Understanding E-Resilience for Pandemic Recovery in Asia and the Pacific

Asia-Pacific Information Superhighway (AP-IS) Working Paper Series

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

Correspondence concerning this working paper should be addressed to the email: escap-ids@un.org.

Contact:
ICT and Development Section
Information and Communications Technology and Disaster Risk Reduction Division
United Nations Economic and Social Commission for Asia and the Pacific
United Nations Building
RajadamnernNok Avenue
Bangkok 10200, Thailand
Email: escap-ids@un.org

Preface

The COVID-19 pandemic has accelerated the digital transformation and underscored its importance for mitigating the economic slowdown, sustaining wellbeing, and speeding up recovery. Governments, smart policymaking, as well as regional cooperation play an essential role in helping to both enable digital transformation to occur and in facilitating access to technology. In this regard, the Secretary-General's Roadmap for Digital Cooperation, presented on June 11, 2020, comes at a critical inflection point for digital issues by outlining key areas for action to advance a safer, more equitable digital world.

The adoption of digital tools contributes substantially to the achievement of the SDGs. The development of the digital infrastructure to reduce the digital divide would first advance SDG 9 (Industry, Innovation, and Infrastructure). By providing access to more health-related information, ICT drives progress on SDG 3 (Good Health and Well-being). Digital tools can also democratize education and facilitate remote working, thereby promoting SDG 4 (Quality Education) and 8 (Decent Work and Economic Growth). Further, ICT can lead to progress on SDG 11 (Sustainable Cities and Communities) and 7 (Affordable and Clean Energy) among other SDGs. Finally, SDG17 identifies technology in general, and ICT specifically, as an essential Means of Implementation for the SDGs and as a tool for supporting international partnership towards the SDGS.

Recognizing the importance of digital connectivity and e-resilience for development, as well as for overcoming major challenges such as COVID-19, IDD and TIID of ESCAP presented a number of analytical papers to the Third Session of the Committee on ICT and Science Technology and Innovation (CICTSTI) on August 19-20, 2020. The Committee recommended that the ESCAP secretariat support the expansion of regional collaboration to scale up broadband Internet capacities for technological innovation. In addition, it recognized the importance of collaborative actions to harness technology to address disasters and welcomed collaborative multi-stakeholder efforts to forge technology alliances. The Committee also emphasized the importance of science, technology, and innovation for the achievement of the Sustainable Development Goals in Asia and the Pacific.

This paper is aimed to provide a basic overview of the policy responses in support of ICT for development, with a focus on the use of technology in the region under the framework of e-resilience and inclusive broadband, two key pillars of the Asia-Pacific Information Superhighway (AP-IS).

This paper is geared towards government officials across Asia and the Pacific that are involved in the formulation and implementation of national policies and programmes affecting ICT, transport, energy infrastructure development, emergency situations, and SDGs in their respective countries. It is also intended for the Working Group on Innovation and Technology for Sustainable Development (ITSD), a subsidiary body under the UN Special Programme for the Economies of Central Asia (SPECA) comprising senior policymakers, researchers, and decision-makers in the areas of digital connectivity, innovation, and technology.

The draft paper is shared for the peer-review process on 5 October and presented for the regional Expert Group Meeting (EGM) on 10 November 2020, aimed to inform the development of the AP-IS 2022-2026 by the regional working group.

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Abbreviations

AI	Artificial Intelligence
AP-IS	Asia-Pacific Information Superhighway initiative
DRR	Disaster Risk Reduction
ESCAP	Economic and Social Commission for Asia and the Pacific
GDP	Gross Domestic Product
GNI	Gross National Income
GPS	Geographic Information System
ICT	Information and Communication Technology
ITU	International Telecommunication Union
IOT	Internet of Things
LTE	Long term evolution
OECD	Organization for Economic Co-operation and Development
PDNA	Post Disaster Needs Assessment
RS	Remote Sensing
WHO	World Health Organization
3G	Third generation mobile
4G	Fourth generation mobile
5G	Fifth generation mobile

Executive Summary

ICT is playing a key role in the response of Asia and the Pacific to the COVID-19 pandemic. Emerging technologies are being deployed across the region in an effort help fight the outbreak and have become essential to the functioning of society and the economy in times of social distancing.

The unprecedented uptake of digital solutions, tools, and services in response to the pandemic is speeding up the global transition towards a digital economy. Social distancing has generated a high demand for fast and reliable connectivity to support the growing information flow. Since January 2020, data traffic has increased all over the world, and, in some cases, it has exploded overnight. The quality of connectivity depends on the level of development of the underlying ICT infrastructure, which has been crucial in the response of countries to the pandemic.

In an effort to flatten the curve of the spread of the infection, governments have been prompted to closely monitor the spread of the outbreak to prevent the risk of further contamination through digital tracing, digital tracking, and the mapping of the contamination. Digital tools have also been deployed to mitigate the impact of COVID-19 through risk communication, community engagement and the use of technology by healthcare systems. In the face of unprecedented socio-economic disturbances, the move towards remote working and education has permitted individuals to respect social distancing without social isolation and to preserve their livelihoods.

However, the deployment of technology across the region has also revealed the yawning gap between under-connected and hyper-digitalized sates in Asia and the Pacific, where almost half of the population does not have access to the Internet. Those that are less digitally equipped are more vulnerable to the devastating effects of the pandemic. With a rapidly increasing digital divide, less advanced countries run the risk of being left even further behind. The region urgently needs to multiply its efforts to bridge the digital gap by accelerating the implementation of technologies at local, national, and regional levels.

This study is concerned with the resilience of ICT networks in Asia and the Pacific in the face of a pandemic. As the third pillar of the Asia-Pacific Information Superhighway (AP-IS), e-resilience is defined as the ability of ICT systems to withstand, recover from and change in the face of an external disturbance. In addition, e-resilience is concerned with utilizing ICT for societal resilience. These two aspects of e-resilience are inter-dependent and have gained in importance and political momentum.

Digital infrastructure needs strengthening to deal with the impact of COVID-19 and future public health crises. In this context, this study provides an overview of experiences and lessons learned and identifies policy priorities and areas for regional cooperation. The study proposes a cooperation framework that sets out guiding principles and defines specific tasks for the periods of recovery and preparedness for new crises. It also proposes to develop an e-resilience preparedness monitoring tool to inform and assess digital performance across the region and ensure that ICT systems are in place to handle future crises.

The paper highlights the following key messages:

- The pandemic underscored the **vital role of ICT in the crisis's periods**. Various Digital tools helped governments to slow down the spread of COVID-19 via e.g. monitoring of people's contacts, the real-time observation of quarantine periods, emergency communication and supporting overstretched healthcare systems. Internet access helped to firms, institutions and individuals to continue business and study through restructuring their work towards remote mode of operation.

- Pandemic has also revealed the **yawning gap between under-connected and hyper-digitalized states** in Asia and the Pacific, with those that are less digitally equipped are more vulnerable to the devastating effects of the pandemic.
- The paper underscores importance of a resilient ICT infrastructure with two mains aspects of e-resilience: **ICT for its own resilience and ICT for societal resilience, which are inter-dependent** and are especially critical in times of crisis. Strengthened ICT infrastructure and improved access to Internet would ease the response and societal resilience to the possible future crises, as for example current COVID-19 pandemic, and ensure the post-crises recovery phase.
- It's important for governments to have a **tool helping to assess the resilience** (or vulnerability) of their digital infrastructure. It includes the importance to measure e-resilience from different perspectives (e.g. technological, human, political, etc.), in order to help countries better understand their strength and weakness and in turn develop effective policies.

I. Digital Technology under the E-resilience Framework in Pandemic and in Post Crises Period

Asia and the Pacific has effectively deployed digital technologies to trace chains of past contamination, track individual's movements and map out the spread of the virus. The most effective promotion of e-resilience rested on the adoption of the needed technologies, a digital infrastructure enabled and activated by the government, and seamless data sharing between the public and private sector.

Organized support services and improved access to infrastructure would ease the response and societal resilience to the pandemic and ensure the post-crises recovery phase. Each group of actors, from government entities to the private sector, community groups, and the public, have roles to play. In this regard, the e-resilience preparedness and its monitoring would be instrumental to inform and in making assessments that would define the future sustainable strategies build on complementarity principles.

The proposed framework is presented in Table 1 on e-resilience from management perspective.

Table 1: E-resilience from pandemic management perspective[1]

Pandemic phase and ICT Role	Risk Prevention	Risk Reduction	Preparedness, adaptation and Response	Recovery Phase
Key task	Improving pandemic-informed measures for investments, strategies, operations	Mitigating the chance of virus-induced disruption, damage, and socio-economic losses, through lessons learnt	Lessening adverse impacts by preparing for new pandemics and developing the e-resilience monitoring dashboard to define the collaboration entry points	Restoring livelihoods and health, recovering social & economic assets and operations, and building back better
ICT for its own resilience	▪ Avoiding the creation of new risks, the exacerbation of existing risks, and the transfer of risks ▪ Co-deployment of ICT with road transport and energy infrastructure	▪ Addressing the underlying risk factors ▪ Reducing vulnerability to virus ▪ Increasing capacity & protection ▪ Retrofitting assets and capital ▪ Reducing exposure ▪ Investing in early warning	▪ Ensuring continuity plans on connectivity ▪ Ensuring redundancy & backups ▪ Ensuring response readiness ▪ Ensuring training & drills in shared infrastructure ▪ Ensuring contingency planning ▪ Ensuring emergency mechanisms ▪ Ensuring early recovery	▪ Enabling rapid multi-dimensional assessment ▪ Enabling estimation of needs ▪ Ensuring recovery strategy ▪ Investing to reduce future risks ▪ Resilience thinking adaptive ICT framework

1 CICTSTI, 19-20 August 2020. Agenda Item 2 on "Collaborative Actions to Harness Technologies During Pandemics", https://www.unescap.org/sites/default/files/CICTSTI_1_item%202_E.pdf

ICT for society's resilience	▪ Utilizing ICT to improve risk assessments ▪ Utilizing ICT for better analysis ▪ Utilizing ICT for development planning through real data management, scenario planning techniques and considering who is left behind	▪ Establishing and utilizing risk databases ▪ Utilizing GIS, RS, ST for DRR ▪ Fostering knowledge & innovation ▪ Enhancing coordination ▪ Enhancing risk monitoring & warning	▪ Utilizing ICT for preparedness ▪ Utilizing ICT for assessment and emergency decision making ▪ Enhancing communication and coordination at all levels ▪ Enhancing technologies for real data management and scenario planning	▪ Enabling rapid assessments and detailed PDNA ▪ Acceptance of uncertainty and unpredictability ▪ Enhancing polycentric governance built on diversity and redundancy ▪ Diversify economy

The pandemic underscores the importance of a **resilient ICT infrastructure**. The reliability, diversity, speed and resilience of national and regional ICT infrastructure, in particular broadband networks, is a critical development priority in the region. During times of crisis and social distancing, ICT permits real-data information flow, gives access to digital learning tools to students, enables electronic stock market exchanges and online consumption. In this environment, the resilience of core Internet infrastructure takes on unprecedented importance.

The role of e-resilience can be enhanced by ICT network diversity and by recognizing the importance of a resilient ICT infrastructure for sustainable development. The quality of infrastructure affects the quality and the capacity of technology to absorb big data and its technical capacity to process real-data management in times of crisis.

E-resilience is also concerned with utilizing **ICT for societal resilience**. It plays a significant role in linking people and machines, as well as institutions and communities at all levels. Well-connected systems can recover from disturbances faster due to the timeliness and speed of the information flow, but overly connected systems may lead to the rapid spread of disturbances and misleading information.

Societal resilience depends on information, knowledge flow and the quality of ICT infrastructure resilience, which can better support disaster management systems and ensure one-to-many communication during the pandemic period.

Policymakers should share the **e-resilience guiding principles** with member states, to promote a better understanding of risk and information sharing principles, customize actionable information, as well as use real-time information in pre- and post-pandemic phases for effective decision-making. Partnerships between important actors would soften the impact of the pandemic on human lives and digital technologies would effectively serve their indented purpose.

ESCAP has developed an **e-resilience toolkit** that can be adapted to the current situation and offers insights into a broad spectrum of available ICT tools and best practices regarding seamless connectivity and data sharing. The cooperation framework between countries and between the public and private sectors in the post-pandemic period may focus on recovery and crisis preparedness. This would involve the further development of ICT infrastructure resilience and ICT for societal resilience.

This Chapter I provides an overview of digital tools and applications which helped governments to slow down the spread of COVID-19 via e.g. monitoring of people's contacts, the real-time observation of quarantine periods and other surveillance tools; provided emergency communication, online work and learning and supported overstretched healthcare systems.

1.1 Risk Prevention: Monitoring the Spread Of COVID-19 Through Digital Tools

The importance of ICT in disaster risk reduction and management became apparent in the use of digital tools in the region's response to COVID-19. In the face of a contagious disease, one of the best ways to slow its spread is through contact tracing and tracking, which identifies individuals that may have encountered an infected person. With the viral spread being too fast to be contained by manual contact[2], countries have harnessed capacities of digital technologies to trace chains of past contamination, track individual's movements and map out the spread of the contamination.

By adopting the appropriate technologies and developing a strong and inclusive ICT infrastructure for **e-resilience**, governments can manage the risks posed by the crisis and improve societal resilience. With a better access to the proper resources and the availability of well-connected systems, communities will be able to cope with the consequences and adapt to the unfolding crisis.

1.1.1 Digital Tracing spread of a virus

As a risk prevention measure to stop the spread of COVID-19, the governments in Asia and the Pacific have been particularly active in deploying digital tracing tools. These tools collect data on the progress of the virus by following people's movements and contacts. This method is an important factor in infectious disease control and is more effective at the earlier stages of an outbreak[3]. So far, different frameworks for building COVID-19 mobile software applications have been developed. However, some privacy concerns have been raised, especially concerning systems that use the geographical location of app users.

In **Singapore**, the government encouraged citizens to install the mobile application "TraceTogether,"[4] which uses Bluetooth technology to identify and record data from the nearby phones that also have the app installed. When a contact is suspected with an infected person, users must upload the data from the phone to a server.

The government of **India** has also launched its official COVID-19 tracking app called "Aarogya Setu." The software was developed by the Ministry of Electronics and Information Technology and uses location data and Bluetooth to see if a user has been near a COVID-19 infected person. If a user comes in close contact with someone, who has tested positive for the virus, user data is then shared with the government.[5]

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[2] https://science.sciencemag.org/content/early/2020/04/09/science.abb6936
[3] https://www.ncbi.nlm.nih.gov/pubmed/30380305
[4] https://www.gov.sg/article/help-speed-up-contact-tracing-with-tracetogether
[5] https://www.mygov.in/covid-19/?cbps=1

In the **Republic of Korea**, where one of the more striking case of curve-flattening was observed, private developers have produced mobile apps that supplement official government contact tracing efforts. The app "Corona 100m"[6] collects data from public government sources that alert users of any diagnosed COVID-19 patient, along with the patient's diagnosis date, nationality, age, gender, and prior locations.

Traditionally, contact tracing has been laborious work. Trained staff need to interview infected individuals and trace all the contacts they have been in touch with. This approach is particularly effective when the number of infected people is small. However, when transmission takes places at a massive scale, it is imperative to adopt more powerful digital technologies for more efficient tracing.

To be effective at the regional or national level, contact-tracing apps need to be nearly ubiquitous. They are characterized by strong network effects, meaning that their value to any user depends on how many other people download the app and use it regularly. If only a small proportion of the population is using the app, it becomes worthless or even harmful. Indeed, the app's indications will be highly inaccurate and could even give a false sense of security. Some estimate that for contact-tracing apps to stop contagion, adoption would need to be at least 60% of the population[7]. And for apps to ensure that each user is accurately informed about all of his or her contacts, adoption would have to be even greater.

Instead of launching contact-tracing apps broadly and indiscriminately, one other strategy could be to deploy these apps in a highly focused way. Indeed, by targeting contained communities such as religious communities, workplaces, schools, restaurants, hotels, trains, or airplanes, adoption within each small community might approach 100%. Once these apps gain critical mass in small communities, they can gradually be scaled and connected to the point where most of the population will have downloaded it.

The data gathered from these apps can greatly empower tracers to quickly identify possible groups of people who may have been in contact with the infected individual. Such technology can also enable researchers to better understand the transmission pattern and take appropriate action. This explains why so many countries in the region (Table 2) have adopted contact tracing technologies using smartphones

Table 2: Contact-tracing apps developed by the ESCAP member ***(Source: see URL)***

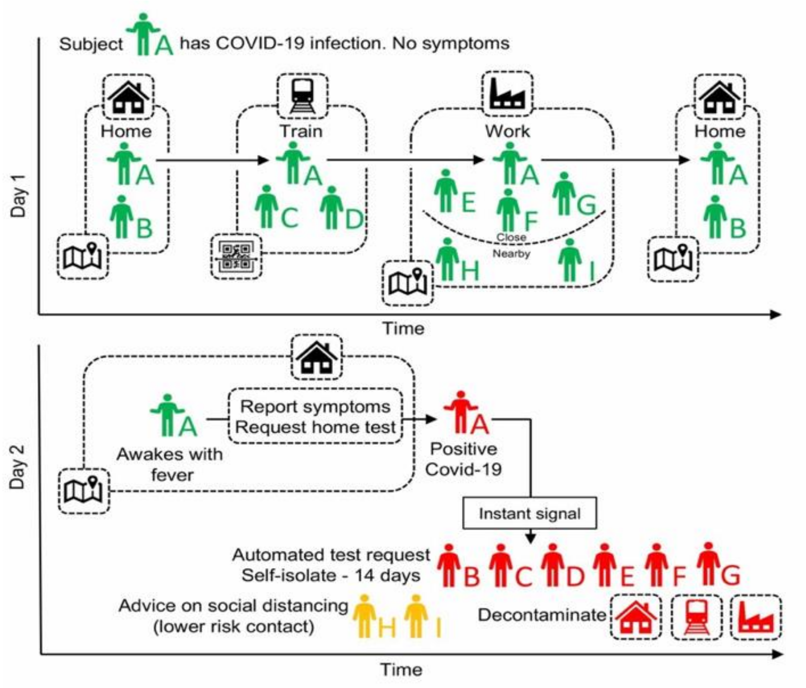
Country	App Name (and URL)	Initiated by government or private sector	iOS / Android	Bluetooth / GPS
Australia	COVIDSafe	Government	Both	Bluetooth
Bangladesh	Corona Tracer BD	Government	Android	Bluetooth
China	Close Contact Detector	Private – Government	Alipay, WeChat & QQ	Gov. surveillance data
Hong Kong, China	StayHomeSafe	Government	Both	Bluetooth & GPS
India	SAIYAM - Track & Trace Together	Private	Android	Bluetooth & GPS
India	Aarogya Setu	Government	Both	Bluetooth & GPS

[6] http://www.korea.net/NewsFocus/Society/view?articleId=183129
[7] https://hbr.org/2020/07/how-to-get-people-to-actually-use-contact-tracing-apps

India (Arunachal Pradesh)	COVID CARE	Private	Android	GPS
India (Goa)	Covid Locator	Private – Government	Android	GPS
India (Karnataka)	Corona Watch	Government	Android	GPS
India (Maharashta)	MahaKavach	Government	Android	GPS
India (Odisha)	COVID-19 Odisha	Government	Android	Bluetooth & GPS
India (Surat)	SMC COVID-19 Tracker	Government	Android	GPS
India (Tamil Nadu)	COVID-19 Quarantine Monitor Tamil Nadu	Private – Government	Android	GPS
India (Uttar Pradesh)	UP Home Isolation App	Government	Android	GPS
India (Uttarakhand)	Uttarakhand CV 19 Tracking System	Government	Android	GPS
Indonesia	PeduliLindungi	Government	Android	Bluetooth & GPS
Japan	COCOA	Government	Both	Bluetooth
Kyrgyzstan	Stop COVID-19 KG	Government	Android	GPS
Malaysia	MyTrace	Private – Government	Android	Bluetooth
New Zealand	NZ COVID Tracer	Private – Government	Both	Neither (QR code)
Philippines (Cebu)	WeTrace	Private – Government	Both	GPS
Singapore	TraceTogether	Government	Both	Bluetooth
Singapore	Contact Trace	Private	Android	GPS
Republic of Korea	코로나 100m (Corona 100m)	Private	Android	GPS
Republic of Korea	신천지위치알림 Byungchul YOO	Private	Both	GPS
Thailand	Thai Chana	Government	Both	Neither (QR code)
Thailand	MorChana - หมอชนะ.	Private – Government	Both	Bluetooth & GPS
Vietnam	Bluezone	Government	Both	Bluetooth

Figure 1 explains how a contact tracing app works. Contacts of individual A (and all individuals using the app) are traced using GPS co-localisations with other app users, supplemented by scanning QR-codes displayed on high-traffic public amenities where GPS is too coarse. Individual A requests a test using the app, and their positive test result trigger an instant notification to individuals who have been in close contact. The app would then recommend to the Individual A to self-isolate.

Figure 1: A schematic of app-based COVID-19 contact tracing



Source: Ferretti, Luca & al (2020-03-31). "Quantifying SARS-CoV-2 transmission suggests epidemic control with digital contact tracing". Science. doi:10.1126/science.abb6936, accessed at:https://science.sciencemag.org/content/early/2020/04/09/science.abb6936/tab-figures-data

1.1.2 Digital Tracking and Physical Surveillance

Extensive surveillance measures were adopted by countries in the region to slow the spread of COVID-19. The real-time observation of quarantine periods and other forms of physical surveillance during emergencies were deployed through apps, facial recognition cameras equipped with heat sensors, and surveillance drones used to monitor citizens' movements.

Mobile phone monitoring has emerged as an essential tool in enforcing self-quarantine measures. In **Taiwan**, **China**, where the outbreak was quite successfully contained, the government provided individuals with a mobile phone to monitor their whereabouts. Upon request, health authorities are given access to individual records to track with whom infected or risky persons have been in contact and extend quarantine measures.[8]

In order to enforce compliance of a 14-day quarantine upon entry for overseas arrivals, **Hong Kong, China, Vietnam, and other countries** require each new arrival to download the *"StayHomeSafe"* app[9].

[8] C. Jason Wang, Chun Y. Ng, and Robert H. Brook, "Response to COVID-19 in Taiwan", JAMA, March 3, 2020, https://doi.org/10.1001/jama.2020.3151
[9] StayHomeSafe

Individuals are also given a paired wristband that uses geofencing technology[10] to monitor their location. It can trigger a warning and alert the government if the measures are violated. In Kazakhstan, the Ministry of Health has required over 8000 officials to use the *"SmartAstana"* tracking app, which guarantees that individual stay at home in isolation during quarantine[11].

Another surveillance tool that has been utilized to track the spread of the virus is facial recognition technology connected to a temperature sensor, which measures a person's body temperature, while also identifying their face and name. **Thailand** is the first country to have introduced a biometric fever screening solution that is fully integrated into its existing biometric border control system.[12] In **China**, facial recognition cameras are being rolled out at massive scale. The country has installed trial facial recognition thermometers on buses[13] to detect coronavirus symptoms, which scan passenger's faces at the entrance of the bus and alerts the driver if an anomaly has been detected. However, all this can be rendered useless if the thermometers are not connected to the cloud, as the data points can be very useful in producing real-time map zones of high-fever cluster areas as disease surveillance and upon detection, a decision can immediately by called upon by local government to lock-down the area.

The use of drones for the purpose of enforcing public-health practices has also emerged as a tool in preventing the spread of the virus. In **China**, the government uses drones provided by DJ-Innovations to access remote parts of the country in order to ensure that its citizens respect stay-at-home guidelines and wear masks in public.[14] KazUAV, **Kazakhstan's** leading drone service provider and a member of **Japan**-based Terra Drone Corporation, has been working at the frontlines to keep communities safe amid the COVID-19 pandemic outbreak. Providing direct support to the operational headquarters set up to prevent the spread of coronavirus in **Kazakhstan**, KazUAV has been helping the Nur-Sultan Police Department to patrol the borders of the locked-down capital city with drones, ensuring 'contactless' surveillance and fast-paced operations. Using drone-mounted cameras with both visible and infrared sensors, the KazUAV team broadcast all captured data, as well as the exact coordinates of objects of interest, directly to the operational headquarters command centre. This has led to the authorities discovering multiple bypass roads and irregularities in the locked-down area – without which, the quarantine measures could not have proven effective.[15]

For the moment, we are not fully aware about contact tracing and tracking mobile apps or how they could impact society. How many people will download apps? What data will they collect and how long will that information be stored for? Are there policies in place to prevent abuses? With a carefully coordinated strategy between governments and local communities, emphasizing on a focused, systematic adoption and instant impact, coupled with a thoughtful approach to the trade-offs between health and the privacy, such mobile apps can and should be instrumental and crucial in fighting pandemics.

In **Australia**, police drones are also being deployed to public spaces, such as beaches, parks, and cafe strips, to deliver audio warnings to people disrespecting social distancing rules[16]. The drones can

[10] https://qz.com/1822215/hong-kong-uses-tracking-wristbands-for-coronavirus-quarantine/
[11] https://privacyinternational.org/examples/apps-and-covid-19
[12] https://findbiometrics.com/biometrics-news-dermalog-provides-biometric-fever-detection-thai-border-021802/
[13] http://www.xinhuanet.com/english/2020-02/18/c_138795692.htm
[14] https://www.cnbc.com/2020/02/25/coronavirus-china-to-boost-mass-surveillance-machine-experts-say.html
[15] https://www.terra-drone.net/global/2020/04/09/kazakhstan-drones-patrol-coronavirus-covid-19-lockdown/
[16] https://www.watoday.com.au/national/western-australia/extreme-and-draconian-wa-police-launch-drones-to-enforce-social-distancing-rules-20200330-p54fdc.html

broadcast messages up to a range of one kilometre and can be dispatched rapidly in areas that do not have a police presence. The drones also feature sirens and flashing lights to ensure they are not missed by the public.

Table 3 summarises the types of technologies with critical capabilities for implementing surveillance. Advanced video surveillance and facial recognition cameras could not function without cloud computing capabilities, but cloud computing in isolation is not inherently oriented toward surveillance. Therefore, these secondary use of AI technologies are also "enabling technologies" . This underlines the importance of developing a strong and sustainable infrastructure to support these AI technologies.

Table 3: AI surveillance–enabling technologies

AI Surveillance Technique	**Description**
Automated Border Control Systems	Biometric systems powered by facial recognition to automatically control airports or broader access
Cloud Computing	Infrastructural components, networks, and sensors that enable AI processing and operations (for example, cloud servers, data centers, IOT networks)
Internet of Things	Devices connected via the Internet that allow data to be shared for analytic processing in the cloud
Other AI Technology	Other relevant secondary use of AI technologies such in digital government, in AI training centres, and in AI research centres

1.1.3 Digital Mapping Tools

Maps and geographic information systems (GIS) provide valuable insights to manage the COVID-19 crisis, maintain continuity of operations, and increase resilience for long-term recovery. An instant image of risk areas and response capacity can be mapped showing the cases and the spread of the virus to inform on the target interventions and suppress the exponential spread of the virus. A number of countries are planning to contain local outbreaks of COVID-19 based on different categories of risk zones, establishing containment and buffer zones within the risk hotspots[17]. The resulting cluster-containment response strategies are yielding positive results and helping countries to restrict the transmissions of COVID-19, especially within vulnerable communities[18].

In the **Republic of Korea**, among the multitude of web and mobile applications that were developed during the outbreak are "corona maps"[19]. These real-time exposure maps trace the movement trajectories of confirmed cases by using data from the *Korea Centers for Disease Control and Prevention*. On the Coronamap.live website, a click on the button "See whether I am safe" allows users to know whether

[17] https://www.unescap.org/blog/outpacing-covid-19-key-innovations-prompt-early-warning-early-actions
[18] https://www.unescap.org/blog/outpacing-covid-19-key-innovations-prompt-early-warning-early-actions
[19] https://www.reuters.com/article/us-china-health-southkorea-maps/mapping-coronavirus-south-koreans-turn-to-online-tracking-as-cases-surge-idUSKCN20I0HG

there are any confirmed COVID-19 cases in their neighborhood[20]. These type of infection maps helps the public to absorb the information and adjust their own behavior in response.

Similarly, in **Indonesia**, an interactive map dashboard[21] was released by the *Coronavirus Disease Mitigation Acceleration Task Force*, which coordinates the government's efforts to mitigate the spread of COVID-19. The map helps track and visualize the spread of the disease in the country's 34 affected provinces. The dashboard represents the authoritative source of information about infections and may be used to share data with other government departments, enabling them to deploy resources more efficiently and make well informed decisions about their course of action to combat the virus.

Table 4: A comparison of digital maps visualizing COVID-19 and/or related impacts

	China's Nikkei Asian Review	**Japan's COVID-19 Tracker**	**Republic of Korea's Corona Map**	**Indonesia's Distribution Map**	**Australia's map of at risk populations**
URL	https://vdata.nikkei.com/en/newsgraphics/coronavirus-china-map/?open	https://covid19japan.com	https://coronamap.live	https://covid19.go.id/peta-sebaran	https://absstats.maps.arcgis.com/apps/MapSeries/index.html?appid=bacd58f73b554c329f431ceb02ef9ab8
Visuals	Shows total infections and total deaths over time at the national and provincial levels	Shows clusters of people infected with the virus in each prefecture	Traces the movement trajectories of confirmed cases and gives their information, including residence, gender, contacts, nationality	Tracks and visualizes the spread of the disease in the country's provinces	Shows the geographic distribution of people with chronic health conditions by area of residence
Goal	Allows users to gain access to accurate information about the scale of the outbreak	Help users understand the current conditions of the outbreak and allows them to directly download their source data	Helps users absorb the information and adjust their own behaviour in response	Enable the public and other government departments to make informed decisions and deploy	Provide insights into the geographic spread of these conditions by using the map in conjunction with local or

[20] https://coronamap.live
[21] https://www.covid19.go.id/situasi-virus-corona/

				resources more efficiently	expert knowledge
Data Sources	WHO and **China**'s National Health Commission	**Japanese** Ministry of Health	**Korea** Centers for Disease Control and Prevention	**Indonesia**'s Coronavirus Disease Mitigation Acceleration Task Force	**Australian** National Health Survey

Source: see "URL"

Table 4 above compares digital maps that have been developed in response to COVID-19, and the ways in which they can be useful for the population and the government. The options for mapping data continue to grow, and countries have come up with different ways of visualizing the outbreak and related impacts. In order to present such types of geographical data, one needs access to GIS technology. There are different programs available today to get access to this technology, including specific resources for COVID-19 that are made freely available, such as QGIS and R Studio[22].

1.2 Risk Reduction: Seamless Connectivity and Innovation in Technology

The pandemic has created the risk of disinformation on the pandemic and of overburdened healthcare systems. In an effort to enhance **e-resilience**, countries have deployed digital infrastructure to enable the exchange of real-time information and provide more support to healthcare systems. Indeed, in the face of this crisis, technology and digital solutions enhance **societal resilience** as well as the **resilience and adaptability of traditional healthcare systems**, helping them to become agile and change at pace and scale.

1.2.1 Risk Communication and Community Engagement

Digital tools work as an interface between government management of big data and an information and risk communication service to users. By spreading awareness on the pandemic, these tools educate citizens, who in turn can take informed decisions to protect themselves and reduce the outbreak's devastating effects. ICTs has been efficiently used for disaster risk reduction (DRR): in the emergency communication, broadcasting over a cellular network (cell broadcast) and SMS (SMS broadcast), business continuity management (BCM) of telecom operators and business in general.

Although the **Japanese** government makes little use of digital tracing and tracking tools, the digital dimension to the country's crisis management remains crucial. Due to the level of protection and safeguards offered by the *Act on the Protection of Personal Information*, **Japan's** data investigations rely very much on human cooperation[23]. Several prefectural governments have been using the messaging application "Line"[24] to provide free consultations and advice to users that may have the virus. After messaging their symptoms, users can expect an AI software to determine whether they need to consult a medical facility. This is not a contact tracing approach, as access is not granted to the list of contacts

[22] https://www.unescap.org/sites/default/files/Stats_Brief_Issue24_Apr2020_Why_reliable_and_timely_population_statistics_are_more_important.pdf
[23] https://www.institutmontaigne.org/ressources/pdfs/publications/fighting-covid-19-east-asian-responses.pdf p.86
[24] The Mainichi, "19 Japan Prefectures Using Line App to Offer Coronavirus Consultations - The Mainichi", March 31, 2020, https://mainichi.jp/english/articles/20200331/p2a/00m/0na/012000c

registered in the Line app of the user. The Government of Japan also conducts scientific simulations for the prevention of infectious diseases, using Artificial Intelligence and supercomputers (such as Fugaku).[25]

As an immediate citizen awareness building and online service provision tool, the ICT Division and the Cabinet Division in **Bangladesh** launched a web platform where citizens can get up-to-date information on the COVID-19 status of Bangladesh and access official prevention guideline from the government. In order to raise mass awareness on the COVID-19 crisis, various government and non-government partner organizations also developed campaign initiatives through Bangladesh Television, social media, and various traditional and new media. 'Corona Helpline' programs have regularly aired on 'RTV' and 'Ekattor Television' with participation of doctors from Bangabandhu Sheikh Mujib Medical University (BSMMU). The TV channel 'RTV' has also partnered with the company 'SMC' and the 'a2i' programme of the government's ICT division to launch a television series that raises awareness on violence against women during COVID-19 and encourages women to contribute to the fight against the pandemic.

In **Taiwan**, **China,** digital tools have also been effective in providing information on the availability of masks during the outbreak. A nationalized system of mask distribution has been operated through a digital platform. Users download from the *National Health Insurance Administration* the "NHI Express App"[26], register their social security number and access information on the availability of masks for sale. Access to that information is also possible through other applications. This enables the government to implement its mask rationing policy of 3 masks per adult and 5 masks per children per week, as the platform also stores the purchase data for each registered individual so that it can be accessed at authorized stores. This effort required the setting up of 20 servers by the *National Health Insurance Administration* to ensure the cloud capacity can handle the surplus traffic. [27]

In **Russia**, in order to provide the information on COVID-19 and raise awareness of the population, the government launched a bot in Telegram (a cloud-based instant messaging and voice over IP service) with questions and answers on the most common issues regarding the organization of flights from abroad to Russia. In addition, a digital pass system has been introduced during the quarantine period in Moscow. The digital passes take form of QR codes which are shown on demand at the public transport system, taxis or at the request of the police. Issuing of all passes was automatic on receiving a one-click application via e-government platforms or by helpline, without any prior authorization.[28]

The Philippines applies science, technology, and innovation in its response to the COVID-19 pandemic through the Department of Science and Technology (DOST) funded the successful development of the local GenAmplify™ COVID-19 rRT-PCR Testing Kits. Other innovative response of the Philippines include: an application called "FASSSTER" can monitor and predict the spread of the disease; RxBox, a telemedicine device for bedside monitoring of a patient's condition; use of Quick Response (QR) codes for Quarantine Control Checkpoints; and SafePass application for contact-tracing and health declaration. The Philippines also expressed its support to the Roadmap on Digital

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[25] https://www.unescap.org/sites/default/files/Japan%2C%20item%202_0.pdf
[26]https://www.nhi.gov.tw/English/News_Content.aspx?n=996D1B4B5DC48343&sms=F0EAFEB716DE7FFA&s=3F2D8EF2E5AEC431
[27] Lee Hsin-Yin, "Tech Experts Helped Make Taiwan's Mask Rationing System a Success", Focustaiwan.tw, February 28, 2020,
https://focustaiwan.tw/society/202002280019aspx?n=9E7670F7D08B6646&sms=DFFA119D1FD5602C&s=0781CF3F1BCB9D6A
[28] https://www.unescap.org/sites/default/files/Russian%20Federation%2C%20item%203.pdf

Cooperation launched by the Secretary-General and to the Global Declaration on Digital Response to COVID-19. [29]

In **India**, an official WhatsApp chatbot called "*MyGov Corona Helpdesk*" is another example of an effort to communicate better risk information to the community. The service was designed by the central government to provide up-to-date information on COVID-19[30]. By connecting to the bot, citizens can get instant answers to their coronavirus queries such as the symptoms of the viral disease, and how to protect themselves and seek additional help. By making sure the public has accurate and timely information about COVID-19, the service aims to fight rumours and misinformation concerning the pandemic.

1.2.2 Technology in Healthcare Systems

With the spread of COVID-19, the adoption of digital operating models has helped overstretched healthcare systems in the Asia-Pacific region to keep up with the explosive demand in medical assistance. Indeed, governments and hospital systems have leveraged AI-powered sensors to support triage in sophisticated ways, provide decision support for CT scans, and automate hospital operations. This has served to alleviate the workload of health care workers and in some areas, replace them altogether. *ICT therefore drives progress on SDG 3, which advances good health and well-being for all.*

During the outbreak of COVID-19, **China** has emerged as one of the undeniable leaders in the deployment of high tech in the field of healthcare. In the *Zhongnan Hospital of Wuhan*, the radiology department is employing software that reads lung scans to look for signs of pneumonia caused by COVID-19[31]. The programme is designed to help overworked staff screen patients and prioritize those most likely to be infected with the virus for further examination. Another Wuhan hospital was converted into a smart field hospital staffed largely by robots and other smart devices[32]. These robots can monitor patient's vital signs, thereby avoiding direct person-to-person contact. They can also disinfect hospitals[33,] reducing the workload of the hospital staff and limiting the risk of cross-infection of the epidemic. High tech tools can also play a key role in delivering essential goods to patients from medical facilitates to underserved areas or individual's homes. They avoid unnecessary human contact throughout the transport cycle and prevent secondary transmission.

In **Thailand**, the Ministry of Digital Economy and Society together with Huawei Technologies have helped the Thai medical personnel at Ramathibodi Hospital with CLOUD technology. As one of the determinants for the diagnosis and treatment of COVID-19, Computed Tomography (CT) scans are fast and accurate but require multiple rechecks and image reviews. HUAWEI CLOUD has therefore provided a faster AI solution for CT quantification results of COVID-19 diagnosis. It reduces the time required for image analysis of COVID-19 to 25 seconds per case and facilitates early screening and prevention. [34]

In **India**, the National Mission on Interdisciplinary Cyber Physical Systems have created a technology platform that will also focus on development and deployment of applications based on AI- driven diagnostics, personalized treatment, early identification of potential pandemics, imaging diagnostics, etc.

[29] https://www.unescap.org/sites/default/files/Philippines%2C%20item%202_0.pdf
[30] https://gadgets.ndtv.com/apps/news/mygov-corona-newsdesk-telegram-coronavirus-updates-join-news-2200080
[31] https://www.wired.com/story/chinese-hospitals-deploy-ai-help-diagnose-covid-19/
[32] https://www.cnbc.com/2020/03/23/video-hospital-in-china-where-covid-19-patients-treated-by-robots.html
[33] http://www.xinhuanet.com/english/2020-04/02/c_138940861.htm
[34] https://ddc.moph.go.th/viralpneumonia/index.php

The Common Service Centers (CSCs) in India are delivering financial and e-health/ tele- medicine to the citizens and also assisting in data entry, validation and management to provide the accurate dissemination of information in public domain with respect to COVID-19. Also, A tele-medicine solution -- e-Sanjeevani OPD, has been developed by the Government of India that aims to provide health-care services to patients through safe and structured video-based clinical consultations between doctors in a hospital and patients in the confines of their home during the current situation. What is more, India has also implemented a project called Remedial Action, Knowledge Skimming and Holistic Analysis of COVID-19 (RAKSHAK) that attempts to find quick and long-lasting solutions to problems faced by different segments of the society from the COVID-19 pandemic using Artificial Intelligence as the enabling core technology.[35]

The use of ICTs will help fight the pandemic by supporting the provision of health care services to underserved or hard to reach populations, such as older persons in rural areas or persons being denied access to hospitals due to overcrowding. With the advent of COVID-19, the benefits of digital health platforms became clear, with virtual visits becoming a safe and convenient solution for a face-to-face medical consultation. If governments plan to create an integrated medical service delivery system using ICT, telemedicine may be the driving force to improve accessibility of health-care services[36].

It can also help reduce medical expenses while enhancing the quality of medical services and business competitiveness in the health-care field[37]. Indeed, telemedicine can save on the construction and maintenance costs of facilities and the cost of supplying medical personnel in remote areas, which can help to reduce the national medical expenses. However, to initiate ICT-based health-care services, governments in Asia and the Pacific will need to implement policies that promote telemedicine while conducting piloted tests to determine the most effective services for the context of COVID-19[38].

The COVID-19 experience highlights the need to build and truly invest in and scale a new digitalized infrastructure. The future of healthcare technology holds tremendous promise for democratizing access to healthcare, increasing patient access to earlier diagnosis and treatment of disease, and improving healthcare quality and affordability. Data, analytics, AI, and connectivity is expected to only become more central to delivering care. Changing the approach to healthcare from reactive to preventative, combined with a move from institutional to community or home-based care will reduce hospitalizations and be more sustainable and efficient for the future.

1.3 Adaptive Measures: Socio-Economic Repercussions and Digital Technologies

The COVID-19 pandemic has had far-reaching consequences beyond the spread of the disease itself and efforts to contain it. Indeed, it has had a strong negative impact on both education and employment, leading to increased poverty in the region. Developing **e-resilience** by accelerating the adoption of digital technology for distance working and learning is an urgent imperative among governments in Asia and the Pacific. However, access to broadband connectivity may hinder remote participation. This is a serious issue for countries that still do not have access to affordable digital connectivity and underscores the need to develop a **resilient digital infrastructure** across the region.

[35] https://www.unescap.org/sites/default/files/India%2C%20item%202_0.pdf
[36] https://www.unescap.org/sites/default/files/publications/APPJ%20Vol.%2032%20No.1.pdf
[37] https://www.unescap.org/sites/default/files/publications/APPJ%20Vol.%2032%20No.1.pdf
[38] https://www.unescap.org/sites/default/files/publications/APPJ%20Vol.%2032%20No.1.pdf

Strategically, the supply-chain digitalization in companies create the business resilience against supply chain disruption. In this context, big data analytics assist firms in streamlining their supplier selection process. The cloud-computing is increasingly being used to facilitate and manage supplier relationships. Logistics and shipping processes can be greatly enhanced through automation and the internet of things. A renewed urgency behind automation and the use of robotics to mitigate against the disruptive impact on supply chains is placed by COVID-19 pandemic, as it has restricted the movement of people. For example, in **China**, the production already has a head start on operations in Cadillac's Shanghai plant using around 400 robots and two fully automated production lines that do welding and painting.

This section of the discussion paper is providing an overview only in two areas: on remote work and education.

1.3.1 Remote Working

With the advent of COVID-19, many nonessential businesses have been compelled to either shut down or adapt to social distancing measures. In attempts to curb infection rates, digital technologies have, therefore, emerged as essential tools for organizations whose operations can be done remotely. Companies that lack the technology or infrastructure to allow their employees to work from home have been driven to fast-track their digital transformation. A rise in technological innovation could lead to higher levels of productivity and economic growth. *This would advance SDG 8, which promotes inclusive and sustainable economic growth, employment and decent work for all.*

In **China,** large technology firms were the first to ask employees to work from home, building on pre-existing infrastructure such as office chat groups, remote access to critical tools, and the fact that much knowledge work can be carried out remotely. Small and medium enterprises quickly followed suit. The adoption of *Alibaba's DingTalk, WeChat Work, and Tencent Meeting* to connect physically distanced teams resulted in a dramatic market expansion[39]. This surge in broadband and wireless consumption has not yet resulted in widespread outages or unusually long service disruptions.

In countries where governments have been less proactive in their response to the pandemic, some businesses and organizations have transitioned to remote work autonomously. Indeed, while the governments of **Kazakhstan** and **Kyrgyzstan** in Central Asia have adopted a number of measures in their response to the pandemic, **Turkmenistan** and **Tajikistan** have yet to announce the closer of nonessential businesses.

According to local media in **Tajikistan**, a number of private companies, embassies, and international organizations, have nevertheless restructured their work to switch to a remote mode of operation[40]. If a lockdown is imposed in the future, however, the slow and expensive *Tajik Internet* is expected to pose a significant challenge. In order to make progress on *achieving SDG 8 (Decent Work and Economic Growth)*, **Tajikistan** needs to improve its ICT infrastructure and incorporate new technologies in its development model.

1.3.2 Digital Tools in Education

In the case of education, the use of ICTs has proven crucial in the shift to distance learning during the pandemic. However, the pandemic has also brought to light the staggering disparities in digitally based distance learning. Unless school connectivity and ICT education in those areas are prioritized, students

[39] https://go.forrester.com/blogs/lessons-from-enterprise-collaboration-experiments-in-china-in-the-wake-of-covid-19/
[40] https://asiaplustj.info/ru/news/tajikistan/society/20200409/kak-pandemiya-uzhe-povliyala-na-zhizn-v-tadzhikistane

in unconnected rural communities will be left behind in education. *The respective goals of reducing digital inequality under SDG 9 (Industry, Innovation and Industrialization) and educational inequality under SDG 4 (Quality Education) are in tandem with and reinforce one another*. ICT in education has the potential to fully apply inclusive access to broadband connectivity to create real impact in education and for advancing both goals.

China, which was initially hit by the virus, is the first country to have embarked on what might amount to the largest simultaneous online learning exercise in human history. In early February 2020, about 200 million primary and secondary school students started their new semester online. The Ministry of Education launched an initiative entitled "*Ensuring learning undisrupted when classes are disrupted."* [41] The Ministry moved fast to organized teleconferences with school management agencies, online platform and course providers, and other stakeholders to plan the implementation of the initiative. [42] It also worked with the Ministry of Industry and Information Technology to boost Internet connectivity service, upgrade the bandwidth of online education platforms, mobilize resources for online resources, adopt appropriate methodologies to facilitate learning, and strengthen online security. [43]

Other countries or school systems are less prepared in terms of the depth of the remote learning facilities being made available and the scale to cover needs. Access to technology in households may vary, and access to high bandwidth Internet is related to income even in middle income countries. In **Turkey**, the *Ministry of National Education* has launched EBA[44], a free education platform with a television and Internet-based curriculum. While 18 million students may use EBA, not everyone has online access. [45] The Ministry is therefore reviewing options to support families with extra data packages. [46] Educational TV is also being utilized to mitigate Internet access and bandwidth problems. Primary school, middle school and high school EBA programs are being broadcasted on 18 different channels.[47]

> The ability to make the shift to remote working and learning has turned into a cornerstone of emergency preparedness. But online learning and working tools may not only be relevant in times of crisis. In fact, the COVID-19 outbreak is also accelerating the trend toward remote working and learning, possibly for the long term. Technological advances can also be expected to bring large-scale changes in the demand for roles in the workforce, with industries such as the tourism, aviation, retail and food service sectors, being severely hit by the pandemic. Leaders must therefore be prepared to take large-scale and coordinated policy measures to facilitate this transformation.

In the **South Asian** state of **Bhutan**, the Ministry of Education launched the **Bhutan** e-Learning program[48] in late March 2020, following the closer of schools. The platform has allowed students to access lessons through educational television and YouTube. However, some students have protested the exorbitant data charges, while others do not even have access to the Internet or

[41] https://en.unesco.org/news/how-china-ensuring-learning-when-classes-are-disrupted-coronavirus
[42] https://en.unesco.org/news/how-china-ensuring-learning-when-classes-are-disrupted-coronavirus
[43] https://en.unesco.org/news/how-china-ensuring-learning-when-classes-are-disrupted-coronavirus
[44] https://www.eba.gov.tr/
[45] https://www.worldbank.org/en/topic/edutech/brief/how-countries-are-using-edtech-to-support-remote-learning-during-the-covid-19-pandemic
[46] https://www.worldbank.org/en/topic/edutech/brief/how-countries-are-using-edtech-to-support-remote-learning-during-the-covid-19-pandemic
[47] https://www.worldbank.org/en/topic/edutech/brief/how-countries-are-using-edtech-to-support-remote-learning-during-the-covid-19-pandemic
[48] https://kuenselonline.com/e-learning-begins-today/

tools that facilitate e-learning. In response, the government started working in conjunction with several telecommunications companies, such as *Bhutan Telecom and TashiCell*, to provide students with additional data for a certain educational content and online tools[49]. The government has made clear that e-learning was not compulsory but has emphasized that students still needed to continue learning[50].

In this time of crisis, the direct impact of digital inequality on educational inequality is clearly visible and should be urgently addressed.

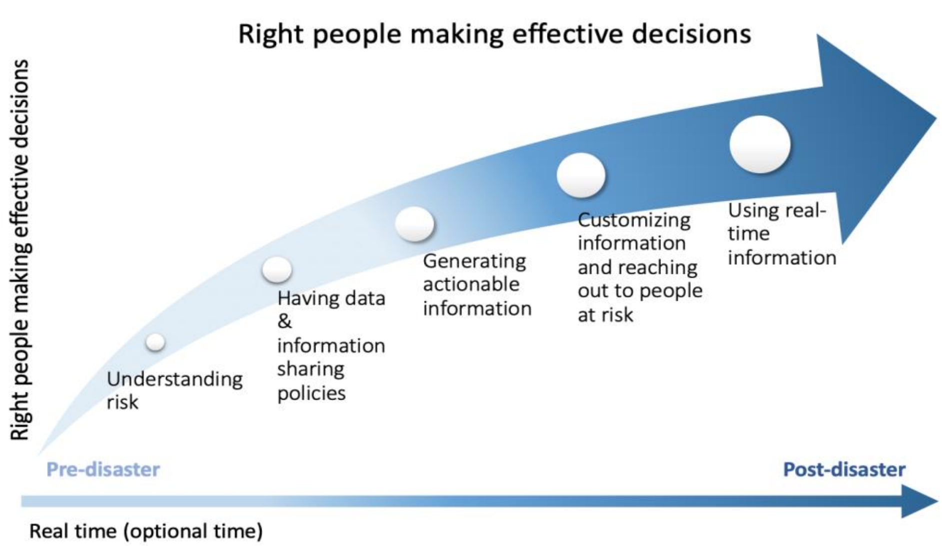
II. Building Back Better with E-Resilience

As highlighted in previous chapters, the pandemic underscores the two mains aspects of e-resilience: **ICT for its own resilience and ICT for societal resilience.** These two elements of e-resilience **are inter-dependent** and are especially critical in times of crisis.

The COVID-19 pandemic has emphasized the importance of ICT infrastructure resilience in the face of disasters. The degree to which ICT systems are capable to withstand, recover from, and change in the face of an adverse event determines their ability to reach and maintain an acceptable level of functioning and structure.

ESCAP proposes five essential steps and guiding principles to enhance e-resilience (see Figure 13 below). Given the key role that ICT plays across the different phases of disaster risk reduction and management, attention should be brought – after having understood the risk and installed data- and information-sharing policies – on generating actionable information, customizing that information and reaching out to people at risk, and finally using real-time information on building and strengthening e-resilience during the COVID-19 crisis. Overall, e-resilience therefore has the potential to reduce disaster risks and improve disaster management, and it can be instrumental in reducing economic loss and preventing human casualties.

Figure 2: E-resilience guiding principles



[49] https://kuenselonline.com/telecos-propose-students-data-quota-to-moe/
[50] https://kuenselonline.com/learning-should-continue-e-learning-is-optional-pm/

Development of e-resilience varies across Asia and the Pacific. Developed economies are relatively advanced in their use of ICT for responding and adapting to hazardous events. Most developing countries are less advanced and, to improve e-resilience in these countries, a comparable measurement framework is important.

This Chapter II provides an overview of the state of digital infrastructure about subscriptions to networks, access and affordability as well as the overview of indexes related to e-resilience from the perspective of the e-resilience of infrastructure and networks and the ICT for societal resilience.

2.1 The State of the Digital Infrastructure in Asia and the Pacific

Digital infrastructure is the key to enabling the benefits of the digital economy and society, and to overcoming COVID-19 through e-resilience. Digital infrastructure is the physical hardware and related software that enables end-to-end information and communications system to operate, as shown in Figure 3. It includes internet backbone, fixed broadband infrastructure (fibre optic cable networks), mobile communications infrastructure and networks, broadband communications satellites, data and cloud computing facilities, end user equipment (computers, Wi-Fi and Bluetooth networks), software platforms, and network edge devices (sensors, robots).

Figure 3: Digital infrastructure

Source: Windsor Place Consulting, 2019

Once the region moves beyond the pandemic, countries have a unique chance for a green and inclusive recovery. The public and private sector should work together to ensure that this recovery not only includes income and jobs, but also has broader goals, such as strong climate and biodiversity action, and building resilience. This means that the Sustainable Development Goals need to be designed into the DNA of global recovery. As plans are formulated to help countries and communities rebuild their economies and societies, this is an opportunity to embrace renewable energy, green technology and sustainable new sectors that put the planet on a fast-track path to decarbonisation. This global health crisis can be a unique opportunity for countries to learn that urgent and decisive national- and regional-level action that includes the adoption of digital technologies can turn a crisis around.

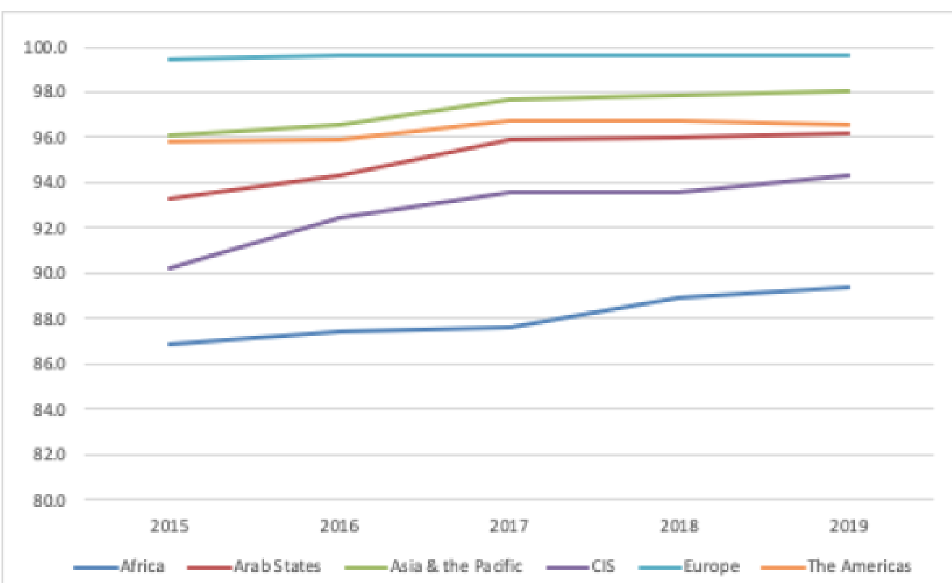
The role of infrastructure is critical to improving connectivity. While much progress has been made in infrastructure development over the past few decades, a lot more needs to be done to provide adequate facilities for the region's people and to support large cross-border flows of trade and investments. Most countries in Asia and the Pacific require substantial amounts of spending to be directed towards infrastructure to allow for growth in their economies.

At any point in time, different parts of the digital infrastructure system will be at different stages of development compared to other parts and obstructions will likely appear. This means that areas of priority development will shift around the network as technologies change and network upgrades occur. For example, as greater numbers of mobile communications towers are established, the demand for backhaul fibre will increase. To further advance the quality of coverage of digital infrastructure, governments can build on principles of sustainable industrialization and fostered innovation, as per SDG 9.

2.1.1 Subscriptions to the Networks

During times of crisis such as the COVID-19 pandemic, effective risk communication relies on the quality of the digital infrastructure. Figure 4 shows the differences in mobile connection coverage in different regions of the world. The Asia-Pacific is only the second region in the world after Europe with the highest percentage of its population covered by a mobile-cellular network. The Americas, Arab States, the Commonwealth of Independent States (CIS), and Africa all lag the region in that regard.

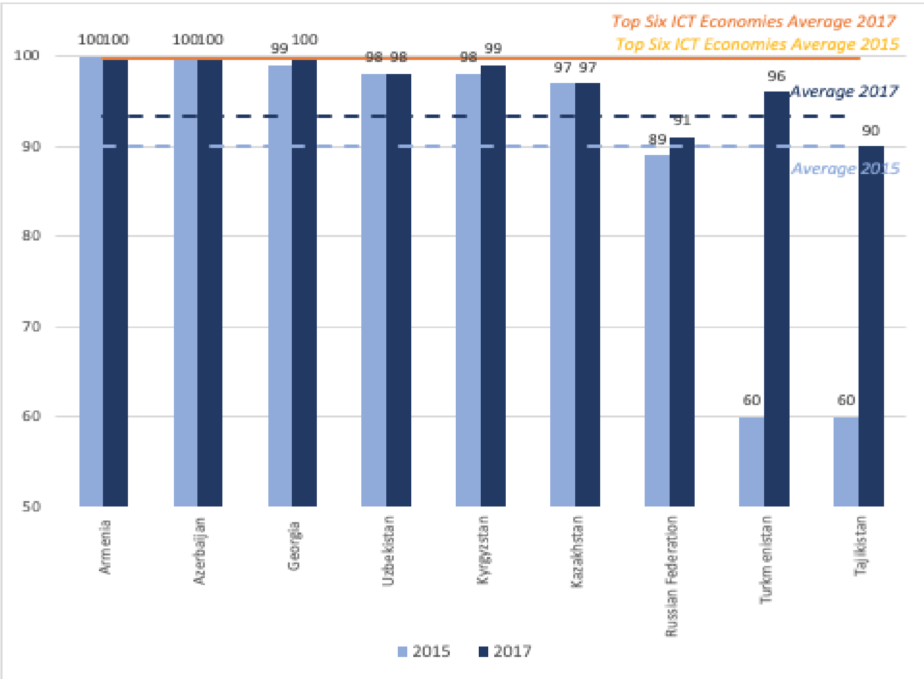
Figure 4: Percentage of the population covered by a mobile-cellular network



Source: Produced by ESCAP based on data from the ITU, World Telecommunication/

ICT Indicators database 2019 (December 2019 Edition).

Figure 5: Percentage of the population covered by a mobile-cellular network in North and Central Asian countries, 2015 & 2017



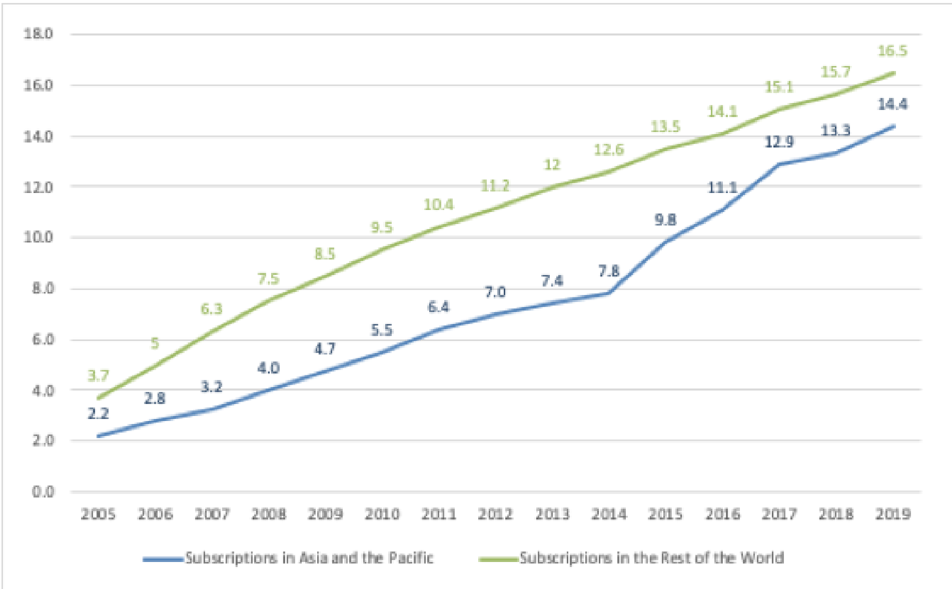
Source: Produced by ESCAP based on data from the ITU, World Telecommunication/ICT Indicators database 2019 (December 2019 Edition). Note: The top six ICT advanced economies are the most advanced economies of ESCAP in terms of the ICT development index (IDI); the Republic of Korea, Hong Kong China, Japan, New Zealand, Australia, and Singapore.

Although Asia and the Pacific fares well in mobile-cellular network coverage compared to other world regions, there are important disparities between and within subregions. In North and Central Asian Countries, for example, all of **Armenia**'s population was covered by at least 3G network, while only 60% of **Turkmenistan**'s population was covered by at least 3G network in 2015. However, there has been important improvements in the past years, with 96% of **Turkmenistan**'s population being covered by at least 3G network in 2019. This improvement will prove essential for the country's capacity to communicate reliable information and reach out to its people during the pandemic.

The speed and rate of download of wireless connections ultimately depend on the capacity of fixed networks. Therefore, fixed and mobile networks broadband play an important role in digital transformation. Reliable fast mobile broadband will be a key enabler of Asia-Pacific growth, which will require large investments in fibre for backhaul and national backbone networks. The need for fibre investment will grow as the capacity of customer wireless networks continues to increase through 4G LTE and 5G technologies, without which the performance of these customer access networks will be compromised by congestion.

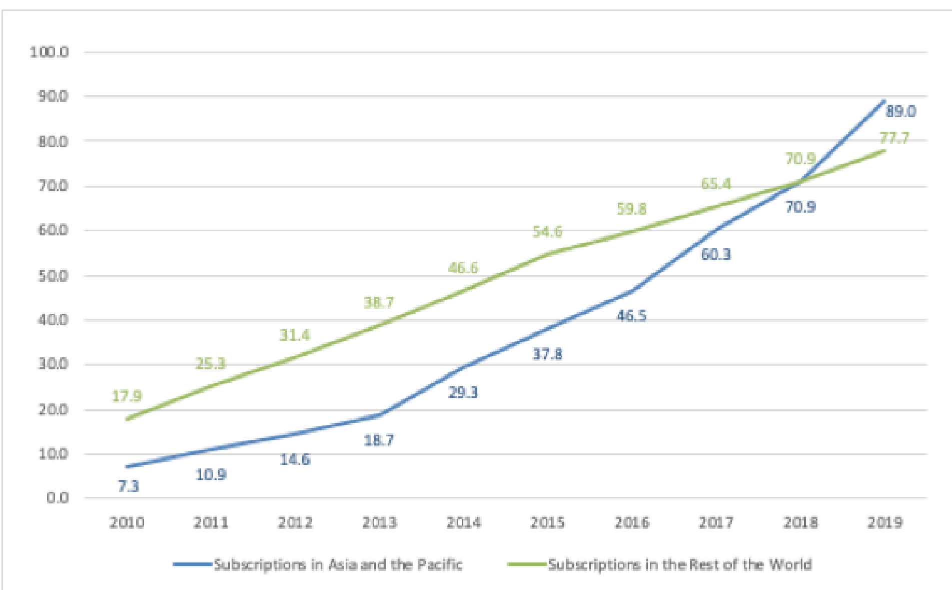
Figures 6 and 7 show the fixed- and mobile-broadband subscriptions per 100 inhabitants in Asia and the Pacific in comparison with the rest of the world. The proportion of subscriptions have been steadily increasing, with the amount of fixed-broadband subscriptions per 100 inhabitants in Asia and the Pacific going from 2.2 in 2005 to 14.4 in 2019, but always staying below the proportion of the rest of the world. The amount of mobile-broadband subscriptions per 100 inhabitants in Asia and the Pacific, however, went from 7.3 in 2010 to 89.0 in 2019, exceeding the proportion of the rest of the world, which was 77.7 in 2019.

Figure 6: Fixed-broadband subscriptions per 100 inhabitants in Asia and the Pacific and the Rest of the World, 2010-2019



Source: Produced by ESCAP based on data from the ITU, World Telecommunication/ICT Indicators database 2019 (December 2019 Edition).

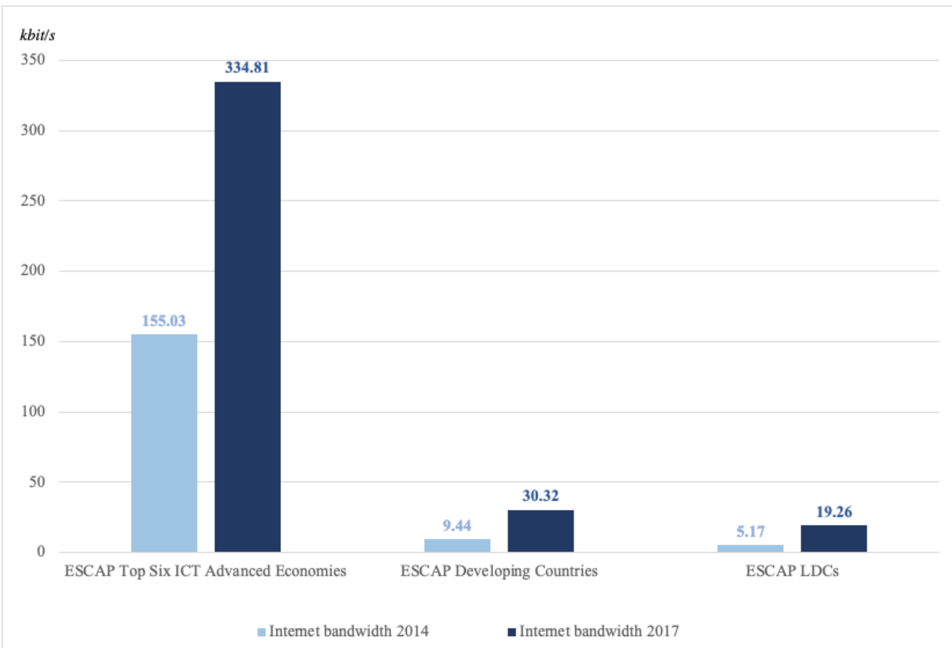
Figure 7: Active mobile-broadband subscriptions per 100 inhabitants in Asia and the Pacific and the Rest of the World, 2010-2019



Source: Produced by ESCAP based on data from the ITU, World Telecommunication/ICT Indicators database 2019 (December 2019 Edition).

Figure 8 shows the differences in international bandwidth (Kbit/s) per Internet user in ESCAP Advanced Economies, ESCAP Developing Countries, and ESCAP LDCs. International Bandwidth is the maximum quantity of data transmission from a country to the rest of the world and is an important factor when determining the quality and speed of a network or the internet connection. International bandwidth is substantially lower in ESCAP Developing Countries and LDCs compared with the top six advanced economies. Between 2014 to 2017, international bandwidth per Internet user has nearly quadrupled in the ESCAP LDCs, going from 5.17 kbit/s to 19.26 kbit/s. During this same time period, it has more than tripled in ESCAP Developing Countries, going from 9.44 kbit/s to 30.32 kbit/s. In the top six ICT advanced economies, international bandwidth has doubled, going from 155.03 kbit/s in 2014 to 30.32 kbit/s in 2017.

Figure 8: International bandwidth (kbit/s) per Internet user, 2014 & 2017



Source: Produced by ESCAP based on data from the ITU, World Telecommunication/ICT Indicators database 2019 (December 2019 Edition).

Note: The top six ICT advanced economies are the most advanced economies of ESCAP in terms of the ICT development index (IDI); the Republic of Korea, Hong Kong China, Japan, New Zealand, Australia, and Singapore.

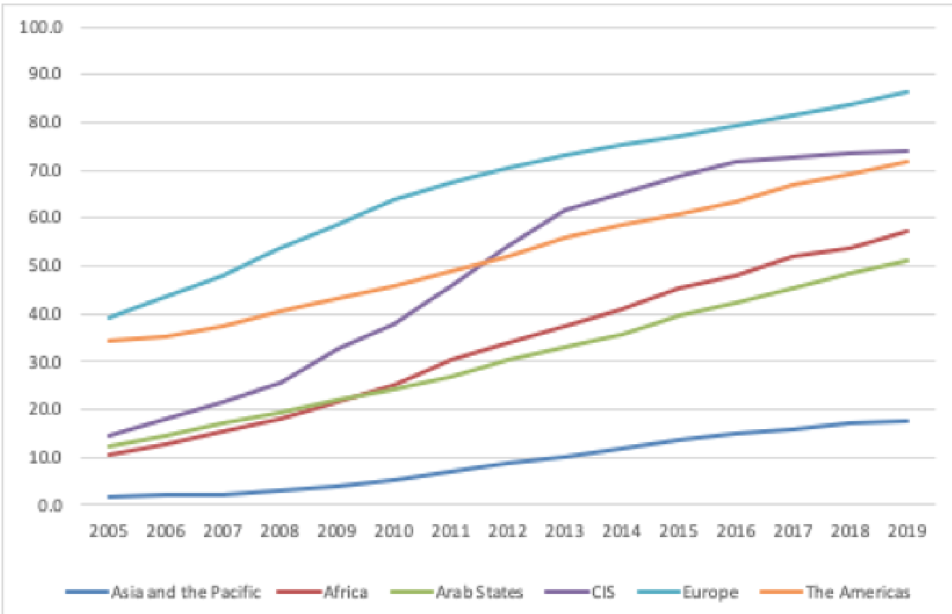
2.1.2 Access & Affordability

Access to the internet is still a major challenge in most parts of Asia and the Pacific. Indeed, Figure 9 shows that households in Asia and the Pacific have the least internet access compared to any other world region, with less than 20% of households having access to the internet.

Figure 10 shows the estimated proportion of households with Internet access at home in **North and Central Asian countries** in 2014 and 2017. Although there has been a sizable increase in the proportion of households with Internet access in every country, with the average proportion of households with Internet access going from 64% in 2014 to 72% in 2017, there are still striking disparities between countries. In **Kazakhstan**, 85% of households had access to the Internet in 2017. In **Kyrgyzstan** and

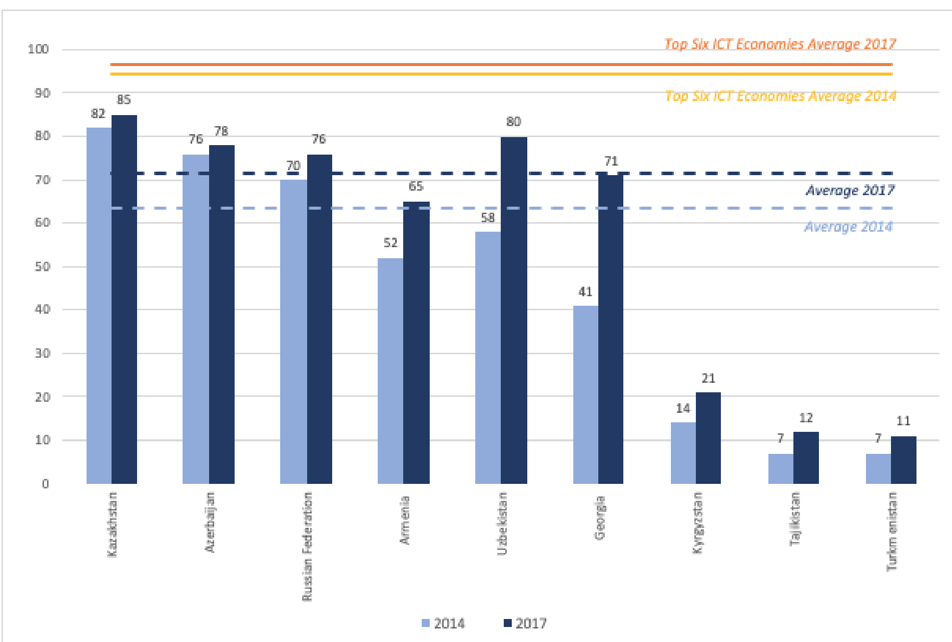
Tajikistan, however, the proportion of the households with access to the Internet in 2017 well below the 72% average, at 12% and 11%, respectively. The most striking rise in the proportion of households with Internet access between 2011 and 2017 was observed in **Georgia**, with a 30%. This progress is a good start if countries intend, for example, to make remote learning more accessible to the youth.

Figure 9: Households with Internet access at home



Source: Produced by ESCAP based on data from the ITU, World Telecommunication/ICT Indicators database 2019 (December 2019 Edition).

Figure 10: Estimated proportion of households with Internet access at home in North and Central Asian countries, 2014 & 2017



Source: Produced by ESCAP based on data from the ITU, World Telecommunication/ICT Indicators database 2019 (December 2019 Edition).

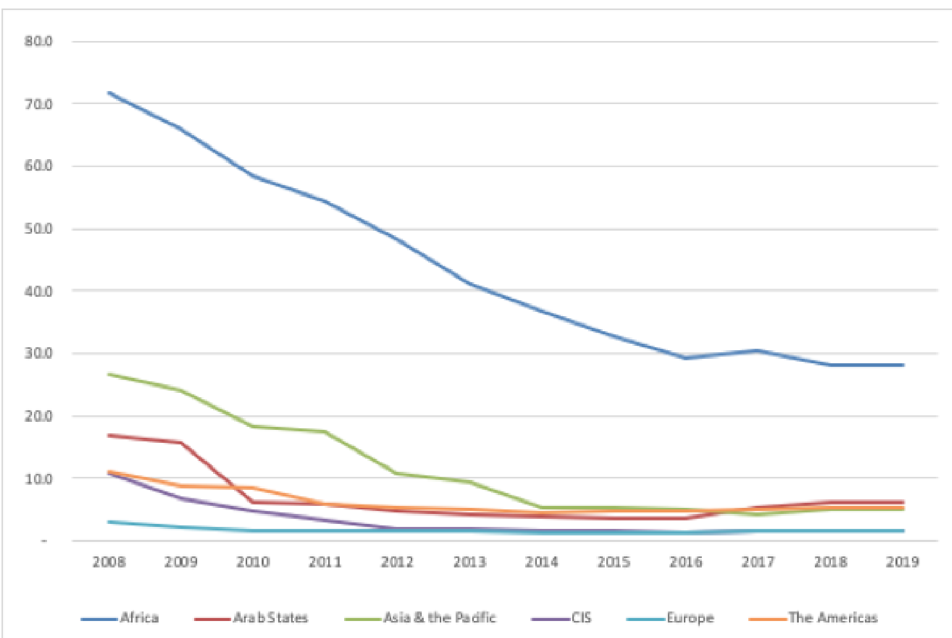
Note: The top six ICT advanced economies are the most advanced economies of ESCAP in terms of the ICT development index (IDI); the Republic of Korea, Hong Kong China, Japan, New Zealand, Australia, and Singapore.

The more widespread use of ICTs translates into more social development and general economic growth. Given the large economic and social positive externalities of ICTs, governments should promote their use. This role requires, among other things, making the adoption and use of ICT affordable. Policies should aim to reduce the "affordability gap", defined as the number of people or households who do not access ICT services because they are not able to cover such expenses.

The relative cost of being connected underpins the global digital divide. Figure 11 compares the affordability of broadband in different world regions by using a fixed-broadband basket as a percentage of GNI per capita. As a region, Asia and the Pacific has made great progress in reducing the cost of connectivity. Indeed, a fixed-broadband basket went from being about 27% of GNI per capita in 2008 to only 5% in 2019.

It can be noted that the CIS region has rather low prices for both fixed and mobile communications. Four countries have already achieved the Broadband Commission target of fixed-broadband prices (below 2 % of GNI p.c.): the Russian Federation, Belarus, Kazakhstan and Azerbaijan[51]. At the same time, the region has its own leaders and "catching up" countries. This gap could be closed by using and expanding the best locally relevant practices.

Figure 11: Fixed-broadband basket as a percentage of GNI per capita



Source: Produced by ESCAP based on data from the ITU, World Telecommunication/ICT Indicators database 2019 (December 2019 Edition).

[51] https://www.itu.int/en/ITU-D/Statistics/Documents/publications/prices2019/ITU_ICTpriceTrends_2019.pdf

Note: 2008-2017 data refer to a fixed-broadband basket with a monthly data usage of (a minimum of) 1 GB. 2018 onwards refer to a revised fixed-broadband basket with a monthly data usage of (a minimum of) 5 GB.

The opportunity to have own or have access to a computer also mostly depends on affordability. Figure 12 shows the disparities between countries in the estimated proportion of households with a computer in North and Central Asia in 2013 and 2017. While the **Russian Federation** and **Kazakhstan** were above the regional average of 64% in 2017, **Kyrgyzstan**, **Turkmenistan**, and **Tajikistan** were still far behind, with less than 23% of households estimated to have a computer. Although there has been an increase in the proportion of households with a computer in every country over these four years, the increase in the proportion of households has not been important enough to close this gap. In countries like **Tajikistan**, where only 15% of households are estimated to own a computer, a national shift to remote work is difficult to conceive.

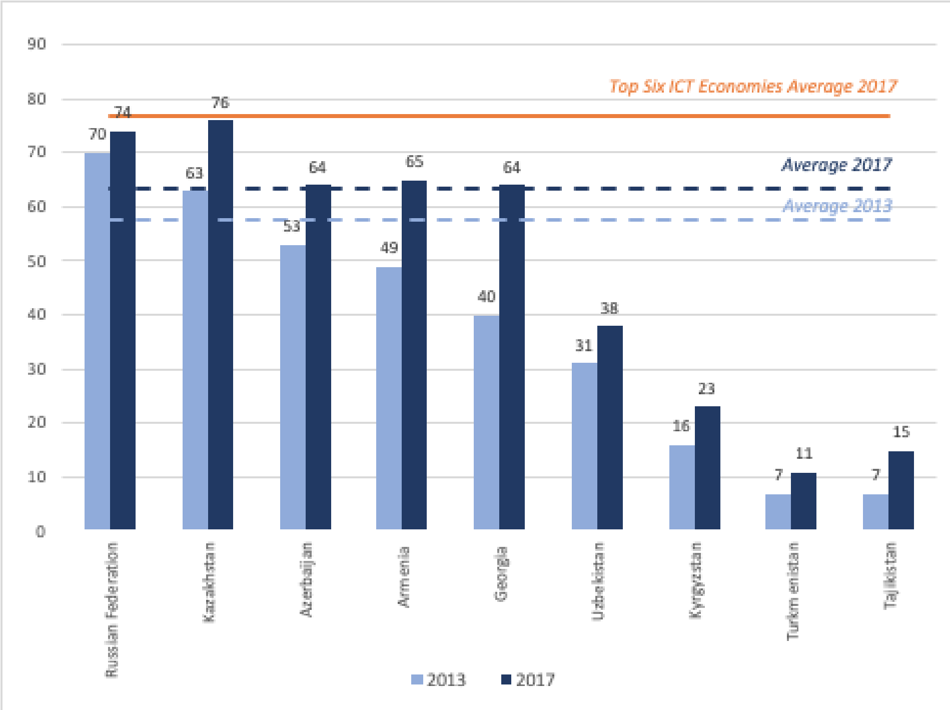
Fortunately, efforts have been taken by countries in Asia and the Pacific to solve the problem of digital divide. For example, in **Russia**, a pilot initiative called "Affordable Internet" has been implemented since April 2020. The big five fixed broadband access providers in the country supported this initiative to maintain the Internet connection of the users who temporary do not have money to pay for the Internet access services, limiting it to the list of socially important websites as set out by the amount of unique Russian visitors and public discussion during the pandemic[52].

In **Kazakhstan,** some of the settlements with a large number of residents also receive broadband Internet access services using ADSL, 3G, 4G technologies. The main lagging zones in the development of broadband Internet access are rural settlements with a small number of residents. The infrastructure built in three years (2018-2020) will be more than 20 thousand km and will be used for the development of cellular networks. As a result of the implementation of the these projects, by the end of 2020, 99.3% of the total population of the country will be covered by broadband Internet access[53].

In **Kyrgyzstan**, in order to strengthen the infrastructure, the government planned to create a network of backbone fiber-optic communication lines, covering all regions of the country. The corresponding investments in infrastructure will have a positive effect on the development of mobile Internet, it is expected that 4G coverage will be able to exceed 90% of the total number of settlements. It is also expected that prices for Internet communication services will decrease, which will further stimulate the use of digital technologies.[54]

[52] https://www.unescap.org/sites/default/files/Russian%20Federation%2C%20item%203.pdf
[53] https://www.unescap.org/sites/default/files/Kazakhstan%2C%20item%203.pdf
[54] https://www.unescap.org/sites/default/files/Kyrgyzstan%2C%20item%203.pdf

Figure 12: Estimated Proportion of Households with a Computer in North and Central Asian Countries, 2013 & 2017



Source: Produced by ESCAP based on data from the ITU, World Telecommunication/ICT Indicators database 2019 (December 2019 Edition).

Note: The top six ICT advanced economies are the most advanced economies of ESCAP in terms of the ICT development index (IDI); the Republic of Korea, Hong Kong China, Japan, New Zealand, Australia, and Singapore.

2.2 Overview of the Available ICT Related Indices

This section provides and overview of the available ICT related indexes, and the basic analytical comparison between indexes and indicators' framework.

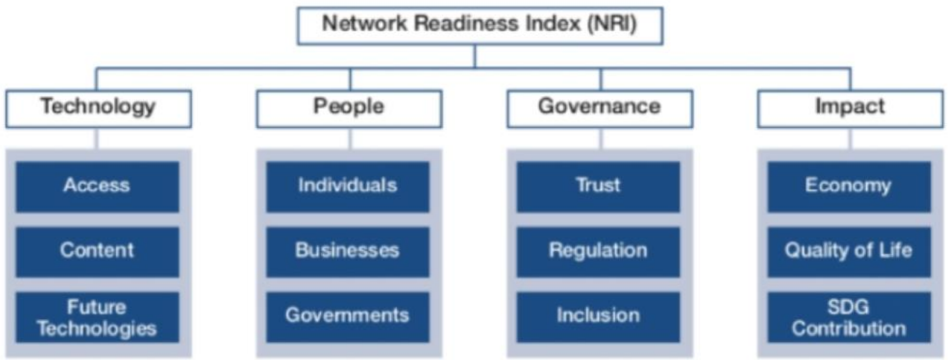
2.2.1 The Network Readiness Index (NRI)

The **Network Readiness Index (NRI)**[55] was first launched in 2002 by the World Economic Forum. It assesses the factors, policies, and institutions that enable a country to fully leverage information and communication technologies (ICTs) for inclusive, sustainable growth, competitiveness, and well-being.

The latest NRI model rests on four pillars: Technology, People, Governance, and Impact. Each pillar is itself comprised of three sub-pillars, leading to the redesigned NRI model depicted in Figure 14.

[55] https://networkreadinessindex.org/#reports

Figure 13: The NRI 2019 Model



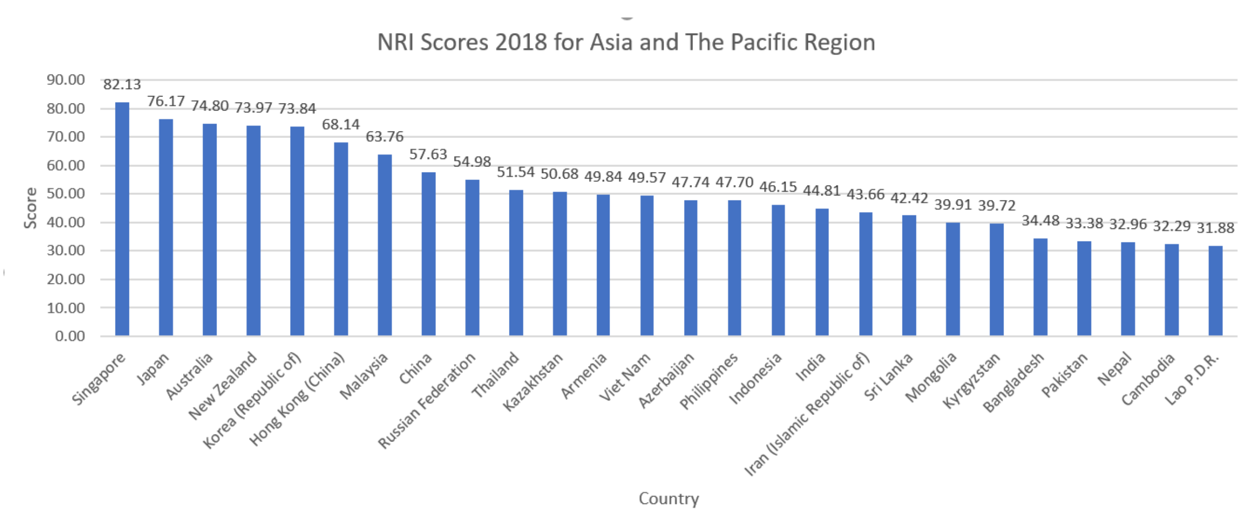
The Technology pillar includes access to ICT, the type of digital technology produced in countries, and the content/applications that can be deployed locally, as well as the extent to which countries are prepared for the future of the network economy and new technology trends such as artificial intelligence (AI) and Internet of Things (IoT).

The People pillar includes how individuals use technology and how they leverage their skills to participate in the network economy, how businesses use ICT and participate in the network economy, and how governments use and invest in ICT for the benefit of the general population.

The Governance pillar includes how safe individuals and firms are in the context of the network economy, the extent to which the government promotes participation in the network economy through regulation, and how issues such as inequality based on gender, disabilities, and socioeconomic status are being addressed.

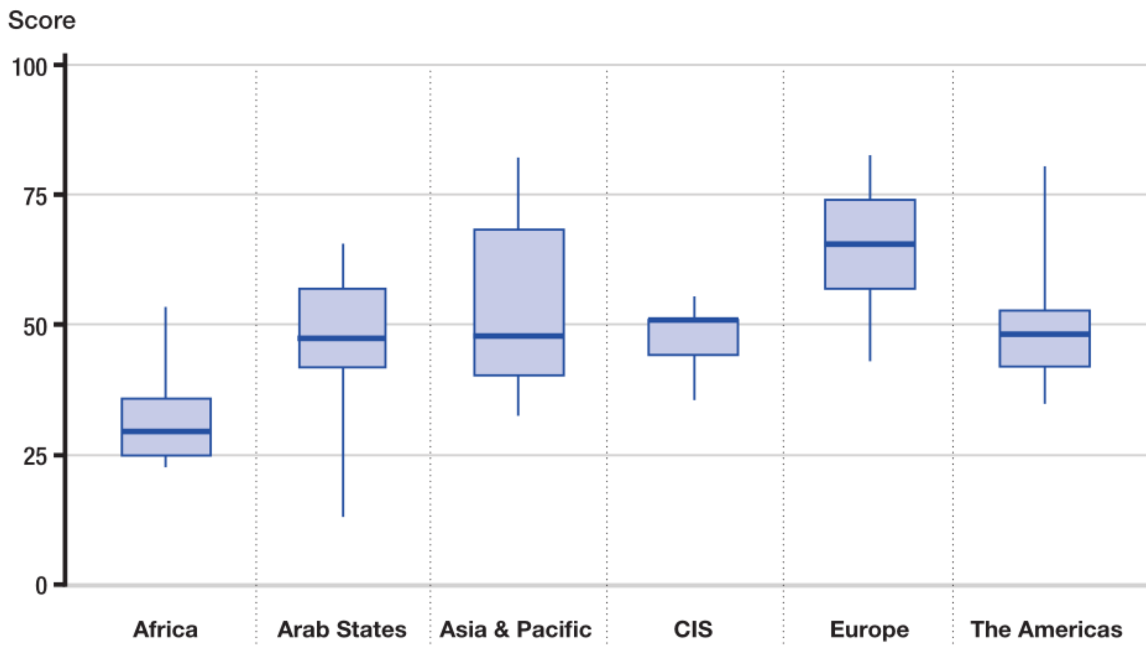
Finally, the Impact pillar includes the economic impact of participating in the network economy, the social impact of participating in the network economy, and the impact of participating in the network economy in the context of the SDGs. The focus is on goals where ICT has an important role to play, including such indicators as health, education, and environment.

Figure 14: NRI Scores 2018 for Asia and The Pacific Region



Source: Produced by ESCAP based on data from the NRI

Figure 15: NRI scores by region



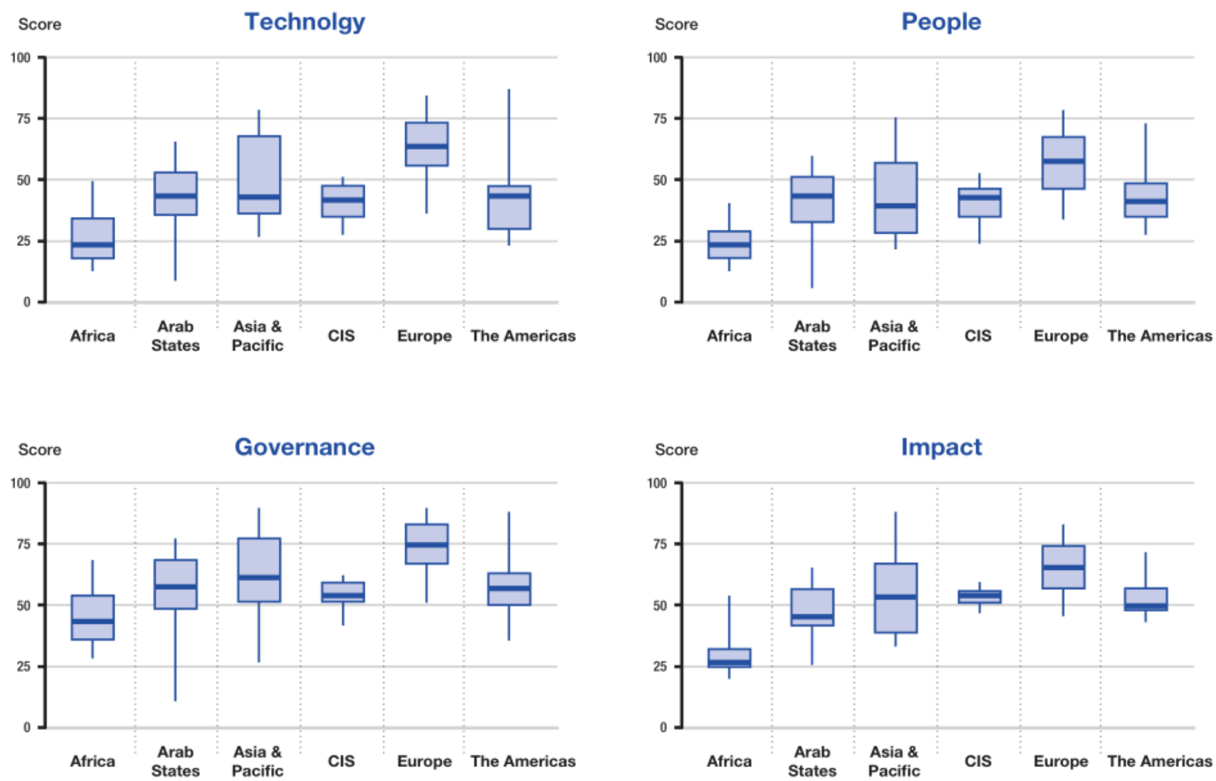
Note: The whiskers indicate minimum and maximum values, while the extremes of a box indicate the 25th and 75th percentiles. The line within a box represents the median (i.e. 50th percentile). CIS = Commonwealth of Independent States.

Source: https://networkreadinessindex.org/

More interesting than comparing regional performances in the overall NRI is to analyze how regions fare in each of the four pillars (Figure 3). To be sure, the rankings of some regions at the pillar level are in line with their overall rankings. The Asia & Pacific region is often only behind Europe in many of the dimensions included in the NRI. That said, it performs slightly better in the Governance and Impact pillars and their associated sub-pillars[56]. That reveals for ESCAP the importance to measure e-resilience from different perspectives, in order to help countries better understand their strength and weakness and in turn develop effective policies.

[56] https://networkreadinessindex.org/nri-2019-analysis/

Figure 16: NRI scores by region and pillar



Note: The whiskers indicate minimum and maximum values, while the extremes of a box indicate the 25th and 75th percentiles. The line within a box represents the median (i.e. 50th percentile). CIS = Commonwealth of Independent States.

Source: *https://networkreadinessindex.org/*

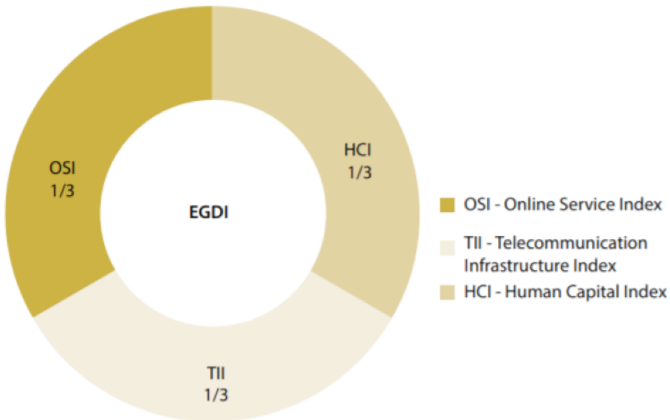
2.2.2 The E-Government Development Index (EGDI)

E-government readiness is a significant indicator of whether a country is prepared to harvest efficiencies gained from ICT-enabled public administrations. The UN E-Government Survey [57] tracks progress of e-government development via the **E-Government Development Index (EGDI)**.

The EGDI is a composite index based on the weighted average of three normalized indices and it ranges from 0 (low level of readiness) to 1 (high level of readiness). Along with an assessment of the website development patterns in a country, the index incorporates the access characteristics, such as the infrastructure and educational levels, to reflect how a country is using information technologies to promote access and inclusion of its people.

[57] https://publicadministration.un.org/en/Research/UN-e-Government-Surveys

Figure 17: The three components of the E-Government Development Index (IGDI)



Source: UN E-Government Survey report 2020

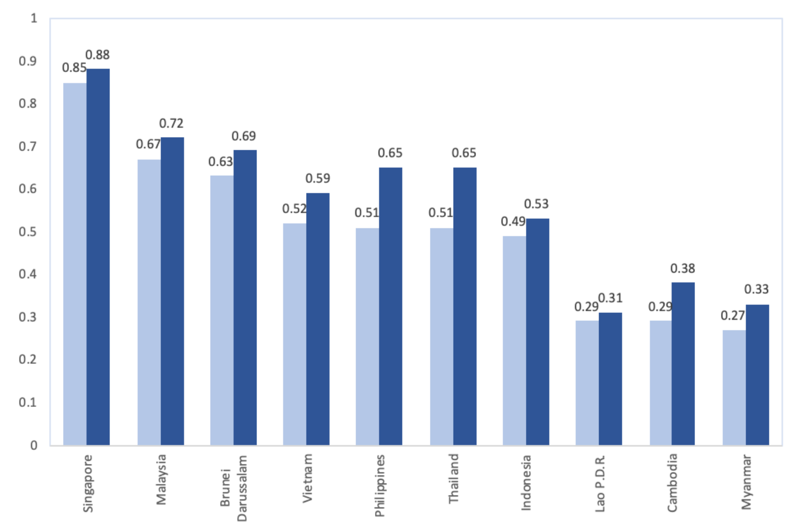
One of the three components of the EGDI is the Telecommunication Infrastructure Index (TII), which is based on data provided by the International Telecommunications Union (ITU). The TII is comprised of fixed telephone subscriptions per 100 inhabitants, mobile cellular telephone subscriptions per 100 inhabitants, percentage of Individuals using the Internet, fixed broadband subscriptions per 100 inhabitants, and active mobile broadband subscriptions per 100 inhabitants.

Another component of the EGDI is the Human Capital Index (HCI), which quantifies the contribution of health and education to the productivity of the next generation of workers. Countries can use it to assess how much income they are foregoing because of human capital gaps, and how much faster they can turn these losses into gains if they act now.

The last component of the IGDI is the Online Service Index (OSI), which is a composite normalized score derived on the basis on an Online Service Questionnaire conducted by UNDESA. The OSI assesses the national online presence of all 193 United Nations Member States. The 2020 Online Services Questionnaire (OSQ) consists of a list of 148 questions (vs. 140 question in 2018). Each question calls for a binary response. Every positive answer generates a “more in-depth question” inside and across the patterns. The outcome is an enhanced quantitative survey with a wider range of point distributions reflecting the differences in the levels of e-government development among Member States.

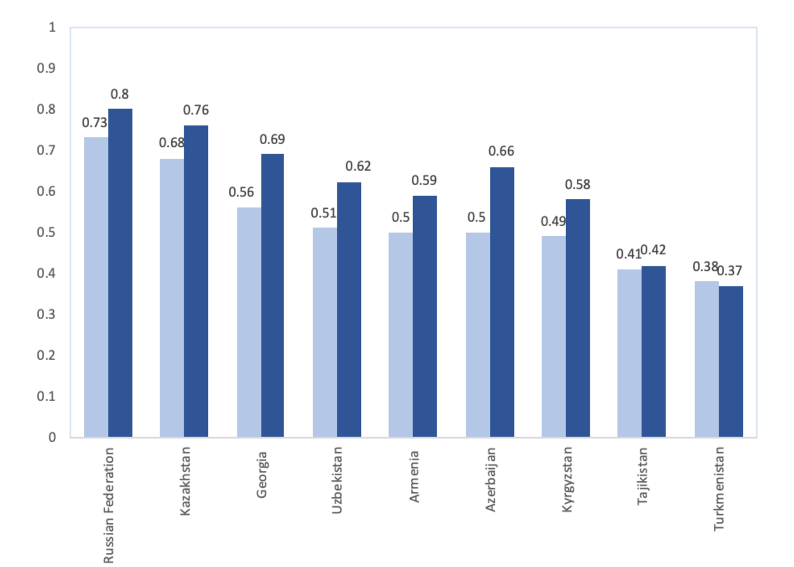
Figures 16 and 17 show the E-Government Development Index (EGDI) in **ASEAN** countries and in **North and Central Asian** Countries in 2012 and 2018. The figures show that there are important disparities between countries. In 2018, **Singapore**’s EGDI was 0.88, while **Lao P.D.R.**’s EDGI was 0.30. That same year, the **Russian Federation**’s EGDI was 0.80, while **Turkmenistan**’s EDGI was 0.37, which indicates a slight decline of compared to the country’s score in 2012.

Figure 18: E-government Development Index in ASEAN countries, 2012 and 2018



Source: Produced by ESCAP based on ESCAP based on United Nations E-Government Survey Report 2012-2018

Figure 19: E-government Development Index North and Central Asian countries, 2012 and 2018



Source: Produced by ESCAP based on ESCAP based on United Nations E-Government Survey Report 2012-2018

2.2.3 The ICT Development Index (IDI)

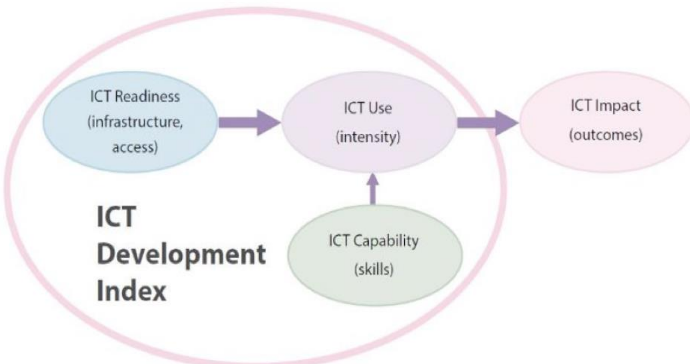
The **ICT Development Index (IDI)**[58] is a tool for monitoring the progress towards a global information society. It has three pillars: “access”, “use” and “skills” with a number of indicators being collected under these pillars into composite benchmark measure that serves to monitor and compare developments in information and communication technology (ICT) across countries and over time.

58 https://www.itu.int/en/ITU-D/Statistics/Pages/publications/mis2017/methodology.aspx

The main objectives of the IDI are to measure (1) the level and evolution over time of ICT developments within countries and the experience of those countries relative to others; (2) the progress in ICT development in both developed and developing countries; (3) the digital divide, i.e. differences between countries in terms of their levels of ICT development, and (4) the development potential of ICTs and the extent to which countries can make use of them to enhance growth and development in the context of available capabilities and skills.

Recognizing that ICTs can be development enablers is central to the IDI's conceptual framework. The ICT development process, and a country's evolution towards becoming an information society, can be depicted using the three-stage model illustrated in Figure 20.

Figure 20: Three stages in the evolution towards an information society



Source: ITU

Based on this conceptual framework, the IDI is divided into the three pillars as shown in Figure 21.

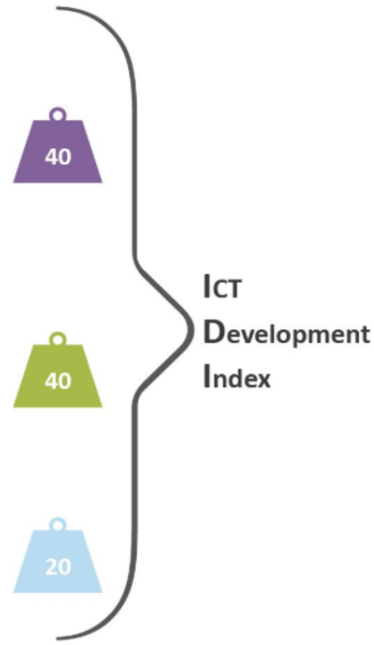
The access sub-index captures ICT readiness and includes five infrastructure and access indicators (fixed-telephone subscriptions, mobile-cellular telephone subscriptions, international Internet bandwidth per Internet user, households with a computer, and households with Internet access).

The ICT use sub-index captures ICT intensity and includes three intensity and usage indicators (individuals using the Internet, fixed broadband subscriptions, and mobile-broadband subscriptions).

The ICT skills sub-index seeks to capture capabilities or skills which are important for ICTs. It includes three proxy indicators (mean years of schooling, gross secondary enrolment, and gross tertiary enrolment). As these are proxy indicators, rather than indicators directly measuring ICT-related skills, the skills sub-index is given less weight in the computation of the IDI than the other two sub-indices.

Figure 21: ICT Development Index: indicators, reference values and weights

ICT access	Reference value	(%)
1. Fixed-telephone subscriptions per 100 inhabitants	60	20
2. Mobile-cellular telephone subscriptions per 100 inhabitants	120	20
3. International Internet bandwith (bit/s) per internet user	2'158'212*	20
4. Percentage of households with a computer	100	20
5. Percentage of households with Internet access	100	20
ICT use	**Reference value**	**(%)**
6. Percentage of individuals using the Internet	100	33
7. Fixed-broadband subscriptions per 100 inhabitants	60	33
8. Active mobile-broadband subscriptions per 100 inhabitants	100	33
ICT skills	**Reference value**	**(%)**
9. Mean years of schooling	15	33
10. Secondary gross enrolment ratio	100	33
11. Tertiary gross enrolment ratio	100	33



Note: *This corresponds to a log value of 6.33, which was used in the normalization step.

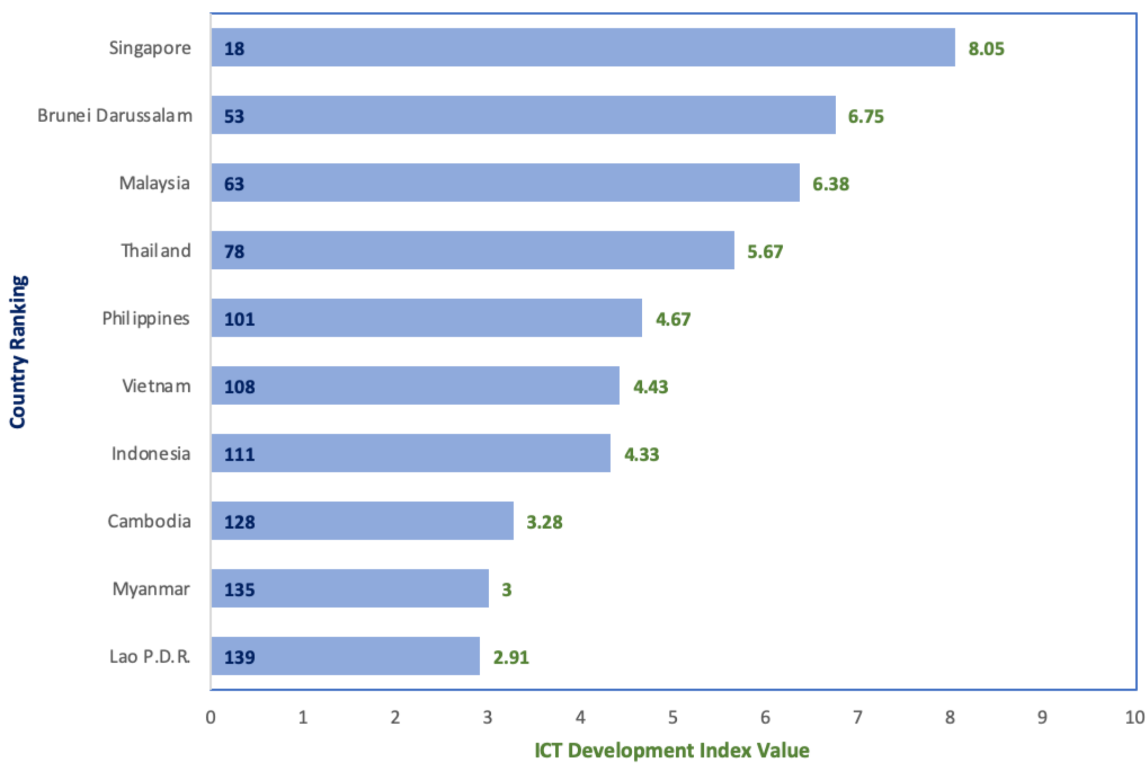
Source: ITU.

The IDI has been published by ITU annually since 2009. The latest IDI report from 2017 ranks the performance of 176 economies with regard to ICT infrastructure, use and skills, allowing for comparisons to be made between countries and over time.

Figure 22 below shows the ICT Development Index (IDI) ranking in **ASEAN** countries in 2017. In the 2017 report, **ASEAN** countries fare differently in the ranking. While **Singapore** was ranked 18 globally, **Lao P.D.R**. was ranked 139. ASEAN countries can make use of the development potential of ICTs in making assessments and developing measures in the countries to enhance the e-resilience of the society.

The IDI index is only one possible way of assessing and comparing the strength of ICT infrastructure across countries. The expert group discussion may consider alternative approaches to establish the conditions necessary for a resilient ICT infrastructure that promotes societal resilience.

Figure 22: ICT Development Index (IDI) ranking in ASEAN countries, 2017



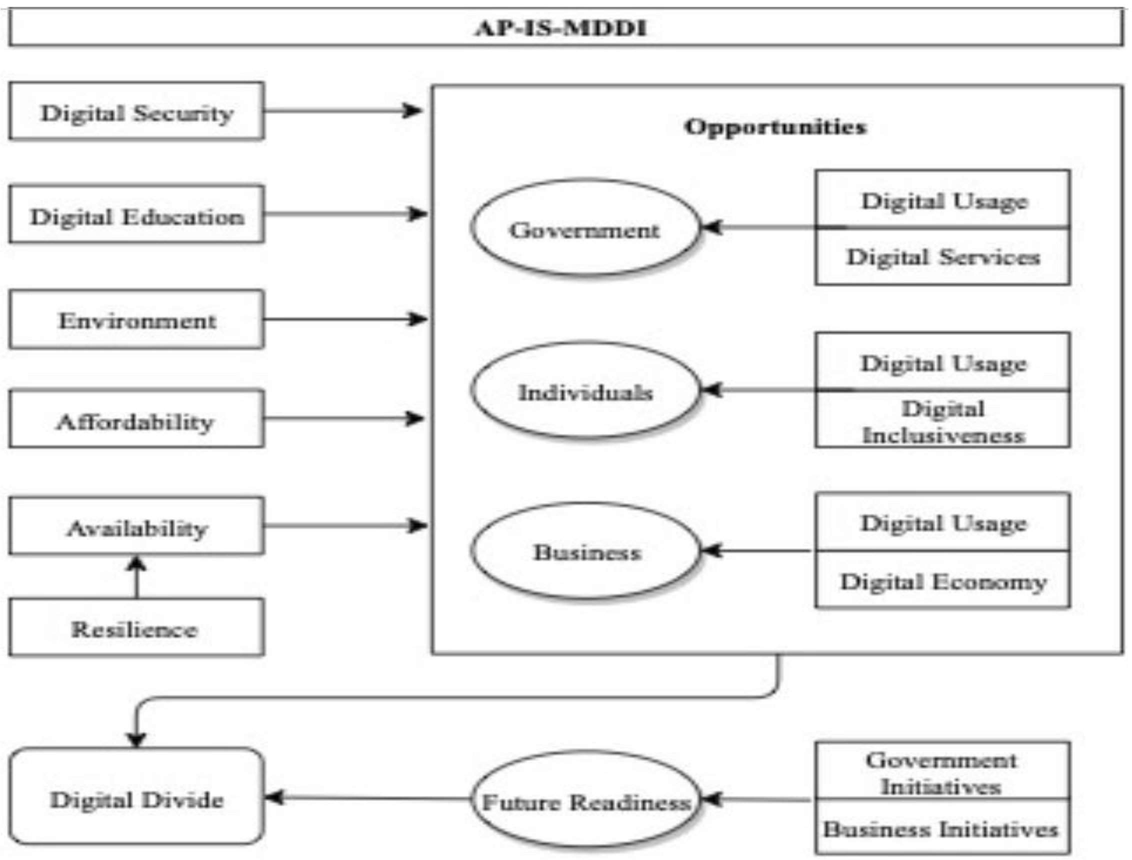
Source: Produced by ESCAP based on data from the ITU.

2.2.4 The Asia-Pacific Superhighway Multidimensional Digital Divide Index (AP-IS-MDDI)

The Asia Pacific Information Superhighway Multidimensional Digital Divide Index (AP-IS-MDDI) is another ICT index. In 2019, the London School of Economics and the ICT and Disaster Risk Reduction Division of the ICT and Development Section of ESCAP studied the possibility of creating a new digital divide measurement tool utilizing the OECD's definition. The index is supposed to incorporate the conceptual framework that encapsulates the social and technological complexities of the digital divide. Following the OECD's definition, the measurement will look at both multidimensional stakeholders and access.

The AP-IS-MDDI Model includes eleven dimensions and three main actors: government, business and individuals. The digital divide is influenced by the opportunities these three actors have. In Figure 23 below, we identified six dimensions with the same variables that impact the opportunities for all three actors.

Figure 23: AP-IS-MDDI Model



Source: ESCAP

Digital security is one of the factors that has a direct impact on government, individuals and business. It refers to security, censorship, privacy, and other factors that affect engagement in the digital realm. Example variables include e-commerce safety and secure internet servers per one million people.

Digital education makes reference to variables that measure the digital education, skills, knowledge, and capacity of governments, individuals and businesses to engage with digital content.

Environment refers to the overall economic, political, and social situation in the country. It includes the legal and conflict aspects of the country that may hinder the closing of the digital divide. Therefore, this dimension includes variables like the Global Peace Index, the doing business scores as well as number of procedures to enforce a contract.

Affordability concerns the economic affordability of the internet and digital devices. It takes the purchasing power parity into account when looking at variables like the GNI per capita.

Availability captures the infrastructure aspects of the digital divide. Variables could include access to networks, the amount of internet exchange points, and the quality of traffic/network management. Upload and download speed may also play a key role, as well as the access to electricity.

Resilience refers to variables that measure the resilience of ICT networks, including through disaster management systems and last-mile disaster communication. Through our model, resilience is especially important since it has a direct effect on the availability dimension (which mainly captures infrastructure variables) and is a crucial foundation to bridge the digital divide.

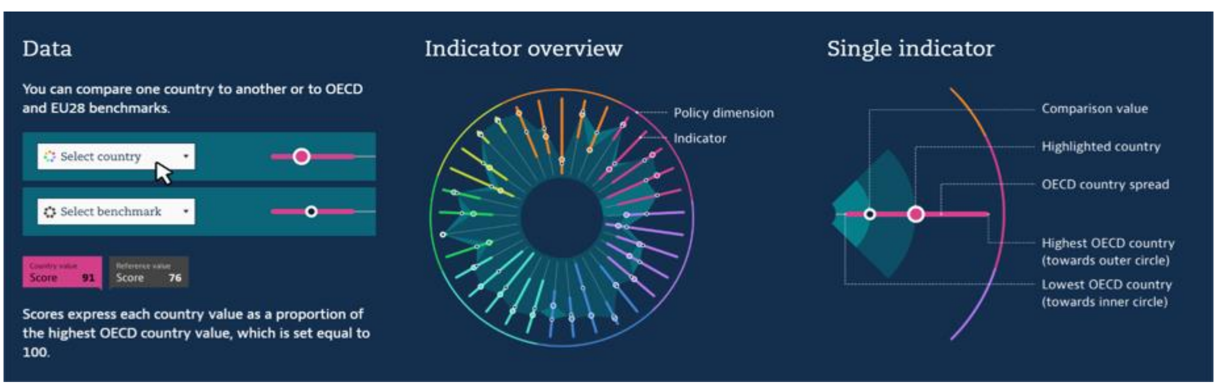
2.2.5 The Going Digital Toolkit

The **Going Digital Toolkit**[59] helps countries assess their level of digital development and formulate policy strategies and approaches in response. Data exploration and visualization are key features of the Toolkit. It includes seven policy dimensions, that bring together interrelated areas to ensure a holistic approach that balances the opportunities and risks of digital transformation.

Policy dimensions are represented by a number of indicators collected by different sources, including the ITU, the OECD, and Eurostat. These indicators indicate the level of access to communications infrastructures, services and data (e.g., fixed broadband subscriptions per 100 inhabitants, mobile broadband subscriptions per 100 inhabitants, share of households with broadband connections), the effective use of digital technologies and date (e.g. internet users as a share of individuals, share of small businesses making e-commerce sales in the last 12 months), the level of data-driven and digital innovation (e.g., ICT investment as a percentage of GDP, business R&D expenditure in Information Industries as a percentage of GDP, venture capital investment in the ICT sector as a percentage of GDP), the level of ICT jobs (e.g., ICT task-intensive jobs as a percentage of total employment, digital, digital-intensive sectors' share in total employment), the level of social prosperity and inclusion (e.g., percentage of individuals aged 55-74 using the Internet, women as a share of all 16-24 year-olds who can program, e-waste generated, kilograms per inhabitant), the level of trust in the digital age (e.g., percentage of individuals not buying online due to payment security concerns, percentage of individuals not buying online due to concerns about returning products), market openness in digital business environments (e.g., share of businesses making e-commerce sales that sell across borders, Digital Services Trade Restrictiveness Index, Foreign Direct Investment Regulatory Restrictiveness Index).

As shown in Figure 24, the Toolkit maps a core set of indicators to each of the seven policy dimensions and allows users to interactively explore these data to assess a country's state of digital development. The Toolkit also contains OECD policy guidance and insights related to each of the policy dimensions to help governments design and implement policies that are fit for the digital age. In due course, the Toolkit will incorporate innovative policy practices.

Figure 24: The Going Digital Toolkit indicators



Source: OECD

[59] https://goingdigital.oecd.org/en/

2.2.6 Global Finance's ranking of Most Technologically Advanced Countries in The World 2020

To determine where a country stands in the global tech race, the Index used four integrated metrics, three of which serve as standard measures of the availability and prevalence of technology: internet users as a proportion of the population; smartphone users as a percentage of the population; and LTE users as a percentage of the population. The fourth metric used is a Digital Competitiveness score developed by the IMD World Competitiveness Center. Their competitiveness score focuses on technological knowledge, readiness for developing new technologies, and the ability to exploit and build on new innovations[60].

Ranking nations according to these metrics produced interesting results. For example, smaller advanced countries seem to score better than larger ones—Hong Kong and Taiwan are both ranked above Japan. This is likely due to the fact that smartphone penetration is higher in Hong Kong and Taiwan.

Another surprising finding is that Kazakhstan, a developing country with a population of only 18 million and a GDP per capita of $8,830, ranks above Italy, China, and Saudi Arabia. This seems shocking considering that Kazakhstan has a much smaller and less developed economy. However, Kazakhstan's government announced a strategy in 2012 emphasizing technological innovation and investment as a part of its overall mission to become an advanced country. The government expanded internet access and smartphone penetration while working to improve its digital competitiveness, thus giving it a relatively strong score.

2.3 Overview of the Available Resilience Indices

In response to concerns about the consequences of increase in frequency and severity of disaster events, over the past four decades, the concept of community resilience[61] has gained increasing prominence in science and policy circles. Diffusion of the concept of community resilience also signifies the recognition of the fact that not all threats can be avoided and there should be mechanisms in place to ensure that disturbances are kept to a minimum.

Furthermore, resilience implies learning lessons from the disruptive event and adopting adaptive and transformative approaches that lead to long-term incremental evolution of the system. To operationalize this concept and reduce the ambiguities surrounding it, since the turn of the century, various resilience assessment methodologies have been introduced[62].

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[60] https://www.gfmag.com/global-data/non-economic-data/best-tech-countries

[61] Note: E-resilience is defined as the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management. E-resilience forms one of the four pillars of the Asia-Pacific Information Superhighway initiative and the Master Plan for the Asia-Pacific Information Superhighway, 2019–2022. The Asia-Pacific Information Superhighway initiative aims to increase the availability and affordability of broadband across the region by strengthening the underlying infrastructure through regional cooperation. Ref: CICTSTI paper Agenda Item 2 "Collaborative Actions Harnessing Technologies Against Pandemic".

[62] Available at https://www.researchgate.net/publication/303635482_A_critical_review_of_selected_tools_for_assessing_community_resilience

2.3.1 The Resilience Index Measurement and Analysis (RIMA)

The Food and Agriculture Organization (FAO) of the United Nations was the first organization to adopt the concept of resilience in a food security context with an econometric approach. Its latest version of the **Resilience Index Measurement and Analysis (RIMA)** is known as RIMA-II [63].

RIMA was created using the following definition of resilience: "The capacity of a household to bounce back to a previous level of well-being (for instance food security) after a shock". However, it reflects the definition that has been recently adopted by the Resilience Measurement Technical Working Group[64] (RM-TWG) where resilience was defined as "a capacity that ensures stressors and shocks do not have long-lasting adverse development consequences".

Resilience is not easily measured, and given this constraint, it is necessary to look at resilience using a proxy measure, of which there are two, one direct and the other indirect. A direct (or descriptive) measure of resilience aims at targeting and ranking households. Its main purpose is to identify those households less likely to resist a shock, and thus functions as a descriptive tool. The direct measure looks at capacity and structure at a specific moment in time. There is also the possibility to look at how capacity and structure evolve over time. An indirect (or inferential) measure of resilience looks at its main determinants. There is a range of resilience indicators that can be employed, such as speed of recovery and extent of loss or recovery. The indirect measure allows statistical inference to be made that ultimately translates into clear and sound policy indications and can be adopted for predicting a dynamic perspective of resilience. An ideal bridge between direct and indirect measures of resilience is represented by the Resilience Capacity Index (RCI), which can be employed as to predict food security.

RIMA-II therefore represents a package that includes the two approaches, direct and indirect. The direct approach measures the RCI and the Resilience Structure Matrix (RSM). The indirect approach looks at the determinants of food security loss and recovery.

A broad distinction between immediate needs and intervention over the long term places the resilience discussion in the debate between emergency and development response mechanisms. This has a number of implications for measurement. Firstly, a long-term framework is needed to ensure response mechanisms are effective. It is likely that the well-being indicators fluctuate during the short and medium term and finally stabilize over the long term. Secondly, when a shock occurs there may be long-lasting consequences for household assets and livelihoods (for instance, selling assets is a typical strategy but its impact on household livelihood depends on the assets sold). Thirdly, a distinction needs to be made in terms of long-term and short-term interventions. Policies aiming at increasing resilience or minimizing reduction in well-being connected with a shock can have immediate effect (food for work projects, transfer mechanisms) or long-term implications (typically education).

Fundamental pillars of RIMA II resilience are (1) Access to Basic Services (ABS) such as schools, health centres, water, electricity and nearby markets, is a fundamental aspect of resilience. ABS refers to both access to services and the quality of access and services, (2) assets (AST), including income, (3) Social Safety Nets (SSN) such as access to transfers, whether cash or in-kind, which represents a major source of poverty alleviation in many developing countries and includes both formal and informal transfers, (4)

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[63] http://www.fao.org/emergencies/resources/documents/resources-detail/it/c/416587/

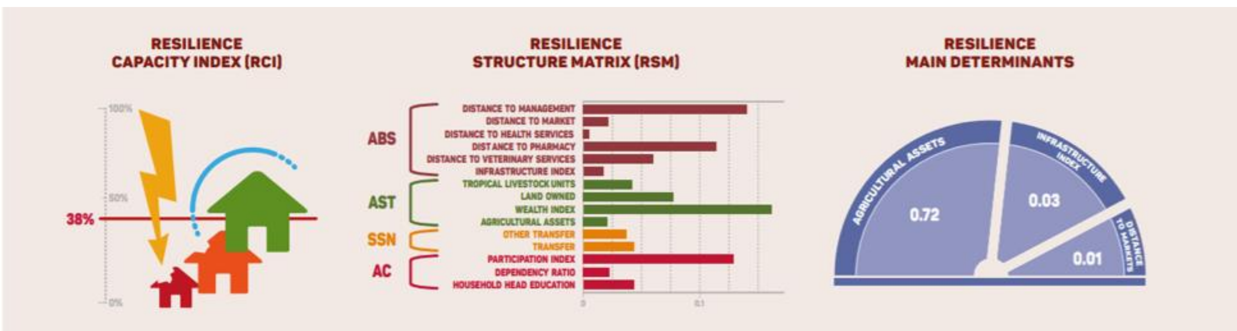
[64] Further information are available at www.fsincop.net/topics/resilience-measurement/technical-working-group

Sensitivity (S), which relates to exposure, the extent to which a household livelihood is affected by a specific shock, and to shock resistance, and finally (5) Adaptive Capacity (AC), which represents household ability to adapt to the changing environment in which it operates. Other pillars could be included, such as aspects of institutional environment.

Household resilience can be measured using multidimensional surveys that focus on household behavior. Considering the described resilience pillars, a resilience-oriented survey should include aspects of income and income generating activities, access to basic services, access to infrastructure, productive and non-productive assets, formal and informal safety nets, social networks, shocks, food security indicators, institutional environment, and climate change.

RIMA-II comprises two parts, one direct (or descriptive) and one indirect (or inferential). The direct approach measures Resilience Capacity Index (RCI) and Resilience Structure Matrix (RSM). The indirect approach looks at the determinants of food security loss and recovery. The Resilience Info Pack follows, which includes the three sets of resilience measures cited above.

Figure 25: Resilience info pack



Source: FAO

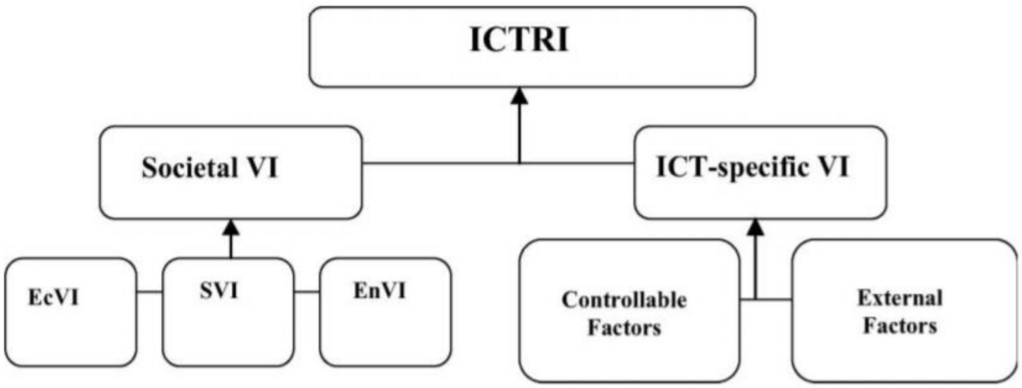
2.3.2 The ICT Resilience Index (ICTRI)

The **ICT Resilience Index (ICTRI)** is a composite index comprised of two components aimed at generating an overall summary measure of ICT vulnerability within a SIDS. The first component is the societal Vulnerability Index (VI) which is itself a composite index of three sub-indices (namely, the economic vulnerability index (EcVI), the social vulnerability index (SVI) and the environmental vulnerability index (EnVI)). The second is an ICT-specific Vulnerability Index (ICT-specific VI) comprised of two sub-components [65].

ICT Resilience is the capacity of a digital environment to accommodate, tolerate, withstand, adapt to, and/or recover from upsets, disruptions, failures, and/or attacks on ICT infrastructure and assets

[65] https://www.researchgate.net/publication/248959433_Increasing_Competitiveness_in_SIDS_by_Building_ICT_Resilience_An_Extension_of_the_Vulnerability_Hypothesis_Framework

Figure 26: Computing an ICT resilience index



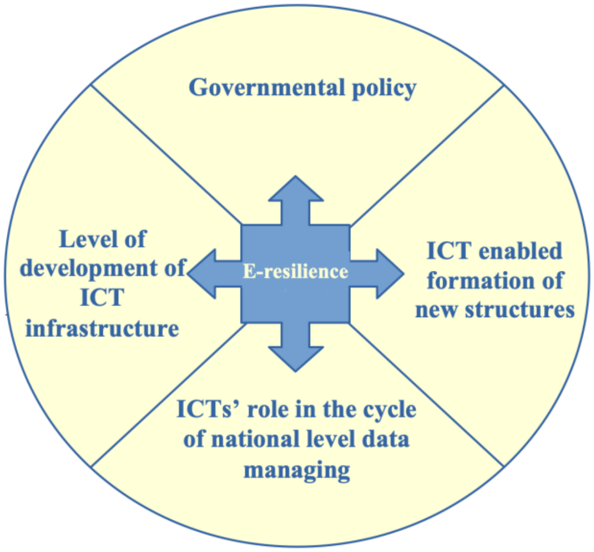
2.4 ICT Infrastructure Resilience and Societal Resilience: Forming an E-Resilience Dashboard

An e-resilience model that encompasses the performance of all ICT components from immediate impact through the recovery phase of a disaster is not yet available. However, measuring e-resilience is a key component of successful disaster risk management and disaster adaptation and the recovery period. ESCAP aims to develop the e-resilience model that encompasses the performance of all ICT components from immediate impact through the recovery phase of a disaster.

The pandemic underscores the two mains aspects of e-resilience: ICT for its own resilience and ICT for societal resilience (whole of society resilience). These two elements of e-resilience are inter-dependent and are especially critical in times of crisis.

Quantitative, indicator-based assessments can be applied to evaluate resilience and e-resilience readiness by combining different indicators of performance into a single composite dashboard. Like the E-Government Development Index (EGDI), which consists of three equally weighted indexes (Online Service Index, Telecommunication Index and Human Capital Index), an e-resilience monitoring dashboard should cover a broad range of topics that are relevant for that particular purpose.

Figure 27: E-resilience monitoring dashboard topics



Source: ESCAP (Authors)

Four important areas in which ICT plays a critical role at the national level have been identified. The first area is governmental policy on ICT infrastructure and applications that are the foundation for e-resilience. Depending on the included indicators, the level of co-deployment implementation inside countries and/or cross border can be analyzed.

The second one is ICT enabled formation of new structures that can play a role in e-adaptation and recovering from the pandemic.

The third area is ICTs' role in the cycle of national level data managing (gathering, analysis, and decision making) that then leads into actions and policies which influence disaster resilience and adaptability.

Finally, the forth area is a direct measure of ICT resilience aimed at targeting and ranking households from the perspective of ICT infrastructure and applications access and level of development of national and international ICT infrastructure, which is a physical foundation for all the above components. Depending on the enabled indicators, this component may also reflect the physical aspect of digital divide. Its main purpose can be to identify level of population "ICT well-being" and those households less likely to resist a shock. It may be composed of the following indicators: Fixed-broadband subscriptions, mobile broadband subscriptions, population covered by mobile-cellular and mobile-broadband network, international Internet bandwidth per Internet user, households with a computer, households with Internet access, etc.

2.4.1 Examining ICT for Its Own Resilience & ICT for Societal Resilience from an E-Resilience Lens

To organize an e-resilience monitoring, this chapter considers all the reasoning above and presents an initial overview of the available indices and initial mapping of the respective indicators under the framework of e-resilience.

Table 5 compiles the basic dashboard of indicators under the respective selected indices, falling under two categories of ICT infrastructure and network resilience and the ICT for societal resilience.

The "+" symbol marks the indicators which are potentially applicable for building the new ESCAP e-resilience monitoring dashboard.

The indicators are colored in respective light green and the pink color and the size of colored segment reflects the approximate grade of relevance of the indicator to one or another measurement category mentioned above. For example, under the NRI, Pillar 1 and sub pillar on 1.1. Access, 1.1.1 Mobile tariffs indicator the 2/5th colored in pink color and 3/5th – in green color. It means that this indicator is more relevant to the ICT infrastructure and the network resilience.

Table 5: Dashboard of available indices with their respective indicators in relation to e-resilience

Green colour: indicates ICT infrastructure and the network resilience
Pink colour: indicates the ICT for societal resilience

Indicator	Number of indicators	Potentially applicable to the ESCAP e-resilience dashboard	The extent of indicator's relevance to "ICT for its own resilience and network" and the ICT for societal resilience
The Network Readiness Index (NRI) **Pillar 1. Technology** Sub pillar 1.1 Access			
1.1.1 Mobile tariffs	7	+	
1.1.2 Handset prices		+	
1.1.3 Households with internet access		+	
1.1.4 4G mobile network coverage		+	
1.1.5 Fixed-broadband subscriptions		+	
1.1.6 International Internet bandwidth		+	
1.1.7 Internet access in schools		+	
Sub pillar 1.2 Content			
1.2.1 Digital participation and content creation	3	+	
1.2.2 Mobile apps development		+	
1.2.3 Intellectual property receipts		+	
Sub pillar 1.3 Future Technologies			
1.3.1 Availability of latest technologies	6	+	
1.3.2 Company investment in emerging technology		+	
1.3.3 Government procurement of advanced technology products		+	
1.3.4 ICT PCT patent applications		+	
1.3.5 Computer software spending		+	
1.3.6 Robot density		+	
Pillar 2. People Sub pillar 2.1 Individuals			
2.1.1 Internet users	6	+	

2.1.2	Active mobile-broadband subscription		+	
2.1.3	Use of virtual social networks		+	
2.1.4	Tertiary enrolment			
2.1.5	Adult literacy rate		+	
2.1.6	ICT skills		+	
Sub pillar 2.2 Businesses				
2.2.1	Firms with website	6	+	
2.2.2	Internet shopping		+	
2.2.3	Professionals		+	
2.2.4	Technicians and associate professionals			
2.2.5	Extent of staff training		+	
2.2.6	R&D expenditure by businesses		+	
Sub pillar 2.3 Government				
2.3.1	Government online services	4	+	
2.3.2	Publication and use of open data		+	
2.3.3	ICT use and government efficiency		+	
2.3.4	R&D expenditure by governments and higher education		+	
Pillar 3. Governance Sub pillar 3.1 Trust				
3.1.1	Rule of law	5		
3.1.2	Software piracy rate			
3.1.3	Secure Internet servers			
3.1.4	Cybersecurity			
3.1.5	Online trust and safety			
3.1.6	Rule of law			
Sub pillar 3.2 Regulation				
3.2.1	Regulatory quality	6	+	
3.2.2	Ease of doing business		+	
3.2.3	Legal framework's adaptability to digital business models		+	
3.2.4	E-commerce legislation		+	
3.2.5	Social safety net protection		+	
3.2.6	ICT regulatory environment		+	
Sub pillar 3.3 Inclusion				
3.3.1	E-Participation	5	+	
3.3.2	Socioeconomic gap in use of digital payments		+	
3.3.3	Availability of local online content		+	
3.3.4	Gender gap in internet use		+	
3.3.5	Rural gap in use of digital payments		+	
Pillar 4. Impact Sub pillar 4.1 Economy				
4.1.1	Medium and high-tech industry	4		
4.1.2	High-tech exports			
4.1.3	PCT patent applications			

4.1.4 Labour productivity per employee			
Sub pillar 4.2 Quality of Life			
4.2.1 Happiness	4		
4.2.2 Freedom to make life choices			
4.2.3 Income inequality			
4.2.4 Healthy life expectancy at birth			
4.2.5 Happiness			
Sub pillar 4.3 contribution			
4.3.1 Access to basic services	6		
4.3.2 Pollution			
4.3.3 Road safety			
4.3.4 Reading proficiency in schools		+	
4.3.5 Maths proficiency in schools		+	
4.3.6 Use of clean fuels and technology			

The E-Government Development Index (EGDI) by UN DESA (10 indicators**)** **Pillar 1. OSI**			
1.1. Normalized to a range of 0 to1 score of a list of 148 questions	1		
Pillar 2. TII			
2.1 internet users per 100 inhabitants	4	+	
2.2 number of mobile subscribers per 100 inhabitants		+	
2.3 active mobile-broadband subscription			
2.4 number of fixed broadband subscriptions per 100 inhabitants			
Pillar 3. HCI			
3.1 Adult literacy rate	4	+	
3.2 Gross enrolment ratio		+	
3.3 Estimated years of schooling		+	
3.4 Mean years of schooling		+	

The ICT Development Index (IDI) by ITU (11 indicators) **Pillar 1. ICT Access**			
1.1 Fixed-telephone subscriptions per 100 inhabitants	5		
1.2 Mobile-cellular telephone subscriptions per 100 inhabitants			
1.3 International Internet bandwidth (bit/s) per Internet user			
1.4 Percentage of households with a computer		+	
1.5 Percentage of households with Internet access			
Pillar 2. ICT Use			
2.5 internet users per 100 inhabitants	4	+	

2.6 number of mobile subscribers per 100 inhabitants			
2.7 active mobile-broadband subscription		+	
2.8 number of fixed broadband subscriptions per 100 inhabitants		+	
Pillar 3. ICT Skills			
3.5 Adult literacy rate	4	+	
3.6 Gross enrolment ratio		+	
3.7 Estimated years of schooling		+	
3.8 Mean years of schooling		+	

The Going Digital Toolkit by OECD (38 indicators) **Pillar 1. Access to communications infrastructures, services, and data**			
1.1 Fixed broadband subscriptions per 100 inhabitants	6		
1.2 M2M (machine-to-machine) SIM cards per 100 inhabitants			
1.3 Mobile broadband subscriptions per 100 inhabitants			
1.4 Average monthly mobile data usage per mobile broadband subscription, GB			
1.5 Share of households with broadband connections			
1.6 Share of businesses with broadband contracted speed of 30 Mbps or more			
Pillar 2. Effective use of digital technologies and data			
2.1 Internet users as a share of individuals	6		
2.2 Share of individuals using the Internet to interact with public authorities		+	
2.3 Share of Internet users who have purchased online in the last 12 months			
2.4 Share of small businesses making e-commerce sales in the last 12 months			
2.5 Share of businesses purchasing cloud services		+	
2.6 Share of adults proficient at problem-solving in technology-rich environments		+	
Pillar 3. Data-driven and digital innovation			
3.1 ICT investment as a percentage of GDP	6	+	
3.2 Business R&D expenditure in Information Industries as a percentage of GDP		+	
3.3 Venture capital investment in the ICT sector as a percentage of GDP		+	
3.4 Venture capital investment in the ICT sector as a percentage of GDP		+	
3.5 Share of start-up firms (up to 2 years old) in the business population		+	
3.6 Top 10% most-cited documents in computer science, as a percentage of the			

top 10% ranked documents			
Pillar 4. Good jobs for all			
4.1 ICT task-intensive jobs as a percentage of total employment	5	+	
4.2 Digital-intensive sectors' share in total employment		+	
4.3 Workers receiving employment-based training, as a percentage of total employment			
4.4 New tertiary graduates in science, technology, engineering, and mathematics, as a percentage of new graduates		+	
4.5 Public spending on active labour market policies, as a percentage of GDP			
Pillar 5. Social prosperity and inclusion			
5.1 Percentage of individuals aged 55-74 using the Internet	6	+	
5.2 Percentage of individuals who live in households with income in the lowest quartile using the Internet		+	
5.3 Women as a share of all 16-24-year-olds who can program		+	
5.4 Percentage of individuals who use digital equipment at work that telework from home once a week or more		+	
5.5 Top-performing 15-16-year-old students in science, mathematics and reading			
5.6 E-waste generated, kilograms per inhabitant		+	
Pillar 6. Trust in the digital age			
6.1 Percentage of Internet users experiencing abuse of personal information or privacy violations	4		
6.2 Percentage of individuals not buying online due to payment security concerns			
6.3 Percentage of individuals not buying online due to concerns about returning products			
6.4 Percentage of businesses in which ICT security and data protection tasks are mainly performed by own employees			
Pillar 7. Market openness in digital business environment			
7.1 Share of businesses making e-commerce sales that sell across borders	5		
7.2 Share of predominantly digitally-delivered services in commercial services trade			
7.3 Digital-intensive services value added embodied in manufacturing exports, as			

a percentage of manufacturing export value			
7.4 Digital Services Trade Restrictiveness Index			
7.5 Foreign Direct Investment Regulatory Restrictiveness Index			

Similar to the e-government development index developed by the Department of Economic and Social Affairs of the Secretariat, which consists of three equally weighted indices (namely, an online services index, a telecommunication infrastructure index and a human capital index), an ESCAP e-resilience dashboard could include indicators related to speed, latency, bandwidth and redundancy and other factors that are relevant to digital and societal readiness. The table above demonstrates that the indicators capable to provide necessary assessments of e-resilience most probably already exist, and the shaping of these indicators into monitoring set for new purpose can be the matter of research.

The secretariat requests further member-states to join the discussion on this matter through Community of Practice, with the aim to develop the calculation methodology in open, fully accessible for all stakeholder's way (e.g. online form). As an initial phase for this research the secretariat may provide the on-line platform for the expert group discussion, that may consider alternative approaches to establish the conditions necessary for a resilient ICT infrastructure, seek suggestions on the number and type of indicators applicable for the purpose, monitoring and calculation methodic.

During the Expert Group Meeting (EGM) of 10 November, experts identified the main filter that could be used in the future to analyze the indicators, namely, through answering the question: "Is there a clear path of impact from the indicator to the results of e-resilience?" or, alternatively, "How does the theory of change relate to each of the indicators?" Thus, while many of the above indicators have some relevance to both the resilience of ICT infrastructure and ICT for the resilience of society, some of them can still be seen as proxies or not directly correlated with resilience.

EGM also recognized the complexity of the task due to the fact that e-resilience / cyber resilience is a system-wide outcome and an attribute that emerges out of complex interactions between different stakeholders, across different domains, and at different levels.

From the resilience of ICT infrastructure perspective, indicators associated with ICT systems resilience and resilience engineering, such as robustness, redundancy, and modularity, would potentially suffice for e-resilience monitoring.

From the ICT for societal resilience perspective, experts recommend indicators associated with business continuity planning, organizational cyber risk management, society-wide awareness and capacity-building, organizational adoption and use of relevant resilience frameworks (including standards and models), quadruplex-helix partnerships for innovation, and national capacity for ICT/cyber incident response.

In summary, the complexity of e-resilience influences the choice of analytical approaches that may be employed for formulating and evaluating suitable e-resilience indicators. One such approach is using a country-level positive deviance approach - starting with the identification of countries that have proven the most resilient (e.g., during the COVID19 pandemic or a natural disaster), analyzing the factors that contributed to their resilience, and mapping specific indicators to those factors. Another approach could employ collaborative systems modeling to experiment with the various indicators and to identify the resultant impact on the desired e-resilience outcomes.

2.4.2 SWOT Analysis from an E-Resilience Lens

Further, Table 6 represents the SWOT analysis of available indices regarding their capacity to measure the E-resilience of the countries. This table illustrates the strength, weaknesses, opportunities and threats in a bullet point format.

Table 6: SWOT analysis of available indices in relation to e-resilience monitoring tools

Index/Analysis	S (strengths)	W (weaknesses)	O (opportunities)	T (threats)
The Network Readiness Index (NRI)	▪ Accepted and used in many countries ▪ Considers policy and governance measures ▪ Links people and technological progress with the right governance structures as a key to achieve SDGs	▪ Does not measure e-resilience in response to crisis (e.g. pandemic) ▪ More static than dynamic Index	▪ Sub-pillars and indicators can be applied for the assessment of e-resilience ▪ Legal framework adaptable to digital business models, e-commerce legislation, e-participation etc.	Threat to complicate calculations of e-resilience index, because of too many indicators
E-Government Development Index (EGDI)	▪ Well known and analyzed by many countries ▪ A holistic view of the progress of e-government development	▪ Does not measure e-resilience in response to crisis (e.g. pandemic) ▪ Limited focus to measure the readiness & capacity of national institutions to use ICTs to deliver public services	▪ Good as a second component of e-resilience: contains indicators of the adequacy of ICT infrastructure, the ability of human resources to use ICTs, and the availability of online services and content ▪ Likely to measure ICT application for societal resilience	NA

The ICT Development Index (IDI)	▪ Well known and most widely used and analyzed index ▪ Assesses and compares the state of ICT development within and between countries ▪ Monitors the changes in the development of ICTs over time	▪ Does not measure e-resilience in response to crisis (e.g. pandemic) ▪ Last report published in 2017, set of indicators is currently being revised	▪ Well established process and wide number of indicators collected for analysis and building of index ▪ Good as a second component of e-resilience: ICT infrastructure and network resilience	The flaws related to the selection of indicators persist, which delays the publication of an updated IDI for an unknown period (quote from communications with ITU)
AP-IS-MDDI (Asia Pacific Information Superhighway Multidimensional Digital Divide Index)	Designed to be aligned with the four pillars of the AP-IS (connectivity, traffic management, broadband for all, and e-resilience)	Designed primarily to measure the digital divide. Resilience -as one of the 4 dimensions is a small component. It has a direct effect on the Availability dimension and is a crucial foundation to bridge the digital divide.	A closer look can be taken at the Resilience component (one out four) of the index	Exists as a concept only. Not yet operationalised.
Going Digital Toolkit (OECD)	▪ Measures state of digital development of countries with defined purpose to formulate policy strategies and approaches ▪ Well structured: allows users to explore data through different dimensions and themes ▪ Contains OECD policy guidance to help governments to design and implement policies that fit for the digital age	Does not measure e-resilience in response to crises	▪ Possibility to consider web structure as a basis ▪ Can be consulted in choice of some indicators	Not all countries of Asia and the Pacific region are included (mainly OECD countries)

Most Technologically Advanced Countries in The World 2020	New, recently developed index	▪ Aimed at competitiveness component of digital development of countries shows where a country stands in the global tech race ▪ Historical data is not available	▪ Metrics is implemented to produce interesting and unexpected scoring results, which can capture the attention of governments ▪ Good as a component of e-resilience: can be considered as part of ICT for societal resilience	Not all countries participate
RIMA-II, The Food and Agriculture Organization (FAO) **Index**	Introduces the relevant definition of resilience as the capacity of a household to bounce back to a previous level of well-being after a shock	Not relevant to the ICT field	▪ Highly relevant on resilience definition and its concept and ▪ Fundamental pillars might be taken for consideration for the ESCAP e-resilience index framework	NA
The ICTRI - ICT Resilience Index	Focused on ICT vulnerability within SIDS via societal and ICT-specific components indicators	▪ Measures vulnerability, which is the contrary of resilience ▪ Does not consider recovery phase of a disaster ▪ Exists only as a concept, not implemented to operation	Cooperation with index developers might be beneficial for design of ESCAP ICT resilience dashboard	NA
E-resilience dashboard (ESCAP-IDD concept proposal)	▪ Novel model that encompasses the performance of all ICT components from immediate impact through the recovery phase of a disaster ▪ The end goal is to develop an improved and integrated understanding	Could be misunderstood and misinterpreted by decision makers without a clarity in defining the methodology, its acceptance by experts and further the policy advocacy	▪ Possibility to design new multi-faceted features, e.g. assessment of both resilience of ICT to shocks and ICT applicability in shock resistance of national economies ▪ Quantitative, indicator-based assessments can be applied to evaluate resilience and e-resilience readiness by combining	Possible competition with other known ICT indices if structure not very well shaped

	of e-resilience where ICT can be used by policymakers in preparation for future events		different indicators of performance into a single composite index	

III. The Way Forward

In summary, this paper offers a framework for monitoring e-resilience and opportunities for collaboration between government and public sector, with private sector, between governments in fighting the consequences of the pandemic. This chapter provides examples of such collaboration.

Pandemics open many opportunities for collaboration at the sub-national, national, and regional levels. The pace of innovation in emerging digital technologies can be held back by inappropriate infrastructure, lack of financing and bureaucratic constraints. Faced with a challenge like the COVID-19 outbreak, there are strong incentives to overcome these constraints quickly, build up **e-resilience**, and put new technology to the test. This necessitates the combined effort of governments and the public and private sectors, swift action by individual states and close regional collaboration. This section identifies some of the advancements that have been made in these regards, as well as opportunities for improvement.

3.1 Private Sector Cooperation

The digital infrastructure of countries across Asia and the Pacific still needs strengthening in order to ensure connectivity and access to all levels of society. In order to leverage digital technologies, governments should partner with private technology companies, social entrepreneurs or other national and international organizations to meet the needs of citizens and soften the impact of the pandemic on their lives.

In **China**, the state is aware that the actors that allow for a data-driven pandemic response are giant tech companies such as *Alibaba and Tencent*. By gathering large amounts of user data in real-time, these firms may know more about individual's movements than the government itself. The spread of the virus can therefore be mitigated through effective collaboration and data-sharing. This was done with the development of the Alipay Health Code[66], a color-coded health rating system that is tracking millions of people daily by using big data and artificial intelligence (AI) for facial recognition and temperature detection techniques. It relies on the public's heavy reliance on the mobile payment app Alipay [67]. The Health Code dictates users' freedom to travel, by assigning them into one of three categories based on their COVID-19 risk factors calculated using self-reported and collected data.

In **India**, with a high density of population and millions of inhabitants in rural villages and urban slums, preventing a large-scale spread of COVID-19 requires the mobilization of both governmental and private stakeholders. Indeed, the private sector can provide technological solutions to use data on movement

[66] https://www.nytimes.com/2020/03/01/business/china-coronavirus-surveillance.html
[67] https://www.theguardian.com/world/2020/apr/01/chinas-coronavirus-health-code-apps-raise-concerns-over-privacy

patterns and health symptoms, and to leverage the smartphone penetration in India to build contact tracing. Businesses can also play a key role on social media and other communication platforms in quelling false rumors and providing accurate and timely information. One example of this is Indian mobile networks playing a 30-second coronavirus information alert[68] before the beginning of every phone call. The private sector can also support virtual medicine efforts to monitor patients and offload hospitals. Finally, businesses should use this opportunity to invest in their digital capability and trainings that allow for easier and efficient ways for their employees to work from home.

In **Japan**, to understand the impact of COVID- 19, the Japan Aerospace Exploration Agency (JAXA) collaborates with NASA and the European Space Agency (ESA) and analyzes changes in the global environment and socio-economic activities using Earth observation satellite data, and disseminates such analysis through the JAXA website and Earth Observation Dashboard.[69]

In **Russia**, a new law authorizing the prolonged validity of qualified electronic signatures has come into force. This allows the private sector to continue business operations in the crisis time. [70]

In **Sri Lanka**, the Arthur C Clarke Institution for Modern Technologies developed a smart electronic biosensor for rapid detection of Covid-19, and has already been laboratory-tested successfully. [71]

Several calls and initiatives to bring the private sector and other stakeholders together have already been launched. **The APEC (Asia-Pacific Economic Cooperation) Business Advisory Council** has called on the region's economies to fully exploit digital technologies and connectivity, to collaborate across economies and allow a level of economic activity to continue[72]. The council underlined the importance of access to resilient digital infrastructure such as broadband, especially in emerging economies, and the need to minimize barriers to cross border data flows.[73]

The **World Economic Forum** has established the *COVID Action Platform*[74] to stimulate global cooperation among governments, international organizations and the business community. The platform focuses on encouraging the private sector for collective action, facilitating business continuity, safeguarding people's livelihoods and mobilizing cooperation for the COVID-19 response.

3.2 Public Sector Cooperation

In order for ICT systems to successfully withstand, recuperate and transform in the face of the COVID-19 crisis, states need to fast-track the construction of new digital infrastructure. By developing those capabilities, countries will be better equipped to trace and monitor diseases and their transmission. It allows the population to obtain accurate and timely information on the virus, gain access to online medical assistance, and work or study remotely.

[68] https://www.livemint.com/industry/telecom/put-coronavirus-awareness-messages-in-place-of-ringing-tones-dot-asks-telcos-11583593053009.html
[69] https://www.unescap.org/sites/default/files/Japan%2C%20item%202_0.pdf
[70] https://www.unescap.org/sites/default/files/Russian%20Federation%2C%20item%203.pdf
[71] https://www.unescap.org/sites/default/files/Sri%20Lanka%2C%20item%204.pdf
[72] https://www.apec.org/Press/News-Releases/2020/0328_ABAC
[73] https://www.apec.org/Press/News-Releases/2020/0328_ABAC
[74] https://www.weforum.org/covid-action-platform

Governments, ICT ministers and sector regulators must ensure resilient broadband and adjust to the increasing data traffic that accompanies the shift to online services and tools.

In addition, governments must take urgent steps to bridge the digital divides by promoting affordable access to underserved areas. As soon as interpersonal connectivity turns into virtual reality during pandemic, those with the least access to information, notably on pandemic preparedness and mitigation, become more vulnerable. This can intensify the exposure of the poor to the virus and generate new inequalities.

The recent imperative to adopt new technology has underscored the importance of improving connectivity and network management within countries. Indeed, if the Internet Exchange Points (IXPs) have not provided sufficient compute, storage, or bandwidth resources to cope with increased traffic, there might be network failures.

Examples of such failures have been observed in **China** in early February 2020, when companies started moving to remote working[75]. Servers supporting Baidu's iQiyi streaming service, an educational application called Xuexitong, and video conferencing applications DingTalk and WeChat Work all crashed due to a sudden increase in traffic.[76] Governments should therefore work towards increasing bandwidth and strengthening network resilience. To ensure continuity of public services, they should prioritize connections to critical government functions and vital services such as hospitals, pharmacies, emergency centers, and transportation hubs. This may require temporary relaxation of regulations and other policy measures to fast-track the response.

During confinement, digital connectivity ensures access to vital information and promotes social cohesion. It is therefore crucial to increase the affordability, availability and accessibility of digital services and devices, especially for underserved or hard to reach populations. Otherwise, some sectors of society might be excluded from the digital transformation.

In order to respond to these challenges, **India**'s National Digital Communications Policy (NDCP), formulated in 2018, presents the policy framework to build Robust Digital Communications Infrastructure, enable Next Generation Technologies and Services through Investments, Innovation and IPR generation, and to ensure Sovereignty, Safety and Security of Digital Communications. The Indian Government has embarked upon one of the world's largest rural optical fibre roll-outs, aiming to connect 600,000 of its villages to broadband through its flagship initiative called 'BharatNet'. Around 454,000 km of optical fibre cable has already been laid down covering over 154,000 Village Councils or the grass-roots local government bodies.

To provide a holistic development of broadband infrastructure in India, the National Broadband Mission was launched in December 2019 to design and implement the strategy to be adopted by all stakeholders to achieve the goal of 'Broadband for All' towards bridging the Digital Divide. The objective being access to broadband to all the villages by 2022 with availability of high broadband speeds up to 50 Mbps.

In the face of the COVID-19 pandemic, the Indian government has tried to make the fight against the pandemic a people's movement, by combining the efforts of government and society to give the highest priority to deliver benefits to poor households. India has announced a package of more than USD 300 billion to bring the economy back on track, build modern infrastructure and put in place a technology-

[75] https://global.chinadaily.com.cn/a/202002/20/WS5e4dec2fa310128217278eb1.html

[76] https://www.abacusnews.com/culture/worlds-biggest-online-population-staying-home-and-chinas-internet-cant-cope/article/3050947

driven system. India has put forward a vision of 'Atmanirbhar Bharat'--a self-reliant and resilient India, integrated with the global economy.[77]

In the special case of **Myanmar**, the Internet has been blocked since June 2019 in nine townships of the Arakan and Chin States amid the violent armed conflict[78]. By keeping Internet restrictions in place, many of the most vulnerable will be unable to access critical information regarding the pandemic[79]. The government has attributed the shutdown to the instability in the region and has described it as way to prevent hate speech and disinformation, prompting backlash from human rights defenders and activists[80].

3.3 Intergovernmental Collaboration

The regional level will also be key in assessing the ways in which Asia and the Pacific's digital landscape will change in response to COVID-19. The digital divide in the region continues to be one of the largest in the world, and the divide has even expanded in recent years[81]. This gap exists among sub-regions between **East/North-East Asia** and **South/South-West Asia and the Pacific**[82]. Highly connected countries with access to more advanced technologies end up dominating the digital ecosystem. In the common interest of spreading kindness and solidarity, member states may consider boosting cooperation to mitigate the spread of the virus and limit its devastating economic fallout.

The Association of Southeast Asian Nations (ASEAN), which comprises ten countries in **South-East Asia**, has recognized the imperative of finding adequate solutions through greater international collaboration and policy dialogue. **ASEAN** leaders and the leaders of **China**, **Japan** and the **Republic of Korea** have therefore pledged in April 2020 to boost cooperation to mitigate the spread of the virus and limit its devastating economic fallout[83].

Several initiatives to enhance connectivity in the region had already been established prior to the beginning of the outbreak. Indeed, policymakers in **South-East Asia** have recognized that better policies to enhance connectivity will benefit all citizens through improved linkage[84]. Existing cooperation frameworks include the *Initiative for ASEAN Integration*, *the ASEAN Economic Community Blueprint 2025*, and the *Master Plan on ASEAN Connectivity 2025*[85]. Development strategies on the interregional level count the *Indo-Pacific strategies*, ***Korea's*** *New Southern Policy*, and *the Belt and Road Initiative (BRI)*[86]. The need to step up collaboration in the digital field is exacerbated by the various challenges posed by the virus.

During the Third Session of the Committee on ICT, Science, Technology and Innovation in August 2020, the **Islamic Republic of Iran** called for the establishment of a cooperation framework on nanotechnology to combat negative impacts of COVID -19 in the context of South-South cooperation. Nanotechnology has provided enormous opportunities and solutions in the areas of prevention (e.g. masks and

[77] https://www.unescap.org/sites/default/files/India%2C%20item%202_0.pdf
[78] https://thediplomat.com/2020/04/myanmar-must-end-repression-now-says-rights-group-in-new-report/
[79] https://thediplomat.com/2020/04/myanmar-must-end-repression-now-says-rights-group-in-new-report/
[80] https://thediplomat.com/2020/04/myanmar-must-end-repression-now-says-rights-group-in-new-report/
[81] https://www.unescap.org/sites/default/files/COVID%20_Report_ESCAP.pdf
[82] https://www.unescap.org/sites/default/files/Measuring%20the%20Digital%20Divide%20in%20the%20Asia-Pacific%20Region%20for%20the%20United%20Nations%20Economic%20and%20Social%20Commission%20for%20Asia%20and%20the%20Pacific_0.pdf
[83] https://www.channelnewsasia.com/news/singapore/covid19-unprecedented-cooperation-asean-necessary-analysts-12644446
[84] http://www.oecd.org/southeast-asia/events/regional-forum/SEARPForum-Agenda-2019.pdf
[85] http://www.oecd.org/southeast-asia/events/regional-forum/SEARPForum-Agenda-2019.pdf
[86] http://www.oecd.org/southeast-asia/events/regional-forum/SEARPForum-Agenda-2019.pdf

disinfectants), detection (e.g. nano-sensors) and treatment (e.g. nano-medicines) to combat the current pandemic as well as future probable deceases. The development and practical application of advanced technologies like nanotechnology to combat pandemic crisis needs close cooperation among government and institutions worldwide. To follow such model of cooperation, knowledge and data sharing, technological matchmaking, human resource capacity building and resource sharing is needed.

In an effort to bridge the digital divide for inclusive broadband, Central Asian countries are working to expand their information transit capabilities. The Europe-Persia Express Gateway (EPEG), a high capacity fibre optic cable system, already provides connectivity between Europe and the Middle East. In addition, a project on laying fiber-optic cable lines through Azerbaijan-Kazakhstan and Azerbaijan-Turkmenistan routes along the bottom of the Caspian Sea launched at the beginning of 2020. The intergovernmental agreement is projected to give a serious impetus to the implementation of the "Trans-Eurasian Information Super Highway" (TASIM). This major regional initiative is aimed at the creation of transnational fiber-optic backbone targeting primarily the countries of Eurasia from Western Europe to Eastern Asia. This route will bring together the largest information exchange centers of Europe and Asia. The transit route will stretch through China, Kazakhstan, Azerbaijan, Georgia, Turkey and reach Germany.

Intergovernmental cooperation is also being driven, as noted previously, by countries that already have a strong foothold on the digital ecosystem. **China** is looking to enhance digital connectivity and is pushing for the expansion of 5G beyond its borders through some of its global infrastructure programs such as the *Digital Silk Road*, a subset of the *BRI*.

In an environment in which where resources are even more constrained, with half of the world's countries considering bailouts from the IMF[87], ICT projects are generally lower cost and easier to deliver and monetize. Companies in **China** have also seen the pandemic as an opportunity to sell their products overseas. The tech giant Alibaba, for example, has offered health professionals around the world its AI and cloud services to model regional outbreaks[88].

With few affordable alternatives, developing and emerging markets are likely to welcome these companies[89]. Nearly half the world still lacks access to the internet, and firms in **China** already have a track record of bringing connectivity to overlooked markets[90].

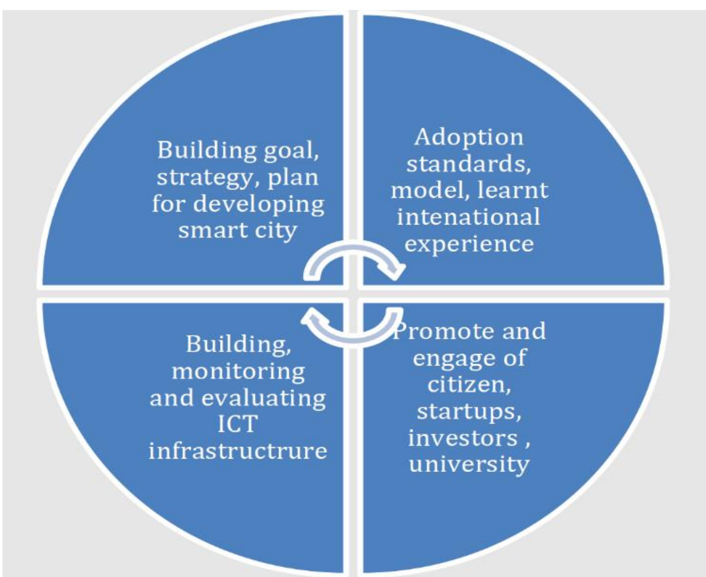
Multilateral cooperation has also been present in areas such as smart cities. A smart city can be defined as an *"innovative city that uses ICTs and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental, as well as cultural aspects*[91]". The concept relies on the idea that cities drive economic growth, emphasizing the need to deliver high-speed reliable connectivity to cities[92].

[87] https://www.wsj.com/articles/imf-world-bank-face-deluge-of-aid-requests-from-developing-world-11586424609?mod=hp_lead_pos4
[88] https://www.capacitymedia.com/articles/3825337/alibaba-cloud-offers-ai-and-cloud-services-to-help-battle-covid-19-worldwide
[89] https://www.csis.org/analysis/chinas-digital-silk-road-after-coronavirus
[90] https://www.csis.org/analysis/chinas-digital-silk-road-after-coronavirus
[91] https://www.itu.int/en/ITU-D/Regional-Presence/AsiaPacific/SiteAssets/Pages/Events/2019/RRITP2019/ASP/ITU_2019_Digital_Infrastructure_28Aug2019FNL.pdf
[92] https://www.itu.int/en/ITU-D/Regional-Presence/AsiaPacific/SiteAssets/Pages/Events/2019/RRITP2019/ASP/ITU_2019_Digital_Infrastructure_28Aug2019FNL.pdf

To make metropoles inclusive, safe, resilient and sustainable, a number of countries have joined international initiatives, driving progress on SDG 11 (Sustainable Cities and Communities). Such improvements should also lead to a reduction in energy consumption and create better conditions for promoting entrepreneurship and job creation, thereby also contributing to SDG 7 (Affordable and Clean Energy) and SDG 9 (Industry, Innovation and Infrastructure). A number of cities in **Japan** are, for example, offering best practices and solutions to a series of development challenges facing mega- to mid-sized cities[93]. To disseminate its work, Japan has joined *the World Bank Smart City Partnership Program, the Group of 20 Global Smart Cities Alliance*, the *Asia Smart City Conference* and the *ASEAN Smart Cities Network*[94].

A comprehensive plan for smart cities is required to have a clear timeline, standards for ICT infrastructure, connectivity, smart services, and available regulations. ICT infrastructures readiness is a prerequisite for smart city deployment in any economy. It provides connections to the Internet and the basis to offer smart services. However, each economy has different infrastructures and conditions for developing smart sustainable cities. Governments therefore need to analyze information about their current ICT infrastructures situations before deciding their smart city approaches. Furthermore, they need to determine timelines, stages or phases to roll out powerful ICT infrastructures with advanced emerging technologies. Governments are also required to apply suitable standards and technologies to enhance Internet access speed, increase broadband coverage and ensure security.[95]

Figure 28: The roadmap toward smart sustainable city development



Source: APEC https://www.apec.org/Publications/2020/04/Recommendations-for-Implementation-of-Smart-Sustainable-City

Countries have recognized the importance of encouraging innovation and promoting more accessible services across the Asia-Pacific region, and new instances of collaboration will be important to watch.

[93] https://www.worldbank.org/en/news/feature/2017/01/12/city-partnership-program-addressing-complex-development-challenges-together
[94] https://www.japantimes.co.jp/opinion/2020/04/29/commentary/world-commentary/covid-19-disease-surveillance-smart-cities/#.XqzMey8ZM1g
[95] https://www.apec.org/Publications/2020/04/Recommendations-for-Implementation-of-Smart-Sustainable-City

But governments must also keep in mind the potential detriments and responsibilities that can arise from digital platforms obtaining increased power and continuing largely self-regulated. Digital tools may be used by state and non-state actors to conduct cyberattacks[96] and power disinformation campaigns[97]. The standards to govern data use and protection are therefore important to consider.

Also, the work of Telecommunication working groups (TELWG) fostering cooperation and information sharing within the framework of APEC can be mentioned[98].

3.4 Next Steps

The ESCAP Secretariat proposes expert networks to develop the methodology to monitor the e-resilience by country (Ref CICTSTI[99] paper AI2). The composite monitoring framework in the form of e-resilience related indicator dashboard would visualize the extent of e-resilience and serve as a monitoring tool for governments to assess the resilience (or vulnerability) of their digital infrastructure to inform and ensure that digital systems have the capacity to handle the crises of the future.

To develop this monitoring tool, the secretariat proposes setting up a working group of experts under the overall guidance of the Asia-Pacific Information Superhighway Steering Committee. As a first step, the secretariat plans to include this in the work programme of the newly constituted thematic *working group on innovation and technology for sustainable development of the United Nations Special Programme for the Economies of Central Asia*.

To this date, ESCAP has developed a Perception-Based Survey on E-resilience Readiness in RECI project target countries and the Survey on the status of policy in Kazakhstan, Kyrgyzstan, and Mongolia as well as in SPECA countries. The preliminary review of responses is presented in the Annex (Ref Annex 3 of the Webinar of 3 July on "E-resilience Against Pandemic" and of SPECA WG on ITSD 30 July).

Results of this survey are available at the respective event pages of 3rd and 30th July meetings on "E-resilience Against Pandemic" and the *SPECA Working Group on Innovation and Technology for SD*, supported by RECI project and by ESCAP- ECE partnership.

Looking beyond the COVID-19 crisis, member states in Asia and the Pacific may need to share the progress made on the AP-IS Master Plan of 2019-2022 in preparation for the new AP-IS Master Plan for 2022-2024 from e-resilience perspective. The review process of the implementation of the Master Plan thus far. It may build the necessary foundations for the next phase as proposed below in six key points:

- First, member states can assess the progress made in terms of the development, upgrading and harmonization of national and sub-regional broadband policies and regulations. These policies include infrastructure sharing, Internet traffic management and inclusive broadband connectivity.
- Second, states can report on the progress that has been made in building a regional consensus on cross-border infrastructure sharing principles.

[96] https://www.vmware.com/content/dam/digitalmarketing/vmware/en/pdf/company/vmw-cyber-smart-enabling-apac-businesses.pdf
[97] https://www.politico.com/news/2020/04/21/russia-china-iran-disinformation-coronavirus-state-department-193107
[98] http://mddb.apec.org/pages/browseGroup.aspx
[99] CICTSTI, Agenda Item 2: "Collaborative actions to harness technologies during pandemics" https://www.unescap.org/sites/default/files/CICTSTI_1_item%202_E.pdf

- Third, states can report on the progress that has been achieved in building a regional consensus around the enabling of broadband policies, regulations, programmes and legislations that have been identified for national and sub-regional policy updates and harmonization.
- Fourth, members can share information on relevant case studies and on analysis based on good practices and lessons learned on inclusive broadband.
- Fifth, members can share their plans on how they propose to accelerate the achievement of SDG 9, which promotes building resilient infrastructure and is highly relevant in the context of ICT for sustainable development.
- Finally, members may need to reassess the capacities and reliability of digital platforms and develop appropriate measures to improve internet connection service and its e-resilience. This will allow, for example, to ensure the reliability and security of electronic tools for communication, such as digital health platforms.

ESCAP Secretariat will further develop/facilitate development methodology for development of an e-resilience monitoring framework through interactive dashboards and maps, which can be aligned with the SDG 9 framework.

Expert group meeting (EGM) on 10 November gathered experts of the region, and beyond. The EGM participants highlighted specific importance of assessment of the e-resilience readiness in the region. RECI and SPECA participating countries could scale-up the sharing of good practices and technical expertise within different programmes (e.g. the programme of work of the SPECA *Working Group on Innovation and Technology for Sustainable Development*) with the purpose of crisis preparedness through seamless digital connectivity and enabling digital policy environment; assessment of the e-resilience readiness in the region is also important to ensure no one is left behind in the crisis recovery efforts, including from current COVID-19 crisis.

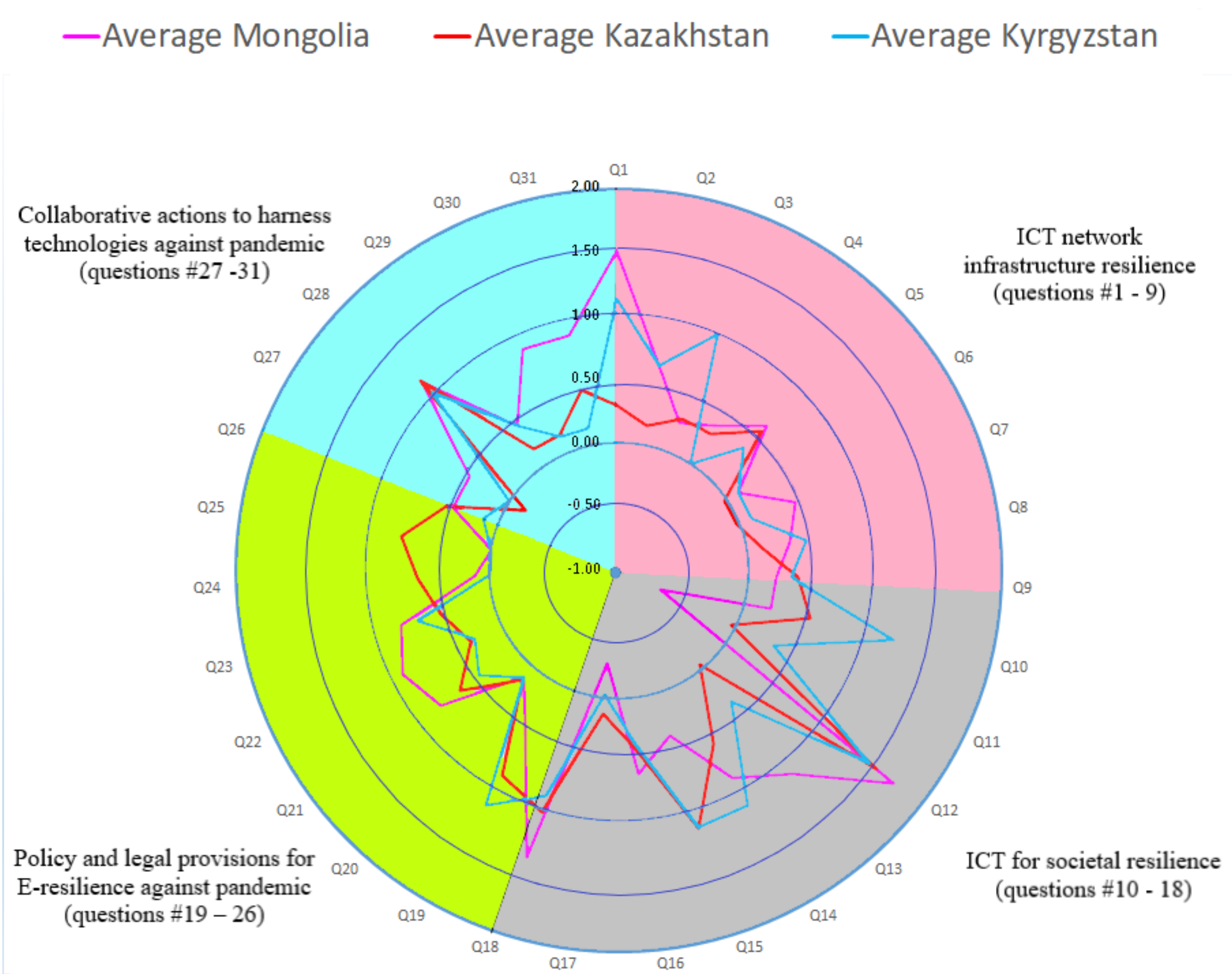
At the same time, it was noted that the selection of e-resilience dashboard indicators is a complicated topic, since it is quite often politicized, facing problems of finding good source for background data, issue of index collection. Furthermore, it was highlighted that it is important to think within the local context and local lessons learned. The importance of the active role of different societal stakeholders in the core production of national and societal cyber resilience was highlighted, in the context of the societal resilience to the major cyber-related threats and in the context of enabling the continuity of societal life. Trust is a very important indicator of resilience of the whole society and its ability to use the ICT for societal resilience and networks. The only way to build resilience is by setting a public-private partnership with people at the center.

The dashboard may also provide information for the analysis and frameworks on technological trends and illustrate the impacts of related digital technologies across sectors to open-up opportunities for start-up projects in public and private constituencies resulting from better ICT connectivity. To enable the AP-IS academy network, the ESCAP Secretariat may continue strengthening the promotion of cross-border ICT infrastructure connectivity and related digital infrastructure development with a particular focus on the needs of countries with special connectivity needs.

ESCAP member states may further explore regional policy options and facilitate the development of the regional strategies for the efficient, equitable and socially responsible development of technology for e-resilience and share experiences at the next series of meetings in 2021.

Annex 1 The visualization of the Survey results (list of questions in Annex 2)

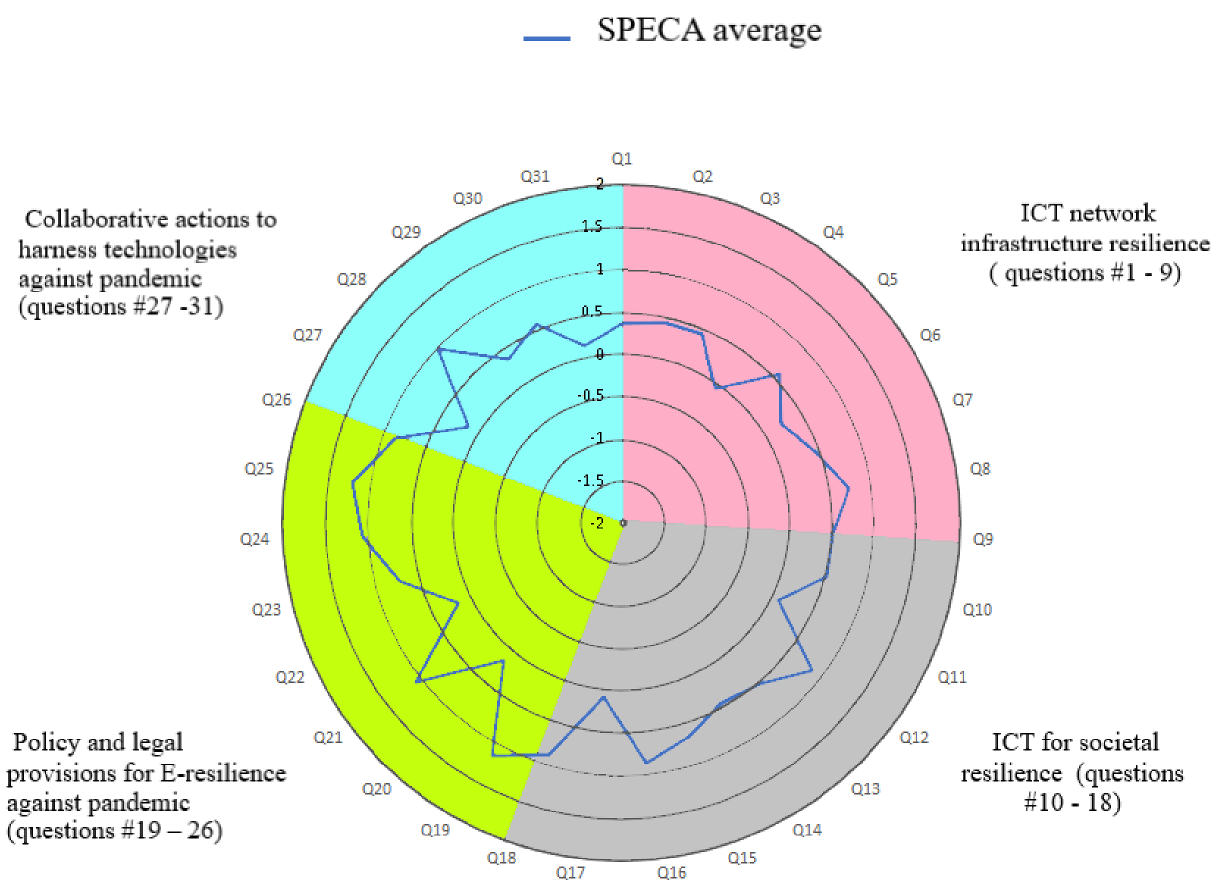
Figure 29: E-resilience Readiness in RECI target countries, as of 3 July 2020



Source: https://www.unescap.org/events/e-resilience-pandemic-recovery-intercountry-consultations-preparation-cictsti

and the report could be found at: https://www.unescap.org/sites/default/files/Annex%203%2C%20Survey%20A%20results%2C%20updated_0.pdf

Figure 30: E-resilience readiness in SPECA countries, as of 30 July 2020



Source: https://www.unescap.org/events/speca-working-group-innovation-and-technology-sustainable-development and the web link to the report: https://www.unescap.org/sites/default/files/SPECA_E-Resilience_Survey%20results-English_0.pdf

Annex 2 List of Questions of the Survey (see answers in Annex 1)

LIST OF QUESTIONS IN SURVEY A: E-RESILIENCE READINESS

1. ICT network infrastructure resilience

1. How would you rate the level of broadband Internet access sufficiency (Mobile and Fixed) in your country from the perspective to leverage ICT for minimization of disruptions, which people are faced with during COVID-19 outbreak?

2. How would you rate your country's ICT infrastructure compatibility for co-deployment projects with road transport infrastructure?

3. How would you rate your country's ICT infrastructure compatibility for co-deployment projects with energy infrastructure.? (Risk Prevention)

4. To which extent your country utilizes ICT for verification, risk assessment, and analysis investigation for the prevention, detection, and control of infectious disease outbreaks? (Risk Prevention)

5. How would you rate your country's efforts to promote network resilience? e.g. by facilitating emergency access to relevant ICT resources, or expediting the approval of new sites and installations and, or allowing voluntary infrastructure sharing when necessary? (Response)

6. To which extent the ICT infrastructure in your country ensures continuity plans on connectivity (e.g. contingency planning, emergency measures, and drills and backups)? (Response)

7. To what extent you agree that your country utilize ICT to establish preparedness and response plans and mechanisms, as well as regular testing for emergency preparedness (Risk Reduction)

8. How would you rate probability that your country plans to change/adapt its ICT infrastructure in a post pandemic era? (Recovery Phase)

9. What is your level of confidence that your country plans to invest in ICT infrastructure to reduce future risks? (Recovery Phase)

2. ICT for societal resilience

10. How would you rate the diffusion among citizens of your country of reliable broadband Internet access from home.

11. I have access to risk databases, such as GIS (geographic information system), for DRR? (Risk Reduction)

12. How would you rate your own experience of using on-line services and applications during period of social distancing (e.g online banking, shopping, training courses, on-line cinemas, forums etc.)

13. To what extent your country utilizes ICT for infectious disease outbreaks preparedness by supporting digital tools, developing content services and promoting digital skills across the population as a whole? (Risk Reduction)

14. How would you rate ICT utilization in your country for effective emergency risk communications and information sharing across all levels of government, within communities, and between public and private organizations? (Response)

15. How well does your country ensure access to affordable digital services for citizens such as internet access or mobile plans during times of crisis e.g. COVID-19 outbreak? (Response)

16. How well do current policies and strategies in your country support compliance with social distancing principles while providing vital connectivity, e.g. through remote working, on-line official services availability. (Response)

17. How effectively ICT is utilized in your country to facilitate access to essential health services through, for example, e-health, telemedicine and big data. (Response)

18. Do you feel that you have all the necessary digital skills to adapt to an online economy?

3. Policy and legal provisions for E-resilience against pandemic

19. Does your country already have, and currently implement the state programs of development of broadband access infrastructure?

20. Did your country invest in early warning and has accessible financing mechanisms available for the prevention, detection, and control of infectious disease outbreaks based on ICT? (Risk Reduction)

21. To what extent you agree that legislation in your country generally allows and encourages new initiatives on methods to increase affordable broadband access and the efficiency of digital services?

22. To what extent you agree that your country has already developed a competitive environment in the broadband access market.

23. Does your country have institutions (organizations or inter-ministerial working group) to coordinate, select, evaluate and prepare innovative ICT projects for implementation, e.g. ICT infrastructure projects compatible for co-deployment with road transport and energy infrastructure. (Risk Prevention)

24. What is your confidence level that legislation allows for the budgetary and extra-budgetary financing of innovative activities, including international grants, public-private partnership (PPP), etc.

25. Does your country have a digital economic strategy?

26. To what extent you agree that your country promotes network resilience by facilitating emergency access to relevant resources and allowing voluntary infrastructure sharing when necessary.

4. Collaborative actions to harness technologies against pandemic

27. How effectively the communities, health-care facilities, and points of entry in your country report and communicate in order to prevent and detect infectious disease outbreaks. (Response)

28. How would you rate your country's readiness to collaborate with other countries during emergency and ICT infrastructure-sharing experience?

29. To what extent the inter-ministerial working group for ICT infrastructure sharing is set and delivered regularly.

30. How would you rate the level of the coordination mechanism between state authorized institutions and/or independent bodies involved in the regulation of broadband access?

31. How would you rate the level of stimulation of public-private partnership (PPP) in the development of broadband access in your country?