon Graver, Kevin Zhang, and Dan Rutherford, "CO2 Emissions from Commercial Aviation, 2018", The International Council on Clean Transportation, Working Paper, 19 September 2019. Available at https://theicct.org/publication/co2-emissions-from-commercial-aviation-2018/

28 Robert Muggah, Rafal Rohozinski, and Ian Goldin, "The dark side of digitalization – and how to fix it", World Economic Forum, 23 September 2020. Available at https://www.weforum.org/agenda/2020/09/dark-side-digitalization/ (accessed on 14 February 2022).

29 Ibid.

30 Anne Delaporte and Kalvin Bahia, "The State of Mobile Internet Connectivity Report 2021", GSMA, September 2021. Available at https://www.gsma.com/r/somic/

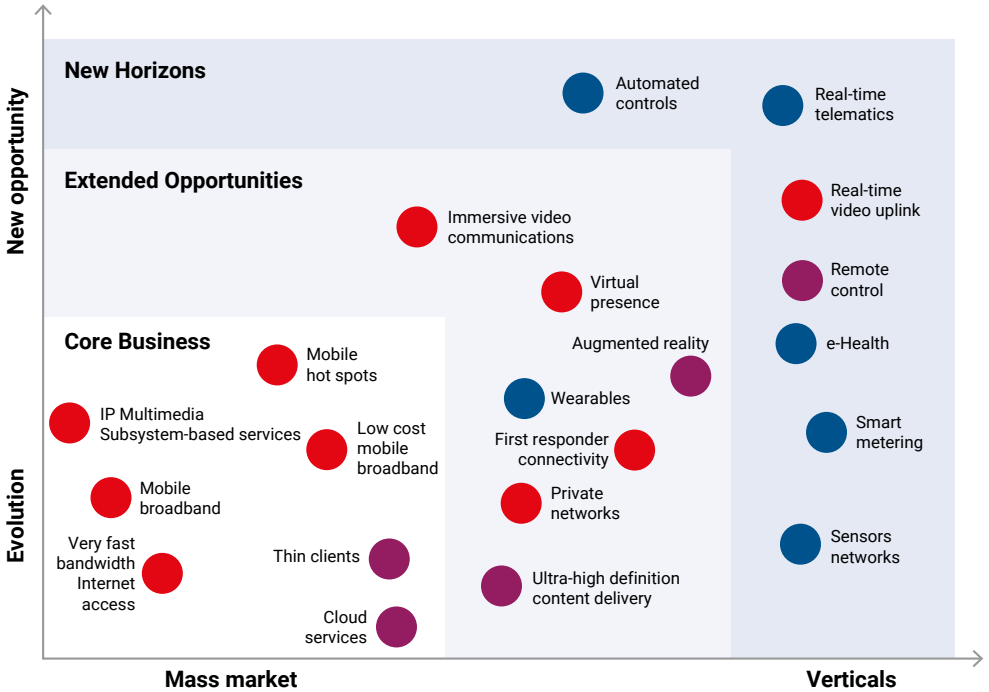
Figure 2-1. Investment and coverage in mobile Internet in Asia and the Pacific



Source: Anne Delaporte and Kalvin Bahia, "The State of Mobile Internet Connectivity Report 2021", GSMA, September 2021. Available at https://www.gsma.com/r/somic/

These investments have enabled a rapid rise in data traffic, which is set to continue. Between 2021 and 2025, monthly global usage is likely to increase from 9 to 34 gigabytes per subscriber, and usage in Asia and the Pacific is likely to increase from 12 to 37 gigabytes per subscriber. In 2019, the Republic of Korea launched the first commercial 5G services. This new wireless standard offered much higher network speeds, data capacity and new options for linking users, machines, objects, and devices (Figure 2-2).

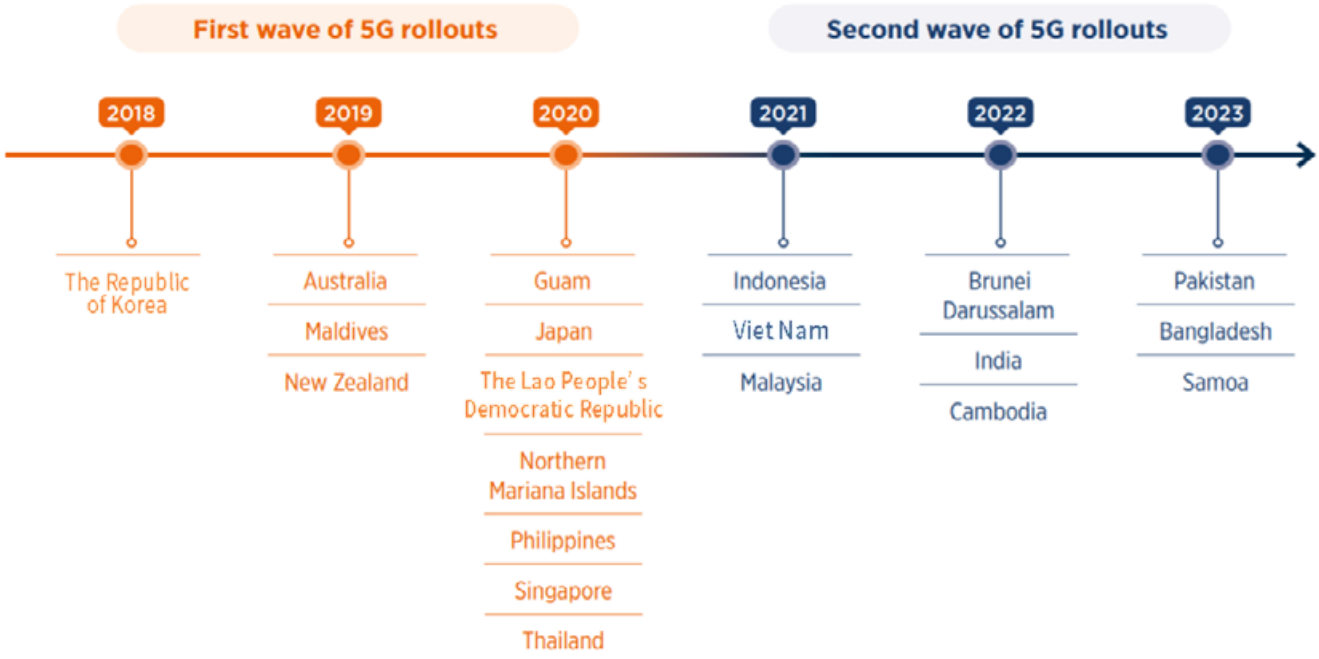
Figure 2-2. The 5G opportunity framework



Source: GSMA, "Unlocking Commercial Opportunities: From 4G Evolution to 5G". February 2016. Available at https://www.gsma.com/futurenetworks/resources/27161/

These 5G services have opened up many opportunities for innovative public services as well as new business models in, for example, consumer electronics, home entertainment, health care, agriculture, manufacturing, and transportation (see Boxes 2-1 to 2-6). Since then, 5G has steadily been rolled out across the region (Figure 2-3). By the end of 2021, 14 Asia-Pacific countries had 5G Internet services.[31] Over the next ten years, about 70 per cent of new economic value will be created on digitally-enabled platforms,[32] and by 2022 over 60 per cent of global GDP will be digitized.[33]

Figure 2-3. **Progress of 5G Internet in Asia and the Pacific**



Source: GSMA, "The Mobile Economy Asia Pacific Report 2022", 2021c. Available at https://www.gsma.com/mobileeconomy/asiapacific/

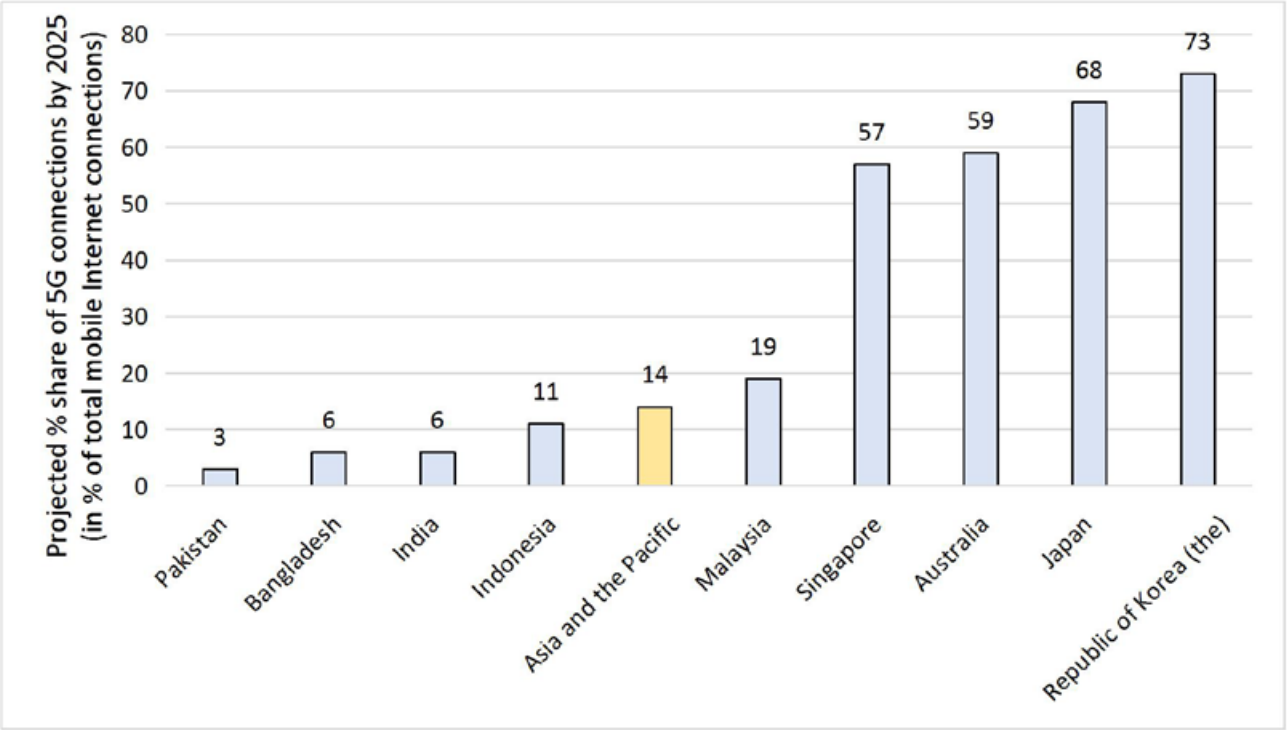
Across the Asia-Pacific region overall, 5G coverage has expanded to 18 per cent of the population, but in East Asia to over 40 per cent. The expected share of 5G connections, as a proportion of total connections, across the region by 2025 is shown in Figure 2-4.

31 Kenechi Okeleke and James Joiner, "Digital societies in Asia Pacific: Accelerating progress through collaboration", GSMA, October 2021. Available at https://www.gsma.com/asia-pacific/resources/apac-digital-societies-2021/

32 World Economic Forum (WEF), "Shaping the Future of Digital Economy and New Value Creation", 2022. Available at https://www.weforum.org/platforms/shaping-the-future-of-digital-economy-and-new-value-creation

33 World Economic Forum (WEF), "Our Shared Digital Future: Responsible Digital Transformation - Board Briefing", 6 February 2019. Available at https://www.weforum.org/whitepapers/our-shared-digital-future-responsible-digital-transformation-board-briefing-9ddf729993

Figure 2-4. **Status of 5G connections by 2025 across the Asia-Pacific region**



Source: GSMA, "The Mobile Economy Asia Pacific Report 2022", 2021c. Available at https://www.gsma.com/mobileeconomy/asiapacific/

Building e-resilience

ICT infrastructure is fundamental to digital transformations, but also creates new vulnerabilities. It is essential therefore to ensure that networks are as resilient as possible, with the capacity to withstand, recover from and change in response to external shocks. ESCAP and the Alliance for Affordable Internet conducted a joint study on infrastructure for five countries: Bhutan, Kyrgyzstan, Indonesia, Mongolia, and Papua New Guinea.[34] This study found that the most extensive infrastructure was in the East and North-East Asia subregion.

For infrastructure development, policymakers need to consider risk prevention, risk reduction, preparedness, adaptation and response, and recovery. To track progress on this work, the ESCAP secretariat has developed an online E-resilience Monitoring Dashboard.[35] This covers ICT policy, the creation of new systems and applications, data management, and physical ICT infrastructure.[36]

Some countries, such as Kazakhstan and Mongolia, have vast national territories over which it is difficult to extend cable infrastructure. The solution here is to make more use of space technology and geospatial information systems. Using 5G networks and satellite Internet constellations, such as Starlink, it is possible to record and transmit massive volumes of data in real time and across longer distances using the next generation of sensors, including IoT, drones, and personal communication devices. Such satellite data can be integrated with AI to support smart agriculture, post-disaster mapping, supply chain management, forest fire mapping, air quality mapping, as well as traffic management.

34 Four target criteria for meaningful connectivity are: (1) daily access to the Internet; (2) having access to an appropriate device (smartphone); (3) enough data available at home, place or work or school for use; and (4) fast Internet connection.

35 Aida Karazhanova, Maya Barkin, Elena Dyakonova, "Understanding E-Resilience for Pandemic Recovery in Asia and the Pacific", Asia-Pacific Information Superhighway Working Paper Series, ESCAP, IDD, 23 November 2020. p. 10.

36 Aida Karazhanova and Zorikto Gomboin, "E-Resilience Monitoring Toolkit: Methodological Notes and Pilot Countries' Profiles", Asia-Pacific Information Superhighway Working Paper Series, No. 26, ESCAP, IDD, 24 November 2021. Bangkok. Available at https://www.unescap.org/sites/default/d8files/knowledge-products/E-resilience%20Monitoring%20Toolkit%20Methodological%20Notes%20and%20Pilot%20Countries'%20Profiles.pdf

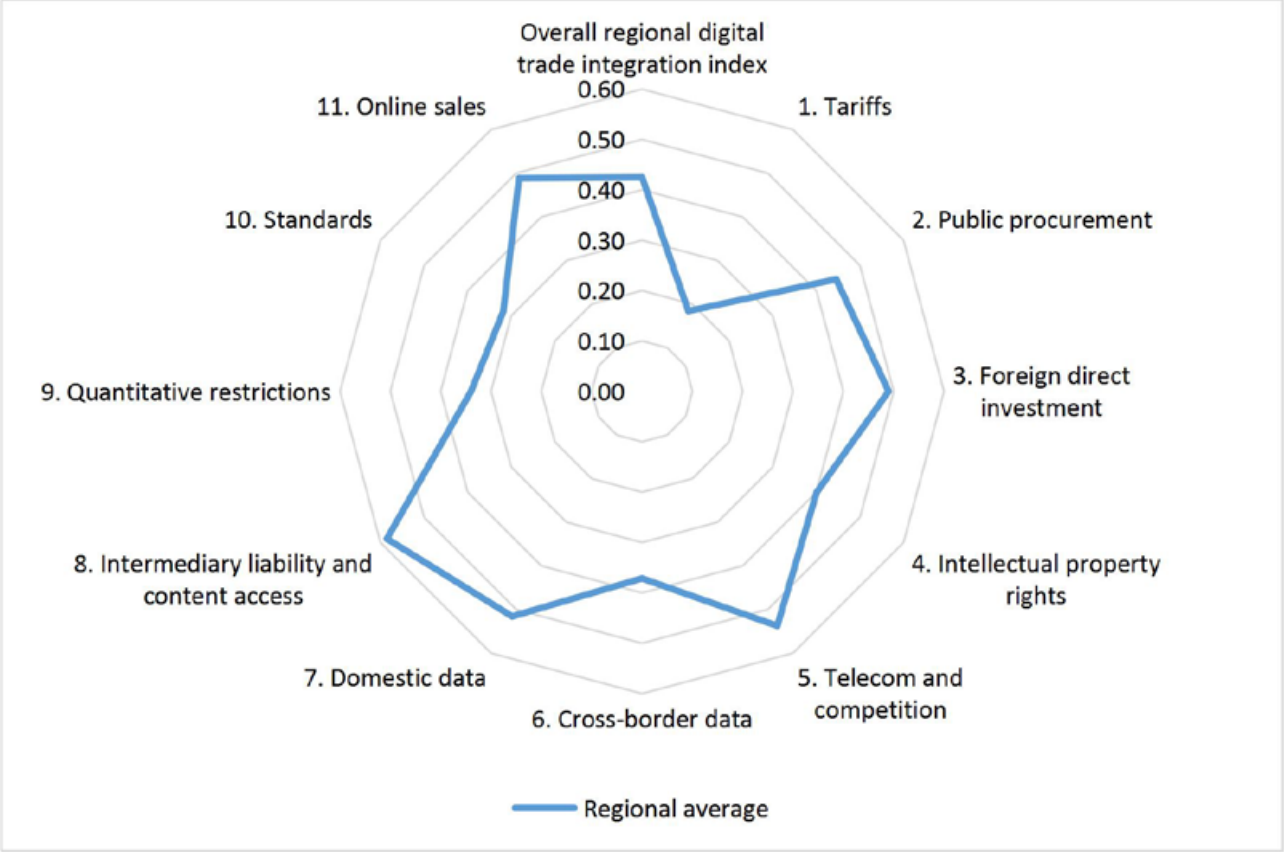
In 2019, the Third Ministerial Conference on Space Applications for Sustainable Development in Asia and the Pacific endorsed the Asia-Pacific Plan of Action on Space Applications for Sustainable Development (2018–2030).[37] The Conference also requested that the ESCAP secretariat offer support on harnessing digital technologies and geospatial activities.[38] The Fourth Ministerial Conference on Space Applications for Sustainable Development in Asia and the Pacific will be held in Indonesia, in October 2022.

Government

Complex regulations

Digital trade across borders is often hampered by regulatory complexity. This is clear from ESCAP's regional Digital Trade Integration Index which identifies high levels of restriction on domestic data protection, Internet intermediary liability and content access, as well as challenges in competition regulation (Figure 2-5).[39] Some restrictions are legitimate, but they may make trade and business difficult. A more inclusive and sustainable regional digital economy will mean removing unnecessary barriers to digital trade and harmonizing regulations.

Figure 2-5. Regional digital trade integration in Asia and the Pacific



Source: ESCAP-OECD, "Asia-Pacific Digital Trade Regulatory Review 2022: ESCAP-OECD Initiative on Digital Trade Regulatory Analysis", 23 June 2022. Available at https://www.unescap.org/kp/2022/asia-pacific-digital-trade-regulatory-review-2022

Note: Average RDTII Scores in 2020, by policy pillar; higher score indicates more restrictive policies. Data are based on 21 Asia-Pacific economies.

37 United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), "Asia-Pacific Plan of Action on Space Applications for Sustainable Development (2018-2030)". Available at https://www.unescap.org/resources/asia-pacific-plan-action-space-applications-sustainable-development-2018-2030] The Conference also requested that the ESCAP secretariat offer support on harnessing digital technologies and geospatial activities.[See ESCAP/RES/75/6.

38 See ESCAP/RES/75/6.

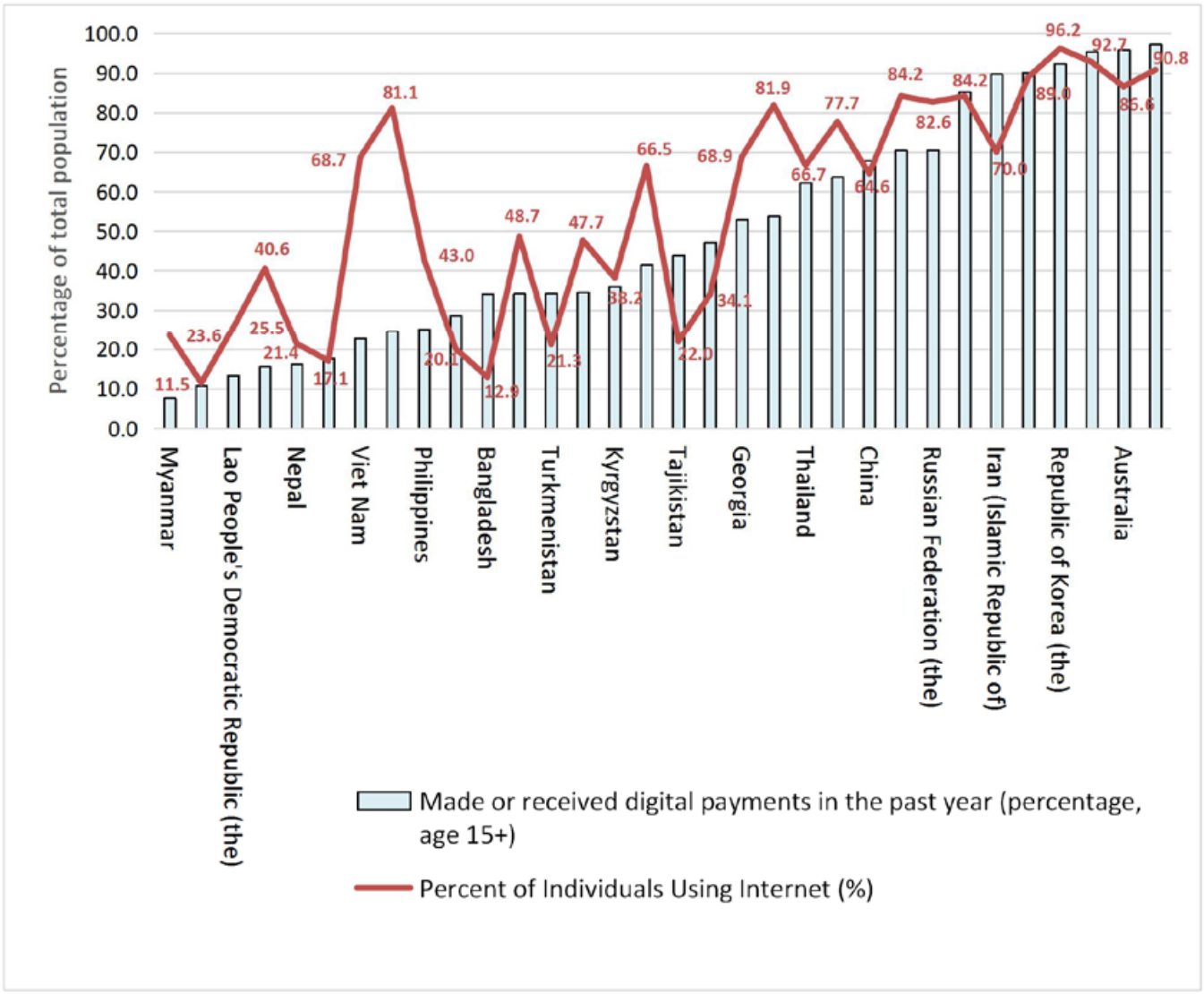
39 United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), "Asia-Pacific Plan of Action on Space Applications for Sustainable Development (2018-2030)". Available at https://www.unescap.org/resources/asia-pacific-plan-action-space-applications-sustainable-development-2018-2030] The Conference also requested that the ESCAP secretariat offer support on harnessing digital technologies and geospatial activities.[See ESCAP/RES/75/6.United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) (forthcoming), "Regional Digital Trade Integration Index Guideline".

Business and industry

Digital finance

At the heart of the transformation of both business and government activities is the expansion of digital payments. In 2021, the transaction value for the digital payments market in Asia and the Pacific, reached $4 trillion, and by 2026 it is projected to reach $6.7 trillion. In 2021, two-thirds of these transactions were in e-commerce. But, in the future the most dynamic segment is expected to be payments made through mobile point of service (POS) which, between 2021 and 2026, is expected to increase its share from 39 to 43 per cent.[40] Despite this progress, there remain wide disparities across countries in their use of digital payments, related to uneven access to the Internet (Figure 2-6).

Figure 2-6. **Percentage of the population in Asia-Pacific countries using the Internet and making digital payments**



Source: ESCAP based on data from World Bank (2017), Global Findex Database, International Telecommunications Union (2019-2020), Facts and Figures.

40 The third component, digital remittances, represents a small share of the market, about 0.02 per cent. See Statista.com (accessed on 25 June 2022).

The adoption of digital financial services (DFS) in Asia and the Pacific, has been primarily spurred by digital payment systems, followed by other offerings, such as savings, loans and the emerging trend of investment. Digital financial service providers, such as FinTechs and telecommunication companies, played a pioneering role in the development of digital payments services, with the mobile network operator Globe Telecom in the Philippines launching the e-wallet GCash in 2004. The success of its business model, which allowed domestic money transfers among individuals that did not have bank accounts, was in part due to the ease of usage, even by rural populations. To facilitate access to payments by unbanked individuals, DFS providers often set up robust agent networks to support clients in cashing in and cashing out their funds, and they added other offerings, such as bill payments. Receiving and sending cash could be done on feature phones that allowed senders and recipients to be notified via text message. Similar payments services that cover the 'last mile' include Wave Money in Myanmar, bKash in Bangladesh and Wing in Cambodia.

More recently, new payment solutions, such as mobile wallets, have expanded rapidly with increasing access to smart phones and innovations, such as the use of QR codes for online payments, POS payments, and peer-to-peer transfers. . This has been spearheaded by big tech companies, such as Ali Baba and Tencent in China, or Grab and Gojek in South-East Asia, which set up the popular mobile e-wallets Alipay, Tenpay, GrabPay, and GoPay. But not everyone is benefiting. The expansion of such payment solutions more broadly across the population is hampered by insufficient access to the Internet, unaffordable smartphones, and poor digital literacy.

While private businesses have led the way with digital payments, governments are catching up through the development of instant payment systems, such as Unified Payments Interface (UPI) in India, Pay Now in Singapore, or PromptPay in Thailand. The aim of these payment systems is to create interoperability across different payment platforms, handled by both traditional financial institutions and by newcomers, such as Alipay, GrabPay or Wing. Instant payment systems are available round the clock and allow the transfer of funds from the payer to the payee to take place in real time or near real time.

New developments in payments include the interconnection of national instant payment systems, such as the pioneering linkage between Thailand's PromptPay and Singapore's Pay Now. In India, Aadhaar is making digital IDs available for the whole population.

Most of the progress on digital finance is currently around payments which are the foundation of all economic activity and finance. Solid digital payment systems, including appropriate regulatory frameworks to protect consumers, will ensure financial stability and expand financial and digital literacy, and set a strong basis for other developments, including the financing of micro-, small- and medium-sized enterprises and the financing of sustainable development.

Smart transport systems

ESCAP defines a smart transport system as "an agglomeration of diverse technologies that enhance the sustainability of transport systems in a safer, smarter and greener way".[41] Such systems use a mix of technologies to monitor traffic conditions and communicate with vehicles, centres and facilities. Many car drivers are familiar with the simple guidance from Google maps which uses crowdsourcing from its own users to gather data on the density and speed of traffic.[42]

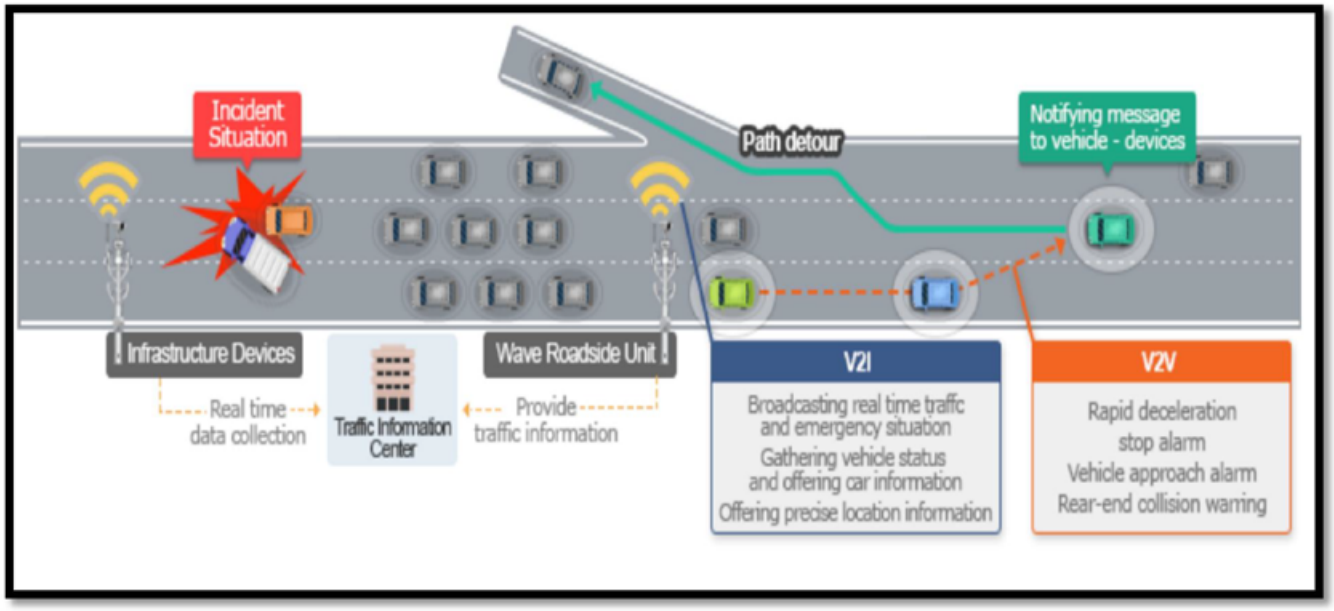
41 United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), "Guidelines for the Regulatory Frameworks of Intelligent Transport Systems in Asia and the Pacific", 31 May 2019c, Bangkok. Available at https://www.unescap.org/resources/guidelines-regulatory-frameworks-intelligent-transport-systems-asia-and-pacific

42 Science ABC, "How does Google Maps know about traffic conditions?" 8 July 2022. Available at https://www.scienceabc.com/innovation/how-does-google-maps-know-about-traffic-conditions.html

Smart transport systems can link modes, such as car sharing, ride sharing, bike sharing and demand-responsive transport.[43] In Shanghai, China, for example, a bike-sharing scheme based on a smartphone app and electronic payments reduced carbon dioxide emissions by 25,240 tons, and nitrogen oxide emissions by 64 tons.[44] Similarly in Victoria state, Australia, a test run of EVs demonstrated a reduction of 27 million tons of GHG emissions along with $706 million in health benefits.[45]

A frequent component of smart transport is a cooperative intelligent transport system (C-ITS), through which vehicles communicate with each other and with roadside infrastructure about their location and the state of traffic. C-ITSs have been deployed in Asia and the Pacific since 1990, and can now be found in, for example, Australia, China, Japan, the Republic of Korea and Singapore.[46] In the Republic of Korea, C-ITS is expected to increase travel speed by about one-third while halving accidents (Figure 2-7).[47]

Figure 2-7. **Expected effectiveness of cooperative intelligent transport systems**



Source: Ministry of Land, Infrastructure and Transport (MOLIT), Republic of Korea. Available at https://www.molit.go.kr/english/intro.do

Real-time traffic information, smart logistics, intelligent lighting, and other ICT-enabled solutions can help everyone reach their destinations faster and at less cost.[48] There can also be fewer accidents. C-ITS is now being supplemented by intelligent traffic infrastructure solutions, such as 'traffic digital twins' to optimize the flow of traffic. A digital twin is a virtual representation that serves as the real-time digital counterpart of a physical object or process.

Similarly for shipping, smart ports use digital technologies to rationalize, reorganize and streamline maritime activities. Smart ports are also being integrated and harmonized with hinterland road and rail,

43 Clara Benevolo, Renata Dameri, and Beatrice D'Auria, "Smart mobility in smart city: Action taxonomy, ICT intensity and public benefits", in *Empowering Organizations: Enabling Platforms and Artefacts*, Teresina Torre, Alessio Mario Braccini and Riccardo Spinelli, eds. (Cham, Switzerland: Springer, 2016).

44 Yongping Zhang and Zhifu Mi, "Environmental benefits of bike sharing: a big data-based analysis", *Applied Energy*, vol. 220 (15 June 2018), pp. 296-301.

45 KPMG Australia, "Australia's future transport and mobility: progress, policies and people", February, 2019. Available at https://fdocuments.in/document/australia-s-future-transport-and-mobility-australiaas-future-transport-and-mobility.html?page=1

46 ITS Asia-Pacific, "Examples of ITS deployment by country/area", 2015. Available at http://itsasia-pacific.com/about-its-asia-pacific/examples-of-its-deployment-by-countryarea/

47 Ministry of Land, Infrastructure and Transport, Korea Expressway Corporation, "About C-ITS". Available at https://www.c-its.kr/english/introduction.do

48 Global e-Sustainability Initiative (GeSI), "#SMARTer2030: ICT Solutions for 21st Century Challenges", Belgium, 2015. Available at https://smarter2030.gesi.org/downloads/Full_report.pdf

becoming part of intermodal networks and creating synergy and connectivity in terms of safety, mobility, efficiency and protection of the environment.[49]

For railways, digital technologies also offer huge prospects for improving capacity, traffic management, reliability, energy efficiency and services. Digital technologies allow for more accurate monitoring, guarantee more robust security, shorten train tracking intervals, and improve transport capacity, while also lowering operating costs. China Railway, for example, plans to use 5G technology and the BeiDou satellite navigation to create an integrated train control system.[50] In January 2020, China Railway introduced driverless high-speed trains connecting Chinese cities. In March 2022, China's first subway BeiDou satellite navigation system began along the Beijing Capital International Airport Subway Express.[51, 52]

Smart grid energy

A smart electricity grid uses digital technologies to control various aspects of electricity delivery from source to end users. This ensures proper energy resource management. By directly reducing power losses and thus energy consumption, and integrating renewables, smart grids can reduce carbon emissions, heighten transparency, and improve energy efficiency.[53]

One of the world's leading players in smart grid technologies is Singapore. Its two-phase smart grid Intelligent Energy System allows digital remote control of an automated electricity delivery system. In 2016, the state's utility provider, Singapore Power, signed a $7.4 million deal with the American company 3M on grid sensing and data analytics. Singapore has also partnered with General Electric on digitalizing its substations.

Another important component of smart energy systems is advanced metering infrastructure (AMI). AMI provides end users with real-time data of their electricity consumption, enabling them to take measures to ensure more efficient use of electricity. Over the period 2021-2025, it has been estimated that around 600 million smart meters will be installed in China, India, and the Republic of Korea.[54] Malaysia's state power producer, Tenaga Nasional Berhad has also begun work on a Grid of the Future which introduces automation and AMI. Under this initiative, smart grids would reduce blackout hours, give consumers more control over their energy bills and improve energy efficiency.

Economic integration

The digital transformation is also boosting regional integration. This is being tracked in Asia and the Pacific by ESCAP's digital and sustainable regional integration Index (DigiSRII).[55] Each economy or region may prioritize different issues, so DigiSRII uses simple aggregation techniques that enable countries to use the underlying data to develop their own indices. The DigiSRII for the region as a whole shows that, between 2010-2014 and 2015-2019, regional integration increased, driven largely by liberalization of trade in ICT goods as well as the extension of banking and other services through mobile phones (Figure 2-8). The DigiSRII data can be disaggregated, as shown in Figure 2-8, which shows that women are not sufficiently represented in online commerce.

49 United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), "Smart Ports Development Policies in Asia and the Pacific", February 2021c. Available at https://www.unescap.org/sites/default/d8files/event-documents/SmartPortDevelopment_Feb2021.pdf

50 Global Times, "China to build smart railway network by 2035 using 5G, BeiDou Navigation Satellite System", 13 August 2020. Available at https://www.globaltimes.cn/content/1197628.shtml#:~:text=It%20said%20China%20will%20build,with%20population%20of%20over%20500%2C000.

51 China Railway Group Limited, "China's first subway BeiDou Satellite Navigation System to be installed on Beijing Capital International Airport Subway Express", 25 March 2022. Available at http://www.crecg.com/english/2691/2743/10192560/index.html

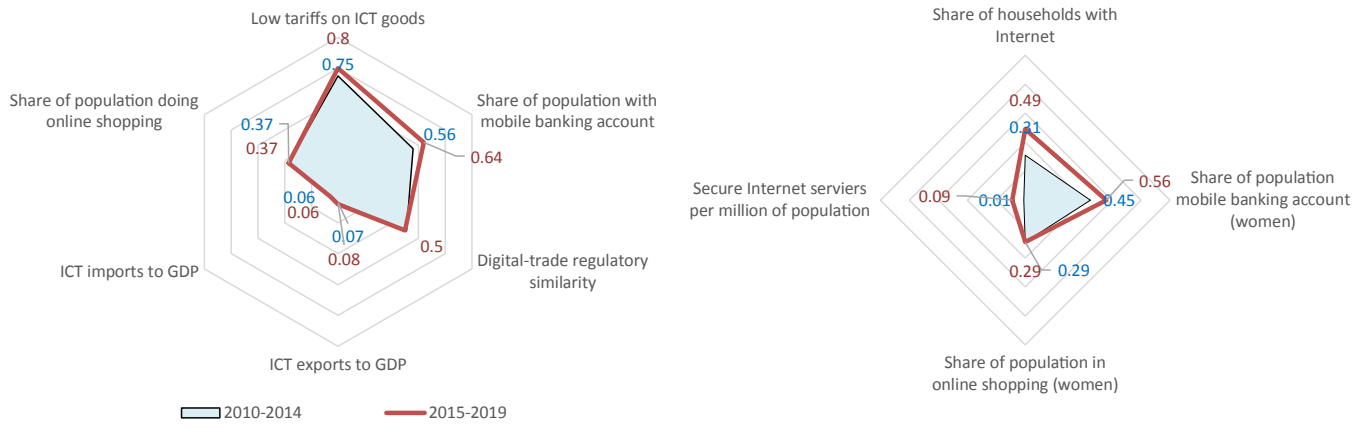
52 The BeiDou Navigation Satellite System is the Chinese satellite navigation system which consists of two separate satellite constellations.

53 Global e-Sustainability Initiative (GeSI), "#SMARTer2030: ICT Solutions for 21st Century Challenges", Belgium, 2015. Available at https://smarter2030.gesi.org/downloads/Full_report.pdf

54 IOT Business News, "More than 570 million smart electricity meters to be deployed in Asian markets until 2025", 2 March 2021. Available at https://iotbusinessnews.com/2021/03/02/95414-more-than-570-million-smart-electricity-meters-to-be-deployed-in-asian-markets-until-2025/#:~:text=A%20new%20research%20study%20from%20the%20IoT%20analyst,to%20an%20installed%20base%20of%20653.3%20million%20units.

55 United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), "Regional integration for sustainable development in Asia and the Pacific: ESCAP Digital and Sustainable Regional Integration Index and Indicator Framework, DigiSRII 1.0", Bangkok, Thailand, 2020. Available at https://www.unescap.org/resources/DigiSRII

Figure 2-8. **Digital economy integration and inclusiveness of the Asia-Pacific region, 2010 to 2019**



Source: Adapted from the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), "Regional integration for sustainable development in Asia and the Pacific: ESCAP Digital and Sustainable Regional Integration Index and Indicator Framework, DigiSRII 1.0", Bangkok, Thailand, 2020. Available at https://www.unescap.org/resources/DigiSRII

Generally, the lower-middle income and low-income economies struggle to keep pace with the higher-income countries. Of the 15 worst-performing economies, 11 are landlocked developing countries.

Ecosystems and natural resources

Digital technologies and improved design can reduce the impact of consumer societies on natural resources. Tracking, and tracing can enable circular economies to ensure that with less material input and fewer emissions, we can still deliver the same, or better, output. This can reduce the depletion of natural resources and other materials by an estimated 90 per cent.[56]

Digital applications have also started to shape discourses and practices in conservation.[57] High-tech sensors allow for better, faster, and cheaper capture of data on the natural world. Multi-sensor-equipped smart phones, satellite tags carried by animals, camera traps, drones, deep-sea submarines and space satellites generate important data. Combined with artificial intelligence and predictive modelling, this has enabled large-scale monitoring of the natural environment, more frequently and in finer resolution, and in inaccessible or dangerous locations, and has resulted in near-real-time sensing.[58]

Conservationists are optimistic that the digital era will support better decision-making systems while offering new communication routes, and exciting visual representations.[59] Devices and applications, especially smartphones, also create more space for participation through citizen science, often for nature conservation (Box 2-2).

The International Union for Conservation of Nature, in collaboration with the Chinese company Huawei, has initiated a new open partnership called Tech4Nature. The aim of the partnership is to harness innovative technologies in support of better conservation outcomes in and around protected and conserved areas throughout Asia and the Pacific.

56 James Arbib, and Tony Seba, *Rethinking humanity: Five Foundational Sector Disruptions, the Lifecycle of Civilizations, and the Coming Age of Freedom* (Tony Seba, 2020).

57 Koen Arts, René van der Wal and William M. Adams, "Digital technology and the conservation of nature", Ambio, vol. 44 (2015). Available at https://link.springer.com/article/10.1007/s13280-015-0705-1

58 Insider, "Huawei, IUCN join hands to preserve biodiversity in APAC with tech innovations", press release, 9 August 2021. Available at https://markets.businessinsider.com/news/stocks/huawei-iucn-join-hands-to-preserve-biodiversity-in-apac-with-tech-innovations-1030709185

59 Koen Arts, René van der Wal and William M. Adams, "Digital technology and the conservation of nature", Ambio, vol. 44 (2015). Available at https://link.springer.com/article/10.1007/s13280-015-0705-1

Smart climate action

In 2015, the Global e-Sustainability Initiative and Accenture Strategy estimated that digital ICT can enable a 20 per cent reduction in global carbon dioxide (CO_2) emissions when applied to five sectors: mobility, manufacturing, agriculture, energy, and buildings.[60] ICT solutions can help cut CO_2 emissions by ten times more than they emit.[61] Smart manufacturing embraces virtual manufacturing, customer-centric production, circular supply chains and smart services.[62] Smart agriculture can boost yields by 30 per cent, cut food waste by 20 per cent and also reduce the demand for water.[63] For buildings, smart solutions could cut emissions from the housing sector, reducing energy costs and creating revenue opportunities.[64]

Pollution reduction

Digital technologies can help reduce waste and detoxify supply chains by a factor of 10 to 100, through improved design, tracking, resource substitution and circularity.[65] These technologies can be used to study, predict, control, and manage air, water, and land pollution.

On the air pollution front, digital applications, such as Air Map Korea, IQAir, and the World Air Quality Recommendation for Sensitive Groups, are tracking air pollution and related effects on vulnerable groups (Box 2-3 and Box 2-4). In Indonesia, for example, smartphone applications can manage household waste.[66] Similarly, digital applications like Blue Map are being used to track the impact of water pollution on vulnerable groups.[67]

Further opportunities for tackling air, water, and land pollution are offered by smart sensing and artificial intelligence.[68] The Geostationary Environment Monitoring Spectrometer satellite, for example, can generate rapid and high-resolution data and imagery to identify types and sources of air pollution which, in conjunction with ground-based sensors, will monitor air quality. Machine learning and artificial intelligence, with modelling, can also predict air pollution and hotspots. The sharing of data can help mitigate pollution and strengthen regional cooperation.

Robotics and AI can be used in systems to sort hazardous waste, create innovative services and business models, and nudge behavioural change. Similarly at sea, smart sensor networks can improve the health of aquatic ecosystems by automatically detecting potential oil leaks or plastic debris.

The circular economy

The circular economy holds the promise for systemic transformation of our society. Its core tenants include designing out waste and pollution, keeping products and materials in use and regenerating natural systems.[69] CE-based business models are facilitated by digitalization which enable smart and

60 Global e-Sustainability Initiative (GeSI), "#SMARTer2030: ICT Solutions for 21st Century Challenges", Belgium, 2015. Available at https://smarter2030.gesi.org/downloads/Full_report.pdf

61 GSMA, "The Enablement Effect: The impact of mobile communications technologies on carbon emission reductions", London, 2019. Available at https://www.gsma.com/betterfuture/wp-content/uploads/2019/12/GSMA_Enablement_Effect.pdf

62 Global e-Sustainability Initiative (GeSI), "#SMARTer2030: ICT Solutions for 21st Century Challenges", Belgium, 2015. Available at https://smarter2030.gesi.org/downloads/Full_report.pdfbusinessinsider.com/news/stocks/huawei-iucn-join-hands-to-preserve-biodiversity-in-apac-with-tech-innovations-1030709185

63 Ibid.

64 Ibid.

65 Arbib, J., Seba T. (2020). Rethinking humanity: Five Foundational Sector Disruptions, the Lifecycle of Civilizations, and the Coming Age of Freedom.

66 DW Akademie, "Indonesia: A smartphone app to manage household waste", video, 6 December 2019. https://www.dw.com/en/indonesia-a-smartphone-app-to-manage-household-waste/av-51558686#:~:text=People%20in%20the%20Indonesian%20city,an%20efficient%20waste%20treatment%20process.

67 Asian Development Bank, *Digital technologies for climate action, disaster resilience, and environmental sustainability* (Philippines, October 2021). Available at https://www.adb.org/sites/default/files/publication/700396/digital-technologies-climate-action.pdf

68 Ibid.

69 Ellen MacArthur Foundation, (n.d.). What is the circular economy? Available at: https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview

connected products. Producers can now monitor, control, analyse and optimize product performance and collect usage data, enabling predictive maintenance and increasing product reliability and lifetimes. Verifiable information can also be incorporated in digital codes or passports which carry data about the product's origin, composition, environmental and carbon performance, as well as its repair, and dismantling possibilities and end-of-life handling. Combining connectivity, digital technologies, big data, data mining, data analytics and the Internet of Things, these new consolidated approaches and models provide major opportunities for creating sustainable value.[70, 71]

Digital solutions are also providing a boost to end of use (EoU). In 2014, UNDP, China, and the Internet company Baidu, produced an application to link corporate and private end-users with legally certified e-waste disposal companies. At relatively little cost and effort, citizens can tap into information about superior product designs, EoU options, and sharing opportunities. Alibaba is already adding some of this information to its vast consumer goods catalogue.

Digital solutions at sea

Technological developments and digitalization can help protect the oceans and even increase the effectiveness of tsunami early warning systems. The framework of the United Nations Decade of Ocean Science for Sustainable Development (2021-2030) provides an opportunity to apply digital technologies and deliver specific products, such as digital representations of the ocean. These may build on existing programmes, such as the EU Copernicus Marine Portfolio. For example, 'digital twin' technologies can help accelerate the delivery of SDG 14 on life below water, and support efforts to tackle marine debris and rising sea levels, while also collecting valuable ocean data. Open access to the digital twin technologies would help governments and other stakeholders in the sustainable management and use of ecosystem services.

The WMO/ITU/UNESCO-IOC Joint Task Force, Science Monitoring and Reliable Telecommunications (JTF SMART) Subsea Cables continues to make progress. This initiative integrates environmental sensors, for ocean bottom temperature, pressure, and seismic acceleration, into submarine telecommunications cables. The purpose is to support climate and ocean observation, sea level monitoring, observations of Earth structure, and tsunami and earthquake early warning and disaster risk reduction, including hazard quantification. Recent advances include regional SMART pilot systems that are the first steps to trans-ocean and global implementation. Examples of pilots include: the InSEA wet demonstration project off Sicily at the European Multidisciplinary Seafloor and the water column Observatory Western Ionian Facility; New Caledonia and Vanuatu (proposed to be installed by 2025); starting with short pilot systems in Indonesia and working toward systems for the Sumatra-Java megathrust zone; and the Portugal SMART CAM 3,700 km ring system connecting the Continent, Azores, and Madeira.[72] The latter system was recently authorized by the Government of Portugal to be ready for service in 2025; it will set valuable precedents for similar systems around the world.

It is further recognized that standardization of the submarine SMART cables is needed to ensure harmonized development, implementation and operation of these systems globally, making it possible to use all the data available from the whole submarine SMART cable network. While the Joint Task Force continues to promote current and future projects, and to conduct studies on issues impacting the feasibility of operational SMART cable systems, cooperation is underway with ITU Telecommunication Standardization Sector to develop appropriate recommendations. Cooperation is also underway with other standards development organizations (SDOs), research institutes and the United Nations to contribute to the achievement of the goals of the 2030 Agenda for Sustainable Development.

70 Ibid.

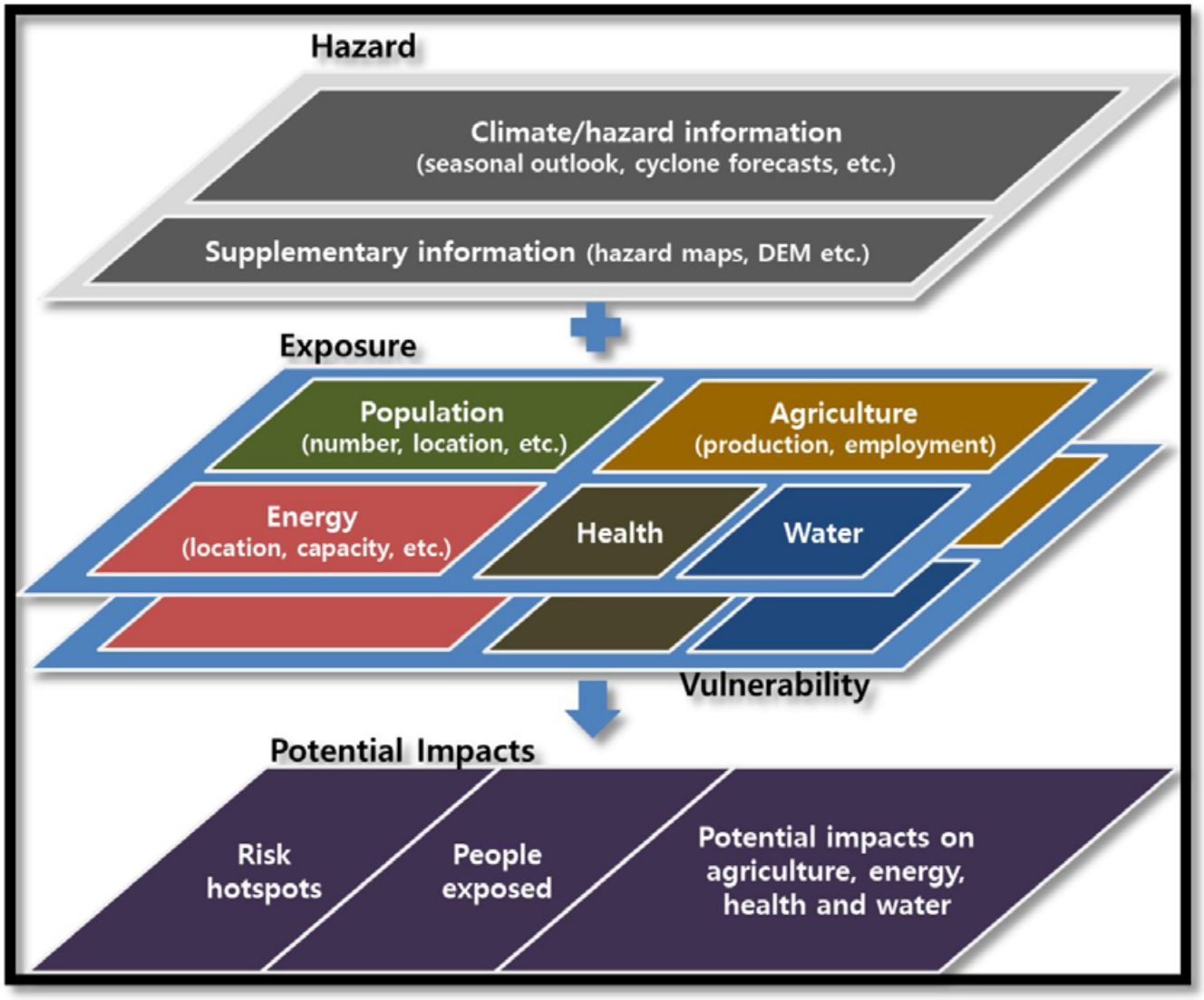
71 Ellen Macarthur Foundation, "The circular economy opportunity for urban and industrial innovation in China". Available at https://ellenmacarthurfoundation.org/urban-and-industrial-innovation-in-china

72 Bruce M. Howe and others, "SMART Subsea Cables for observing the Earth and ocean, mitigating environmental hazards, and supporting the blue economy", *Frontiers in Earth Science* (7 February 2022). Available at https://www.frontiersin.org/articles/10.3389/feart.2021.775544/full

Disaster risk reduction

In Asia and the Pacific, frontier technologies, such as AI, big data and the use of drones, have already transformed the accuracy of risk forecasts, which is a paradigm shift from 'what the weather will be' to 'what the weather will do'. ESCAP has developed a methodology for forecasting the impact of extreme events and slow-onset disasters. For tropical cyclones, for example, the wind speed data are overlayed on demographic information to indicate the number and location of people likely to be hit (Figure 2-9).

Figure 2-9. Methodology for impact-based forecasting

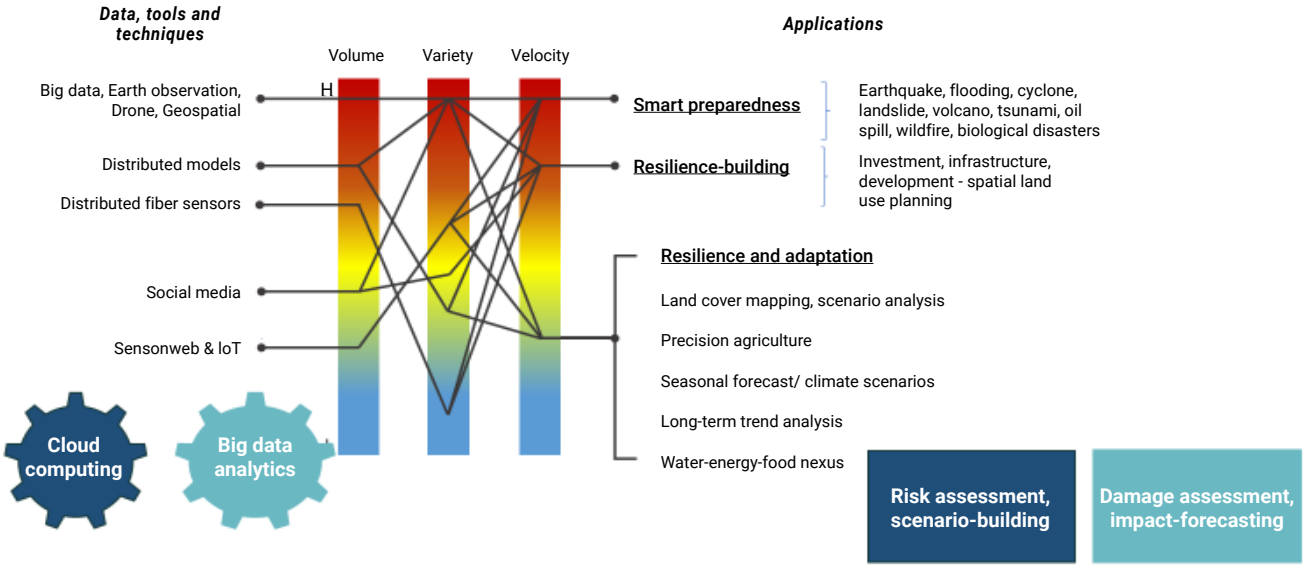


Source: United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) and the World Meteorological Organization (WMO), "Manual for Operationalizing Impact-based Forecasting and Warning Services (IBFWS)", 4 August 2021. Available at https://www.unescap.org/kp/2021/manual-operationalizing-impact-based-forecasting-and-warning-services-ibfws

For extreme events, whether meteorological, climatic or biological, risk analytics can now use multiple data platforms and distributed models, gathering information from sensor webs, the Internet of Things as well as from social media (Figure 2-10).[73]

73 Alexander Y. Sun and Bridget R. Scanlon, "How can Big Data and machine learning benefit environment and water management: A survey of methods, applications, and future directions", *Environmental Research Letters*, vol. 14, No. 7 (2019). Available at https://iopscience.iop.org/article/10.1088/1748-9326/ab1b7d

Figure 2-10. Risk analytics infrastructure for smart preparedness



Source: Adapted by ESCAP from Alexander Y. Sun and Bridget R. Scanlon, "How can Big Data and machine learning benefit environment and water management: A survey of methods, applications, and future directions", *Environmental Research Letters*, vol. 14, No. 7 (2019). Available at https://iopscience.iop.org/article/10.1088/1748-9326/ab1b7d

For example, in 2020, Google extended its AI-based flood forecasting work in India and Bangladesh in time for the monsoon season. Using AI technology, Governments of the two countries were able to offer more accurate flood alerts to over 200 million people across more than 250,000 square kilometres.

Analysts have also used data from NASA's Shuttle Radar Topography Mission. Coastal digital elevation models, using AI and machine learning, produce more accurate datasets, particularly for densely-populated areas. These indicate that, by 2100, land currently home to 200 million people could fall permanently below the high-tide line, with the greatest number of people being affected in China, Bangladesh, India, Viet Nam, Indonesia, and Thailand. The figure for China alone is 43 million people.[74]

In 2020, after Fiji was hit by cyclone Harold, the United Nations used the One Trinity unmanned aerial vehicle to survey affected regions, assess the damage and direct emergency response.[75] In just 45 minutes, the drone covered 400 acres and made nearly a thousand images of damaged and destroyed rooftops, fallen trees, blocked roads, and river flooding. Similarly, in Vanuatu following tropical cyclone Harold, the authorities used UNITAR-UNOSAT Pleiades satellite imagery to identify damaged structures and support local post-disaster reconstruction (Figure 2-11).[76]

In 2022, the volcanic eruptions from Hunga Tonga and Hunga Ha'apai volcanic islands in Tonga sent ash more than 20 kilometres into the air in a five kilometres plume. The eruption triggered an unprecedented Pacific-wide tsunami with 15-metre waves hitting several islands in Tonga. The tsunami waves inflicted severe damages to infrastructures, caused 3 fatalities and broke the only submarine fiber-optic cable that connected the Internet between Tonga and the outside world.[77] Satellite communications provided limited bandwidth for disaster relief operations by government authorities. Tonga was without Internet for five weeks.

74 Coastal DEM elevation data indicate that by 2100, land currently home to 200 million people could fall permanently below the high-tide line, with the greatest number of people affected in China, Bangladesh, India, Viet Nam, Indonesia, and Thailand. The figure is 43 million people in China alone.

75 Quantum Systems, "Use Case - Aerial mapping - Post Cyclone Harold Damage assessment", Drone services Fiji, 2020. Available at https://www.quantum-systems.com/project/aerial-mapping-post-cyclone-harold-damage-assessment/

76 United Nations Institute for Training and Research (UNITAR), "United Nations Satellite Centre UNOSAT". Available at https://www.unitar.org/sustainable-development-goals/united-nations-satellite-centre-UNOSAT

77 The Prime Minister's Office, "First official update following the volcanic eruption", Government of The Kingdom of Tonga, 28 January 2022. Available at https://pmo.gov.to/index.php/2022/01/28/first-official-update-following-the-volcanic-eruption/

Figure 2-11. Damage to buildings in Sanma province, Vanuatu, following cyclone Harold, 2020

Source: United Nations Institute for Training and Research (UNITAR), "Buildings Damage Assessment & Related Density in South of Sanma Province, Vanuatu", 16 April 2020. Available at https://unitar.org/maps/map/3035

Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

The COVID-19 pandemic has highlighted the value of real-time disease surveillance for epidemic early warning systems. Recent advances in AI, deep learning, and agent-based modelling have indicated exposure and vulnerability of at-risk communities (Figure 2-12).[78]

Figure 2-12. An AI-enabled early warning framework for biological hazards

1. Big data represents disruptive technology that will affect many aspects of climate, disaster and health outcomes

- Statistical and real time data – climate, environment/weather, epidemiological/ health outcomes and socioeconomic vulnerability
- Earth observation satellite data – vegetation indices, temperature and soil moisture

2. Data-driven research can provide novel insights and help discover salient features

- Internet of things
- Drone
- Artificial intelligence
- Geospatial

3. Big data and deep learning approaches are most useful when combined with physics-based research to generate results that are human interpretable

Artificial intelligence, machine-learning methods, including deep learning, and agent-based modelling are key enablers for development of early warning system for biological hazards

Source: ESCAP adapted from Alexander Y. Sun and Bridget R. Scanlon, "How can Big Data and machine learning benefit environment and water management: A survey of methods, applications, and future directions", *Environmental Research Letters*, vol. 14, No. 7 (2019). Available at https://iopscience.iop.org/article/10.1088/1748-9326/ab1b7d

For tracking infectious diseases, public health surveillance has traditionally relied heavily on statistical techniques that have been hampered by lack of positive training and the sparsity of data. Such systems can, however, now capitalize on innovations in computational epidemiology that use big data, AI, and algorithms to detect unusual patterns or clusters of illness.[79]

Such tracking requires highly granular or personal data for contact tracing, which raise concerns about security and privacy. These are being addressed by several international frameworks including the open protocol Decentralised Privacy-Preserving Proximity Tracing (DP-3T) project, the Pan-European Privacy-Preserving Proximity Tracing initiative, and the joint Google-Apple framework. Ultimately, this should ensure better preparedness for any future pandemics though there may still be concerns about data privacy and the interpretation of models.

A digital transformation assessment tool

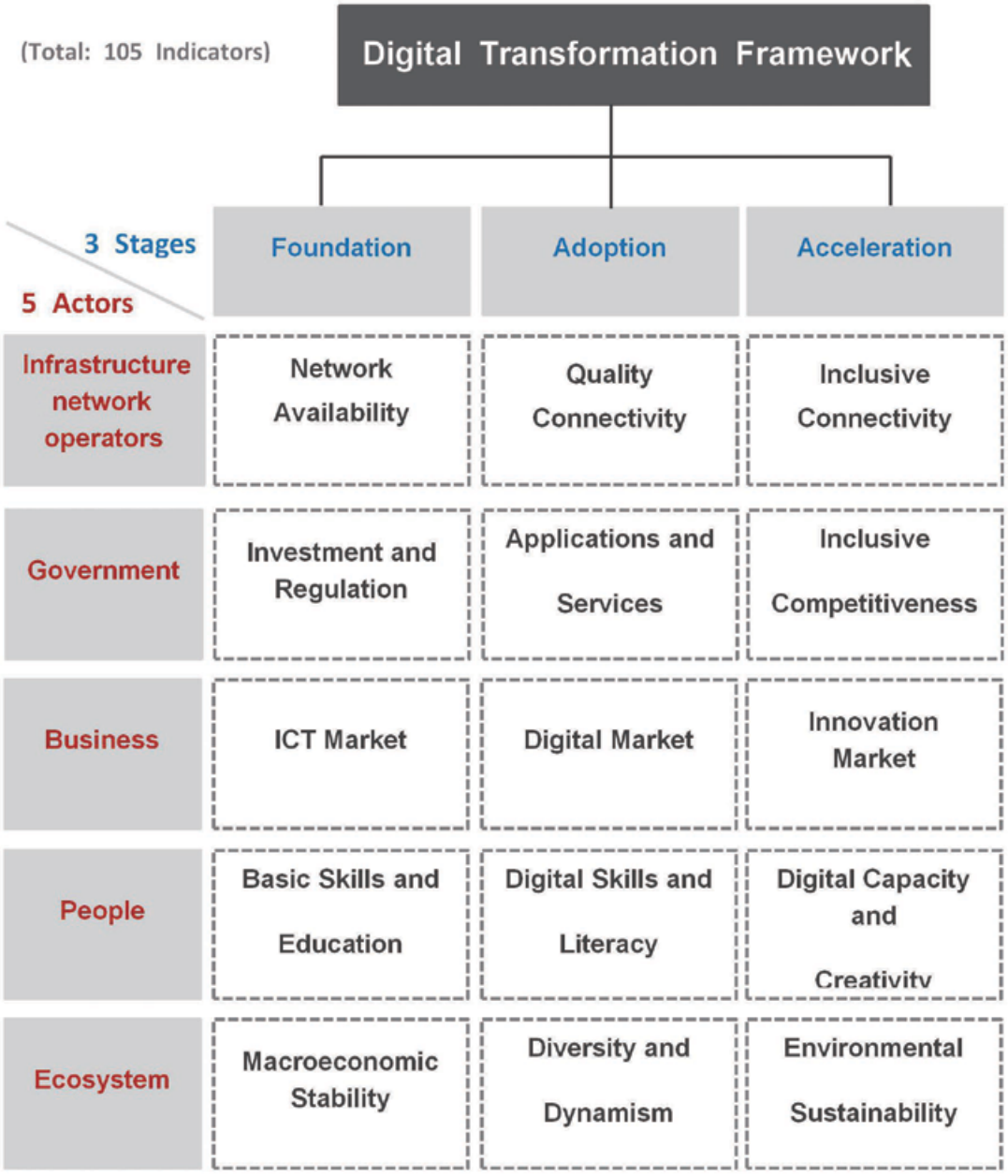
Despite their economic status, countries across Asia and the Pacific, are embarking on an inevitable journey of digital transformation; a process that embraces a multitude of issues and activities that are complex and interconnected. A transformation that is so broad and diverse is inevitably difficult to keep track of. Nevertheless, many policymakers and stakeholders will want to monitor the changing landscape of digital transformation at regional and country levels so they can choose suitable pathways, policies and regulatory frameworks.

78 Odu Nikuri, Rajesh Prasad, and Onime Clement, "Prediction of malaria incidence using climate variability and machine learning", *Informatics in Medicine Unlocked*, vol. 22 (2021). Available at https://www.sciencedirect.com/science/article/pii/S2352914820306596

79 Sanjay Srivastava, "Science Technology and Innovation (STI) based solution for resilient future", blog, ESCAP, ICT and Disaster Risk Reduction Division, 6 January 2021. Available at https://www.unescap.org/blog/sti-based-solutions-resilient-future

To respond to these transformations, ESCAP has constructed a digital transformation framework, which covers three different stages of transformation: foundation, adoption, and acceleration. The framework is based on five actors that correspond to the five different areas of operation: network infrastructure, government, business, people, and ecosystems (Figure 2-13). This framework can be used as a basis for tracking the transformation along with its key driving forces and good practices.

Figure 2-13. The digital transformation framework



The initial scoping analysis suggested 105 digital-related indicators. These can be compiled from eight global datasets and supplementary data sources.[80] To reduce these to a single indicator of overall national status and progress, they have been normalized to a value between 1 (low) and 100 (high), and weighted on the basis of previous research and analyses in this area.

80 Jongsur Park, Seunghwa Jun and Jeong Yoon Kim, "Methodology for data analysis of digital transformation", ESCAP Working Paper Series, 31 May 2022. Available at https://www.unescap.org/kp/2022/methodology-data-analysis-digital-transformation

Table 2-2. Indicators for tracking the progress on digital transformation

	Foundation	Adoption	Acceleration
Network / Infrastructure	**Network availability and affordability**	**Quality of connectivity**	**Inclusiveness of 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 affordability	Servers per population	Private sector initiatives to make Wi-Fi available
Government	**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
	R&D expenditure by government and higher education	Government's responsiveness to change	Online security
	Government promotion of investment in emerging technologies	E-commerce legislation	Degree of future orientation of government
Business	**ICT market**	**Digital market**	**Innovation market**
	Net flow of FDI	Computer software spending	Start-up environment
	R&D expenditures	Venture capital availability	Robot density
	Business environment	Mobile app 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

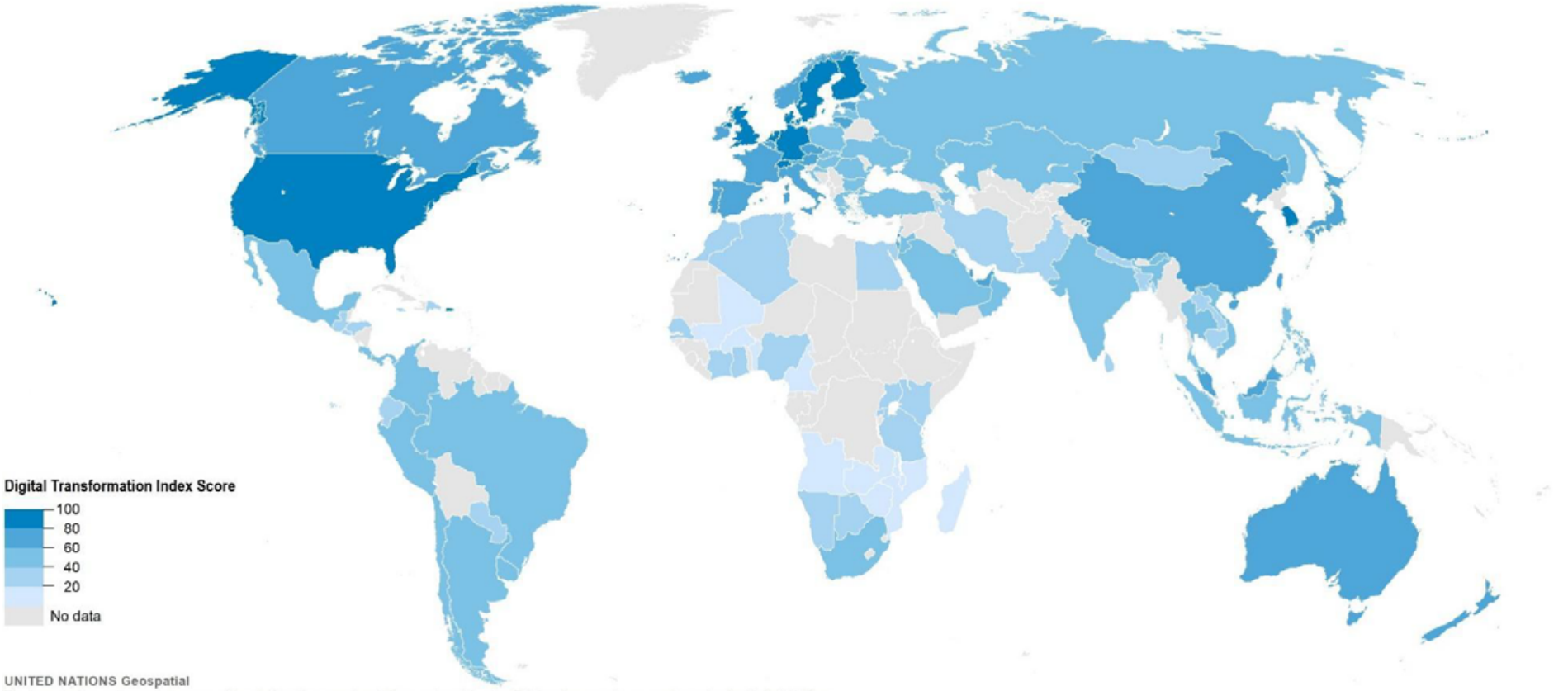
	Foundation	Adoption	Acceleration
People	**Basic skills and education**	**Digital skills and literacy**	**Digital capacity and creativity**
	Labour force participation	Digital skills among active population	Critical thinking in teaching
	Adult literacy	Quality of vocational training	Pupil-teacher ratio in primary education
	Harmonized test score	Ease of finding skilled employees	Harmonized test score
	Public expenditure on education (% of GDP)	Support for digital literacy	Female digital skills training
	Basic skills	Schools with Internet access	Female education in science, technology, engineering and mathematics (STEM)
	Mean years of schooling	Skills of current workforce	Skills of future workforce
Ecosystem	**Macroeconomic stability**	**Diversity and dynamism**	**Environmental sustainability**
	Nominal GDP	Flexibility in labour market	Energy efficiency regulation
	GNI per capital	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/unit of energy use
	Debt dynamics	Joint venture/strategic alliance deals	Environmental performance

Source: ESCAP consolidation of different sources. For further details, refer to Jongsur Park, Seunghwa Jun and Jeong Yoon Kim, "Methodology for data analysis of digital transformation", ESCAP Working Paper Series, 31 May 2022. Available at https://www.unescap.org/kp/2022/methodology-data-analysis-digital-transformation

As might be expected, not all countries can offer data on all 105 indicators. Few of the world's low-income countries had sufficient data so had to be excluded. Even among the middle-income countries, only around 60 per cent had data on all the indicators related to digital transformation. Among the high-income countries the proportion was 86 per cent. For the ESCAP region, 25 countries had internationally comparable data that was immediately available or could be interpolated, for use in the framework.[81] The overall status of these countries is indicated in Figure 2-14.

81 Jongsur Park, Seunghwa Jun and Jeong Yoon Kim, "Methodology for data analysis of digital transformation", ESCAP Working Paper Series, 31 May 2022. Available at https://www.unescap.org/kp/2022/methodology-data-analysis-digital-transformation

Figure 2-14. The status of digital transformation in Asia and the Pacific



Source: Jongsur Park, Seunghwa Jun and Jeong Yoon Kim, "Methodology for data analysis of digital transformation", ESCAP Working Paper Series, 31 May 2022. Available at https://www.unescap.org/kp/2022/methodology-data-analysis-digital-transformation

The status of digital transformation for each country is strongly correlated with its income level. However, the digital transformation status of some Asia-Pacific countries is relatively higher than its income grouping. For example, lower-middle-income Asian countries, including India, the Philippines and Viet Nam, are identified as advanced digital transformation countries compared to their respective income levels.

Among the major global regions, North America (led by the United States of America and Canada) and Europe show highest digital transformation scores. The Asia-Pacific region shows the widest digital divide between advanced and less advanced digital transformation countries. Within Asia and the Pacific subregions, South and South-West Asia is the subregion with the highest digital divide on digital transformation scores.

Even countries with advanced digital transformation statuses are driven by different factors lending support towards a multi-pathway approach for digital transformation. In the case of Singapore, indicators on 'government' (business and government investment and government effectiveness scored highly). On the other hand, the Republic of Korea's overall digital transformation scoring was strongly driven by 'network' (days to get electricity, Internet users, and smartphone penetration). Singapore performs well in government investment and government efficiency indicators, and the Republic of Korea, which is known to be a network powerhouse, is far ahead in the number of Internet users and smartphone penetration.

Countries can be assessed within the five pillars (Table 2-3). China, for example, ranks high in the business pillar as a result of its many unicorn companies and high-tech exports. Malaysia performs well in the people pillar thanks to its strong pupil-teacher ratio in primary education and the skills of its workforce. India scores well in the business pillar, reflecting its number of unicorn companies and the ecosystem pillar with its high renewable energy indicators. The strength of the Philippines in the people pillar is due to the ease of finding skilled employees. Viet Nam shows strength in the network pillar, especially through fixed-line broadband affordability and smartphone penetration.

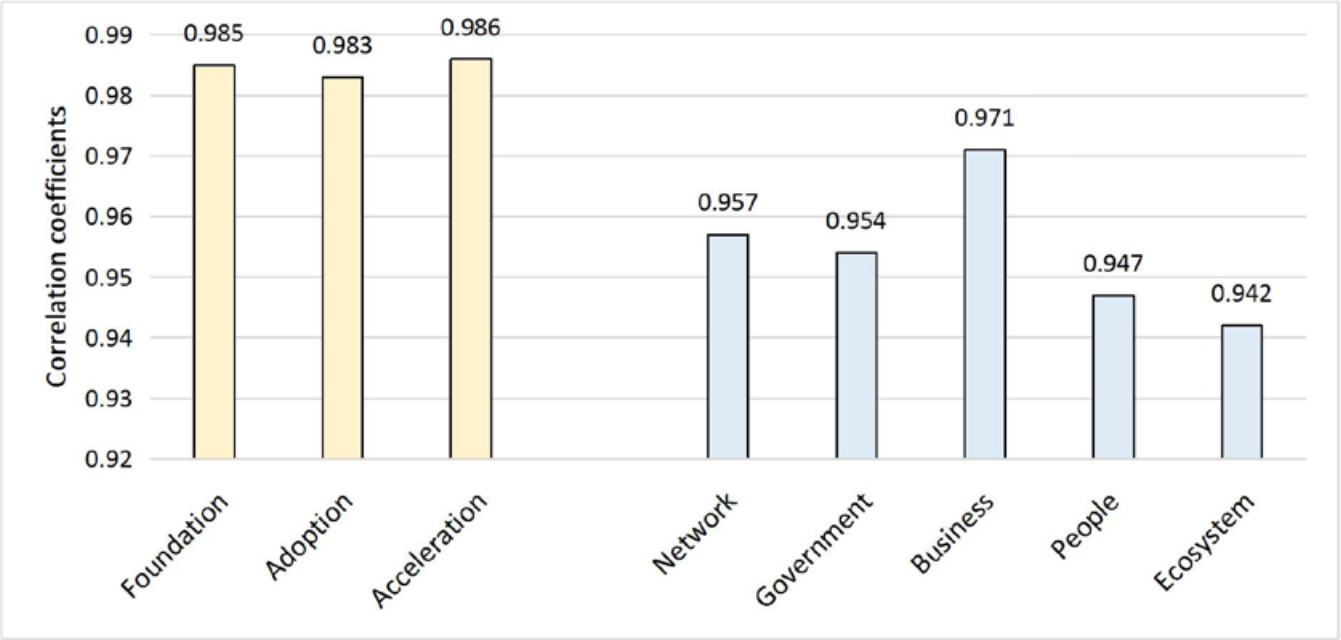
Table 2-3. Indicators driving digital transformation rankings in selected Asian countries

Country	Indicators driving high ranking	Country	Indicators driving high ranking
Singapore	Government - Business and government investment - Government effectiveness	India	Business - Number of tech unicorns Ecosystem - Renewable energy regulation - Environmental treaties in force
The Republic of Korea	Network - Days to get electricity - Internet users - Smartphone penetration	Philippines	People - Ease of finding skilled employees Ecosystem - GDP per unit of energy use
China	Business - High-tech exports - Number of tech unicorns		
Malaysia	People - Pupil-to-teacher ratio in primary education - Skills of future workforce	Viet Nam	Network - Average mobile latency - Fixed-line broadband affordability

Source: Jongsur Park, Seunghwa Jun and Jeong Yoon Kim, "Methodology for data analysis of digital transformation", ESCAP Working Paper Series, 31 May 2022. Available at https://www.unescap.org/kp/2022/methodology-data-analysis-digital-transformation

The most significant determinant of rankings at all three stages of digital transformation was the business pillar. Of the five pillars and at the global level based on 107 countries, the business pillar had the strongest correlation with the total digital transformation score. This underlines the central role of businesses in driving research and development on frontier technologies and in adopting disruptive technologies.

Figure 2-15. **Correlation coefficients between total scores and the different stages and pillars and stages**



Source: Jongsur Park, Seunghwa Jun and Jeong Yoon Kim, "Methodology for data analysis of digital transformation", ESCAP Working Paper Series, 31 May 2022. Available at https://www.unescap.org/kp/2022/methodology-data-analysis-digital-transformation

The pillar most directly under the control of national authorities is that for government. E-governance, is the subject of Chapter 3. This chapter describes the trends and landscape of digital transformation in Asia and the Pacific, discusses the contributing drivers of digital transformation, and presents some country experiences. By understanding the implications of these developments, policymakers can foster innovation and enterprise, and can guide these transformations in their most efficient, productive and fair directions, ensuring that everyone is included, especially the poorest and most vulnerable.

Boxes

Box 2-1: 5G-based emergency medical services in the Republic of Korea

Since December 2019, the Ministry of Health and Welfare of Korea, in collaboration with Korea Telecom and the NFA (National Fire Agency), has jointly developed 5G-based emergency medical services. The 5G-based, 119 emergency video call services in five cities allow rescue officials to respond appropriately and save time for treatment for those people in emergencies.[a] The Government expects this project to increase survival rates by providing customized emergency treatments for patients suffering from the four major critical conditions: cardiovascular disease, cerebrovascular diseases, severe trauma, and cardiac arrest. The project will also ensure fast transport to emergency rooms within the 'golden hour' that maximizes the likelihood of successful treatment.[b]

(1) Collection and analysis of patient information (360° camera, mic, 5G network, cloud)
(2) Emergency patient severity classification and smart medical map
(3) Finding optimal transfer hospital route (AI, clouds)
(4) Support for auto fill-out of emergency care records
(5) Systematic patient care in connection to the National Emergency Department Information System

Source: Ministry of Science and ICT, Republic of Korea. Available at https://www.msit.go.kr/eng/index.do

a Yonhap News Agency, "KT partners with emergency management agency, hospital for 5G-based medical services". 12 December 2019. Available at https://en.yna.co.kr/view/AEN20191212008300320

b Ministry of Science and ICT, "5G-based AI emergency medical system secures the golden hour for emergency patients!". Available at https://www.msit.go.kr/bbs/view.do?sCode=eng&mId=4&mPid=2&bbsSeqNo=42&nttSeqNo=481

Box 2-2: Using frontier technologies to protect rainforests and wildlife

In the Philippines, Tech4Nature and the Department of Environment and Natural Resources (DENR) have collaborated with multiple local organizations to initiate the Rainforest Guardian system. Powered by solar panels, this uses IoT, artificial intelligence, predictive modelling, and visualization tools to monitor and record human activity, such as the use of chainsaws or vehicles, or to indicate illegal logging and poaching activities in near-real time, so that local law enforcement and communities can act quickly. Tech4Nature captures data on patterns of animal behaviour. Similar technologies are being used in China for acoustic monitoring and research on one of the world's most endangered primates, the Hainan gibbon (only 35 primates remain) which lives in the Hainan Tropical Rainforest National Park, to develop more effective conservation measures.

Box 2-3: Air Map Korea for a green environment

Advanced 5G networks, combined with digital solutions, can be used to monitor dust pollution. Air Map Korea, for example, is a mobile app run by KT, in collaboration with the Korean Society for Atmospheric Environment, to address fine dust nationwide using its 2,000 public telephone booths, telecom poles, and base stations. Air Map Korea allows users to check local conditions.

The air quality data is used to guide the operation of road sprinkler trucks, and the choice of locations of mosses installed to reduce dust. The app can also analyse the causes of dust and the particle dissemination paths. In 2020, the project areas were expanded to the insides of buildings, factories, and livestock pens. In addition, its scope was extended to air odour and water quality. The aim is to optimize the indoor environment and manage livestock pens by linking air quality meters with air purifiers and air handling units.

Box 2-4: Frontier technologies for pollution reduction in Viet Nam

Da Nang city, Viet Nam, is using the Internet of Things to address congestion in transportation networks. This involves smart sensors and big data analysis for predicting and preventing congestion on roads, and for coordinating responses to accidents or adverse weather. Sensors embedded in roads, highways, and buses detect anomalies and control traffic flow. The system also gives the Department of Transport real-time information on its fleet of buses. From their traffic control centre, city officials can monitor traffic and control traffic lights.

In case of accidents and traffic jams, traffic lights can be adjusted to allow time for affected vehicles to pass through. Bus passengers too can see the latest status on mobile apps or screens at bus stations which inform them of the location and speed of buses and predicted times of trips. In the future, citizens will also be alerted on how crowded a bus is likely to be when it arrives.

Box 2-5: Digital solutions for pollution reduction and the circular economy

Countries in Asia contribute to over half of the world's land-based sources of marine plastic pollution. Of total plastic waste leakage into the environment, around 60 per cent is from cities with underdeveloped waste management systems. Around 75 per cent of land-based marine plastic pollution comes from uncollected waste, and 25 per cent from leakage within municipal waste management systems.

As part of an ESCAP-led project, Closing the Loop, four cities in South-East Asia are adopting a digital platform to reduce the environmental impact of plastic pollution and ultimately stop plastic leaking into the marine environment. The project will provide people with skills to use data innovations and smart technologies to monitor, assess, report on and sustainably manage plastic waste. In addition, it will help cities align investment with regional plans for circular economies and for the management of plastic waste.

Closing the Loop has developed a digital tool that combines remote sensing, citizen-science, and AI algorithms to enable local governments to monitor and visualize plastic waste leakage. The aim is to:

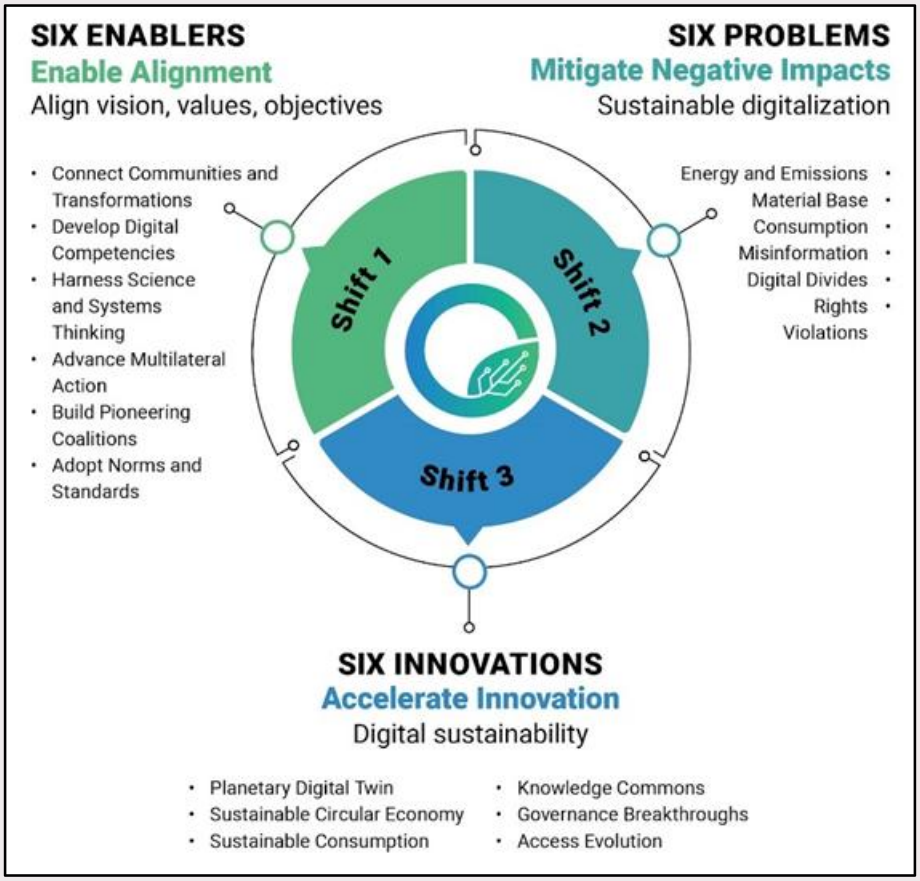
- mprove the identification of plastic waste generation hot spots;
- Identify points where plastic waste is entering water streams;
- Improve municipal waste management to prevent leakage of plastic waste into water streams and the ocean.

The digital platform is informing waste management service provision and future circular economy policies, as well as end producer responsibilities schemes within the plastics value chain.

Box 2-6: Action plan for a sustainable planet

In March 2021, UNEP, UNDP, the International Science Council, the German Environment Agency, the Kenyan Ministry of Environment and Forestry, Future Earth, and Sustainability in the Digital Age launched the Coalition for Digital Environmental Sustainability (CODES). The coalition has identified three fundamental shifts required to harness digital technologies for environmental and social sustainability; enable alignment, mitigate negative impacts; and accelerate innovation. Each shift involves six strategic priorities that must be addressed collectively by the global community for the shifts to actualize.

The Action Plan for a Sustainable Planet in the Digital Age



Source: United Nations Environment Programme (UNEP) and others, "Coalition for Digital Environment Sustainability (CODES): Action Plan for a Sustainable Planet in the Digital Age", 2022. Available at https://doi.org/10.5281/zenodo.6573509

CHAPTER 3.

Governing digitally

E-government is a central driver of the digital transformation, which comprises of the delivery of national or local government information and services via the Internet or other digital means. E-government has far-reaching potential, not just for improving institutional processes and public service deliveries, but also for extending inclusion, participation, accountability and transparency, and helping to build trust between societies and governments.

E-government goes beyond the provision of information on websites. Many governments now offer opportunities for e-participation, as public service agencies work together in shared whole-of-government responses.[82] Governments in the region have also developed one-stop platforms that allow access to a range of public services.

The terms 'e-government' and 'e-governance' are often used interchangeably. But there is a distinction. E-governance focuses on administration and management in supporting and transforming functions and structures, whereas e-government is the entire system of operation.

Since early 2020, e-government has been reinvigorated by the global COVID-19 pandemic and the need for social distancing which has accelerated the use of online interactions. When face-to-face meetings were discouraged or became impossible digital government services and solutions and platforms proved vital.

Open government initiatives

A number of e-government initiatives have been launched around the 'once-only' principle. When government agencies share information more systematically through digital platforms and applications they can gather more complete and consistent data. They can thus avoid duplication and limit the number of times that individuals or firms have to provide the same information.[83] Citizens then interact more easily with public administrations which in turn can be more responsive. Cooperation between government agencies also reduces errors and discrepancies, and enables governments to work more transparently and efficiently, make evidence-based decisions, and reduce fraud.

Much of the data generated should also be freely available in open formats, as 'open government data' (OGD). Public data access increases transparency, leading to greater accountability and trust in governments and public institutions. Many countries have OGD portals or catalogues that list available datasets, usually organized by ministry or by theme, such as environment, spending or health.

Nevertheless, across Asia and the Pacific the extent of online service and participation tools differs widely between countries, as do the levels of transparency and the degree to which decision-makers take into account inputs from citizens. Moreover government systems may not be sufficiently integrated or interoperable.

82 *E-Government Survey 2012: E-Government for the People* (United Nations publication, 2012).

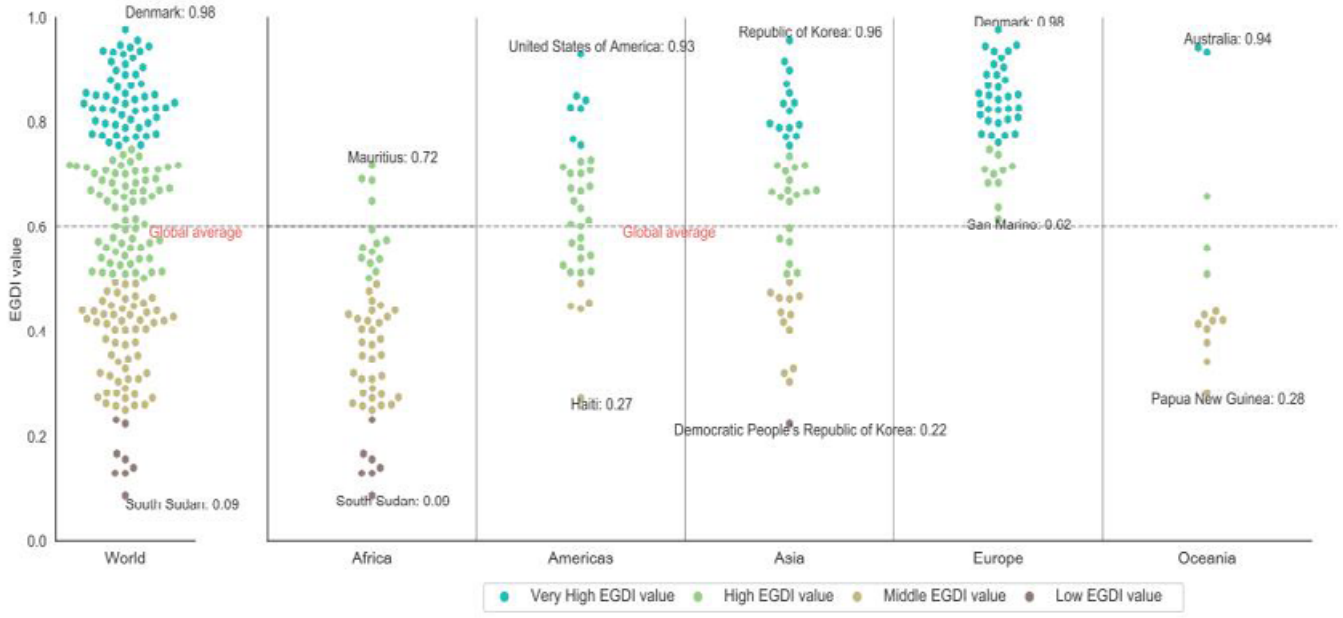
83 *E-Government Survey 2014: E-Government for the Future We Want* (United Nations publication, 2014).

Some countries, like China, the Republic of Korea and Singapore are moving towards 'digital by default', meaning that digital services are so straightforward and convenient that all those who can use them will choose to do so. In such services, participation depends on a digital identity linked to a personal identification number. This is easier in countries where most people are online, but the digital-first approach, may exclude those who cannot access online services and thus put vulnerable populations at risk.[84] It is important therefore to supplement online services with technology-enabled offline options. In Denmark, for example, electronic interaction is now mandatory, but for people unable to complete the transactions themselves there is help offline. It is also important to ensure that e-government services holding massive amounts of personal data are reliable, safe, and secure.

The e-government development index

Progress in e-government can be assessed using the UN e-government development index (EGDI). This has three components: the online service index (OSI), the telecommunication infrastructure index (TII), and the human capital index (HCI). The highest proportion of countries with very-high EGDI values are concentrated in Europe, followed by Asia (Figure 3-1).

Figure 3-1. Global and regional distribution of EGDI values



Source: *E-Government Survey 2020: Digital Government in the Decade of Action for Sustainable Development* (United Nations publication). Available at https://publicadministration.un.org/egovkb/en-us/Reports/UN-E-Government-Survey-2020

Between 2018 and 2020, there was a substantial increase in the average EGDI value for lower-middle-income countries (Table 3-1). Over this period, three Asia-Pacific lesser developed countries (LDCs) in Southern Asia, namely Bangladesh, Bhutan and Cambodia, moved from the middle EGDI group to the high EGDI group.

- *Bhutan* – The country has extended Internet connectivity to around 1,000 government offices, schools and hospitals, allowing the provision of e-government services, such as online business licensing and customs trade.

84 *E-Government Survey 2018: Gearing E-Government to Support Transformation Towards Sustainable and Resilient Societies* (United Nations publication, 2018).

- *Bangladesh* – Success has largely been derived from strengthening the online connectivity of the public sector, online service delivery, and investments in the digital literacy of public sector employees. In the past few years, the country has worked on unifying 46,000 virtual government offices and providing information and government services quickly and efficiently.
- *Cambodia* – The telecommunications infrastructure has improved rates of mobile phone penetration. The country has also been using social media platforms and websites to engage citizens in decision-making.

Table 3-1. EGDI rankings, Asia-Pacific countries, 2020

Country	Global rank	EGDI
The Republic of Korea	2	0.96
Australia	5	0.94
New Zealand	8	0.93
Singapore	11	0.92
Japan	14	0.9
Kazakhstan	29	0.84
China	45	0.79
Malaysia	47	0.79
Türkiye	53	0.77
Thailand	57	0.76
Brunei Darussalam	60	0.74
Georgia	65	0.72
Armenia	68	0.71
Azerbaijan	70	0.71
Philippines	77	0.69
Kyrgyzstan	83	0.67
Sri Lanka	85	0.67
Viet Nam	86	0.67
Uzbekistan	87	0.67
Indonesia	88	0.66
Iran (Islamic Republic of)	89	0.66
Fiji	90	0.66
Mongolia	92	0.65
India	100	0.6
Bhutan	103	0.58

Country	Global rank	EGDI
Maldives	105	0.57
Tonga	108	0.56
Jordan	117	0.53
Bangladesh	119	0.52
Cambodia	124	0.51
Palau	125	0.51
Nepal	132	0.47
Tajikistan	133	0.46
Timor-Leste	134	0.46
Vanuatu	142	0.44
Kiribati	145	0.43
Myanmar	146	0.43
Samoa	149	0.42
Tuvalu	151	0.42
Pakistan	153	0.42
Nauru	154	0.42
Marshall Islands	156	0.41
Turkmenistan	158	0.4
Micronesia (Federated States of)	161	0.38
Solomon Islands	166	0.34
Lao People's Democratic Republic	167	0.33
Afghanistan	169	0.32
Papua New Guinea	175	0.28
The Democratic People's Republic of Korea	187	0.22

Source: *E-Government Survey 2020: Digital Government in the Decade of Action for Sustainable Development* (United Nations publication). Available at https://publicadministration.un.org/egovkb/en-us/Reports/UN-E-Government-Survey-2020

Smarter cities

E-government is increasingly evident at the local government level. Though there has been progress during the pandemic, the UN E-Government Survey found that less than one-quarter of the cities were using, or intending to use, emerging technologies. Most city portals did not meet various technology standards or guidelines and often depended on social media networks to interact with the general public. Nevertheless, some cities have become smarter, harnessing technologies such as:

- *Artificial intelligence* – to improve service delivery and streamline internal workforce management.
- *Big data and analytics* – to design and implement effective local government policies, and optimize urban public resources.
- *Internet of Things* – for smart applications in health care, transportation projects, law enforcement and emergency situations.
- *Augmented reality and virtual reality* – to improve navigation experiences and driver safety, while supporting rescue operations.

The UN survey assesses levels of e-government for one major city in 86 countries, through its local online service index (LOSI). It is noticeable that the rankings for these local government portals do not follow their country rankings. Globally, in first position was Madrid, while the highest assessed city in the Asia-Pacific region was Moscow (Table 3-2).

Table 3-2. Local online service index (LOSI) for assessed cities in the Asia-Pacific region

City Name	Global LOSI Rank	LOSI Index
Moscow	6	0.81
Seoul	9	0.78
Shanghai	9	0.78
Istanbul	12	0.76
Sydney	24	0.58
Tokyo	24	0.58
Almaty	29	0.51
Kuala Lumpur	29	0.51
Mumbai	33	0.48
Kabul	38	0.45
Bangkok	39	0.44
Colombo	42	0.40

City Name	Global LOSI Rank	LOSI Index
Ho Chi Minh	42	0.40
Jakarta	47	0.39
Tashkent	56	0.29
Kathmandu	59	0.28
Baku	64	0.23
Karachi	66	0.21
Manila	69	0.20
Yangon	70	0.19
Dhaka	75	0.15
Phnom Penh	78	0.13
Port Moresby	82	0.09

Source: *E-Government Survey 2020: Digital Government in the Decade of Action for Sustainable Development* (United Nations publication). Available at https://publicadministration.un.org/egovkb/en-us/Reports/UN-E-Government-Survey-2020

Public-private partnerships

Where governments lack the infrastructure to deliver more efficient services, a partnership with the private sector can bring finance and foster new solutions.[85, 86] Public-private partnerships (PPPs) can accelerate

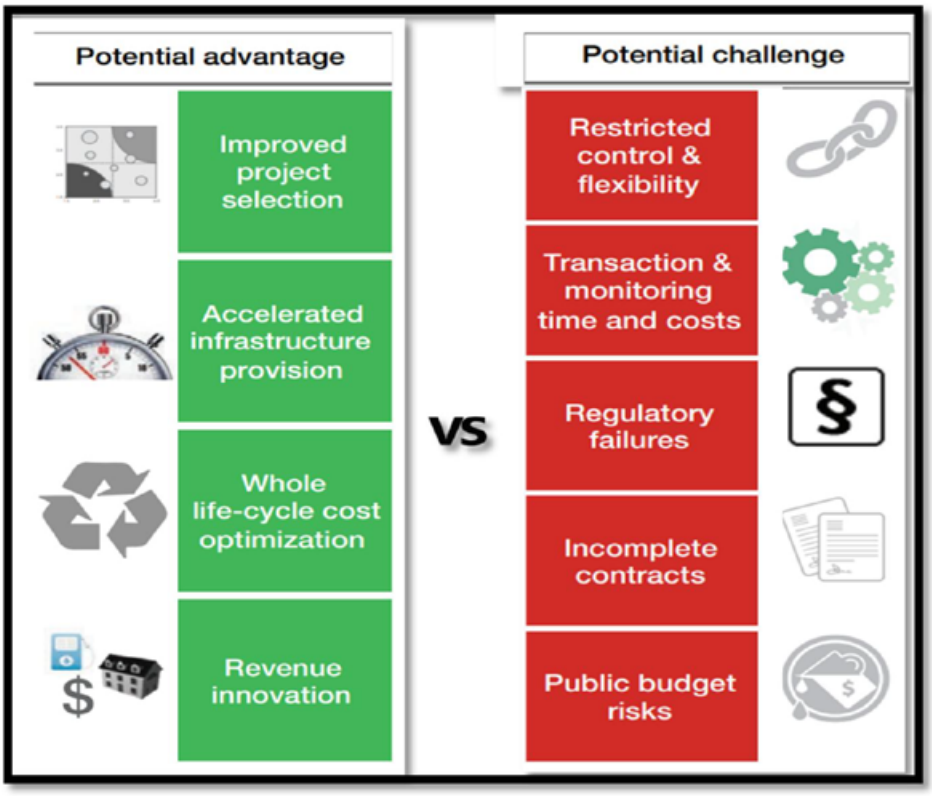
85 World Bank, "About Public-Private Partnerships", 21 June 2022. Available at https://ppp.worldbank.org/public-private-partnership/about-public-private-partnerships

86 Ibid.

infrastructure development by tapping private finance and combining the skills and resources of the public and private sectors, while sharing risks and responsibilities.[87, 88] This enables governments to delegate day-to-day operations to the private sector and focus on policies, planning, and regulation.

In addition, PPPs can bring advantages for project selection, infrastructure provision, cost optimization, and revenue innovation. But there are also drawbacks; notably less control and flexibility, and higher transaction and monitoring costs, along with the possibility of regulatory failure, incomplete contracts, and public budget risks (Figure 3-2).[89]

Figure 3-2. **Advantages and challenges of public-private partnerships**



Source: World Economic Forum, "Strategic infrastructure: Steps to prepare and accelerate public-private partnerships", 21 April 2013. Available at https://www.weforum.org/reports/strategic-infrastructure-steps-prepare-and-accelerate-public-private-partnerships

To narrow the current digital divide, governments need to take a strategic and considered set of PPPs.[90] Businesses are also under increasing pressure to address environmental and social contributions. In the digital era, a new framework for public-private partnerships can enable systemic change by offering market incentives while promoting social good.[91] PPPs should be important components of broader efforts for more inclusive development, which is the subject of the next chapter.

87 World Economic Forum, "Strategic infrastructure: Steps to prepare and accelerate public-private partnerships", 21 April 2013. Available at https://www.weforum.org/reports/strategic-infrastructure-steps-prepare-and-accelerate-public-private-partnerships

88 World Bank, "About Public-Private Partnerships", 21 June 2022. Available at https://ppp.worldbank.org/public-private-partnership/about-public-private-partnerships

89 World Economic Forum, "Strategic infrastructure: Steps to prepare and accelerate public-private partnerships", 21 April 2013. Available at https://www.weforum.org/reports/strategic-infrastructure-steps-prepare-and-accelerate-public-private-partnerships

90 Microsoft News Center, "Public-private partnerships hold the key to future development", 22 September 2020. Available at https://news.microsoft.com/en-xm/2020/09/22/public-private-partnerships-hold-the-key-to-future-development/#:~:text=Public%2Dprivate%20partnerships%20(PPP),in%20the%20global%20digital%20economy

91 Carmine Di Sibio, "Davos Agenda 2022: How to harness the transformative potential of public-private partnerships", World Economic Forum (WEF), 10 January 2022. Available at https://www.weforum.org/agenda/2022/01/how-to-harness-transformative-potential-public-private-partnerships/

CHAPTER 4.

Shaping our digital future

Digital transformation aims at strengthening national competitiveness, boosting the productivity of business and manufacturing, and providing people with new services, while opening up opportunities for sustainable development that change values and mindsets. But it also creates new divides and development gaps. The challenge now is to shape our digital future with new development paradigms, as well as policy and regulatory frameworks including new methods of partnerships, and do so in flexible, adaptive, and corroborative ways, while strengthening global and regional cooperation. Aligned with the Action Plan 2022-2026 of the Asia-Pacific Information Superhighway, the aim should be to lead to fair and positive outcomes for an inclusive digital society that shares digital dividends equitably.

A number of UN global initiatives are working toward increasing digital inclusion, avoiding Internet fragmentation, strengthening data protection, building digital capacity, and providing pathways for cooperation. These include the 'World Summit on the Information Society Action Lines',[92] and the 2018 United Nations Secretary-General's *Strategy on New Technologies*,[93] as well as the United Nations Secretary-General's *Roadmap for Digital Cooperation*, 2020, and *Our Common Agenda*, 2021.

The same principles on digital transformation have also been embedded in comprehensive roadmaps for sustainable development. They are specified, for example, in the Sustainable Development Goals (SDGs 4, 5, 9 and 17),[94] and in *Our Common Agenda*, where one of its commitments is Improving Digital Cooperation,[95] which aims to:

- Connect all people to the Internet including all schools;
- Avoid Internet fragmentation;
- Protect data;
- Apply human rights online;
- Introduce accountability criteria for discrimination and misleading content;
- Promote regulation of artificial intelligence; and
- Digital Commons as a public good.

Among Asia-Pacific countries, there have been series of ESCAP resolutions on ICT/digital agendas such as connectivity, the digital divide, emerging technology, digital skills, the digital economy and digital cooperation, with most recent resolutions being ESCAP/RES/75/7, adopted in 2019, ESCAP/RES/77/1, adopted in 2021, and ESCAP/RES/78/1 that was adopted in May 2022.

92 ITU, "ITU Gateway for WSIS", 2022a. Available at https://www.itu.int/en/itu-wsis/Pages/default.aspx

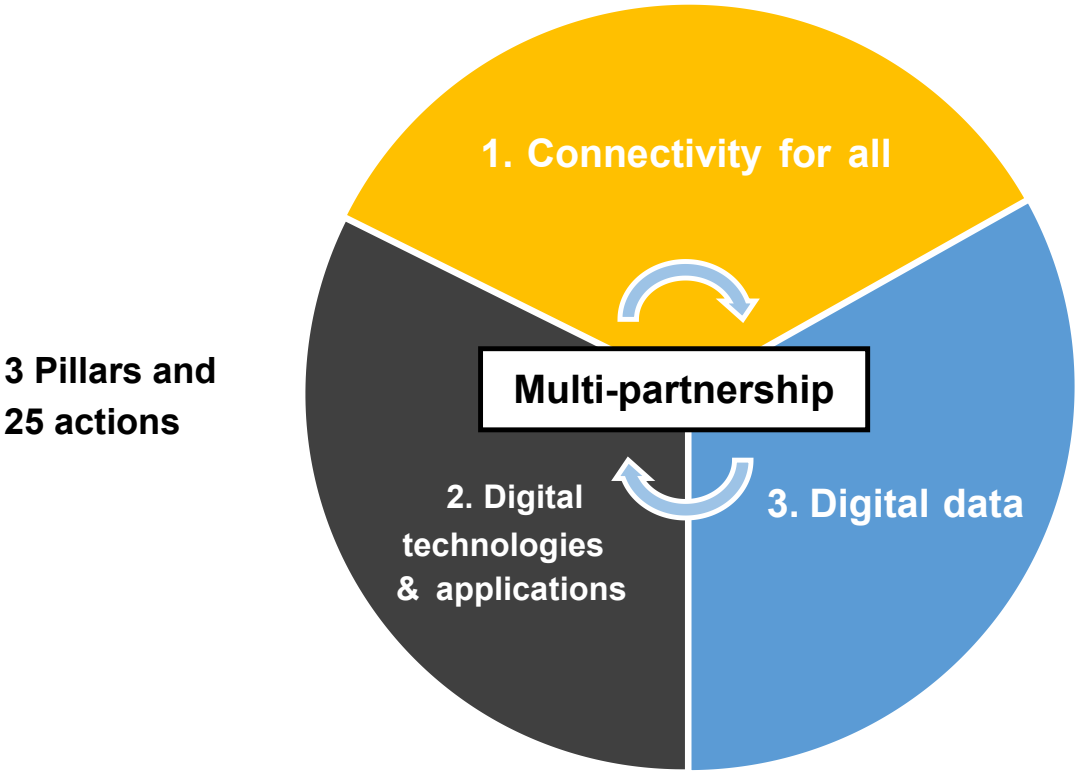
93 United Nations, *UN Secretary-General's Strategy on New Technologies*, September 2018. Available at https://www.un.org/en/newtechnologies/#:~:text=The%20goal%20of%20this%20internal,their%20alignment%20with%20the%20values

94 ITU, "The ITU ICT SDG indicators", 2022b. Available at https://www.itu.int/en/ITU-D/Statistics/Pages/SDGs-ITU-ICT-indicators.aspx

95 United Nations, *UN Secretary-General's Roadmap for Digital Cooperation*, June 2020. Available at https://www.un.org/en/content/digital-cooperation-roadmap/

Member States have also embarked on the Asia-Pacific Information Superhighway (AP-IS) initiative,[96] whose Steering Committee adopted the AP-IS Action Plan 2022-2026, in 2021. The plan has 25 actions based on three main pillars: connectivity for all; digital technologies and applications; and digital data (Figure 4-1).

Figure 4-1. Framework of the AP-IS Action Plan 2022-2026



Source: United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), Information and Communications Technology and Disaster Risk Reduction Division, "Action plan for implementation of the Asia-Pacific Information Superhighway (2022-2026)", November 2021a. Available at https://www.unescap.org/sites/default/d8files/event-documents/AP-IS%20Action%20Plan%202022-2026_Final.pdf

Leadership and vision

Underlying the Asia-Pacific Information Superhighway initiative is the reality that digital transformation is affecting how most people lead their lives and reshaping the way governments in countries, rich and poor alike, operate and deliver services like never before. For better or for worse, becoming digital is no longer a choice; the world is steadily becoming digital by default.

The production and uptake of new devices and services happens first where people have the necessary incomes and capacities to adopt such technological advancements. Policymakers, thus, need to choose the most effective and equitable paths for digital transformation, from guiding the installation of infrastructure to ensuring that the algorithms of commerce and social media lead to fair and positive outcomes. Even the least developed countries have to find ways to foster sound digital ecosystems, capacity and culture.

Addressing such complex and interlinked development agendas will always be demanding. Guiding the Asia-Pacific Information Superhighway initiative will require leadership and vision so as to enable the delivery of services that people and businesses need, and must be done in innovative ways. But the responsibilities

96 The AP-IS initiative is a region-wide intergovernmental platform that aims to bridge the digital divide and accelerate digital transformation through regionally coordinated actions, promoting digital technology, digital connectivity and the use of digital data.

extend far beyond governments. All stakeholders need to commit to the shared responsibility of extending Internet access and use and ensure that, in our largely inter-connected world, no one is left behind.

Aligned with the Asia-Pacific Information Superhighway Action Plan 2022-2026, the following sections consider integrated implementation of the three pathways (tracks). It is also important to note that the three proposals of pathways are not mutually exclusive:

Pathway 1: Infrastructure networks and connectivity

On the supply side, the COVID-19 pandemic provided a critical window of opportunity to extend high-capacity networks that can use the latest 5G technologies. This is identified as the first pathway because it is the essential condition for scaling up innovation and digital transformation. The aim now should be to provide good policies and solutions for effective development of connectivity infrastructure and foster an environment and culture where policymakers and regulators support investment in next generation infrastructure. There are a number of ways in which investments in infrastructure can be made more cost-effective.

Co-deployment and infrastructure-sharing

Along with investment in new connectivity infrastructure and technologies, such as satellite Internet connection, the policies to reduce investment costs should be developed together because deploying new infrastructure entails high budgets and costs.[97] These can be minimized by providing 'corridors' that co-deploy fibre-optic cables with new power lines or roads or railways, following a 'dig-once' policy.[98] Governments can further provide timely access to public facilities, such as buildings of ducts created for utility services. For rural and remote areas, where revenues are low while investment and operating costs are high, governments can allow Internet operators to co-invest in and share ICT infrastructure. At the same time, they should simplify local regulations and administrative processes.[99]

The ESCAP secretariat has developed a tool for analysing the economic efficiency of such schemes. This has been tested in three land-locked countries: Kazakhstan, Kyrgyzstan, and Mongolia.[100] In addition, ESCAP has developed a simulator for identifying beneficial economic corridors, which has been piloted for three corridors: Almaty, Kazakhstan to Cholpon Ata, Kyrgyzstan; Semey, Kazakhstan to Rubtsovsk, the Russian Federation; and also Urzhar, Kazakhstan to Chuguchak, China, which it considered to be the most economically attractive.[101]

Internet exchange points

Another important potential for ESCAP member States is to strengthen Internet traffic management through the adoption of Internet exchange points (IXPs) that connect the networks of different operators across

97 GSMA, "Enabling rural coverage: regulatory and policy recommendations to foster mobile broadband coverage in developing countries", 2018. Available at https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2018/02/Enabling_Rural_Coverage_English_February_2018.pdf

98 For further details, see United Nations ESCAP, "A study on cost-benefit analysis of fibre-optic co-deployment with the Asian Highway connectivity", Asia-Pacific Information Superhighway (AP-IS) Working Paper Series, 13 June 2018a. Available at https://www.unescap.org/resources/study-cost-benefit-analysis-fibre-optic-co-deployment-asian-highway-connectivity; United Nations ESCAP, "Co-Deployment of Fibre Optic Cables along Transport Infrastructure for SDGs Including Cross Border", working paper, 4 December 2018c. Available at https://www.unescap.org/resources/co-deployment-fibre-optic-cables-along-transport-infrastructure-sdgs-including-cross; United Nations ESCAP, "ICT Co-Deployment with the Electricity Infrastructure, The Case of Bhutan", Asia-Pacific Information Superhighway (Ap-IS) Working Paper Series, 20 June 2019d. Available at https://www.unescap.org/resources/ict-co-deployment-electricity-infrastructure-case-bhutan

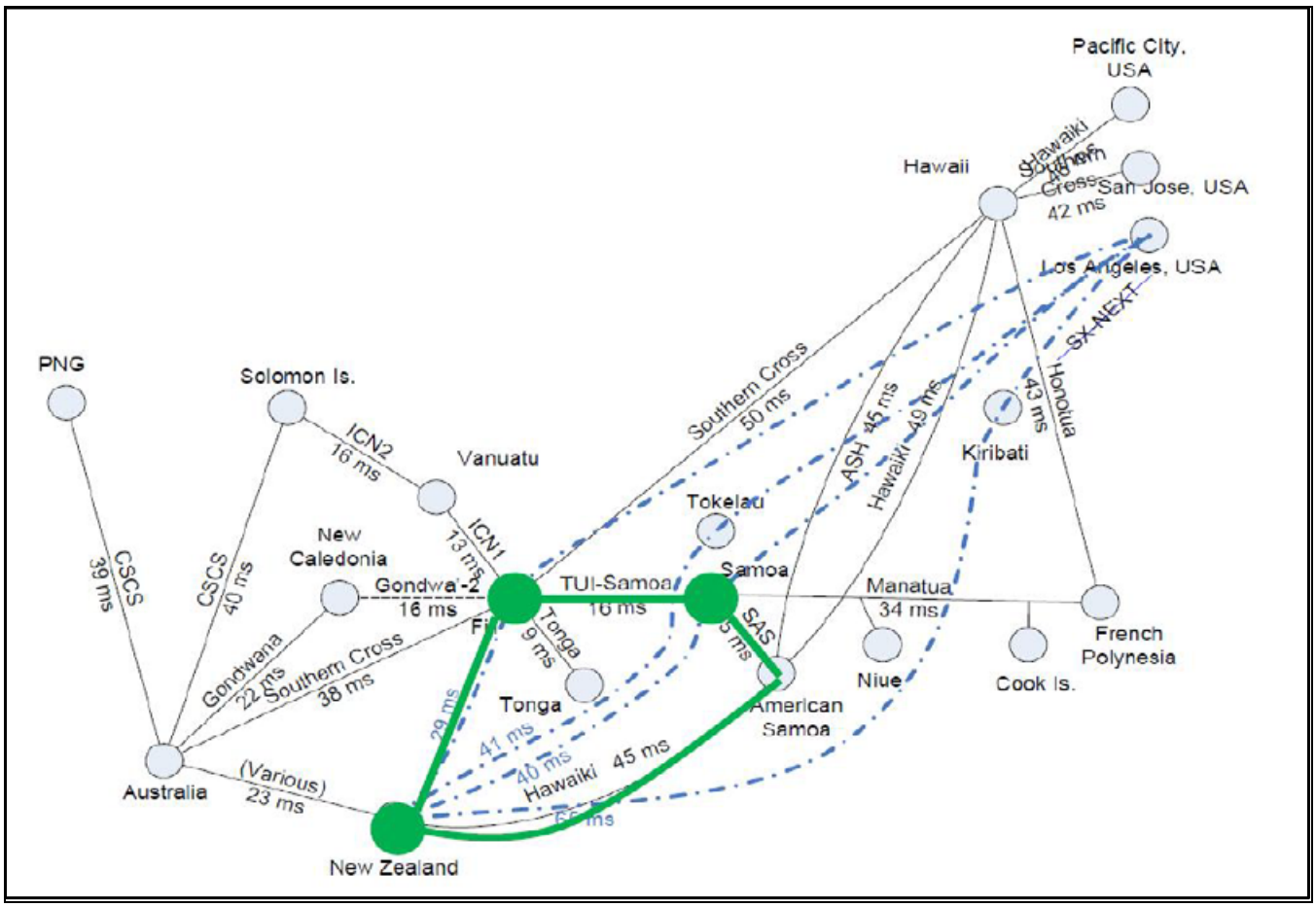
99 GSMA, "Realising 5G's full potential: Setting policies for success", March 2020. Available at https://www.gsma.com/publicpolicy/wp-content/uploads/2020/03/Realising_5Gs_full_potential_setting_policies_for_success_MARCH20.pdf; and GSMA, "Paving the way for 5G readiness in India: A guide for effective policymaking on small cell deployment", 5 January 2022. Available at https://www.gsma.com/asia-pacific/resources/small-cell-deployment/

100 Vadim Kaptur, Aida Karazhanova, "Infrastructure Corridor Series Part II: Toolkit for Determining the Most Promising Model for Infrastructure Corridor Development", Asia-Pacific Information Superhighway (AP-IS) Working Paper Series, June 2021a. Available at https://unece.org/sites/default/files/2021-10/7E%20Infrastructure%20Corridor%20Development%20Series%20Part%20II_2.pdf

101 Vadim Kaptur and Aida Karazhanova, "Infrastructure Corridor Development Series Part III: Calculation Results for Determining the Most Promising Model for Infrastructure Corridor Development", Asia-Pacific Information Superhighway (AP-IS) Working Paper Series, June 2021b. Available at https://www.unescap.org/sites/default/d8files/knowledge-products/Output%203%20Calculus%20Part_III_EN_2.pdf

borders. In 2019, the ESCAP secretariat and the National Information Society Agency of the Republic of Korea supported efforts to improve traffic management in Cambodia, the Lao People's Democratic Republic, Myanmar, and Viet Nam. This work has shown how introducing subregional IXPs can reduce operational costs, promote the use of local traffic, reduce latency, enhance efficiency and improve the stability and resilience of local networks. In addition, the ESCAP secretariat and the Internet Society, in collaboration with Fiji, New Zealand and Samoa, have been supporting the establishment of a neutral Pacific IXP for Internet traffic management (Figure 4-2).

Figure 4-2. Proposal for a neutral Pacific IXP



Source: Paul Brooks, "Pacific-IX Desktop Feasibility Study", Internet Society, December 2019. Available at https://www.unescap.org/resources/pacific-internet-exchange-point-feasibility-study

Note: The three nodes of the proposed Pacific IXP are indicated in green.

Simpler and predictable regulations

The responsibilities for building infrastructure that enables an inclusive digital society, extend beyond any single sector. All relevant stakeholders should work together, spearheaded by proactive governments which should develop regulatory frameworks that enable flexible and adaptive collaboration between the government, businesses, people and the international community.

In this regard, it is important that forward-looking national broadband plans are developed in close collaboration with relevant stakeholders. Moreover, Internet operators often encounter inconsistent local regulations and lengthy permit approval processes and find themselves paying arbitrary fees. To minimize investment costs, governments and regulatory authorities should simplify local regulations and permissions for the installation of mobile base stations. 5G presents an increasing need for densification

of network equipment, often in places where 'small cells' – smaller, low-powered radio equipment – are often the only viable solution to provide additional capacity. These can be attached to the sides of buildings, streetlights or signs. Clear, streamlined policies are therefore crucial for their efficient deployment, and exemptions from reviews of environmental and historic site preservation can be considered for small cells that meet certain criteria.

Fair, transparent and rational spectrum policies

According to research by GSMA, the global body that represents mobile operators, final spectrum prices are on average more than three times higher in developing countries than in developed ones. To keep prices low, governments should allocate sufficient amounts of spectrum and set out clear spectrum roadmaps, based on stakeholder input. To drive 5G innovation and use the highest possible speeds, they can make available 80-100 MHz of contiguous mid-band spectrum, such as 3.5 GHz to each operator, while also offering access to spectrum above 6 GHz.[102]

Universal service funds

In some areas, deployment of Internet infrastructure is commercially unsustainable. To finance services in these areas, governments often consider universal service funds (USFs) based on levies on mobile operators. A regional event, organized by the United States of America for ESCAP members and associate members, highlighted that the Indonesian Government implemented a universal service project with financial assistance from USAID where 140,000 schools and 5,000 health clinics were connected to high-speed Internet by 2021.[103] The effectiveness of USFs should be reviewed while all players who derive benefits from the more lucrative parts of the digital economy can contribute equitably and fairly towards connecting the unconnected.[104] Such initiatives will improve rural digital connectivity, especially on ensuring affordable access to the Internet for women. Other initiatives, such as 'smart villages' or 'smart islands', have similar objectives.

Enhancing the resilience of ICT infrastructures to natural disasters

Given the high vulnerability of the region to natural disasters, ICT infrastructure needs to incorporate network redundancies. In the short term, this increases costs, but in the longer term investments in risk reduction, preparedness, adaptation, and recovery will strengthen e-resilience and the ability of infrastructure to withstand and recover from disasters. In addition, countries need national and regional mechanisms and frameworks for better coordination between different stakeholders, including government ministries, businesses, and community leaders. In this regard, equipping submarine fibre-optic cables with scientific monitoring sensors through the SMART (Scientific Monitoring And Reliable Telecommunications) initiative, although still at experimental stage, has proven effective for enhancing communication networks for seismic early warning as well as for monitoring other ocean-based scientific data.

Pathway 2: Digital technologies and applications

A successful and inclusive digital transformation, in Asia and the Pacific, cannot depend on infrastructure policies alone. Policymakers and regulators have to also consider the demand side; in particular, whether people can afford new products and services and whether they can make use of digital technologies that are information-, data- and knowledge-intensive. This requires a set of concomitant actions and conditions to be put in place as outlined below.

102 GSMA, "5G Mid-Band Spectrum Needs – Vision 2030", 8 July 2021a. Available at https://www.gsma.com/spectrum/resources/5g-mid-band-spectrum-needs-vision-2030/

103 The United States of America was the Co-Chair of Working Group 1 (Connectivity for all) of the Asia-Pacific Information Superhighway initiative that was co-organized with ESCAP. The virtual capacity-building workshop was on the 'Universal Service Fund Modernization in a Post-COVID19 World', held on 22 June 2022. For further information, please visit: https://www.unescap.org/events/2022/universal-service-fund-modernization-post-covid19-world-capacity-building-workshop

104 ITU and UNESCO,Broadband Commission for Sustainable Development, "21st Century Financing Models for Bridging Broadband Connectivity Gaps", 29 October 2021. Available at https://broadbandcommission.org/publication/21st-century-financing-models/

Boosting digital demand through affordable devices and data services

To make Internet costs, handsets and data bundles more affordable, particularly for poorer people, governments can provide subsidies for devices, for Internet subscriptions or for mobile services. A recent study by ESCAP and the Alliance for Affordable Internet highlighted that across low- and middle-income countries, women are 20 per cent less likely to own a smartphone or use the Internet on a mobile device compared to men.[105] Policies should also enable innovative financing mechanisms for devices and ensure flexibility of pricing data bundles. Governments can similarly devise tax policies that encourage the uptake of Internet subscriptions and Internet-enabled devices and data services.

Leveraging new emerging technologies for sustainable development

Frontier technologies, including artificial intelligence, robotics, and biotechnology, being used in various industry sectors are expanding digital applications in striking new ways. These include smart transport, smart energy grids, digital financial services, e-environment and e-health. However, users are unlikely to trust such technologies unless serious attention is paid to digital security. ESCAP has been helping countries to adopt frontier technologies through regulatory sandboxes. In Bangladesh, for example, in conjunction with UN DESA, ESCAP is working on a digital acceleration hub and broadband equity; in Kazakhstan on autonomous vehicles and decentralization, digitalization, and decarbonization in the energy sector; and in Maldives on a central bank digital currency.

Digital government and digital economy

To promote demand for e-government services, relevant information from government agencies needs to be better shared and systematically coordinated in a timely manner through user-friendly, easily navigable e-government digital platforms and applications. This avoids duplication and ensures that all citizens, even those living in remote areas can access the relevant public service delivery more easily. Digital cooperation between government agencies reduces errors and discrepancies and enables governments to work more transparently and efficiently. Digital regulatory policies for sustainable development should strengthen e-commerce, digital innovative business frameworks under public-private partnerships (PPP), the digitalization of small and medium enterprises (SMEs), and that digitalization of other sectors including trade, transport, environment, fisheries, and agriculture.

Skills and capacity-building for government officials

Governments need to build the capacities of their own workforces. This applies not just to digital or data officers but to all government officials who should have sound digital literacy and acquire a digital mindset. The Asian and Pacific Training Centre for ICT for Development (APCICT), a regional institute of ESCAP located in Incheon, the Republic of Korea, has been helping Asia-Pacific policymakers and civil servants through its Academy of ICT Essentials for Government Leaders training programme.

The ESCAP secretariat has also been increasing the capacities of government officials to use digital technologies. There has been specific support for infrastructure corridors through a digital web-toolkit. This consists of a "Simulator for the integrated infrastructure corridors", and an online interactive website called "Partnership portal on co-deployment of ICT infrastructure with energy and transport". ESCAP, along with the International Think Tank for Landlocked Developing Countries in Ulaanbaatar, Mongolia, has also produced a tool for developers and owners of ICT, road and energy infrastructure and projects that enables them to register facilities and to assess infrastructure compatibility and calculate cost-effectiveness.

People-centric skills and capacity development

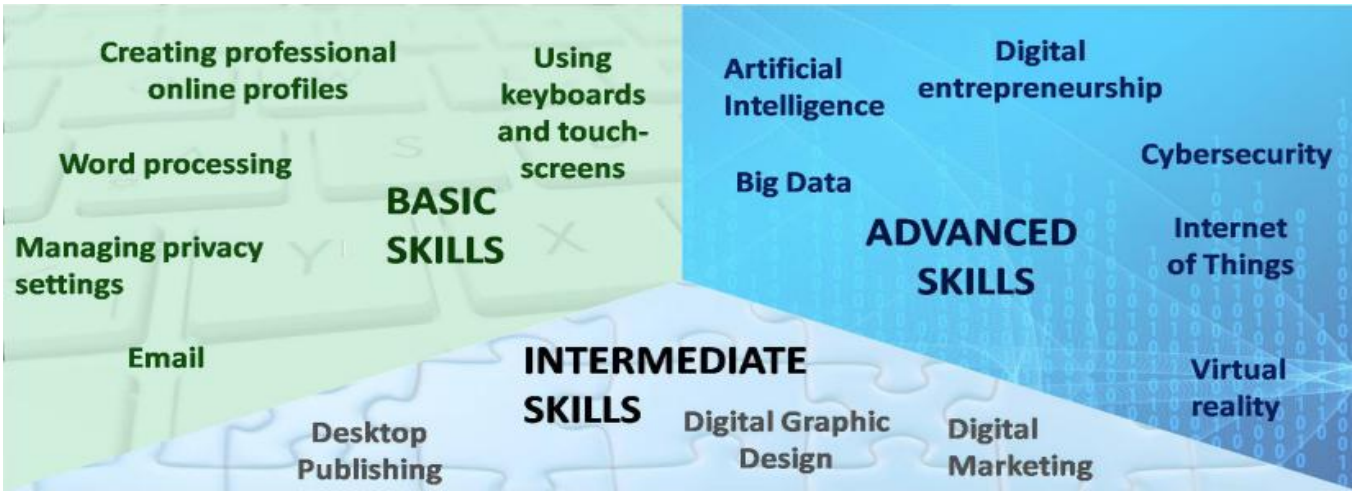
Over and above government officials, everyone, needs the knowledge and skills to take full advantage of the Internet. This involves education and skills-building programmes, from basic to advanced digital literacy,

105 ESCAP and the Alliance for Affordable Internet, "Towards meaningful connectivity: Insights from Asia-Pacific Case Studies", Asia-Pacific Information Superhighway Report", 17 September 2021. Available at https://www.unescap.org/kp/2021/towards-meaningful-connectivity-insights-asia-pacific-case-studies

that meet lifelong learning needs, with special focus on the elderly, women, disabled and other vulnerable groups. Likewise, governments need to support tertiary level programmes, developed with private sector contributions, to equip the youth with skills that match market demands. Equally important is to ensure that services are fully accessible.

The skills continuum can be considered at three levels. The first, alongside traditional literacy, is basic foundational skills and digital literacy; the second is digital skills for the country's workforce; and the third is advanced digital capacity for specialists working in the ICT sector (Figure 4-3).[106]

Figure 4-3. Continuum of digital skills

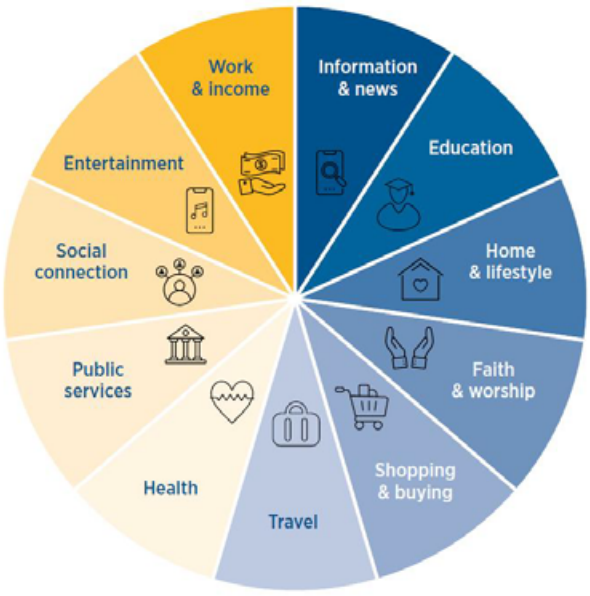


Source: ITU, Digital Skills Toolkit, 2018. Available at https://www.itu.int/en/ITU-D/Digital-Inclusion/Youth-and-Children/Pages/Digital-Skills-Toolkit.aspx

Foundational skills

Foundational skills are consistently ranked as the top barrier to start using the Internet by those people who are aware of it. Basic skills are key for people who remain unconnected, particularly those with low incomes, women, the less educated, those with low incomes, persons with disabilities, and those living in rural areas. To support these underserved populations, policymakers need to understand people's needs, goals and aspirations in each sphere of life that is being affected by digital transformation (Figure 4-4).[107]

Figure 4-4. Spheres of life impacted by the digital transformation



Source: GSMA, "Developing mobile digital skills in low- and middle-income countries", November 2021b. Available at https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2021/11/Developing-mobile-digital-skills-in-low-and-middle-income-countries.pdf

106 ITU, Digital Skills Toolkit, 2018. Available at https://www.itu.int/en/ITU-D/Digital-Inclusion/Youth-and-Children/Pages/Digital-Skills-Toolkit.aspx

107 GSMA, "Developing mobile digital skills in low- and middle-income countries", November 2021b. Available at https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2021/11/Developing-mobile-digital-skills-in-low-and-middle-income-countries.pdf

The United Nations Secretary-General's Roadmap for Digital Cooperation identified digital capacity-building as a key area for action. It underscored capacity-building for digital skills development through effective training, particularly for developing countries.[108]

In India, for example, the priorities have been found to differ between men and women. Men frequently highlight work and income as a priority, while women look to the needs of the household.[109] Needs will also change as people become more skilled. New users may be deterred by the complexity of the Internet and the risks in making mistakes online, so often prefer face-to-face training support that provides reassurance and allows them to ask questions.[110] As users progress, however, they acquire more confidence and can explore and learn by themselves. Tracking the state of digital skills, particularly mobile digital skills, can be done through surveys and qualitative research.[111]

Ensuring gender equality

In addition to providing women with skills and education, especially in science, technology, engineering and mathematics (STEM), it is important to have strong regulatory frameworks that tackle gender stereotypes and societal norms to enable women to reach their full potential. It is also essential to combat the risks of online violence, abuse and harassment as well as threats to privacy, and gender biases in artificial intelligence and robotics. Gender equality should be considered along the Internet user journey, from owning a smartphone, to being aware of the Internet and its benefits through Internet adoption, and then regular use.[112]

ESCAP has been supporting women-owned micro- and small enterprises through its Women ICT Frontier Initiative. In Cambodia, for example, the Centre collaborates with SHE Investments, a social enterprise, to help women entrepreneurs use their mobile devices for bookkeeping and financial management. In Fiji, the Centre works with the Ministry of Women, Children and Poverty Alleviation to train women entrepreneurs in Suva's flea market to use e-commerce and digital marketing in their businesses.

An inclusive digital society that takes account of disabilities

Governments, businesses and civil society need to foster a digital society that is disability-inclusive.[113] For example, digital platforms and contents should be technically accessible for persons who have visual impairments, allowing users to adjust fonts and colours and access information in audio formats. To support access by persons who have hearing difficulties, visual contents and virtual conferences should have sign language interpretation and real-time captioning. For this purpose, both governments and businesses should follow standards and universal design principles, such as the Web Content Accessibility Guidelines.[114]

Many businesses have started to realize the importance of the 'disability market' which globally is larger than the population of China.[115] To support the design and development of disability-inclusive and accessible

108 United Nations, *UN Secretary-General's Roadmap for Digital Cooperation*, June 2020. Available at https://www.un.org/en/content/digital-cooperation-roadmap/

109 GSMA, "Developing mobile digital skills in low- and middle-income countries", November 2021b. Available at https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2021/11/Developing-mobile-digital-skills-in-low-and-middle-income-countries.pdf

110 GSMA, "Understanding people's mobile digital skills needs: insights from India and Ghana", May 2021d. Available at https://www.gsma.com/mobilefordevelopment/resources/understanding-peoples-mobile-digital-skills-needs/

111 GSMA, "Developing mobile digital skills in low- and middle-income countries", November 2021b. Available at https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2021/11/Developing-mobile-digital-skills-in-low-and-middle-income-countries.pdf

112 GSMA, "Policy considerations to accelerate digital inclusion for women in low- and middle-income countries", forthcoming.

113 United Nations Department of Economic and Social Affairs (UN DESA), "Leveraging digital technologies for social inclusion", policy brief No. 92, New York, 2021. Available at https://www.un.org/development/desa/dspd/wp-content/uploads/sites/22/2021/02/PB_92-1.pdf

114 Ibid.

115 Return on Disability Group, "Design Delight from Disability, 2020 Annual Report: The Global Economics of Disability", Toronto, 2020. Available at https://www.rod-group.com/sites/default/files/2020%20Annual%20Report%20-%20The%20Global%20Economics%20of%20Disability.pdf

products and services, businesses have been hiring more persons with disabilities.[116] The chances for employment and entrepreneurships for persons with disabilities have been further improved by advances in ICT and digital technology that have increased telework, e-commerce and e-learning options.[117] Public procurement policies can mandate bidders for public contracts to provide accessible ICT products.[118] There are also indications that employment opportunities for persons with disabilities will increase with the introduction of robots to assist with physical tasks. To this end, some relevant projects have been pioneered in Japan.[119]

Pathway 3: Data about data

Evolving principles for data sharing

Better infrastructure and the greater use of digital technology and applications will generate significant amounts of data that is extensive (from billions of devices) and intensive (detailed data in real time). This entails both rewards and risks. Big data released in real time has well documented benefits in a wide range of sectors, such as disaster risk reduction, air pollution monitoring and mitigation. There are also a number of challenges related to transparency in the use of such data by governments, the private sector, and other actors, related to the protection of privacy and security of data.

Furthermore, between countries, there is a need to advance common understandings on the principles that govern the sharing of such data, particularly with regard to progress in the implementation of SDGs, identifying gaps, and accelerating implementation of SDGs. This requires further study regarding how intergovernmental dialogues, cooperation and norm-setting can evolve.

Over and above these emerging needs, and as the digital transformation assessment tool has revealed, most low-income countries do not have sufficient data to diagnose their digital transformation status. Even two-fifths of the middle-income countries lack data on many of the necessary indicators. To diagnose the current status and challenges and accelerate their digital transformations, such countries also stand to benefit from the development of arching norms and principles that will help strengthen digital data systems and data analytical capacities, which includes benefiting from data-sharing facilities from data-rich countries.

To promote digital transformation, governments may consider a number of concrete actions: capacity-development by promoting literacy and developing the skills of government officials to develop a deeper analysis and understanding of the digital divide and the digital transformation process; using the national and regional intelligent data resource management centres as key infrastructure to maximize data use, provide smart services and expedite innovation; and develop the system for easy sharing of digital and statistical data among public sector organizations, in particular among ministries.

Data privacy and protection

Digital data is a foundational resource and enabler of digital connectivity and digital transformation. Digital data enhances the effectiveness of evidence-based policymaking with more targeted policy interventions for affordable and universal Internet connectivity. Digital data also needs to be accessible while also recognizing the need for privacy and data protection.

116 Ibid.

117 Ibid.

118 United Nations, Economic and Social Commission for Asia and the Pacific (ESCAP), Social Development Division, "Disability-Inclusive Public Procurement: Promoting Universal Design and Accessibility", Social Development Policy Papers, 12 December 2019b. Available at https://www.unescap.org/resources/disability-inclusive-public-procurement-promoting-universal-design-and-accessibility

119 *Disability at A Glance 2021: The Shaping of Disability-Inclusive Employment in Asia and the Pacific* (United Nations publication, 2021b). Available at https://www.unescap.org/sites/default/d8files/knowledge-products/DAG2021-Final.pdf

At the same time, the system and capacity for data privacy and protection, including cybersecurity, are as important as efficient data use in order to build and operate a sound digital society and economy. Therefore, strengthened platforms and actions for enhancing the capacity of Asia-Pacific government officials on developing regulatory policies on data privacy and protection, information security and trust, and cybersecurity must be implemented urgently.

Establishing digital identities

Towards this end, a key building block is the provision of universal digital identities. Today, an estimated 1.1 billion people worldwide, mostly migrants, refugees, those living in poverty or in rural communities and other disadvantaged groups, have no legal identity at all. Sustainable Development Goal 16 (peace, justice and strong institutions), specifically Target 16.9, seeks to remedy this by 2030.

Legal identity is now likely to include a digital identity linked to a personal ID number. Such a legal instrument for authenticating users is fast becoming fundamental to e-governance and e-business as it helps to promote digital services, including financial inclusion and support, to vulnerable groups, and prevent fraud and corruption in the delivery of social services.

Addressing data gaps

Attention needs to be maintained on countries with special needs, notably the Pacific small island developing States as well as the LDCs, where a dearth of data on digital connectivity is preventing a deeper analysis and understanding of the digital divide in these geographically disadvantaged countries. The significant data gaps, including on gender-disaggregated data, constrains policy research and analysis as well as the evidence base for addressing challenges related to universal digital connectivity. A policy priority and capacity-building focus, with commensurate allocation of funding, needs to be directed to addressing these data gaps. The 2050 Strategy for the Blue Pacific Continent,[120] endorsed by Pacific Leaders in July 2022, recognized that technology and ICT connectivity is a critical thematic area for a well-connected region, in particular, on the importance of disaggregated data and data sovereignty for improved decision-making.

Regional cooperative mechanisms in Asia and the Pacific

In May 2022, the 78th Session of the ESCAP Commission adopted the resolution 78/1, "Bangkok declaration on a common agenda to advance sustainable development in Asia and the Pacific". Members and associate members committed to improve digital cooperation and identified the Asia-Pacific Information Superhighway as one of the useful regional platforms.

In response to the commitment, the Government of the Republic of Korea in cooperation with ESCAP is organizing the First Asia-Pacific Digital Ministerial Conference 2022, under the theme: "Shaping Our Common Future", to be held on 10 November 2022 in Seoul, Republic of Korea. It is expected that Ministers will commit to the implementation of the three pathways for digital transformation to shape our digital future through regional cooperation and multi-stakeholder partnerships.

In this connection, the Action Plan 2022-2026 of the Asia-Pacific Information Superhighway provides a useful platform for promoting policy dialogues, cooperation and partnerships between governments, businesses and social groups at regional and global levels. Only by working together, can countries ensure that these technological breakthroughs will work for their economies, societies and the natural environment in an inclusive and sustainable manner.

120 Pacific Islands Forum, "The 2050 Strategy for the Blue Pacific Continent", video, 2022. Available at https://www.forumsec.org/2050strategy/

This demands a people-centred transformation that provides the values and services that people want in flexible, adaptive and innovative ways. The transformation is thus not primarily about technological development but about sustainable human development. The next five to ten years will certainly be transformative but, whatever the changes, the objectives of our actions should be to provide the new products, services and values that the people want and preserve what people treasure about their lives including quality of life and environment protection.

Box

Box 4-1: AI robots for quarantine and care

The AI quarantine robot was unveiled for the first time at the Mobile World Congress 2022. It supports an unattended 24/7 quarantine system at multi-use facilities and public institutions. While moving, the robot purifies the air, using plasma to sterilize airborne viruses and bacteria, and sterilizes floors by irradiating them with UVC LED lamps.[a]

Many local municipalities in the Republic of Korea are also using AI-equipped robots to improve care for the elderly. In an emergency, the robot reports the situation to the 119 service centres and to the family.[b] Over and above these services, a massive deployment of such robots could become a cost-effective means of gathering data which, through AI techniques, can provide useful big data trends that deepen understanding on time sensitive vulnerabilities and early actions needed to alter the course of COVID-19 and the spread of other future biological hazards.

a Lee Jun-sung, "KT to introduce AI and robot at MWC 2022", *Korea IT Times*, 28 February 2022. Available at http://www.koreaittimes.com/news/articleView.html?idxno=111487

b Newsy Today, "The era of robots making coffee", 19 March 2022. Available at https://newsy-today.com/the-era-of-robots-making-coffee/

Contributing Partners

United Nations | Department of Economic and Social Affairs

The Department of Economic and Social Affairs of the United Nations Secretariat is a vital interface between global policies in the economic, social and environmental spheres and national action. The Department works in three main interlinked areas: (i) it compiles, generates and analyses a wide range of economic, social and environmental data and information on which countries draw to review common problems and to take stock of policy options; (ii) it facilitates the negotiations of Member States in intergovernmental bodies on joint course of action to address ongoing or emerging global challenges; and (iii) it advises interested Governments on the ways and means of translating policy frameworks developed in UN conferences and summits into programmes at the country level and, through technical assistance, helps build national capacities.

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UN environment programme

The United Nations Environmental Programme (UNEP) is the voice for the environment within the United Nations system. UNEP acts as a catalyst, advocate, educator and facilitator to promote the wise use and sustainable development of the global environment. UNEP's digital transformations programme aims to harness data and digital technologies to accelerate and scale solutions to the triple planetary crisis: climate action, nature protection and pollution prevention. UNEP is also one of the co-champions of the Coalition for Digital Environmental Sustainability (CODES) and is working to implement the CODES Action Plan for a Sustainable Planet in the Digital Age.

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UNIDO
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

UNIDO is the specialized agency of the United Nations that promotes industrial development for poverty reduction, inclusive globalization and environmental sustainability. The Organization's programmatic focus is implemented in a holistic manner to achieve effective outcomes and impacts through four enabling functions: (i) technical cooperation; (ii) analytical and research functions and policy advisory services; (iii) normative functions and standards and quality-related activities; and (iv) convening and partnerships for knowledge transfer, networking and industrial cooperation.

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The GSMA is a global organization, representing mobile operators and organizations across the mobile ecosystem and adjacent industries. Our vision is to unlock the full power of connectivity so that people, industry, and society thrive. The GSMA delivers for its members through advancing policy, tackling today's biggest societal challenges, underpinning the technology and interoperability that make mobile work, and providing the world's largest platform to convene the mobile ecosystem at the MWC and M360 series of events.

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KT (Korea Telecom) is a leading telecommunications company that has steered the ICT industry in Korea for over 130 years. KT contributes to the advancement of Korea by leading changes in customers' lives and innovations in other industries.

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The National Information Society Agency (NIA) was established in 1987 under the mission "Creates new values as the leading instrument for solving national and social issues with ICT". In an era of the newly emerging Fourth Industrial Revolution and Digital Transformation, NIA continues to play a key role in the intelligent information society. Based on the Framework Act on Intelligent Informatization of Korea, NIA is contributing to the development of "Digital Platform Government" focusing on the core technologies and capabilities of digital transformation: data, network, AI, and digital inclusion.

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