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From SARS to COVID-19: Digital infrastructures of surveillance and segregation in exceptional times

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ABSTRACT

The COVID-19 pandemic, an exceptional crisis, sparked the introduction of new digital infrastructure to halt the novel coronavirus's spread. This paper explores how such digital infrastructure's impact might reverberate over the long term, by comparing Singapore, Hong Kong, and mainland China's utilization of digital technology in response to the 2003 SARS outbreak, and their responses to the 2020 COVID-19 pandemic. We find that advancements in digital technology since 2003 have boosted governments' surveillance and segregation abilities substantially—most dramatically so in China. Even though some of these new digital interventions are ostensibly designed to be temporary ones to address the needs of the immediate crisis, we argue that the resultant extensions of state power experienced during COVID-19 are likely to have profound long-term effects because they fundamentally affect sociopolitical contexts, institutional capabilities, and digital cultures. We also find that the extent to which governments can extend digital surveillance and segregation abilities during the pandemic is contingent on their respective sociopolitical, institutional, and digital cultural contexts.

1. Introduction

Infrastructure has historically been used as one of the tools to reduce the exposure of people to contagious diseases. In the late nineteenth century, water and sanitation infrastructure drastically cut the terrible death toll of infectious diseases like cholera and typhoid (Corburn, 2004; Cutler & Miller, 2005; Frank & Kavage, 2008). It is unsurprising that the COVID-19 pandemic has sparked calls for an infrastructural solution to halt the novel coronavirus's spread—this time digital technologies (Allam & Jones, 2020; Florida, 2020; Klaus, 2020).

Much like water and sanitation infrastructure have shaped modern life as we know it, the impact of digital infrastructure deployed in response to the immediate COVID-19 crisis may reverberate over the long term. How might this new digital infrastructure affect future urban life and management?

To address this question this paper compares governmental responses to COVID-19 against responses to a previous global viral outbreak. In November 2002, a severe acute respiratory syndrome coronavirus (SARS-Cov) broke out in China and resulted in over 8000 cases and 774 deaths in 29 countries. The 2003 SARS outbreak presents

an interesting parallel and counterpoint to the COVID-19 pandemic, having also been caused by a highly infectious, unknown novel coronavirus with similar transmission dynamics through respiratory droplets. While the SARS outbreak was comparatively less devastating than the on-going COVID-19 pandemic, having been contained in about eight months after it was first reported and with much lower casualty numbers, the few jurisdictions that experienced that bulk of SARS cases nevertheless suffered substantial economic and psychological strain (Lam et al., 2003; Wilder-Smith et al., 2020).

Having occurred almost 20 years ago, the SARS outbreak provides an opportunity to assess long-term impacts of the socio-technical infrastructures implemented then to combat the virus, and from there extrapolate the likely longer-term impact of COVID-19 measures. Furthermore, the state of digital technology has progressed tremendously since 2003. By comparing responses to the COVID-19 pandemic with that to SARS, we take stock of the new powerful digital tools that governments have at hand to surveil and segregate populations in the name of disease control.

While several recent studies have focused on the implications of digital surveillance and other digital infrastructure during COVID-19 (e.

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g. Das & Zhang, 2020; French & Monahan, 2020; Ting et al., 2020; Whitelaw et al., 2020) there has been no study that compares current governmental efforts to implement such infrastructures to those during the 2003 SARS outbreak. By drawing on past experiences from SARS 2003 and going beyond a ‘snapshot’ perspective of current happenings, our study seeks to contribute richer insights about the possible long-term effects of COVID-19 digital infrastructure that can help guide both policy-makers as well as the broader public seeking to understand the tradeoffs between public health concerns and individual liberties.

We examine the responses to SARS and COVID-19 in three jurisdictions that were substantially affected by both outbreaks: Singapore, Hong Kong, and mainland China. The latter two will be referred to as ‘Hong Kong’ and ‘China’ respectively for ease of reference in this paper. While the three jurisdictions are in Asia-Pacific, and have populations that are primarily Chinese, they differ substantially in terms of political systems, state-citizen relationships, and attitudes around data privacy and surveillance. These differences in turn shape each government’s particular response. By identifying and analyzing the commonalities and differences between each jurisdiction’s adoption of digital technology across the two pandemics, this study seeks to produce new insights about the relationship between state, infrastructure, and the exercise of control and care.

The rest of the paper is organized as follows: First, we introduce the theoretical concepts and conceptual framework guiding this study’s analysis, focusing on infrastructure as a biopolitical strategy, where care and control are dispensed through methods of segregation and surveillance. Next, we introduce three case study jurisdictions and analyze their responses to SARS and COVID-19 in accordance with conceptual framework. We conclude by discussing longer-term implications of these new infrastructures of the three case study jurisdictions.

2. Literature review

2.1. Infrastructure as a biopolitical strategy of segregation and surveillance

Infrastructures can be understood as built networks that control and direct the flow of goods, people or ideas, and which function as a “base on which to operate modern economic and social systems” (Larkin, 2013, p. 330). When deployed in urban contexts, physical infrastructures are ways to arrange urban space, reconfigure human relationships, and bind human action (Schindler, 2014; Usher, 2018).

Infrastructure has been analyzed as a biopolitical strategy to preserve and enhance population health (Rose, 2001). One of the most widely known formulations of biopolitics was developed by Michel Foucault. Foucault (1980) saw biopolitics as a modern form of exercising power that emerged in the eighteenth century, supported by new disciplines such as statistics, demography, epidemiology, and biology, which collectively made it possible to understand and govern populations through practices of correction, exclusion, normalization, disciplining, therapeutics, and optimization (Lemke et al., 2011). Biopolitics is enacted through a mix of ‘disciplinary technology’ and ‘security technology’. The former, developed in institutions like prisons and schools, focuses on supervising and controlling the individual body, whereas the latter focuses on regulation, administered through the collection of demographic data, health statistics and other information to preserve and protect the population as a biological entity. Building on Foucault’s conception of biopolitics, Larkin (2013) describes infrastructure as an apparatus of governmentality and as a conduit of biopower which operates as a mix of disciplinary and security technologies.

Digital technologies brought a new dimension to the biopolitics of infrastructure: smartphones, self-monitoring apps, and other devices gather data about our communication patterns and content, personal health data, physical habits, and physiological characteristics, in what has been labelled as the quantified self. Although in principle self-tracking refers to the collection and self-examination of individual

characteristics and habits, this data is increasingly shared among users of similar apps, and with companies and governments. Self-tracking has become a biosocial phenomenon, partially grounded on the idea of a participatory and preventive health model (Ajana, 2017).

The following paragraphs unpack how infrastructure, especially newer forms of digital infrastructure, facilitates acts of segregation as part of the biopolitical strategy of discipline, as well as supports surveillance techniques as a means of security.

2.1.1. Discipline through segregation

The two main disease-control measures that operate through segregation are “isolation” and “quarantine”. Isolation refers to the separation of those already diagnosed, whereas quarantine refers to the confinement of individuals who might have been exposed to an infectious disease but whose diagnoses are unconfirmed (Center for Disease Control et al., 2003; Jacobs, 2007). While isolation techniques are well accepted as effective and necessary, quarantines are much more controversial because of their sometimes-weak link to effectiveness; concerns over the ethics of curtailing civil liberties (Day et al., 2006; Mandavilli, 2003; Upshur, 2003), and quarantines’ problematic history of discriminatory imposition based on xenophobia, racism, and ignorance (Rothstein, 2015; Tognotti, 2013).

Beyond temporary quarantines enacted during disease outbreaks, permanent enclosures of minority groups within ethnic ghettos have also been justified as a disciplinary means of controlling disease spread for centuries (Browning, 1988; Duneier, 2016, p. 201; Fuller, 2016; Keil & Ali, 2006; Lakoff, 2015; Sennett, 1996). Such problematic practices have extended to the modern-day, where restrictive zoning ordinances and covenants segregate lower-income, racial/ethnic minorities from wealthier, White populations, in the name of ‘health and safety’ (Maantay, 2001; Shah, 2001).

While physical infrastructure networks mediate flows and mobility of people and goods, they can also be barriers for specific groups (Graham & Marvin, 2001; Larkin, 2013). Infrastructure in space, such as a wall around a ghetto, ‘traffic-calming’ road barriers, or deliberately low highways that cut off areas from public buses’ riders, have been deployed as a disciplinary technology to forcibly segregate those seen as diseased or dangerous (Schindler, 2014).

In recent years, smartphones have become a ubiquitous feature in modern life. They are digitalized artifacts through which users continuously mediate their lived experiences (Yoo, 2010). For example, navigational apps guide travel behaviors, ostensibly with a ‘neutral’ objective of offering travelers shortest routes to their destinations. However, some also seek to reroute users away from areas deemed undesirable (Carlson, 2016). In effect, such apps can cut off traffic to certain neighborhoods, negatively affecting businesses there and perpetuating place-based stigma and discrimination. This phenomenon has been labelled ‘teleological red-lining’ by Jim Thatcher (2013), a term that draws a direct link between this practice and historical, discriminatory practices of race-based residential segregation in the U.S.

The use of biometric features, such as fingerprints and faces, to control entrances to multiple digitally controlled realms, is another recent development. Biometric data is extensively used within the European Union for border and migration management, where travelers are identified and profiled using data from a pan-European network of biometric databases. Scholars have argued that the use of such databases to enforce borders, while seemingly neutral and depersonalized, reinforces patterns of discrimination, disadvantage, and suspicion of certain communities (Amelung et al., 2021; Machado et al., 2020).

2.1.2. Security through surveillance

Surveillance of individuals is another technique through which biopower is enacted, as it enables the disciplining, control, and regulation of the broader population as an entity. Public spaces such as plazas and streets have historically been sites of surveillance in cities. They are monitored to prevent crime, preserve order and decency, as defined

along classist lines (Croll, 1999; Storch, 1976).

Medicine also has had a long history of surveillant practices, starting from the notification and monitoring of infectious disease outbreaks and diseased individuals (Graham & Wood, 2003). Today, public health surveillance involves the tracking of both chronic and acute disease occurrence in populations, through systematic data collection and analysis to uncover the epidemiology of the disease, and to provide a 'baseline' for assessing existing prevention and control measures (Declich & Carter, 1994). Constant syndromic disease surveillance systems also act as 'sentinel' devices to provide early warnings about new outbreaks (Lakoff, 2015).

Digital surveillance technologies, such as closed-circuit televisions, reduce the need for manual, proximate observation of physical spaces, but rather allow for monitoring to occur continuously over large geographic distances (Graham & Wood, 2003). They have become widely accepted as a necessary, ubiquitous fixture to combat crime and terrorism (Goold, 2002; Welsh & Farrington, 2009). Over the past 30 years, autonomous mobile robots have also gained greater traction as the 'next wave' of security guards that limit risks to personnel and reduce manpower requirements (Theodoridis & Hu, 2012).

Similarly, smartphones, as ubiquitous mobile, sensor-rich computing devices, have transformed the landscape of surveillance. They can provide an accurate position of users, either using GPS data or triangulation of the data exchanged with cellphone towers. Mapping the use of cellphones thus gives high-resolution spatial and temporal information about the intensity of urban activities and people's movement through space and time (Ratti et al., 2006), which has helped improve estimates of mobility patterns (Panczak et al., 2020; Wu, Wang, et al., 2020). The wide-spread adoption of mobile health ('mHealth') technology has further enabled fine-grained data to be collected around intimate individual behaviors and bodily functions (Lupton, 2012). Examples of public health surveillance research studies conducted using mobile phone technologies include large-scale physical activity surveillance in the UK (Strain et al., 2019) and an investigation of cholera spread by analyzing the spatiotemporal patterns of human mobility (Finger et al., 2016).

Furthermore, the increasing reliance on biometrics to govern entry points presents the potential for each single, corporeal component used in ostensibly disconnected spaces (building entrances; smartphones; flights), to be transformed into data points in large biometric datasets, weaving apparent disjoint activities into personal behavioral patterns—a phenomenon that Joseph Pugliese (2010, p. 8) describes as the "microphysical distribution of power relations".

In short, advancements in digital technologies have enabled the mass monitoring of entire populations, as opposed to traditionally more targeted scrutiny of select populations or individuals, and to imposing a state of constant control over individual behaviors (Deleuze, 1992; Kitchin et al., 2020; Lyon, 2014).

2.2. Exceptional events as a justification for new biopolitical infrastructures

A fine line divides forms of social care and social control from being considered necessarily desirable to being considered unnecessarily repressive (Borovoy & Zhang, 2017). For instance, physical segregation in the form of quarantines have been justified as part of a public health social contract, where individuals agree to sacrifice certain rights in exchange for the safety of the greater good (Barbera et al., 2001). Similarly, scholars have articulated dualities in public health surveillance between the need to impinge on privacy and liberty against the 'ethical mandate' to enhance population well-being (Fairchild & Bayer, 2004; Mello & Wang, 2020). Taking a broader view beyond health-related surveillance, surveillance more generally is necessary for enabling the modern state to dispense welfare and care to its citizens (Lyon, 1994).

Given these tensions between control and care inherent in

biopolitical strategies of segregation and surveillance, efforts to extend the state's reach in terms of surveillance or segregation are likely to be met with resistance. Thus, large extensions of state-sanctioned surveillance and/or forced segregation are unlikely to materialize, unless an urgent crisis sparks a need for additional care and tilts the existing balance towards an exertion of additional control. Conditions of crisis generate a 'state of exception' — which can be understood as a "no-man's land between public law and political fact, and between the juridical order and life" (Agamben, 2005, p. 1). These conditions are generated in times of crisis, and which are used as a government technique to expand power. Under a state of exception, previously untenable, unconstitutional actions where citizens can be stripped of their political rights are justified based on objective necessity (Agamben, 2005).

During the 2003 SARS outbreak, discussions around efforts to counter the disease relied heavily on war as a metaphor, which generated a sense of urgency, and helped justify heavy-handed policy responses (Agamben, 2005; Chiang & Duann, 2007; Ibrahim, 2007). During the COVID-19 pandemic, various government leaders have similarly framed efforts to tame the coronavirus in war-like terms (Bernard et al., 2020; Serhan, 2020). Undoubtedly, the COVID-19 pandemic has once again created a state of exception where extraordinary, urgent action is necessary.

2.3. The extensive impacts of biopolitical infrastructures

As states of exception are by definition 'out of the ordinary', they should be temporary in nature. However, even after the precipitating crisis fades, the surveillance and segregating infrastructures built to respond to the initial threats can remain permanent. The classic example is London's 'Ring Of Steel', which was initiated as a temporary security zone monitored by CCTV cameras, as a response to a series of Provisional Irish Republican Army bombings during the early to mid 1990s. The ring was subsequently expanded to cover larger sections of the city and became a permanent part of London's urban landscape long after the threat of IRA bombings receded (Coaffee, 2008). Similarly, a state of exception created by the shock of 9/11 terrorist attacks contributed to a massive, permanent increase in surveillance technologies targeted at citizens to profile suspects and pre-empt crimes (Lyon & Haggerty, 2012).

The fact that supposedly temporary infrastructural measures have such permanent impacts is not surprising. Infrastructures are not just physical artifacts; they are socio-technical artifacts that both result from and engender complex arrangements of social, economic, scientific, and political values and interests (Bijker, 1995). The development and implementation of infrastructure—digital or otherwise—involve decision-making influenced by a myriad of factors, from financing through to stakeholder participation, and policy restructuring to allow its functioning. How infrastructure enacts power and control is context-specific and variable, depending on underlying political and institutional structures, as well as value systems (Graham & Wood, 2003; Kitchin et al., 2020). Once implemented, infrastructure can in turn powerfully alter broader socio-political environments, legal frameworks, state capabilities and institutions, and through such modifications sustain influence beyond immediate crises.

2.3.1. Technical and institutional capabilities

Big Data surveillance is contingent on the development of algorithms and techniques to process and manage the massive streams of data collected. Big Data surveillance also relies on a large network of consultants and researchers engaging in developing and executing these processes. In turn, these capabilities, once built up, create a degree of 'path-dependency' such that lower-tech or no-tech alternatives to surveillance are shunned. Existing abilities to store, process and analyze massive amounts of data also precipitate greater eagerness to collect vast amounts of data even before a clear use-case has been established (Lyon,

2014). For example, a response from state and local governments to the 9/11 terrorist attacks was to establish state and local ‘fusion centers’ to collate and analyze local, state, and federal homeland security, terrorism, and law enforcement data (Davis et al., 2010; Regan et al., 2015). While these fusion centers started with a counter-terrorism mission, the majority expanded to include all-crimes/all-hazards—an expansion which scholars have characterized as mission creep. In fact, Regan and Monahan (2013) observed that the daily activities at fusion centers were more oriented towards basic policing practices rather than counterterrorism.

2.3.2. Socio-political environments

Adopting certain types of infrastructure requires the creation and maintenance of specific socio-political environments, which in turn trigger transformations that extend far beyond its primary function (Winner, 1980). Current examples of this dynamic in play include the creation of massive storage centers that store and process the troves of digital data collected by national security agencies. One such center is the National Security Agency's Utah center opened in 2013 (Hogan & Shepherd, 2015). Data centers must be secured against possible threats, through stringent physical safeguards, complex backup systems and redundancies, and centralized control of operations (Knapp et al., 2011) and have impacted geopolitical relationships because of countries' push for greater data localization (Sargsyan, 2016).

Scholars have also observed how the rise of mass surveillance post 9/11, which heavily involved the participation of private sector actors, has shifted the ‘social contract’ between state and citizens towards ‘corporate contracts’ (Kitchin et al., 2020). Furthermore, the acceptance of complex algorithms and automated decision-making required to process data gathered has effectively led to the ‘removal of human discretion’ and has created a greater sense of distance between the decision makers and population (Graham & Wood, 2003; Lyon, 2014).

2.3.3. Digital cultures

Digital culture refers to the knowledge, beliefs and practices of people interacting on digital networks (Poepse, 2018). Scholars have observed how cultures have shifted over time in response to new digital infrastructures, such as an increasing comfort and participation in practices of surveillance. Participating in online surveillant practices via social media platforms can bring enjoyment and value to their users, such that they willingly participate in such practices (Lyon, 2018; Monahan, 2011). At the same time, the increasing popularity of digital social media, which are more difficult to police and censor than traditional news media, has arguably changed relationships between state and citizen. It provides cheap tools for distribution of information, collective discourse, and mobilization for action (Earl & Kimport, 2011). By being an avenue for socialization and self-publicization, digital social media can influence one's ideas about norms and democratic values (Swigger, 2013).

2.4. Conceptual analytical framework

Drawing together the different theoretical concepts around infrastructure, segregation, surveillance, and the reiterative loop between infrastructure and the supporting structures of institutional and technical capabilities, socio-political environments, and cultures, we propose the following conceptual framework that guides this paper's analysis of the three case studies (See Fig. 1).

3. Material and methods

3.1. Overview of case study locations: Singapore, Hong Kong and Mainland China

As this study focuses on comparing state responses to SARS and COVID-19, the case study sites are necessarily limited to those

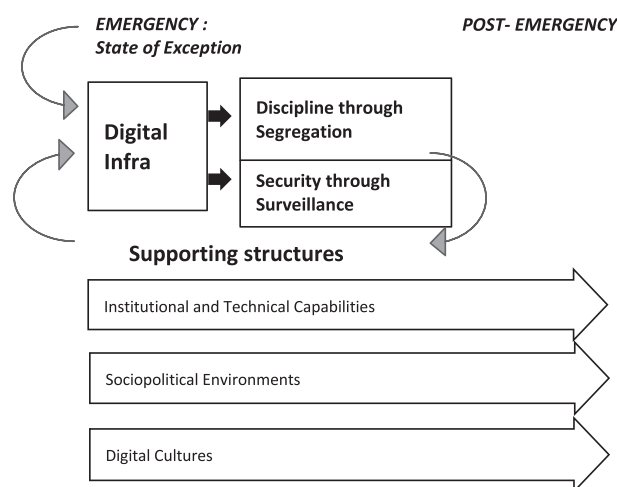


Fig. 1. Analytical framework.

substantially affected by both pandemics. While the 2003 SARS outbreak affected multiple countries, three of the worst hit territories were Mainland China, Hong Kong, and Singapore (Lam et al., 2003). During the early wave of the COVID-19 pandemic, Asia again bore the brunt of cases, with Hong Kong and Singapore being one of the earlier jurisdictions to report cases (Allam, 2020a, 2020b). Furthermore, while the three areas have been characterized as ‘Chinese societies’ (Lau, 1992) and thus share certain cultural similarities, each jurisdiction represents a distinct political system, with different degrees of digital freedom and public trust in government. The following paragraphs summarize some key similarities and differences between each jurisdiction, to provide contextual grounding for this study.

3.1.1. Sociopolitical environments

Singapore is a representative democracy, albeit one that has been classified as ‘flawed’ under the 2020 EIU Democracy Index—a categorization that describes states with free and fair elections and respect for basic civil liberties, though with other weaknesses such as an underdeveloped political culture (Economist Intelligence Unit, 2021). While the country has been described as a ‘soft authoritarian’, administrative state with a relatively underdeveloped civic society and strong top-down government, in recent years, the number of civil society coalitions have increased in Singapore, in part facilitated by the internet and social media (Abdullah, 2020; Ortmann, 2015).

Hong Kong is a special administrative region (SAR) that exists as part of the People's Republic of China with a semi-autonomous status within the ‘One Country Two Systems’. The EIU classifies Hong Kong as a ‘hybrid regime’, which refers to a political system with problematic elections that prevent them from being free and fair; where there is harassment of and pressure on journalists; and where the judiciary is unfree (Economist Intelligence Unit, 2021). While the 1984 Sino-British Joint Declaration, which set out terms of Hong Kong's 1997 handover from the British to China, included promises of a full democracy, the lack of political reform towards this end resulted in a long stalemate between the Chinese government and pro-democracy advocates in Hong Kong. Things came to a head in 2014, when large segments of Hong Kong society participated in a multi-day ‘Umbrella Movement’ protest. The Umbrella Movement failed to achieve any significant concessions from the Chinese government, and instead was met with a tightening of the latter's control over Hong Kong (Cabestan & Florence, 2018; Chan et al., 2021; Ma, 2015). By the time COVID-19 hit, Hong Kong had already undergone months of social protest in response to amendments to the extradition law in 2019, and the proposal and subsequent implementation of a national security law – both legal changes perceived to directly threaten Hong Kong's autonomy from Mainland China.

China is a communist country, with a political system that the EIU describes as ‘authoritarian’, where political pluralism is heavily circumscribed, where no independent judiciary exists, and where criticism of the government is repressed (Economist Intelligence Unit, 2021). In 1978, China embarked on a ‘reform’ era. Reforms included the decentralization of decision-making authority from the central government to regional and local governments, which created a system of “fragmented authoritarianism” (Lieberthal, 1992). Economic and housing market liberalization were also carried out, which saw China undergoing rapid economic development driven by industrialization, housing privatization, as well as integration into the global markets. Observers were initially optimistic about the possibility of greater democracy in tandem with these reforms. However, since 2012, there has been a greater centralization and concentration of power, as well as increased censorship and surveillance (Lee, 2017; Minzner, 2018; Strittmatter, 2020).

Studies also suggest different levels of trust between citizens and government. Tan and Tambyah (2011) analyzed survey data from the 2006 Asian Barometer Survey across China, Hong Kong, Japan, Singapore, South Korea, Taiwan, and Vietnam, and found that Singaporeans had higher levels of trust for political institutions and public service compared to their Chinese and Hong Kong counterparts. Of the three, Hong Kong had lowest levels of trust in political institutions and public service institutions.

3.1.2. Institutional and technical capabilities

While Singapore officially embarked on a ‘Smart Nation’ initiative in 2014, the nation-state has been improving its information and digital infrastructure, as well as levels of population computer literacy since the 1990s. Besides state-of-the-art national broadband and wireless networks, public works and services are also heavily digitized in Singapore today. The government has also encouraged efforts to increase deployment of cashless transactions, autonomous vehicles, sensors, and Internet-connected devices (Woo, 2018). Critics have however argued that the growing integration of digital technologies supports authoritarian rule in Singapore (Ho, 2017).

Similar to Singapore, Hong Kong has ambitions to transform into a ‘smart city’ that incorporates digital and data technologies into policy processes. The Hong Kong government published its Smart City Blueprint in December 2017, which included various digital infrastructure projects such as free Wi-Fi hotspots and upgraded mobile networks, smart mobility systems and sensor-enhanced municipal services (The Government of the Hong Kong Special Administrative Region, 2017).

While both Singapore and Hong Kong have set up centralized agencies to drive their smart city strategies, scholars and other commentators have observed that Singapore’s efforts are proceeding faster and more successfully, with some attributing Hong Kong’s lag to a relatively more laissez-faire approach to state interventions compared to Singapore’s (Woo, 2018).

In China, scholars observe the rising interest in ‘smart city’ technologies dating back to the 2010s. In 2012, the Ministry of Housing and Urban-Rural Development published a plan to pilot smart cities across the nation. Since then, ‘smart city’ initiatives in construction, infrastructure-development, public service provision and social governance have become a ‘trendy’ policy approach for Chinese cities. These initiatives have been encouraged by the central government and supported by global companies like IBM and China-based giants like Tencent, and Alibaba (Hu, 2019). Commentators have also noted rapid advances in incorporating big data into their governance processes—the main demonstration being the deployment of local governmental social credit systems where individuals, businesses, social organizations, and government agencies are assessed for their trustworthiness. Those deemed untrustworthy are sanctioned with limited access to various services and amenities, whereas those deemed trustworthy are rewarded with tax reductions and easier access to government services. These, and other commercially run social credit systems have become an integral part of Chinese citizens’ daily lives (Kostka, 2019). Multiple news reports

describe how facial recognition has been widely deployed in China, facilitated by a vast network of cameras across the country (Lentino, 2019; Ng, 2020). Reports also suggest that the Chinese government has been utilizing such technology to track and detain Uyghur Muslims at an unprecedented scale (CBS News, 2019).

3.1.3. Digital cultures

State efforts over the past two decades have boosted the adoption of digital technologies in Singapore, Hong Kong, and China. Based on World Bank estimates, across the three jurisdictions, the total percent of population with Internet access and mobile cellular access has increased tremendously from 2003 to 2019, although Hong Kong and Singapore have a much higher proportion of their population with access to the Internet and cellular subscriptions than China (The World Bank, n.d.). Table 1 below summarizes.

Freedom House’s 2020 “Freedom on the Net Index”, which quantifies the degree of digital freedom across countries described Singapore as ‘partially free’ because certain websites have been blocked and users have been arrested for political and social content posted online, even though Singapore generally does not restrict network access nor block social media (Freedom House, 2020a). In contrast, China is classified as ‘not free’, as its internet infrastructure and regulatory environment are both tightly controlled by the government. The ‘Great Firewall’—a nation-scale firewall – implements censorship and content filtering to control China’s Internet traffic. Individuals have also been targeted with legal and extralegal reprisals for online activity (Freedom House, 2020b). While common perception is that censorship in China seeks to erase criticism of the Chinese government, a 2013 study instead observed that censors seem to target posts that represent, reinforce, or encourage social mobilization, and thus seem to prioritize the dampening of collective action (King et al., 2013). As for Hong Kong, residents have access to a variety of print, broadcast and digital news sources, and Mainland China’s internet censorship regime has yet to apply there. However, this dynamic seems to be changing, with reports emerging of clampdown on digital freedoms, after the national security law was passed in 2020 (Freedom House, 2020c; Mahtani, 2021).

3.2. Analytic approach

This study applies a secondary case study analysis approach. First, we conducted desk research to compile existing publications in academic journals and grey literature such as government policy reports and articles from reputable, widely circulated newspapers (a full list of sources from the ‘grey literature’ are included in Appendix A).

To guide the analysis of the case study material, we apply our proposed conceptual framework (Fig. 1) to map out the types of digital infrastructures and underlying supporting structures that have been deployed by the three governments for SARS. We repeat the process for COVID-19 and compare responses across the two periods.

4. SARS and COVID-19: empirical findings

4.1. SARS 2003: the development of surveillance and segregation infrastructures in response to ‘states of exception’

As SARS was an unknown pathogen, there were no ready vaccines or

Table 1
Adoption of mobile technology in Singapore, Hong Kong, Singapore.

	% Population using Internet		Mobile cellular subscriptions per 100	
	2003	2019	2003	2019
Mainland China	6.2%	54.3%	20.5	120.4
Hong Kong SAR	52.2%	91.7%	109.3	288.5
Singapore	53.8%	88.9%	86.6	156.4

specific treatment available. Instead, efforts to contain SARS revolved around community containment measures. All three jurisdictions rolled out contact tracing efforts to pinpoint, isolate and quarantine those most likely to have been exposed to SARS. The move to deploy wide-spread quarantines came after a relatively long hiatus of 50 years in the use of quarantines in most jurisdictions (Jacobs, 2007; Wilder-Smith et al., 2020). The decision to employ quarantines was not based on scientific proof of effectiveness, but rather on the urgent need to protect the community from a new disease with high fatality rates using whatever measures were available (Ooi et al., 2005; Upshur, 2003).

By and large, Singapore's response to SARS was characterized as effective, as the outbreak was quickly contained through stringent control measures. Measures included an aggressive, 'wide-net' policy approach, which utilized a broad definition for suspicious cases, and resulted in many individuals being quarantined or put on phone surveillance but who did not contract SARS (Tan, 2006).

In contrast, Hong Kong's initial response to SARS was much criticized because of poor coordination between hospitals, lack of information dissemination to medical practitioners and insufficient knowledge and preparedness. This poor coordination could be attributed to the lack of a consolidated system of sharing of health statistics between different health-related departments. Compared to Singapore, authorities were also slower in introducing isolation and quarantine measures because of initial concerns that patients might go into hiding to avoid being quarantined, considerations around civil liberties and public acceptability, and other complicated political considerations related to Beijing's initial position that SARS was not a serious problem (Christensen & Painter, 2004; Jacobs, 2007).

When the SARS outbreak first occurred in Guangdong Province in November 2002, China's health system was largely under-resourced. The nation had little experience dealing with infectious disease outbreaks and had no information disclosure mechanisms, nor surveillance systems in place in rural areas (Bouey, 2020; Stanway, 2020; WHO, 2003). Furthermore, China was reluctant to admit the severity of the outbreak and initially covered up cases. Scholars attributed this initial slowness in response to the somewhat decentralized nature of political power and lack of centralized oversight over local governments. Local leaders were also purportedly reluctant to report the true severity of the situation to the central government in fear of jeopardizing their own promotion chances (Huang, 2004). By early April 2003, however, challenged by the growing epidemic and increasing domestic and international pressures, the central government took stronger action to contain SARS. During April and May, local authorities locked down urban districts and villages, placing tens of thousands under quarantine (Balasegaram & Schnur, 2006; Rothstein et al., 2003).

Across all jurisdictions, efforts were taken, either during the SARS outbreak itself, or after, to integrate streams of data from different sources, in order to enable easier identification of specific cases of infection and monitoring of future outbreaks. Organizational changes were also put in place, ostensibly to better centralize responses to future epidemics. Except for Singapore's efforts to utilize electronic wrist tags to enforce quarantines and RFID tracking within hospitals, there seemed to be little use of digital technologies to control SARS.

However, the growing availability of mobile phones and the Internet in Asia in the early 2000s had an evident impact on public's responses to Hong Kong and China's government-led efforts (or perceived lack thereof) to tackle SARS. Information, rumors, as well as expressions of dissatisfaction were quickly disseminated via SMS, emails, and web-pages (Huang, 2004; Wong, 2003; Xenii Jardin, 2003), which made it difficult for government actors to control the narrative around how they were managing the outbreak.

The following table summarizes efforts and reactions from each jurisdiction, organized along the three categories of supporting structures. Appendix B includes the full details (Table 2).

Table 2

Government responses during 2003 SARS.

	Singapore	Hong Kong	China
Institutional and technical capabilities			
Digital quarantine measures	Cameras and electronic wrist tags to enforce home quarantine orders	Not documented	Not documented
Improved disease surveillance processes and integrated databases	New contact tracing system that pooled population data	Enhanced contact tracing systems that integrated police and hospital systems	Nation-wide mandatory reporting system established; infectious disease surveillance databases, and national web-based, automated surveillance systems of infectious diseases set up.
Physical surveillance of public spaces	Thermal scanners deployed at borders	Thermal scanners deployed at borders	Thermal scanners deployed at airports, hospital entrances, railway stations
Organizational changes	New group within Ministry of Health introduced	Set up of new center for disease surveillance	New emergency response offices set up in CDCs, recentralization of administrative power
Sociopolitical and legal capabilities			
People-Government relationships	Success in tackling SARS affirmed nation as a collective community	Poor management of the crisis precipitated awakening of civil society, and loss of trust in administration	Attempts to cover-up the initial spread of SARS generated social unrest, and precipitated change towards greater openness around subsequent viral outbreaks
Digital cultures			
Utilization of digital technology to pressure/protest government	Not documented	Alternative websites set up to provide updates (and false information) on SARS outbreaks	Unofficial news, information and rumors circulated via SMSes and emails

4.2. COVID-19: new infrastructures of surveillance and segregation

Post-SARS analyses have found quarantines to have been a necessary tool in halting the spread of SARS (Ooi et al., 2005; Tognotti, 2013; Wilder-Smith et al., 2020). It is thus no surprise that much of China's, Singapore's and Hong Kong's strategies against COVID-19 revolved once again around quarantines. Singapore implemented a series of quarantines of differing strictness that correlated to the perceived risk of being infected (gov.sg, 2020; Yong, 2020).

Hong Kong also enforced extensive quarantines. As early as March 2020, all returning Hong Kong residents had to complete a mandatory 14-day self-quarantine. Prior to Lunar New Year 2021, the government used ambush-style lockdowns on identified neighborhood blocks or buildings and imposed mandatory COVID-19 tests on residents. These lockdowns lasted a day or two, until authorities determined that the area was free of COVID-19 cases (Davidson, 2021).

In China, blanket quarantines were first imposed in Hubei Province, where people were prevented from leaving and entering affected cities. Travelers from or via Hubei were required to be isolated in a quarantine facility or at home for 14 days after their trips (National Health Commission of the People's Republic of China, 2020). Within Wuhan, extreme quarantine measures were taken authorities went door-to-door

for health checks and forcibly isolated residents in makeshift hospitals and quarantine shelters (Hjelmgaard et al., 2020).

One key difference between the SARS outbreak and the COVID-19 pandemic is the digital technologies available to assist in surveillance and quarantining. One much hyped new technology that emerged during COVID-19 is contact tracing apps. These apps work by tracking phone locations using GPS signals or cell-tower triangulation, or by swapping encrypted information with any other nearby phones via Bluetooth to generate a log of potential contacts. Contact tracing apps can quickly provide an easy-to-reference log of potential contacts, without relying on traditional, labor-intensive, intrusive methods of interviews. Contact tracing apps thus theoretically facilitate more targeted testing strategies that limited COVID-19 tests to only those assessed to have been exposed. Similarly, this technology can potentially support selective, efficient quarantining of only those most at risk of contracting and spreading the disease, in-lieu of the costly 'blanket' lockdowns. For these reasons, many governments have sought to introduce contact tracing apps among their populations (O'Neill et al., 2020).

While most contact tracing apps appear to be voluntary in nature, voluntary adoption of contact-tracing apps have had take-up rates too low to reach the targeted penetration rate needed for effectiveness (Browne, 2020). Furthermore, as contact tracing apps are susceptible to errors, when used to enforce quarantines, they may unfairly and inefficiently restrict the mobility and wellbeing of those not actually at risk of infection. Many have thus cautioned for careful ethical oversight over contact tracing apps (Morley et al., 2020).

Singapore, Hong Kong, and China each rolled out their own versions of contact tracing apps, with differing degrees of intensiveness, in terms of data collection, privacy invasion and pervasiveness of application.

Singapore introduced the 'TraceTogether' app in March 2020, the earliest of such contact tracing technology. TraceTogether utilizes Bluetooth technology to record encrypted details of other TraceTogether devices in one's proximity and stores the data for 25 days within each individual device. Users suspected of having been exposed to COVID-19 are required to share data collected with the health ministry. The health ministry would then de-encrypt the data for contact tracing purposes (Chee, 2021). Initial take-up rates were lower than the targeted 75%, despite the early head start and high smartphone utilization rates in Singapore, which were attributed to privacy concerns, fears of potential data breaches, as well the app's impact on phone battery life (Elangovan, 2020). Initial attempts to increase the adoption rates include making it mandatory for foreign migrant workers living in dorms—a group that was particularly badly hit by COVID-19—to utilize the app (Tham & Yip, 2020). The state also manufactured and distributed physical TraceTogether tokens, initially targeting residents who lacked smartphones or the technological know-how to operate the app (Heijmans & Lee, 2020; W. Y. Yip, 2020). While Singaporeans initially pushed back against physical tokens because of concerns over constant surveillance (Asher, 2020) attitudes soon softened and over 1.75 million tokens were collected by end 2020, pushing TraceTogether adoption rates to over 70% (Meah, 2020).

While the government initially assured the public that data collected by TraceTogether would not be used for purposes other than contact tracing, it subsequently clarified that the data could also be used for criminal investigation. This clarification drew significant public backlash, which in turn prompted the government to apologize for their earlier statements, as well as to introduce new legislation to restrict uses to 'serious offences' only, such as rape, kidnapping, or murder (Han, 2021).

Additionally, the Singapore government rolled out a mandatory national digital check-in system that collected an individual's identification number and contact details whenever one visited a business or service, such as malls, schools, public transport, and many more. Effectively, SafeEntry creates a digital record of when and where one interacts with the 'public realm'. This record is stored on government

servers, to facilitate government efforts in COVID-19 hot-spot identification and contact tracing (GoBusiness, 2020). The government subsequently required SafeEntry check-ins to be made via the TraceTogether app or token only, which effectively rendered use of the contact tracing app mandatory for anyone wishing to access public spaces and buildings (Wong, 2020). The authorities were also examining how to integrate the two systems more tightly (Sin, 2020), though with no explicit details published as of April 2021.

Hong Kong launched a voluntary contact-tracing app 'LeaveHomeSafe' in November 2020, which records users' whereabouts and for them to record their visits to different venues via scanning a QR code. For privacy protection reasons, visit records are encrypted and saved on individuals' devices for 31 days, rather than centralized government servers. Should a user be suspected of exposure to COVID-19, they would be required by law to upload relevant visit records for epidemiological investigation ('LeaveHomeSafe,' 2021; The Government of the Hong Kong Special Administrative Region, 2021). From March 2021, the government has required the use of this app to register staff and visitor movements in and out of government buildings. Observers have noted significant public distrust of the LeaveHomeSafe app, which has been attributed to a spike in demand for second-hand 'burner' phones specifically to run the app separately from users' primary mobile devices (J. Chan, 2021).

Public sentiment indicated substantial dissatisfaction with Hong Kong's current efforts. For instance, authorities have been criticized for insufficient testing of high-risk locations, such as residential care homes, as well as for a lack of communication about their plans (R. K. Chan, 2021; Cheung, 2020). At the same time, public responses reflect substantial distrust of the current administration's efforts. Newspaper articles repeatedly highlighted public fears that data collected ostensibly for COVID-19 tracing purposes might be used to suppress calls for democracy and autonomy in Hong Kong (Lee et al., 2013; The Guardian, 2020).

One of China's most discussed and controversial COVID-19 response efforts has been the issuance of individual 'health codes' which act as means of both surveillance and segregation. These health codes were developed by Ant Financial, an Alibaba affiliate, and the social media company Tencent. They have been included as a feature to Alipay, one of the most widely used digital payment wallets in China, as well as into Tencent's popular messaging app WeChat (Li, 2020). Users first fill in a form via the app with personal details, and the software generates a colored QR code: green allows its owner to travel freely, yellow imposes some restrictions on mobility, while red indicates highest risk of being COVID-19 positive and thus requires a quarantine (Mozur et al., 2020). This system was first deployed in Hangzhou and soon expanded to other cities (Ankel, 2020). After blanket local lockdowns were first lifted in April, this form of selective, distributed quarantines administered through the QR health scores became the norm, although lockdowns in some cities continued to be rolled out sporadically in response to local outbreaks (AFP, 2021; Wang, 2021).

The data sources, parameters and algorithms generating these health codes remain shrouded in mystery (Daugelaite, 2020; Mozur et al., 2020). Wu, Xie, et al. (2020) suggest that the generation of health codes may be aided by artificial intelligence (AI) and folded in parameters such as fever clinic visit records, fever-reducing drug purchase records, travel history in high-risk regions, close contact with confirmed or suspected cases, or self-declared physical symptoms. Liang (2020) describes how the app accesses phones' GPS systems and gathers information about user networks and online transactions to evaluate whether users might have had contact with potential carriers of COVID-19. A New York Times article reported that users had to grant the software access to personal information, including location, city name, and an identifying code number. Without explicitly informing users, the software also sent personal information to a server connected to the police, which suggests that information from the app might be used for law enforcement (Mozur et al., 2020). While there was speculation whether user data

from Alipay and Tencent were fed into the health codes, both companies denied doing so (Ankel, 2020).

The few available studies on attitudes in China towards contact tracing apps and surveillance suggest high levels of acceptance. An online survey conducted in June 2020 found that 80% of Chinese respondents ($n = 2201$) reported that they strongly or somewhat accepted contact tracing apps, compared to 39% of US ($n = 2083$) and 41% of German respondents ($n = 2180$) (Kostka & Habich-Sobiegalla, 2020). Similarly, a qualitative study of 38 users of China's Health Code found that all but two users considered the invasion of privacy justifiable in the name of public health. Many also saw in the Health Code an expression of care by the state, while others considered privacy an 'illusory' construct in China, given the multitude of surveillance and censorship systems already in place. At the same time, respondents highlighted concerns about the normalization of the Health Code and continued expansion of government surveillance, as the requirement to utilize the app continued even as the pandemic threat faded in many cities (Liu & Graham, 2021). These fears that the health codes may persist are not unfounded as the city of Hangzhou proposed an expansion of the health code system beyond tracking location-based physical contacts and users' location, to include other behaviors like smoking, or alcohol consumption (Daugelaite, 2020).

Besides differences in the functional scope and extent of intrusiveness of each jurisdiction's contact tracing apps, other differences exist in terms of the degree of individual privacy safeguards. Both Singapore and Hong Kong's authorities, through the design and public communications around their contact tracing apps, stressed that individual privacy would be respected, through safeguards such as finite periods of data storage; de-centralization of data storage on individual devices, and promised restrictions of data use to COVID-19 purposes only. Much less evidence of such attentiveness to data protection can be found in available literature on China.

In addition to these tech-supported contact-tracing efforts, each jurisdiction also implemented technologically intensive measures to contain the COVID-19 outbreak. Both Singapore and Hong Kong implemented electronic monitoring devices to ensure those quarantined did not leave their premises, whereas China relied on a combination of traditional, labor-intensive methods of having community officials enforce quarantines as well as the 'Health Code' app. Singapore and China deployed home-grown surveillance technology, such as bots and imaging technology, to monitor public spaces for safe-distancing practices.

Where the three jurisdictions differed substantially is in the public acceptance and adherence to imposed measures. While residents in Singapore and China seem broadly accepting and supportive of COVID-19 surveillance and quarantining strategies, efforts in Hong Kong faced stronger and sustained push-back and distrust—arguably because of the continued deterioration of the relationship between administration and the public described earlier.

Residents in Singapore, Hong Kong and China all utilized digital platforms to express their dissatisfaction with specific policies around contact-tracing data collection (Singapore); to protest long-drawn lockdowns (China), or to organize antigovernment protests, fueled partially by the poor handling of COVID-19 (Hong Kong) (BBC, 2021; Han, 2021; Lau, 2020; Lew & Zhou, 2020; Marlow, 2020; Qin, 2020; Today, 2021). Authorities have also leaned in on the use of digital technology to manage public dissatisfaction, ranging from active censorship of digital communication practiced in China (BBC, 2020; Lau, 2020; Lew & Zhou, 2020), to the efforts to counter the spread of rumors via the dissemination of 'official' mobile messages in Singapore (Medha, 2020).

The following table summarizes efforts and reactions from each jurisdiction, organized along the three categories of supporting structures. Appendix C includes the full details (Table 3).

Table 3
Government responses during COVID-19.

	Singapore	Hong Kong	China
Institutional and technical capabilities			
Digital quarantine measures	Individual electronic monitoring devices to enforce home quarantine	Individual electronic monitoring devices to enforce home quarantine.	Use of mobile-phone based 'Health Codes'
New disease surveillance processes and databases	Individual tracking systems (mobile phones; bluetooth tokens) Centralized government servers store some aspects of individuals' contact-tracing data (e.g., visits to buildings/public spaces etc.), but only for a specified period before being expunged. No publicized integration or use of data for other purposes.	Individual tracking systems (mobile phones) Resumption of MIISS linkages, with additional immigration records. Decentralized data storage of visits to public places (only on individuals' mobile devices)	Individual tracking systems (mobile phones) Standardized, nationwide governmental servers store basic information of individuals, which is linked to authoritative governmental health data Governmental data storage decentralized at provincial and municipal levels
Physical surveillance of public spaces	Thermal scanners Surveillance bots	Thermal scanners	Thermal scanners Surveillance bots
Organizational changes	N.A.	N.A.	N.A.
Sociopolitical and legal capabilities			
People-Government relationships	General acceptance of contact-tracing and quarantining measures	Substantial mistrust, as evident in efforts to circumvent COVID-19 surveillance efforts	General acceptance of contact-tracing and quarantining measures
Digital cultures			
Public's use of digital technology to pressure/protest government's COVID-19 efforts	Digital petitions, social media posts to organize opposition to contract-tracing tokens and use of data for policing	Pro-democracy protests, which intertwined with dissatisfaction over COVID-19 efforts, facilitated by online organizing	Social media posts expressing dissatisfaction over prolonged lockdowns
Government use of digital technology to manage public dissatisfaction	Using legislation to take down 'fake news'; proactively sending out 'corrective' messages via popular messaging platform Whatsapp	Clampdown on digital freedoms facilitated by COVID-19 social distancing measures	Censorship of critical social media content and journalistic reporting to generate a 'positive' narrative of handling of COVID-19

5. Discussion and conclusion

5.1. Post COVID-19 futures?

A commentary in the medical journal *Lancet* advocating for digital technologies to solve the COVID-19 pandemic concludes with the following quote: "As the saying goes, 'a crisis provides an opportunity'; this first great crisis of 2020 provides a great opportunity for digital technology" (Ting et al., 2020). State-led efforts to adopt and accelerate

technical innovation of new digital infrastructures during the COVID-19 crisis, as described in this paper, demonstrate how COVID-19 was also an opportunity to extend governments' surveillance and segregation powers. Even though some of these new digital interventions have been ostensibly designed to be temporary ones needed to address this immediate crisis, they fundamentally alter institutional and technical capabilities, sociopolitical contexts, and digital cultures in ways that generate longer-term economic, social and political effects beyond the current emergency.

In China, the technical capabilities developed to generate and deploy individual-based quarantine orders in the form of health codes has fundamentally transformed the way segregation is and may continue to be administered. While physical infrastructures of segregation, such as the walls of a quarantine hospital, are spatially fixed, the selective quarantines administered through mobile phones are flexible and easily changeable with new information, algorithms, and priorities. The broad-stroke quarantines imposed during the SARS outbreak, while largely seen as effective (e.g. [Ooi et al., 2005](#); [Tognotti, 2013](#); [Wilder-Smith et al., 2020](#)) were nonetheless criticized for the tremendous economic and social costs of quarantining large numbers of people who eventually turned out not to have SARS ([Day et al., 2006](#); [Schabas, 2004](#)). The individualized nature of 'mobile quarantines' however makes it far harder to pinpoint the contours of segregation, compared to more traditional quarantine orders. Even the COVID-19 quarantines in Hong Kong and Singapore, while given a 'digital twist' of electronic bracelets and mobile app enforcement, are nevertheless based on physical border crossings. In contrast, the 'flexibility' of smartphone-based quarantine makes it easier to fold in a targeted containment and segregation of certain groups without arousing concern or criticism from other quarters. To date, China's digitally enabled mobile quarantines has been the subject of concerns that such technologies may be misused to track, detain and ultimately silence dissenting voices ([French & Monahan, 2020](#); [Kitchin, 2020](#)).

During SARS, and even more so during COVID-19, cities became testing grounds for emergent technologies, with economic implications. In 2003, Singapore's strong push to deploy thermal scanning technologies during the SARS outbreak supported work by a local defence and engineering company. In similar ways, the advancements in digital infrastructure spurred by COVID-19 benefitted companies developing these technologies, and supported state-specific economic strategies. Hong Kong's home quarantine electronic wristbands and app were provided by a local startup ([Kawase, 2020](#)), which has since reported increased interest from other companies and governments in the use of their technology for quarantine tracking and other purposes ([E. Yip, 2020](#), p. 2020). Singapore's digital COVID-19 efforts have also been explicitly linked to the country's national AI strategy, which "maps out how Singapore will develop and deploy AI solutions to transform the economy and improve lives" ([Govtech, 2020](#)). There are however important concerns about the economic mining of COVID-19-related digital infrastructure. On one hand, this could help create valuable jobs and national economic growth; on the other, this could "legitimate surveillance capitalism and the invasive harvesting and exploitation of people's data for profit" ([Kitchin, 2020](#)).

Another long-term implication of the intensive deployment of digital infrastructures during COVID-19 outbreaks is the need for greater data security. The 2003 SARS outbreak led to more tightly integrated systems around public health surveillance, in the form of consolidated health and resident contact databases, which have since become permanent features in Singapore, Hong Kong and China. In comparison, COVID-19 surveillance efforts in Hong Kong and Singapore relied on some degree of decentralized data storage, for data privacy and security reasons. Authorities also promised that the data collected would only be stored for a specified, limited period. These efforts suggest a greater sensitivity to the potential risks of data collection, aggregation, and storage. Nevertheless, there are still potential longer-term impacts of these temporary databases. For one, the streams of new, fine-grained

individual-level data being generated by new COVID-19 related digital surveillance necessitated stringent security measures to defend against any third-party attacks. Singapore's officials acknowledged the heightened threat of attack from hackers as more digital tools were rolled out for COVID-19, and even set aside SGD \$1 billion to build up government capabilities in cyber and data security ([MINDEF, 2020](#)).

As in the case of SARS, COVID-19 surveillance and segregation digital infrastructures might also have longer term sociopolitical implications. In Singapore, successful efforts to tackle SARS helped buttress a sense of national identity and enforced a narrative about the need for individual sacrifice to combat the virus. This narrative was drawn upon during the COVID-19 pandemic. For example, a commentary by notable public figure and former diplomat Professor Tommy Koh (2020) reminded Singaporeans that "[f]rom March to July 2003, Singapore was at war with SARS. It was fought by the whole of Government and by the whole of the people. [...] We should do the same in facing the current crisis" Given Singapore's relatively successful management of the COVID-19 pandemic, which has been repeatedly attributed to the digital contact-tracing tools deployed, the nation's COVID-19 response is likely to become another valuable 'nation-building' story that strengthens state-citizen relationship.

In contrast, scholars have linked public anger over the Hong Kong administration's poor handling of SARS to the revival of the domestic democracy movement, as people had to self-organize to defend against the virus ([Lee, 2009](#); [Ma, 2004](#)). Similarly, public dissatisfaction with the Hong Kong government's COVID-19 response has coincided with broader unhappiness and distrust of both the Hong Kong and China central government. For instance, there has been a spike in demand for second-hand 'burner' phones specifically to run Hong Kong's tracing app separately from users' primary mobile devices ([J. Chan, 2021](#)). Reports also suggest that Hong Kongers were fearful that data being collected was being used to identify and prosecute those protesting Beijing's efforts to impose a national security law on Hong Kong ([Leung & Steinfeld, 2020](#); [The Guardian, 2020](#); [Yam, 2020](#)). By deploying various digital surveillance tools during COVID-19, the Hong Kong government may have further worsened the fragile relationship between administration and Hong Kongers.

Additionally, the massive volumes of new data collected necessitate the use of complex, automatized AI algorithms, to process and simplify information into actionable pieces. Key concerns are that AI algorithms can be impossible to interpret, and can prove frustrating for those seeking explanations for AI-aided decisions. It is also difficult to establish accountability for any mistakes by AI systems. In the case of COVID-19 health codes in China, news outlets reported how individuals whose movements were curtailed by a red health code for reasons unknown to them were frustrated because they were unable to appeal the opaque judgment ([Daugelaite, 2020](#); [Ye, 2020](#)). Despite these shortcomings, the codes met little public resistance, and might even be adapted for longer-term use. Perceptions of China's success in managing COVID-19 using big data (e.g., [The Economic Times, 2020](#); [Wu, Xie, et al., 2020](#); [Wu, Xu, & Wang, 2020](#)) may encourage adoption of such techniques elsewhere in the world.

COVID-19 surveillance and segregation digital infrastructures will likely shape long-term changes in digital cultures, particularly around how the public and the state interact. During the 2003 SARS outbreak, the use of mobile messaging and internet communication enabled the quick dissemination of information and opinions in ways pressured the Chinese and Hong Kong government to change their approach to tackling SARS. Similar use of digital technologies to express dissatisfaction and place pressure on governments can be observed during COVID-19 across all three jurisdictions, and to an even greater degree thanks to improvements in mobile technology and the rise of social media platforms since 2003. Since then however, government actors—especially in China—have adapted to these forms of digital communication and have implemented aggressive measures to shape public discourse. SARS was a painful lesson to the Chinese government in terms of the need to control

the spread information and rumors via social media. They thus adjusted their communication strategies during subsequent epidemics to place greater attention to interacting with the public and proactively offering information via platforms like WeChat (Qiu et al., 2018). News reports and think-tank reports have documented the careful crafting of narratives around COVID-19 in China, including censorship and constant monitoring of social media posts (BBC, 2020; Lau, 2020; Lew & Zhou, 2020) which seems to have achieved its desired goal of painting a positive picture of the country's COVID-19 response, and maintaining a degree of public acquiescence to the strict lockdowns and intensive monitoring deployed. The success China has had in controlling public sentiment, suppressing dissent, and in avoiding the kinds of strong pushback reported in Hong Kong where communications are relatively unfettered, may embolden other governments to consider similar approaches to managing digital communications.

Finally, we find that the extent to which governments can extend digital surveillance and segregation abilities during the pandemic to be contingent on their respective sociopolitical, institutional, and digital cultural contexts. Given China's reputation as an authoritarian government, the sophistication and scale of its pre-COVID-19 digital infrastructures for surveillance, as well as its ambitions for developing smart-city capabilities, it is no surprise that China introduced the most intrusive method of contact tracing and quarantining of the three case studies. In contrast, while Hong Kong's LeaveHomeSafe app represented the least invasive option, it was nevertheless greeted with much resistance. This is arguably a reflection of the embattled relationship between the administration and Hong Kongers, where low levels of public trust stymied efforts to increase direct surveillance. Singapore presents an example where high levels of public trust, a 'soft authoritarian' bent, and substantial government capability in digital technologies built up over the years have enabled quick and extensive deployments of new digital surveillance technologies. As discussed in this paper, insofar the development and deployment of new COVID-19 related digital infrastructures further buttress technical, institutional, sociopolitical, and cultural capabilities that enable the extension of the state's biopolitical reach, one would expect to see Singapore, China, and Hong Kong's post COVID-19 futures to diverge in terms of the degree of state dispensation of care and control.

A final cautionary note: as this study relies largely on government reports, think-tank analyses and published news articles on government responses to SARS and COVID-19, there is a risk of bias, in terms of how these sources present their information. Government reports and press releases tend to portray government policies in a non-critical, optimistic light. Similarly, state-sponsored, or state-influenced news publications, like China's Xinhua News Agency, might also present a similarly rosy picture of government policies. In contrast, Western media tend to present a much more critical perspective of the kinds of surveillance efforts implemented in China, Hong Kong, and Singapore. However, by combining information and narratives from a wide spectrum of sources (Appendix A), we seek to avoid over-reliance on any one source, and achieve some balance between these competing narratives.

Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.cities.2021.103486>.

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