How Asia Confronts COVID-19 through Technology

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Introduction

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 like SARS in 2002 or 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. This preliminary report makes the most important results available to policymakers in a short, accessible format.*

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 heavily depend 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, policies that target the wrong issues, or 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 on 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 behaviours, 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.

* The work presented here is based on a first round of desk-research, and it omits detailed references in the interest of brevity. More detailed and fully-sourced studies will follow: in early May, the LAC will publish the full regional surveys on its website; at a later stage, it will publish an in-depth report that will incorporate detailed policy analyses. All of these outputs are written in English, reflecting the international backgrounds of our contributors.

Japan

Failing to adjust to new developments in the pandemic, a lack of information and impediments in structures of governance have undermined Japanese efforts to contain the spread of the virus, despite the implementation of several risk management strategies. The government has employed public surveys for data collection, using an existing and widely used application, LINE, in order to get a grasp on the magnitude of the spread. However, the Japanese case also highlights how apps are only effective if they are part of a concerted general effort to counter the disease. The current failure to contain the virus will have significant effects on healthcare, public trust, and the national economy.

To understand the limitations of Japan's app usage to combat COVID-19, it is important to highlight several impacts that Japan's current trajectory in crisis management has had more generally:

- The decentralised nature of governance and constitutional limitations have delayed the national strategy for containment.
- A failure to respond adequately to this pandemic continues to exacerbate problems with an already collapsing health care infrastructure.
- The perceived failures of the current administration have heavily eroded public trust in the government's capability to handle future pandemics.
- The failure to adapt is lengthening the negative impact on the national economy.

The main objective of the first stage of the national COVID-19 response was to contain the spread via a cluster-based approach based on identifying patients and any persons with whom this patient has come into contact. However, as of 4 April, over 40 per cent of cases could no longer be traced. The opaque origin of a large number of new cases has led to a clear switch to risk mitigation strategies in Japan's national response.

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 from 7 April to 6 May. The declaration allows prefectural governors to close public facilities and request businesses where people gather to temporarily suspend operations. The government has also requested business operators to switch to teleworking unless they provide essential services and to restrict access to facilities where people gather to reduce personal contact. An initial lack of financial support for those affected has impeded grassroots cooperation, and constitutional restrictions form an impediment to limiting movement in the form of a lockdown. Moreover, there is no national control mechanism in place and the

government is forced to rely on prefectural governors. Accordingly, the response among different regions has been varied.

The government is focusing on creating awareness of the 'three C's': avoid 1) closed spaces, 2) crowded places, and 3) close-contact settings; and of the need for hand washing and avoiding face contact. In addition, the incumbent administration will provide two washable cotton masks to each household in a bid to reduce risk of spreading. In order to promote closures and to limit the economic impact, 100,000 yen (860 EUR) will be provided to each resident. However, due to initial delays in establishing policy for financial compensation, businesses have stayed open for extended periods despite the growing infection rates, and public support has been diminishing steadily in the face of a flailing government.

In order to gather information on the spread of the virus and the level of public cooperation, the Ministry of Health, Labour and Welfare (MHLW) has used LINE, a text-based social media application similar to WhatsApp, to send out nation-wide surveys. With an 87 per cent smartphone user rate and an 82.3 per cent total penetration rate in Japan, LINE is the most widely used online application in the country. 24.5 million Japanese residents responded to the initial survey, a total of 19.05 per cent of the population. Although using a private company to collect personal information requires flexibility in the processing of data, LINE's high user rate has the advantage of allowing the survey to reach a wide audience. The survey does not contain information about the use of the provided information other than that the data is collected for the MHLW. The results of the initial survey were published online, with the main conclusion that current efforts need to be strengthened and personal contact needs to decrease by at least 70-80 per cent.

Data on individual patients is collected through medical institutions and local governments. This data is sorted differently on the MHLW and individual prefectures' websites, with significant variation in the information that is made public. 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. 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. Identifiable personal information, such as precise location data and address, are excluded in all data sets. All official information is published in the form of total numbers or lists of new cases, available as links to pdf files on official websites. This is not user-friendly, and commercial enterprises, the media, and grassroots initiatives have had to fill the gap of providing accessible information to the public through open access media coverage and online maps of infection rates and high-risk areas.

While the high response rate of the national survey suggests high levels of cooperation with the government's risk mitigation strategies, cooperation has nevertheless moved forward piecemeal. Many companies still require employees to come to the office as remote working has failed to take hold at levels necessary for containment. In addition, the two-mask policy has been highly criticised as unscientific, ineffective, and unnecessarily expensive. There are increasing reports of refusals to test possible infections, a collapsing health care infrastructure, shortages of masks and protective gear, and inaccessible phone numbers for medical consults. Because of the state's failure to adequately respond to the pandemic, containing the spread will have to rely on the population's willingness to either endure longer shutdowns or endure high infection rates. Travel restrictions will have to stay in place, also affecting Japan's major tourism industries. In either case, public trust has eroded, economic consequences are severe, and the health care sector will remain critically burdened for an indefinite amount of time.

Mainland China

In February 2020, the Chinese government started working together with Chinese technological giants Alibaba and Tencent to develop apps that could be used in the fight against the COVID-19 epidemic. After introducing initial apps, collectively referred to as "health code" apps, in early February, many provincial governments followed suit and unveiled their own software. "Health code" applications work independently or as mini programs embedded into other popular apps (WeChat, Alipay).

New users are required to answer questions pertaining to their recent travel history, body temperature, contact with infected persons, as well as personal information such as name, ID number, and phone number. Some apps (Beijing) require an ID scans, while others (Shanghai) require photos.

The user is assigned a QR code of varying colours: green (safe), yellow (requires 7-day isolation), or red (requires 14-day isolation). Whenever an app user enters publicly-used establishments, they go through a checkpoint, first scanning their QR code to prove their identity and their status as "safe", then going through temperature screening. In case of fever, the QR code changes colour to either yellow or red. "Health code" apps use governmental data, location-based information, travel routes of infected people and other means to assess whether a person was in contact with the disease. The QR

code changes colour to yellow or red depending on those factors. However, provincial governments and companies involved in creating those apps are not transparent and do not disclose which data is used specifically to assess the risk, or how personal data are gathered, stored, or used.

There is no single unified system across China yet, although there are plans to unify scattered and incompatible programs used by different cities and provinces within one application. Lack of a homogenous system, and of inter-app QR code recognition, impedes travel and is one of the main points of criticism. Unreliability, lack of information, lack of case-to-case solutions, and possible data breaches are other issues. Nevertheless, overall, the introduction of "health code" apps was welcome by the citizens. The Chinese government responded to some domestic criticism, apparently in a fashion that convinced the public at large.

The New York Times reported that Hangzhou's "health code" app contained a tracking program, allowing the user's location to be sent to law enforcement agencies. The Chinese government has not responded to those allegations. Law enforcement authorities were also involved in developing said app.

Drawing on previous experience when China expanded its surveillance system due to major events (2008 Beijing Olympics, Expo 2010), "health code" apps are likely to further escalate citizen control.

Singapore

The Singaporean government started taking precautionary measures in response to COVID-19 relatively early, at the beginning of January. The first case in Singapore was confirmed on January 23rd. On March 20th, the government launched TraceTogether, one of the first apps developed to counter COVID-19. On that day, Singapore had only 385 confirmed cases and zero deaths. The government had not implemented a lockdown, although social distancing measures were in place. Around that time, the approach of the Singaporean government was internationally regarded as exemplary. At the end of March, about 1 million (1 in 6) Singaporeans had downloaded the app.

In April, however, the situation in the city-state has worsened, and the government implemented a lockdown on April 7th after all. April 20th saw a record 22% (1,426 persons) increase in confirmed cases to a total of 8,014. Of the newly confirmed cases, 1,369 are permit holders residing in dormitories, a group which is currently more extensively tested than before. All confirmed cases in Singapore are hospitalised, as has been the approach from the start; 23 patients are in intensive care. In total, 59,737 persons had been tested by April 14th.

TraceTogether works as follows. Individuals can choose to download the app, after which they submit their mo-

bile phone number. The app then attaches a randomly generated ID to this number. Via Bluetooth, the app detects the random IDs of other nearby users and records these. If a user tests positively for COVID-19, he or she can choose to share the app's logs with the Ministry of Health, who will encrypt the IDs of other users found in these logs. This opens up the phone numbers of the infectee's 'close contacts' (users who have been within 2 meters for at least 30 minutes), who will receive a message that they are at high risk of infection, so that they can take steps to prevent further spreading. The app supplements manual contact tracing efforts and is not the only technology relied upon to fight COVID-19, as Singaporeans also receive government updates via WatsApp, while quarantined citizens are being monitored via video calls and have to share their phone locations with officials.

The Singaporean government has stated that it is committed to safeguarding the privacy of TraceTogether's users, emphasising that using the app is voluntary. Furthermore, the data, which is stored securely on non-public servers, only include the user's phone number and random ID. No personal or location data are collected. The data will be deleted if a user chooses to revoke consent. The app solely stores the random IDs of other users, which only the Ministry of Health can decrypt. The personal identity of users will not be revealed on the phones of other users. Third parties are unable to track the identity of a user, since the random ID is refreshed at regular intervals. Finally, the collected data is solely used for tracing persons who might be exposed to COVID-19. If contact tracing ends, users will be prompted to disable the functionality of the app. If they do so, the connection data will be lost. Users could be requested to reinstall or enable permissions in case of a future outbreak.

On April 10, about one in five Singaporeans had downloaded TraceTogether, while authorities stated that 75% of the population should use the app for it to be effective. What could explain this low number is that only 41% of Singaporeans feel comfortable sharing a positive COVID-19 test result via this technology. Furthermore, the app has received negative reviews because of technical issues. Apart from problems deriving from a low adoption rate, a director of TraceTogether 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 in the process and increase accuracy.

Governments and developers from around the world, including from the Netherlands, have shown interest in TraceTogether, partly because the app allows for relatively little privacy intrusion compared to other tracing apps, although privacy concerns still remain. The app's code has been made open source by the Singaporean government.

South Korea

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

The main points and impacts discussed below are as follows:

- User-friendly and mandatory app usage, combined with enforced quarantine guidelines and quick information-gathering mechanisms have enabled a comprehensive approach to containing COVID-19.
- Flexibility in policymaking and the utilization of remote medicare has effectively decreased the burden on healthcare infrastructure.
- National lockdowns and large-scale restrictions of movement are unnecessary with successful containment strategies, limiting the negative economic impact of the pandemic.
- There are permanent impacts on the use of personal information and privacy, and the possibility of future pandemics ensure that information gathering mechanisms will remain in place.

Several apps in both the public and private sectors have been developed in South Korea with the purpose of containing the spread of COVID-19, in addition to national and local emergency systems that notify anyone in a certain radius of possible risks.

The government of South Korea has developed two apps available for public use, the "self-diagnosis app" and the "self-quarantine safety app". The "self-diagnosis app" can be downloaded on arrival into South Korea and is required for both foreigners and Korean nationals to pass through immigration. Users have to enter their "passport information, nationality, name, address, and other necessary information for quarantine" into the system. Refusal to cooperate will result in a denial to enter the country.

Users are required to report possible symptoms once a day during the mandatory 14-day quarantine on arrival. The data is collected through the Korea Centers for Disease Control and Prevention (KCDC) and shared with local governments and public health clinics if the user shows symptoms for more than 2 consecutive days. Local governments are then prompted to have users tested. In order to assure users keep reporting, notifications are sent out whenever a user fails to do so. They are subsequently contacted via phone. If the user refuses to use the application, the police track down the user and enforce compliance.

The app is user-friendly and accessible, and reporting symptoms is done through four yes or no questions asking the user if they have 1) a cough, 2) a fever, 3) a sore throat, or 4) difficulty breathing (dyspnea). This can be done in four languages (Korean, English, Chinese, and Japanese) on either an iOS or Android system. The app also provides information on nearby testing clinics. Testing facilities are widely available, making the process easy to understand and complete.

The "self-quarantine safety app" is available in the same languages and operating systems. The main feature/function of this app is to monitor symptoms and provide a tool for self-diagnosis. In addition, an alarm is set to go off once the user leaves the designated self-quarantine area. Everyone coming from outside of South Korea is obligated to download the app, including Korean nationals. According to the South Korean government, around 91.4 per cent of people in self-quarantine have installed the app, although the authorities do not clarify how this rate is calculated. The government states that: "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." Officials are tasked with checking the data received through the app and following up on possible non-response or violations of self-quarantine guidelines by tracking the movements of the patient using GPS.

Both systems are designed to control large populations of possibly infected users, and they require the collection and processing of big data, on top of vast human resources for enforcement. Ultimately, these apps function to reduce the risk of spreading the virus and govern the movement of (possibly) infected people using surveillance technology.

In the private sector, several apps have been released that utilise publicly available data published by the KCDC. For example, the "Now and Here app" determines the possible risks of a planned route using recorded movement data of confirmed COVID-19 patients. 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 a confirmed patient, also listing the availability of masks at pharmacies based on public data provided by the National Information Society Agency (NIA).

Laws on data use have been revised in order to facilitate such broad use. Through the Infectious Disease Control and Prevention Act (IDPA) and the introduction of the Advancement of Smart Quarantine Information System, the state has made it possible to track individuals coming in from overseas, tracking their movements through ship or flight number, place of departure and destination, arrival time and personal passenger information, GPS data, card transactions, and CCTV recordings. Under the IDPA, any institution,

organization, or individual must share information on anyone who is infected or deemed "likely to be infected by an infectious disease." The KCDC shares information with the "National Police Agency, Credit Finance Association of Korea, 3 telecommunications companies and 22 credit card companies" for the purpose of tracking possible patients and to "quickly identify transmission routes and places". This includes current whereabouts and the total time spent in each location. Information collection is automated and can be done in 10 minutes from the moment a request is made. The use of big data thus extends beyond healthcare and far into the lives of private individuals.

Within the healthcare sector, the government has made temporary arrangements for allowing doctors and nurses to consult with patients through video calls and video conferencing, telemedicine, or "remote medicare". This is done to decrease the burden on hospital staff, and to provide technical knowledge between healthcare facilities. The app "Medihere" allows users to contact hospitals and make an appointment online. "Odoctor" gives patients the option to access general medical information and diagnosis, and it allows them to participate in remote treatment through the "Coronavirus 119" function. This app is also designed to screen patients before they visit clinics and hospitals, and to shorten the amount of time spent there, reducing 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.

Public and private apps have been widely used, with millions of downloads in South Korea. Combined with the emergency system from which receivers cannot opt out, South Korean residents are able to access critical information and avoid high-risk areas. There are signs of fatigue among residents from continuous notifications. However, the use of technology and information-sharing in South Korea has been highly effective in delaying the spread of COVID-19. As a result, the country has avoided severe lockdowns and restrictions of movement on a national scale. Economic impact has been limited by the swift response, and healthcare infrastructure remains intact and able to cope with current levels of infections.

In return, South Koreans and foreign visitors have been subject to invasive changes in terms of privacy protection, with the government able to access personal information if there are suspicions of a possible infection. South Korea has faced multiple pandemics in the past, and these experiences inform a policy approach in which recent changes could be made permanent, in anticipation of possible new pandemics. 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. The measures allowing for the described response have become embedded in policy and law, meaning 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 of future policymaking.

Taiwan

Taiwan has been relatively successful in its fight against COVID-19, and there is no signs of domestic transmission so far. As a result, the most import measures to contain COVID-19 currently is still to effectively quarantine those who travel from outside of Taiwan. The Taiwanese government uses a system called 'digital fence' to help enforce the quarantine, as it monitors if the people under quarantine stay at their quarantine address; to this end, the app uses the location data generated by cellular signals every ten minutes.

To address privacy concerns, the 'digital fence' takes several measures. First, it uses cellular signals instead of GPS signals, which are able to generate more accurate location data to locate people under quarantine. According to the Taiwanese government, this infringes privacy to a lesser degree. Second, the app uses location data exclusively for the purpose of the quarantine, and people under quarantine will not be monitored anymore after the 14-days quarantine period. However, the location data will be stored until the end of the ongoing crisis. Third, the location data is not actually shared with the government, since it is the five major telecommunication companies in Taiwan that do the monitoring, and they only report to the local government authorities in case there are indications of non-compliance.

However, the 'digital fence' system also reported several common problems and has been challenged by civil society. First, the app created false alarms and serious annoyance for people under quarantine, due to various technical issues, such as telephones running out of battery, bad network connections, or simple failures to answer phone calls. Second, as MP Wu I-ding pointed out in her parliamentary inquiry, the government's Home Quarantine Notice fails to properly inform those who undergo quarantine that they will be monitored.

Furthermore, the Taiwanese government, in cooperation with the Taiwan AI Lab, has developed a contact-monitoring smartphone application for possible future scenarios. The usage of this application will be voluntary, and the personal data of the users will be anonymised and will only be stored locally on the user's smartphone. Also, as Taiwan's digital minister explained, there will be no need for this app unless there are signs of domestic transmission in Taiwan. Finally, Taiwan's digital minister has rolled out a well-received 'eMask' app that tracks and displays the inventories of local drugstores, to prevent shortages, panic buying, and price gauging of health-related goods.

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