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Review

Smart technologies for fighting pandemics: The techno- and human- driven approaches in controlling the virus transmission

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ABSTRACT

How do governments in China and Western democracies differ in their technological response to control the transmission of the pandemic? Based on an analysis of academic papers, World Health Organization reports and newspapers, this research compares two opposing approaches, whereas the Chinese cities and government have adopted a techno-driven approach, Western governments have adopted a human-driven approach to control the transmission of Covid-19. The findings highlight that although the techno driven approach may be more productive to identify, isolate and quarantine infected individuals, it also results in the suppression and censoring the citizen views. It is further emphasized that human interaction with the technology is mediated by the political and institutional context in which the technologies are implemented. This paper contributes to literature by understanding the human-technology relationship, and offers five practical observations for controlling virus transmissions during pandemics.

1. Introduction

Pandemics leave enormous burdens on our lives, economies, and societies at large. A pandemic is generally defined as a new disease that rapidly spreads in a number of countries and continents. Even a mild pandemic can kill several millions of people (Osterholm, 2005). Over the past hundred years or so, we have seen three deadly pandemics, namely, in 1918, 1957 and 1968 (Mills, Robins, & Lipsitch, 2004). Novel Coronavirus (Covid-19) is the most recent pandemic that has resulted in unprecedented social and economic impact on society. Covid-19 is one of a large group of viruses that was transmitted to humans from bats in a local live animal market in Wuhan in late 2019 (Ji, Wang, Zhao, Zai, & Li, 2020). It infects the upper respiratory tract and can result in pneumonia and other associated illnesses, which can eventually affect the central nervous system, ultimately leading to death for those with underlying health conditions. Given the potential for human-to-human transmission and that inventing a vaccine would ideally take about one or two years, the World Health Organization (WHO) recommended that governments worldwide should quickly intensify active surveillance to identify infected individuals to allow rapid isolation and quarantine (Heymann & Shindo, 2020).

Geographically, Covid-19 has had a significant impact on cities. Cities contribute a whopping 80% of the total global GDP and host about half of the global population (The World Bank, 2019). As a result, cities became hubs for the quick transmission of the pandemic. Rapid urbanization, population growth, and increased global travel attributable to globalization have all contributed to this transmission. However, we are fortunate that our current cities are more resilient than ever before. This is due to the increased adoption of smart technologies such as the Internet of things (IoT), big data, and artificial intelligence (AI). Especially cities in China and Western democracies are known for adopting smart city based technologies. For the purpose of this paper, Western democracies include the United States of America (USA), the United Kingdom (UK), Italy, Germany, Belgium, the Netherlands, France and Spain. These countries were highly affected by Covid-19 in the initial three months after its first transmission.

These cities either adopt a techno- or human-driven approach under the smart city framing (Kummitha & Crutzen, 2017). While the techno-driven approach seeks ubiquitous adoption of smart technologies, largely pushed into cities by using the top-down approach, the human-driven approach encourages cities to educate their citizens and enhance their social and human capital that would help develop and adopt smart technologies necessary in cities (Mora, Bolici, & Deakin, 2017). These new-age technologies have been employed by city governments as part of their initial response strategies.

By the end of the first three months since the virus was identified, while China is able to control its initial outbreak and is up and running again, Western democracies continue to struggle in controlling the virus

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transmission. For instance, China's response has been described by the WHO-China Joint Mission report as “the most ambitious, agile and aggressive disease containment effort in history” (WHO, 2020a, p. 16). Whereas the response from Western democracies was considered inadequate. With this background, the current article reviews academic papers, WHO reports and newspaper articles published in the first three months following the Covid-19 outbreak in China to answer the following research question: How do governments in China and Western democracies differ in their technological response to control the transmission of the pandemic?

This research finds that with the use of the most sophisticated technologies and stringent surveillance imposed across the cities in the first three months following the outbreak of the virus, the Chinese government adopted the techno-driven approach and was able to keep the transmission relatively under control. However, the Western democracies, have chosen to adopt the human-driven approach to tackle the pandemic. This research argues that the impact of the human-driven approach is slower than the techno-driven approach in controlling the transmission of the virus. It is further argued that while technology can contribute to enhancing resilience and controlling transmission, censorship and human involvement with technology limit its potential. As a result, the impact of smart technologies is potentially moderated by the social and political contexts in which they are implemented.

The remainder of the paper is organized as follows. The second section below reviews the literature on smart technologies in China and Western democracies, while the third section describes the research approach adopted. The fourth and fifth sections discuss the smart technologies used by China and Western democracies, respectively. In the sixth section, it is emphasized how human interventions mediate the potential of technologies. The seventh section provides an overall discussion, considering both the theoretical and practical implications of this work. The last section concludes the paper, highlights the limitations of this research and proposes avenues for future research.

2. Review of the literature

The growing urban population and the need to enhance the potential of city-level governance systems have given birth to the smart city concept (Kummitha & Crutzen, 2017; Lee & Lee, 2014). From a technological point of view, smart cities are equipped with some sort of IoT to collect and analyze data. IoT devices include sensors, processors, wearables, electronics, software, actuators, vehicles, cell phones and computers (Kankahalli, Charalabidis, & Mellouli, 2019; Mora, Deakin, Reid, & Angelidou, 2019). These devices collect data from different locations in the city (Kummitha, 2018), and analyze it using AI for the betterment of city-level planning. AI refers to intelligent machines that think autonomously without significant interference from their human counterparts. Conventionally, significant amounts of time are required to collect, understand and derive trends from such data, whereas AI helps draw imperatives within seconds (Davenport & Ronanki, 2018). The analysis by AI improves with the addition of new information, which makes it more intelligent (Kumar, Ramachandran, & Kumar, 2020). These intelligent machines self-learn and improve their performance based on the big data being gathered by the IoTs installed across the cities. Big data refers to the large amount of data generated from IoTs. One of the prominent uses of big data generated from the IoT helps draw cognitive insights, which allows the detection of patterns using dedicated algorithms (Davenport & Ronanki, 2018). The IoT devices integrate different government departments and establish a platform that hosts data and allows to offer urban services to citizens (Zhang, Zhao, & He, 2019). For example, data from vehicles, mobile phones, and cameras along the roads are used to inform about traffic conditions and provide traffic solutions. Similarly, health care records are analyzed to understand patients' backgrounds and underlying health conditions to offer better treatment. Although cities have been using big data for the past decade to identify weather changes, (Kitchin, 2014), and other urban problems including transportation and public safety (Diaz-Diaz, Munoz, & Perez-Gonzalez, 2017), the use of big data has proven to be extremely valuable in the health sector and during the current outbreak of Covid-19.

When it comes to the governance of smart cities, the level of technology adoption is determined by either the techno- or human-driven approach they adopt (Kummitha, 2018). While the former refers to the enhanced use of technologies, largely using a top-down method in which governments enforce technologies on cities and citizens, the latter refers to educating and enhancing the potential of communities that help create and promote their own technologies based on the local needs. For the last decade, Europe, north America and China have engaged in transforming their cities into smart cities.

2.1. Smart technologies in Chinese cities

China's interest in using smart technologies for governance dates back to the overall shift in its innovation policy that began in the early 2000s (Ling & Naughton, 2016; Liu, Simon, Sun, & Cao, 2011). According to the 2015 statistics, the urban population in China accounts for 56% of the total population, and given the improved living standards and new employment opportunities in cities, it is expected to increase exponentially in the next two decades to 76% (Wu, Zhang, Shen, Mo, & Peng, 2018). In response to the growing population, China has taken an active role in building smart cities where technologies have been used significantly to aid urban governance. One estimate indicates that there are about 500 world-class smart cities present in China (Mak, 2020). Wuhan, the most affected city during the current COVID-19 outbreak itself is a smart city. China stated its commitment to building smart cities in the 12th Five-Year Plan published in 2010 that set a blueprint for the socio, economic and political goals for the next five years. The National New Urbanization Plan which came into effect in 2014 and lasts until 2020 has largely taken charge of constructing new smart cities and remodeling existing cities into smart cities (Zhu, Li, & Feng, 2019). Furthermore, the former Premier of China, Li Keqiang, emphasized in 2015 that smart cities and smart technologies are the two major priorities in the development of the country. The 13th Five-Year Plan, the first under President Xi Jinping's leadership, takes the smart cities vision even more seriously with the aim of not only promoting them but also creating inter-city infrastructures and partnership building among them, which would further aid the national government in its governance (Dameri, Benevolo, Veglianti, & Li, 2019). The concentration of political power in the central government and its control over the provinces and cities allows it to quickly make arrangements for coordination.

At the micro level, the IoT is so far penetrated into Chinese daily life that passenger bus rides are often charged based on facial recognition technology. Furthermore, smart devices are connected to utilities such as rubbish bins, which are electronically connected to a system that alerts authorities when they are full (Andrelini, 2019). Thus, both the built environment and citizens in the major cities have been oriented towards the adoption of the enhanced use of the IoT for the past 10 years. As a result, China has the most sophisticated IoT industry, thanks to its aspirations for building smart cities (Kshetri, 2017). In addition, it has the best technological manufacturing industry in the world (Li, 2018). With the help of the IoT, big data, and AI, cities can perform continuous monitoring, offer catastrophe warnings, and make quick decisions (Zhu et al., 2019). Among the other sectors, health care has benefited significantly due to the heightened adoption of new-age technologies (Sun & Medaglia, 2019). As a result, China has one of the strongest technological potentials for handling pandemics compared to other countries.

2.2. Smart technologies in western democracies

Unlike in China, the regional and city governments in Western democracies enjoy balanced power-sharing with the central governments. Similar to the Chinese context, population growth in urban areas has resulted in cities, especially in North America and Europe, adopting smart city technologies (Albino, Berardi, & Dangelico, 2015). The European Union, for example, initiated several strategies including the European Smart Cities & Communities initiative (Kylili & Fokides, 2015), and the European Innovation Partnership for Smart Cities and Communities (Cardullo & Kitchin, 2019). These programs allow European cities access resources from the European Commission to transform their cities into smart cities. Most Covid-19 affected countries in the Western context are known for their advanced smart cities. These countries are highly interconnected with each other largely due to their geographical proximity and the trading partnerships they have with China. This is the reason the Covid-19 pandemic was able to easily transfer to the major cities in these countries from China (Cohen & Kupfesrchmidt, 2020).

The IoT is interconnected into the physical and human world to offer smart solutions for city-wide problems. Angelidou (2014) shows how New York, for instance, one of the cities highly affected by Covid-19, adopted the IoT for gathering insights from the communities. Other smart cities in the USA include, Washington DC, Boston, Denver, Seattle, Los Angeles, Chicago and Philadelphia (Pyzyk, 2019). When it comes to Europe, Barcelona, a highly affected city in Spain, also built its smart city technological ecosystem to enhance its usage of smart technologies. Especially, IoT driven services in Barcelona smart city have claimed to improve quality of life for its citizens (Kamel Boulos & Al-Shorbaji, 2014). Care, Trotta, Care, and Rizzello (2018) argue that Milan, a smart city in Italy, was built around several innovative mechanisms to adopt smart technologies. Further research emphasizes other smart cities including Berlin and London (Zvolska, Lehner, Palgan, Mont, & Pleplys, 2019), Paris (Martinez-Balleste, Perez-Matinz, & Solanas, 2013), and Amsterdam (Mora, Deakin, & Reid, 2019b). Given the level of smart technologies adopted, smart cities are claimed to offer best living conditions and are equated with healthy cities (Kamel Boulos, Resch, Crowley, et al., 2011).

2.3. Techno- or human-driven approach

Despite the growth of smart cities in China and Western democracies, the techno- or human-driven approach that generally cities adopt in their smart city governance determines their level of technological usage to interact with citizens. The techno-driven approach largely places heightened importance on technologies and makes citizens subordinate to the technologies adopted in the cities. Techno-driven approach does not take 'context' into consideration, rather expects technologies to fix all the glitches in cities (Janssen & Kuk, 2016). This approach resonates with the 'hard technological determinism' that considers new technologies as basis of society where they play a pivotal role in structuring the social systems (Bannister & Connolly, 2020; Nograsek & Vintar, 2014). The inherent capabilities of smart technologies are expected to solve problems experienced by the governments (Helbig, Gil-Garcia, & Ferro, 2009). While Techno-driven approach may be more effective in imposing law and order and offer techno-driven objective governance, it may also curtail human freedom, enhance censorship and raise ethical questions (Bimber, 1994).

In contrast, the human-driven approach is oriented towards citizens, where technologies are selectively used, allowing citizens enjoy their freedoms. This approach resonates with 'soft technological determinism' where individuals retain agency in determining technological use (Nograsek & Vintar, 2014; Pool, 1983). Under this approach, governments also enhance social and human capital among their citizens which allow developing technologies based on the local need. There is an overall understanding that human-driven approach allows governments adopt smart technologies to ensure better citizen engagement, to offer accountability (Gil-Garcia, Zhang, & Puron-Cid, 2016; Mora, Deakin, Reid, & Angelidou, 2019), and streamline interactions between communities and government (Androutsopoulou, Karacapilidis, Loukis, & Charalabidis, 2019). Additionally, citizens seek greater participation in the planning of urban development strategies, often initiating local enterprises (Kummitha, 2019). The variance in the techno- and human-driven approaches potentially holds a key to determining the level of smart technologies used in the context of both Chinese and Western democracies to control the Covid-19 transmission.

3. Research approach

This section highlights the data selected for conducting the study, the methods, and the analytical approach adopted.

3.1. Data selection

Given the active role China plays in the global markets and the networks it forges across the globe, there has been a heightened interest among the governments, businesses, healthcare providers, and individuals to seek further information about COIVD-19 and the mechanisms that help China fight in controlling the transmission of the pandemic. WHO has urged the Chinese government, medical community and scientists to publish information actively about the emergent trends. As the virus transmitted to other parts of the globe towards the end of January 2020, Western media have made a significant effort to show how technology has been used by Western democracies in controlling the transmission. Further, the scientific publishing houses have fast tracked publishing on Covid-19 and made all the published research openly available for anyone to use. In addition, media outlets have shown keen interest in not only publishing current trends but also various interventions being initiated to control the outbreak. Given the availability of the information from both scientific and media publishing houses for the Covid-19 related literature, I have chosen to review the scholarly articles, WHO reports, and newspaper articles to address my research question.

3.2. Methods

For academic articles, I ran through a search in Scopus on 31st March 2020 with search phases such as Coronavirus OR COVID-19 AND tech* and limited the search to identify those articles which were published in the year 2020. This search resulted in a total of 52 publications. I have chosen only those which were published in 2020 because Covid-19 was first identified on 31 December 2019. In addition, I have also refereed through 137 news items that covered the first three months of the pandemic and focused on technologies. The search was conducted in google news and limited to the popular media outlets including BBC news, CNN, The Guardian, The New York Times, Business Insider, The Telegraph, The Economist, Reuters, Financial Times, ABC News, GlobalTimes China, and China File. The use of media outlets to identify the novel mechanisms has been useful to understand the trends and the approaches adopted by various governments (Zhang, 2016). In line with the research question, I have largely focused on technological responses adopted by China and other Western countries. Further, I have read 71 situation reports released by the WHO. These reports have been released on a daily basis from 21 January 2020. The use of research articles, WHO situation reports and news from media outlets form a basis to triangulate the data (Kennedy, 2008).

3.3. Analysis

I have read through all the articles, WHO situation repots, and newspaper items manually and identified clusters of information that could feed into this article. I have carried out a co-occurrence analysis

for analyzing relationships among the major constructs (Kim, Lee, Kim, Lee, & Suh, 2015). As part of the co-occurrence, two constructs need to appear together in a large part of the data being analyzed (Boschma, Heimeriks, & Balland, 2014). As part of the analysis, I used the WHOs recommendation and adopted three constructs– identify, isolate and quarantine for reducing the virus transmission, and seven additional constructs from the adoption and use of technologies to probe techno- or human-driven approaches. Those constructs include governance, smart technology usage, privacy concerns, lockdown, activism, information sharing, and infodemic. These constructs are drawn from the data, allowing to understand whether governments adopt techno- or human-driven approaches and associated benefits and concerns. The findings are discussed in the sections four and five below. While section four discusses the Chinese response, the section five articulates the response from Western democracies.

4. Smart technologies and Covid-19: A Chinese perspective

Given the centralized power structure, the virus outbreak in Wuhan smart city and its quick spread to other cities forced the central government to step up. The central government actively set the IoT ecosystems into motion by bringing together different key stakeholders and devices to trace and track the individuals who were infected. In line with the WHO's (2020b) recommendation to identify, isolate and quarantine those who are infected, China made use of its well-established surveillance system and placed cities under complete quarantine using a draconian approach. This has been enforced across the country under the premise of *feichang shiqi* (which means extraordinary times). It is shown below how China has used its technology to control the spread of the virus. These findings indicate that most of the Chinese efforts were invested in identifying infected patients.

4.1. Active surveillance and identifying the infected

One specific advantage China has is its surveillance system. A recent report highlights that most of the Chinese investment in smart cities is built around improving surveillance on their citizens in addition to focusing on the built environment (Andrelini, 2019). For instance, the smart city of Chongqing in China currently uses 2.6 million security cameras to conduct surveillance of the city's 15.35 million people, equating one camera for every six residents. It is followed by the Shenzhen smart city which has 159 cameras per every 1000 residents, then the Shanghai smart city with 113 cameras, the Tianjin smart city with 93, and the Jinan smart city with 73 cameras, all per every 1000 people. These are the five most surveilled cities in the world. Kharpal (2020) emphasizes that during the quarantine, the government even installed CCTV cameras on apartment doors to ensure that residents would not leave their quarantined houses. Some of these cameras include AI technology and facial recognition to identify people (Keegan, 2019).

Chinese cities were coordinated under the central leadership to make use of the sensors for data collection throughout the cities, conduct decentralized testing, and flag those who were infected by Covid-19. The AI technology developed for identifying individuals is so robust that while CT scan results can take up to 15 min to diagnose, AI can complete the task in 10 seconds (McCall, 2020). Drones equipped with cameras and controlled by operators were further deployed for conducting surveillance and issuing instructions and warnings to those failing to wear masks or failing to follow the emergency protocols. In cases where citizens failed to report their travel history in the affected areas, IoT devices were used to ascertain their travel history and flag those cases (Liu & Li, 2020). For instance, the travel of individuals to the affected areas was monitored and reported to the concerned authorities by AI applications (Jie, 2020). In addition, corporate firms allowed the government to access their systems hosting the mobile applications (apps) that citizens routinely use to track down their travel history. For instance, apps such as Alipay and WeChat which are popularly used across China, helped the government to track down those who were infected (Kupfesrchmidt & Cohen, 2020).

Public transportation has also adopted specific technologies to identify those likely to be infected. Megvii Technology Limited, for instance, has developed an AI body temperature screening system (as having a high or very low temperature is one of the basic symptoms used to identify those infected with Covid-19) which was deployed in most of the metro stations in China. This AI-based system screens up to 15 patients every second from a maximum distance of 3 m based on non-contact remote temperature screening. Baidu, another AI firm, joined the efforts in developing another body temperature scanner, which can scan about 200 people per minute. Other AI firms, such as SenseTime, have also joined in the efforts in developing contactless temperature detection software that has been installed in public places (Jakhar, 2020).

Further, infrared systems with display screens have been installed in popular areas. As people pass through the system, their body temperature is displayed on the screens. Officials monitor the screens to identify those who were infected. Furthermore, police officers in the Chengdu smart city wear smart helmets that detect people with high temperature within a 5-m radius. Thermal scanners were installed in all major Chinese train stations, and once infected persons were identified, they were transferred to a local isolation room from where their travel history was collected to understand where they had travelled and thus identify other potentially infected persons. AI has been used to integrate body and face identification with the help of dual sensing by visible light and infrared cameras to help authorities quickly identify patients. Overall, the AI systems are highly efficient and a source of relief for the overstressed health system in China.

The data collected from different IoT devices are shared with the central server and analyzed using AI to supply the necessary medical resources. In the virus epicenter, Wuhan smart city, administrators coordinated with a consortium comprising five well-known laboratories and set up an emergency response center in Wuhan to enhance the city's virus testing potential. The consortium developed testing kits through war footing that could detect the virus more quickly and comprehensively. One of the well-known firms, BGI, initiated an anti-epidemic[1] initiative which quickly led to 22 cities covering 100 s of companies joining the initiative to develop test kits (GEN, 2020).

4.2. Isolate the infected from others

AI has been useful in assisting the understaffed medical professions to navigate through the available data and understand the emerging trends. At the Zhongshan hospital in Wuhan, a doctor's team used Graphics Processing Unit (GPU)-accelerated AI to identify the visual signs of the virus from those who were likely to be infected. Infervision, a Beijing based start-up, developed a GPU-accelerated AI which was initially intended to detect cancer in the lungs. The system was remodeled for the purpose of detecting Covid-19. The app, Close Contact Detector, was developed to help people find out whether they had been in close contact with someone who was potentially infected.

The travel history of patients who were tested positive for the virus was posted online via social platforms and media outlets, allowing other potential victims who had come close to the patient in the last few days to self-isolate and report to the concerned authorities. The much-matured smart city-based ecosystem which comprises the government, private firms and start-ups, came together to release mobile apps to help citizens check if they had been in contact with infected persons. In Suizhou, which is 170 km from Wuhan, 2.2 million citizens were able to register their health condition using mobile apps. Yang Fei, the vice chief for Fuhe town in the Suizhou smart city, emphasized that “the

[1] Until 11th March, WHO used epidemic to describe the virus outbreak.

technology we use today in epidemic control was hard to imagine in the past" (Jie & Quao, 2020, p. 1). A digital prevention system developed by Alibaba in collaboration with Suizhou enabled DingTalk and Alipay apps to allow citizens to register for health care systems. This technology enabled the self-registration of patients meaning there was a reduced need for them to visit hospitals and spread the infection to medical professionals (Jie & Qiao, 2020). In addition, two major hospitals with a capacity for 1000 beds each were built in Wuhan on war footing to accommodate infected patients.

4.3. Lockdown and quarantine

A new health code was implemented in over 100 cities via an online prevention system allowing people to share their travel history and health status. Every citizen is allocated with a QR (also known as Quick Response) code, which allows to track his/her movements. When citizens use public services such as public transportation or visit a super market, they are expected to scan their QR code. When infectors are detected, then those who could have been possibly infected, including those who travelled on the same bus or those who visited a super market at the same time, are informed and a quarantine procedure followed thereafter. Based on the information shared, individuals were allocated a particular color code. Those allocated a red color code were either affected by the virus or those had travelled recently to Hubei province. Those given a yellow code were required to self-isolate for two weeks (the incubation period for detecting the virus; Lauer et al., 2020), and those given a green code retained access to the city (Jie, 2020). AI determined the allocation of codes but very little information is available about the procedure used for allocation (Krolik & Satariano, 2020).

In addition, China also chose to lockdown the highly affected regions and cities. For instance, in Hubei, the lockdown was imposed from 23rd January, where 15 cities including Wuhan were completely locked down. Drones were employed to ensure that the lockdown was strictly implemented. The entire public transport system was suspended. Citizens were not allowed to leave their houses and neighborhood community-based committees were empowered to take group orders from residents.

While the entire world was closely observing China, its sophisticated technology-based manufacturing industry and technology-based ecosystems came to the rescue in assisting the authorities and imposing discipline among the masses. WHO refers to this approach as "unprecedented in public health history". The infrastructure China had built over the years to conduct surveillance on its citizens became a source of advantage.

5. Smart technologies and Covid-19: A Western perspective

While China was able to "implement astounding, unprecedented and medieval" policies in containing the virus transmission, such an approach may be hard to impose anywhere outside China (Cohen & Kupferschmidt, 2020, p. 963). Human rights experts, for instance, argue that the extreme surveillance measures followed in China may not work in other countries, as they impose severe restrictions on human rights of the citizens (Kupfesrchmidt & Cohen, 2020). While China largely focused on identifying those who are infected, Western democracies have focused on human-driven approach, comprises of collecting anonymous data, ensuring lockdowns, and quarantine. How this strategy varies from that adopted in China is now considered.

5.1. Active surveillance and identifying the infected

Unlike the surveillance system in Chinese smart cities, smart cities in Western democracies have heavily invested in the human capital of citizens. Western societies place significant importance on individual privacy and freedom, which have conventionally resulted in stringent privacy laws. For instance, several states in the United States have banned facial recognition technologies (Pyzyk, 2020). In Europe, the European Union General Data Protection Regulation which came into effect in 2018 aims for greater transparency in collecting and preserving data, thereby ensuring personal data protection. Although smart cities have adopted the IoT to a different degree, data protection laws ensure that the data is not used in such a way that individual freedom and privacy are curtailed. Accordingly, these countries have largely used means of consensus building and persuasion to control the virus transmission.

As a result, instead of rapidly employing technologies to screen citizens or access their mobile phones, the Italian and German governments approached mobile operators to share anonymous and aggregated data about the concentration and movements of the citizens in areas where Covid-19 is prevalent. The USA has conducted talks with Facebook and Google to access its anonymized data. A mismatch between regional and national policy regulations furthered the complications in sharing this anonymized data. Such data are useful to understand how many people are following the imposed strict lockdowns (Polina & Busvine, 2020). This is quite in contrast to the Chinese approach which was more active in identifying infected individuals. Governments often find it hard to navigate through data privacy laws and not to breach the trust conferred by the public on the government (Servick, 2020). In the UK, the National Health Service (NHS) partnered with Amazon, Microsoft and Hancock to analyze the data collected by the NHS telephone service to move available resources to tackle the pandemic. This partnership is expected to develop visual dashboards that offer necessary information for policy makers to inform effective policies (Kelion, 2020).

As existing technologies were not useful for collecting data from citizens due to the privacy regulations in place, several countries including the USA, Germany, France, Italy, Spain and the UK have adopted drive-through testing method to identify those who are infected. Further, universities and start-ups developed new apps that allow people to voluntarily share their data. The UK Covid symptom tracker app, for example, tracks the symptoms of infected individuals and determines the range of virus spreading in a particular area to help understand why some people become critically unwell compared to others (Wakefield, 2020). In order to collect more personalized data, startups have come forward to create voluntary and privacy-conscious tracking apps such as: Safe Paths in the USA, and GeoHealth in Germany which aims to collect GPS location data and store it for 28 days. These apps allows individuals to share their data with health officials, should they be tested positive for the virus (Servick, 2020). Similarly, Germany has developed Corona Data Donation smart watch App which gathers anonymous data from volunteers to track down the infections. However, pressure groups have immediately started to put pressure on the government to respect the privacy of citizens (Kelion, 2020).

5.2. Isolate the infected from others

Although Western democracies have well equipped technological potential and documented information about their citizens, the lack of coordination between regional and national governments in Spain, Italy, the USA, and the different health care departments in Italy, have limited their potential in isolating patients from non-patients. For instance, the Italian prime minister has emphasized that the regions which have the autonomy to implement healthcare have failed to manage the situation adequately. Different regions with different levels of understanding and a lack of coordination have contributed to the spread of the virus. For instance, in Spain, the regional government of Madrid and the national government have failed to coordinate in a timely way (Tremlett, 2020). The lack of coordination initially between smart cities has also resulted in people travelling from one city to another. Both in Italy (smart cities in the north to south), Spain (Madrid to Barcelona) and the USA (New York to other cities), people have

travelled from highly affected smart cities to other cities.

As citizens generally use their unique personal identification numbers for accessing healthcare facilities, government bodies in Italy have the necessary equipment to track down patients and thus strengthen their datasets. However, this information is typically handled by different uncoordinated regional and national healthcare institutions (Carinci, 2020). Italy has faced a situation whereby the lack of coordination between different healthcare departments has resulted in the failure to use available big data effectively. Smart cities, in general, require active coordination among different departments and levels of administration (Angelidou, 2014). Similar situations may be found in other decentralized administrative regimes, including in Germany and the USA, where regions and cities have powers to draw their own strategies, which sometimes would require special laws to impose one specific approach.

The initial lack of coordination between various departments, among different smart cities, and regional and national governments have all contributed to the failure to create effective strategies to use existing resources or to restrict the spread of the virus. Despite these limitations, the technologies are used to different degrees by governments to isolate infected individuals. Table 1 below summarizes the level of techno- and human-driven approaches adopted by China and Western democracies.

5.3. Lockdown and quarantine

While Western countries have not adopted technological approaches for screening and isolating infected patients, they have heavily focused on the lockdown of affected regions and/or entire countries. For instance, the UK, France, Spain, and Germany, among other countries, have followed the national lockdown approach. Although Italy started with regional lockdown, it later imposed a nation-wide lockdown. Overall, there is a general understanding that imposing lockdowns is somewhat draconian in free societies. As the Prime Minister of the UK claimed, “No prime minister wants to enact measures like this”. The police and army have been called in to impose lockdowns in these countries. Drones have been deployed in countries such as Spain, Italy, the USA, Germany and France to strictly implement lockdowns. By the time the lockdowns were imposed, the coordination among the government departments and different cities with their national governments has been strengthened in most of the countries.

6. How human intervention mediates the potential of technologies

The difference between the technological response from China and the Western democracies shows how an authoritative regime can force the use of smart technologies to address a pandemic. However, the very same authoritative regime also forcefully censored the voices of its citizens and reduced the potential of technologies to prevent the widespread infection of the virus. When Li Wenliang, the whistle-blower doctor who first identified the infection trend while working in the Wuhan Central Hospital sent a message in a chat forum to fellow doctors about the potential of the virus outbreak, his views were censored. Wuhan city authorities forced him to write an apology, and the government claimed that the doctor was disturbing the social order (Green, 2020). A total of eight individuals were investigated by the state in connection with this development. Many activists who questioned the government's initial response strategy were forced into quarantine despite not showing any symptoms related to the virus (Xiong & Gan, 2020). China is notoriously known for employing smart technologies to censor any content or data that citizens upload to social media websites that the government does not feel comfortable with (Westcott, 2020). United Nations Development Program (2015) for instance highlighted that, Chinese smart cities are largely focused on the technology infrastructure, known as hardware. Communities are seen as passive beneficiaries of these technologies rather than playing an active role in the society, which resonates with the hard technological determinism (Hu & Zheng, 2020). Overall, the Chinese context illustrates how technologies can be largely used to communicate government planning and to impose citizen compliance.

The Chinese crackdown on whistle-blowers has been a major concern in an authoritarian regime where citizens have very little freedom to express their opinions. Although the communication from Wenliang had the potential to spread information using a digital chat forum and quickly help people take precaution measures, the government nonetheless censored his views. This helped the government to ensure that the only information available was that which it released (Woodward, 2020). The censorship has potentially hampered the ability of digital technology – in this case, a chat forum – to control the spread of the virus to other parts of China and the world. Those who questioned the government's strategy have been put under house arrest. As Zhangrun (2020) summarizes, government and bureaucrats “stood by blithely as the crucial window of opportunity that was available to deal with the outbreak snapped shut in their faces” (p. 2). This is the reason he argues that this catastrophe has been turned into a manmade pandemic. In an interview, Wenliang highlighted that “If the officials had disclosed information about the epidemic earlier I think it would have been a lot better” (Green, 2020, p. 682).

Furthermore, scientists and activists have been silenced from speaking out about China's lack of early response (Thorp, 2020). Although cases in China started to appear from as early as 8th December 2019, the authorities did not make announcements about this until 7th January 2020 (Editorial, 2020a). The Mayor of Wuhan admitted that there had been a delay in announcing the information about the virus as the national government had not given clearance in a timely manner (Ayittey, Dzuvor, Ayittey, Chiwero, & Habib, 2020). In addition, it was not until 20th of January that information about human-to-human transmission was announced. However, Wenliang in his WeChat message sent on 31st December had emphasized the human-to-human transmission potential of the virus. Research has now confirmed that human-to-human transmission took place starting from the middle of December 2019 (Li et al, 2020). Although the Premier Jinping later ordered the free flow of information in a timely fashion, an array of information sources about Covid-19 were censored from the internet, depriving people of the opportunity to know more about the virus. As Kavanagh (2020) highlighted, openness, transference and quick reporting remain active response strategies during an outbreak, which

Table 1
China's Techno-driven approach versus human-driven approach adopted by western democracies.

	China	Western democracies
Identify	Largely relied on technologies to identify individuals who have been most likely infected.	Due to the rights conferred on the protection of individuals privacy, these countries rely on consensus building to access anonymous and aggregated data or to collect data from those who volunteer.
Isolate	Created awareness using technologies to ensure everyone, both infected and uninfected, could be traced with their mobile phones, in order to ensure quick isolation.	Lack of coordination between different departments and regional and national governments have constrained the potential to isolate quickly those who have been infected.
Quarantine	Heavily relied on technology imposed lockdowns	Relied on both technology assisted and manual lockdowns

had been altogether missed due to the authoritative nature of government action. Overall, the acts of censorship and the concealment of information resulted in reducing the potential of technologies to be harnessed to effectively communicate about the virus.

Compared to the Chinese context, Western democracies had plenty of time to plan their management of the crisis before potentially identifying transmitted cases in their regions. However, governments to different extents downplayed the potential of transmission and the damage it could cause. For instance, the president of the USA was vocal until the second week of March that the damage would be minimal. A similar strategy was visible in the case of the UK. Gaps in governance resulting from the decentralized political system remain a constraint to effectively implementing strategies. In addition, the individual freedom and rights conferred to individuals, the privacy protection laws enacted and the human-driven approaches adopted in smart cities, all limit the potential to actively adopt technologies to constrain the transmission of the virus compared to China.

7. Discussion

The findings indicate that while China has adopted a techno-driven approach, Western democracies have relied on a human-driven approach. As summarized in the Table 2 below, both the Chinese and Western governments have initially denied the potential risk from Covid-19. However, while China has denied the impact of the virus by adopting the means of suppression, the Western democracies have denied by freely sharing the information with their citizens. When it comes to the governance aspect, Chinese smart cities have actively coordinated where the majority of interventions have been drawn from the central government (Normile, 2020). In comparison, lack of coordination in the Western context between the cities, regional governments and the national governments have contributed to the quick transmission of the virus. When it comes to adopting ubiquitous technologies, China draws its strategies based on a techno-driven perspective, where its well established technological ecosystem has been mobilized to impose technological solutions (Hu & Zheng, 2020). In Western democracies, technologies are selectively used, partly due to the human-driven approach adopted in promoting technological ecosystems that allow limited use of technologies. For instance, Western democracies continue to rely on anonymous data, which may not be as effective as collecting data from individuals (Stamali, Papadopoulos, & Anagnostopoluos, 2015). The data protection laws in the Western democracies ensure personal data protection. Such a provision limits the governments options to collect data from citizens directly. As Caragliu et al. (2011) highlighted, these smart cities focus on social inclusion, knowledge networks, voluntary organizations, and social and relational capital, in addition to achieving social and environmental sustainability. The overall intention is to empower communities as smart communities which are able to develop their own smart technologies and use them for solving urban problems. In order to enhance creativity among citizens, these smart cities have invested in building city-level ecosystems that can bring government, communities, private firms and universities together, so that cities act as clusters of innovation to enable and facilitate the invention of technologies that look after their needs and bring competitive advantages to the cities (Kummitha & Crutzen, 2019).

Accordingly, the enhanced use of technologies and data collection in the Chinese context raise privacy concerns which are not addressed by the government authorities. The enormous investment in surveillance has meant that Chinese smart cities have become surveillance cities. Moreover, it has systems in place that ensure citizens follow rules set forth without fail and demonstrate discipline towards the government and state. For instance, the mobile phones of citizens are reportedly spied upon repeatedly using government-sponsored mobile applications such as Great Nation, which is used by 100 million registered users including students, civil servants and workers that have installed the app under pressure from the government. Scores are allocated to those who spend time on the app, which is seen as a symbol of patriotism as the app allows citizens to learn about the leader and the history of the country. Those with low scores are often shamed and penalized in schools and workplaces (Hernadez, 2019). As Braun, Fung, Iqbal, and Shah (2018) highlighted, more data collection would create further opportunities for privacy invasion, whereas Western democracies are forced to work within strict data privacy laws that protect the privacy of their citizens.

Most importantly, citizens are disciplined while using technologies in China such that whistleblowers and other activists were silenced from raising further concerns about the Chinese authority's regime. Thus, controlling transmission and censoring the whistleblower about transmissions reflect the use of technology for meeting contradictory ends. Technologies are instead used by the government in the Western democracies to inform decisions and to find ways in which problems can be addressed (Hollands, 2008; Komninos, 2008). Further, activists are freely allowed to write to the governments to speak up about the rights of the citizens and to seek for transparency in the governments approach. While these countries have freely shared the data about the virus transmission and allowed everyone aware about the growing trends, China has been accused of concealing information from public and international community. However, due to the techno-driven approach, China has not reportedly witnessed infodemic. Infomedic refers to the misinformation in circulation. Whereas the widespread availability of social media in Western democracies resulted in infodemic, as the WHO director highlights “we're not just fighting an epidemic (pandemic); we're fighting an infodemic” (The Lancet, 2020, p. 537). These findings highlight that a techno-driven approach may be more effective compared to human-driven approach in controlling the virus transmission during pandemics. The political and social arrangements in Western democracies most likely do not allow top-down technological visioning, thereby reducing the potential impact that technologies can have.

7.1. Theoretical implications

The case of Covid-19 highlights that the smart technological response to controlling a pandemic may be more effective in authoritative regimes, as we have witnessed in the Chinese context. Governments

Table 2
Summary of the different responses from China and Western democracies.

	China	Western democracies
Initial response	Denial by suppression	Denial by communication
Governance	Coordination: Centrally controlled administrative regime was able to quickly coordinate with the cities and impose rules and regulations	Lack of coordination: Decentralized power concentration between the city and national governments resulted in lack of coordination
Smart technologies	Smart technologies are deployed ubiquitously	Technologies are selectively deployed
Privacy	Government has unanswered privacy concerns	Governments have clarified their protection of privacy
Activism	Whistle-blowers are not allowed to speak up	Activists can write to the governments and speak up about their rights
Information sharing	Accused of hiding information	Openly share information within and outside the country
Infodemic	Very limited due to censorship	Prevalent due to the mass usage of social media.

may gain full control over the situation by adopting a techno-driven approach and imposing technologies to tackle the pandemic. The enhanced use of technology allowed Chinese authorities to reach into the private space of individuals and breach the privacy of its citizens. Such a forceful approach helped the Chinese regime keep the virus transmission under control in a relatively quick timeframe (Johnson, Robinson, & Philpot, 2020). The level of technology deployed to impose government regulations shows that technology is useful for taking forward the stringent policies set forth. The well-established smart technology ecosystem aids their cities and lets the national government coordinate the strategy. While conventionally, societal needs and norms determine individual behavior, modern days mark the enhanced use of technologies to impose discipline and compliance. The Covid-19 response from China provides direct answers for smart city researchers who raised questions around the problem-solving potential of urban technologies (Greenfield, 2013). The techno-driven approach proven effective to control the virus transmission. However, Western democracies may choose much more holistic approaches by the means of consensus and persuasion, where technologies are used to educate citizens and ensure their compliance with the rules set forth. Under such circumstances, controlling the transmission of the pandemic may be slow and time-consuming. Although technological ecosystems are active in Western democracies, they are mostly oriented towards adopting human-driven approach.

Despite the positive effect in controlling the transmission in the Chinese context, the authoritative nature of the political establishment has, in fact, limited the potential of the technology itself through censorship. Concealing information about the virus for over a month allowed it to transmit among the population and across regions. As a result, the nature of the political and institutional context moderates the level of surveillance and discipline imposed. The political and institutional context played a major role in limiting technological determinism (Janssen & Kuk, 2016). In the Western context, the societal and institutional set up does not allow the top-down approaches followed in the Chinese context. Thus, it is safe to argue that, although smart technologies are said to have transformative powers, their potential is subject to the social, political and institutional context in which they are deployed (Kuk & Janssen, 2013; Kummitha, 2020). Earlier research has articulated that smart city initiatives often lack the engagement of social and political conditions (Luque-Ayala & Marvin, 2015). However, the present work highlights that the political and institutional context has indeed played a key role in determining the course of action for controlling the virus transmission.

Further, early research emphasized that smart technologies institutionalize and mechanize processes by collecting and analyzing data and then solving problems without significant levels of human intervention (Chatterjee, Kar, & Gupta, 2018) and that interaction between humans and devices would result in 'superior judgements' (Sohoemaker & Tetlock, 2017). The literature has also emphasized that smart city spaces are governed by algorithmic administration and categorization (Dalton, Wilmott, Fraser, & Thatcher, 2020), whereas this research demonstrates that such an understanding is merely an imaginary. This research also highlights that governments continue to retain their agency and conceal information that they deem not to be shared, which limits the influence of technologies. Although the smart city literature emphasizes that technologies aid city authorities in addressing stubborn social problems, the way that Covid-19 has been handled highlights that the techno-driven approach do not directly result in technological determinism, rather, it offers a vector of options for decision-makers to choose, based on their own judgment. As a result, the impact of smart technologies is less effective in smart cities than has been projected in the literature (Hollands, 2008), because of the way humans use, interpret, manipulate and communicate the trends picked by the IoT based on political and institutional needs. In addition, the potential of technologies is constrained by the social and institutional arrangements prevalent in national contexts. Thus, those who govern may continue to exploit new-age technologies for their own benefit.

7.2. How to control human-to-human transmission during a pandemic? Five practical recommendations

First, we have learned that the Chinese techno-driven approach appears to be more promising than the human-driven approach largely adopted in Western democracies. However, one specific aspect governments should address during health emergencies is ensuring that their citizens are fully informed about their privacy rights and assured that any data collected during the pandemic will be handled to benefit the society at large. Governments also need to ensure that the enhanced collection and use of data will be temporary and the activity will cease once the situation comes under control. In this way, governments will be able to assure their citizens about their rights and the governmental responsibility to protect these rights. Such an approach allows citizens to voluntarily come forward to communicate their health data and download dedicated mobile apps to share their health updates and location histories. In countries where the top-down adoption of technologies is impossible, this approach allows crowdsourcing the information from citizens. A specific strength of technological advancement is that communities even in the developing and least developed countries have access to mobile technologies, and hence, data may still be sourced (Klaus, 2020).

Second, governments need to actively share the information they collected about infectious diseases with their citizens and global community. This allows global community to make necessary arrangements to prevent the transmission. Governments may be able to roll out early surveillance measures and organize the medical supply chains. As advised by WHO and learned from the Chinese context, early surveillance is the most effective strategy available for the prevention of transmission. While conducting the surveillance that matches with the Chinese approach may not be possible in most of the modern democracies, the governments need to impose lockdowns as early as possible. The delay in imposing lockdowns may result in excessive transmission as happened in several Western countries in the case of Covid-19.

Third, cities need to partner with each other in addition to actively coordinating with the national governments. Authoritative regimes may need to empower their regional governments to share health related information quickly, whereas in the Western context, the coordination between regional and national governments needs to engage in a sustained effort to minimize the impact.

Fourth, in order to control the impact of infodemic, there is a need that the authorities keep vigilant and ensure passing the information to the public quickly. Governments may need to partner with the technology based firms that own the social media platforms to control infodemic. Fifth, there is a need for sharing best practices among the countries such as encouraging different key stakeholders in their technological ecosystems to come together to invent and implement necessary technologies which may help detect and isolate the infected patients, and build community-level resilience in order to cope with the crisis. I believe that this is the right time to promote the smart community concept where communities build resilient and address their own social problems (Gil-Garcia, Helbig, & Ojo, 2014).

8. Conclusions

This paper discussed how China and Western democracies differ in their approaches to adopting smart technologies to control the transmission of the Covid-19 pandemic. While Chinese smart cities have actively coordinated and let the national government take control over the regions in a techno-driven approach, the smart cities in the Western democracies have initially lacked in their coordination efforts with the national governments and adopted a human-driven approach to control the transmission. Although both China and Western democracies have well-established technological regimes, technological usage differed

significantly in both contexts, largely as a result of constraints imposed by the political and institutional environments. While in the Chinese context, governments adopted top-down technologies to discipline and censor their citizens, in the Western context, technologies were used to inform, persuade and attain consensus among citizens to help limit virus transmission. In both contexts, findings highlight that humans mediate with the technologies and limit their impacts. However, there is an overall concern that governments may take advantage of the Covid-19 to reinforce technological visioning on citizens beyond controlling the pandemic.

8.1. Limitations and future research

The issues discussed in this paper need to be generalized with caution. First, given the ongoing nature of Covid-19, many aspects highlighted in this article may continue to evolve. Second, the newspaper-based analysis used in this article was unstructured. For instance, experts have specifically raised their concerns about China's capabilities regarding censorship. They argue that the WHO and the Western media have largely relied on the information censored by the Chinse government to make their arrangements (Jong, 2020). Hence, these findings need to be generalized with caution.

The Covid-19 outbreak is not only about health care, but also businesses, livelihoods, wellbeing, innovation and resilience. While medical researchers and scientists are active in bringing out new findings and data about the pandemic, scholars from other disciplines should come forward and contribute to advancing our combined potential to face this pandemic. In particular, it would be interesting to understand how cities and governments in other countries are handling the pandemic. Further research may focus on rural areas as well to understand the strategies rural communities and governments adopt to limit the transmission.

It may also be useful to understand how technologies are used to enhance the potential of the health care systems in different countries. It will also be interesting to study how service firms, including essential delivery services, have used technology to aid delivery. For instance, Lin (2020) shows that during the lockdowns grocery orders were delivered in 20 min in major cities in China. However, we need more evidence from different parts of the globe. There is also evidence that community-based initiatives, both technological and non-technological in nature, are in effect to serve the most needy and vulnerable. For instance, community-based apps, such as the Nextdoor app, offer necessary support for those in need in the community. Thus, it is worthwhile to study community-level resilience and how it supplements or even replaces technological responses to handling the pandemic. The other research avenue is to study how governments, technology firms and international agencies address the infodemic to control fake news. Overall, research on the technological innovations, local community active participation to build resilience, partnerships being built to contain the outbreak, and process innovations could build the resilience of cities and help address the current and future outbreaks.

In addition, lockdowns have resulted in the world's largest work from home experiment. It will be worthwhile to study how various technologies have been useful for workers, universities and businesses. For social scientists, it is an opportunity to study several rarely experienced occurrences. What happens when everyone works from home, universities go online, communities follow social distancing, and governments are free to collect whatever information they wish to collect or make new provisions and laws to enhance their own powers, thus curtailing human rights and citizen privacy (Harari, 2020). While the majority of these changes will return to previous normality in due course, governments may continue to employ some measures that restrict the freedom and powers of individuals. For example, the National Assembly of Hungary voted to confer sweeping powers to the government to rule by decree during the Covid-19 emergency. Thus, it would be interesting to understand what kind of impact such developments leave on the society. Further, it is also worthwhile to study how the technologies and innovations employed by the governments to control the Covid-19 transmission are used beyond the pandemic control and how citizens react to them.

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References

Albino, V., Berardi, U., & Dangelico, R. M. (2015). Smart cities: Definitions, dimensions, performance, and initiatives. *Journal of Urban Technology, 22*(1), 3–21.

Andrelini, J. (2019). How China's smart city tech focuses on its own citizens. *Financial Times*https://www.ft.com/content/46bc137a-5d27-11e9-840c-530737425559/ accessed 28 February 2020.

Androutsopoulou, A., Karacapilidis, N., Loukis, E., & Charalabidis, Y. (2019). Transforming the communication between citizens and government through AI-guided chatbots. *Government Information Quarterly, 36*(2), 358–367.

Angelidou, M. (2014). Smart city policies: A spatial approach. *Cities, 41*(1), S3–S11.

Ayittey, F. K., Dzuvor, C., Ayittey, M. K., Chiwero, N. B., & Habib, A. (2020). Updates on Wuhan 2019 novel coronavirus epidemic. *Journal of Medical Virology, 92*(4), 403–407.

Bannister, F., & Connolly, R. (2020). The future ain't what it used to be: Forecasting the impact of ICT on the public sphere. *Government Information Quarterly, 37*(1), 101410.

Bimber, B. (1994). Three faces of technological determinism. In R. Smith, & L. Marx (Eds.). *Does Technology Drive History? The Dilemma of Technological Determinism* (pp. 79–100). Cambridge, MA: MIT Press.

Boschma, R., Heimeriks, G., & Balland, P. (2014). Scientific knowledge dynamics and relatedness in biotech cities. *Research Policy, 43*(1), 107–114.

Braun, T., Fung, B. C. M., Iqbal, F., & Shah, B. (2018). Security and privacy challenges in smart cities. *Sustainable Cities and Society, 39*, 499–507.

Caragliu, A., Bo, C., & Nijkamp, P. (2011). Smart Cities in Europe. *Journal of Urban Technology, 18*(2), 65–82.

Cardullo, P., & Kitchin, R. (2019). Smart urbanism and smart citizenship: The neoliberal logic of "citizen-focused" smart cities in Europe. *Environment Planning C: Politics and Space, 37*(5), 813–830.

Care, S., Trotta, A., Care, R., & Rizzello, A. (2018). Crowdsourcing for the development of smart cities. *Business Horizon, 61*(4), 501–509.

Carinci, F. (2020). Covid-19: preparedness, decentralisation, and the hunt for patient zero. *BMJ*. https://doi.org/10.1136/bmj.m799 368:bmj.m799.

Chatterjee, S., Kar, A. K., & Gupta, M. P. (2018). Success of IoT in smart cities of India: An empirical analysis. *Government Information Quarterly, 35*(3), 349–361.

Cohen, J., & Kupfesrchmidt, K. (2020). Strategies shift as coronavirus pandemic looms. *Globalization and Health, 367*, 962–963.

Dalton, C., Wilmott, C., Fraser, E., & Thatcher, J. (2020). "smart" discourse, the liits of representation, and new regimes of spatial data. *Annals of American Association of Geographers, 110*(2), 485–496.

Dameri, R. P., Benevolo, C., Veglianti, E., & Li, Y. (2019). Understanding smart cities as a glocal strategy: A comparision between Italy and China. *Technological Forecasting and Social Change, 142*, 26–41.

Davenport, T. J., & Ronanki, R. (2018). Artificial intelligence for the real world. *Harvard Business Review,* 1–10.

Diaz-Diaz, R., Munoz, L., & Perez-Gonzalez, D. (2017). Business model analysis of public services operating in the smart city ecosystem: The case of SmartSantander. *Future Generation Computer Systems, 76*, 198–214.

Editorial (2020a). Rapid outbreak response requires trust. *Nature Microbiology, 5*, 227–228.

GEN (2020). BGI's coronavirus response?: Building a lab in Wuhan, China. *Genetic Engineering & Biotechnology News, 40*(3), 10–11.

Gil-Garcia, J. R., Helbig, N., & Ojo, A. (2014). Being smart: Emerging technologies and innovation in the public sector. *Government Information Quarterly, 31*(1), I1–I8.

Gil-Garcia, J. R., Zhang, J., & Puron-Cid, G. (2016). Conceptualizing smartness in government: An integrative and multi-dimensional view. *Government Information Quarterly, 33*(3), 524–534.

Green, A. (2020). Li Wenliang. *The Lancet*. https://doi.org/10.1016/S0140-6736(20)30382-2.

Greenfield, A. (2013). *Against the smart city (the city is here for you to use: Book 1)*. New York: Do project.

Harari, Y. N. (2020). Yuval Noah Harari: The World After Coronavirus. https://www.ft.com/content/19d90308-6858-11ea-a3c9-1fe6fedcca75.

Helbig, N., Gil-Garcia, J. R., & Ferro, E. (2009). Understanding the complexity of electronic government: Implications from the digital divide literature. *Government Information Quarterly, 26*(1), 89–97.

Hernadez, J. C. (2019). The hottest app in China teaches citizens about their leader – and, yes, that's a test. *The New York Times*https://www.nytimes.com/2019/04/07/world/asia/china-xi-jinping-study-the-great-nation-app.html/ accessed 28 February 2020.

Heymann, D. L., & Shindo, N. (2020). COVID-19: What is next for public health? *The Lancet, 395*(10224), 22–28.

Hollands, R. G. (2008). Will the real smart city please stand up? *City: Analysis of Urban Trends, Culture, Theory, Policy, Action, 12*(3), 303–320.

Hu, Q., & Zheng, Y. (2020). Smart city initiatives: A comparative study of American and Chinese cities. *Journal of Urban Affairs*. https://doi.org/10.1080/07352166.2019.1694413.

Jakhar, P.. Coronavirus: China's tech fights back. (2020). https://www.bbc.co.uk/news/technology-51717164 retrieved on 20 March, 2020.

Janssen, M., & Kuk, G. (2016). The challenges and limits of big data algorithms in technocratic governance. *Government Information Quarterly, 33*(3), 371–377.

Ji, W., Wang, W., Zhao, X., Zai, J., & Li, X. (2020). Cross-species transmission of the newly identified coronavirus 2019-nCoV. *Journal of Medical Virology, 92*(4), 433–440.

Jie, S.. Big data, grid management support disease control in Quzhou. (2020). https://www.globaltimes.cn/content/1179731.shtml/ accessed 20 February 2020.

Jie, S., & Qiao, L. (2020). Smart city projects help China contain coronavirus. *Global Times*. retrieved from https://www.globaltimes.cn/content/1179737.shtml/ accessed 2 March 2020 .

Johnson, P. A., Robinson, P. J., & Philpot, S. (2020). Type, tweet, tap, and pass: How smart city technology is creating a transactional citizen. *Government Information Quarterly, 37*(1), 101414.

Jong, M. (2020). The Shadow of a Black Swan in China. https://www.eur.nl/en/news/shadow-black-swan-china.

Kamel Boulos, M. N., & Al-Shorbaji, N. M. (2014). On the internet of things, smart cities and the WHO healthy cities. *International Journal of Health Geographics, 13*, 10. https://doi.org/10.1186/1476-072X-13-10.

Kamel Boulos, M. N., Resch, B., Crowley, D. N., et al. (2011). Crowdsourcing, citizen sensing and sensor web technologies for public and environmental health surveillance and crisis management: Trends, OGC standards and application examples. *International Journal of Health Geographics, 10*, 67. https://doi.org/10.1186/1476-072X-10-67.

Kankahalli, A., Charalabidis, Y., & Mellouli, S. (2019). IOT and AI for smart government: A research agenda. *Government Information Quarterly, 36*(2), 304–309.

Karpal, A.. use of surveillance to fight coronavirus raises concerns about government power after pandemic ends. (2020). https://www.cnbc.com/2020/03/27/coronavirus-surveillance-used-by-governments-to-fight-pandemic-privacy-concerns.html accessed on 1 April, 2020.

Kavanagh, M.. Transparency and Testing Work Better Than Coercion in Coronavirus Battle. (2020). https://foreignpolicy.com/2020/03/16/coronavirus-what-works-transparency-testing-coercion/ retrieved on 26 March 2020.

Keegan, M. (2019). Big brother is watching: Chinese city with 2.6m cameras is world's most heavily surveilled. *The Guardian*https://www.theguardian.com/cities/2019/dec/02/big-brother-is-watching-chinese-city-with-26m-cameras-is-worlds-most-heavily-surveilled/ accessed 24 February 2020.

Kelion, L. (2020). UK coronavirus app must respect privacy rights. https://www.bbc.co.uk/news/technology-52003984.

Kennedy, M. T. (2008). Getting counted: Markets, media, and reality. *American Sociological Review, 73*, 270–295.

Kim, N., Lee, H., Kim, W., Lee, H., & Suh, J. H. (2015). Dynamic patterns of industry convergence: Evidence from a large amount of unstructured data. *Research Policy, 44*(9), 1734–1748.

Kitchin, R. (2014). The real-time city? Big data and smart urbanism. *GeoJournal, 79*(1), 1–14.

Klaus, I.. Pandemics are also an urban planning problem. (2020). https://www.citylab.com/design/2020/03/coronavirus-urban-planning-global-cities-infectious-disease/607603/ accessed 6 March 2020.

Komninos, N. (2008). *Intelligent Cities and Globalization of Innovation Networks.* New York: Routledge.

Krolik, A., & Satariano, A. (2020). As coronavirus surveillance escalates, personal privacy plummets. https://www.nytimes.com/2020/03/23/technology/coronavirus-surveillance-tracking-privacy.html.

Kshetri, N. (2017). The evolution of the internet of things industry and market in China: An interplay of institutions, demands and supply. *Telecommunication Policy, 41*(1), 49–67.

Kuk, G., & Janssen, M. (2013). Assembling infrastructures and business models for service design and innovation. *Information Systems Journal, 23*, 445–469.

Kumar, V., Ramachandran, D., & Kumar, B. (2020). Influence of new-age technologies on marketing: A research agenda. *Journal of Business Research*. https://doi.org/10.1016/j.jbusres.2020.01.007.

Kummitha, R. K. R. (2018). Entrepreneurial urbanism and technological panacea: Why smart city planning needs to go beyond corporate visioning? *Technological Forecasting and Social Change, 137*, 330–339.

Kummitha, R. K. R. (2019). Smart cities and entrepreneurship: An agenda for future research. *Technological Forecasting and Social Change, 149*, 119763.

Kummitha, R. K. R. (2020). Why distance matters: The relatedness between technology development and its appropriation in smart cities. *Technological Forecasting & Social Change* In press.

Kummitha, R. K. R., & Crutzen, N. (2017). How do we understand smart cities? An evolutionary perspective. *Cities, 67*, 43–52.

Kummitha, R. K. R., & Crutzen, N. (2019). Smart cities and the citizen-driven internet of things: A qualitative inquirty into an emerging smart city. *Technological Forecasting and Social Change, 140*, 44–53.

Kupfesrchmidt, K., & Cohen, J. (2020). Can China's COVID-19 strategy work elsewhere? *Science, 367*, 1061–1062.

Kylili, A., & Fokides, P. A. (2015). European smat cities: The role of zero energy buildings. *Sustainable Cities and Society, 15*, 86–95.

Lauer, S. A., et al. (2020). The incubation period of coronavirus disease 2019 (COVID-19) from publicly reported confirmed cases: Estimation and application. *Annals of Internal Medicine*. https://doi.org/10.7326/M20-0504.

Lee, J., & Lee, H. (2014). Developing and validating a citizen-centric typology for smart city services. *Government Information Quarterly, 31*(1), S93–S105.

Quan Li, M. Med., Xuhua Guan, Ph. D., Peng Wu, Ph. D., Xiaoye Wang, M. P. H., Lei Zhou, M. Med., et al. (2020). Early transmission dynamics in Wuhan, China, of Novel Coronavirus infected pneumonia. *The New England Journal of Medicine*. https://doi.org/10.1056/NEJMoa2001316.

Li, L. (2018). China's manufacturing locus in 2025: With a comparison of "made-in-China 2025" and "industry 4.0". *Technological Forecasting and Social Change, 135*, 66–74.

Lin, C. (2020). Delivery technology is keeping Chinese cities afloat through coronavirus. *Harvard Business Review*https://hbr.org/2020/03/delivery-technology-is-keeping-chinese-cities-afloat-through-coronavirus retrieved on 25 March, 2020.

Ling, C., & Naughton, B. (2016). An institutionalized policy-making mechanism: China's return to techno-industrial policy. *Research Policy, 45*(10), 2138–2152.

Liu, F., Simon, D. F., Sun, Y., & Cao, C. (2011). China's innovation policies: Evolution, institutional structure, and trajectory. *Research Policy, 40*(7), 917–931.

Liu, H., & Li, Y. (2020). Smart cities for emergency management. *Nature, 578*, 515.

Luque-Ayala, A., & Marvin, S. (2015). Developing a critical understanding of smart urbanism? *Urban Studies, 52*(12), 2105–2116.

Mak, R. (2020). Breakingviews – Wuhan virus will shape China's smart city vision. https://www.nasdaq.com/articles/breakingviews-wuhan-virus-will-shape-chinas-smart-city-vision-2020-01-24/.

Martinez-Balleste, A., Perez-martinez, P. A., & Solanas, A. (2013). The pursuit of citizens' privacy: a privacy-aware smart city is in IEEE Communications Magazine. *51*(6), 136–141.

McCall, B. (2020). COVID-19 and artificial intelligence: protecting health-care workers and curbing the spread. *The Lancet Digital Health, 2*(4), PE166–PE167. https://doi.org/10.1016/S2589-7500(20)30054-6.

Mills, C. E., Robins, J. M., & Lipsitch, M. (2004). Transmissibility of 1918 pandemic influenza. *Nature, 432*, 904–906.

Mora, L., Bolici, R., & Deakin, M. (2017). The first two decades of smart-city research: A bibliometric analysis. *Journal of Urban Technology, 24*(1), 3–27.

Mora, L., Deakin, M., & Reid, A. (2019b). Strategic principles for smart city development: A multiple case study analysis of European best practices. *Technological Forecasting and Social Change, 142*, 70–97.

Mora, L., Deakin, M., Reid, A., & Angelidou, M. (2019). How to overcome the dichotomous nature of smart city research: Proposed methodology and results of a pilot study. *Journal of Urban Technology, 26*(2), 89–128.

Nograsek, J., & Vintar, M. (2014). E-government and organizational transformation of government: Black box revisited? *Government Information Quarterly, 31*(1), 108–118.

Normile, D. (2020). Can China return to normalcy: While keeping the coronavirus in check? *The Science*. https://doi.org/10.1126/science.abb9384.

Osterholm, M. T. (2005). Preparing for the next pandemic. *The New England Journal of Medicine, 352*(18), 1839–1842.

Polina, E., & Busvine, D. (2020). *European mobile operators share data for coronavirus fight.* Reutershttps://www.reuters.com/article/us-health-coronavirus-europe-telecoms/european-mobile-operators-share-data-for-coronavirus-fight-idUSKBN2152C2.

Pool, I. (1983). *Technologies of Freedom.* Cambridge: Harvard University Press.

Pyzyk, K. (2019). No US city makes top 10 of global smart city ranking. https://www.smartcitiesdive.com/news/no-us-cities-make-top-10-of-global-smart-city-ranking/564330/.

Pyzyk, K. (2020). Outpacing an outbreak: How tech helps cities handle public health threats. https://www.smartcitiesdive.com/news/outpacing-an-outbreak-how-tech-helps-cities-handle-public-health-threats/572372/.

Servick, K. (2020). Cellphone tracking could help stem the spread of coronavirus. Is privacy the price? *Science*. https://doi.org/10.1126/science.abb8296.

Sohoemaker, P. J. H., & Tetlock, P. E. (2017). Building a more intelligent Enterprise. *Sloan Management Review, 58*(3), 28–38.

Stamali, T., Papadopoulos, T., & Anagnostopoluos, D. (2015). Social media for openness and accountability in the public sector: Cases in the Greek context. *Government Information Quarterly, 32*(1), 12–29.

Sun, T. Q., & Medaglia, R. (2019). Mapping the challenges of artificial intelligence in the public sector: Evidence from public healthcare. *Government Information Quarterly, 36*(2), 368–383.

The Lancet (2020). COVID-19: Fighting panic with information. *The Lancet, 395*, 537.

The World Bank. Urban Development. (2019). https://www.worldbank.org/en/topic/urbandevelopment/overview/ accessed 10 February 2020.

Thorp, H. H. (2020). The costs of secrecy. *Science, 367*, 959.

Tremlett, G. (2020). How did Spain get its Coronavirus response so wrong? https://www.theguardian.com/world/2020/mar/26/spain-coronavirus-response-analysis.

UNDP (2015). Rethinking smart cities: ICT for new-type urbanization and public participation at the city and community level in China. https://www.cn.undp.org/content/china/en/home/library/democratic_governance/Rethinking-Smart-Cities_ICT-for-New-type-Urbanization-and-Public-Participation-at-the-City-and-Community-Level-in-China.html/.

Wakefield, J. (2020). Coronavirus: Tracking app aims for one million downloads. https://

www.bbc.co.uk/news/technology-52033210.
Westcott, B. (2020). China has made eating wild animals illegal aftet the coronavirus outbreak. But ending the trade wont' be easy. https://edition.cnn.com/2020/03/05/asia/china-coronavirus-wildlife-consumption-ban-intl-hnk/index.html/.
WHO (2020a). *Report on the WHO-China joint mission on Coronavirus disease 2019 (COVID-19), 16–24 February 2020*.
WHO. Global surveillance for COVID-19 disease caused by human infection with novel coronavirus (COVID-19). (2020). https://www.who.int/publications-detail/global-surveillance-for-human-infection-with-novel-coronavirus-(2019-ncov)/ accessed 9 March 2020.
Woodward, A. (2020). At least 5 people in China have disappeard, gotten arrested, or been silenced after speaking out about the coronavirus- here's what we know about them. *Business Insider*https://www.businessinsider.com/china-coronavirus-whistleblowers-speak-out-vanish-2020-2?r=US&IR=T/ accessed 24 February 2020.
Wu, Y., Zhang, W., Shen, J., Mo, Z., & Peng, Y. (2018). Smart city with Chinese characteristics against the background of big data: Idea, action and risk. *Journal of Cleaner Production, 173*, 60–66.
Xiong, Y., Gan, N. (2020). This Chinese doctor tried to save lives, but was silenced. Now he has coronavirus, CNN, https://edition.cnn.com/2020/02/03/asia/coronavirus-doctor-whistle-blower-intl-hnk/index.html/disclosed information about the epidemic accessed 8 February 2020.
Zhang, M. Y. (2016). Meso-level factors in technological transitions: The development of TD-SCDMA in China. *Research Policy, 45*(2), 546–559.
Zhang, N., Zhao, Z., & He, X. (2019). Understanding the relationship between information architectures and business models: An empirical study on the success configurations of smart communities. *Government Information Quarterly*. https://doi.org/10.1016/j.giq.2019.101439.
Zhangrun, X. (2020). Viral alarm: When fury overcomes fear. *ChinaFile*. Retrieved from https://www.chinafile.com/reporting-opinion/viewpoint/viral-alarm-when-fury-overcomes-fear/ accessed 11 March 2020 .
Zhu, S., Li, D., & Feng, H. (2019). Is smart city resilient? Evidence from China. *Sustainable Cities and Society, 50*, 101636.
Zvolska, L., Lehner, M., Palgan, Y. V., Mont, O., & Pleplys, A. (2019). Urban sharing in smart cities: The cases of Berlin and London. *Local Environment: The International Journal of Justice and Sustainability, 24*(7), 628–645.