INFORMATION AND COMMUNICATONS TECHNOLOGY AND
DISASTER RISK REDUCTION DIVISION

E-Resilience Monitoring Toolkit: Methodological Notes and Pilot Countries' Profiles

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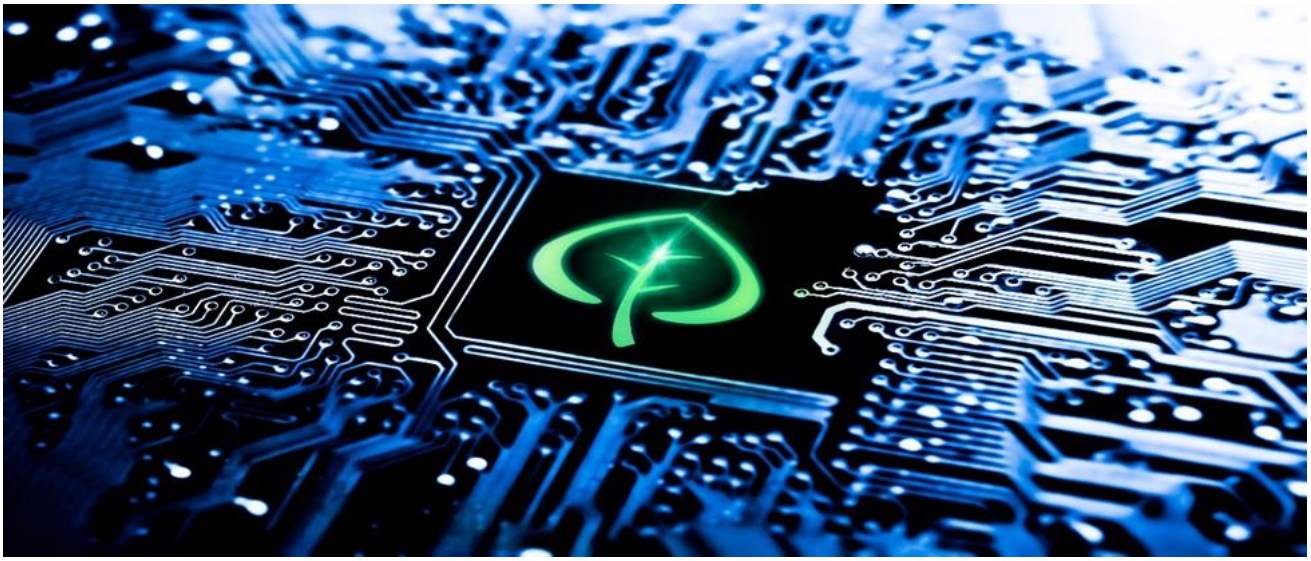

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Abstract

The ongoing COVID-19 pandemic has shown the extent to which we rely on digital products and services to sustain our lives. These digital products and services can become a source of innovation and hope during crises and emergencies.

Information and communications technologies (ICTs) are powerful tools for managing hazards and exposures, and for successful recovery that leaves no one behind. But this requires an underlying ICT infrastructure that is reliable, high quality, accessible and affordable on which digital products and services can be delivered.

For this reason, regional cooperation in strengthening e-resilience is critical to ensure that the ICT infrastructure is resilient and can effectively support disaster risk reduction and sustainable development.

Against this background, this working paper aims to establish a methodology for the measurement and monitoring of e-resilience across countries to support policymaking and facilitate regional dialogue and cooperation in strengthening e-resilience.

In particular, the working paper describes the process of e-resilience data collection, techniques to transform the data into a single dataset, operations with data, such as missing values treatment and normalization, and visualization of the data.

The dataset for several pilot countries used for this working paper is publicly available online on the website of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) in the form of a dashboard that includes the pilot country profiles and policy recommendations.

Hopes are high for decisive actions in the upcoming decade to achieve the 2030 Agenda for Sustainable Development and the climate commitments set to meet the Paris Agreement. Implementation of the Asia-Pacific Information Superhighway (AP-IS) Action Plan for 2022-2026, which was adopted by the Steering Committee of AP-IS, is a promising enabling framework to address digital agendas under the connectivity pillar, which goes along with consideration of the readiness on e-resilience. Seamless connectivity coupled with efforts towards better e-resilience readiness cannot be efficient without proper measurements and networking support from the member states.

Data-driven and cooperative actions are needed more than ever. The resilience of the digital infrastructure and services requires strong policy set up and implementation by the member States and stakeholders. ESCAP is ready to assist member States in building e-resilience in line with the vision of a prosperous, safe, resilient, and the digital Asia-Pacific.

Keywords: e-resilience, methodology, composite index, policy recommendations, country profile, monitoring dashboard.

I. INTRODUCTION

1.1. Background on E-Resilience

In the Master Plan for the Asia-Pacific Information Superhighway (AP-IS) 2019-2022, the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) Secretariat was directed to assist member States in developing their e-resilience, the third pillar of the AP-IS, which is understood as:

> *The ability of information and communications technology (ICT) systems to withstand, recover from and change in the face of an external disturbance.*

The AP-IS Action Plan 2022-2026 addresses e-resilience agendas in the framework of its pillar on Connectivity for All, with the intention of advancing e-resilience measurement at the country level, while also creating a dedicated stakeholder group and further expanding the scope of work on e-resilience.

In order to understand the needs of the countries and keep better track of the progress achieved, the ESCAP Secretariat created an online dashboard that sources data from existing indicators to visualize progress aimed at strengthening e-resilience in the ESCAP region.

The ESCAP Committee on ICT, Science, Technology and Innovation has guided the ESCAP Secretariat in developing the methodology.

Meanwhile, there are many existing organizations that are already collecting data on different aspects of e-resilience, including United Nations agencies and other international organizations, regional forums, business associations, academic institutions, and other stakeholders.

With this in mind, the e-resilience dashboard is as an attempt to leverage existing knowledge and measurements so that available resources are effectively used.

In this working paper, we discuss the ways to measure e-resilience, provide methodological notes for creating a composite index, and prepare pilot country profiles and sample policy recommendations for Kazakhstan, Kyrgyzstan, Mongolia, and Tajikistan to showcase the potential usefulness of this toolkit.

1.2. Pillars of E-Resilience

In measuring e-resilience, it is crucial to understand and structure the object of the measurement along more manageable pillars. Such pillars need to provide a balanced and complete picture of e-resilience, and at the same time, they need to be measurable.

As a result, e-resilience indicators have been grouped under five pillars: (1) ICT infrastructure; (2) ICT policy; (3) new systems and applications; (4) digital data; and (5) hazard and exposure.

Firstly, the **ICT infrastructure** is the foundation upon which everything else related to ICT is built.

Secondly, **ICT policy** is the measure with which a society is able to form an enabling environment for e-resilience.

Thirdly, the **new systems and applications** pillar is related to the adoption of emerging technologies, innovations and new business models.

Fourthly, **digital data** covers the ability of a society to absorb changes, the everyday use of digital services, and the extent to which the society is ready to use digital tools in a public health crisis or in other emergencies.

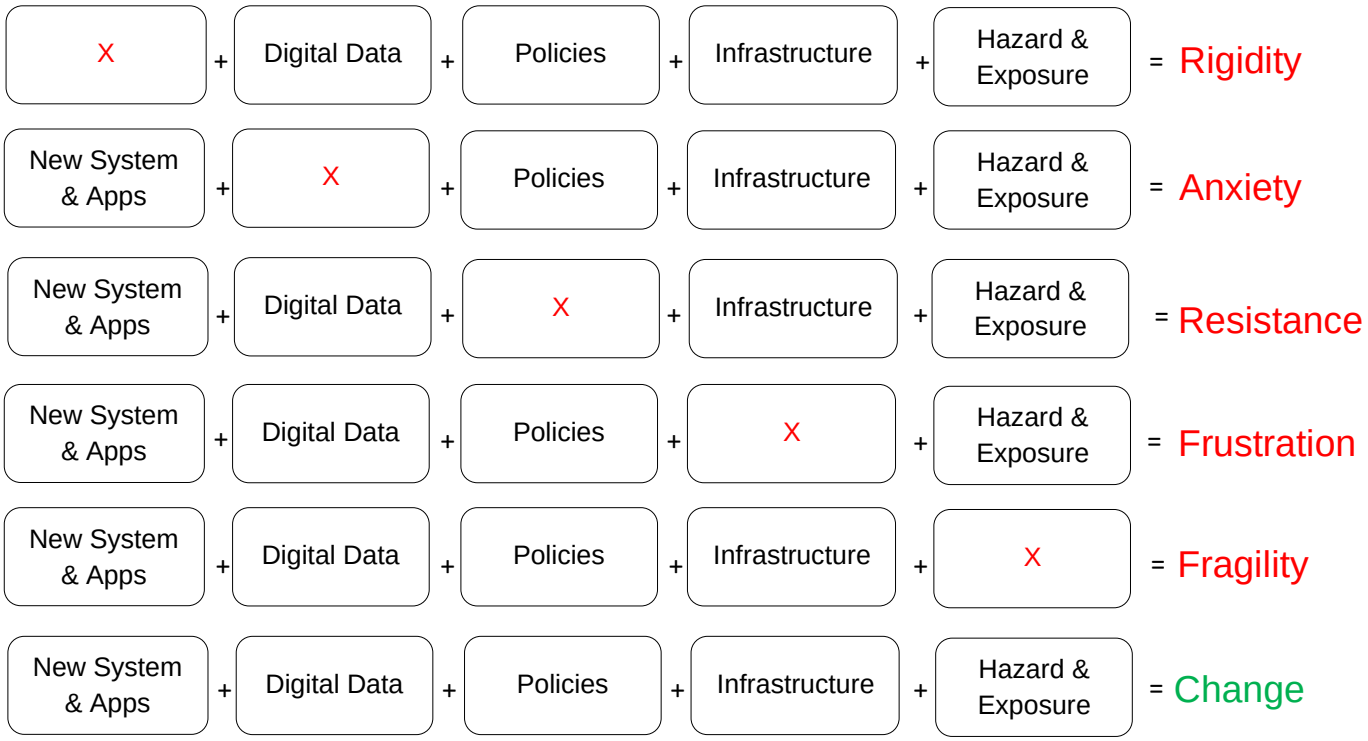
Lastly, the **hazard and exposure** pillar is a measure of attention given to all aspects of disaster resilience, including preparedness, response and recovery.

The conceptual basis of e-resilience from the pandemic management perspective was developed after it was presented at the CICTSTI 2019. It showcases the nexus between the ICTs and the stages of pandemic management, namely risk prevention, risk reduction, preparedness, adaptation and response, and recovery. [2] In order to build synergies and put these concepts into real practice, a change framework was established.

Figure 1 shows a change framework reference model for a deeper understanding of the interconnections between the e-resilience pillars. In the absence of one pillar, the ecosystem will be in a state of rigidity, anxiety, resistance, frustration or fragility. A holistic approach with the presence of all interconnected pillars is required to drive change in the ecosystem towards sustained e-resilience.

[2] Aida Karazhanova, Maya Barkin, Elena Dyakonova. (2020). Understanding E-Resilience for Pandemic Recovery in Asia and the Pacific. Asia-Pacific Information Superhighway Working Paper Series. United Nations ESCAP, IDD, November 2020. Bangkok, page 10

Figure 1: Change framework reference model for e-resilience pillars



Source: Adapted from M. Lipitt, "The Managing Complex Change Model", 1987, via E. Casali, IntenseMinimalism.com.

1.3. Initial Data

The data has been gathered from multiple sources for 50 indicators spread across five pillars.

These indicators have been published online in the form of a repository visualized by the PowerBI online dashboard, alongside static maps connecting the data for visualization purposes.

The dashboard is presented in a table with indicators grouped under pillars on the vertical axis. The country names are placed along the horizontal axis, with the possibility of viewing the data by economic grouping (e.g., least developed countries, landlocked developing countries, etc.) or by geography (e.g., East and North-East Asia, Pacific Island Countries, South-East Asia, etc.).

Each indicator is assigned a colour coding representing the level of resilience, with green representing the best scores, and red representing the worst scores. There is also light green, yellow and orange coding representing scores in between.

Figure 2: Snapshot of dashboard covering e-resilience scores for the least developed countries

Pillar	Name	Afghanistan	Bangladesh	Bhutan	Kiribati	Myanmar	Nepal	Solomon Islands	Timor-Leste	Tuvalu	Vanuatu
ICT infrastructure as a physical foundation	4G mobile network coverage (0-100 % max)		58,00				15,50				
	Active mobile-broadband subscriptions per 100 inhabitants (0-100 % max)	18,82	41,24	101,64	1,46	92,69	47,52	17,50	31,61	0,00	65,07
	Computer software spending (0-100 % max)		0,18				1,40				
	Fixed (wired) broadband subscriptions per 100 inhabitants	0,04	6,34	1,43	0,76	0,24	2,82	0,23	0,05	3,96	1,61
	Fixed-broadband subscriptions, > 10 Mbit/s, % of total fixed-broadband subscriptions, (0-100 % max)		20,00								
	Handset pricec (%monthly GDP per capita) (0-100 max)		46,95				21,20				
	International Internet bendwidth per Internet user (kbit/s)		24 095,79				13 198,35				
	Internet access in schools (0-100 % max)		4,14								
	Mobile cellular subscriptions per 100 inhabitants (0-100 max)	59,12	100,24	93,26	50,79	113,84	120,00	73,83	115,81	70,36	85,91
	Mobile tariffs (%monthly GDP per capita) (0-100% max)		69,55				49,50				
	Percentage of Households with a computer (0-100 % max)	3,43	5,60	23,58			13,97				
	Percentage of Households with Internet access at home (0-100 % max)		6,75				17,70				
	Percentage of Individuals using the Internet (0-100 % max)	13,50	15,00	48,11	14,58	30,68	34,00	11,92	27,49	49,32	25,72
ICT policy in different sectors	Adult Literacy (0-100 % max)	43,02	73,91	66,56	93,00	75,55	67,91	76,60	68,07	98,00	87,51
	Cybersecurity (0-1 max)		0,52				0,26				
	DRR Implementation 0-10 (max, the worst)	6,30	3,00	4,50		7,10	5,40	6,60	6,30		5,40
	Ease of doing business (0-100 max)		26,20				58,30				

1.4. General Considerations

Substantive inputs have been received through discussions on the e-resilience composite index with member countries of the Special Programme for the Economies of Central Asia, experts of the Working Group on Innovation and Technology for Sustainable Development, and ESCAP's consultant and expert community.

From these discussions, there is agreement that the index should be an evolving tool that can be adapted to the needs of member States. Measurement is intended for self-review, and is not suitable for country comparisons.

This index should be driven by the inputs of the broad community, i.e., representatives of regulators, business community, civil society and academia, and should be updated and revised periodically.

The core idea is to create a basis for future work, involving partners, with a clear methodology, simple measurement design, and scope built with a possibility for scale up.

II. METHODOLOGICAL NOTES

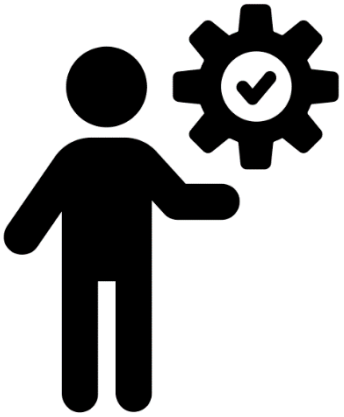
2.1. Issues and Challenges

Several issues came to the fore while gathering data from a variety of sources.

Firstly, there was no data consistency, which meant it was hard to understand what characteristics each source had, what data ranges and what methodologies were used in the collection of the data, and the extent to which indicators were compatible to each other and could co-exist in a single dataset.

Secondly, the measurement scale for each indicator was not the same. Some indicators had a range of scores, such as from 0 to 100, others were measured in absolute values (e.g., number of secure Internet servers), while some relied on the share of the variable compared to the population size (e.g., number of mobile-broadband subscriptions per 100 inhabitants). Moreover, some indicators' scales allowed negative values, such as -2.5 to 2.5 for regulatory quality, and others had reverse scales, where lower scores represented better outcomes (e.g., in hazard and exposure indicators). These different scales did not allow for comparison between the indicators.

Perhaps most challenging were the missing values in the data, especially for some countries. The missing values meant a single digit general score per pillar could not be constructed, and it also meant incomplete datasets. As a result, many data operations could not be performed.



Last but not least, the data was presented in a format that was difficult for end users to draw any useful information from, especially since they had no clear picture, like visual graphs or single-digit scores.

To address these challenges, the following actions were proposed: (1) review the data sources and unify the data; (2) handle missing values using rigorous but simple international statistics techniques; (3) perform normalization of data and bring all the values to a 0 to 100 scale; and (4) weight the indicators and calculate a pillar score.

The following subsections detail the steps that have been taken for the proposed actions.

2.2. Review of the Data Sources

The first step is to examine the data sources and unify the data. The three main data sources are:

1) International Telecommunication Union (ITU) World Telecommunication Indicators Database (WTID);

2) United Nations E-Government Development Index (EGDI); and

3) World Economic Forum (WEF) Network Readiness Index (NRI).

Data from the WTID and EGDI is collected directly from the member States statistical agencies' surveys and country studies, and are therefore considered primary sources.

The NRI, however, is a composite index, with data pulled from a variety of different sources, which makes it an intermediary source.

In constructing a composite index, it is essential to use data as close to the source as possible to minimize distortions. Therefore, as part of this toolkit, we tried as much as possible to use primary sources of data.

It is also important to identify the source for future data normalization in order to find global minimum and maximum reference values.

One of the issues with the NRI data is that the NRI does not provide the original data, and there is insufficient metadata to fully understand the data and year of data that is used in the index, as well as how the data has been normalized.

Some of the NRI calculations are done in-house, and the methodology used is not clear enough for replication. Moreover, different datasets may be using different methodologies and data collection sources, with varying margins of error.

Table 1: Original data sources for the Network Readiness Index

Indicator source	Entity responsible for data collection	Link
World Development Indicators	World Bank	http://wdi.worldbank.org/
Global Findex database	World Bank	https://globalfindex.worldbank.org/
Global Innovation Index	World Intellectual Property Organization	https://www.globalinnovationindex.org/
ITU ICT Regulatory Tracker	ITU	https://www.itu.int/net4/itu-d/irt/
ITU World Telecommunications Indicators Database	ITU	https://www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx
ITU Global Cybersecurity Index	ITU	https://www.itu.int/en/ITU-D/Cybersecurity/Pages/global-cybersecurity-index.aspx
Mobile Connectivity Index	GSMA	https://www.mobileconnectivityindex.com/
WEF Executive Opinion Survey	WEF	https://www.weforum.org/reports/
WEF Global Competitiveness Index	WEF	https://www.weforum.org/reports/the-global-competitiveness-report-2020
UNCTAD Cyberlaw Tracker	United Nations Conference on Trade and Development (UNCTAD)	https://unctad.org/page/cyberlaw-tracker-country-detail
UNESCO UIS Stat Database	United Nations Educational, Scientific and Cultural Organization (UNESCO)	http://data.uis.unesco.org/
UNIDO Competitive Industrial Performance Index	United Nations Industrial Development Organization (UNIDO)	https://stat.unido.org/cip/
IHS Markit ICT Database	IHS Inc.	Not available
Tarifica Mobile Tariffs Database	Tarifica	Not available

2.3. Handling Missing Values

After all the sources have been checked, the values for the indicators are updated with the latest 2020 data where possible. However, there is the issue of missing data.

Missing data or missing values occur when no data value is stored for the variable in an observation. Missing data is a common occurrence and can have a significant effect on the conclusions that are drawn from the data.

As the aim is to create a robust composite index with a dataset that has a conventional "completeness" of cases, the missing values can have considerable influence on the outcomes and lead to substantial inaccuracies.

To reduce this influence, various international statistics techniques have been applied to develop a complete dataset. While it is necessary to use these techniques, we must be mindful of the assumptions, and understand that the completeness of this dataset is only a convention.

As such, the missing values have been imputed based on the **missing-at-random assumption** that assumes the missing values have nothing to do with the country's level of e-resilience, and these values are missing not because of any other indicators in the measurement tool.

For missing values, the **cold-deck imputation** technique has been used to replace the missing values with the older available data for the same country.

For the remaining data, all indicators are checked to ensure that they have no more than one case missing per pillar, and **case deletion (complete case analysis)** has been used. Here, the remaining missing record in the calculation of a pillar score is omitted (pillar score calculation "ignores" a missing case, instead of counting it as a zero). This technique allows a better measurement, and does not make zero-value assumption, which can be incorrectly "punishing" the countries with missing values in an indicator.

The application of these techniques to the pilot countries has been sufficient to develop a complete dataset with no missing data.

In future, consideration should be given to other imputation techniques, such as **hot-deck imputation** that imputes missing values with similar country data. One of the ways to identify similar countries involve consideration of countries' demographic and economic conditions. Missing values can then be replaced with the average values of the similar countries. This of course is not a perfect solution, but it can be used to help complete the dataset.

More importantly, it is necessary to engage partners in the future to find and populate missing values and data, and create more complete datasets.

2.4. Data Normalization

The data collected from multiple sources often uses different scales, which makes data comparison difficult. In this case, it is necessary to perform an appropriate normalization procedure.

Global minimum and maximum values are identified for each indicator. The values are then normalized to a 0-100 scale using the **Min-Max method** by subtracting the minimum value and dividing by the range of the indicator values.

The Min-Max method identifies the global reference maximum value (*Xmax)* and minimum value (*Xmin)*, and then using case value score (*Xi)*, identifies a score relative to these reference values, which is also called a normalized value or *Xi (nm)*.

Mathematically, the formula for the normalized indicator value $Xi\ (nm)$ is as follows:

$$Xi(nm) = \frac{(Xi - Xmin)}{(Xmax - Xmin)} * 100$$

The formula for a reverse Min-Max (for indicators where higher values represent worse outcomes) is as follows:

$$Xi(nm) = \frac{(Xmax - Xi)}{(Xmax - Xmin)} * 100$$

Not all the indicators have been normalized this way. Following good international practices, we respect the data properties and have refrained from normalization where the original scale is at 0-100 range so that the inherent data remains intact, such as in the indicators calculating numbers per 100 inhabitants.

Table 2: Example of Min-Max reference value identification

Economy	High-tech exports, % of total exports	
Hong Kong SAR	65.57	$= Xmax$
…	…	
…	…	
…	…	
…	…	
Country X	30	$= Xi$
…	…	
…	…	
…	…	
…	…	
…	…	
Mauritania	0	$= Xmin$

In future, it may be beneficial to consider the influence of outliers to the normalization, and some of the reference values can be taken from the regional level instead of the global level (e.g., ESCAP regional data). A way to detect and deal with outliers is to analyse skewness and kurtosis, and use the **winsorization** and/or **log transformation** technique.

2.5. Data Weighting and Pillar Score Calculation

Weighting has been performed with the **equal weights** approach where equal weights are assigned to each indicator to calculate the pillar score.

The general formula for the calculation of the weighted pillar scores is as follows:

$$X = \frac{X_1W_1 + X_2W_2 + \ldots + X_nW_n}{W_1 + W_2 + \ldots + W_n},$$

where *X* is the pillar score, X_1 is a score for the first indicator within that pillar, and *Wx* is the **weighting coefficient** or **weighting factor**. In this approach of equal weights, it is assumed that *W* is equal for all *X*, which means that the resulting value is equal to the arithmetic mean.

Although the number of indicators is not the same in every pillar, this does not imbalance the index, as there is no single index score.

In future, it may be beneficial to have a discussion or expert review on assigning different weights to the indicators.

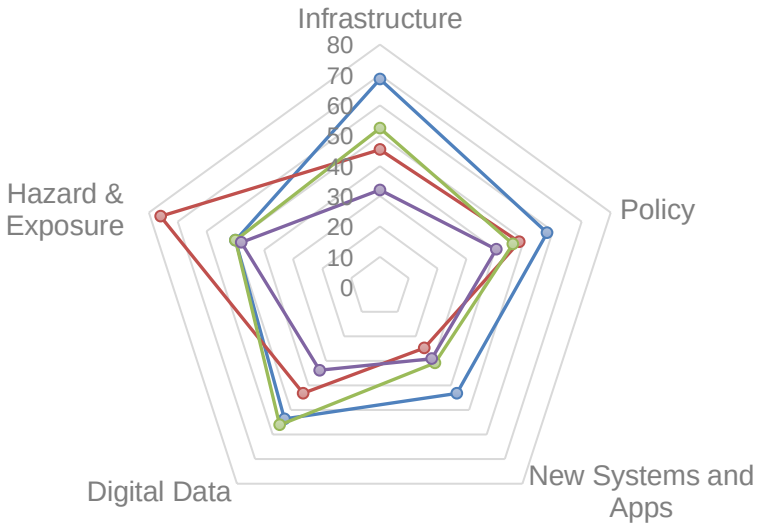
2.6. Data Visualization

The resulting score for each pillar is visualized using a radar chart, which is a simple but powerful tool for the user to understand the findings of the measurement, while also giving the depth and incentive to investigate the data further.

This visualization form allows users to have a data-driven and informed discussion on "what the numbers show".

Simple visualizations allow us to draw important policy lessons and recommendations, and these can be further supported by a deeper dive into the data, and presented to user in the form of a story or profile about a specific country case (see Section III).

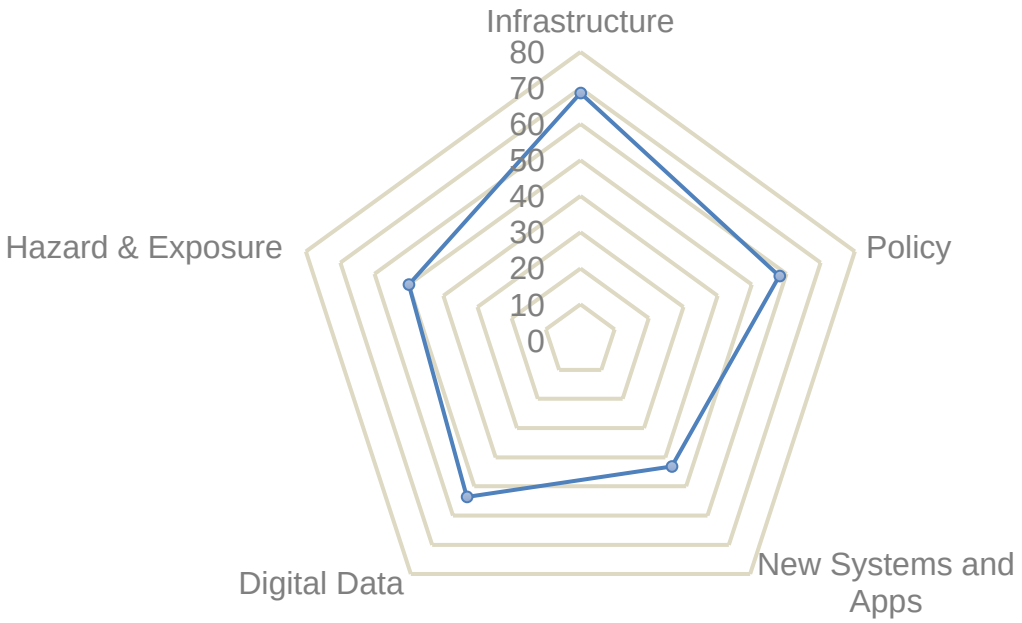
Figure 3: Sample visualization radar chart for four pilot countries



III. COUNTRY PROFILES AND POLICY RECOMMENDATIONS

3.1. Kazakhstan

Figure 4: Kazakhstan e-resilience radar chart



Overall, the e-resilience scores of 2020 for Kazakhstan show solid performance across all five pillars of e-resilience. Its forte is in infrastructure and policy, where Kazakhstan has impressive scores in Internet use and broadband affordability. However, there is potential scope for further development in strengthening the resilience of the domestic computer software industry and promoting the creation of locally relevant digital products and services that strengthen people's resilience to crises and disasters. Kazakhstan may also benefit from enhancing cooperation in the new systems and applications pillar, particularly by incentivizing investments in domestic research and development.

Kazakhstan has a high score in the **ICT infrastructure** pillar with five Internet users for every six individuals residing in the country. Almost the same share of Kazakhs actively enjoys mobile broadband, which is not surprising, given that Kazakhstan is one of the global leaders in terms of affordability of mobile tariffs.

Building on the well-developed ICT infrastructure, Kazakhstan may want to consider giving more attention to domestic computer software development, tailored to the local conditions and needs, to improve crisis and disaster preparedness, response and recovery.

In terms of **ICT policy**, Kazakhstan gives significant attention to the ease of doing business and general education support. Its cybersecurity policies also contribute to its high score under this pillar.

At the same time, there is room for improvement, for example, in providing incentives for the network operators and webmasters to protect data and deploy modern encryption technologies, as currently the number of servers using trusted Secure Sockets Layer (SSL) and Transport Layer Security (TLS) certificates is not very high.

Stronger encryption can provide security of financial transactions, which is paramount during and after crises, and can also contribute to building public trust in digital services and

achieving better e-resilience. Additional consideration may be given to supporting national research and development efforts in this area.

Regarding **new systems and applications**, this is an area that requires attention. While there are strong points, such as the high number of apps developed relative to the population size, and government's investment in emerging technologies, consumers and businesses' use of digital products and services remains quite low.

Future policy directions may include studies on the digital needs of consumers and businesses, and the barriers they face in accessing and using digital products and services.

Another issue is the relatively low share of high- and medium-tech industries in the export structure, which is a complex problem, pointing at a general need to seek opportunities and niches for domestic companies to achieve a level of regional and global competitiveness and sustainability. Achieving this can help national ICT ecosystems withstand and recover from crises, and develop capacity to adapt to evolving needs.

Under the pillar of **digital data**, Kazakhstan has developed popular and powerful e-government systems, and its population generally has a high level of ICT skills. These two aspects are crucial during crises, as evident in the ongoing COVID-19 pandemic, where the presence of ICT skills and availability of e-government services have enabled economies and societies to continue the usual way of life with minimal disruptions.

As a further step towards greater e-resilience, Kazakhstan may consider opening its data to make government more accountable and give citizens new ways to participate in their communities, as well as incentivize the creation of locally relevant content online, especially for rural and remote communities.

Additional consideration can be given to the healthy inflow of ICT professionals working in the industry to contribute to these efforts.

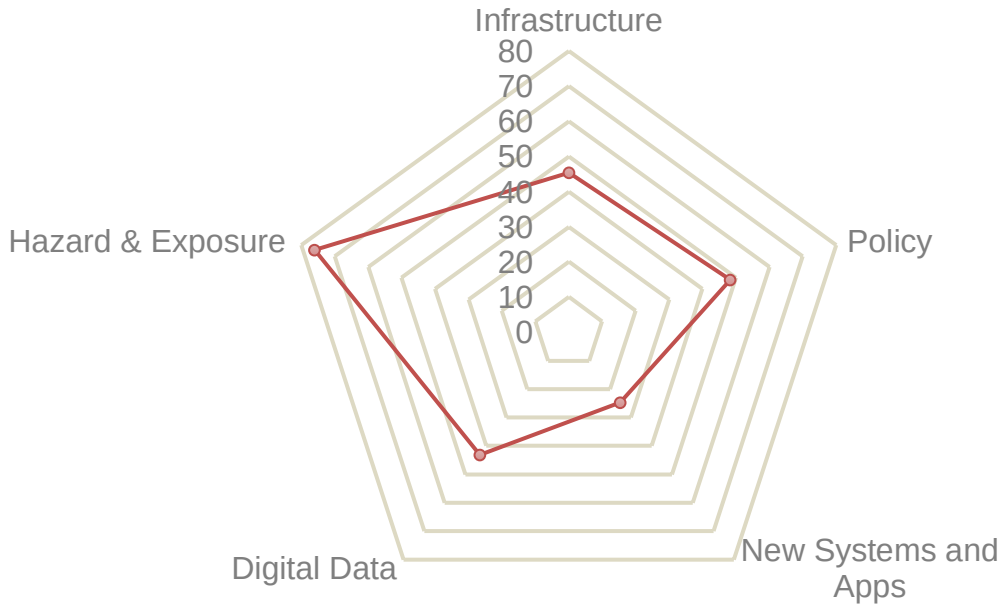
On **hazard and exposure**, Kazakhstan shows mediocre score, highlighting the need to provide more support to efforts in disaster risk reduction, such as participating in regional and global initiatives that are aligned with the Sendai Framework for Disaster Risk Reduction. Kazakhstan's strong ICT systems should be leveraged to improve disaster risk preparedness and management systems.

Referring to the change framework reference model for e-resilience, Kazakhstan faces a risk of overall **rigidity**, and inability for flexible changes to meet the rapidly evolving needs.

In regional cooperation to achieve meaningful change, Kazakhstan can share with the region, good practices in deploying infrastructure, and learn about innovative ways to facilitate new and emerging technologies, and ensure that conducive conditions are in place to promote innovation.

3.2. Kyrgyzstan

Figure 5: Kyrgyzstan e-resilience radar chart



Overall, the 2020 e-resilience scores for Kyrgyzstan are good especially under the hazard and exposure pillar, demonstrating strong political will and broad consensus for creating a more resilient society.

There is also indication of good progress in policies promoting e-resilience. Kyrgyzstan may benefit from expanding cooperation in the adoption of new and emerging technologies, taking measures to lower the cost of Internet access, and developing robust national cybersecurity policies and systems in line with international and regional best practices.

Related to the **ICT infrastructure**, there are more than 100 mobile cellular subscriptions per 100 inhabitants of Kyrgyzstan, and over 85 per cent of its territory has 4G mobile network coverage. Kyrgyzstan's infrastructure may benefit from expanded cooperation in increasing fixed-broadband subscriptions and the number of households with computers, and making mobile- and fixed-broadband more affordable.

Related to **new systems and applications**, one in four Kyrgyz companies have a website, and a significant number of apps are developed in the country compared to the population size. Areas for improvement through regional cooperation include strengthening consumers' trust to shop online, and promoting the adoption of new and emerging technologies.

In **ICT policy**, the Kyrgyz government has given significant attention to the ease of doing business and to developing modern ICT regulation in recent years, which are essential in times of crisis, as evidenced in the ongoing COVID-19 pandemic.

Kyrgyz authorities may explore further areas of cooperation at regional and international levels, and make use of lessons learned in developing strong national cybersecurity frameworks and ensuring the flexibility of national laws and regulations, allowing innovative uses of ICTs to contain threats and build back better.

Under the **digital data** pillar, Kyrgyzstan has relatively progressive e-government systems, but more importantly, there is high availability of locally relevant content online. An area where Kyrgyzstan can achieve higher scores is in ICT skills, both for supporting the higher education of ICT professionals and developing basic ICT skills

among its population.

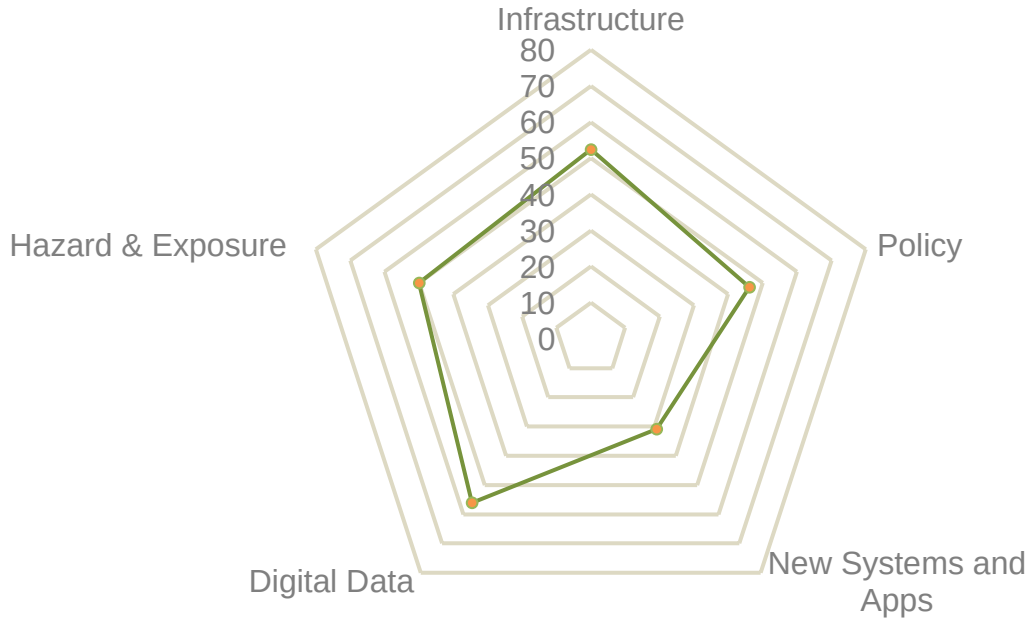
Kyrgyzstan has a high score for its good management of **hazard and exposure**, and it is crucial to continue in this direction through strengthening the resilience of ICT systems and using ICTs to recover and build back better.

Kyrgyzstan is prone to overall **rigidity** risks, but most notably there is a limited ability to absorb changes and mitigate the impact with the everyday use of digital services, which creates significant threats and **anxiety** over possible emergencies, like public health crises and disasters.

Kyrgyzstan can be a model and case study for excellent government commitment towards managing hazard and exposure, which can be widely shared regionally and internationally with other developing countries. For substantial change to take place, Kyrgyzstan can look at how other Central Asian countries are promoting the use of digital services and adopting data-driven approaches. A good reference is Mongolia's experience.

3.3. Mongolia

Figure 6: Mongolia e-resilience radar chart



Overall, Mongolia has average scores across all e-resilience pillars.

Remarkably, Mongolia has an excellent inclusion practice that has resulted in a balanced gender profile of Internet usage and significantly higher than average rural use of digital payment systems that other countries can learn from and adopt.

Mongolia may benefit from expanding cooperation in promoting greater availability of e-government services and expanding 4G mobile network coverage across the country.

Regarding the **ICT infrastructure**, more than 65 per cent of the Mongolian population aged 15 and above are using the Internet, while more than half of the broadband subscriptions have high (more than 10 Mbit/sec) data rate,

contributing to its average score. Expanding 4G mobile network coverage through cooperation between governments, national operators and civil society can further improve access to ICTs.

Related to **new systems and applications**, Mongolia has a developed medium- and high-tech industry, and a good number of companies have online presence via websites. Mongolia may wish to explore best practices to strengthen consumers' trust to shop online and support investments in emerging tech.

In **ICT policy**, Mongolia has a relatively well-developed and modern ICT regulation framework in place, coupled with an e-commerce legislation, helping to offset restrictions such as lockdowns during crises. To further improve its score under this pillar, Mongolia may wish to review best practices in developing national cybersecurity policies, and engage with regional partners in supporting research and development activities.

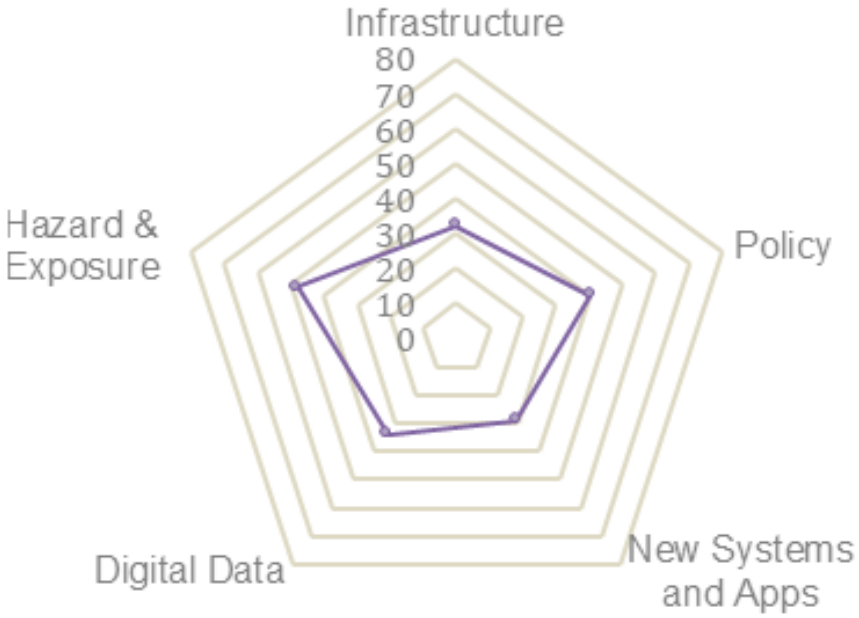
Related to **digital data**, Mongolia has achieved a balanced gender profile of Internet usage and its rural inhabitants are active user of digital payments. Almost half of Mongolia's population are active users of Internet banking, which has been crucial in supporting livelihoods during COVID-19 lockdowns. Learning from other countries, Mongolia can consider developing its e-government services to further encourage Internet use.

Finally, on managing **hazard and exposure**, Mongolia shows a mediocre score, highlighting the need to give more attention to disaster risk reduction, for example, by participating in regional and global initiatives, including the activities under the Sendai Framework for Disaster Risk Reduction.

Mongolia can tackle potential **rigidness** by encouraging the development and adoption of new and emerging technologies for strengthening e-resilience through enhanced regional cooperation and exchange of good practices.

3.4. Tajikistan

Figure 7: Tajikistan e-resilience radar chart



Overall, the 2020 e-resilience scores for Tajikistan are fair, while its hazard and exposure score stands out. Tajikistan has taken an active approach to supporting new and emerging tech adoption, and may benefit the most from regional cooperation in improving ICT regulation and cybersecurity policies, developing e-government services, and lowering the cost of mobile tariffs relative to household incomes.

Related to Tajikistan's **ICT infrastructure**, there are more than 100 mobile cellular subscriptions per 100 inhabitants, and 80 per cent of the country is covered by 4G networks. However, it is vital for Tajikistan to reduce the mobile tariffs, which is very high relative to household incomes, and incentivize consumers to use broadband for economic benefits, as a crucial component of strengthening national e-resilience.

Regarding **new systems and applications**, the government has made significant investments in promoting the development and adoption of emerging tech. Tajikistan may consider leveraging regional partnerships to ensure that the technology adoption and the associated benefits are distributed fairly in society, so that during crises and disasters, nobody is left behind.

In **ICT policy**, the public trust is there for the policies implemented. However, there is scope for cooperation related to modern ICT regulatory practices and ensuring legal framework adaptability.

On the **digital data**, there is a remarkably high level of ICT skills penetration in the population and the rural inhabitants are active users of e-payments. Tajikistan can benefit from best practices to further develop its e-government services.

Although Tajikistan's **hazard and exposure** score stands out, continued improvement in using ICTs to strengthen disaster risk reduction system will be important.

Tajikistan can benefit from expanded regional networks of partnerships as there are significant rigidity, anxiety and frustration risks. Tajikistan can take a closer look at its regional infrastructure development and overall policy frameworks, and adopt good practices from other countries, such as Kazakhstan, in expanding and strengthening its national ICT infrastructure.

IV. WAY FORWARD

This working paper is an attempt to lay a foundation for a simple but sound methodology to measure e-resilience. It aims to spark discussions among member States to strengthen and sharpen this measurement tool, and develop member States' capacities in line with national public policy objectives and needs.

In future, we recommend creating a membership-led process of continuous review of this tool together with a wide range of stakeholders, and promote usage of this tool in the ESCAP region.

The review process can involve specialists with different backgrounds, including policymakers, ICT experts, statisticians and potential users of this toolkit.

Some specific issues this review process can address include selecting indicators to add or remove, identifying relevant data sources, applying appropriate missing values treatments, discussing how the indicators should be weighted in the pillar scores, adopting better data visualization techniques that better align with end users' needs and expectations, and other considerations.

Such process can also be used to disseminate e-resilience measurement findings across the region and among different stakeholder groups in support of data-driven decision-making.

In implementation of the AP-IS Action Plan (2022-2026), this work can promote and support enhanced regional cooperation in data collection, analysis and visualization towards meaningful, smart and impactful actions for an e-resilient Asia-Pacific.

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