

Sweden ranks first globally in Digital Potential

— Japan ranks 16th in JCER’s newly developed index

18 February 2022

Eriko Takahashi*, Atsushi Tomiyama†

The Japan Center for Economic Research (JCER)’s newly developed “Digital Potential Index” measures the potential of 84 countries and regions around the world to promote Digital Transformation (DX), key to economic growth. Sweden, which has made progress in the digitization of public services and DX in education, and is rich in both infrastructure and human resources, ranked first in 2020, with Singapore in second place. Although Japan has made progress in infrastructure development, it faces many headwinds in terms of regulations and business practices, and was ranked 16th.

◇What is the JCER Digital Potential Index?

The JCER Digital Potential Index indicates the extent to which countries have the potential to promote DX, key to improving productivity. It is based on 20 years-worth of statistical data of 84 countries and regions, and consists of four categories: (1) telecommunications infrastructure, (2) human capital and R&D, (3) business environment, regulations and governance, and (4) IT-related industries. The four categories are each further divided into 3~5 subfactors (16 in total). There are other indices that measure digital competitiveness and progress, but most conventional indices focus on the advancement of digital technology rather than the potential of DX, and the countries covered are usually advanced economies. This perspective is not appropriate for forecasting growth in emerging Asian countries. Therefore, our analysis places emphasis on the infrastructure, resources and environment necessary to promote DX rather than advanced technology, to estimate the degree of DX progress in each country.

Fig.1 JCER Digital Potential Ranking (2020)

Rank		Country/Region	Index
1	(2)	Sweden	74.9
2	(3)	Singapore	73.8
3	(1)	Finland	73.7
4	(7)	Germany	71.2
5	(8)	South Korea	70.8
6	(5)	Denmark	70.4
7	(4)	Ireland	70.0
8	(9)	Hong Kong	70.0
9	(13)	USA	68.3
10	(22)	Austria	67.5
16	(14)	Japan	66.3
41	(59)	China	55.5

(Note) 2010 ranking in parentheses.

1. Sweden promotes digital government services to the benefit of citizens

The top rankings are shown in Figure 1. Sweden, which came in first, ranked in the top 10 in all four categories. The Swedish government has been pushing forward its digital strategy since June 2017, promoting the installation of high-speed connections to businesses and homes, and the online submission of official documents that previously required visits to government offices. The percentage of citizens who interact with government authorities online is nearly 80%, far higher than the European Union (EU) average of 30-50%¹.

* Senior Economist, Japan Center for Economic Research

† Principal Economist, Japan Center for Economic Research

¹ European Commission “Digital Government Factsheet 2019 Sweden” (2019)

(https://joinup.ec.europa.eu/sites/default/files/inline-files/Digital_Government_Factsheets_Sweden_2019.pdf)

The highest-ranking country in Asia was Singapore, which came in second out of 84 countries and regions. Although it is a small country with a population of 5.69 million, Singapore is known for its ease of doing business. Singapore has created a business-friendly environment for foreign companies in terms of regulations, taxation, etc. In addition, Singapore has a high level of education and a large number of highly-skilled IT professionals. The fact that Google and Facebook have made the country their base in Asia and are promoting the development of digital human resources is also providing a tailwind. DX in the country is spreading to a wide range of industries, and Denka, a major Japanese chemical company, is working on the practical application of a smart factory in Singapore. The company is using artificial intelligence (AI) and IoT, to collect and analyze big data to improve productivity. In the fight against COVID-19, the government introduced the "Trace Together" app in March 2020 to identify people in close contact with a COVID-19 patient, and over 90% of the population is registered². The accumulated data is also being used for criminal investigations.

As for other Asian countries, South Korea and Hong Kong are ranked fifth and eighth respectively, in the overall ranking, making notable progress since 2010. South Korea has also made e-government an important policy and has been actively promoting the online provision of administrative services. It is also ahead of the curve in infrastructure development, with the commercialization of the 5G high-speed communication standard in 2019. However, like Japan, South Korea has fallen behind in terms of ease of doing business due to its old business practices and inefficient laws and regulations.

2. Japan has the infrastructure, but old-fashioned business practices remain risk

Hong Kong and Japan ranked first and second respectively in the "telecommunications infrastructure" category (Figure 2, left). Hong Kong's mobile cellular subscriptions per 100 people marked 291 in 2020, and mobile broadband users per 100 people was reported at 140, far more than mainland China (96). Hong Kong has long invested in developing its IT infrastructure as an international financial center, and there are several major companies with regional headquarters in Hong Kong. However, there are concerns that businesses will be adversely affected by the implementation of the National Security Maintenance Law in June 2020. According to a report by the Japan External Trade Organization (JETRO) in July 2021, 56% of Japanese companies operating in Hong Kong expressed their concerns about the law.

Fig. 2: Top 3 countries by category (left) and Japan's ranking by category (right)

Top 3 countries by category (2020)					Japan's ranking by category		
Rank	Infrastructure	Human capital/ R&D	Business environment	IT-related industries	Category	2010	2020
1	Hong Kong	Germany	Austria	Ireland	Infrastructure	13	2 (↑)
2	Japan	South Korea	Germany	Finland	Human capital/ R&D	10	18 (↓)
3	Denmark	Switzerland	Sweden	Singapore	Business environment	12	6 (↑)
					IT-related industries	47	51 (↓)
					JCER Digital Potential Index	14	16 (↓)

² Trace Together "Trace Together, safer together" (<https://www.tracetgether.gov.sg/>)

Japan's overall ranking dropped from 14th in 2010 to 16th in 2020 (Figure 2, right). The number of mobile broadband users per 100 people in 2020 hit 206, the highest in all 84 countries/regions, and the number of mobile cellular subscriptions per 100 people, which ranked 65th in 2010, jumped to 8th overall in 2020. It can be said that Japan has sufficient telecommunications infrastructure, one of the country's strengths, to promote DX. Japan's ranking in the "business environment and regulations" category has risen due to efficient logistics and government services, but there is still a risk that old-fashioned business practices, such as the emphasis on "Hanko (personal name stamps used in lieu of handwritten signatures)", faxing, and face-to-face interaction, will hinder DX.

Japan's rankings for "human capital and R&D" and "IT-related industries" declined between 2010 and 2020. Human capital and R&D dropped from 10th place in 2010 to 18th in 2020. There was a notable drop in the percentage of STEM degree holders, one of the subfactors in the "human capital and R&D" category, falling from 43rd to 66th overall. "IT-related industries" was the only category in which Japan failed to rank among the top 20 countries by 2020; it ranking 51st out of 84 countries, which is the about the same level as Indonesia, which ranked 56th. The key to improving the country's digital potential is to increase its exports of high-tech products and ICT services.

South Korea, which ranked second in human capital and R&D, has been increasing its R&D spending as a percentage of GDP since 2000, reaching 4.5% in 2018, the highest level among major countries. The number of R&D workers per million people in 2006 was 7980, the highest among the 84 countries and regions covered in the analysis.

3. Vietnam's Leapfrogging Breakthrough

Vietnam's ranking in the Digital Potential Index improved the most among the 84 countries and regions covered between 2010 and 2020 (Figure 3), rising from 77th in 2010 to 55th in 2020. Vietnam joined the World Trade Organization (WTO) in 2007, and the negative aspects

Rank	Country (Change in rank)	2010	2020
UP	① Vietnam (↑22)	77	55
	② Ukraine (↑19)	68	49
	③ China (↑18)	59	41
DOWN	① Panama (↓24)	45	69
	② El Salvador (↓19)	49	68
	③ Morocco (↓17)	57	74

of the country's business environment, such as the preferential treatment of state-owned enterprises and corrupt business practices, gradually improved. In terms of infrastructure, the rapid spread of smartphones has led to leapfrogging development through rapid DX. DX is spreading in many fields, such as apps for identifying people with COVID-19, online shopping, and electronic money. In neighboring Cambodia, DX is also advancing in many areas, including the Central Bank Digital Currency (CBDC) and online digital casinos.

China was the country with the third largest change in ranking, rising from 59th to 41st. The development of telecommunications infrastructure to promote DX, such as the spread of broadband and cell phones, and the remarkable development of the digital economy have contributed to a significant improvement in the "IT-related industries" category. The development of the information and

communications industry in China has contributed to job creation and productivity growth, and is playing a key role in driving growth. China's IT giants such as Alibaba, Tencent and Weibo have grown rapidly. Because of the country's large size and population, it is only ranked 41st, but many major cities are as advanced in DX as developed countries.

As DX progresses, production efficiency will increase and energy consumption will decrease, leading to decarbonization. We believe that the Digital Potential Index is also effective in determining the outlook for total factor productivity (TFP), which is the key to our medium-term economic forecast. In our 7th Medium-term Asian Economic Forecast (2021-2035), we have adopted the Digital Potential Index as an explanatory variable of TFP, replacing the previously used R&D expenditure as a percentage of GDP. We will continue to make improvements to the index, such as by replacing subfactors, in order to make the indicator as accurate as possible in subsequent editions.

Figure 4: Overall and category rankings of the 18 countries/regions covered by JCER's Medium-term Asian Economic Forecast (2010 & 2020)

	Digital Potential Index		①Infrastructure		②Human capital/R&D		③Business environment		④IT-related industries	
	2010	2020	2010	2020	2010	2020	2010	2020	2010	2020
USA	13	9	14	4	16	11	13	13	21	23
Canada	20	27	18	29	21	25	17	18	43	58
Australia	24	31	15	20	15	22	26	27	67	71
Japan	14	16	13	2	10	18	12	6	47	51
South Korea	8	5	1	6	5	2	15	14	35	31
Hong Kong	9	8	4	1	25	20	3	8	9	16
Singapore	3	2	7	13	7	7	5	5	7	3
Taiwan	17	18	23	35	3	5	39	44	8	14
China	59	41	67	43	40	38	56	54	59	25
India	61	61	80	81	43	44	67	59	13	29
Indonesia	76	70	78	75	80	74	76	61	45	56
Philippines	66	56	74	68	78	78	59	55	18	19
Malaysia	29	23	45	45	28	29	41	38	5	6
Thailand	62	45	56	49	48	42	47	40	66	63
Vietnam	77	55	60	59	73	61	71	62	82	30
Cambodia	81	77	83	74	82	71	77	79	63	67
Lao PDR	83	83	81	83	84	47	83	81	68	80
Myanmar	84	84	84	78	81	84	84	84	75	73

Appendix 1: Methodology for Estimating the JCER Digital Potential Index

The JCER Digital Potential Index is a comprehensive index that shows the degree of progress and growth potential of DX in 84 countries and regions (Appendix 1, Figure 1). It consists of four categories that are important for promoting DX: (1) telecommunications infrastructure, (2) human capital and R&D, (3) business environment and regulations, and (4) IT-related industries, each of which are further divided into multiple subfactors (Appendix 1, Figure 2). The indicators that make up each category are indexed using the "Max-min method"³, and the formula for converting an indicator value $V_{i,t}$ of country i in year t into an index score $I_{i,t}$, which takes values from 0 to 100, is as follows.

$$I_{i,t} = \frac{V_{i,t} - V_{min}}{V_{max} - V_{min}} \times 100$$

The maximum (V_{max}) and minimum (V_{min}) values (the upper and lower bound) of each indicator are calculated from the average values of all 84 countries/regions for the entire period 2000–2020 ± 3 standard deviations. The average of the subfactor indices was calculated to create an index for each of the four categories, and lastly, the average of the four category indices was calculated follows to create the Digital Potential Index.

Digital Potential Index _{i,t}

$$= \textcircled{1}Infrastructure_{i,t} \times 0.25 + \textcircled{2}Human\ capital, R\&D_{i,t} \times 0.25 \\ + \textcircled{3}Business\ environment_{i,t} \times 0.25 + \textcircled{4}IT\ related\ industries_{i,t} \times 0.25$$

Appendix 1 Figure 1: List of 84 countries and regions covered

East Asia & Pacific		Europe & Central Asia			Latin America & Caribbean	North America
Australia	Mongolia	Armenia	United Kingdom	North Macedonia	Argentina	Canada
China	Malaysia	Austria	Georgia	Montenegro	Brazil	USA
Hong Kong	New Zealand	Belgium	Greece	Netherlands	Chile	
Indonesia	Philippines	Bulgaria	Croatia	Norway	Colombia	Middle East & Africa
Japan	Singapore	Bosnia & Herzegovina	Hungary	Poland	Costa Rica	Egypt
Cambodia	Thailand	Switzerland	Ireland	Portugal	Ecuador	Morocco
South Korea	Taiwan	Cyprus	Iceland	Romania	Guatemala	Malta
Laos	Vietnam	Czech Republic	Italy	Russia	Honduras	Oman
Myanmar		Germany	Kazakhstan	Serbia	Mexico	Qatar
		Denmark	Kyrgyzstan	Slovakia	Panama	Saudi Arabia
	South Asia	Spain	Lithuania	Slovenia	El Salvador	Tunisia
	India	Estonia	Luxembourg	Sweden	Uruguay	South Africa
	Sri Lanka	Finland	Latvia	Turkey		
	Pakistan	France	Moldova	Ukraine		

³ United Nations "Max-min procedure to convert indicators into indices"
<https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/max-min.pdf>

Appendix 1 Figure 2: JCER Digital Potential Index Categories and Subfactors

Category	Subfactor indicator		Latest data
① Telecommunications infrastructure	1	【ITU】Fixed-broadband subscriptions (per 100 inhabitants)	2020
	2	【ITU】Mobile-broadband subscriptions (per 100 inhabitants)	2020
	3	【ITU】Mobile-cellular subscriptions (per 100 inhabitants)	2020
	4	【ITU】Percentage of Individuals using the Internet	2020
	5	【UN】E-Government Development Index (EGDI)	2020
② Human capital/ R&D	6	【UNESCO】R&D expenditure (% of GDP)	2018
	7	【ILO】Mean nominal monthly earnings of employees (Professional, scientific and technical activities)	2020
	8	【UNESCO】Researchers per million inhabitants	2018
	9	【OECD】Percentage of graduates from Science, Technology, Engineering and Mathematics programmes in tertiary education	2020
③ Business environment and regulations	10	【WB】Worldwide Governance Indicator (WGI), Regulatory Quality	2020
	11	【WB】Logistics Performance Index (LPI)	2018
	12	【Heritage Foundation】Index of Economic Freedom (Investment freedom)	2021
	13	【Harvard Growth Lab】Economic Complexity Index (ECI)	2019
④ IT-related industries	14	【UNCTAD, IMF】Bilateral trade flows by ICT goods categories (% of GDP)	2020
	15	【WB】ICT service exports (% of service exports)	2017
	16	【OECD, Haver Analytics】Information and Communication (% of GVA)	2020

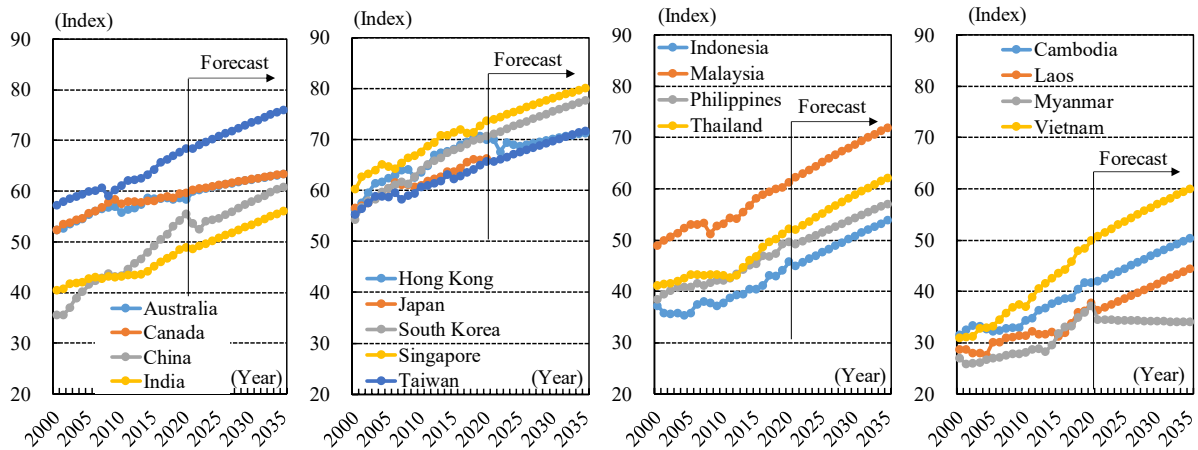
Appendix 2: Methodology for Estimating the JCER Digital Potential Index Forecast (2021-2035)

The JCER Digital Potential Index forecasts to 2035 were estimated for 18 countries and regions mainly in Asia, including China, India, NIES, ASEAN, and CLM countries. Projections for (1) telecommunications infrastructure, (2) human capital and R&D, (3) business environment and regulations, and (4) IT-related industries were made using the 10-year average growth trend (2010~2019) of each category index, to formulate the Digital Potential Index forecasts. Events that may not be reflected in the data were also considered and incorporated into the forecast values.

For example, in China, where the Digital Potential Index has improved significantly in recent years, we believe that the "Business Environment and Regulation" index will be pushed down considering tighter regulations on major IT companies such as Alibaba. Similarly, for Hong Kong, we expect that such regulations will put downward pressure on DX, and we assume the Business Environment and Regulations Index for both countries to decline by 20% from the current level (2020) until 2025, and to remain unchanged from 2026 onward. In Myanmar, the impact of the military coup in early 2021 will inevitably lead to stagnation in infrastructure investment and deterioration in the business environment, and this is reflected in the respective indices.

The forecasts and rankings of the Digital Potential Index through 2035 are shown in Appendix 2, Figure 1 and 2. During the forecast period, Singapore and South Korea ranked first and second respectively. The U.S. and Japan moved up from the 2020 rankings to third and fourth respectively from 2025 onward. Due to the impact of stricter regulations, Hong Kong fell from third place in 2020 to fifth in 2025 and then to seventh in 2035, while China's ranking also dropped to 11th in the forecast period.

Appendix 2 Figure 1: Digital Potential Index, 2000~2035



Appendix 2 Figure 2: Digital Potential Index Ranking, 2000~2035

	USA	Canada	Australia	Japan	South Korea	Hong Kong	Singapore	Taiwan	China	India	Indonesia	Philippines	Malaysia	Thailand	Vietnam	Cambodia	Laos	Myanmar
2000	2	8	7	3	6	4	1	5	14	11	13	12	9	10	16	15	17	18
2010	4	7	8	5	2	3	1	6	10	11	14	13	9	12	15	16	17	18
2020	4	8	9	5	2	3	1	6	10	14	15	13	7	11	12	16	17	18
2025	3	8	9	4	2	5	1	6	11	14	15	13	7	10	12	16	17	18
2030	3	8	9	4	2	5	1	6	11	14	15	13	7	10	12	16	17	18
2035	3	8	9	4	2	7	1	6	11	14	15	13	5	10	12	16	17	18

(Contact: Asian Research Team 03-6256-7740)

Japan Center for Economic Research
 Nikkei Bldg. 11F, 1-3-7 Otemachi, Chiyoda-ku
 Tokyo 100-8066 JAPAN
 TEL:03-6256-7710 / FAX:03-6256-7924