

How Asia Confronts COVID-19 through Technology

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Introduction

- *Dr. Florian Schneider*

With societies around the world tackling the Coronavirus pandemic, the role of digital technology has come into focus as a means of augmenting efforts to manage disease and its impacts. What can apps, big data, and digital analytics contribute to such efforts, and what risks do they pose?

Asia provides important lessons. Not only have societies in the region long been at the forefront of technological development, but they have also proactively adopted digital solutions as they confront COVID-19. Importantly, Asia has a history of managing highly contagious diseases, and outbreaks such as SARS in 2002 and H1N1 in 2009 have provided experiences in risk management and health provision that now powerfully inform both digital and non-digital responses to the current pandemic. The result is a diverse range of different approaches that can teach us much about the advantages and disadvantages of designing tech solutions to fight pandemics.

The Leiden Asia Centre (LAC) has asked social science and area studies researchers knowledgeable about tech developments in Asia to survey current practices and results in five different settings: mainland China, Japan, Singapore, South Korea, and Taiwan. In what follows, we provide an overview of app-based approaches in each setting. Our study shows how technology and its uses are never neutral. They instead depend heavily on the decisions that stakeholders make in specific contexts. The following are our five main lessons from the Asian cases:

1. Tech is embedded in society: apps and other digital solutions are only ever as effective as the measures ‘on the ground’. They do not exist in a vacuum; instead they flank, augment, and amplify policy decisions in ways that are highly contingent on broader societal efforts. Across Asia, digital solutions interact with generally high-quality healthcare systems, strong border controls, strict social distancing measures, aggressive testing and re-testing, pro-active tracking, and a widespread use of masks and disinfectants throughout society. Any digital measures have to be understood in those contexts.

2. Tech is political: digital tools are designed by someone, for someone, and for specific purposes. They reflect the experiences and assumptions of designers and of the people commissioning such apps. This means that they can contain biases, sometimes invisibly so.

3. Tech relies on data: digital tools are only ever as good as the data they use. Garbage in, garbage out. If data is incomplete, or compromised, or unreliable, then so is the app. The result can be highly detrimental, leading to a false sense of security, to policies that target the wrong issues, or to discrimination of vulnerable groups.

4. Tech solutions require choices: governing a pandemic requires trade-offs, and this is also true for digital responses. In the case of apps, a prominent trade-off is between efficiency and privacy/freedom. Societal and political actors who wish to enhance their governance through apps will have to make choices about how to balance this trade-off; there is no single best-practice solution to this dilemma.

5. Tech is 'sticky': technological solutions are powerful because they can quickly, and seemingly comprehensively, shape behaviour, establish new habits, and form specific practices. They become institutions, and this means they can become 'entrenched' and suffer 'mission creep', making it hard to phase them out once they've fulfilled their purpose.

Japan's Fragmented Response: Technology, Governance, and COVID-19 - *Anoma P. van der Veere*

Japanese efforts to contain the spread of the virus have been undermined by a failure to adjust to new developments in the pandemic, a lack of information, and a decentralised response. This is despite the implementation of several mitigation strategies. The government has employed public surveys for data collection, making use of an existing and widely-used application called LINE in order to grasp the magnitude of the spread. As a result of the popular use of LINE by members of Japanese society, the surveys' response rates have been high. The government is now also planning on introducing a "contact-tracing" app which is designed to inform users if they have been in contact with someone infected. However, the Japanese case highlights how apps are only effective if they are part of a concerted general effort to counter the disease. Disorganised data collection has rendered information inaccessible. A fragmented approach to the implementation of technology in governance has also impeded its use in the national COVID-19 response. Importantly, a continued failure to contain the virus will have significant effects on healthcare, public trust, and the national economy.

Spread

The first official case of the COVID-19 virus was confirmed on 15 January 2020 in Kanagawa prefecture, just south of Tokyo.¹ As of 7 May there have been 15,354 confirmed cases and 543 deaths,² with an official death rate of 3.54 percent. The initial spread seemed to be under control in January and February, until a short spike on 6 March was followed by exponential growth after 24 March. Major metropolitan areas such as Tokyo and Osaka have been hit the hardest.³ The Japanese government has been reluctant to increase testing opportunities. In total, 188,927 tests have been administered, with 173,573 tests coming back negative. Only around 0.15 percent of the total population has been tested.⁴ Moreover, there are strong indications that the testing rate is only 20 percent of total capacity.⁵ In Osaka, for example, some patients have been forced to wait more than 10 days for a test.⁶ In a dramatic turn, a recent study conducted in Kobe, Japan, suggested that the actual total infection rate was between 396 and 858 times higher than the official number.⁷

There have been accusations that the government had purposefully suppressed information about the number of cases during the first months of the spread in order to ensure that the Tokyo 2020 Olympic and Paralympic Games could take place.⁸ This remains conjecture, even if the incumbent cabinet has shown signs of prioritising the Tokyo 2020 Games over tackling the COVID-19 pandemic.⁹ For now, two things are sure: the Games have been postponed until 2021 and there has been a significant spike in confirmed cases.

Limited Response: Japan's Handling of the Pandemic

The main objective of the first stage of the COVID-19 response was to contain the spread by adopting a cluster-based approach which was based on identifying patients and persons with whom patients had come into contact.¹⁰ However, by 4 April it emerged that over 40 percent of cases could no longer be traced.¹¹ The government had stated that it did not expect a new explosion of cases, but this statement was then immediately followed by an exponential rise that has taken weeks to stabilise.¹² These sudden developments have led to a clear switch to risk-mitigation strategies in Japan's national response.

The percentage of confirmed cases coming from abroad, which was 13 to 29 percent of the total cases between 11 and 25 March,¹³ has resulted in limitations being placed on travel and immigration. Entry into Japan has been limited since 3 April, with permission to enter denied to anyone who does not have a Japanese passport and who has come from 76 countries within the last 14 days.¹⁴ Permanent and long-term residents are also denied entry.¹⁵

In accordance with the revised *Act on Special Measures for Pandemic Influenza and New Infectious Diseases Preparedness and Response*, a state of emergency was declared for large parts of the country between 7 April and 6 May.¹⁶ The state of emergency was later expanded to include the whole country, and its duration was extended until June 2020.¹⁷ The declaration allows prefectural governors to close public facilities and to request that businesses temporarily suspend operations.¹⁸ Business operators have been asked to switch to teleworking unless they provide essential services and to restrict access to facilities where people gather.¹⁹ However, the government claims that constitutional restrictions prevent it from limiting movement by imposing a lockdown²⁰ and so it is forced to rely on prefectural governors and grassroots cooperation. The Cabinet has not chosen to propose national emergency provisions to the National Diet, where such provisions could allow it to implement a more comprehensive national response (such as national closures). Instead, it has chosen to delegate responsibility to lower levels of government.²¹ This has resulted in a decentralised approach to the pandemic. Consequently, the response has been varied.

For example, several regional governments have chosen to reopen schools despite the risks²². Meanwhile, other regional governments have set unclear and continuously shifting dates regarding closures.²³ In order to promote closures and to limit the economic impact, the government has now decided to provide 100,000 yen (860 euro) to each resident. However, due to the initial delays in establishing policies for financial compensation, businesses have stayed open for extended periods in spite of the growing infection rates, and public support has been diminishing steadily in the face of a flailing government.²⁴

The initial lack of financial support for those affected, as well as the government's delayed response, have slowed grassroots cooperation.²⁵ Various business sectors in Japan have not responded to the request to switch to teleworking.²⁶ Meanwhile, pachinko (gambling) parlours which have refused to close can only be publicly

shamed because there are no enforceable ways of shutting them down legally.²⁷ However, many large cultural events have been cancelled and crowded locations such as Universal Studios and Disneyland Tokyo have voluntarily closed operations.²⁸

Instead of hard measures, the government has been focusing on creating awareness of the “three Cs”: These tell people to avoid 1) Closed spaces, 2) Crowded places, and 3) Close-contact settings. The government has also sought to inform people about the need for hand washing and for avoiding touching their faces.²⁹ In a highly criticised move, the incumbent administration is now also providing two washable cotton masks to each household in a bid to reduce risk of spreading.³⁰ Soft measures, however, have had no discernable impact on the viability of Japan’s medical system.

At the time of writing, the medical infrastructure in large metropolitan areas such as Tokyo and Osaka had been on the verge of collapse for weeks. This situation is likely to worsen in the subsequent months.³¹ ICUs have been overwhelmed as they have struggled with shortages of beds and basic protective equipment such as masks.³² There have been increasing reports of refusals to test possible infections, a collapsing health care infrastructure, and inaccessible phone numbers for medical consults. In early March, it was reported that patients needed to be prepared to move to neighbouring prefectures because of a lack of capacity in some places³³. Meanwhile in Tokyo and Osaka, patients with light symptoms were being housed in lodging facilities to decrease the burden on hospitals.³⁴ To make matters worse, patients in critical condition were being turned away,³⁵ while hospitals which were afraid to take on COVID-19 patients remained empty.³⁶

Japan’s handling of the pandemic has been hindered by its decentralised approach and the delays in the national response. These factors contributed to limited business and grassroots cooperation, while the country’s medical infrastructure has been under heavy strain. In its response so far, the government has mostly relied on traditional methods of governance. However, it has also recently started slowly integrating technology into its broader response to COVID-19.

Technology, Governance, and the COVID-19 Response

Japan’s potential for utilising technology in governance contrasts with the country’s actual progress in doing so. In a 2001 survey of e-governance conducted by the United Nations (UN), it was observed that the Japanese government suffered from an “obdurate bureaucracy” that impeded cooperation between its national institutions and agencies.³⁷ Japan’s ‘e-governance ranking’, as designated by the UN, has gradually increased over time and in the latest 2018 survey it occupied tenth place in the rankings.³⁸ However, the way in which prefectural and municipal offices have adopted different IT-systems produced by different companies has severely impeded Japan’s establishment of a nationally viable e-governance strategy.³⁹

This is reflected in the country’s reporting system, where fragmentation has prevented the rapid sharing of information between healthcare providers and government agencies.⁴⁰ Paper notices are still being used and handwritten documents are

sent in to report new findings to the Ministry of Health, Labour and Welfare (MHLW). After months of pressure from the pandemic, this Ministry is now finally considering moving to an online reporting system.⁴¹ Whether this will be done, and if so how, and how quickly, remain unclear.

Innovation within the health care sector has long been stifled.⁴² Despite Japan's aging population, technology in healthcare remains a utopian dream for policymakers, with real results still few and far between.⁴³ The government has spent over a billion euro on developing telemedicine (such as remote consultation, electronic medical dossiers, etc.). However, there are serious concerns about the efficiency of telemedicine's usage in Japan.⁴⁴ The technology is widely available, yet mostly remains in the clinical trial phase.⁴⁵ Moreover, this technology seems to have been severely underutilized within the broader COVID-19 response. There is no centralised system for the collection of medical data.

Currently, the data on COVID-19 patients is first collected by medical institutions and then by local governments. Then this data is forwarded to the Ministry for Health, Labour and Welfare (MHLW). This data is presented differently by the websites of the MHLW and individual prefectures, with significant variation in the information that is made public.⁴⁶ The MHLW's national data includes a concise timeline of symptoms and test result, age range (in 10-year segments), sex, nationality, and prefecture and city.⁴⁷ In contrast, in Osaka Prefecture, case information includes case number, age range (in 10-year segments), sex, date of test, prefecture and city, household structure, occupation, symptoms and an indication of severity, and current working situation.⁴⁸ Identifiable personal information, such as precise location data and address, are excluded in all data sets.

Official information about the spread has been scattered and inaccessible. Data is spread across different websites, agencies, and institutions, and has only been provided in a piecemeal way throughout the months starting from the first case in January. As a result, the media, companies, and private individuals have tried to collect and aggregate information to inform the public of COVID-19 related developments.

For example, Toyokeizai Online has constructed a visualised overview in the form of graphs using data retrieved from different parts of the MHLW website.⁴⁹ Amazon Web Services (AWS) has built 'coromap.info', a mapped visualisation of all the confirmed cases down to municipal level.⁵⁰ Information is obtained from both the MHLW website as well as from the prefectural websites and media sources. National news outlet *NHK* has built a special portal for COVID-19 related news, providing total numbers for each prefecture and the latest news.⁵¹ This format has been emulated by other media outlets as well.

Grassroots projects have also found fertile ground. Notably, individual developers have ventured into aggregating a diverse range of data from different sources into accessible formats. For example, the website 'www.stopcovid19.jp' shows total active cases, but categorises these by prefecture and maximum bed occupancy, making the burden on ICUs in different prefectures immediately visible.⁵² Getting access to information is even more difficult for foreign residents who do not speak Japanese.

International hotlines are frequently inaccessible and official website have limited information or suffer from bad translations that make the website incoherent.⁵³ To cope, foreign residents have started building communities on popular platforms such as Reddit⁵⁴ and Facebook to collect information⁵⁵.

In an attempt to centralise information on the spread of the virus and the level of public cooperation, the Ministry for Health, Labour, and Welfare has used LINE, a text-based social media application similar to WhatsApp, to send out nation-wide surveys.⁵⁶ Smartphones are used by 87 percent of the population in Japan. With an 82.3 percent total penetration rate,⁵⁷ LINE is the most widely used online application in the country.⁵⁸ A total of 24.5 million Japanese residents responded to the initial survey,⁵⁹ or 19 percent of the population.⁶⁰ Although using a private company to collect personal information requires flexibility in the processing of data, the fact that LINE has so many users means that its use allows the survey to reach a wide audience. It is necessary to note, however, that although more than 80 percent of people aged 10-59 use LINE, only 53 percent of people aged 60-69 use the app.⁶¹ The number of users amongst older demographics is unknown and is likely to be even lower. As a consequence, the most vulnerable group in society has been largely left out of the LINE survey results.

The survey itself focuses on health, symptoms, recent visits to a hospital or health care provider, and possible contact with anyone who has been diagnosed with COVID-19 in the past two weeks. It also asks whether the respondent has been avoiding enclosed or crowded places and close contact. It asks whether the respondent has been maintaining proper hygiene (washing hands, disinfectant use) and wearing a mask (or other covering), as well as whether they are teleworking and whether they have been abroad within the last two weeks. Finally the survey asks the respondent for their occupation and asks them some general questions about their age, sex, and postal code. If the postal code is unknown, then it is only possible to determine the respondent's location down to the municipal level.

Several surveys have now been sent out using the same method. The questions in each survey are identical and users who have already answered a survey are redirected to a page stating they have already finished the survey. This limits the survey results in two ways: 1) there is no feedback in terms of changes in condition or behaviour across the chosen timeframe, and 2) there is limited likelihood of duplicate data. The survey does not give information about how the provided information will be used, other than stating that the data is collected for the MHLW. The results of the initial survey have been published online with the main conclusion that current efforts need to be strengthened and personal contact needs to decrease by at least 70-80 percent.⁶²

In late April, the Deputy Minister of IT at the Cabinet Office announced that the government was currently developing a 'tracking app', which would be released in May.⁶³ This was announced as part of the wider strategy adopted to respond to COVID-19.⁶⁴ A private organisation named Code for Japan (COD), which is made up of voluntary IT-engineers, has been tasked with the development of the tracking app.

The app's primary function will be to notify users when they have come into close contact with someone who is infected. Users have to be in close contact longer than 30 minutes and to be within two meters. Public health centres will be responsible for notifying users. However, the aim is to keep the system anonymous, by not notifying the user of the name of the infected person, the place, or time of contact.⁶⁵ The specific functions of the app remain unknown, including what data is collected and how this data is shared. Consequently, questions have already been raised concerning privacy issues.⁶⁶ Another important complication is that the app needs to be downloaded by a large portion of the population for it to be effective. As other countries have shown (see the contribution on Singapore in this report), this penetration rate is difficult to achieve.⁶⁷ How the government intends to address these issues remains unclear.

Conclusion

There are no nationwide mechanisms in place in Japan for controlling population movement on a wide scale. Therefore, the national response relies on the collection of data and clear communication towards, and cooperation from, local governments, commercial industries, and the public. The integration of (public) technology into the COVID-19 response has been limited and the use of existing technology, such as tele-medicine, insufficient. Applicable technology has not proliferated well enough into Japanese governance and society for it to be accommodated in the COVID-19 response, leading to systematic fragmentation. Along with low testing rates, disorderly collection and communication of information at different levels has made effective data collection difficult and has further hampered the use of technological solutions.

However, the use of LINE to carry out surveys and collect information has seen a significant response from the public. These LINE surveys allow for a broad collection of new data. While the high response rate of the national survey suggests high levels of cooperation with the government's risk mitigation strategies, overall cooperation with its policies has moved forward in a piecemeal fashion. The government is also preparing to launch an app for tracing new cases. The effectiveness of this use of technology is still a matter of speculation. It is nevertheless clear that technology has not been a central part of Japan's response to COVID-19, despite the country's technological potential. Because of the state's failure to adequately respond to the pandemic,⁶⁸ efforts to further contain COVID-19 will require the population's continued willingness to either put up with longer shutdowns or endure high infection rates. Travel restrictions will have to stay in place, while the economy continues to suffer heavily from declined spending. On top of that, public trust has been eroded and the health care sector will remain critically burdened for an indefinite amount of time.

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- ⁹ Jeff Kingston, “Abe Prioritized Olympics, Slowing Japan’s Pandemic Response,” *Asia-Pacific Journal: Japan Focus* 18:7 (2020), <https://apjpf.org/2020/7/Kingston.html>.
- ¹⁰ Cabinet Secretariat, “28th Meeting of the Novel Coronavirus Response Headquarters,” p. 1.
- ¹¹ This number is expected to rise to over half of the total cases in every prefecture. *Ibid.*, p. 3, 5.
- ¹² *Ibid.*, p. 4.
- ¹³ The data does not differentiate between foreign visitors and returning Japanese nationals, making it unclear if infections from abroad are actually being brought in by foreign nationals. *Ibid.*
- ¹⁴ This is done in order to protect public security and public interests: Ministry of Justice, “新型コロナウイルス感染症の拡大防止に係る上陸拒否について (About the Denial to Enter to Prevent the Spread of the Novel Coronavirus),” 29 April 2020, last accessed 8 May 2020, <http://www.moj.go.jp/content/001318288.pdf>; e-Gov, “出入国管理及び難民認定法 (Immigration Control and Refugee Recognition Act),” 4 December 2019, last accessed 8 May 2020, https://elaws.e-gov.go.jp/search/elawsSearch/elaws_search/lsg0500/detail?lawId=326CO0000000319#78.
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²⁵ Taturō Kawai and Ryūichi Yamashita, “緊急事態宣言の方針「遅い」「補償も」 与野党から注文 (State of Emergency Declaration Policy “Slow” and “Compensation too”; An Order from Ruling and Opposition Parties),” *Asahi Shimbun*, 6 April 2020, last accessed 8 May 2020, <https://www.asahi.com/articles/ASN466JMLN46UTFK00N.html>.

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²⁷ In a twist of irony, public shaming has actually increased clientele in the parlors refusing to close. Yuta Shibayama and Masaki Ishikawa, “Defying local gov’t request, Osaka pachinko parlor reopens as 100s of customers line up,” *The Mainichi*, 7 May 2020, last accessed 8 May 2020, <https://mainichi.jp/english/articles/20200507/p2a/00m/0na/006000c>.

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The Use of Apps to Fight COVID-19 in Mainland China – Emma Burgers and Ryszard Sicinski

Background

China is a highly digitalised country. For several years now, smartphones have been an inseparable part of Chinese life, with mobile payment apps, in most part, replacing traditional payment methods. Smartphones are ubiquitously used not only to communicate, but also to order food, buy products, use bike share services, read news and books, reserve accommodation, as well as to buy tickets for entertainment, public transport, and train or plane travel. In order to sign up, every application requires users to provide a domestic phone number. There are several “super-apps”, such as WeChat, Meituan, and Alipay, which provide many of the services listed above on one platform. This means that personal information and user data is concentrated in a few hands, those of the companies behind these dominant apps. It is in this context that the Chinese government decided to use smartphones and apps to counter the pandemic, working hand in hand with the companies behind Alipay (the Alibaba Group) and WeChat (Tencent).

Introduction

In February 2020, the Chinese government started working together with technology companies to develop apps that could be used in the fight against the COVID-19 epidemic. Alipay’s ‘Health Code’ app, which was developed in collaboration with Ant Financial, an affiliate of the Alibaba Group, was first introduced on 7 February in Hangzhou’s Yuhang district. Then two days later it was introduced across the whole of Hangzhou.¹ Meanwhile, on 9 February, Tencent launched its first app in Shenzhen.² In the next two weeks, the app developed by Alipay was deployed in three different Chinese provinces, making it available in over 100 cities.³ Since then, the provincial governments in other Chinese provinces have started introducing applications, mainly with the help of Alibaba and Tencent. Both companies have expanded the provision of their ‘health apps’ to hundreds of cities and more than half of China’s population.⁴

General Information

The ‘health code’ applications are either self-sustained or are embedded as mini-programs into apps that are already widely used, such as WeChat (a messaging and mobile payment app created by Tencent) and Alipay (an online payment app developed by Alibaba). Each of these apps claims over one billion users. When installing the ‘health code’ apps, users are required to answer questions about their recent travel history, body temperature, and possible symptoms of COVID-19, as well as to give personal information such as their name, ID number, and phone number. The app

then assigns the user a coloured QR code: green, yellow, or red, which gives an indication of their health status. Green means the user of the app is healthy and allowed to travel without restrictions, whereas yellow indicates that the person should self-isolate for seven days. A red code means the user is probably infected and needs to undergo quarantine for 14 days. The code returns to green after the user spends the allotted time in isolation.

Dispersed system

To date, no single unified system has been established across China. This means, for instance, that a code obtained in Beijing will not function in Shanghai. There are currently nearly 100 different, largely incompatible, systems across the country.⁵ China is in the process of unifying the different systems into 'One Passcode', with groups of provinces working together in different combinations.⁶ Several technical standards and guidelines have been created since the launch of the various 'health code' apps. The first of such documents was the *Epidemic Prevention Passcode Reference Material and Technical Guidelines*⁷, which was drafted by Tencent for the Shenzhen Municipal Government. On 29 April, the Standardisation Administration of the People's Republic of China published⁸ three other documents: *Personal Health Information Code – Reference model*,⁹ *Personal Health Information Code – Data format*,¹⁰ and *Personal Health Information Code – Application interface*.¹¹ Regional governments, standardisation bodies, research institutes, and Chinese technological companies such as Alibaba, Tencent, Baidu, and the state-owned CETC were involved in drafting the guidelines.

The basic idea behind the many different 'health code' apps is almost identical. People have their QR codes scanned when entering residential compounds, public transportation, restaurants, shops, companies, and other establishments used by the public. At every checkpoint, after their identity is confirmed, their temperature is measured and their health status is updated. Depending on where they are located, checkpoints can be more or less lax. The checkpoints in Shenzhen, for example, are supposedly less restrictive.¹² As well as recording people's data, the apps use governmental data and location-based information, as well as the travel trajectories of other infected people and risk levels in a given municipality, to assess whether a person was in contact with an infected individual and determine the duration of this exposure.¹³ They supposedly do this with the help of big data and AI analysis.¹⁴ Based on this information, the QR code on the app can change colour, telling the user they are expected to self-isolate for a designated time period.

Some cities and counties treat these 'health code' apps as the only official document which can allow an individual access to certain public places. Other cities and counties, however, list them as one of several valid types of document that can certify an individual's health.¹⁵ The use of smartphone apps has become so ubiquitous in China that returning Chinese nationals are required to fill in their health details in an international version of WeChat. If they do not do this, they will not be allowed to board their flight to China.¹⁶ At the same time, domestically, there are sometimes multiple

'health code' apps available in the same province, branded differently and covering different areas. For instance, while some apps operate on a municipal level, others operate on a provincial level.

Other Measures

When assessing the effects of China's use of different tracking, tracing, and health apps in countering COVID-19, it is important to recognise that these apps have not been the only way in which the Chinese government has sought to tackle the virus. Besides these apps, the Chinese authorities have taken a number of different measures, many of which are still in place. With a low number of new cases at present, China is now trying to prevent a second wave of infections. This is where the use of apps comes into play and is also the focus of the other measures that currently remain in place. Without these other measures, the use of apps would also be less effective.

Besides the regular apps there are also apps aimed at different segments of the Chinese public. For example, Tencent has developed a 'health code' app which is specifically aimed at school students. In the app, the students must fill in their temperature on a daily basis and then they too obtain a coloured QR code.¹⁷

Some of these 'health code' applications can also be used by members of the public in order to get information about COVID-19, to identify affected areas, and to apply for online consultations. Online health-care services had already been used in China before the epidemic, with healthcare mini-programs available on both Alipay and WeChat. Other apps that provide online health consultations, such as JD Health and Ping An Good Doctor, have reported a rise in the number of online consultations they have offered related to respiratory issues. This suggests that people concerned about possible COVID-19 symptoms have also been turning to these health-related apps.

Alongside the use of apps, another measure taken by the Chinese government in their efforts to confront COVID-19 has been the restriction of individual movement. This takes on many different forms. As seen with the situation in Wuhan and the surrounding Hubei Province, when it is necessary entire cities or provinces can go into lockdown. Such a widespread restriction of individual movement is something that authorities want to prevent through other containment strategies. When in April several new infections were reported in Harbin, a city in the northeast of China, the authorities took additional restrictive measures. Authorities delayed the reopening of schools, forbid entrance to residential compounds for anyone except the residents themselves, and limited travel to and from the city. The four districts where the new outbreak was centred were put under a complete lockdown for two weeks.¹⁸

Another restriction of movement applies to those traveling to China. At the end of March, the PRC closed its borders to most foreign travellers. This restriction applies to foreigners holding valid visas or residence permits.¹⁹ Before this restriction went into effect, most foreigners were already required to be tested upon arrival and to self-isolate for two weeks. After this quarantine period, foreigners were also required to use the 'health code' apps and their QR code system.

Besides these restrictions of movement, the wearing of facemasks is also mandatory for everyone who visits particular public places. In some locations this is limited to public transport or other public facilities. Facemasks are sometimes also temporarily required in outdoor places. In Shanghai, for example, this was the case from early February until mid-March.²⁰

To ensure public places do not get too crowded, some public establishments, such as restaurants and gyms, have introduced restrictions on the number visitors they will accept, in combination with (online) reservations. This has been the case, for example, with some outdoor fitness facilities and gyms in Beijing.²¹ There are no measures of this kind at a central level and public transport such as buses and metro systems are still accessible without any restrictions.

A lot of the measures taken in China can be summarized by the idea of the ‘four musts’. These are four requirements that people should adhere to: 1) measuring people’s temperature, 2) asking for their identification, 3) recording and saving data, and 4) wearing masks in busy places. Such requirements have been put in place in the city of Xiaogan in Hubei, for example.²²

The use of apps and other digital measures should not be seen as standalones. They work together and can be successful in combination with other measures. As such, it is difficult to say to what degree the decline of new cases is due to the use of apps. According to official records, most new infections are now due to people coming from abroad. The number of new confirmed infections and suspected infections has declined almost every day in recent weeks.²³ Since the spread of the virus started to slow down in China, the Chinese government has been promoting its methods of curbing the spread of infections. The National Health Commission of the People’s Republic of China, for example, offers links to a website called: “*Fighting COVID-19 – The Chinese Way.*” This website features recommendations for the use of big data technology and digitalised systems to improve the precision and efficiency of epidemiological investigations.²⁴

Data collection and protection

The provincial governments and companies involved in creating the ‘health code’ apps have not been transparent about what data these apps use to assess risk. They have not disclosed how personal data is gathered, stored, or used. In some places it has been reported that the temperature data is only kept for five hours after measurement. However, information on how such apps retain and use their data is difficult to obtain or assess. We cannot extrapolate from this limited information to judge all of the ‘health code’ applications.

When the Beijing government launched a reformed app “Health Treasure 2.0”, they informed the public that they were reducing personal information collection.²⁵ However, by definition, an app serving as a replacement for ID collects vital data. Both

Beijing's app and Shanghai's 'Carry Shanghai Code' ask users for a photo that is verified through a facial recognition system.²⁶ The use of such verification has been made possible by China's state-of-the-art face recognition technology.

Developments surrounding the COVID-19 pandemic suggest that these face recognition tools are becoming even more advanced. Several companies are working to improve the capabilities of face recognition software²⁷ and even to avoid the misidentification of masked individuals.²⁸ Despite the improvements, Chinese facial recognition technology has been reported to experience issues when processing foreign faces. Beijing's app, therefore, requires foreign residents to upload a scan of their passport. Even so, foreigners living in China are already affected by the datafied reality of social control in the country. After downloading Beijing's health app, foreigners encounter a request to enter a phone number and once this is entered the app will fill in the user's personal information (name and surname) automatically. Then, the system requests a scan of their passport. After uploading the scan, its validity is verified instantaneously. The speed of verification practically excludes the possibility of it being a manual process. These facts raise questions regarding how much digitally processed personal data about foreigners is held by the Chinese government and tech companies.

Employers have also been required to monitor their employees' health, measuring their temperatures every time they enter the premises and periodically during their time at work. In some companies, the employees have been instructed by their employers to fill in forms asking about whether they have been in contact with infected persons. Identity is not protected in any way in these questionnaires. Employees are able to see the information and responses that have been given by their co-workers when they are filling in their own responses. All this data is then sent by the employer to the local government. In other workplaces, applications imitating public 'health code' apps have been introduced.

Citizen response to the apps

Chinese state media has presented the 'health code' apps as a digital line of defence against the virus which is essential to help the Chinese nation go from "stillness" to "movement". The use of these apps has become an integral part of the Chinese authorities' management of the movement of people in and out of affected provinces and cities. Because of the usage of these apps, it has been possible to reverse more severe lockdown measures. The public reception to the use of apps has been mixed and has varied between locations and points in time. Because of their prolonged lockdown, and their inability to lead a normal life, Chinese people have generally accepted the apps. With the passing of time, there appears to have been less discussion and criticism of the 'health code' apps.

Criticism and response

However, the use of these apps has met with some criticism, especially as more issues related to the apps have been reported. The main points of critique made about the

apps include: their unreliability, the lack of information, the lack of case-to-case solutions, the possible data breaches, and the inter-app incompatibility. There have been complaints on Chinese social media about the lack of transparency regarding how the apps work and how the colour codes are calculated. This criticism has stated that sometimes it is unclear how and why a user is designated with a yellow or red code. It also criticises the fact that there is no possibility to correct an erroneous code and it can be unclear how to change one's health code back to green.²⁹

Several cases have been reported of people self-isolating for an allotted time, based on the app's instructions, only to have this prolonged. Some citizens reported that their statuses changed colour overnight, without any apparent reason.³⁰ In one case, a woman travelling to a different county subsequently received a negative status. In this case, further investigation revealed that due to issues with the service provider she was deemed by the program to have crossed a border between two prefectures, which she had not done.³¹

The biggest issue people have had with the apps, which has been directly addressed by the Chinese state, has been the incompatibility of QR codes used in different cities and provinces. In March, Yang Wenzhuang, who is Director-General of the Department of Population Monitoring and Family Development of the National Health Commission, publicly addressed the topic during a press briefing and explained the reasons why there was no single app that combined all the other apps.³² Since then, the Chinese government has made efforts to unify all systems, although many of the issues still remain. People have difficulties travelling between cities and provinces,³³ usually needing to undergo 14-day isolation periods upon arrival in a new place. There was also one case in which a woman was released from the hospital with all necessary paper documents proving that she was allowed to take a flight, only to be denied boarding because her in-app health status was red.³⁴

Another point of critique has been the potential for users' personal data to be leaked to third-party programs as well as the potential for this personal data to be misused.³⁵ This criticism has been addressed by the government. The Ministry of Industry and Information Technology has assured citizens that the systems do not allow any breach of privacy.³⁶ Tencent and Alibaba have also ensured citizens that their data is safe and that Tencent and Alibaba only serve as intermediaries.³⁷

Additionally, cases of public disobedience have been observed, with people refusing to show their phones or attacking health inspectors verbally and physically after being issued a red status by the apps. Some conspiracy theories, which link the apps to internal Party rivalries, have also made the rounds.

Government access to data

Not long after China unveiled the first 'health code' apps, *The New York Times* reported that Alibaba's 'Health Code' app for Hangzhou contained a tracking program called 'reportInfoAndLocationToPolice'.³⁸ According to the report, when the code of someone who is using this app is scanned, this individual's location information and identifying code are sent to an unknown server. For users of the app, it is not clear whether

or how the server connects to the IT systems of the law enforcement authorities. This information was also publicised widely by other media around the world, including a number of Taiwanese and some Hong Kong media outlets. Chinese state media did not respond to these allegations.

The New York Times also reported that law enforcement authorities were involved in the construction of the app, a fact that was verified by Chinese state media and official police social media accounts. Due to the variety of apps that fall under the umbrella category of ‘health code’ apps, it is unknown to what extent other apps have also incorporated tracking functions. According to official government reports, the ‘Health Treasure’ app, which has been used in Beijing, does not collect personal location-based information. Instead it depends on its users’ registration at different checkpoints to determine the travel paths of its users and so whether a particular user has been in contact with an infected person.³⁹

Conclusion

The ‘health code’ apps being used in China to fight the COVID-19 epidemic have been met with concerns and received criticism regarding both privacy and practicality. For the users of these apps, it remains unclear how they collect and share data with the government. It has been reported that Chinese technology companies frequently share data with the government. For the duration of the pandemic, a case can be made for the necessity of these apps. However, in the past the surveillance system employed by the Chinese government has typically been expanded at the time of major events, such as the 2008 Beijing Olympics and the 2010 World Expo in Shanghai, and then the monitoring tools introduced during these events have not been completely dismantled afterwards. It is likely that the same will happen with the surveillance capabilities and tools such as the ‘health code’ apps which have been introduced during efforts to combat COVID-19. Once such technologies have been implemented, they are likely to stay and even be enhanced.

The Chinese public generally accepts the trade-offs, with many agreeing to give away their privacy for the greater cause. Opposition is short lived. This is illustrated by a quote from one Chinese commentator, who stated that “whether you want it or not, society's development demands efficiency.”⁴⁰ The Chinese government has been able to control public opinion well enough to curb societal discord through improvements to the system it uses, positive propaganda, and China’s high degree of digitisation.

Currently, the system of health apps in China is still under development. There are different apps being used in various regions and cities which have been developed by several companies. The government is currently joining hands with some of the biggest domestic tech companies to establish a unified ‘health code’ system. The implementation of one universal app in China might diminish some of the complaints which are made about the apps, but privacy concerns would still remain. It is highly likely that not only do the companies behind these apps have access to the data collected, but that the government does as well. This breach of privacy is accepted by the

public even though it remains difficult to say to what extent the use of apps contributes to the decline of COVID-19 infections. Whether the apps and the technology used for them will be made redundant after COVID-19 also remains uncertain.

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Responding to COVID-19 with Tech in Singapore - Jonas P. Lammertink

One of the earliest and most widely reported examples of a smartphone app designed to counter the outbreak of COVID-19 has been ‘TraceTogether’, developed by the government of Singapore. This app, which at the time of writing was based on voluntary participation, is only one of several digital technologies that are being deployed in Singapore to counter the spread of the virus. In fact, the Singaporean Government Technology Agency has presented a range of digital tools on its website, under the unmistakable header “Responding to COVID-19 with Tech”. This brief report analyses the political context, functioning, and effects of these digital technologies.

Politics, tech, and privacy in Singapore

Singapore’s political system is a parliamentary democracy where multiple parties contend for seats in parliament during general elections. However, Singapore’s ruling People’s Action Party (PAP) has been in office since 1959, consistently winning a majority of seats in every election. During the last election in 2015, the PAP won 83 out of a total of 89 seats. In order to stay in power, the PAP deploys various repressive measures, including restricting freedom of expression and freedom of the press, as well as using lawsuits to block opposition members from running for elections. At the same time, Singapore is rated highly on government efficiency, rule of law, and control of corruption by the governance indicators of the World Bank.¹ Under the leadership of the PAP, the city-state has witnessed remarkable economic and social progress and the party continues to enjoy broad-based support. The government and the political system, including its illiberal aspects, appear to be at least partly legitimised by its performance.

Singapore is also one of the most technologically advanced societies in the world. According to the UN, the city-state is the most innovative country in Asia and its government ranks near the top of the UN E-Government Development Index.² The authorities aim to transform Singapore into the world’s first ‘Smart Nation’ by using technology to improve the services of government agencies, strengthen businesses, and enhance the quality of life of its citizens.³ Many steps have been taken in that direction and data related to everyday life is collected and analysed on a large scale.⁴ The city state also has a centrally controlled and well-established surveillance system, which includes access to communications data, mandatory SIM card registration, and big data analytics.⁵

This concerns organisations such as Privacy International, which has stated that “the legal framework regulating interception of communication falls short of applicable international human rights standards, and judicial authorisation is side-lined and democratic oversight inexistent”.⁶ In fact, the Singaporean constitution does not include a right to privacy. Singapore is also among a select group of countries that

have not ratified the International Covenant on Civil and Political Rights, which stipulates that “no one shall be subjected to arbitrary or unlawful interference with his [sic] privacy”.⁷ The data protection provisions of the 2012 *Personal Data Protection Act* restrict the use of private information by companies, but do not apply to public agencies.⁸ According to Simon Chesterman, Professor of Data Protection Law at the National University of Singapore, such laws and regulation are primarily designed to create an environment in which big data can thrive, rather than to protect individual rights.⁹

The initial outbreak of COVID-19

From as early as 2 January 2020, the Singaporean government started taking precautionary measures in response to COVID-19 and called upon the public to adopt good personal hygiene practices.¹⁰ Singapore confirmed its first imported COVID-19 case on 23 January and its first local cases on 4 February.¹¹ By 20 March, which was the day the ‘TraceTogether’ app was launched, 385 cases of COVID-19 had been confirmed, a 12 percent increase compared to the previous day. Of these cases, 131 had fully recovered and there had been no deaths.¹² Although the government had already prohibited gatherings of over 250 people at this point, and had taken social distancing measures, a lockdown was not yet implemented, unlike in many of the countries in the region.¹³ At that time, Singapore’s COVID-19 response was seen by people around the world as successful and exemplary, because of its low infection rate, lack of deaths, and relatively small negative economic impact. Singapore’s success was attributed to the fact that it was well prepared to deal with such outbreaks (having learnt from earlier health crises such as SARS), that the government recognised the seriousness of the situation relatively early and responded accordingly, and that there was effective communication. Aggressive testing, strict border checks and intensive contact tracing made quick identification and isolation of new cases possible, while every positively tested person was hospitalised.¹⁴

Contact tracing technologies

One of the main strategies employed by the Singaporean government from the start to contain the spread of the virus has been thoroughly tracing the close contacts of people who had tested positively for COVID-19. In order to supplement the labour-intensive manual contact tracing efforts, several digital technologies have been developed, of which the ‘TraceTogether’ app is the most prominent example. ‘TraceTogether’ was introduced on 20 March and is a contact tracing app which makes it possible to identify the phone numbers of people who have been in close physical contact with those who have tested positively for COVID-19.¹⁵

‘TraceTogether’ works in the following way: Individuals choose to download the app and then submit their mobile phone number. The app then attaches a randomly generated ID to this number. Using Bluetooth, the app detects the random IDs of other nearby users and records these. If a user tests positively for COVID-19, they

can choose to share the app's logs with the Ministry of Health. The Ministry will encrypt the random IDs of other users found in these logs. This will then indicate the phone numbers of the infected person's "close contacts", or other users who have been within two meters of the infected person for more than 30 minutes. These "close contacts" then receive a text message informing them that they are at high risk of infection, so that they can take steps to prevent further spreading.¹⁶

Another important digital tool to counter COVID-19, which was introduced on 23 April, is 'SafeEntry'. This technology serves as a visitor registration system at "hotspots", such as supermarkets, workplaces, and malls. Visitors and employees are required to register when they enter or leave such locations. They can do so by scanning a QR code with their phone and subsequently submitting their name, National Registration Identity Card number, and mobile phone number. Directly scanning identity cards is an alternative option. This allows for the logging of the entrance and exit times of visitors and employees at certain locations. From 12 May, all operating businesses will have to make use of 'SafeEntry'. However, people are not obliged to register at places where people are on the move, such as metro stations and parks. Using 'SafeEntry', more data is collected that can be used for contact tracing.¹⁷

Tools such as 'TraceTogether' and 'SafeEntry' have not replaced manual contact tracing efforts in Singapore, but supplemented these.¹⁸ Manual efforts consist of careful research, including the extensive interviewing of infected persons, contact of their family members, and collection of surveillance footage from local business, as well as the use of digital data such as digital payment records.¹⁹

Other technologies

Apart from supplementing contact tracing efforts, digital technologies have also been used in other ways to counter COVID-19. Citizens can subscribe, for example, to receive daily COVID-19 updates on the WhatsApp messaging app. These updates are sent by an official government WhatsApp account.²⁰ An online portal called 'Safe Distance @ Parks' has allowed citizens to check online how crowded parks are in order to prevent overcrowding. The data for this portal is collected by aerial photographs shot by drones and by local staff on the ground.²¹ Meanwhile, another use of technology has been employed for those people who have received instructions to stay at home or to have a leave of absence, those for example who are a close contact of a confirmed case. These citizens are supposed to frequently share their phone's GPS location with authorities via a link that they receive through text messages. They can also be requested to submit photographs of their surroundings. Finally, the websites 'MaskGoWhere' and 'FluGoWhere' have provided Singaporeans with information about the collection of face masks (in a campaign which had already concluded by the time of writing,) as well as information about where to find Public Health Preparedness Clinics for people with flu-like symptoms.²² There has also been the opportunity for some private initiatives to prove their value during the current health crisis. An example would be the 'MaNaDr' app, which provides online health consultations and has been reported to have helped relieve the burden on medical facilities.²³

COVID-19 technologies and privacy

The Singaporean government's approach towards the privacy of its population with regards to the use of technology to counter COVID-19 appears to contain discrepancies. For the 'TraceTogether' app, the government went to great lengths to stress its commitment to safeguarding the privacy of users and emphasised that using the app is voluntary. Furthermore, the data, which is stored securely on non-public servers, only includes the user's phone number and random ID. No personal or location data is collected. This data will be deleted if the user chooses to revoke consent. The app only stores the random IDs of other users and only the Ministry of Health can decrypt these. The personal identities of users are not revealed on the phones of other users. Third parties are unable to find out the identity of a user, since the random ID is refreshed at regular intervals. The collected data is solely used for tracing persons who might have been exposed to COVID-19. If contact tracing ends, users will be prompted to disable the app. When they do so, the connection data will be lost. Users could be requested to reinstall or enable permissions in case of a future outbreak.²⁴

While the protection of individual privacy appears to have been a priority during the development of the 'TraceTogether' app, this does not seem to have been the case with the other contact tracing technologies that have been deployed. Use of 'SafeEntry', for example, will be mandatory in many places. In contrast to 'Trace Together', this technology does collect the actual identification and location data of citizens. The authorities have stressed that this data is encrypted and stored on a government server, that it will be used solely by authorised personnel for the purpose of contact tracing, and that strict safeguard measures are in place which include punishments for public officials who misuse the data. However, the way in which this data will be used for contact tracing efforts is not fully disclosed. It is mentioned that "the data may be de-identified and aggregated for analytics purposes". However, it is unclear whether these analytics will still be related to contact tracing efforts.²⁵ Regarding the time frame for use of this technology, the government has stated that businesses will have to collect data for as long as is required by law during COVID-19 and that the data will be "purged" when it is no longer required for the purpose of contact tracing.²⁶

As discussed above, privacy laws in Singapore primarily restrict how companies can collect and use personal data. These privacy laws exclude government agencies. The World Economic Forum has also noted that data protection terms in Singapore have been relaxed for the purpose of contact tracing and other measures adopted to respond to COVID-19.²⁷ The website of the Personal Data Protection Commission states that: "In the event of a COVID-19 case, relevant personal data can be collected, used and disclosed without consent during this period to carry out contact tracing and other response measures, as this is necessary to respond to an emergency that threatens the life, health or safety of other individuals".²⁸

The discrepancy regarding the government's approach to privacy in relation to different technologies might be explained by the fact that use of the 'TraceTogether' app, in contrast to many other contact tracing technologies, is voluntary. This means

that Singaporeans have to be convinced about using 'TraceTogether', which implies that their privacy concerns must be taken into account.

Reception and effects

At the beginning of the outbreak, Singapore's approach to COVID-19 received international praise. In April, however, the situation in the city-state worsened. On 7 April 2020, the country implemented a lockdown. On 6 May, the authorities reported 20,198 total cases, an increase of 788 from the previous day. This made Singapore the country with the highest number of confirmed cases in Southeast Asia.²⁹

However, these statistics do not reflect the complexity of the situation in Singapore. To date, figures indicate that only 24 people have been in intensive care in the city-state and only 20 people have died as a result of COVID-19. The Singaporean government has been successful in containing the spread of the virus in what it calls "the community", which consists of permanent residents and inhabitants with work permits. For this section of the population, there were only 13 new confirmed cases reported on 6 May. However, the government has been much less able to contain the virus among foreign work permit holders who often reside in less favourable conditions, living in large groups and in dormitories. For this section of the population, there were 775 new confirmed cases reported on 6 May. Overall, over 90 percent of all confirmed cases have belonged to this latter group.³⁰ As a result, some experts have argued that there are two separate COVID-19 outbreaks in Singapore: a "massive outbreak in the dorms and a relatively controlled outbreak in the rest of society".³¹ This makes it challenging to analyse what kind of impact the technologies which have been employed to respond to COVID-19 have had so far. In addition, the fact that technologies such as 'SafeEntry' have not been implemented on a large scale yet means that it is difficult to discuss their reception.

Some things can be said, however, about the reception and effects of 'TraceTogether'. On 22 April, about one in five Singaporeans had downloaded 'TraceTogether'. The Singaporean authorities had stated that 75 per cent of the population should use the app in order for it to be effective. The low number of people using the app might be explained by the fact that, according to a survey of 503 respondents, only 41 percent of Singaporeans feel comfortable sharing a positive COVID-19 test result using this technology. The app has also received negative reviews because of technical issues.³² As a result of the low adoption rate, the chairman of the Government Parliamentary Committee for Health proposed making use of 'TraceTogether' mandatory.³³

A director of the organisation behind the 'TraceTogether' app has warned against over-reliance on contact tracing apps and stated that these should not replace manual contact tracing efforts, which can take into account more factors and so offer greater accuracy.³⁴ Internationally, the 'TraceTogether' app has received much attention. Governments from over 50 countries, and many more private enterprises, have shown interest in the app.³⁵ This can at least partly be explained by the app's relatively low privacy intrusion when compared to alternatives. The Singaporean government has made the programming behind 'TraceTogether' open source.³⁶

The authorities in Singapore hope to end the lockdown on 1 June, after which they want economic and community activities to resume gradually. In order to enable the safe resumption of such activities, the government aims to “leverage technology to speed up contact tracing” and in this regard it specifically mentions the use of ‘SafeEntry’.³⁷ Technologies which contribute to safe workplaces, such as telecommunications software, will also likely need to be employed.³⁸ Furthermore, non-digital tools will continue to be important when Singapore opens-up again. For instance, Singapore’s testing capacity, which is already extensive and has been doubled since April will be further expanded.³⁹

Conclusion

Even though it is difficult to conclude what kind of impact technology has had on the response to COVID-19 in Singapore, this report has brought a few things to light. The digital tools that have been implemented in Singapore to counter COVID-19 are embedded in a technologically advanced society which is tightly controlled by a government that deploys digital technologies to govern effectively, even when use of this technology undercuts individual privacy. The design and implementation of digital tools to respond to COVID-19 generally has reflected this reality regarding the nature of Singaporean society and governance. This is highlighted by the fact that the one technology that does successfully address privacy concerns, namely the ‘TraceTogether’ app, likely does so because of the fact that it is dependent on voluntary adoption. This app therefore contrasts in its voluntary nature with most contact tracing, which has been imposed top-down. The low adoption rate and subsequent ineffectiveness of the ‘TraceTogether’ app proves that technological tools ultimately depend on the quality and quantity of data. The ineffectiveness of ‘TraceTogether’ and the ensuing decision by the authorities to implement a mandatory tool which is more intrusive of people’s privacy, namely the ‘SafeEntry’ system, suggests that the Singaporean government has been forced to consider trade-offs between efficiency and privacy in fighting COVID-19.

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South Korea: Containing COVID-19 through Big Data - Anoma P. van der Veere and Sungbin Ha

South Korea's early success in containing the spread of COVID-19 was due to its integration of broad testing, strict enforcement of quarantine guidelines, the use of big data and user-friendly applications, and regulations in terms of data sharing capabilities. The country will be among the first in the world to have a viable and efficient long-term strategy for containing pandemics. However, the use of personal information in tracking patients, and regulations with regard to data collection and sharing, are expected to permanently affect individual privacy.

Spread

On 30 April 2020, South Korea reported no new confirmed cases of domestic transmission of COVID-19. It had taken the country 72 days to regain control after a major surge in infections originating from the South-Eastern city of Deagu.¹ The government's pro-active attitude towards testing has resulted in 651,562 people being tested, out of which 608,286 tested negative for COVID-19. Approximately 1.2 percent of the total population has undergone testing.² As of 2 May, there had been 10,780 confirmed cases of infection, with 250 deaths. This is a fatality rate of 2.32 percent. A total of 9,123 people have fully recovered and 1,407 people remain in quarantine or are receiving treatment. Meanwhile, there are 8,496 other people who are under inspection for suspected infection. These figures mean that South Korea has been less affected in terms of total numbers than other countries such as China, the United States, the United Kingdom, France, and Italy. This is due in large part to a concerted effort to tackle the spread of COVID-19. In this broad effort, technology, and specifically ICT solutions, have played an essential role.

A Broad Response: K-Epidemic Prevention Model

The South Korean government is attempting to standardise its experience in handling epidemics, calling it the "K-Epidemic Prevention Model"³. This model for handling epidemics is currently under review by the International Standard Organization (ISO).⁴ This model is a concise summary of the complete South Korean response to COVID-19. It consists of the three following steps:

(1) Inspection and confirmation of infections:

- Diagnosis of infection: Polymerase Chain Reaction (PCR) procedures, reagents, and test methods for diagnosis.
- Screening clinics: operating Drive Thru and Walk Thru testing.

(2) Epidemiological investigation and tracking:

- Linking self-diagnosis results to electronic medical records (EMR) using the self-quarantine safety protection app.

(3) Quarantine and treatment:

- Operation of treatment centres, disseminating personal hygiene and infection prevention guidelines, sharing of digital logs of infected people and protecting their privacy, appropriate treatment for low-income households.

In order to fully implement these three steps, the government has chosen to pursue technological solutions. Among them are two applications that have been widely utilised for both information gathering and enforcing policies.

Using Apps for Self-Diagnosis and Self-Quarantine

Apps for containing the spread of COVID-19 have been developed in both the public and private sectors in South Korea.⁵ These apps are in addition to national and local emergency systems that notify anyone in a certain radius of possible risks.⁶ Specifically, the South Korean government has developed two apps for public use: the 'self-diagnosis app'⁷ and the 'self-quarantine safety app'.⁸

These apps were released on 7 March for Android and on 16 March for iOS.⁹ While the apps were initially used by Koreans and foreigners living in South Korea, since 1 April all people entering the country have also been required to install these apps. The 'self-diagnosis app' can be downloaded on arrival. Users must enter their passport information, nationality, name, address, and other necessary information for quarantine into the system. If a person refuses to cooperate, they will be denied entry into the country.¹⁰ Users are required to report possible symptoms twice a day during the mandatory 14-day quarantine which they must undergo after arrival in South Korea.

The data collected through this self-diagnosis app is sent to the Korea Centers for Disease Control and Prevention (KCDC). The data is also shared with local governments and public health clinics if the user shows symptoms for more than two consecutive days. Local governments are prompted to have users tested if they show symptoms. In order to assure users keep reporting, notifications are sent out whenever a user fails to do so. Users are also called after they fail to report. In case users remain non-responsive, the police track them down and enforce compliance.¹¹

The app is user-friendly and accessible. Reporting is done through four yes-or-no questions: do you have 1) a cough, 2) a fever, 3) a sore throat, or 4) difficulty breathing (dyspnea)? The app can be used in four different languages installed: Korean, English, Chinese, and Japanese. It also provides information on nearby testing clinics. Testing facilities are widely available, making the process easy to understand and complete.¹²

Home visits and phone calls from public officials were previously the most common methods for checking on people in self-quarantine. This is now primarily done through the 'self-quarantine safety app'. This app is available in the same four languages as the self-diagnosis app. Its main function is similarly to monitor symptoms and provide a tool for self-diagnosis. However, an additional alarm is set to go off once the user leaves the designated self-quarantine area.¹³ Everyone coming to the country from outside of South Korea must download the app, including Korean nationals. According to the South Korean government, around 91 percent of the people in self-quarantine have installed the app, though the authorities do not clarify how they arrive at this figure.¹⁴ The government gives the following description of the app: "The application largely has 3 key functions: a self-diagnosis for the users to conduct and submit the results with the assigned government officers; a GPS-based location tracking to prevent possible violation of self-quarantine orders; and providing necessary information including self-quarantine guidelines and the contact info of the assigned government case officers."¹⁵

There are two versions of the 'self-quarantine safety app'. One is for the user and one is for public officials.¹⁶ People who might be infected are required to use the user version. In order to qualify for this measure, a person has to have come within two meters of a confirmed patient who has shown symptoms or they have to have been in a confined space together with such a person without using a mask. In these cases, the person is required to self-quarantine for 14 days even if they have tested negative for the virus. This is done to ensure the virus will not be spread by people whose symptoms develop later. Officials are tasked with checking the data received through the public official app. They have to follow up on cases where people have not responded via the app or may have violated the self-quarantine guidelines by tracking the movements of these people using the app's geographic information system (GIS) function.¹⁷

When the self-quarantine guidelines were initially introduced, there was a spate of problems with people escaping the quarantine area with their phones or leaving their phones at home to go out. The South Korean government responded to these issues by imposing heavy penalties. The *Law on Infectious Diseases and Control* (hereafter referred to as the *Infection Law*) was amended and went into effect on 5 April. This stipulated new penalties for violators, including one year imprisonment or a fine of up to 10 million won (7,504 euro). The police were instructed to immediately return anyone violating the self-quarantine guidelines to their original quarantine area and to press charges. As a result, on 8 April an Indonesian man and a married couple from Vietnam were deported for violating self-quarantine orders. Around 300 people across the country have currently been charged with violating the *Infection Law*.

To counter this behaviour, the government has introduced the 'relief-band' (Figure 1).¹⁸ The 'relief-band' is connected to a smartphone through Bluetooth. It sends out notifications to public officials if the wearer goes more than twenty metres outside of the self-quarantine area or if the band is disconnected.¹⁹ These bands are now used

for people who have received a penalty. Self-quarantine violators are offered two options: if they agree to wear the band, a local government officer attaches it and then brings the person to the self-quarantine area of their choosing. Alternatively, if the person disagrees with wearing the band, they are brought to a secure third location. These are dormitories where nurses and police are present. Users are not allowed to leave until they have finished their time in quarantine. Whether or not users consent to wearing the band, they are officially charged with violating self-quarantine rules and indicted accordingly.²⁰



Figure 1: “Relief-band”, Ministry of Health and Welfare, 2020.²¹

The government has also made temporary arrangements in the healthcare sector, allowing doctors and nurses to consult with patients through video calls and video conferencing, telemedicine, or “remote medicare”.²² This has been done to decrease the burden on hospital staff and to enable the sharing of technical knowledge between healthcare facilities. The app ‘Medihere’ allows users to contact hospitals and make an appointment online. ‘Odoctor’ gives patients the option of accessing general medical information and diagnosis. It also allows them to participate in remote treatment through the ‘Coronavirus 119’ function.²³ This app is also designed to screen patients before they visit clinics and hospitals, shortening the amount of time they spend there and so reducing the possibility of transmission. In order to make use of these apps, patients are required to answer questions concerning their medical history. This information is shared with care providers.²⁴

Similarly, in the private sector, several apps have been developed that use the data published by the KCDC. For example, the ‘Now and Here’ app determines the possible risks that might be faced by taking a particular route by using data about the movements of people who have been confirmed as having been infected. It also provides the locations of testing facilities. The ‘Cobaek’ app tracks the movement of users and alerts them when they are within 100 meters of somebody who has been confirmed as having been infected. It also lists the availability of masks at pharmacies based on public data provided by the National Information Society Agency (NIA).²⁵

Whether public or private, these technological solutions rely on vast amounts of data. Laws on data utilisation have been revised in order to facilitate this broad use of private information. Through the *Infectious Disease Control and Prevention Act (IDCPA)* and the introduction of the *Advancement of Smart Quarantine Information System*, the state has made it possible to track individuals coming in from overseas, and then to track their movements through their ship or flight numbers, their places of

departure and destinations, their arrival times and their personal passenger information, as well as through GPS data, card transactions, and CCTV recordings.²⁶ Under the IDCPA, any institution, organization, or individual must share information on anyone who is infected or deemed “likely to be infected by an infectious disease”.²⁷ The KCDC shares information with the National Police Agency, the Credit Finance Association of Korea, three telecommunications companies and 22 credit card companies in order to track people who might be infected and to “quickly identify transmission routes and places”. This data includes a person’s current whereabouts and the total time they have spent in each location. Information collection is automated and can be provided in ten minutes from the moment a request is made.²⁸ The use of big data thus extends beyond healthcare and far into the lives of private individuals.

Governance and Technology in South Korea

The integrated use of technological solutions in South Korea’s policies is the result of the nation’s longer history of facing external threats, among them the Middle East Respiratory Syndrome (MERS) epidemic in 2015. The first cases of MERS in South Korea were confirmed on 20 May 2015. By July 2015, 186 people had been infected, 2,451 people had been quarantined, and 36 people had died. Understanding the routes of infections became a focal point in countering epidemics. However, for many cases, the initial routes could not be determined, leading to uncertainty among policymakers. In response, the Korea Centers for Disease Control increased its number of epidemiological specialists. For the COVID-19 response, however, simply adding people proved inadequate as the spread increased exponentially. It is because of this that the South Korean government decided to pursue the development of the aforementioned apps.

South Korea has also benefitted from the early establishment of a comprehensive resident registration system. The government introduced the resident registration number system in 1968 in order to identify possible spies from North Korea. Resident registration numbers are now also used in a wide range of fields such as medical care, finance, taxation. Now they have been used as part of the COVID-19 response. For example, this system has been used to check the movement of an infected person by tracking credit card use.

The government has become increasingly IT-enabled in many ways. This can be attributed to the 1997 foreign currency crisis. Under Kim Dae-jung’s administration, South Korea began to promote e-government solutions in order to improve administrative efficiency.²⁹ South Korea held the top position in the UN’s E-Government Survey between 2010 and 2014, and then the third position between 2016 and 2018.³⁰ South Korea is also the world’s leading nation when it comes to smartphone penetration, with 95 per cent of the population using a smartphone.³¹ This shows that South Koreans are generally adept at using technology. These developments have paved the way for South Korea’s successful use of the apps described above in its response to COVID-19. These apps, which were developed by the National Information Society

Agency (NIA), under the Ministry of Science, Technology and Information Technology (MSIT),³² have seen wide usage across the population. This shows that there is a high degree of willingness among the population to cooperate with the COVID-19 response.

Recent survey results point in the same direction. Tables 1 and 2 below show some of the results from a survey of 1,000 Korean adult men and women which was conducted by You Lab (2020) between 10 and 13 April, among.³³ Table 1 shows that 76.6 percent of the respondents agreed that it was “fair” that the penalties (fines) for self-quarantine violations had been strengthened through recent amendments to the *Infection Law*. In addition, 90.2 per cent of the respondents agreed that stronger control mechanisms were necessary in order to increase the security of self-quarantine measures.

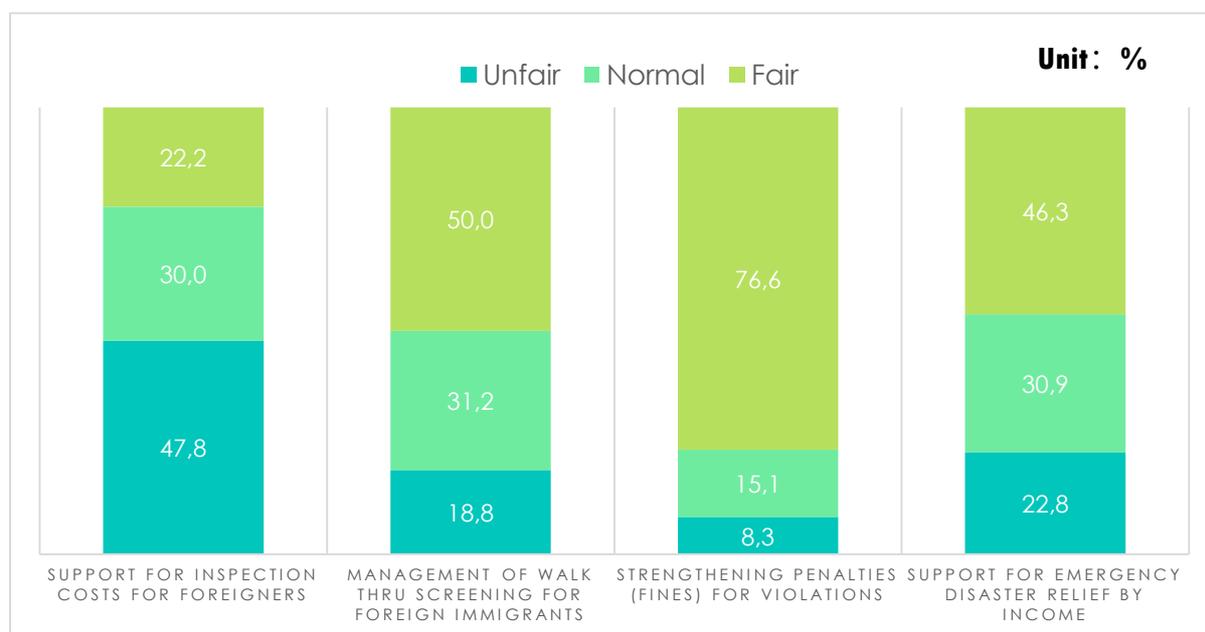


Table 1: Public opinion on South Korea’s COVID-19 response.³⁴

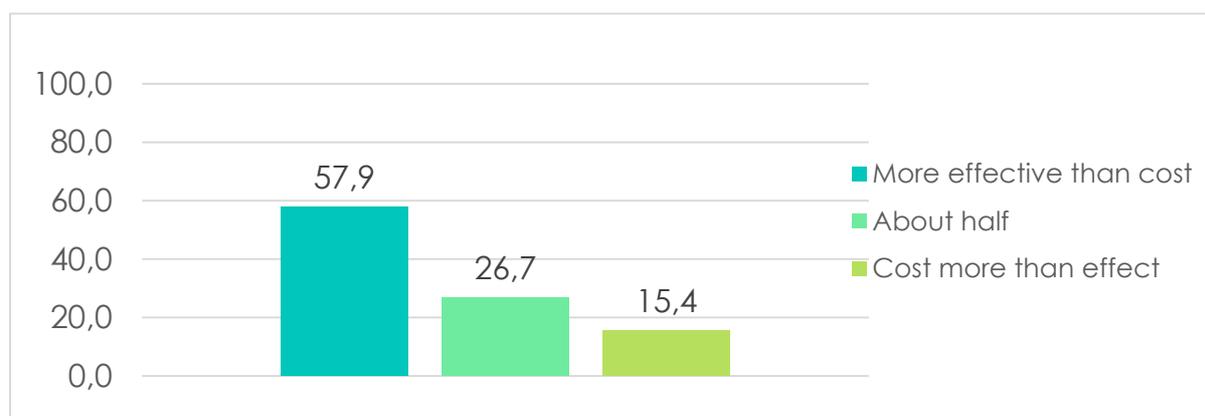


Table 2: Public opinion on the use of “relief bands”.³⁵

On the other hand, the results regarding use of the ‘relief bands’ (Table 2), which were still under discussion at the time of the survey, indicated that public opinions were more divided. Still, more than half of the respondents (57.7 per cent) agreed that the benefits were greater than the costs, indicating that they recognised a need for stronger regulations to manage self-quarantine.

On 15 April, whilst the COVID-19 crisis was still ongoing, a general election was held in South Korea. Initially, the South Korean government had planned to restrict voting rights for those in self-quarantine, but it changed its position and allowed people who applied in advance to vote between 5:20pm and 6pm, with these people separated from other voters. The geographic information system (GIS) function of the ‘self-quarantine safety’ app was in use at this time. Those under self-quarantine were allowed out between 5.20pm and 7pm. They were instructed to go straight from their designated quarantine location to the polling station and then to immediately return. Those who left the route were tracked down. As a result of these stringent measures, there were no new outbreaks immediately after 15 April. On 30 April, the disaster safety task force announced that “there was no spread of COVID-19 following the election”.³⁶ The lack of proliferation as a result of the election was seen as a victory for the South Korean government’s use of technology and the people who accepted it, regardless of the outcome of the election.

Conclusion

South Korea has been able to quickly embrace technology in its COVID-19 response. As a result, the country has avoided severe national lockdowns. The economic impact of the virus has been limited by the swift response and at the time of writing healthcare infrastructure remains intact and able to cope with current levels of infections. However, successful utilisation of such technological solutions has required certain pre-conditions, such as widespread acceptance of the use of personal data and the use of strict control mechanisms to enforce policies. Ultimately, these technologies all function to reduce the risk of spreading the virus and govern the movement of (possibly) infected people using surveillance technology.

These systems are designed to control large populations and they require big data. In addition, vast human resources are required for checking the data and enforcing strict quarantine guidelines when necessary. Importantly, this technology does not function on its own. Users have to be willing to share their data. In South Korea, people are willing to do so, accepting a trade-off on their personal privacy for an improved sense of security. Nevertheless, there are always those who do not cooperate. The implementation of heavy fines and the ‘relief-band’ to control those who violate self-quarantine guidelines represent two choices policymakers have made in order to further strengthen their control over the population. As such, South Koreans and foreign visitors have been subject to invasive changes in terms of privacy protection. The government is now able to access personal information if there are any suspicions of a possible infection.

South Korea has faced multiple pandemics in the past, and these experiences inform a policy approach whereby recent changes could be made permanent, in anticipation of possible new pandemics. Evidence that this may happen is offered by South Korea's attempt to standardize its response into a new, exportable, model. Although the government has stated it will remove any personal information after the pandemic is over, a clear line delineating the end of the pandemic has not been established, and there is a high likelihood of these measures and these technologies 'sticking around'. The government's response to COVID-19 has become embedded in policy and law, and the measures it has taken have been embedded into South Korean society. This means that these mechanisms can be started up quickly whenever a new pandemic arises. Moreover, the government has stated it will pursue further investments in enhancing and innovating the current systems, enshrining current strategies as a benchmark for future policymaking.

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³ H.M. Kang, "S. Korean Epidemic Prevention Model Proposed as International Standard," *The Korea Bizwire*, 27 April 2020, last accessed 6 May 2020, <http://koreabizwire.com/s-korean-epidemic-prevention-model-proposed-as-international-standard/>; Shim Woo-hyun, "S. Korea pushes to make COVID-19 test scheme international standard," 26 April 2020, last accessed 6 May 2020, <http://www.koreaherald.com/view.php?ud=20200426000271>.

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¹⁰ "How Korea responded to a pandemic using ICT," p. 29-30.

¹¹ *Ibid.*

¹² Ibid., p. 30.

¹³ Ibid., p. 35.

¹⁴ Ibid.

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¹⁸ Central Disease Control Headquarters, “코로나바이러스감염증-19 중앙재난안전대책본부 정례브리핑 (Coronavirus Infectious Diseases-19 Disaster Safety Headquarters Regular Briefing),” 28 April 2020, last accessed 6 May 2020, http://ncov.mohw.go.kr/tcmBoardView.do?brdId=&brdGubun=&dataGubun=&ncvContSeq=354196&contSeq=354196&board_id=140&gubun=BDJ.

¹⁹ The original term 안심밴드 (*ansimbaendeu*) can also be translated as “safety band”, as the concept 안심 (*ansim*) has no precise English counterpart. It denotes a sense of security and safety not only for the user, but for others as well. Ministry of Health and Welfare, “코로나바이러스감염증-19 중앙재난안전대책본부 정례브리핑 (Coronavirus Infectious Diseases-19 Disaster Safety Headquarters Regular Briefing),” 28 April 2020, p. 3, last accessed 6 May 2020, http://www.mohw.go.kr/react/modules/download.jsp?BOARD_ID=140&CONT_SEQ=354250&FILE_SEQ=286696.

²⁰ Ministry of Health and Welfare, “코로나바이러스감염증-19 중앙재난안전대책본부 정례브리핑 (Coronavirus Infectious Diseases-19 Disaster Safety Headquarters Regular Briefing),” 24 April 2020, p. 5, last accessed 6 May 2020, http://www.mohw.go.kr/react/al/sal0301vw.jsp?PAR_MENU_ID=04&MENU_ID=0403&page=4&CONT_SEQ=354196

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²² “How Korea responded to a pandemic using ICT,” p. 16.

²³ Ibid., p.17.

²⁴ Ibid.

²⁵ Ibid., p. 18.

²⁶ “How Korea responded to a pandemic using ICT,” p. 33.

²⁷ Ibid., p. 41.

²⁸ Ibid., p. 44.

²⁹ Sungbin Ha, “日本における電子政府化政策のポリティクス・イン・タイム (The ‘Politics in Time’ of E-Government Policy in Japan)” Graduate School of Law Kobe University, 2018, Doctoral dissertation.

³⁰ United Nations, “E-Government Survey,” *Department of Economic and Social Affairs (DESA)*, 19 July 2018, last accessed 6 May 2020, <https://www.un.org/development/desa/publications/2018-un-e-government-survey.html>.

³¹ Laura Silver, “Smartphone Ownership Is Growing Rapidly Around the World, but Not Always Equally,” *Pew Research Center*, 5 February 2019, last accessed 6 May 2020, <https://www.pewresearch.org/global/2019/02/05/smartphone-ownership-is-growing-rapidly-around-the-world-but-not-always-equally/>.

³² National Information Society Agency (NIA), <https://www.nia.or.kr/>.

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³⁴ Ibid.

³⁵ Ibid.

³⁶ Central Disease Control Headquarters, “코로나바이러스감염증-19 국내 발생 현황 (4 월 30 일 정례브리핑) (Coronavirus Infectious Diseases-19 - Domestic Occurrence (April 30 Regular Briefing)),” 30 April 2020, last accessed 6 May 2020, http://ncov.mohw.go.kr/tcmBoardView.do?brdId=&brdGubun=&dataGubun=&ncvContSeq=354313&contSeq=354313&board_id=140&gubun=BDJ.

Enforcing quarantine with digital technologies in Taiwan - Siyi (Eric) Zhang

Introduction

Taiwan has been relatively successful in its fight against COVID-19. At the time of writing (6 May 2020), there have been 439 infected cases and six deaths in Taiwan, which has a population of roughly 24 million.¹ While governments around the world are using, or considering using, health and contact-monitoring smartphone applications to counter the Coronavirus crisis, the Taiwanese government has not yet done so. To date, it has mainly employed a digital technology called the 'digital fence'. This monitors the locations of people who have come from outside of Taiwan and thus are required to undergo quarantine. The technology uses location data collected from cellular signals. The Taiwanese Digital Minister, Audrey Tang, has stated that using a contact-monitoring app only makes sense when there are community transmissions domestically within a country.² Up until now, there have been no signs of sustained domestic transmissions in Taiwan. This means that the most important goal for the authorities at the time of writing is to quarantine people who have come from outside of Taiwan. This task is being carried out with the help of the aforementioned 'digital fence'.

The introduction of digital tools to enforce quarantine raises important questions regarding privacy and fundamental rights. To address these concerns, the 'digital fence' has been given certain features. First, it uses cellular signals instead of GPS signals which would provide more accurate location data. According to the Taiwanese government, this use of cellular signals is a smaller infringement on the privacy of those under quarantine.³ Second, the 'digital fence' uses location data exclusively for the purpose of the quarantine. After the 14-day quarantine period is completed, people who are no longer under quarantine will not be monitored anymore. However, the location data will be stored until the end of the on-going crisis. Third, the location data recorded by the 'digital fence' is not actually shared with the government. It is the five major telecommunication companies in Taiwan that perform the monitoring and they only report to the local government authorities in cases where there are indications of non-compliance.

Several problems have been reported with the 'digital fence' system. The system has produced false alarms and serious annoyance for some people under quarantine as a result of various technical issues such as phones running out of battery, bad network connections, or users' failures to answer phone calls. Another issue, which was pointed out by the MP Wu I-ding in her parliamentary inquiry, has been that the government's *Home Quarantine Notice* fails to properly inform those who undergo quarantine that they will be monitored.⁴

Other noteworthy Artificial Intelligence (AI) technologies have also been used to reinforce Taiwan’s COVID-19 strategy. AI technologies have been used to distribute resources in high demand and a pre-purchase system has been employed in order to coordinate the sale of face masks and prevent shortages and panic buying. Alongside these things, as a contingency plan a contact-tracing smartphone application has also been developed for possible future scenarios.

To contain or to delay and mitigate?

The choices made when responding to epidemics are a balance between the threat of the disease and the cost of the control measures, both in human and economic terms. The WHO handbook *Managing Epidemics, Key Facts about Major Deadly Diseases*, describes the epidemic phases and the corresponding response interventions that policy makers are advised to take.⁵ The disease is first introduced into a community (phase 1). Then there is localised transmission (phase 2) where the pathogen is transmitted from human to human within the community. When the infectious disease threat reaches an epidemic or pandemic level, the disease enters the amplification stage (phase 3).⁶ It should be pointed out that the difference between phase 2 – localised transmission – and phase 3 – amplification – is that human to human transmission in a community is sporadic in phase 2, whereas it is sustained in phase 3 (see Figure 1).⁷

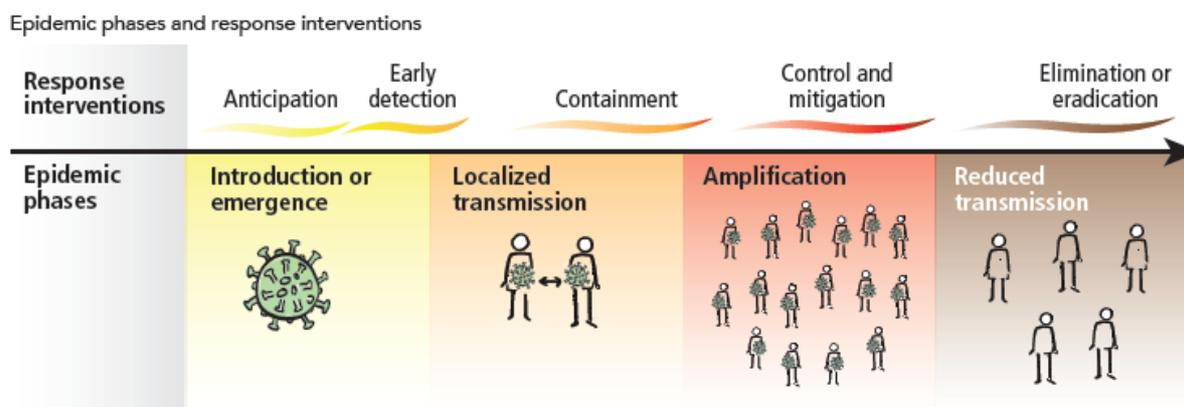


Figure 1: Epidemic phases and response interventions

As illustrated in Figure 1 above, whether policy-makers should choose to respond with containment or delay and mitigation depends on whether the epidemic is in the localised transmission phase or the amplification phase. In other words, it depends on whether there is sustained human to human transmission in the community. Containment aims to minimise imported cases, and to control the local transmission of the disease. The methods of doing this include such things as quarantine, restriction of movement, and contact-tracing. In case containment fails, control and mitigation aims to “flatten the curve”. This is usually attempted by social distancing measures

such as the suspension of all non-essential commercial and social activities. This is done so as not to overburden the health care system.⁸

In Taiwan, there has been no evidence of sustained localised transmission to date.⁹ Taiwan was not the region where the virus broke out. Therefore most of the measures that have been taken so far have fallen within the scope of containment. Theoretically, by effectively imposing quarantine measures on those who have come from outside of Taiwan, with the help of the 'digital fence', the Taiwanese government can prevent the domestic spread of the virus and minimise the local impact of imported cases.

How does the 'digital fence' work?

In Taiwan, a 'digital fence' (電子圍籬) has been used since 29 January 2020 to enforce measures requiring home isolation (居家隔離) and home quarantine (居家檢疫). These measures were introduced one day after the first two cases of coronavirus were confirmed in Taiwan. Both measures require people to stay at their quarantine address, but home isolation applies to those who have had contact with a confirmed infected case, whereas home quarantine applies to those who have recently travelled outside Taiwan.¹⁰

The 'digital fence' is not a smartphone app but a surveillance system that monitors the location of the people who undergo home quarantine or home isolation from cellular signals from their phones. In the process, the five major telecommunication companies in Taiwan are responsible for collecting the location data and monitoring people undergoing home quarantine or isolation. In cases of quarantine non-compliance, the companies are responsible for reporting this to certain local government authorities that are responsible for the enforcement of isolation or quarantine. If cellular signals indicate that the isolated or quarantined person is not at their quarantine location, or if cellular signals are lost, the local authority will be informed and frontline quarantine enforcement will be sent to check if the quarantined or isolated person is at their quarantine location.¹¹

The implications on privacy and fundamental rights

According to the digital minister of Taiwan, the 'digital fence' is merely a means to an end and it plays a complementary role in enforcing the quarantine measures so that government personnel are not overburdened.¹² Yet, the introduction of digital means to enforce quarantine can raise questions regarding privacy and fundamental rights. Initially, the Taiwanese government distributed phones to the people who were quarantined and planned to recycle these phones after the quarantine period. However, this supply of phones soon ran out and the government had to include the personal phone numbers of quarantined people in the 'digital fence' system. The Taiwanese government cited the *Constitutional Ruling No. 690*, made during 2003 SARS epidemic, as the constitutional basis for the quarantine measure. In 2003, Taiwan's Constitutional Court had ruled that people were obliged to comply with quarantine measures

in times of epidemics. However, it had also required the Legislative Yuan (the Parliament) to find a less intrusive way than a physical barrier.¹³

The Taiwanese government has also taken several measures to address concerns over privacy and fundamental rights. First, location data that is collected for the 'digital fence' system is based on cellular signals instead of GPS signals. According to the Taiwanese Minister of Justice, Tsai Ching-hsiang, the 'digital fence' system monitors quarantine using cellular signals in a way that is based on the "least harm principle". Compared with a system that collects data from GPS signals, the use of location data acquired from cellular signals is less precise, but also infringes less on the privacy of those under quarantine. The GPS system can locate a person to within a few meters, whereas cellular signals can locate a person to within about 50 meters in urban areas and are even less accurate in rural areas.¹⁴

In addition to this, the locational data collected by the 'digital fence' is used and stored only for the specific purpose of quarantine. The data is shared and made public to the smallest extent possible. The telecommunication companies responsible for monitoring (and therefore collecting and storing the locational data) only indicate possible non-compliance to the frontline quarantine enforcement, so that these authorities are able to confirm if there is an actual breach of quarantine by visiting the quarantine address. They do this without sharing or transferring the location data.

Potential issues and irritations

In general, it appears the Taiwanese public has been satisfied with the measures that the government has taken to tackle the coronavirus. According to the Taiwanese Digital Minister, about 90 percent of the population support the Centers for Disease Control (CDC)'s approach.¹⁵

There have, however, been some reported problems with the 'digital fence' system. First, technical issues and negligence have been reported to cause false alarms. The telephones in the system needs to remain turned on in order for telecommunication companies to receive location data. The people who are quarantined will receive one or two check-up phone calls from the local authorities. Unintended negligence, such as allowing the phone to run out of battery, failing to pick up, or even running out of phone credit, can cause a false alarm and police officers to show up at the doors of those who are quarantined. Second, the monitoring of the locations of the people who are quarantined based on their cellular signals has been reported to sometimes experience technical issues resulting from its low level of accuracy and the fact that location is calculated based on the signals' distances to different cellular base stations. It has been reported that there have been problems with bad reception and falsely reported locations. These things can happen especially if the person is quarantined at an address in a rural area or which is in between base stations.

It should also be noted that the Taiwanese disease control authorities appear to have failed to sufficiently inform quarantined people that they will be monitored before their quarantine starts. When people enter Taiwan, they receive the *COVID-19*

Health Declaration and Home Quarantine Notice. This notice only mentions that the person being quarantined should “comply with the measures including the digital monitoring of personal radius of activity”.¹⁶ However, it does not explain what digital monitoring entails.

The application of digital technologies in the distribution of face masks

Although there has been no global consensus on the necessity of wearing face masks during the COVID-19 pandemic, the Taiwanese government has considered it an important part of its COVID-19 strategy to recommend that people wear facemasks. The authorities have used a pre-purchase system to coordinate the sale of masks and prevent shortages and panic buying. For governments elsewhere in the world, Taiwan’s application of digital technology for managing face mask distribution might offer a good example of how AI technologies can help a government in distributing important resources necessary for fighting COVID-19.

Residents of Taiwan, with their social security numbers, can pre-purchase masks in advance either (1) at the eMask website, (2) through the government health care smartphone application, or (3) at the physical locations of convenience stores and supermarkets. The buyer of the masks then receives a notification telling them to collect their pre-purchased face masks.¹⁷

Taiwan’s contact-tracing apps

As a contingency plan, the Taiwanese government, in cooperation with the Taiwan AI Lab, has developed a contact-tracing smartphone application for possible future scenarios.¹⁸ It notifies users about how crowded locations are in order to help the population keep social distance. It also warns users when they may have been in close contact with an infected person. Use of this application would be voluntary. The personal data of users would be anonymised and only be stored locally on the user’s smartphone. Consent would also need to be obtained from people who had been infected with COVID-19 before they can be registered as infected in the system of the smartphone application.

In order to better inform people about how to keep social distance during the Labour Day holidays which occurred at the end of April, the official smartphone application of the Ministry of Transportation and Communications – Highway 1968 [高速公路 1968] – was updated with an extension indicating how crowded public venues were. This information was based on cellular big data that had been collected between 1 November 2019 and 22 January 2020 and which was provided by Chunghwa Telecom.¹⁹

Conclusion

The Taiwanese government’s successful containment of the coronavirus has been widely praised around the world, and one of the main measures it has employed – the ‘digital fence’ – has also received global attention. The surveillance system monitors

the location of quarantined people and plays a complementary role in the government's effort to ensure that people comply with quarantine measures. Still some technical issues need to be improved, such as the inaccuracy of location data generated by cellular signals and the irritation that is caused to those who are quarantined by false alarms.

Taiwan's success proves that the 'digital fence' is an effective measure to enforce quarantine and isolation, which is crucial for preventing further spread of the virus. Therefore, governments in other parts of the world can learn much from Taiwan's measures as they develop better epidemic response measures for the future. For the current fight against COVID-19, effective isolation and quarantine are the only ways to mitigate the spread of the virus before a vaccine is found. Compliance is crucial for any policy. Effective monitoring measures are also key to ensure full compliance from those people who are quarantined.

Of course, as the Digital Minister of Taiwan has admitted, the 'digital fence' does raise questions about privacy.²⁰ After all, this system requires that people who are quarantined share their location data. Yet, the issue of privacy is not only a legal one, but also a political one. In extraordinary circumstances, such as the COVID-19 pandemic, the political choice between an effective response and the protection of privacy is one that should be carefully considered.

It is also important to consider to what extent Taiwan's success can be replicated. At least a part of the success of the 'digital fence' in Taiwan can be attributed to Taiwan's "natural borders". The fact that Taiwan's jurisdiction consists of islands means it is feasible to enforce quarantines at border entry points. In addition, for most of the countries and regions where there are already sustained local transmissions applying the 'digital fence' would not be sufficient. Other AI technologies, such as contact-tracing applications, can be used to detect the risk of and mitigate transmission among the population.

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⁴ Liu Shiyi, "居家檢疫手機遭追蹤 蔡清祥：侵害小符合比例" (Cellphone Being Tracked during Home Quarantine, Cai Qingxiang: It Complies with the Proportionality Rule), CNA, 9 April 2020, last accessed 13 May 2020, <https://www.cna.com.tw/news/aip/202004090152.aspx>

⁵ World Health Organisation, Handbook: Managing epidemics, key facts about major deadly diseases, 2018, p. 29, last accessed 13 May 2020,

<https://www.who.int/emergencies/diseases/managing-epidemics-interactive.pdf>.

⁶ *Handbook: Managing epidemics, key facts about major deadly diseases*, p. 29.

⁷ *Ibid.*, p.29.

⁸ *Ibid.*, p.30.

⁹ "COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University,".

¹⁰ Taiwan Centres for Disease Control, “具感染風險民衆追蹤管理機制” (The Tracking and Management System of Citizens with Risks of Infection), 7 April 2020, last accessed 13 May 2020, Retrieved from: <https://www.cdc.gov.tw/File/Get/BEA0oQpYDsnWonHk8UFmWg>

¹¹ Ibid.

¹² “Erken dat je de privacy een beetje moet schenden”.

¹³ Constitutional Court of ROC, Consitutional ruling No. 690, 30 September 2011, Last Accessed 13 May 2020, <http://cons.judicial.gov.tw/jcc/zh-tw/jep03/show?expno=690>

¹⁴ Guo Jiahong, “【10 多個國家想跟台灣學】電子圍籬採用基地台定位，能掌握檢疫者位置並保障隱私” ([More than ten countries want to learn from Taiwan] The Digital Fence uses Cellular Base Station for Tracking, It Can Locate the Quarantined and Safeguard Privacy), 10 April 2020, last accessed 13 May 2020, <https://buzzorange.com/techorange/2020/04/10/taiwanese-virtual-fence/>

¹⁵ “Erken dat je de privacy een beetje moet schenden”.

¹⁶ Taiwan Centres for Disease Control, COVID-19 Health Declaration and Home Quarantine Notice, 18 April 2020, Last Accessed 13 May 2020, https://www.cdc.gov.tw/File/Get/7rNiRyH4RF_45nyVKVy80g

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¹⁹ Ministry of Transport and Communication R.O.C, “交通部懶人包 – 高速公路 1968 人潮示警功能” (Ministry of Transport and Communication Lazy Pack – Highway 1968 Crowdedness Warning Function), 28 April, 2020, last accessed 13 May 2020, <https://www.ey.gov.tw/File/19A8F638E840DFDA?A=C>.

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COVID-19 Apps in Asia: Risks, Opportunities, and Lessons - Dr. Florian Schneider

The studies in this report illustrate how political and societal stakeholders in five different Asian contexts have used digital technology to augment their efforts to tackle COVID-19. These efforts include the use of apps for different purposes, including for diagnosis, tracking, quarantine management, and access to health-care goods and services. Some of these tech solutions are targeted at professionals, others are targeted at private citizens, and their usage ranges from voluntary to mandatory. This conclusion will highlight the most important findings that our team, headed by Dr. Rogier Creemers and myself, has identified across these different studies. It will identify the crucial lessons that the cases from Asia can teach policymakers, administrators, tech designers, and the general public elsewhere in the world.

COVID-19 in East Asia

The reception and impact of various apps has been as diverse as the contexts that spawned them. It is important to recall that the cases have run the gamut from democratic to authoritarian societies, and that each of these societies features distinct social, economic, and political configurations. What is more, the East Asian contexts that this report examined each feature their own geographic realities, and these in turn affect policy outcomes. South Korea's peninsula only has one land border with neighbouring North Korea, and that border is largely impermeable. Singapore has a busy land border with Malaysia, but there are only two points of entry by land and one by sea. Japan and Taiwan are islands, so entry takes place at ports and airports where incoming traffic can be more readily monitored. In addition, visits to Taiwan from mainland China had severely decreased in the run-up to the outbreak, after the People's Republic of China (PRC) restricted tourism to the island for political reasons ahead of the ROC's presidential election on 11 January 2020.¹ All of this has created conditions that may not always compare to the situation in other places, for instance in Europe, with its open borders that are easy to cross nearly anywhere.

The specific configurations of East Asian societies produce numerous idiosyncrasies, and the outcomes of COVID-19 responses have varied accordingly. Japan, for instance, faces challenges that are intimately tied to its fragmented regional institutions and its lack of a coherent national-level response, as van der Veere has shown in his analysis. This has led to a haphazard and overall risky approach that has been criticised for erratic policy signals, a lack of testing, and an overtaxed medical system.² South Korea, on the other hand, has wed its tech usage to an aggressive containment approach, which van der Veere and Ha have examined in their contribution to this report. At the time of writing, and notwithstanding a very recent new outbreak, the overall results of the South Korean response had been widely praised.³ Meanwhile, the PRC has rolled out stringent movement and quarantine controls.⁴ As Burgers and Sicinski have shown in their study, the lockdown measures have been accompanied

by severe digital tracking efforts, even as implementation via apps remained highly inconsistent and fragmented across this large country. In contrast to this, the small states of Singapore and the Republic of China (ROC) on Taiwan have relied more heavily on voluntary participation, as Lammertink and Zhang have shown, respectively. While this approach seems to have served Taiwan well,⁵ it has had more mixed results in Singapore,⁶ where citizens are not necessarily comfortable sharing sensitive information with the authorities.

Commonalities across East Asia

As diverse as these outcomes are, a few commonalities are nevertheless worth highlighting, particularly as they contrast with practices in Europe.

First, Asian societies have been at the forefront of technological innovation for decades.⁷ Smartphone and wireless penetration are high, and digital technologies are embedded in daily life to a degree not comparable with Europe, especially in urban contexts. Such strong reliance on digital technology has arguably accustomed many to the idea that apps might provide fruitful solutions to social and political problems, and efforts to roll out new apps in the wake of the current health crisis have consequently fallen on mostly fertile ground. This is not to say that users in Asia are uncritical when it comes to digital technology. Far from it: journalists, civil society actors, and political organisations in Asia often warn of the risks that data-driven solutions can entail.⁸ However, the ubiquity of digital technologies in everyday life may well mean that many citizens are willing to make trade-offs, for instance between privacy and efficiency, and these choices can differ markedly from similar preferences in European or American contexts.

Second, and maybe more importantly, the societies we have studied here all have long-standing experiences with pandemics. The 2002 SARS outbreak was traumatic, leading to systematic disease control approaches across the region and desensitizing citizens to certain precautions and preventative measures.⁹ Subsequent pandemics, such as the H5N1 bird flu pandemic of 2005 and the H1N1 outbreak in 2009, have further reinforced awareness of the risks that pathogens pose in an interconnected world.¹⁰ General preparedness has consequently remained high, especially in densely populated places. This has created a very different context for the COVID-19 pandemic than the one found in other regions, such as Europe or America. It has led to diverse and at times unique policies. However, all differences aside, responses in Asia have generally emphasised several common themes. These include:

- strong border controls,
- strict social distancing measures,
- aggressive testing and re-testing
- pro-active contact tracing.

The responses have also relied on predominantly high-quality healthcare systems and widespread habits among citizens of using disinfectants and wearing masks.¹¹ Digital measures sit “on top” of these policies; they augment and facilitate already existing

social practices and policy efforts “on the ground”. Their efficacies and shortcomings consequently need to be understood against this backdrop.

Technology in context

What lessons should we then draw from the East Asian experience of tackling COVID-19 and the use of technology in Japan, the PRC, Singapore, South Korea, and the ROC on Taiwan? As our analyses have shown, digital technologies are characterised by certain design choices that shape their use and their usefulness. This is in line with scholarship in science and technology studies, which has long followed the dictum of Melvin Kranzberg that “technology is neither good nor bad; nor is it neutral”.¹² Technologies are highly contingent on the contexts in which they are designed and deployed. This is also true for COVID-19 tech, which is embedded in society and interacts with pre-existing social and political setups.

This is emphatically not to say that the societies we have studied should be seen as somehow fundamentally different “cultures” that do not compare to “the West”. Such cultural essentialism is unhelpful for understanding the myriad of human responses to crises around the world, and it may even get in the way of learning from approaches that, at first glance, may appear uniquely “Chinese” or “Korean” rather than “Western”.¹³ As it were, the responses we have studied here are indeed informed by concerns and rationales that in many ways mirror those that can be found in contexts outside of Asia. There might then be good reasons to transfer technologies that have been successful in East Asian societies to other countries. Tools modelled on Taiwan’s ‘digital fence’ or South Korea’s ‘self-quarantine safety’ could be helpful in quarantine procedures, and apps like Singapore’s ‘TraceTogether’ promise open-source methods for voluntary contact tracing. However, the risks and benefits of such measures heavily depend on socio-political factors in the target societies, including the ability and willingness of political actors to formulate functioning health and safety responses on which these technologies can then rest. Digital tools are no panacea. The use of such apps then also hinges on compliance, which means that the beliefs and habits of those who need to use such technology are bound to shape how effective such tech turns out to be. In short, it is crucial to remember that technology is deeply social.

A second issue to keep in mind is that technology is designed by someone, for someone, and for specific purposes. In some cases, designers may have outright sinister intentions, for instance using their designs to increase power, accumulate or protect wealth, or control vulnerable populations. Langdon Winner famously claimed that this had been the case for the American urban planner Robert Moses, who allegedly built the bridges across the parkways leading to Long Island in such a way that they would not allow people of colour to reach the rich neighbourhoods: the bridges were ostensibly too low to let public busses pass.¹⁴ However, technology does not have to be designed with malicious intent to unfold socially problematic effects. Digital technologies, which are far more complex than technologies such as bridges or

roads, are particularly prone to biases that can remain nearly invisible. Facial recognition and mobile phone tracking mechanics, for instance, have frequently reproduced wider social prejudices.¹⁵ An example of this has become tragically visible in South Korea: during the second weekend of May, the country was facing a renewed outbreak that started in gay nightclubs in South Korea's capital. Contact-tracing strategies interacted with long-standing societal prejudices in ways that maligned and stigmatized queer people.¹⁶ It is important to remember that digital technologies reflect the experiences and assumptions of those who design, commission, and use them, and if these actors are blind to the needs of non-mainstream groups, then this can lead to biases and reinforce prejudices. Technology is always political.

Thirdly, digital technologies require data to function, and it is worth keeping in mind a saying popular among computer scientists: garbage in, garbage out. If the input is flawed, for example because the data does not come from a representative sample, contains errors, or is imprecise, incomplete, or unreliable, then the outputs will be faulty. This can lead to false conclusions and may lead policymakers to target the wrong issues. It can also lure users into a false sense of security, for instance if a contact-tracing app generates so-called type I errors (false positives) that mistakenly green-light certain places as safe for social interactions. The reverse can also be true, as the study of Chinese 'health code' apps in this report illustrated: many users in China have suffered the consequences of type II errors (false negatives), leading to discrimination and administrative fiat. Such detrimental outcomes are particularly egregious if they affect already vulnerable groups, for instance the elderly, the infirm, or minorities. Singapore's policy response to COVID-19, which had been lauded early on for its efficiency and its high-tech characteristics, later threatened to become derailed by a serious 'cognitive blindspot': the crisis response had failed to properly account for the crowded living conditions of disenfranchised migrant workers.¹⁷ In short, any solution to a problem is only as good as the data from which it draws.

A fourth point worth making is that selecting and implementing a technology is a choice. Such choices come with opportunity costs. They require trade-offs, much like any decision, and this can become difficult to see amidst a crisis when "something must be done". A prominent trade-off when it comes to apps is between their efficiency and the freedom of their users. Societal and political actors who wish to enhance their governance through apps will have to make choices on how to balance such target conflicts. As our report has illustrated, some policymakers make the choice to ignore concerns over personal freedoms and rights, such as privacy, as is the case in much of the PRC response. Other cases place a strong premium on privacy, for instance in Taiwan or Japan, and yet others find an uneasy balance between these two goals, as has been the case in South Korea and Singapore. There is no single best-practice solution to such a dilemma, short of revamping the socio-economic conditions that created the dilemma in the first place - an attractive option in the long run, but one that is bound to be too complex and time-consuming to implement in times of urgency. All in all, implementing tech means making choices. To arrive at a fair and convincing use of technology in crisis situations, it is crucial to make target conflicts

explicit. This way, the rationales that drive such choices can become the subject of fair and transparent discussion rather than remaining invisible background assumptions.

Finally, technology is itself an institution.¹⁸ It is embroiled in power, which increases its inertia and can make it a seemingly natural and permanent feature of our societies. Technology is not easily phased out once it has been implemented. Technology and policy hang together, and they further connect with economic interests and human habits in ways that can keep flawed or outdated technical solutions in place long after their shelf life has effectively expired. A classic example is the standard QWERTY layout that computer keyboards use. This layout was introduced in 1873 to slow down the users of mechanical typewriters to avoid jamming of the keys, and it has remained the default ever since, even though it serves no practical function today.¹⁹ Safety and security measures are ripe with such idiosyncrasies. Airline security illustrates this perfectly, both in terms of low-tech and high-tech solutions. As critics have pointed out, the use of 100-ml bottles and special plastic bags to seal fluids, or the use of expensive and intrusive full-body scanners, are all flawed technologies for countering terror attacks, and yet these measures have stayed in place for two decades after their controversial and rushed introduction in the wake of a major political crisis: the September 11 terror attacks of 2001.²⁰

There is then a real risk that COVID-19 tech, whether effective or not, could similarly become entrenched. Certain surveillance technologies might suffer “mission creep” as policymakers or administrators start seeing potential for deploying them in contexts for which they were not originally designed and approved. Private enterprises may lobby for the continuous use of their proprietary technology as they try to make a profit. Users may become so accustomed to certain interventions that they no longer question their efficacy. It can then be difficult to phase out such technologies once they have fulfilled their purpose. Our studies already found indications in the case of South Korea that intrusive monitoring practices could remain in place, legitimated by the promise that such measures would help tackle future health crises.

To conclude, technology is never just a value-free tool. It is highly social, eminently political, reliant on good data, dependant on tough choices, and at risk of becoming “sticky”. Societies will need to remain vigilant about what happens in the long run to the technologies they release during crisis moments, and they will need to continuously assess and reassess the balances they strike during moments of heightened risk. As this report has illustrated, societies in East Asia have much experience with such choices and their consequences, and policymakers elsewhere in the world ignore the successes and failures of these societies at their own peril.

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² Craig Mark, “Analysis: How Shinzo Abe Has Fumbled Japan’s Coronavirus Response,” *The Conversation*, 27 April 2020, last accessed 12 May 2020, <https://www.abc.net.au/news/2020-04-27/how-japan-pm-shinzo-abe-fumbled-coronavirus-response/12189076>. Rupert Wingfield-Hayes, “Coronavirus: Japan’s Low Testing Rate Raises Questions,” *BBC News*, 30 April 2020, last accessed 12 May 2020, <https://www.bbc.com/news/world-asia-52466834>.

³ Soo Rin Kim, Tiffany Kung, and Mark Abdelmalek, “Trust, Testing and Tracing: How South Korea Succeeded Where the US Stumbled in Coronavirus Response,” *ABC News*, 1 May 2020, last accessed 12 May 2020, <https://abcnews.go.com/Health/trust-testing-tracing-south-korea-succeeded-us-stumbled/story?id=70433504>. Eun A Jo, “A Democratic Response to Coronavirus: Lessons From South Korea,” *The Diplomat*, 30 March 2020, last accessed 12 May 2020, <https://thediplomat.com/2020/03/a-democratic-response-to-coronavirus-lessons-from-south-korea/>.

⁴ Emma Graham-Harrison and Lily Kuo, “China’s Coronavirus Lockdown Strategy: Brutal but Effective,” *The Guardian*, 19 March 2020, last accessed 12 May 2020, <https://www.theguardian.com/world/2020/mar/19/china-coronavirus-lockdown-strategy-brutal-but-effective>. Peter Hessler, “Life on Lockdown in China,” *The New Yorker*, 23 March 2020, last accessed 12 May 2020, <https://www.newyorker.com/magazine/2020/03/30/life-on-lockdown-in-china>.

⁵ Hsien-Ming Lin, “Lessons from Taiwan’s Coronavirus Response,” *East Asia Forum*, 2 April 2020, last accessed 12 May 2020, <https://www.easiaforum.org/2020/04/02/lessons-from-taiwans-coronavirus-response/>. C. Jason Wang, Chun Y. Ng, and Robert H. Brook, “Response to COVID-19 in Taiwan: Big Data Analytics, New Technology, and Proactive Testing,” *JAMA* (3 March 2020), 231(14), 1341-1342, last accessed 12 May 2020, <https://jamanetwork.com/journals/jama/fullarticle/2762689>.

⁶ Simon Tay and Kevin Chen, “Singapore and COVID-19: Strengths, Shifts, and Limits of National Response,” *Council on Foreign Relations*, 21 April 2020, last accessed 12 May 2020, <https://www.cfr.org/blog/singapore-and-covid-19-strengths-shifts-and-limits-national-response>. James Griffiths, “Singapore Had a Model coronavirus response, then cases spiked. What happened?” *CNN*, 19 April 2020, last accessed 12 May 2020, <https://edition.cnn.com/2020/04/18/asia/singapore-coronavirus-response-intl-hnk/index.html>.

⁷ For recent academic studies, see the contributions in Adrian Athique and Emma Baulch (eds), *Digital Transactions in Asia: Economic, Informational, and Social Exchanges*, New York: Routledge, 2019. Earlier assessments are available in Ho Kong Chong, Randolph Kluver, and Kenneth C.C. Yang (eds), *Asia.com: Asia Encounters the Internet*, London et al.: RoutledgeCurzon, 2003. The World Bank provides detailed reports and data on digital developments at <https://www.worldbank.org/en/topic/digitaldevelopment> (last accessed 12 May 2020).

⁸ The data security of digital tools such as Zoom has been hotly debated in Asian societies, e.g. in the South China Morning Post (see Sarah Dai, “Zoom’s Security Backlash Points to Bigger Threats in Coronavirus-led Telecommuting Wave, Experts Say,” *SCMP*, 7 April 2020, last accessed 12 May 2020, <https://www.scmp.com/tech/enterprises/article/3078566/zooms-security-backlash-points-bigger-threats-coronavirus-led>). Privacy is frequently a concern, for instance in Japan and Taiwan; see Mainichi Shimbun, “Concerns over Privacy as Japan Gov’t Asks Tech Firms for User Data to Combat Coronavirus,” 1 April 2020, last accessed 12 May 2020, <https://mainichi.jp/english/articles/20200401/p2a/00m/0na/019000c> and Roy Ngerng, “Taiwan’s Digital Response to Covid-19: Impressive, But Is Privacy Respected?” *The News Lens*, 27 March 2020, last accessed 12 May 2020, <https://international.thenewslens.com/article/133095>.

⁹ For details on the SARS crisis, see Mely Caballero-Anthony, “SARS in Asia: Crisis, Vulnerabilities, and Regional Responses,” *Asia Survey* (2005), 43(3), 475-495, as well as the contributions in Xiaosui Xiao and John H. Powers (eds), *The Social Construction of SARS: Studies of a Health Communication Crisis*, Amsterdam: John Benjamins, 2008, and, specifically on China, in John Wong and Yong-Nian Zheng (eds), *The SARS Epidemic: Challenges to China’s Crisis Management*, Singapore: World Scientific, 2004.

¹⁰ On the 2005 outbreak, see the contributions in Paul Tambyah and Ping-Chung Leung (eds), *Bird Flu: A Rising Pandemic in Asia and Beyond?* Singapore: World Scientific, 2006. On H1N1, see Dale Fisher, David S. Hui, Zhancheng Gao et al., “Pandemic Response Lessons from Influenza H1N1 2009 in Asia,” *Respirology* (2011), 16(6), 876-882.

¹¹ For a study of mask-wearing in China, see Maria Shun Ying Sin, “Masking Fears: SARS and the Politics of Public Health in China,” *Critical Public Health* (2016), 26(1), 88-98, last accessed 12 May 2020, <https://www.tandfonline.com/doi/full/10.1080/09581596.2014.923815>. On Japan, see Adam Burgees and Mitsutoshi Horii, “Risk, Ritual and Health Responsibilisation: Japan’s ‘Safety Blanket’ of Surgical Face Mask-Wearing,” *Sociology of Health & Illness* (2012), 34(8), 1184-1198, last accessed 12 May 2020, <https://onlinelibrary.wiley.com/doi/full/10.1111/j.1467-9566.2012.01466.x>. For general discussion of the masks and their benefits during epidemic outbreaks, see Jessica McDonald, “COVID-19 Face Mask Advice, Explained,” *FactCheck.org*, 6 April 2020, last accessed 12 May 2020, <https://www.factcheck.org/2020/04/covid-19-face-mask-advice-explained/>.

¹² Melvin Kranzberg, “Technology and History: ‘Kranzberg’s Laws’,” *Bulletin of Science, Technology & Society* (1995), 15(1), 5-13.

¹³ For critiques of cultural essentialisms, see the various contributions in Terence Wesley-Smith and Jon Goss (eds), *Remaking Area Studies: Teaching and Learning Across Asia and the Pacific*, Honolulu: University of Hawaii Press, particularly the chapters by Neil Smith and Martin W. Lewis, respectively.

¹⁴ Langdon Winner, "Do Artifacts Have Politics?" *Daedalus* (1980), 109(1), 121-136. For a discussion of the controversies that have trailed Winner's arguments, see Steve Woolgar and Geoff Cooper, "Do Artefacts Have Ambivalence? Moses Bridges, Winner's Bridges and other Urban Legends in S&TS," *Social Studies of Science* (1999), 29(3), 433-449.

¹⁵ On biases in facial recognition software, see Patrick Grother, Mei Ngan, and Kayee Hanaoka, "Face Recognition Vendor Test (FRVT) Part 3: Demographic Effects," US National Institute of Standards and Technology, 2019, last accessed 12 May 2020, <https://nvlpubs.nist.gov/nistpubs/ir/2019/NIST.IR.8280.pdf>. For a discussion of digital biases in traffic and infrastructure monitoring, see Peter Wilkins, "Keeping Traffic and Transit Passengers Moving – The Use of Big Data," in Jonathan D. Breul and Gustaf Jakob Petersson (eds), *Cyber Society, Big Data, and Evaluation*, New York: Routledge, 2017, 129-146.

¹⁶ Nemo Kim, "South Korea Struggles to Contain New Outbreak amid Anti-Gay Backlash," *The Guardian*, 11 May 2020, last accessed 12 May 2020, <https://www.theguardian.com/world/2020/may/11/south-korea-struggles-to-contain-new-outbreak-amid-anti-lgbt-backlash>.

¹⁷ Hillary Leung, "Why Singapore, Once a Model for Coronavirus Response, Lost Control of Its Outbreak," *TIME*, 20 April 2020, last accessed 12 May 2020, <https://time.com/5824039/singapore-outbreak-migrant-workers/>.

¹⁸ Daniel R. McCarthy, *Power, Information Technology, and International Relations Theory: The Power and Politics of US Foreign Policy and Internet*, New York: Palgrave Macmillan, 2015.

¹⁹ See Everett M. Rogers, *Diffusion of Innovations*, New York et al.: Free Press (5th ed). Rogers discusses the keyboard example on pp.8-9, but his history of innovation contains many similar examples throughout modern times.

²⁰ Bruce Schneier, "Harms of Post-9/11 Airline Security," *Schneier on Security*, 29 March 2012, last accessed 12 May 2020, https://www.schneier.com/blog/archives/2012/03/harms_of_post-9.html. Schneier, a security expert, has also discussed digital security issues at length in Bruce Schneider, *Data and Goliath: The Hidden Battles to Collect Your Data and Control Your World*, New York & London: W.W. Norton (2015).