Asia in the Global Dynamics of Embracing the Digital Revolution: Performance & Strategic Priorities for Policy Action

Author Khuong Vu

By Khuong Vu

Asia's Efforts in Embracing the Digital Revolution

Asia is a major contributor to the rapid progress and penetration of the digital revolution.

Contributions to frontier technology innovation

Four Asian economies – Japan, South Korea, China, and Taiwan – are among the leading nations that are at the forefront of the digital revolution. According to the Statista online database (2021), these four economies are in the list of top 10 countries by patenting activities in at least one of three frontier technologies: 5G, Artificial Intelligence (AI), and the Internet of Things (IoT).

In addition, statistics from the European Patent Office (EPO) show that China, Japan, and South Korea together with their companies are among leading innovators in the two fundamental drivers of the digital revolution – computer technology and digital communication *(Table 1)*. Furthermore, the number of worldwide patent applications grew from 2018 to 2019 at two-digit rates, which were faster for

TABLE 1

Patent applications in 2019 in European office by country & company in fields of Computer Technology & Digital Communication

Country	Rank	2019	2019 vs 2018	Share	Company	Rank	2019	Share
Computer Technology								
US	1	4,866	+13.6%	38.1%	Alphabet	1	673	5.3%
China	2	1,356	+18.7%	10.6%	Microsoft	2	673	5.3%
Japan	3	1,212	-0.9%	9.5%	Samsung	3	630	4.9%
Germany	4	1,130	+13.8%	8.8%	Huawei	4	382	3.0%
South Korea	5	830	+6.4%	6.5%	Intel	5	339	2.7%
OEPO2*	6	824	+3.5%	6.5%	Siemens	6	324	2.5%
France	7	587	-3.0%	4.6%	Sony	7	284	2.2%
UK	8	467	+24.5%	3.7%	Philips	8	215	1.7%
Netherlands	9	411	+5.7%	3.2%	Alibaba	9	173	1.4%
Sweden	10	252	+24.8%	2.0%	Apple	10	167	1.3%
Others	–	839	+4.9%	6.6%	Others	–	8,914	69.8%
Total	**–**	**12,774**	**+10.2%**	**100%**	**Total**	**–**	**12,774**	**100%**
Digital Communication								
China	1	3,736	+64.6%	26.4%	Huawei	1	2,260	15.9%
US	2	3,684	+14.6%	26.0%	Ericsson	2	1,227	8.7%
Sweden	3	1,301	+11.8%	9.2%	Qualcomm	3	1,061	7.5%
Japan	4	1,270	-5.6%	9.0%	Samsung	4	567	4.0%
South Korea	5	1,230	+36.1%	8.7%	LG	5	545	3.8%
Germany	6	744	+12.9%	5.2%	OPPO	6	496	3.5%
OEPO1*	7	558	-6.5%	3.9%	Sony	7	424	3.0%
France	8	403	-18.3%	2.8%	Nokia	8	388	2.7%
Finland	9	347	0.0%	2.4%	ZTE	9	287	2.0%
UK	10	240	+7.1%	1.7%	Intel	10	236	1.7%
Others	–	662	+4.4%	4.7%	Others	–	6,684	47.2%
Total	**–**	**14,175**	**+19.6%**	**100%**	**Total**	**–**	**14,175**	**100%**

*Note: *EPO states consist of 38 member states of the European Patent Organisation, including the 28 states of the EU at the time; OEPO1 are the EPO states other than Germany, France, Finland, and UK; OEPO2 are the EPO states other than Germany, France, UK, the Netherlands, and Sweden.*

Source: Author's compilation using data from European Patent Office (EPO), Patent Index 2019; available at https://www.epo.org/about-us/annual-reports-statistics/statistics/2019.html

digital communication (19.6%) than for computer technology (10.2%). In this global innovation vibrancy, China far outperformed the world aggregate, growing at 64.6% in digital communication and 18.7% in computer technology, while South Korea grew faster than the world in the former (36.1%) but slower in the latter (6.4%).

Table 1 also shows that Asian companies hold leading positions in digital innovation in the business sector. In the list of the world's top 10 companies in computer technology innovation, four are from Asia (Samsung, Huawei, Sony, and Alibaba); while in the list for digital communication, six are from Asia (Huawei, Samsung, LG, OPPO, Sony, and ZTE).

ICT development and adoption

Regarding development and adoption of Information and Communications Technology (ICT), Asia has made remarkable achievements in both scale and speed. As shown in *Table 2*, the Asia-Pacific accounts for more than 50% of the world's total in most key indicators on ICT adoption, including mobile phone (55.3%), mobile broadband (56.6%), and fixed broadband (54.7%). In terms of speed, the compound average growth rate (CAGR) over 2000-2018 for the Asia-Pacific is higher than the world average across ICT adoption indicators: 27.7% vs 21.7% for mobile broadband; 11.7% vs 8.4% for fixed broadband; 18.8% vs 15.6% of population covered by 4G networks; and 41.9% vs 34.0% for international bandwidth.

The fact that Asia's share in the world's population covered by 4G networks (61.7%) is larger than that by 3G networks (57.2%) supports the claim that Asia has tended to move faster than the world average in embracing new mobile technologies.

Asia is also a leading player in adopting digital applications. For example, Asia handled a total online purchase of $2,448 billion in 2020, accounting for 57% of the world total value of retail e-commerce. For comparison, these respective figures are $749 billion (18%) for North America and $498 billion (12%) for Western Europe.

Investment in frontier digital technologies

Investment in frontier digital technologies is an important measure of efforts to advance in the digital age. Three noteworthy observations are salient in *Table 3*.

First, the Asia-Pacific accounts for more than one-fifth of the global market in each of the core frontier digital technologies, which is 23.2% for Cloud Computing, 22.0% for Big Data and Analytics, 23.5% for Mobility/Social Media, 22.5% for Cybersecurity, 23.9% for AI, and 22.4% for IoT. In addition, from 2014 to 2019 the region grew faster than the world in the total investment in all the core digital technologies (21.2% vs 18.4%) and in five of them the figures were: Cloud Computing (18.6% vs 15.0%), Big Data & Analytics (23.5% vs 18.7%), Mobility/Social Media (24.7% vs 19.3%), Cyber Security (21.7% vs 19.0%), and IoT (19.1% vs 17.7%).

TABLE 2

Key ICT development & adoption indicators by region in 2020

Region	Mobile	Mobile Broadband	Fixed Broadband	3G	4G	International Bandwidth (Tbit/s)
	Total subscribers/users/covered population (million)					
Africa	882	354	6	829	475	11
Arab States	427	261	35	396	270	35
Asia-Pacific	4,503	3,296	644	4,139	4,057	301
CIS	360	213	47	215	196	19
Europe	847	689	227	679	671	153
The Americas	1,129	1,010	218	972	903	141
WORLD	**8,148**	**5,823**	**1,177**	**7,230**	**6,571**	**660**
	World share					
Africa	10.8%	6.1%	0.5%	11.5%	7.2%	1.7%
Arab States	5.2%	4.5%	3.0%	5.5%	4.1%	5.3%
Asia-Pacific	55.3%	56.6%	54.7%	57.2%	61.7%	45.6%
CIS	4.4%	3.7%	4.0%	3.0%	3.0%	2.9%
Europe	10.4%	11.8%	19.3%	9.4%	10.2%	23.2%
The Americas	13.9%	17.3%	18.5%	13.4%	13.7%	21.3%
WORLD	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
	CAGR (2010-2020) *					
Africa	9.2%	37.8%	16.1%	11.5%	39.9%	45.8%
Arab States	3.2%	25.0%	17.0%	6.0%	29.6%	43.2%
Asia-Pacific	5.5%	27.7%	11.7%	4.8%	18.8%	41.9%
CIS	1.2%	13.6%	9.4%	5.5%	14.3%	31.0%
Europe	1.1%	13.7%	4.1%	1.2%	6.1%	25.6%
The Americas	2.5%	15.6%	5.0%	1.8%	4.9%	29.4%
WORLD	**4.5%**	**21.7%**	**8.4%**	**4.7%**	**15.6%**	**34.0%**

*Notes: CIS=Commonwealth of Independent States; * the period of compound average growth rate (CAGR) is 2015-2020 for population covered by LTE/WiMAX networks and International Bandwidth.*

Source: ITU

TABLE 3

Digital transformation market size & growth by region

	World	North America	Europe	Asia-Pacific	MEA	Latin America
Market size in 2020 (US$ million)						
Cloud Computing	129,589	44,944	31,555	30,015	13,787	9,288
Big Data and Analytics	83,015	28,893	21,846	18,224	8,082	5,971
Mobility/Social Media	104,901	35,314	26,700	24,655	10,935	7,297
Cybersecurity	61,811	20,867	16,991	13,936	5,705	4,312
AI	49,265	16,052	13,350	11,792	4,754	3,317
IoT	23,965	8,026	6,068	5,360	2,853	1,659
Others*	17,244	6,421	4,855	3,216	1,426	1,327
Total	**469,790**	**160,517**	**121,365**	**107,198**	**47,542**	**33,171**
Market share in 2020 (%)						
Cloud Computing	100.0	34.7	24.4	23.2	10.6	7.2
Big Data and Analytics	100.0	34.8	26.3	22.0	9.7	7.2
Mobility/Social Media	100.0	33.7	25.5	23.5	10.4	7.0
Cybersecurity	100.0	33.8	27.5	22.5	9.2	7.0
AI	100.0	32.6	27.1	23.9	9.6	6.7
IoT	100.0	33.5	25.3	22.4	11.9	6.9
Others*	100.0	37.2	28.2	18.6	8.3	7.7
Total	**100.0**	**34.2**	**25.8**	**22.8**	**10.1**	**7.1**
2014-19 growth, CARG (%)						
Cloud Computing	15.0%	11.2%	13.8%	18.6%	17.3%	18.0%
Big Data and Analytics	18.7%	17.8%	15.8%	23.5%	20.4%	18.2%
Mobility/Social Media	19.3%	17.2%	16.6%	24.7%	22.1%	19.0%
Cybersecurity	19.0%	15.2%	20.7%	21.7%	19.4%	22.4%
AI	22.7%	24.7%	24.5%	18.1%	15.7%	25.8%
IoT	17.7%	16.1%	19.4%	19.1%	17.2%	21.1%
Others*	17.5%	18.1%	19.1%	13.6%	11.4%	21.2%
Total	**18.4%**	**16.8%**	**17.6%**	**21.2%**	**19.0%**	**20.0%**

*Notes: MEA=Middle East and Africa; * Others include blockchain and robotics.*
Source: M&M (2020)

Exports of ICT goods and services

Asia is a major player in the global supply of ICT goods and a significant contributor to the world's ICT services exports. From *Table 4*, the following observations stand out.

First, East Asia and the Pacific (EAP) accounts for more than 70% of the world's total ICT goods exports, with a total value of US$1,608 billion in 2019. The main contributors to this performance are China ($662 billion; 30% of the world's total), South Korea ($140 billion; 6.3%), Singapore ($115 billion; 5.2%), Vietnam ($93 billion; 4.2%), and Malaysia ($77 billion; 3.5%), Japan ($56 billion; 2.6%), Thailand ($35 billion; 1.6%), and Philippines ($35 billion; 1.6%). It should be noted, however, the world share of EAP in this measure slightly declined from 2017 to 2019 as the world's total grew faster (from $1,992.4 billion to $2,207.9 billion or 5.3% per year) than EAP (from $1,493.8 billion to $1,607.7 billion or 3.7% per year). This trend is also observed for most EAP countries, with the exception of Vietnam, the Philippines, and Malaysia.

On ICT services exports, India stands out as the noteworthy outlier with a total value of $78.5 billion, accounting for 14.6% of the world total in 2017. Other significant Asian players in this front are China ($27 billion, 5%), Singapore ($11.3 billion, 2.1%), the Philippines ($5.8 billion, 1.1%), Japan ($5 billion, 0.9%), South Korea ($4.3 billion, 0.8%), and Malaysia ($2.7 billion, 0.5%). In total, Asia claims more than a quarter of the world ICT services exports, with a total value exceeding $134 billion.

Asian Countries in the Global Dynamics of Digital Evolution

To capture a nation's position in the global dynamics of digital evolution, the Digital Evolution Scorecard developed by scholars at Tufts University's Fletcher School in partnership with Mastercard provides valuable insights. This approach ("Which Economies Showed the Most Digital Progress in 2020" by Bhaskar Chakravorti, Ravi Shankar Chaturvedi, and Ajay Bhalla, *Harvard Business Review*, Dec. 18, 2020; https://hbr.org/2020/12/which-economies-showed-the-most-digital-progress-in-2020) assesses the digital evolution of 90 economies along two dimensions: digital evolution state (DES) and digital evolution momentum (DEM). While the DES indicates the digital state of an economy, the DEM captures the country's progress on this measure over the past 12 years. Based on the DES in 2019 and the DEM over 2008-2019, Chakravorti *et al.* classify the 90

TABLE 4

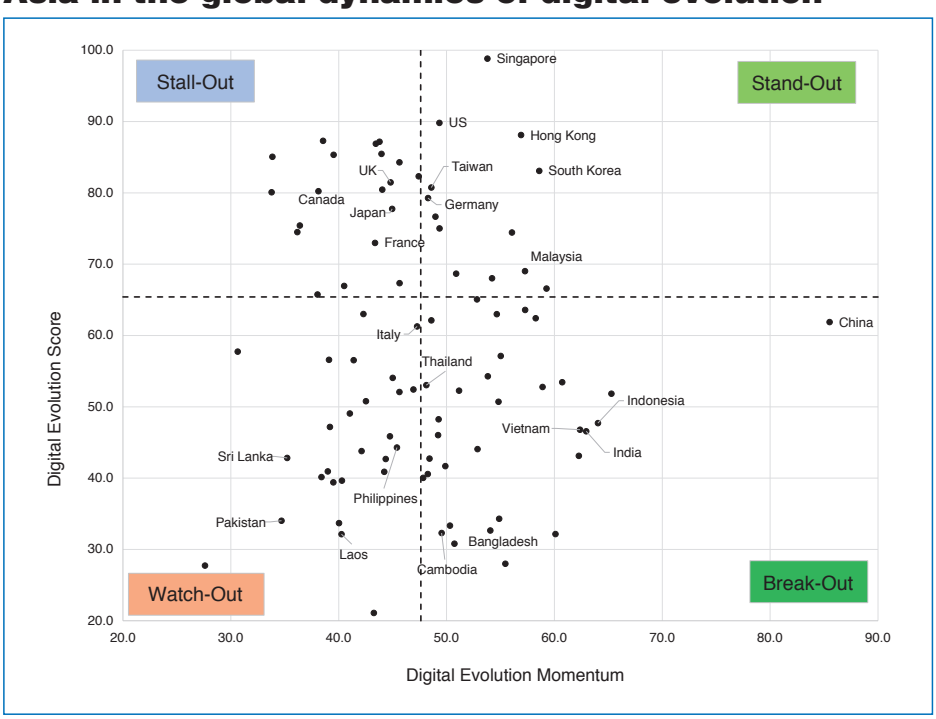
Asia's ICT goods & services exports

Economy	ICT goods exports						ICT services exports		
	Value (US$ Bil.)		% of goods exports		Share in world (%)		Value (US$ Bil.)	% of services exports	Share in world (%)
	2019	2017	2019	2017	2019	2017	2017	2017	2017
China	662.4	612.7	26.5	27.1	30.0	30.8	27.0	12.7	5.0
India	6.5	2.6	2.0	0.9	0.3	0.1	78.5	42.4	14.6
Indonesia	4.7	5.0	2.8	3.0	0.2	0.3	1.0	4.0	0.2
Japan	56.4	58.3	8.0	8.4	2.6	2.9	5.0	2.7	0.9
South Korea	139.7	141.9	25.8	24.7	6.3	7.1	4.3	4.8	0.8
Malaysia	77.4	67.7	32.5	31.0	3.5	3.4	2.7	7.2	0.5
Philippines	34.8	24.6	49.0	35.9	1.6	1.2	5.8	16.5	1.1
Singapore	114.5	119.6	29.3	32.0	5.2	6.0	11.3	6.6	2.1
Thailand	35.3	38.1	14.4	16.1	1.6	1.9	0.5	0.6	0.1
Vietnam	92.5	71.9	35.0	33.5	4.2	3.6	–	–	–
EAP*	***1,607.7***	***1,493.8***	***25.2***	***24.9***	***72.8***	***75.0***	***>54***	***6.4***	***>10%***
EAP & India	***1,614.2***	***1,496.4***	**–**	**–**	***73.1***	***75.1***	***>134***	**–**	***>25%***
Memorandums									
OECD members	754.8	726.2	6.8	7.0	34.2	36.4	370.1	9.5	69.0
US	143.6	146.6	8.7	9.5	6.5	7.4	42.2	5.1	7.9
World	**2,207.9**	**1,992.4**	**11.5**	**11.2**	**100.0**	**100.0**	**536.0**	**10.4**	**100.0**

*Notes: data on ICT goods exports are for 2019 and on ICT services exports are for 2017; data for Taiwan is not available. *EAP= East Asia & Pacific.*
Source: WDI (2021)

CHART

Asia in the global dynamics of digital evolution



Source: Compiled by the author based on Bhaskar Chakravorti, Ravi Shankar Chaturvedi, and Ajay Bhalla

economies into four groups: Stand-Out, Stall-Out, Break-Out, and Watch-Out *(Chart)*.

The Stand-Out group includes economies with both high levels of digital evolution and a strong momentum in making their digital evolution advancement. Among 13 economies in this group, five are from Asia: Singapore, Hong Kong, South Korea, Taiwan, and Malaysia. Note that only two G7 economies – the US and Germany – belong to this group. The authors identify six common features shared by the Stand-Out economies:

(i) Expanding adoption of digital consumer tools such as e-commerce and digital payments.
(ii) Attracting, training, and retaining digital talent.
(iii) Fostering digital entrepreneurial ventures.
(iv) Providing fast, universal, fixed and mobile broadband Internet access.
(v) Specializing in the export of digital goods, services, or media.
(vi) Coordinating innovation between universities, businesses, and digital authorities.

The Break-Out group includes the economies that are limited in existing levels of digital evolution but are making rapid progress in digital advancement. Among 32 economies in this group, seven are from Asia – China, India, Indonesia, Vietnam, Thailand, Bangladesh, and Cambodia. It is worth noting that China is a noteworthy outlier in

this group with far stronger performance in the digital advancing momentum. According to the authors of this study, the countries in this group share the following four characteristics in policy prioritisation:

(i) Improving mobile Internet access, affordability, and quality to foster more widespread adoption.
(ii) Strengthening institutional environments and developing digital regulations.
(iii) Generating investment in digital enterprises, funding digital R&D, training digital talent, and leveraging digital applications to create jobs.
(iv) Taking steps to reduce inequities in access to digital tools across gender, class, ethnicity, and geographic boundaries (though many access gaps still remain).

The Stall-Out group comprises countries with high levels of digital evolution but lacking vigour in making continuous digital advancement. Among 19 economies in this group only Japan is from Asia. According to the authors of this study, to regain their digital evolution momentum, the Stall-Out countries should take the following four strategic policy priorities:

(i) Safeguarding against "digital plateaus" by continuing to invest in robust institutional foundations, regulatory environments, and capital markets to support ongoing innovation.
(ii) Continuing to use policy tools and regulation to ensure inclusive access to digital capabilities and to protect all consumers from privacy violations, cyberattacks, and other threats.
(iii) Attracting, training, and retaining professionals with digital skills, often through reforming immigration policies.
(iv) Identifying new technological niches and fostering environments friendly to innovation in those areas.

The Watch-Out group consists of economies that face limitations in both digital evolution and momentum to make digital advancement. Among 26 economies in this group, four are from Asia: the Philippines, Sri Lanka, Laos, and Pakistan. According to the authors of this study, the Watch-Out economies can look to Break-Out economies as role models, prioritizing the following policy measures:

(i) Making long-term investments to address basic infrastructure gaps.
(ii) Creating an institutional environment that supports safe, widespread consumer adoption of digital products and services, especially those that enable productivity and job creation.
(iii) Promoting initiatives (particularly through public-private cooperation) that invest in digital access to historically disadvantaged segments of the population.
(iv) Promoting applications that solve pressing needs and could therefore act as catalysts for widespread adoption of digital tools.

To have a rough assessment of the dynamism of digital evolution for a given geographic region in the global dynamics described in this study, one can use the ratio of the number of its countries in the Stand-Out and Break-Out groups to its total number of countries. For Asia, this ratio is (5+7)/(5+7+1+4)=12/17=71%, which is much higher than the ratio for the world sample, which is (13+32)/(13+32+19+26)=45/90=50%.

Contributions of ICT to Economic Growth in Asia

The channels through which ICT affects economic growth

As the ICT revolution has profoundly transformed the way people communicate, work, and spend time, it has also significantly contributed to economic growth in most nations. The ICT revolution can affect economic growth through several channels, which include the following.

First, ICT boosts learning and innovation. ICT evolution has enabled billions of people to have unprecedented opportunities and capabilities in accessing global knowledge, exchanging ideas, and distributing their innovative products and services. This development, which substantially reduces the costs of learning and innovation while increasing their speed and potential rewards, is an important channel for ICT to have long-term substantial effects on economic growth.

Second, the digital revolution fosters investment in digital technologies, which improves operational efficiency and expansion across sectors, especially in banking and finance, manufacturing, energy, and retail. Through this channel, ICT has a direct tangible effect on economic growth.

Third, ICT bolsters the effectiveness of markets and institutions by fostering transparency and predictability, improving the quality of investment decisions, and cultivating attitudes about embracing change. These capabilities collectively enhance the quality and sustainability of growth.

Fourth, ICT fosters the creation of synergistic value through collaboration platforms and sharing economy models. Through this channel, ICT enables individuals and companies to employ global resources to meet global demand in real time. Uber, Grab, Airbnb, Amazon, and Alibaba can serve as prominent examples.

Fifth and finally, the ICT revolution opens a new era, in which all stakeholders – from governments to businesses, from academics to industrial associations – have to rethink and reform their traditional development models and approaches. As a result, not only existing resources will be used more productively but many new resources will surface for value creation. For example, smart city development and green transformation are new areas of growth that many countries are embracing in economic strategies.

Measuring the contribution of ICT to economic growth

One can quantitatively capture the contribution of ICT to economic growth, using different approaches and assumptions, which may not produce the same estimates. In the literature, growth accounting and measurement of the digital economy are the two main existing methods.

TABLE 5

Asia's ICT goods & services exports

Region/Group	2000-2010								2010-2018							
	GDP Growth (%)	Sources of Growth (% point)							GDP Growth (%)	Sources of Growth (% point)						
		Capital input			Labor input			TFP		Capital input			Labor input			TFP
		Total	ICT	NICT	Total	LQ	Hrw			Total	ICT	NICT	Total	LQ	Hrw	
World (120 Economies)	**3.83**	**2.26**	**0.51**	**1.75**	**0.73**	**0.35**	**0.38**	**0.84**	**3.57**	**2.14**	**0.37**	**1.77**	**0.86**	**0.30**	**0.56**	**0.57**
G7 Economies (7)	***1.56***	***1.30***	***0.48***	***0.81***	***0.18***	***0.31***	***-0.13***	***0.08***	***1.89***	***0.98***	***0.36***	***0.62***	***0.94***	***0.25***	***0.68***	***-0.03***
Non-G7 (19)	1.98	1.78	0.52	1.26	0.73	0.26	0.47	-0.53	1.61	1.15	0.34	0.81	0.71	0.27	0.44	-0.25
Developing Asia (16)	***7.61***	***3.92***	***0.64***	***3.28***	***1.00***	***0.38***	***0.62***	***2.69***	***6.42***	***3.50***	***0.41***	***3.09***	***0.75***	***0.35***	***0.40***	***2.17***
Latin America (16)	3.09	1.76	0.34	1.42	1.53	0.57	0.96	-0.19	1.51	1.71	0.25	1.46	0.86	0.34	0.52	-1.06
Eastern Europe (27)	4.69	1.02	0.42	0.59	0.48	0.27	0.21	3.19	2.33	0.99	0.23	0.76	0.42	0.20	0.22	0.92
Sub-Saharan Africa (20)	5.72	2.66	0.42	2.24	1.26	0.22	1.04	1.79	3.55	2.48	0.28	2.20	1.29	0.16	1.13	-0.22
North Africa & Middle East (15)	4.34	3.94	0.56	3.38	1.89	0.48	1.42	-1.49	3.28	3.40	0.52	2.87	1.45	0.45	1.00	-1.57
G7 economies																
Canada	1.84	1.73	0.56	1.17	0.76	0.17	0.59	-0.65	2.07	1.17	0.25	0.93	0.88	0.15	0.73	0.02
Germany	0.90	0.90	0.34	0.56	0.18	0.29	-0.11	-0.19	1.78	0.79	0.23	0.55	0.61	0.10	0.51	0.38
France	1.24	1.13	0.33	0.80	0.45	0.24	0.21	-0.33	1.27	0.85	0.34	0.51	0.44	0.31	0.12	-0.02
UK	1.60	1.36	0.42	0.94	0.53	0.35	0.18	-0.29	1.91	0.96	0.19	0.76	1.07	0.26	0.81	-0.11
Italy	0.31	1.09	0.26	0.83	0.40	0.23	0.17	-1.18	0.08	0.26	0.19	0.07	0.05	0.11	-0.06	-0.22
Japan	1.22	1.23	0.51	0.72	0.13	0.38	-0.25	-0.13	1.28	0.73	0.27	0.46	0.42	0.25	0.18	0.12
US	2.03	1.41	0.57	0.84	0.02	0.32	-0.30	0.60	2.40	1.19	0.47	0.71	1.33	0.31	1.02	-0.12

Source: Author's calculation, using results from Dale Jorgenson and Khuong Vu (2021)

Growth accounting

The growth accounting method allows one to estimate the contribution of investment in ICT assets as a source of economic growth. *Table 5*, which is based on the data and method used by the G20 and the world economy ("The G20 and the world economy: Performance and prospects" by Dale Jorgenson and Khuong Vu, *Journal of Policy Modeling*, 2021; https://doi.org/10.1016/j.jpolmod.2021.02.006), reports results of growth decomposition for developing Asia and other groups of countries over two periods, 2000-2010 and 2010-2018. The sources of GDP growth over a period for a given group are decomposed into the contributions of capital inputs, labor inputs, and total factor productivity (TFP). The contributions of capital inputs, in turn, include those of ICT capital and non-ICT (NICT) capital, while the contributions of the labor inputs come from two sources: labor quality (LQ) and hours worked (Hrw). *Table 5* also reports the growth decomposition results for Japan and other G7 economies for comparison. Several observations are notable.

First, the contribution of ICT capital to economic growth in developing Asia, which is 0.64% points for 2000-2010 and 0.41% for 2010-2018, is larger than that for other groups in each respective period.

Second, developing Asia also outperformed other groups on TFP growth in both the periods, which may imply that the regions' strong efforts to embrace the digital revolution as presented above have enhanced its economic growth not only through the direct contribution of ICT investment but also by increasing the efficiency of resources allocation and use.

Third, developing Asia was also stronger than other groups in the contributions of NICT capital and labor quality, which implies that creating a favorable environment to promote investments in analog assets and human capital development are also needed to enable a country to benefit more from investment in digital assets. This, to a certain extent, explains the high GDP growth of developing Asia in both periods.

Table 5 shows that the contribution of ICT to GDP growth is larger for Japan (0.51% points in 2000-2010 and 0.27% points in 2010-2018) than for most G7 economies, with the exception of the US (in both periods), Canada (2000-2010) and France (2010-2018). Furthermore, Japan's growth in the second period (2010-2018) was stronger than in the first period (2000-2010), with significant improvements in both HrW and TFP growth, which tends to suggest overall effects of ICT investments in Japan's economy.

Measurement of the digital economy

Examining the digital economy is an increasingly important approach to capture the effect of ICT to economic performance. "Defining and Measuring the Digital Economy" by Kevin Barefoot, Dave Curtis, William Jolliff, Jessica R. Nicholson, and Robert Omohundro (US Bureau of Economic Analysis (BEA), 2018; https://www.bea.gov/sites/default/files/papers/defining-and-measuring-the-digital-economy.pdf) introduces a framework for

measuring the digital economy, which is based on the OECD's digital economy measurement work. This framework estimates the digital economy in its three major components: (i) the digital-enabling infrastructure, which include communication and computer hardware, Internet-enabled devices, computer software, cloud computing services, and other ICT support services; (ii) the digital transactions (e-commerce), which include economic gains from online trade and sharing economy transactions; and (iii) the content that digital economy users create and access ("digital media"), which include online education and entertainment, social media, and big data. It should be noted that this approach is a low-end estimate of the size of the digital economy given the fact that digital technologies have penetrated across economic sectors and activities.

According to the estimates provided by the authors, the US digital economy totaled $1,209.2 billion in 2016, which accounts for 6.5% of total US GDP ($18,624.5 billion). Furthermore, during the period from 2006 to 2016, the US digital economy grew (in real terms) at an average annual rate of 5.6%, which is much faster than the growth rate of 1.5% observed for the overall economy.

While this method is a good start, it appears to underestimate the size of the digital economy. Dr. Sun Ke, who is from the China Academy of Information and Communication Technology (CAICT), combined the growth accounting and the study by Kevin Barefoot and others ("A CAICT Approach to Measuring Digital Economy: Definition, Methodology and Key Findings", 2018; http://www.stats.gov.cn/english/pdf/202011/P020201103357050683304.pdf) to seek a more comprehensive measurement of the digital economy. According to him, in 2014 the digital economy was estimated at $7,490 billion (accounting for 44.7% of GDP) for the US, $2,180 billion (26.1%) for China, $1,580 billion (32.3%) for Japan, and $764 billion (30.3%) for the United Kingdom. In addition, China's digital economy increased at two-digit growth rates, amounting to $3,600 (32.9% of GDP) in 2017. Although the method used by Dr. Ke may have overestimated the size of the digital economy, it suggests that China and Japan are among the world's largest digital economies and that the growth rate of the digital economy has been much faster than that of the overall economy.

Impacts of the Covid-19 pandemic on Asian economies

The Covid-19 pandemic has forced people, businesses, and governments across countries to take a quantum leap in digital adoption. The pandemic has also posed strategic challenges to multinational companies in strategies for supply change deployment and management, which requires the companies to give a higher priority to resilience and sustainability in addition to the traditional objectives of efficiency and competitiveness. The Covid-19 pandemic, therefore, is expected to have more substantial impacts on Asia, where the momentum of ICT adoption is relatively stronger and the share of global manufacturing activity is larger in comparison to other parts of the word.

Thanks to the stronger momentum of Asian economies in the digital revolution, the surge in digital adoption triggered by the Covid-19 crisis is expected to be more sustained. That is, ICT development and digital transformation in Asia is expected to advance faster in the post-pandemic era.

As a hub of exports of ICT goods and services, the rapid expansion of markets for digital goods and services during the pandemic has also benefited ICT-exporting Asian economies. In fact, FDI inflows to the ICT industry in developing Asia, which ranges from M&A to green field investment projects in data centers and ICT production, increased in 2020 amid the global slowdown in FDI activity. In the long term, however, many multinational companies may consider reshoring, nearshoring, and diversification of their production facilities to enhance the resilience of their global supply chains, which will affect the FDI-reliant Asian economies.

The practice of work from home (WFH) and work from anywhere (WFA), which has become increasingly accepted since the Covid crisis, is expected to work in favor of Asia's abundance of skilled labor supply. WFA will allow high-skilled workers from Asia to virtually join the workforce of developed nations, which foster the region's employment, learning, and productivity growth.

Strategic Priorities for Policy Action

The digital revolution has profoundly changed the world and its transformative effects are expected to be even more revolutionary in the decades to come in every nation. As one of the most proactive and dynamic places in embracing the digital revolution for economic advancement, Asia has been reaping tremendous benefits from ICT development and digital transformation. However, the opportunities and challenges will be much greater and more unpredictable in the time ahead, which requires governments to promote the embrace of the digital revolution with a more effective digital strategy for policy action. In this endeavor, governments need to work closely with representatives from business, academia, and society to discuss and decide the key issues concerning the six components of an effective strategy: strategic objectives, global mega trends, core challenges, strategic positioning, coordination, and continuous renewal.

Strategic objectives

These objectives are based on a comprehensive and integrated set of measures, which include quality of life, productivity, efficiency, sustainability, and resilience. Note that while quality of life should be the ultimate goal of the strategy, sustainability and resilience are becoming important strategic priorities in addition to the traditional strategic objectives – efficiency and productivity.

Global megatrends

Policy makers must deeply understand and appreciate the global megatrends, which are shaping the world, to make their digital strategy and policy initiatives to best leverage the forces of change in responding to development challenges. These global megatrends include the following:

(i) The VUCA: volatile (V), uncertain (U), complex (C), and ambiguous (A), the trend globally observed in the digital economy
(ii) Globalization
(iii) The rise of Asia
(iv) Urbanization
(v) Population aging
(vi) The imperative of sustainable development
(vii) Corporate social responsibility as the norm
(viii) The 4th industrial transformation.

Core challenges

Identifying the core challenges facing a country in its endeavor to make leapfrogging advancements in the digital age is a critical component of digital strategy. For a typical country, these core challenges are the old-fashioned mindset and cybersecurity. They would pose insurmountable problems if not fundamentally addressed. If governments are saddled by an old-fashioned mindset, they would tend to rely on established assumptions and traditional approaches, which would not be most effective in the digital age. For example, the traditional approach of deregulation to promote economic growth may not work best for the development of the digital economy. Instead, governments need to work closely with business, creating a sandbox for policy experimentations, to formulate the most effective regulatory framework that is critical to digital transformation.

Similarly, fostering competition and supporting infant industries also require fundamental changes in conceptual thinking. Building digital ecosystems and standing on the shoulders of tech giants to address the most challenging problems, ranging from climate change and the Covid-19 pandemic to cybersecurity and terrorism, may be far more meaningful than imposing heavy fines on the "monopoly behaviors" of some tech firms.

To develop a mindset most suited for the digital age, governments should embrace three strategic shifts in their strategy and policy action. The first shift is in positioning, which changes a government's role from a regulator to a convener, who brings all social stakeholders, especially tech firms and users, together to find the most effective and forward-looking solutions to the most daunting shared problems. The second shift is in the way a government supports the digital sector and digital transformation, which changes from subsidizing selected groups to enabling them to create more value from digital transformation. The third shift is in the role of government in managing change, which should shift from promoting to pioneering. As a pioneering embracer of the digital transformation, a government will be far more effective in inspiring the nation to advance faster in the digital era.

While the old-fashioned mindset will phase out over time, cybersecurity is the core problem that will be persistent, extensive, and increasingly formidable. The most effective way to deal with this core challenge is to give it the utmost priority in strategy formulation, resource allocation, and operational and preparatory activity. If the world, from governments and businesses to academics and ordinary people, consider cybersecurity threats as a type of Covid-19 pandemic or a looming terrorist attack, it will work together most vigorously and innovatively to develop an effective defense system to minimize losses caused by this problem.

Strategic positioning

While making substantial investments in digital infrastructure is essential, an effective digital strategy needs to establish a wise strategic positioning to best leverage a country's strengths and turn its physical vulnerabilities/limitations to new advantages in the digital age. For example, Japan's strengths in innovation and technological capabilities should be leveraged to promote Industry 4.0 transformation worldwide. At the same time, Japan can turn its constraints in labor immigration to vigorous efforts to make the country virtually borderless in engaging skilled labor around the world to work with local businesses.

Guiding principles

An effective digital strategy establishes a clear set of guiding principles for policy formulation and action. Among them, the following seven principles are essential:

(i) All strategic plans or actions should start with a clear reimagination of the future with robust foresight.
(ii) Knowledge acquisition and innovation are the most powerful drivers of digital advancement.
(iii) People must be at the center of digital transformation.
(iv) Market mechanisms, competition, and incentives are essential forces to promote development.
(v) Embracing globalization and digital partnerships provide a strategic move necessary for making leapfrogging progress.
(vi) Enhancing transparency and good governance is a foundational priority.
(vii) Promoting synergistic value creation should be of top priority.

Coordination, learning, and continuous renewal

This component requires the government to establish a national steering committee or an agency in charge of coordinating nationwide efforts in embracing the digital revolution and monitoring the country's progress in this endeavor. The government also needs to work closely with the ICT sector, especially global tech giants, businesses, academics, and experts to build a robust digital ecosystem for ICT development and digital transformation. Vigorous efforts to reflect on past experiences, learn from international best practices, and develop foresights into the future are essential for the country to make continual strategic renewals for rapid advancements in the digital age. JS

Dr. Khuong Vu is an associate professor at the Lee Kuan Yew School of Public Policy, National University of Singapore.