Security and Health: Biopolitical Health Surveillance in China's Digital Response to COVID-19

by

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Abstract

Why is health a security issue now? An emerging paradigm that links epidemics and security concerns has influenced how we think about health and the preparedness of health surveillance. As the ongoing COVID-19 pandemic has swept the world with its tremendous threats to public health and societies, innovative digital health surveillance technologies have been (and continue to be) developed for pandemic surveillance. With a special focus on China's Health Code system and its implementation in Wuhan since the Wuhan lockdown, this thesis aims to examine the surveillance dynamics of such technological artefacts. In doing so, this thesis applies institutional ethnography (IE) to illustrate how the ruling relations embedded in such assemblages coordinate and organize citizens' everyday lives. The primary findings of this thesis suggest that Health Code as a health security practice is a flexible and dynamic surveillance assemblage embedded with political classifications and decisions to define and mediate risk in everyday settings, located in a larger network of power relations. The insecurities and anxieties brought by the normalized use of Health Code exacerbate the fear of being classified as sick, as the threat of illness leads people to embrace the current situation and cooperate with the existing surveillance system through the rationalization of collective norms and the valorization and stabilization of data-driven knowledge.

Keywords: institutional ethnography; digital health surveillance; security and health; biopolitics; surveillance studies

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List of Acronyms

IE	Institutional Ethnography
SARS	Severe Acute Respiratory Syndrome
GFT	Google Flu Trend
GT	Google Trends
FNY	Flu Near You
UNGP	United Nations Global Pulse
WHO	World Health Organization
BLE	Bluetooth Low Energy
GovTech	Government Technology Agency
CCTV	Closed-Circuit Television Cameras
SAMR	State Administration for Market Regulation
COVID-19	Coronavirus Disease 2019
CTID	Cyber Trusted Identity
IOGSP	Integrated Online Government Service Platform

Chapter 1. Introduction

My interests in digital health surveillance technologies emerged out of my distanced observations of and perceptions about China's digital solutions in response to the COVID-19 pandemic. As a native of Wuhan, China, I began hearing about a mysterious and novel illness which appeared in Wuhan city before it was front page news in North America, during the late days of 2019. The mysterious outbreak quickly exhausted the public health resources and local authorities were operating in radical uncertainty faced as a result of the unprecedented crisis of what came to be known as the COVID-19 pandemic. My concerns and worries for my family grew as authorities in China decided to impose a massive lockdown in Wuhan which included stringent measures such as local confinement, quarantine, isolation and more. In the meantime, besides the pandemic control measures implemented in Wuhan during the lockdown, local authorities also launched a new digital application called Health Code that could determine users' risk level of exposure to the virus via big data analytics. Out of curiosity, anxiety, doubt, or mixed feelings, soon after the official launch of the system, most of my friends and family members signed onto the system, fed in their personal information and health data, and applied for their health codes. After signing in, the Health Code system assigned personal health codes to individuals, which are colored QR codes which are either green, yellow or red, with each colour having different meanings. A red health code indicates a high-risk status of infection of the virus, a yellow health code implies a moderate-risk of infection, and a green code suggests a low-risk status. All of a sudden, the personal health codes became something to hold on to during a time of crisis for individual citizens in Wuhan. After the lockdown ended, as Wuhan started to slowly restore normal social activities, Health Code was not abandoned, but used as a digital support to contact tracing in epidemiological investigations, by tracking human mobility within the city. The digital health codes were used as a kind of health credential of individuals who were required to present the codes whenever an individual wanted to enter public places. Health Code was adapted to the post-lockdown conditions in that it generated new forms of risks and insecurities to maintain its utility.

Health Code, the digital application implemented during the crisis, is continually used in almost every city in China, and seems still to have held some sorts of meaning for those using it, into the present. As an outsider watching all of these social processes from Canada, I witnessed how an innovative health surveillance technology emerged out of nowhere, and quickly become a necessity in people's daily practices. Aside from the case in China, at the time of writing, digital tools such as contact tracing apps, virtual vaccine passports and related applications have been developed and introduced as a part of pandemic control strategies in many countries including Canada (Madianou, 2020; Meaney, 2021). As a relatively new resident of Canada (I arrived at the end of August 2019, 5 months before the Wuhan lockdown) and Chinese citizen, I found myself pondering the varied surveillance implications of such a novel digital health surveillance technology in China, and whether the rest of the world would soon be riding a digital wave of pandemic control. With this as the backdrop, I decided to focus my thesis research on the use of the Health Code system in Wuhan.

I began my inquiry by examining the existing literature and scholarly work related to my mode of inquiry. This exploring practice of related academic literature led me to a set of exciting fields and concepts within those fields. The current digital health surveillance technologies are not the first to apply advances in digital technology and big data analytic tools in disease control and health surveillance. Surveillance in public health is considered as positive and a significant element in disease control (Thacker et al., 1989). A new field of digital epidemiology that focuses on using digital technologies to improve epidemiology and health surveillance has been growing rapidly in the past few years. Early examples of digital epidemiology used digital traces of online user behaviors, web search queries, phone call data records, etc., for the purpose of disease surveillance (Ginsberg et al., 2009; Signorini et al., 2011; Wesolowski et al., 2012). As some believed digital epidemiology could be a valid support for disease control (Lippi et al., 2019), others raised issues and concerns in terms of validation (Bansal et al., 2016; Velasco, 2018; Denecke, 2017), and bias and representativeness (Simonsen et al., 2016; Bansal et al., 2016). Faced with these obstacles, scholars in digital epidemiology believed that certain kinds of collaboration or integration of digital epidemiology systems and traditional disease surveillance programs should be expected for future public health surveillance (Kostkova et al., 2014; Moon et al. 2015; Kostkova, 2018; Velasco, 2018; Lazer et al., 2014). The discipline of digital epidemiology not only helped me to

contextualize previous works about digital technologies and disease surveillance, but also prompted me to think about the critical and surveillance perspectives of digital health surveillance. What seemed interesting in the discussions was that proponents of digital epidemiology largely see surveillance as a beneficial, neutral, and inevitable technological practice, neglecting the critical, political, and ethical perspectives of surveillance. These conflicting views of surveillance made me ponder how different strands of thoughts around surveillance could drive distinct approaches and decisions in practice.

From this point, I moved to exploring existing literature on current digital applications and practices for health surveillance during the COVID-19 pandemic, with a particular focus on works and materials addressing the background and development of China's Health Code and the implementation in Wuhan. My exploration of the background and context information of China's Health Code system found a "virus exceptionalism" at play in the dynamics (Boeing & Wang, 2021). Though in the current literature, there is an emerging consensus that digital technologies can aid in the response of the COVID-19 pandemic in contact tracing and disease surveillance (Budd et al., 2020; Ivers & Weitzner, 2020; MacIntyre, 2020; Kucharski et al., 2020; Munzert et al., 2021), similar to debates around digital epidemiology, scholars raised concerns about whether these health surveillance technologies could be ethnically justified (Abeler et al., 2020; Guinchard, 2020; Luciano, 2020; Bradford et al., 2020).

As I read through the literature and pondered materials and fields of thought, I found my mind kept pivoting around the meanings of surveillance as used in epidemiology (for public health surveillance) and as surveillance of human subjects. The particularity of the current digital health surveillance technology developed in China is that it is a digital surveillance tool used for public health surveillance. What distinguishes and justifies surveillance in public health is that it applies to diseases, not human beings. But does that condition hold true in today's digital health surveillance? This question remains unanswered in the present literature. French (2009) examined the historical conception of public health surveillance, and in a more recent work, French & Monahan (2020) returned to the concept of public health surveillance and called for a surveillance studies orientation of thinking about pandemic surveillance. From there, I noticed a gap in examining the surveillance complexity embedded in digital health surveillance technologies. Moreover, I also noticed that in the current literature about COVID-19

contact tracing apps and other surveillance technologies, little was known about the lived experience of surveillance subjects. At times of crisis such as the pandemic, I wondered what kinds of new networks and power relations were constructed, and how risk was defined and mediated through the decisions and classifications in such systems. These questions and gaps led me to formulate the following research questions: How is health securitized through the design, implementation, and normalization of Health Code? What ideas and perceptions about biological identities have been formulated through the normalization of digital health categorization in the name of epidemiological purposes? How is knowledge about the everyday lives of local individuals in Wuhan, China organized and managed by the ruling relations embedded in Health Code? In answering these questions, I applied institutional ethnography as the research method in my research. My data collection included institutional texts (policy documents and technical standards) and semi-structured interviews. Institutional ethnography provided me with a special lens for viewing and examining the power dynamics of Health Code embedded in people's everyday settings. Thus, by investigating China's Health Code system, this thesis aims to bridge the existing gap of surveillance dynamics implied in digital health surveillance technologies and contribute to knowledge of surveillance subjects.

I address these questions by first reviewing the literature and debates around digital epidemiology and health surveillance in the COVID-19 pandemic in Chapter 2. This provides important background and context that led to the research questions I pursue here. Building on theories and concepts around security and the biopolitics of health, Chapter 3 elaborates on how ideas and thoughts from security studies and the Foucauldian notion of biopolitics served as my theoretical framework in this thesis. Then, Chapter 4 explains my mode of inquiry and the research design of this project in detail. Chapter 5 shifts to the presentation and discussion of my findings pertaining to my research questions, explaining the surveillance implications of such systems, the perceptions from surveillance subjects, and the ruling relations embedded in the systems. Chapter 6 concludes my thesis with reflections on how the digital health surveillance system embedded with political classifications and decisions becomes a shared site of legitimizing and mediating forces and practices, as well as how beliefs and values reflected in the normalized use of Health Code implies a type of cruel optimism.

Chapter 2. Background and Context: Digital Epidemiology and Health Surveillance in the COVID-19 pandemic

2.1. Introduction

In recent years, the emerging area of digital epidemiology has been regarded as a useful means to improve the quality and efficiency of public health surveillance (O'Shea, 2017). In this chapter, I first explain the significance in theory and practice of digital epidemiology and how it has opened new possibilities of infectious disease surveillance. By doing so, I aim at introducing the public health notion of surveillance as a solid foundation of disease control and epidemiology, and show how this lens of viewing surveillance becomes problematic with the advances and developments of digital epidemiology.

Then I will illustrate how a series of innovative digital health surveillance systems has grown to be an important aspect of practice in response to the COVID-19 pandemic in many countries. In digital health surveillance practices, the public health facet of surveillance as a significant element for public good comes to intersect with the critical notion of surveillance as a politics of control and classification of human subjects. With a special focus on the integrated digital health surveillance system known as Health Code developed in China, my goal here is to demonstrate how these two different lenses through which surveillance can be viewed drive distinct decisions and debates around health surveillance and pandemic control.

Through my review of the literature, I will also show that existing research on digital health surveillance systems during the COVID-19 outbreak lacks a critical perspective to examine the conflicting notions of surveillance embedded in these integrated health surveillance systems. This finding sets the stage for my project, which seeks to bridge this gap by providing insights about the surveillance implications of such systems and how people living with China's Health Code system experienced it.

2.2. Overview of Digital Epidemiology

Digital epidemiology, which can be broadly defined as epidemiology that uses digital data outside of the public health arena, is a new field that has been growing rapidly in the past few years, fueled by the widespread availability of mobile devices and internet access, and big data technologies (Salathé, 2018). The potential applications of this new discipline promise new insights into infectious disease monitoring (Lippi et al., 2019). Driven by enthusiasm for digital technologies, scholars in digital epidemiology advocate a digital revolution in epidemiology and health surveillance, mainly focusing on addressing issues of validity and functionality about digital epidemiology for disease surveillance applications. This is needed because the critical, ethical, and political implications of digital health surveillance could not be justified by the promise of a digital "upgraded" epidemiological surveillance system envisioned by digital epidemiology proponents.

In this section, I will first provide a brief historical overview of the two concepts epidemiology and public health surveillance, introducing the public health notion of surveillance in disease control and epidemiology studies. Then I will trace the development of digital epidemiology and illustrate how the public health perspective of viewing surveillance has greatly influenced how proponents of digital epidemiology think about digital technologies and surveillance. Through an overview of the discussions and issues surrounding digital epidemiology, I argue that the conventional public health surveillance concept has become insufficient to account for the new surveillance implications, and is controversial.

2.2.1. Traditional Epidemiology

Epidemiology is defined as "the study of the occurrence and distribution of health-related events, states, and processes in specified populations, including the study of the determinants influencing such processes, and the application of this knowledge to control relevant health problems." (Porta, 2014, p. 95) Epidemiological studies include surveillance, observation, screening, hypothesis testing, analytic research, experiments, and prediction of diseases. Epidemiology aims at investigating the distribution, incidence, and etiology of human diseases in order to promote, protect, and restore health, and to advance scientific knowledge (Salathé et al., 2012; Porta, 2014). It has

significantly contributed to public health utilizing relative information to keep the public informed of methods to prevent disease outbreaks and maintain public health.

Conventionally, epidemiology mainly relies on the data collected by public health agencies and medical institutions within the health care domain (Salathé et al., 2012; Mittelstadt et al., 2018). This form of data collections is based on the obligatory reporting of certain diseases to central public health agencies and is dependent on data from clinical visits and laboratory confirmations, which often is costly and requires a formal structure in public health systems (O'Shea, 2017). Time and resource constraints, and the hierarchical structure of reporting systems inevitably have an adverse effect on the completeness and effectiveness of reporting, leading to an insufficient knowledge of diseases (Milinovich et al., 2014).

2.2.2. Public Health Surveillance

The application of surveillance has been recognized as an important element in disease control for many years (Thacker et al., 1989). Surveillance was at first considered as a branch of epidemiology, and gradually developed into a complete discipline within the public health domain in the 1980s (Declich & Carter, 1994). As defined by Thacker & Berkelman (1988), public health surveillance is the ongoing systematic collection, analysis, and interpretation of data, closely integrated with the timely dissemination of these data to those responsible for preventing and controlling disease and injury. In this thesis, the definition provided by Thacker & Berkelman (1988) is used to understand public health surveillance.

The ongoing and systematic monitoring of population health is an integral part of public health practices (Brookmeyer, 2004). An ideal surveillance system offers timely reporting and validation of its outputs (Simonsen et al., 2016). In surveillance systems, full situational awareness requires "availability of multiple surveillance data streams that capture mild and severe clinical outcomes (death certificates, hospital admissions, and emergency department and outpatient visits), as well as laboratory-based information (confirmed cases, genetic sequences, and serologic findings)" (Simonsen et al., 2016, p. S380).

2.2.3. The Development of Digital Epidemiology

While many known infectious diseases have gained much attention among research institutions and global health agencies, and public health interventions and investments have resulted in positive impacts on disease control, the seeming continuous emergence and re-emergence of diseases such as severe acute respiratory syndrome (SARS) and Ebola in recent years have contributed to a public perception that infectious disease outbreaks are becoming a major threat to global public health (Velasco, 2018). Traditional public health surveillance systems face multiple challenges because of the growing number of newly emerging infectious pathogens happening across the world, as well as high levels of human mobility in many parts of the globe. In the field of infectious disease epidemiology, new digital solutions are anticipated and envisioned to increase effectiveness and efficiency of response to emerging infectious diseases.

Conception of Digital Epidemiology

The digital revolution, linked to the explosion of mobile phone and Internet usage, has facilitated the rapid and unprecedented increase in the availability of digital data sources that could potentially provide insights into public health (Salathé et al., 2012; Mittelstadt et al., 2018). With digital technologies, it has become much easier to capture and aggregate large amounts of infectious disease related data from a wide array of sources including online platforms and personal communication devices (Mittelstadt et al., 2018). These novel data streams generated through digital platforms and networked devices offer a unique perspective different from traditional surveillance systems which were historically used to investigate public health. Digital data sources outside of public health systems have become significant for a new generation of digital health surveillance systems that can fill in the gaps in existing public health infrastructure (Salathé et al., 2012).

A new discipline – digital epidemiology – emerged with the goal of enhancing the understandings of disease dynamics through analysis of digital traces. Digital epidemiology offers methods and strategies for using digital technologies to enhance disease control planning and surveillance and to improve understandings of attitudes and concerns about infectious diseases among populations (Denecke, 2017).

Digital epidemiology can be directly understood as epidemiology that uses digital methods from data collection to data analysis, however, this broad definition is rather vague and unclear. A more precise definition of digital epidemiology was introduced by Salathé in 2018. According to Salathé (2018, p. 2), Digital epidemiology is "epidemiology that uses data that was generated outside the public health system, i.e., with data that was not generated with the primary purpose of doing epidemiology." This narrower definition puts emphasis on the use of new digital data sources in epidemiological studies, which encourages researchers to think about identifying and utilizing unexplored data avenues to enrich epidemiological research.

Is the use of digital data sources the only difference between digital epidemiology and traditional epidemiology? What are the characteristics of this new discipline? The definition of digital epidemiology provided by Salathé offers a general framework of distinguishing it from traditional epidemiology. To suggest a working definition, Mittelstadt et al. (2018) proposed a set of characteristics of digital epidemiology according to the routine processing of data that describe:

> (1) health or are health-related (what we term non-medical), meaning they have not been sourced from a formal medical institution or service but can be used to generate knowledge about health; are (2) personal and granular, meaning they describe the behaviours and health of individuals (even if the individual is not identifiable); and are (3) proprietary or private rather than public, meaning they have been created through interactions with proprietary online platforms and technologies that offer limited public accessibility to the data collected. (pp. 10-11)

These characteristics indicate that digital epidemiology is distinct insofar as it involves processing of personal data (different from population-level data) on a routine basis which forms digital records of people's behaviors and interactions with platforms, systems, and devices (Mittelstadt et al., 2018). Mittelstadt et al. (2018) argued that digital epidemiology often requires the constant processing and analysis of digital datasets describing the behaviors of individuals in great detail, which is often not the case in traditional epidemiology. Both Salathé (2018) and Mittelstadt et al. (2018) acknowledged that much of the data used in digital epidemiology is sourced from personal domains. The value of using data generated for non-medical purposes in epidemiological studies is recognized in the conception of digital epidemiology.

Practices of Digital Epidemiology

Digital epidemiology includes “the use of digital means for the purposes of – and the monitoring, research, analysis, and decision making implicit in – disease surveillance” (Velasco, 2018, p. 2). Applications of digital epidemiology mostly rely on the digital traces of online user behaviors. Google Flu Trend (GFT), an Internet-based disease monitoring system launched in 2008, was one of the earliest projects of digital epidemiology that used data from search queries to track and predict influenza-like illnesses (Ginsberg et al., 2009). By aggregating and analyzing Google search queries, GFT attempted to estimate predictions about flu activity by region in near-real time (Park et al., 2018). Similarly, Google Trends (GT), an innovative freely accessible tool developed by Google that allows users to interact with Google search data has also been used as a useful data source for digital epidemiology (Nuti et al., 2014).

Besides web search queries, digital epidemiological research also explored other novel data sources. Signorini et al. (2011) used data from Twitter to track and measure actual disease activity with respect to the H1N1 influenza pandemic. Their results showed that real-time estimates of influenza-like illness derived from Twitter data accurately tracked reported regional disease levels. Wikipedia data was also used for digital epidemiology. For example, McIver & Brownstein (2014) introduced an innovative method to estimate the level of influenza-like illness in the United States by monitoring the rate of influenza related Wikipedia article views. In terms of some life-threatening infectious diseases such as malaria, collecting data about human movements could be an important way of understanding disease transmission which could support the development of preventive control programs (Wesolowski et al., 2012). Guided by this idea, Wesolowski et al., (2012) aggregated and analyzed mobile phone call data records of 15 million mobile phone owners in Kenya to examine their travel patterns. They also developed a detailed malaria risk map to estimate malaria parasite movements across Kenya that could be caused by human movements, enabling detailed analysis of parasite sources and sinks between hundreds of local settlements (Wesolowski et al., 2012).

Organizations and academic institutions have played an important role in digital epidemiology by creating participatory systems and platforms dedicated to digital disease surveillance (Salathé, 2018). Platforms using crowd-sourced disease related

data have been credited with reducing the time needed to recognize an outbreak, preventing governments from suppressing outbreak information, and facilitating public health responses to outbreaks and emerging epidemic diseases (Brownstein et al., 2009). Flu Near You (FNY) is a crowd-sourced participatory disease surveillance system that gathers data from voluntary users about their health in real-time. The data is visualized and mapped to enable viewers to track flu prevalence in North America. Online participatory disease surveillance systems such as FNY offer advantages in speed, sensitivity, and scalability, and their reports have become important complements to traditional health surveillance systems (Smolinski, et al., 2015; Baltrusaitis et al., 2018).

The continued growth of digital epidemiology has been regarded as a promising support to generate timely alerts for public health agencies about infectious disease outbreaks, and is viewed by some scholars in clinical epidemiology such as Lippi, Mattiuzzi, and Cervellin as more efficient than conventional epidemiological approaches (Lippi et al., 2019). While the development of digital epidemiology has shown its potential in disease surveillance ((Barboza et al., 2013), existing literature raises issues regarding the validity and functionality of digital epidemiology.

For the field of digital epidemiology, a key requirement is a careful and continued validation against established traditional public health systems (Bansal et al., 2016). Though early examples of GT and GFT brought new perspectives in epidemiological studies, research has shown that Google search queries frequently overestimated the incidence of flu prevalence (Lazer et al., 2014). The failure of the GFT project to detect disease outbreaks has shown the importance in testing results against known associations. “The era of internet-based data will need to evolve with mechanisms that bring back validation measures, and transparency that can continue to drive science” (Velasco, 2018, p. 4). The data used in digital epidemiology needs to be constantly verified and examined in relation to confirmed medical data for analysis (Denecke, 2017). Furthermore, the accuracy and specificity of digital epidemiology needs to be considered, so as not to overload the public health systems with false and useless outbreak alerts (Bansal et al., 2016).

Digital epidemiology relies on digital data sources and many of these data streams lack demographic information such as age, sex, and ethnicity group

membership, all of which are significant components of traditional epidemiological studies (Bansal et al., 2016). Successful epidemiological research is rooted in positivist world views, which include the ability to generalize from a sample to a general population. The representativeness of the epidemiological research sample may enhance generalizability in studies with strong descriptive components (Porta, 2014). Traditional epidemiological studies should be representative of the specific population, flexible, and resilient (Simonsen et al., 2016). Representativeness is a key requirement of epidemiology in that it may help identify important biases in terms of specific populations systematically excluded in the process (Declich & Carter, 1994).

Another set of concerns with digital epidemiology relate to the concept of digital divides. Digital divides can be understood as the gap between those with ready access to information and communication technologies and those without such access or knowledge—a situation which still exists on a global scale (Cullen, 2001). In digital epidemiology, data collection only represents a limited portion of the population, with fewer elderly than younger individuals involved, and a lack of coverage among young children (Bansal et al., 2016). Digital epidemiological data may also reflect geographic heterogeneity in data collection, with underrepresentation of data reflecting conditions in developing countries. Thus, digital epidemiology may reflect inevitable biases compared to traditional epidemiology.

Regardless of issues and problems concerning validity and feasibility of digital epidemiology in health surveillance, the increasing availability of new types of health data and access to personal information through diverse channels will continue to have wide implications for public health surveillance (Velasco, 2018). While big data in digital epidemiology offers possibilities for understanding human interactions with rich spatial and temporal dynamics, traditional epidemiological data collection often provides information that is not accessible in big data (Lazer et al., 2014). Instead of focusing solely on the big data revolution in epidemiology and disease surveillance, digital epidemiology scholars call for the possibility of an “all data revolution” which aims at using data from all traditional and new sources to provide deeper understandings of disease control (Lazer et al., 2014).

Current collaboration between online disease surveillance systems and traditional disease surveillance programs is still in the early stages. In public health

surveillance, there is a need for radically integrated solutions connecting independent systems (both traditional and online disease surveillance systems) via shared data and functionality, rather than continuing with existing isolated online surveillance programs lacking common data standards and validity (Kostkova, 2018). Facing threats of infectious disease outbreaks, such innovative integrated tools leveraging opportunities of data sharing from varied systems to enable risk assessment and rapid response of public health professionals are urgently required. Without successful and comprehensive integration of online surveillance programs with formal epidemic intelligence and routine surveillance done by public health agencies to support risk assessment and response measures evaluating the severity of outbreak and guiding mitigating measures, public health interventions in outbreak control will still remain slow and separated (Kostkova et al., 2014; Moon et al. 2015; Kostkova, 2018). Therefore, as the field of digital epidemiology continues to develop and advancements in digital health technologies become central in delivering public health interventions, the real challenge for public health authorities will be to accept innovation and a paradigm shift for public health surveillance (Velasco, 2018).

Ethical Issues and Concerns

The emergence and growth of digital epidemiology has created an epistemic shift in the infectious disease surveillance landscape which historically has only relied on conventional systems (Kostkova, 2018). In digital epidemiology, incorporating new digital data sources is encouraged, and seen as a means of contributing to improvements in effectiveness and efficiency in public health surveillance. Nevertheless, promises of public health benefits brought by digital epidemiology are also accompanied by significant ethical concerns and challenges.

A wide range of ethical issues have challenged researchers in digital epidemiology, including risks to individual privacy and autonomy, individuals' duties to contribute to the common good, and the demands of transparency and trust (Salathé et al., 2012; Vayena et al., 2015). For example, existing literature has explored the ethical and legal concerns regarding data collections from social networks (Flicker et al., 2004; Moreno et al., 2008; Bender et al., 2017). At the center of these ethical issues of digital epidemiology, lie several key questions (Vayena et al., 2015):

> how can big data be utilized for the common good whilst respecting individual rights and liberties, such as the right to privacy? What are the acceptable trade-offs between individual rights and the common good, and how do we determine the thresholds for such trade-offs? (pp. 2-3)

Digital epidemiology has a public health function which seeks to improve public health at the population level. The particular goal of digital epidemiology for the public good distinguishes it from other types of health-related big data activities, and therefore these ethical issues should be addressed in a new context (Denecke, 2017).

"Societal obligations to foster the common good of public health may generate duties on corporate data collectors to make data available for use in digital epidemiology" (Vayena et al., 2015, p. 3). The emphasis on data sharing and social obligations in digital epidemiology echoes the notion of data philanthropy. This idea was introduced by the United Nations Global Pulse (UNGP), a collaborative initiative set up in 2009 to explore innovative ways of harnessing the potential of big data sources in various fields. Data philanthropy sees data sharing practices as positive acts that benefit the public and society in numerous ways. The use of the term philanthropy makes this clear and emphasizes the beneficence of data donation (Ajana, 2017). Data philanthropy is understood as the donation of data to the public sphere from individuals, private companies, and public entities. It attempts to form a collaboration that centers around the principle of data sharing in the name of public benefit. In the context of digital epidemiology, data philanthropy is considered to have a vital role in forming data commons which operates on the basis of clear rules about privacy and codes of conduct (Vayena et al., 2015).

Understanding the politics of participation in digital epidemiology requires a critique of the discourses of volunteerism and philanthropy (Bratich et al., 2003). In the notion of data philanthropy, individuals have the duty to voluntarily participate in the sharing of health data for collective benefits. Though in conventional epidemiology, individuals may have an implicit duty to participate, this duty cannot be easily extended to digital epidemiology (Mittelstadt et al., 2018). As digital epidemiology aggregates new data sources, which are often non-medical digital datasets, this may result in pervasive "dataveillance," or what Zuboff (2015) refers to as "surveillance capitalism," that is, the extraction, exploitation, and commodification of individuals' data. Even when there is a duty for individuals to participate in digital epidemiology, the capacity to refuse to

participate should always be retained (Mittelstadt et al., 2018). Mittelstadt et al. (2018) suggested that legal coercion for participation in digital epidemiology should only be used in extreme and abnormal conditions when there is an immediate and overwhelming threat to public health. Thus, promoting an awareness of ethical issues related to the public benefits which can result from digital epidemiology will be essential to achieving those benefits (Vayena et al., 2015; Mittelstadt et al., 2018).

Besides the above ethical concerns, the public health notion of surveillance as a justifiable and beneficial practice in disease control has become problematic with the development of digital epidemiology. The enthusiasm for digital technologies and the ideal health surveillance systems which will bring more comprehensive and accurate results of disease control is a dangerous one. The existing literature on digital epidemiology is mainly driven by the public health notion of surveillance, lacking a critical perspective of digital surveillance as a politics of control and classification. For example, digital epidemiology scholars such as Salathé (2018) believed that the epic fall of GFT was due to the lack of collaboration between corporates and public health authorities, and large errors in influenza-like illnesses prediction were largely avoidable (Lazer et al., 2014), neglecting other “non-epidemiological” implications of such digital health surveillance practices.

For proponents of digital epidemiology, new data will lead to new health surveillance methods and tools, and the use of those methods and tools will allow for new interpretation and understanding of the complex dynamics of infectious disease surveillance and early outbreak detection and mitigation (Velasco, 2018; Tarkoma et al., 2020). However, digital surveillance tools cannot be perceived as merely a kind of inevitable and neutral enhancement of conventional epidemiological surveillance. The novel data sources actively being sourced by digital epidemiology greatly challenge the implied social contract between public health systems, individuals, and epidemiologists undertaking health surveillance.

2.3. Innovative Digital Health Surveillance Systems in the COVID-19 Pandemic

Since 2019, the coronavirus disease (COVID-19) pandemic has posed unprecedented challenges for public health authorities, governments, and societies on a

global scale (Anderson et al., 2020). Its novelty, communicability, and rapid spread throughout the world requires fast and effective public health interventions. The development of digital epidemiology continues as innovative digital tools and integrated systems for tracking and detecting potential disease outbreaks are widely used in response to the COVID-19 pandemic in many countries. In this section, I discuss current practices and studies of digital health surveillance systems and tools with a particular focus on the Health Code system in China. In particular, in my discussion I will examine the varied assumptions of surveillance underpinning such systems.

2.3.1. Global Public Health Crisis

The COVID-19 pandemic is regarded as the greatest public health threat that the world has seen in the last 100 years (Altmann et al., 2020). In December 2019, a series of pneumonia cases of unknown cause emerged in Wuhan, Hubei, China, with clinical presentations greatly resembling coronavirus infections (Huang et al., 2020; World Health Organization, 2020). In the following months, infections spread to 115 countries, leading health authorities from the World Health Organization (WHO) to describe this COVID-19 outbreak as a pandemic (World Health Organization, 2020). COVID-19 has been described as a disaster because of its fast arrival, severe infectiousness, and rapid spread in countries with depleted public health resources and inadequate response and policies (Madianou, 2020). To date, millions of people have died, and hundreds of millions have been infected with COVID-19 around the world (Dong & Gardner, 2020).

One of the characteristics of COVID-19 is its high rate of spread among populations. According to Umakanthan et al. (2020), human-to-human transmission occurs through multiple routes, including direct transmission, contact transmission, airborne transmissions through aerosols (a suspension of fine solid particles or liquid droplets in the air), and even during medical procedures. In a globally interconnected world, the rapid spread of COVID-19 has led to numerous efforts to contain the pandemic (Walrave et al., 2020; Shaw et al., 2020). During the first year of the COVID-19 pandemic, vaccines were not expected to be available, and stockpiles of antiviral medications – some not yet shown to be effective – were limited and reserved for treating severe COVID-19 patients (Fong et al., 2020). As scientists endeavored to develop COVID-19 vaccinations, studies have shown that major non-pharmaceutical interventions have had a large effect on mitigating and containing the transmission of

COVID-19 (Oliver et al., 2020; Flaxman et al., 2020). These interventions include total lockdowns of cities, bans on mass gatherings, social distancing policies, international and domestic mobility restrictions, quarantines, and testing and tracing of potential infected individuals (Chinazzi et al., 2020; Lai et al., 2020; Fong et al., 2020). Such measures were undertaken in an effort to prevent public health systems from becoming overloaded by reducing the transmission of the COVID-19 virus.

Though strict non-pharmaceutical interventions such as large scale lockdowns and quarantines were effective in disease control, the long-term applications of these measures would bring adverse economic and societal consequences (Chowdhury et al., 2020). Thus, dynamic and new interventions for continued disease surveillance offered alternate and arguably more suitable and favorable alternatives to continuous lockdowns and quarantines for many countries, allowing them to resume economic growth while keeping COVID-19 under control. These measures require a combination of strong governance, digital tracking technologies for disease surveillance, and high compliance in communities and solidarity (Shaw et al., 2020).

2.3.2. Current Digital Health Surveillance Applications

The belief that big data technologies benefit the public health infrastructure by mitigating the spread of infectious diseases has been widely promoted in digital epidemiology. In the ongoing trend of legitimizing the use of big data technologies in digital epidemiology (Velasco, 2018), digital innovations and big data have become integral to the public health response to the COVID-19 pandemic. In the management of COVID-19, existing applications of digital technologies include a wide array of systems and tools ranging from self-diagnosis mobile phone applications (apps), treatment guidance apps, and COVID-19 maps along with contact tracing apps and integrated digital health surveillance systems (Wen et al., 2020; Madianou, 2020). Although all of these innovations warrant in depth examination, such a broad examination is beyond the scope of this thesis. Rather than attempting to address all the COVID-19 themed digital tools, here I will focus particularly on contact tracing apps and integrated health surveillance systems designed through collaborations between researchers and governments with private tech companies for the purpose of health surveillance, which use routine collection and analysis of personal and granular data generated outside of public health systems. By referring to the concepts of digital epidemiology (Mittelstadt et

al., 2018; Salathé, 2018) and public health surveillance (Thacker & Berkelman, 1988), such systems and applications are referred to in the context of this work as digital health surveillance.

Contact Tracing Apps

Contact Tracing

Contact tracing – also known as case finding in epidemiology – is defined as (Porta, 2014):

> A standard procedure in the control of certain contagious diseases (e.g., tuberculosis and sexually transmitted diseases) whereby diligent efforts are made to locate and treat persons who have had close or intimate contact with a known case. Also, seeking persons who have been exposed to risk of other potentially harmful factors, like toxic substances, epidemic conditions, or outbreaks such as food poisoning. (p. 36)

Contact tracing is an infectious disease control strategy aiming at identifying individuals who may have had close contact with a known infected case. In traditional contact tracing, public health officials conduct extensive interviews with infected patients and collect necessary information including locations they visited and people they met while infectious (Wen et al., 2020). Through manual contact tracing, public health officials can identify infected individuals before they develop symptoms, prevent onward transmission, and advise exposed contacts to monitor symptoms or obtain medical evaluation and treatment (Kleinman & Merkel, 2020; Keeling et al., 2020). This disease control strategy was a critical intervention to contain infection transmission in previous epidemics such as SARS (Svoboda et al., 2004) and Ebola (Swanson et al., 2018). Nevertheless, Swanson et al. (2018) found that there were limitations to the performance of this manual approach during peak transmission of epidemics. During the COVID-19 pandemic, limitations of conventional contact tracing strategies have become more apparent as such techniques may cause large delays and inaccuracies in identifications (Wen et al., 2020).

Digital Data Types

The rapid spread and short average serial interval and incubation period of COVID-19 require more efficient and accurate contact tracking techniques (Alene et al., 2021). The use of mobile phone data in innovative ways can work as a supplementary

tool and be of benefit for effectively detecting infected individuals and tracing their prior contacts during all stages of the pandemic (Hernández-Orallo et al., 2020). In many countries, digital contact tracing apps have been developed and launched as part of post-lockdown strategies (Madianou, 2020).

Passively collected smartphone data have been used as a valuable data source for contact tracing in two ways: location tracing and proximity tracing (Oliver et al., 2020; Wen et al., 2020). For direct location tracing, a variety of location sensitive data can be collected from cell phones, using features such as location-based (GPS) sensors, location information from cell towers or a nearby Wi-Fi hotpot showing the specific location of users. Call detail records can also be collected. Location tracking techniques are currently used in COVID-19 contact tracing apps developed in countries such as Iceland, Bulgaria and Israel (Wen et al., 2020). Besides location tracing, another technique called proximity tracing that detects and tracks the proximity between smartphone users has also been used in contact tracing. This is achieved via the Bluetooth Low Energy (BLE) technology on smartphones (Abuhammad et al., 2020). BLE is known for its low energy consumption and its signal strength can be utilized to calculate the distance between two contacts (Wen et al., 2020). Singapore's Government Technology Agency (GovTech)[1] has developed a framework on using BLE technology for contact tracing, and BLE-based apps have been released in Singapore, Australia and Alberta, Canada (Kleinman & Merkel, 2020).

Architectures

"The type of architecture adopted for the data collection aspects of tracing apps has been a matter of much discussion due to both security and privacy concerns" (Ahmed et al., 2020, p. 134578). Depending on the functionality of the central server and where the contact detection is performed, there are two typical architectures: the centralized systems and the decentralized ones. In the centralized systems, the central server performs all the detections and notifications, whereas these processes are transferred to each device in the decentralized architecture, leaving the central server with much less involvement in the process (Ahmed et al., 2020).

[1] The Government Technology Agency (GovTech) is a statutory board of the Singapore government, under the Prime Minister's Office.

There is an ongoing heated debate in academia and industry about which architecture works the best (Wen et al., 2020). The centralized architecture empowers public health officials with more control over the pandemic circumstances in that all the risk analysis and notification process are performed at the central server. For the decentralized systems, preserving privacy is a major benefit. User privacy is enhanced because all the contact tracing functions are delegated to individual devices which protect user identities from the central server. In a systematic review on current COVID-19 contact tracing apps, Wen et al. (2020) found that most governments and public health officials tend to choose a centralized system to collect data, even though the industry-wide trend is moving towards decentralized architectures following the release of a decentralized standard in May 2020 by Apple and Google (Kleinman & Merkel, 2020). Still, each system – decentralized processing by private companies or more centralized architecture overseen by public health agencies and governments – has privacy advantages and disadvantages (Bradford et al., 2020). In addition, hybrid protocols are proposed by researchers in Germany and the United States to combine the features from both the centralized and decentralized approaches (Ahmed et al., 2020). The workload and management of processes are split between the central server and each device in these hybrid architectures.

The Hybrid Health Surveillance Approach

For strategies in Singapore, South Korea, and China, digital technologies for contact tracing and surveillance have complemented traditional approaches during the COVID-19 pandemic (Cohen et al., 2020). Besides the use of mobile phone data, a hybrid approach to link conventional public health surveillance with different digital technologies for mitigating the spread of COVID-19 has been suggested in the literature (Ivers & Weitzner, 2020; Kleinman & Merkel, 2020; Hernández-Orallo et al., 2020; Shaw et al., 2020). Wu et al. (2020) showed it is possible to integrate data from the Official Aviation Guide and person mobility data from WeChat and other digital sources to forecast the spread of COVID-19. In this respect, the severity of the COVID-19 pandemic has created a public-interest rationale to leverage data from varied digital devices and analytics tools to contain the spread (Ienca & Vayena, 2020).

For example, in South Korea, the COVID-19 contact investigations were conducted by a combination of conventional and innovative tracing methods. Public

health officials would conduct interviews with patients and their acquaintances to obtain information about patients' route claims. These traditional contact tracing interviews were further verified by and supplemented with data from medical facility records, GPS data from smartphones, histories of credit card transactions, and closed-circuit television cameras (CCTV) (COVID-19 National Emergency Response Center et al., 2020). Detailed information of past routes taken by infected cases would be shared to individuals who may have visited those places. By profiling a detailed and accurate record of an infected patient's movements, the use of these methods helps to obtain comprehensive tracing information and reduce potential ambiguity and bias or inaccuracies generated from interviews, thus preventing transmission (Kleinman & Merkel, 2020).

Well-known for its well-established technological infrastructure for public health and its successful record for dealing with the SARS outbreak in 2003, Singapore was one of the first countries to develop a mobile tracing app, called TraceTogether, in response to the pandemic (Lee & Lee, 2020). However, the TraceTogether app was not widely accepted and downloaded by the population because of privacy concerns. GovTech – the Singapore's government technology agency that developed TraceTogether – then pivoted towards developing a wearable device independent from personal cell phones to brush off concerns about privacy intrusion and reach all residents. Other digital surveillance methods implemented in Singapore included a national digital check-in system (called the SafeEntry app) that requires individuals to check-in by scanning a QR code whenever they enter certain public places such as restaurants, malls, workplaces, hospitals, etc. (GovTech, 2020; Woo, 2020).

Integrated Digital Health Surveillance System – Health Code in China

During the COVID-19 pandemic, public health strategies in China included a combination of digital innovations, strong political governance, strict regulations, and large-scale community and citizen participation, forming an integrated digital health surveillance system (Hua & Shaw, 2020). Effective, comprehensive, accurate, and timely digital contact tracing and health surveillance require high compliance of communities and citizens, advanced big data analytics, and political supports (Braithwaite et al., 2020). In the case of China where the first COVID-19 outbreak was found, an integrated

digital health surveillance system in response to the COVID-19 pandemic was formed based on collaborations among varied stakeholders.

In the face of the rapidly spreading COVID-19 outbreak which first started in Wuhan and the increasing number of confirmed cases in the country, on January 20, 2020, China declared the coronavirus disease a second-class infectious disease, but introduced management measures for a first-class (or Level 1) infectious disease (considered as the most dangerous category of infection) (Xiao & Torok, 2020). A level-1 public health response implies that a severe public health emergency requires the provincial headquarters to organize and respond within its administrative area following the decisions and unified commands of the State Council. The classification of COVID-19 as a severe health security emergency that this invoked was in part a means of rallying political support and financial resources for emergency measures to combat the epidemic, referred as “virus exceptionalism” (Boeing & Wang, 2021). On January 25, 2020, the central government issued orders for handling the developing public health crisis, which was perceived as the most severe public health emergency since the founding of the People’s Republic of China. From that point on, the need to contain the spread of COVID-19 was regarded as the most urgent mission of the whole country. A level-1 public health response to control the spread of COVID-19 was initiated in almost 31 provinces (including Hubei) in China in January 2020 (Deng & Peng, 2020).

To strengthen public health surveillance, health administration departments, centers for disease control, and medical institutions at all levels have worked closely together in COVID-19 management (Deng & Peng, 2020). However, as traditional mitigation approaches appeared to be ineffective and public health resources became rapidly exhausted, digital surveillance methods were introduced and quickly adopted by the governments (Wang & Jia, 2021). Health Code was first launched on the digital platform Alipay by the giant tech company Alibaba on February 9, 2020. Immediately, another big tech company – Tencent – also introduced its Health Code software on its social media platform WeChat. Though these two systems were installed on different platforms by different companies at first, they shared similar functionalities and could be used interchangeably afterwards (Liang, 2020). This Health Code (also referred to as the Anti-epidemic Code) system was first implemented in Hangzhou City as a pilot project for COVID-19 infection control with collaboration between Alibaba and the Hangzhou municipal government. It was later adopted across the whole country. The main purpose

of Health Code is to help governments monitor and trace the transmission of COVID-19 and maintain normal social order (Pan, 2020). Health Code collects two types of data to review users' contagion risks (Lei et al., 2020; Liang, 2020):

- 1) Self-declaration data of personal identification information (name and national ID number), physical conditions, recent travel history, recent contacts
- 2) Spatial-temporal data aggregated by Alipay and WeChat in daily routine usage of smartphones

This data collection is supplemented with data from network carriers and data of user networks and online transactions to evaluate whether people encountered infected cases of COVID-19. Health Code has a centralized architecture and is location-based with QR code (Wen et al., 2020). Based on algorithms and big data analytics, Health Code can assign users personal health QR codes indicating their exposure risks of COVID-19 and mobility patterns. All users are classified into three color-based categories, following the conventions of traffic lights: green, yellow and red. While people with green codes would be considered healthy and safe enough to access public places freely, a yellow or red code could mean that the user had medium or high exposure risk of COVID-19 and thus needed to be self-quarantined (7 to 14 days) or referred to nearby hospitals for evaluation, quarantine, and treatment. The status of Health Code is reviewed and updated on a dynamic basis.

Health Code has been promoted and used in more than 300 cities in China and it has become mandatory (Liang, 2020). Governments have paid significant attention to the digital management of the COVID-19 response. Local governments have integrated the use of Health Code as a vital part in disease control regulations and required active participation of citizens to promote and normalize the use of Health Code. The State Administration for Market Regulation (SAMR) in China issued national standards for the adoption of Health Code in April 2020. With the strong technological supports of private giant tech companies, municipal governments became capable of monitoring citizens' health and geo-location data through the system, which enabled governments and public health agencies to undertake timely disease control measures and provided needed health services (Boeing & Wang, 2021).

The Case in Wuhan

Under the legal endorsement of the provincial governments, in cities such as Wuhan where the first outbreak started, strict local and community-based regulations and interventions were implemented together with the digital health surveillance system. After Health Code was introduced in Hangzhou, the Wuhan municipal government quickly adopted the system in late February 2020 when the city was still in lockdown. At the time of writing, current studies have tracked the public health interventions (Pan et al., 2020), policies, and developments of the integrated digital health surveillance system in Wuhan (Boeing & Wang, 2021). In contrast to other cities in China, Wuhan best represented the “virus exceptionalism” as it was severely hit by the first COVID-19 outbreak and stringent measures and policies were developed to contain the spread.

In the administrative hierarchy, communities are often perceived as the intermediaries that practice policies assigned by the government and deliver services to their citizens (Bovaird, 2007). Local communities played significant parts in supporting and practicing the implementation of digital health surveillance in Wuhan. During the Wuhan lockdown, the main goal of digital tracing was to detect unknown cases within the city. In addition to issuing individual health QR codes, the Health Code system also assigned a community grid for monitoring (Boeing & Wang, 2021). Civil servants and volunteers were dispatched as contact tracers to aggregate data with residents in the community grids. Then the government and tech companies compared the community-level data with existing administrative databases to evaluate and estimate the risk of infection within local communities, which in turn allowed them to identify potential infected cases for quarantine (Boeing & Wang, 2021). After the draconian lockdown was ended, the digital health surveillance for identifying infected cases in the lockdown period was then repurposed to monitor human mobility within the city to prevent further infection. As the city gradually resumed normal social activities, the job of contact tracers became regularly checking the colors of people’s health QR codes at entrances of residential areas, when entering public transportation or any public venues. These efforts formed an integrated digital health surveillance system.

2.3.3. Surveillance Implications

Prior to the COVID-19 pandemic, digital epidemiology as a nascent field promoted the benefits of using digital technology in epidemiology and infectious disease control (Salathé, 2018; O'Shea, 2017; Lippi et al., 2019; Lazer et al., 2014; Kostkova, 2018), and integrated systems with the combination of online digital surveillance systems and traditional health surveillance approaches seemed to be the way forward in public health surveillance (Velasco, 2018; Tarkoma et al., 2020). As the world has been swept by the COVID-19 pandemic since 2019, one of the most severe public health crises in decades, we have seen much more complex and intrusive digital surveillance methods in use in an effort to control COVID-19. We have also seen closer collaboration between different stakeholders in developing health surveillance systems. The ways surveillance is enacted in such systems, and the ways the concept is understood by varied citizens has become much more complex and warrants further examination.

In the current literature, the emerging consensus is that digital technologies can contribute to the mitigation of the COVID-19 pandemic through contact tracing and health surveillance (Budd et al., 2020; Ivers & Weitzner, 2020; MacIntyre, 2020; Kucharski et al., 2020; Munzert et al., 2021). However, there are concerns and questions about whether the use of digital technologies in the context of COVID-19 control can be ethically justified. For example, Maccari & Cagno (2021) directly questioned the use of technology in response to the COVID-19 pandemic, and Klenk & Duijf (2020) argued that before societies implement digital tracing, proper considerations of efficiency and ethical legitimacy should be undertaken. The lack of digital ethics guidelines and standards in this novel field has also prompted some scholars to call for data protection methods in the design and implementation process of digital technologies (Abeler et al., 2020; Guinchard, 2020; Luciano, 2020; Bradford et al., 2020).

The concept of surveillance creep, developed by Marx (1988, p. 2) suggested that "as powerful new surveillance tactics are developed, the range of their legitimate and illegitimate use is likely to spread. Where there is a way, there is often a will. There is a danger of an almost imperceptible surveillance creep." Concerns over surveillance creep have been widely raised in the literature (Calvo et al., 2020; French & Monahan, 2020). Particularly, French & Monahan (2020) argued that a surveillance studies orientation can contribute to critical thinking about pandemic surveillance and touched

on the different use of surveillance in public health and surveillance studies. However, there is a clear gap in existing research that examines the surveillance implications of such integrated digital health surveillance systems. Especially in the case of China, where an integrated digital health surveillance system that encompasses functions of digital surveillance methods is justified through the necessity of public health surveillance in pandemic control, the issue of surveillance has become much more complex in digital disease control.

In section 2.2.2, I presented a definition of public health surveillance as a discipline. To situate surveillance in public health discourses, the specific challenge in public health ethics is the dilemma between protecting and promoting population health and the risk of causing potential harms and costs to individuals (Holland, 2015). Ethics can be broadly defined as a "discipline dealing with what is good and bad and with moral, duty and obligation" (Denecke, 2017, p. 2). A part of public health ethics deals with the particular moral questions of public actions for disease prevention. The specific and unique perspective of public health is that it focuses on the population perspective. Conventionally, epidemiologists have long enjoyed privileged access to some of the data generated by public health agencies and medical institutions, such as diagnostic records, laboratory results, and administrative datasets (Mittelstadt et al., 2018). Public health data, often anonymized or used in aggregated form, is routinely shared in public health systems to aid in disease control, with a particular emphasis on detecting potential disease outbreaks (Mittelstadt et al., 2018). In the case of infectious disease control in public health ethics, consent is often not required even when personal data are used in identifiable form, as the public interest in mitigating the spread of disease usually outweighs personal interests in privacy that would otherwise be protected by consent mechanisms (Lee et al., 2012). Still, overriding individual privacy and autonomy must be justified in terms of "the obligation of public health to improve population health, reduce inequities, attend to the health of vulnerable and systematically disadvantaged persons, and prevent harm" (Lee et al., 2012, p. 38).

The aim of improving population health justifies the surveillance practices in public health. Prior to 1950, the term surveillance meant "the close observation of persons exposed to a communicable disease to detect early symptoms and institute prompt isolation and control measures" (Declich & Carter, 1994, p. 287). The current concept of surveillance as the monitoring of diseases was promoted by Langmuir (1963):

> Surveillance, when applied to a disease, means the continued watchfulness over the distribution and trends of incidence through the systematic collection, consolidation and evaluation of morbidity and mortality reports and other relevant data. Intrinsic in the concept is the regular dissemination of the basic data and interpretations to all who have contributed and to all others who need to know. (pp. 182-183)

Langmuir (1963) demonstrated that surveillance applies to diseases rather than persons which distinguishes surveillance for public health purposes from control activities. Thacker & Berkelman (1988) officially introduced the term “public health surveillance.” As mentioned in section 2.2.2, surveillance in public health includes “not only data collection and analysis but also the application of these data to control and prevention activities by disseminating information to practitioners of public health and others who need to know” (Thacker & Berkelman, 1988, p. 185). As the Langmuir-Thacker-Berkelman formulation of public health surveillance has been globalized (French, 2009), the term has gained common use in WHO (World Health Organization, 2014).

Both Langmuir (1963) and Thacker & Berkelman (1988) highlighted the key phrase “who need to know” in their definitions of public health surveillance. This focusses our attention on the question, who are those who need to know? Though public health surveillance itself does not include administration of disease control, there is an intrinsic link of public health surveillance with disease control programs and systems (Declich & Carter, 1994). In the case of integrated digital health surveillance systems, such as Heath Code developed with the collaboration between governments, public health officials, and giant tech companies, those ‘who need to know’ often might include all these stakeholders. With massive collaborations happening between public health agencies and other sectors for pandemic control, the concept of public health surveillance needs to be re-examined to reflect these new circumstances and collaborations. In addition, it is important to note that what distinguishes and justifies public health surveillance is that it applies to diseases rather than individuals. However, approaches embedded in current digital COVID-19 contact tracing practices and systems blur these earlier distinctions, leaving public health surveillance resembling other forms of surveillance of individuals.

Furthermore, digital health surveillance assemblages imply complex surveillance dynamics. In current literature about Health Code, the majority of research focuses on institutional or technical aspects of Health Code, (Liang, 2020; Lei et al., 2020; Boeing &

Wang, 2021), leaving little known about the lived experience of surveillance subjects within such systems. As Ball (2009, p. 654) has argued, “the surveillance society is said to have impacts on the individual, but surveillance studies have not yet developed a take on the surveilled subject.” Discussions of the surveillance society have assumed a limited range of positions in describing the surveilled subject, reducing our understanding of the experience of surveillance. However, the lack of criticism or protest opposing current digital health surveillance assemblages among surveilled individuals does not mean that surveillance means nothing to them. In fact, surveillance may be tolerated or even strongly sought after at the time of crisis or because the giving of data eases individual fears and anxieties, or it may represent patriotic or collective values to the individual (Ball, 2009). This thesis aims to contribute to our understanding of subjects’ experiences of surveillance, from the perspective of surveilled individuals. In remaining chapters, I explain the research design and methods employed in my examination of subjects’ lived experiences as subjects of public health surveillance in relation to China’s Health Code system (Chapter 4). In chapter 5, I first present a detailed analysis of the system architecture and institutional processes of Health Code and its implementation in Wuhan for pandemic control, which forms the basis for understanding the newly introduced health surveillance system and its governing logic. Thereupon, I explore how individual’s experiences are linked to and managed by discursive, managerial, and professional forms of power within Health Code (Walby, 2005).

2.4. Conclusion

This chapter has set the stage for my examination of the digital health code system from a critical perspective, introduced as an integral part of China’s COVID-19 response. I have outlined how the development of digital epidemiology has guided an epistemic shift in infectious disease control that embraces innovative digital technologies and the ethical concerns and issues related to health surveillance which have followed. During the COVID-19 pandemic, different digital surveillance tools are being used to contain the spread of the disease. By mapping the current applications and studies of digital health surveillance systems in response to the COVID-19 pandemic, and problematizing surveillance implications underlying such systems, this chapter has

highlighted the need for a critical examination of how these different lenses around surveillance drive very distinct beliefs and decisions in health surveillance.

I have argued that to better capture the complex surveillance dynamics at work in the COVID-19 pandemic, it has become necessary to shift the conceptual framework to a broader understanding of surveillance than the definitions of surveillance which have guided the public health perspective (French & Monahan, 2020). In subsequent chapters, I will show that shifting conceptual frameworks and incorporating a view of surveillance which builds on social science perspectives of surveillance, – and specifically, considering power relations underlying recently introduced digital epidemiology systems can yield useful insights about how bodies and pathogens are being defined, measured, tracked, and regulated by the massive tracking and monitoring technologies enrolled into the work of current digital health surveillance. Before outlining the methods I have used in this study in Chapter 4, in the next chapter I will introduce key ideas from theoretical discussions about security and health, biopolitics and biological identities which have been central to the development of my research questions, as well as analysis of data I collected through the course of this study. Literature discussed has helped deepen my understanding of the integrated health surveillance system, and sets the stage for outlining the theoretical framework I have used in explicating the complex surveillance dynamics at work in China's Health Code System.

Chapter 3. Security Studies and the Biopolitics of Health

3.1. Introduction

This chapter introduces readers to key concepts from security studies, including the broad notion of security studies established by the Copenhagen School. In particular, I discuss the Copenhagen School's approach, often touted as having a wider approach and broader agenda than previous approaches to security studies, and how the conceptual apparatus put forward by the Copenhagen School can be applied to examine health threats. The theoretical linkage between security and health is of great value as it can be used to inform an interdisciplinary approach to the questions concerned in this thesis, and offers relevant concepts which can be used to unpack the complexity of digital health surveillance technologies. In addition to providing an overview of security studies and the Copenhagen School, I also highlight why an interdisciplinary theoretical approach is necessary to understand and study the questions addressed in this thesis.

I begin by outlining the contributions raised by scholars from the Copenhagen School of security studies. Then I explore the theoretical intersection between security studies and health studies by illustrating how logics of security and securitization have influenced the way of thinking about health and the preparedness of health surveillance. Underlying the key intersection of security and health is biopolitics. I discuss the Foucauldian concept of biopolitics, and reception and elaboration originated from Foucault's theorization of biopolitics, which I use to introduce critical insights into explaining the governing techniques and embedded assumptions in the definition and classification of human bodies made by digital health surveillance technologies. In health surveillance systems, definitions and categories of human bodies based on health conditions used in health surveillance systems are often tied to the broader imagination of the overall wellbeing of public health in society that ought to be defended. New forms of biological identity are generated through the health categorization of individuals made by health surveillance systems. Finally, by integrating and critically approaching ideas and theories concerned with security, health, and biopolitics, this chapter will demonstrate how the interdisciplinary theoretical approach put forward here relates to the issues and objectives of this thesis.

3.2. The Intersection of Security Studies and Health Studies

Security studies – also known as international security studies – was originally a sub-field within the discipline of international relations studies which focuses on states and military conflicts (Collins, 2016; Krause & Williams, 1996). The field of security studies rapidly developed during the Cold War era and can be defined by Walt (1991, p. 212) as "the study of the threat, use, and control of military force." Though this field examines "the phenomenon of war" (Walt, 1991, p. 212), with the Cold War ended, its implications for a wider, non-military centered understanding of security have been recognized by many theorists collectively known as the Copenhagen School (Ullman, 1983; Wæver, 1995; Buzan, 1983; Brown, 1989). As non-military issues and phenomena pose great threats to states and populations, members of the Copenhagen School have explicitly argued for a widening security agenda that moves beyond the initial narrow focus of security studies which focussed on military obsessions, to incorporate many other threats such as environmental crises and pandemics (Buzan et al., 1998).

In this section, I will discuss the correlation of security and health and the securitization theory developed by the Copenhagen School theorists, as they offer useful analytical guidance in identifying and examining logics of security in policies and measures dealing with emerging health threats. The theoretical linkage between security and health guides a particular way of thinking through the securitization of health during pandemics.

3.2.1. The Emerging Health Sector

The Copenhagen School theorists think about security in terms of different sectors, and sectors can be considered as referring to specific types of interactions (Buzan et al., 1998). Security sectors imply certain assumptions about what needs to be secured and how the social world is structured (Albert & Buzan, 2011). The concept of sectors widens the security agenda and sheds light on emerging security dynamics in varied fields.

As Berlinguer (2003, p. 57) notes, "[h]ealth itself is a power, a fundamental capacity for the development or maintenance of all other capacities." The value of security has been recognized in many newly developed security concepts that describe

the social and global problem of maintaining health and life. In the post-Cold War world, as old threats polarized by the ideological conflict and geopolitical interests of superpowers subsided, more attention has been focused on threats within the state that had the potential capability of causing state instability (Heymann, 2003). Under the circumstances, the focus of national security has shifted to safeguarding the stability of states by addressing internal concerns rather than defending national borders from external threats (Holsti, 1996). Thus, the meaning of national security becomes broader and more complex than before. Ullman (1983) defines a threat to national security:

> A threat to national security is an action or sequence of events that (1) threatens drastically and over a relatively brief span of time to degrade the quality of life for the inhabitants of a state, or (2) threatens to significantly narrow the range of policy choices available to the government of a state or to private, nongovernmental entities. (p. 133)

Ullman's definition implies that infectious diseases certainly can be classified as threats to national security, insofar as the emergence of an infectious pathogen can result in a disease outbreak that will significantly degrade the quality of life for the inhabitants of a state (Price-Smith, 2002).

Moreover, increasing worldwide attention has recently been paid to a broader issue: the effect of infectious disease on the concept of human security in global health. In People, State and Fear, Buzan (1983) classified security into three levels: individual, state, and the international system. Buzan (1983) defines individual human security as follows:

> An enormous array of threats, dangers and doubts loom over everyone, and although the better-off can distance themselves from some of these (starvation, preventable/curable disease, physical exposure, criminal violence, economic exploitation, and such like), they share others equally with the poor (incurable disease, natural disasters, nuclear war), and create some new ones for themselves because of their advantages (air crashes, kidnappings, diseases of excessive consumption, and so forth). (p. 50)

Buzan recognizes the importance of individual human security and mentions diseases as one of the major threats. This view echoes the newly evolving concept of human security (United Nations Development Programme, 1994). Announced by the United Nations, the concept of human security attempts to broaden security thinking from national security to a people- centered approach of coping with multiple threats faced by ordinary people in a globalizing world (Chen & Narasimhan, 2003). The objective of

human security is defined as a desire to safeguard the “vital core” of human lives from critical pervasive threats while promoting long-term human flourishing (Alkire, 2002). This definition attempts to clarify human security by focusing on the “vital core” of human lives and critical and pervasive threats. The ethos and mission of public health to prevent and treat these vital health insecurities situates health in the mainstream of human security (Chen & Narasimhan, 2003).

Security as a State of Being

Unpacking the concept of security sectors raises a far-reaching question: why is security so valuable in the social world? The concept itself is not an independent good; each account of it is constituted by reference to other goods: freedom, human rights, and so on (Herington, 2012). Almost all accounts of security imply that the set of goods specified is necessary for the referent to fulfill. As McSweeney (1999, p. 92) argues, “Security is a choice we make, which is contingent upon a moral judgment about human needs, not just human fears; it is not simply an intellectual discovery based on objective observation of facts.” Thus, accounts of human security are premised on the assertion that particular goods such as food, safety, and water are necessary conditions for human life. Similarly, accounts of national security are usually based on the premise that political independence is a necessary condition for a sovereign state. As a state of being, security involves two questions: security for what (the referent object) and what does security entail (the secure condition). The referent animates the meaning of security, and what referents are secured reflects the value of objects. Each referent of security emphasizes a certain perspective and implies different claims about what is important and valuable about security.

Definitions of security as a state of being imply a series of secure conditions, but what it means for each referent to be secured varies widely. “Secure” can be interpreted as meaning that the existence of the referent is protected (Buzan, 1998), that the basic needs of the referent are safeguarded (McSweeney, 1999), and so forth. Nevertheless, there seems to be one common descriptive feature of any secure condition regardless of the context: a particular set of goods are protected from threats and risks. In this sense, security is essentially about order and disorder. Its goal is the elimination of any doubt, danger, or risk, all of which are states of insecurity. The value of being secured thus needs to be constantly justified by referring back to depictions of threat and insecurity.

Similar to the value of security, the sense of threat and insecurity are socially constructed. Bubandt (2005) introduced the concept of ontological uncertainty to illustrate this point. Ontological uncertainty refers to the socially constructed anxiety that shapes pertinent forms of danger, threat, and fear for a particular referent. The all-embracing tendency of security as a state of being in social life is an attempt to tame insecurity by constructing its absence as a variety of goods (Bubandt, 2005). Thus, the value of security is a particular kind of scale-making that deals with the ontological issue of uncertainty (Bubandt, 2005).

3.2.2. Securitization Theory

While the concept of security sectors encourages us to think through the emerging infectious diseases as health threats to the security of states and populations, securitization theory directly provides a useful theoretical tool to examine the security practices surrounding health threats. Developed by the Copenhagen School of security studies, securitization theory is built on the understanding that the concept of security articulates a particular way of organizing forms of life (Huysmans, 1998). In other words, security informs a particular set of social or political practices. The concept of performative, as developed by Austin (1975), indicates that the issuing of the utterance is the performing of an action. The constructive quality of security utterances reflects the performative power of language (Huysmans, 2002). By declaring something as a security problem, the utterance itself is the act. Other than describing or picturing a representation of reality, security organizes social relations into security relations. It is the utterance of “security” that introduces social issues to the particular order of security. Nevertheless, security also has a “content” in the sense that the ordering it performs in a particular context is a specific kind of ordering (Huysmans, 1998). Huysmans (1998) further proposes that by approaching the essential contestability of security, such analysis may identify a “common core” or structure to definitions, over which there appears to be broad agreement. As Huysmans (1998) points out:

> Security positions people in their relations to themselves, to nature and to other human beings within a particular discursive, symbolic order. This order is not what we generally understand under “content of security” (e.g., a specific threat) but refers to the logic of security. (p. 232)

This particular discursive and symbolic order is an ensemble of rules that is immanent to a security practice, and that defines the practice in its specificity (Huysmans, 1998).

Thus, the structure of securitization theory is organized around “securitization as an act, as a productive moment, as a discontinuous reconfiguration of a social state” (Wæver, 2011, p. 468). To further illustrate what securitization entails, Buzan et al. (2003, p. 491) define securitization as a successful speech act “through which an intersubjective understanding is constructed within a political community to treat something as an existential threat to a valued referent object, and to enable a call for urgent and exceptional measures to deal with the threat.” The defining feature of the Copenhagen School approach to security is the fact that it proposes the performative articulation of security is a crucial form of security action (Stritzel, 2007). This structure, that the basic idea of security is a speech act itself put forward by members of the Copenhagen School, was criticized by Stritzel (2007), who suggested that it is too limited to allow scholars to study real world securitizations. A single declarative security articulation at a particular time cannot explain the entire social process of securitization. Instead, securitization contains a process of articulations and, more importantly, actions that include the intersubjective establishment of an existential threat and the positional power of securitizing actors to deploy emergency actions upon the threat (Buzan et al., 1998). Hence, I follow Stritzel (2007) in arguing that securitization denotes much more than a speech act. The underlying security logics of securitization processes imply a particular way of thinking and dealing with the existential threat. These processes and actions taken to securitize threats also need to be examined and studied in order to develop a more nuanced and grounded understanding of securitization.

The idea of exceptionalism plays an important role in the securitization of things. As Buzan et al. (1998, p. 26) have illustrated, “the essential quality of security in general is the staging of existential threats and issues in politics to lift them above politics.” In security logics, when a problem is presented as an issue of supreme priority, by labeling such issues as threats to security, a securitizing actor (often governments or institutions) claims an urgent need for and a right to respond to it with extraordinary means. Thus, the process of constructing and normalizing a shared understanding of what is to be considered and collectively responded to as a threat is essential to the securitization. By taking a social constructivist approach to understanding the processes through which issues become securitized, scholars in the Copenhagen School consider security issues

to be socially constructed and demarcated from normal practices by the use of "emergency measures" (Buzan et al., 1998, p. 25).

Securitization of Health

The concept of securitization introduces a distinct perspective that can be used to look at how emerging infectious diseases are classified as threats to the security of states and populations. It plays an important role in unpacking the security complexity of today's health surveillance polices and technologies. Scholars such as French (2009) and Elbe (2006) have turned their eyes onto the security practices in health surveillance and disease surveillance. French (2009) traced the historical establishment of public health surveillance and he found that the ideational and institutional development of public health surveillance started with the aim of defending states against biological warfare, which was the securitization of biological threats. The underlying security logics and emergency-management strategies of contemporary public health surveillance have framed the emerging infectious diseases as major threats that needs to be securitized in the globally connected world (French, 2009). One of its most prominent examples can be seen in the securitization of HIV/AIDS in global health discourses (Elbe, 2006). Since the passage of the United Nations Security Council (2000) expressed how HIV/AIDS might pose great risks to stability and security globally, HIV/AIDS has been increasingly portrayed by a range of international organizations, state governments, non-governmental organizations, and academic scholars as having security implications from a range of security perspectives (Elbe, 2006).

This merging of infectious diseases and security concerns marks a new evolving paradigm that centers around the security-informed orientation of health (Cecchine & Moore, 2006). As the analytical tools developed by the Copenhagen School theorists provide theoretically rich understandings towards logics and practices of security regarding non-military threats, they are of great value in examining the securitization of health threats in today's societies. Thus, in this thesis, I follow the conceptual framework developed by theorists in the Copenhagen School of security studies to unpack the security complexity of health surveillance technologies during pandemics.

3.3. Biopolitics and Biological Identity

The previous section has outlined the broader conceptual linkage of security and health by illustrating how theories of the Copenhagen School of security studies can be applied to look at current health threats. At the center of the securitization of health during pandemics lie several vital questions: How is the population classified and managed through securitization processes? And what kinds of broader imagination of society that ought to be defended are tied to these categories?

To frame a health issue as a security problem inevitably is to lend it a sense of urgency, and to seek some of the overriding interest associated with more political concepts of security (Selgelid & Enemark, 2008). Such framing recognizes the inherent biopolitical implications of securitization of health. The Foucauldian theorization of biopower and biopolitics offers valuable insights to understand these issues. In this section, I will first discuss the Foucauldian notion of biopolitics before going on to present one of the elaborations emanating from Foucault's approach: Mbembe's concept of necropolitics. These two notions work together in developing an understanding of how contemporary governing on the level of the population operates through a combination of techniques for controlling living population as well as the threat of death as a governing technique during crisis. In the following section 3.3.2, I will introduce another line of reception of the Foucauldian notion of biopolitics that focuses on the "substance of life" (Lemke et al., 2011, p. 7). Scholars working within this strand of thought such as Rabinow and Rose have provided works that help to shed light on how biometrics and technological surveillance have transformed biopolitical interventions and enhanced access to the human body and processes of life. Through the regulation of the population and biometrical surveillance of the human body, the self-constitution of individual and collective subjects has given rise to new biological forms of identity. Such technologies and regulations refer to the society as an imaginary totality and collective body that ought to be defended.

3.3.1. Biopolitics and Necropolitics

The Foucauldian Theorization of Biopolitics

The Foucauldian theorization of biopolitics has been a key strand of thought used to capture the growing focus of the exercise of modern power in relation to the biological dimensions of human existence (Elbe, 2008). Biopolitics can be understood as a form of governing that perceives the administration of life and the population as its subject. Before discussing biopolitics, this thesis needs to introduce the wider power relations in which biopolitics is put to work in our societies. In the book The History of Sexuality, Vol. 1, Foucault analyses various mechanisms of power by comparing sovereign power with a new type of power emerging in the classical age. The repressive sovereign power exercised mainly by forms of "deduction" which Foucault (1978, p. 136) describes as: "The sovereign exercised his right of life only by exercising his right to kill, or by refraining from killing; he evidenced his power over life only through the death he was capable of requiring." In other words, sovereign power consists of the right to deprive products, goods, and services, or to seize things, time, bodies, ultimately the life of subjects (Rabinow & Rose, 2006). According to Foucault (1978, p. 137), while sovereign power is a repressive kind based on the right to kill, this new emerging power is "a power that exerts a positive influence on life, that endeavors to administer, optimize, and multiply it, subjecting it to the precise controls and comprehensive regulations." In Foucault's writing, this power is designated as biopower, and it marks "the acquisition of power over man insofar as man is a living being" (Foucault, 2003, p. 239). The particularity of biopower is that it "brought life and its mechanisms into the realm of explicit calculations and made knowledge-power an agent of transformation of human life" (Foucault, 1978, p. 143). Thus, the biological traits of the population become subjects of politics, and as Foucault argues, power is now situated and exercised at the level of life (Rabinow & Rose, 2006).

As Rabinow & Rose (2006, pp. 196-197) point out, at its most general, the concept of biopower "serves to bring into view a field comprised of more or less rationalized attempts to intervene upon the vital characteristics of human existence." Within the field of biopower, the vital characteristics of human existence are approached in two dimensions: the individual body and the "social body" which is the collective population. The former is the anatomo-politics of human body and it focuses on the

disciplining of the individual body in the attempt to maximize its productive forces and involves Foucault's work on discipline and disciplinary power (Rabinow & Rose, 2006; Elbe, 2008). Anatomo-politics perceives the human body as a machine and centers on the "optimization of its capacities" (Foucault, 1978, p. 139), which refers to a series of discipline technologies that directly act on an individual body to make individuals more obedient and productive. The latter on the other hand, is applied to "man-as-species" (Foucault, 2003), aiming at the regulatory control of the population. Here, population does not denote a legal or political identity to Foucault, rather, it is an "independent biological corpus" (Lemke, 2011, p. 36): a population that is characterized by its own biological occurrences and processes. Accordingly, biopolitics manifests Foucault's (1997, p. 73) idea that modernity is characterized by a biopolitical power of regulatory controls that endeavors to "rationalize the problems presented to governmental practice by the phenomena characteristic of a group of living human beings constituted as a population: health, sanitation, birthrate, longevity, race."

While Foucault distinguishes these two basic forms of biopower as distinct ones, in the meantime he stresses that "these forms are not antithetical, however; they constitute rather two poles of development linked together by a whole intermediary cluster of relations" (Foucault, 1978, p. 139). The disciplining and the regulatory control are not mutually exclusive entities but define each other (Lemke et al., 2011). According to Foucault (2003, p. 242), "discipline tries to rule a multiplicity of men to the extent that their multiplicity can and must be dissolved into individual bodies that can be kept under surveillance." In this respect, the disciplining of an individual body presupposes a multiplicity of people. Likewise, population is a collective body formed and aggregated by individual bodies, and it constitutes the "combination of individualized patterns of existence" (Lemke et al., 2011, p. 37). Together, the individualizing and the massifying modes of power are two components of a biopolitical rationality that seek control of the human as both individual body and as species.

The modern emergence of biopower and biopolitics is accompanied with liberal forms of social regulations (Lemke et al., 2011). In the very model of liberal government, biopolitics and biopower become important mechanisms focusing on ensuring healthy subjects for the possible governing and cultivating of massive populations through freedom and productivity in the capitalist market. Following this Foucauldian tradition of biopolitics, to govern is to keep populations healthy. Maintaining healthy and robust

populations is a crucial precondition for their productivity and thriving for capital (rather than altruism or other moral reasons).

Biopolitical Disease Management

So long as regimes aspire to the control of populations for maintaining productivity, biopolitical apparatuses will exercise power in guiding particular forms of health surveillance and disease management. Studies about the health of populations often draw on Foucault's conception of biopolitics (Fries, 2008; Wright & Harwood, 2012; Briggs & Nichter, 2009). Biopolitics names a particular political rationality and strategy that encompasses "problematizations of collective human vitality, morbidity and mortality; over the forms of knowledge, regimes of authority and practices of intervention that are desirable, legitimate and efficacious" (Rabinow & Rose, 2006, p. 197). Foucault (2003, p. 249) sees the particularity of this biopolitical control in the fact that it implies a new "technology of security" targeting life. According to Foucault (2003), this technology focuses on the mass effects characteristic of a population and the variation of random conditions that can occur in the population to predict the probability of those conditions or to compensate for their effects. Through large scale of regulation and control, bodies are managed as general biological processes. These biopolitical instruments represent "a technology [of security] which aims to establish a sort of homeostasis, not by training individuals, but by achieving an overall equilibrium that protects the security of the whole from internal dangers" (Foucault, 2003, p. 249).

Foucault's later lectures given at the Collège de France in 1978–79 can be considered as a continuation of his thoughts on biopower and biopolitics. In these works, Foucault further examines the security technology regarding the management of populations. This technology, as explained by Foucault (2007), tries to govern reality through a series of analyses and specific arrangements. More specifically, by comparing different ways of disease management in different periods, Foucault (2007) discusses how an apparatus of security operating on a population level brought new forms of biopolitical governance. Using the case of smallpox in the 18th century as an example, Foucault found that the disease surveillance interventions for smallpox depended mostly on statistical methods. The use of statistics made it possible to determine probabilities and the distribution of cases in a population circumscribed in time or space (Foucault, 2007). These distribution analyses established standards of averages and enabled

individuals within the population to calculate their risk of disease infection based on their age, location, or profession. Particular groups of individuals or regions that appeared to be on the above-average side were described as “dangerous” and “at risk” (Elbe, 2008). Consequently, as Foucault (2007) argues, the statistical approach rationalizes disease management:

> The notion of case appears, which is not the individual case, but a way of individualizing the collective phenomenon of the disease, or of collectivizing the phenomena, integrating individual phenomena within a collective field, but in the form of quantification and of the rational and identifiable. (p. 60)

Foucault also stresses that the security apparatus is essential in the management of disease and the establishment of an idea of the “normal” distribution of disease in a population, including both the sick and the healthy bodies. Based on the establishment of this normal distributional curve, the apparatus can identify and reduce the most unfavorable and deviant normalities in relation to the normal averages (Foucault, 2007; Butler, 2007). Foucault (2007) calls this the normalization process, in which the “normal” distribution is established first and the norm is deduced from it. And once the norm is fixed, it plays its operational role in the interplay of differential normalities. Finally, as Foucault argues, this biopolitical governing of disease at the level of population differs entirely from the way that disease was addressed under sovereign power through exclusion and quarantine. Rather, the security technology tries to “halt epidemic or endemic phenomena” (Foucault, 2007, p. 10) with the biopolitical management of collective population dynamics. Elbe (2006) illustrates that during the management process, risk is marked as a biopolitical rationality:

> This last aspect makes risk a biopolitical rationality, for not only does the language of risk accompany various political strategies that seek to manage collective population dynamics, but it is also the language of risk that enables these collective dynamics, including overall levels of disease, to be governed at the level of population. (p. 191)

Hence, notions of case and risk call for a series of techniques and interventions with the aim of rationalizing a biopolitical governing of epidemics. At the nexus of security, risk, and health, biopolitics serves as a conceptual apparatus to safeguard and regulate the lives of populations.

Necropolitics and Slow Violence

Foucault's conception of biopolitics offers rich concepts which can be used to theorize the contemporary management of health at the level of populations. Biopolitics incorporates a series of techniques to tame the risk within the population and normalize epidemics into routinized and manageable tasks of governing. However, in terms of exceptional crises such as pandemics, biopolitics is not sufficient for explaining how the threat of death continues to prevail as a governing technique in contemporary settings. So how can we further theorize the management of populations during crisis? In this regard, the concept of necropolitics, developed by Mbembe offers critical insights that are helpful in thinking through this question.

Mbembe (2019, p. 66) defines necropolitics as "the work of death", which is a corrective complement to Foucault's ideas of biopower and biopolitics. For Foucault (2003, p. 241), biopower differs from the sovereignty's old right to "take life or let live" in that it is the power to "make live or to let die", and the power that asserts its control over the domain of life. The justification for contemporary governing under a regime of biopower builds on the reproduction of living populations (Wright, 2011). The key focus of this regime is centered on the "dispersed management of the biological threat posed by certain populations to the reproduction of the normatively framed general good life of a society" (Berlant, 2007, p. 756). In this sense, though biopower is presented as a protective kind that fosters the health and longevity of populations, it inevitably involves the subjugation of non-normative groups of people. Foucault (2003, p. 61) states that the claim of preserving life and population enables the state to intervene in governing populations, which in turn, also justifies racism as a rationality that "against those who deviate from that norm, against those who pose a threat to the biological heritage." In Wright & Harwood's (2012, p. 16) words, biopower is a "power that appears life conserving, yet functions to fortify populations in the name of modern state power, commanding practices in the name of life (and whether these are indeed life enhancing is open to debate)." Mbembe (2019) suggests a different way to understand the right of biopower to make live or let die. In Mbembe's analysis, the sovereign agency under a regime of biopower not only "let die" but also indeed expose people to the possibility of death (Davies, 2018). Using the concept of biopower as a departure, Mbembe (2019, p. 66) furthers this point and seeks to explore "under what practical conditions is the right to kill, to allow to live, or to expose to death exercised?" Death is situated at the centrality

of necropolitics, just as the meaning of life is central to biopolitics. The concept of necropolitics entails the “subjugation of life to the power of death” (Mbembe, 2019, p. 92). Mbembe looks at cases from the more politically volatile states of the postcolonial context to illustrates how politics serves as the work of death and through which necropower dictates who may live and who must die emerges (Wright, 2011). Examples drawn by Mbembe are slavery, colonization, apartheid, and the “war on terror”, all to show how different forms of necropower expose people to precarious conditions of living (Mbembe, 2019). Looking at the relationship between politics and death enables a new way of understanding the capacity of sovereign agency to “define who matters and who does not, who is disposable and who is not” in a state of emergency (Mbembe, 2019, p. 80).

Mbembe’s concept of necropolitics illustrates how contemporary forms of subjugation force bodies to remain in different states of being between life and death (Mbembe, 2003). Violence, in his view, does not only denote the outright killing of individuals, but it also involves social or political death, enslavement, and other forms of violence. Mbembe (2019, p. 75) uses the case of slave planation to demonstrate how colonized bodies were “kept alive in a state of injury, in a phantom-like world of horrors and intense cruelty and profanity.” From these repressed and violent conditions of cruelty, Mbembe (2019, p. 92) aims to suggest that “form of necropower blurs the lines between resistance and suicide, sacrifice and redemption, martyrdom and freedom.” With a major focus on violent death in post-colonial worlds, necropolitics is used to:

> account for the various ways in which, in our contemporary world, weapons are deployed in the interest of maximally destroying persons and creating death-worlds, that is, new and unique forms of social existence in which vast populations are subjected to living conditions that confer upon them the status of the living dead. (p. 92)

Nevertheless, the concept of necropolitics also provides critical insights into examining more subtle ways of violence associated with socially uneven distributions and arrangements of power in contemporary settings (Davies, 2018; Wright, 2011; Sandset, 2021). Violence is usually conceived as a destructive action or incident that is instant in time, explosive and spectacular in space (Nixon, 2011). But what do subtle forms of violence entail? Nixon’s (2011) notion of slow violence is useful here to guide the discussion. Slow violence refers to the violence that “occurs gradually and out of sight, a violence of delayed destruction that is dispersed across time and space, and attritional

violence that is typically not viewed as violence at all" (Nixon, 2011, p. 2). While necropolitics is concerned with visible forms of violence, slow violence directs the analytical gaze to more gradual and time-delayed versions of violence. As Davies (2018, p. 1539) states, the concept of slow violence has value in revealing the "slow and hidden brutality" of certain places. It can be used to analyze the structural violence of suffering produced through uneven social conditions. It looks beyond the moment of crisis to think through the hidden, incremental, and accretive nature of violence.

Pandemics, as a form of exceptional crisis, exemplify the hidden necropolitics and slow violence in today's social worlds. Looking at the ongoing COVID-19 pandemic, Sandset (2021, p. 2) suggests that the "COVID-19 pandemic is entangled with necropolitical factors of slow violence and death that preceded the pandemic and adds to the disproportional distribution of vulnerabilities towards the risk of infection, death, and economic impoverishment." Sandset (2021, p. 5) argued that necropolitics is also connected to a state of acceptance in which "the slow and steady violence and death zones created every day rely on an affective mode of expecting and accepting that certain people and communities will die and suffer." The notion of necropolitics allows us to examine embedded social and health inequalities, and how certain bodies are marked out as dispensable, and their losses are acceptable in a pandemic.

Considerations

The notions of biopolitics and necropolitics offer a broader theoretical framework to think through the nexus of security, risk, and public health in the COVID-19 pandemic. Population control, as a form of biopolitical and necropolitical power, frames how bodies are classified and managed through varied measures and instruments. The former focuses on examining the interventions and controls applied to manage populations, and the latter focusses on investigating the repressive and negative conditions in which people are subjugated. Power, in this sense, is not simply repressive, but also productive of categories of identities and knowledges of social difference that work to discipline and regulate bodies (Chung, 2020).

3.3.2. Biological Identity

Moving beyond the managing and controlling aspirations of biopolitics and necropolitics on the level of populations, I now turn to another line of extension of

biopolitics that focuses on life itself to help theorize how contemporary biometrics and technological surveillance have increased control over life and brought new forms of biological identities. This line of studies acknowledges that developments in scientific knowledge and technology have greatly altered and enriched the understanding of the concept of life (Lemke et al., 2011). Scholarships within this field advance and expand the concept of biopolitics to concepts of biosociality (Rabinow, 1996), biological citizenship (Rose & Novas, 2005), and ethopolitics (Rose, 2001; 2007) that examine in what new ways has our biological existence become social concerns (Braun, 2007).

Biosociality and Biological Citizenship

Biosociality is introduced by Rabinow (1996) as an extension of biopolitics to describe the new forms of collective identification emerging from biotechnological innovations. Rabinow (1996, pp. 99-100) argues that in light of these technoscientific developments, a postdisciplinary society characterized by “a mutation of social technologies that minimize direct therapeutic intervention, supplanted by an increasing emphasis on a preventive administrative management of populations at risk” has come into being. Rabinow (1996) proposes that in contemporary society, social relationships are understood through biological categories and processes:

> In the future, the new genetics will cease to be a biological metaphor for modern society and will become instead a circulation network of identity terms and restriction loci, around which and through which a truly new type of autoproduction will emerge, which I call "biosociality". If sociobiology is culture constructed on the basis of a metaphor of nature, then in biosociality nature will be modeled on culture understood as a practice. (p. 99)

In Rabinow’s research, he believes that to some extent in the near future when genetic information and knowledge is popularized among populations, people will describe or identify themselves in terms of biological terminologies. His research leads him to identify new types of group and individual identities arising out of new techniques of genetic diagnosis and monitoring of genetic risks. As Rabinow proposes, innovative technological classification systems create the corporeal foundation for new forms of socialization, representations, and identities (Lemke et al., 2011; Rose, 2007). Hence, people’s experiences, relations to others, and their forms of life are all reshaped by biological characteristics. Additionally, Rabinow (1996, p. 102) foresees the way in which individuals perceive themselves in biological knowledge accompanied by “a heavy

panoply of pastoral keepers to help them experience, share, intervene, and 'understand' their fate."

Rose & Novas (2005) acknowledge similar developments in relation to biosociality and suggest a different concept, namely biological citizenship, to approach these issues. For Rose & Novas, biological citizenship highlights the way that citizenship has been shaped by conceptions of "specific vital characteristics of human beings" (Rose, 2007). The notion of biological citizenship thus describes forms of citizenship that have linked their conceptions of citizens to beliefs about biological existence of human beings (Rose & Novas, 2005). In Rose's (2007) later book, he further states that many citizenship projects were organized in the name of medicalization and health:

> Biopolitics, here, was not exhausted by sterilization, euthanasia, and the death camps. … In the education of German citizens in the Third Reich, in eugenic education campaigns in the United States, Britain, and many European countries, making social citizens involved instructing those citizens in the care of their bodies - from school meals to toothbrush use, inculcation of the habits of cleanliness and domesticity, especially in women and mothers, state regulation of the purity of food, interventions into the workplace in the name of health and safety, instructing those contemplating marriage and procreation on the choice of marriage partners, family allowances, and much else. (p. 24)

According to Rose (2007), citizens are not merely passive recipients of social rights but also are obliged to care for their own bodies. While states would act on biopolitical measures for managing the collective health of populations, Rose (2007, p. 24) argues, "individuals themselves must exercise biological prudence, for their own sake, that of their families, that of their own lineage, and that of their nation as a whole."

Critiques and Considerations

Contemporary biotechnologies show potentials to dismantle and recombine human bodies to an extent that Foucault did not anticipate (Lemke et al., 2011). With a special focus on biotechnologies and genetic knowledge, both notions of biosociality and biological citizenship seek to examine new connections between biology and social identity. In following this line of thinking (Rose & Novas, 2005; Rabinow, 1996), I continue to argue that biometrics and technological surveillance tools applied for health surveillance purposes also engage in reshaping knowledge of human bodies and forming new biological identities in societies. Human bodies are conceived as

fragmented, exploitable objects that can be physically tracked, categorized, and reshaped into readable and manageable subjects by digital health surveillance technologies.

The formation of a new biological citizenship is both individualizing and collectivizing. It is individualized to the extent that individuals shape their relations with themselves in terms of knowledge of their somatic individuality (Rose & Novas, 2005). Through digital health surveillance technologies, biological health status, explanations, values, and judgments get entangled with a more general contemporary "regime of the self" as a prudent yet enterprising individual, actively shaping her or his identity (Rose & Novas, 2005, p. 36). Biological citizenship is collectivized, as new forms of biosociality are being assembled around a biological conception of a shared identity that ought to be defended (Rabinow, 1996).

Ethopolitics – The Individualization of Risk

Rose proceeds to argue that advancements in biological knowledge and technological practices blur the boundary between biology and society (Lemke et al., 2011). "Health, understood as an imperative, for the self and for others, to maximize the vital forces and potentialities of the living body, has become a key element in contemporary ethical regimes" (Rose, 2007, p. 23). According to Rose (2007), the medicalization and popularization of hygienic norms and measures implemented by governments that aim at improving population health gradually result in individuals taking on the role of health management. Hence, another notion of ethopolitics, developed by Rose (2001) as the politics of life itself, concerns the self-management techniques by which individuals should judge themselves and act upon themselves to make themselves better than they are. Ethopolitics names a form of neoliberal self-government and the individualization of risk. Rose (2001) describes ethopolitics as:

> By ethopolitics I mean to characterize ways in which the ethos of human existence - the sentiments, moral nature or guiding beliefs of persons, groups, or institutions - have come to provide the "medium" within which the self-government of the autonomous individual can be connected up with the imperatives of good government. In ethopolitics, life itself, as it is lived in its everyday manifestations, is the object of adjudication. (p. 18)

With this regard, the concept of ethopolitics engages in a new set of ethical and social questions emerging out of the increasingly blurred boundaries between the normal and

the pathological, thus requiring individuals to actively respond to state-organized governing and act upon their own health management (Lemke et al., 2011). The responsibility of protecting population health and individual wellbeing is gradually transferred to individuals and internalized into a new formation of biosocial grouping in the postdisciplinary society.

Critiques and Considerations

Braun (2007) provides a critique of ethopolitics, suggesting that it is not adequate to account for other perceptions of the body in an unpredictable world full of pathogen risks. Looking at epidemics, Braun (2007) finds that in epidemic control, discourses regarding the prevention of the spread of a given pathogen often presume an open and vulnerable body that is permanently threatened by the risk of infectious disease. To address these dangers, a set of political technologies, which Braun (2007) coins as biosecurity, seek to govern biological disorder in the name of a particular community through extraterritorial acts.

Braun's critique of ethopolitics highlights the developmental cycles and contingencies of biological life, which further points to a broader picture of the governing dynamics in contemporary societies (Lemke et al., 2011). For this thesis, I follow Braun's critique in arguing that a thorough examination of biopolitical dynamics of health surveillance system requires considerations of the broader issues of biosecurity as well as the ethopolitical mechanisms. Additionally, I would add to the critique of ethopolitics that the ethopolitcal mechanisms also "design in" protection and "design out" insecurity through the individualization of risk and the normalization and routinization of health surveillance practices to make individuals more adaptable to future pandemics (Lacy, 2008). As more health surveillance systems are benignly woven into the fabric of individuals' everyday life in the name of population health, individuals will inevitably become more adaptive to these systems in order to be categorized and recognized as the normal and healthy.

This individualization of risk presented by ethopolitics is inherently connected to the broader picture of biopolitics referred to the emerging biometric state (Muller, 2008). I borrow Muller's (2008) conception of the emerging biometric state to describe the prevalence of biometric health surveillance systems and other forms of social sorting based on biological characteristics of individuals in pandemic societies. The obsession

with technological health surveillance practices in pandemic control represents attempts to tame the risk and "govern what appears to be ungovernable" (Aradau & van Munster, 2007, p. 107). The relation of risk to security and biopolitics has encountered renewed interests (Aradau et al., 2008):

> As an attempt to tame uncertainty and contingency, our general understanding of risks builds on the premise that they can be classified, quantified and to some extent predicted. … Risk implies a specific relation to the future, a relation that requires a monitoring of the future, an attempt to calculate what the future can offer, and a need to control and minimize its potentially harmful effects. (p. 149)

Thus, in biopolitical digital health surveillance, risk infuses exceptionalism within the governmentality of everydayness through normalized routine processes of classification and categorization of the healthy and the sick. Besides, the imagination of the unknowable and unpredictable catastrophic future has become the driving force that shapes health surveillance systems. "The sovereign order is no longer simply that of decision, but also that of imagination" (Aradau et al., 2008, p. 150). The emerging biometric state is indeed a specific rendering of these assemblages of strategies of power and employs a range of governing rationalities and technologies to prevent the occurrence of infections and securitize health (Muller, 2008).

3.4. Conclusion

This chapter has outlined an interdisciplinary theoretical framework informed by the conceptual linkage between security and health and illustrated the theoretical values in examining the research questions and objectives through biopolitical perspectives. It has situated the thesis within these theoretical areas of scholarship, and identified the way forward to critically engage in further discussions. In the next chapter, I will provide an overview of my methodological approach and how I conducted the analysis.

Chapter 4. Research Design

4.1. Introduction

This chapter will introduce the research methods employed in this research to explore the broad topic of how power relations are embedded in digital health surveillance technology, and specifically, the research questions below which arose through a review of literature outlined in chapters 2 and 3. This thesis applies institutional ethnography as the research approach to address my research questions. A thorough explanation of my mode of inquiry, illustrating the rationale of my chosen approach is presented in section 4.3. I will provide an overview of the rationale and processes of the data collection, followed by a detailed demonstration of the data analytic strategies applied in this project. Specifically, the data collection in this thesis includes institutional texts (e.g., technical standards and policy documents) and semi-structured interviews with informants. The data analytic strategies utilized in this project include tracing, mapping, indexing, and writing, which are techniques suggested for approaching, managing, and analyzing data in institutional ethnography studies (Rankin, 2017). This chapter will also present my methods for enhancing the validity of the research (section 4.6) and ethical considerations (section 4.7).

4.2. Research Questions

Following from gaps in literature concerned with security and health, biopolitics, theories of classification, and surveillance technologies, issues identified in chapters 2 and 3 led to the formation of the following research questions, which are explored in the remainder of this thesis:

RQ1: How is health securitized through the design, implementation, and normalization of Health Code?

RQ2: What ideas and perceptions about biological identities have been formulated through the normalization of digital health categorization in the name of epidemiological purposes?

RQ3: How is knowledge about the everyday lives of local individuals in Wuhan, China organized and managed by the ruling relations embedded in Health Code?

Research question 1 aims to explore how the notion of securitizing health as a dominant value is reflected in the design features, implementation methods, and the propagation of Health Code. The second question focuses on the biopolitical aspects of this technology. More specifically, it seeks to examine what kinds of ideas are assigned to people's biological identities via the classification of human bodies embedded into the Health Code system, and how individuals relate to their identities. The third question seeks to understand how those living with and using the Health Code system experience it. It focusses on the lived experiences of local individuals in Wuhan living within the Health Code system, and unpacks the power relations that organize their everyday experiences and practices.

4.3. Mode of Inquiry

A problematic is similar to a "puzzle" in the social world, which focuses on discovering how lives of individuals are socially organized and coordinated by ruling relations (Smith, 2005). The problematic in this study focused on exploring how Health Code and related disease control policies organized people's daily activities in Wuhan during the COVID-19 pandemic. Guided by this problematic, I required a research approach that would meet the following criteria. First, in order to understand how people in Wuhan experienced the pandemic in general and use of the Health Code system in particular, I needed a research approach which would allow for an in-depth ethnographic exploration of Wuhan people's local experiences with the system. Second, I wanted an approach which would allow me to link people's everyday experiences and practices to the broader social and institutional phenomenon. To address the first part of the problematic – people's everyday experiences – ethnographic interviews were deemed appropriate. To pursue the second aspect of my problematic, I needed an approach which would allow me to connect everyday activities to broader institutional phenomenon with a critical analysis of institutional texts.

Upon a careful consideration, I determined that critical institutional ethnography (IE) was the best choice. Developed and named by Canadian sociologist Dorothy E. Smith in the early 1980s, IE has spread not only globally in sociology studies but also

through a number of other fields such as nursing, education, social work, criminal justice studies, and so on (DeVault, 2006; Pence, 2001).

IE is not about doing observational ethnographic work in institutions, rather it is a method that explores the embodied knowledge and experience of individuals in a particular local and social setting and problematizes social relations, while examining how institutional texts coordinate people's actions extra locally (Smith, 1987). An IE study typically starts with an exploration of the problematic from the standpoint of a special group of individuals whose experience provides the starting point of investigation (DeVault & McCoy, 2002). One of the major objectives in this research was to listen to the lived experiences of local Wuhan people who have been living within Health Code, the digital health surveillance system and its attendant policies during the COVID-19 pandemic. Ordinary Wuhan citizens are expert informants when it comes to their embodied experiences within this problematic. The standpoint of Wuhan people's embodied experiences was applied as the analytic entry point through which connections of their everyday institutional process are revealed, through a critical analysis of institutional texts.

Unlike standard sociological studies that represent the ruling relations as system or structure, IE, as part of an alternative sociology, "returns to the actualities of people's lives and activities" (Smith, 1999, p. 93). Ruling relations in IE studies cannot be reduced to relations of domination or hegemony, however, they are "text mediated and text-based systems of communication, knowledge, information, regulation, control, and the like" (Smith, 1999, p. 77). Ruling relations rely on texts, language and knowledge to organize activities. Based on this conceptualization of ruling relations, the notion of institution points to a group of text-mediated relations organized around specific ruling functions (DeVault & McCoy, 2002). In this project, institution does not refer to a specific organization or administration, rather it denotes a system of health surveillance during the COVID-19 pandemic in Wuhan, directing to coordinated and intersecting work processes (DeVault & McCoy, 2002), which are organized through texts, including policies, software and more.

From the standpoint of Wuhan people, I aimed to reveal the ruling relations that organize and manage everyday local activities and their experiences of Health Code. IE provides a mode of inquiry which makes it possible to uncover how the ruling practices

reconstructed people's understanding to their bodies and health as security issues, and led to the formation of new connections between biology and self-identity with and through Health Code technology. Achieving this objective offers important insights in the interacting relationship between public health and digital surveillance. Thus, IE was an appropriate approach for me to conduct this research.

4.4. Data Collection

"The method of IE was founded on the assumption that humans are social beings and that our everyday lives are socially organized" (Deveau, 2008, p. 6). Therefore, to explore how people's lives were socially coordinated, the data collection involved two parts: 1) institutional texts, such as policies and national standards; 2) semi-structured interviews with individuals. These two approaches offered a profound understanding about how institutional texts organize individual's daily experience and practices. By analyzing institutional texts, it was possible to unpack the discursive and managerial process of institutions. This allowed a critical examination of the key concept, which is securitizing health (RQ1). Interviews – conducted via an online video conferencing software Zoom due to the pandemic – served as the fundamental process of investigating individual's embodied experience of the system. This combination of institutional texts and interviews allowed me to look into ideas and perceptions of biopolitical identities (RQ2), and trace and map the correlation between policies and people's experience organized by them (RQ3).

4.4.1. Institutional Texts

In IE research, texts play a crucial role in explicating the power relations that coordinate people's practices (Campbell & Gregor, 2002). Texts often refer to some kinds of documents or forms of representation that have a "relatively fixed and replicable character" (DeVault & McCoy, 2002; p. 765). As standards and mediators, texts are replicated electronically in varied locations to regulate local activities (Smith, 1999).

An analysis of institutional texts is a significant part of the data collection. In this project, I mainly focused on institutional texts used in bureaucratic settings such as documents, regulations, policies, and technical standards. I carried out document retrieval and analysis because these text-based forms of knowledge were "speakers in a

conversation," and the texts worked directly in bringing an authoritative understanding to people as well as organizing their local activities (Bell & Campbell, 2003, p. 117).

To address my research questions, I chose to collect documents that were a) technical standards released by The State Administration for Market Regulation (SAMR) in China and/or by municipal research Institutes; b) current and/or archived standardized policy documents accessible via the public domain that related to governing and organizing local activities with Health Code.

Procedure

Technical Standards

To gain better understandings of how technical standards of the system were developed during the time, three types of standards of Health Code were collected in this research, including two technical standards issued by municipal institutes and national standards released by SAMR. These technical standards of Health Code collected in this thesis are primarily technical documents which also include some information about the deployment plan of Health Code in introducing the system.

Before the national standards of Health Code were introduced on April 29, 2020 to the public, there were two municipal standards available: one was written in a collaboration between Tencent (a giant technology company in China) and a research institute named Shenzhen Institute of Standards and Technology on March 5, 2020; the other was developed under the leadership of the Hangzhou Municipal Health Commission together with eight governmental actors and technology companies including Alibaba on April 9, 2020. The two local standards for Health Code will be abbreviated as the Shenzhen standard and the Hangzhou standard respectively in the rest of the thesis.

The Shenzhen standard, as the first technical standard of Health Code, provided guidance in the following areas: terms and definitions, the architecture of Health Code, technical requirements, and data protection. In contrast, the Hangzhou standard focused more on health code assignment rules, system management, and daily applications and services. The national technical standards of Health Code concentrated on the reference model, application interface, and data format of Health Code, promoting a standardized

understanding of the system (a listing of the technical standards is contained in Appendix A).

Policy Documents

Governmental policies and regulations played a significant role in describing Health Code to the public and integrating the system into the whole disease control plan in Wuhan. Thus, I collected all the available public policies and documents related to Health Code from the Wuhan Municipal Health Commission from early February 2020 to late October 2020. I chose this time period because it best captured how the system worked in organizing people's lives from the start of the Wuhan lockdown and afterwards. A total of twenty-five documents were retrieved from the official website of Wuhan Municipal Health Commission, including five documents issued by National Health Commission of the People's Republic of China and three documents released by Health Commission of Hubei Province To avoid ambiguities when referring to these policy documents in the analysis, I coded the documents in a hierarchical order. "NLPD" refers to documents issued by the national health authority, "PLPD" indicates documents released by the Hubei provincial health agency, and "MLPD" denotes policies and documents published by the Wuhan municipal health authority (a listing of the documents is contained in Appendix B).

These policy documents provided direct guidance and regulations about how to use Health Code as a part of the COVID-19 infectious disease control measures in assessing people's contagion risks and tracking their traces in the city.

4.4.2. Semi-structured Interviews

Semi-structured interviewing is flexible and dynamic to some degree in that it involves the implementation of a range of special topics and semi-standardized questions (Berg, 2001). Especially when researchers are interested in understanding informants' perceptions on their lives and experiences, semi-structured in-depth interviews can provide a useful means of access (Taylor et al., 2015).

In addition to analyzing institutional texts, I also conducted semi-structured interviews with sixteen informants to understand people's lived experience. Interviews are of great importance in this project because they provide an entry into how local

practices are organized by institutional texts via the standpoint of informants' experience in their daily lives (Deveau, 2008).

Procedure

Informants

I sought to take the standpoint of local people whose experiences could be utilized as the starting point of my investigation of Health Code and related institutional texts. The standpoint guided this project was that of ordinary people living in Wuhan who were subjected to the management of Health Code since its implementation in Wuhan during the COVID-19 pandemic. Health Code was introduced in Wuhan in late February 2020 when Wuhan was still under lockdown. The embodied experiential knowledge and information provided by local Wuhan people served as an analytic point of entry into the problematic (Campbell & Gregor, 2002).

Ordinary Wuhan citizens who were subject to the management of Health Code were referred to as citizens in this study. The experiential data of local people was used as the main source of information which guided me to further discover traces of social organizations in their daily lives. The inclusion criteria for selecting citizen participants was: people who had lived in Wuhan during the COVID-19 pandemic, more specifically since the implementation of Health Code in late February 2020; and people who used Health Code on a daily basis for access to public places. Reasons for establishing the inclusion and exclusion criteria were:

- Wuhan was the center of the COVID-19 outbreak which required massive health surveillance. The implementation and utilization of Health Code in Wuhan was the most comprehensive compared to other cities. Delimiting the scope of this project to local individuals in Wuhan provided more precision and concrete knowledge in explicating the relations of ruling. In addition, Health Code was implemented in almost every city in China as part of disease control measures and different cities might have different policies of governing. Focussing on Wuhan specifically served as a means of delineating the boundaries of a case study.

- People who were in Wuhan since the implementation of Health Code had embodied, expert and profound knowledge and experience of Health Code and its related institutional texts.

- In order to gain more profound understandings of people's lived experience with this system, the citizen informants involved in this project represented a variety of demographic characteristics. They varied in age, gender,

occupation, and geographic location in the city (see Appendix C for a summary of demographic characteristics of interview informants). This allowed me to cover a broad range and diversity of experiences regarding the problematic in this study.

- The color-based code assigned to each person indicated the exposure risk and freedom of movement of that person. People who had been issued with a green, yellow or red code might have different experiences with the system. Therefore informants who had been assigned each risk level-- green, yellow or red health codes provided more comprehensive understandings.

Because different standpoints and social locations may bring different views and understandings of Health Code, this research also included Wuhan people who worked as volunteers or directly at checkpoints of public places such as malls, marts, local communities, etc., referred to here as citizen-supporters. Because these people worked as part of the regulatory body of the health surveillance system, they could provide complimentary information and knowledge of their particular experience with Health Code as part of the system. Hence, the inclusion criterion for selecting citizen-supporter participants was:

- People who worked for the health surveillance system in Wuhan as volunteers or in other positions were recruited as citizen-supporter informants to supplement different standpoints of experience with Health Code.

Recruitment

I have lived in Wuhan and completed my bachelor's degree in Wuhan prior to my studies in Canada. In light of travel restrictions and other challenges, a convenience sampling method was used to recruit both citizen and citizen-supporter informants. I used my connections to contact prospective participants who might be willing to participate in this research. I reached out to my friends, relatives, and alumni who lived in Wuhan during the COVID-19 pandemic. I also used my network in Wuhan to find prospective participants who worked as volunteers or other positions in the health surveillance system of Health Code.

I started by developing a list of personal contacts of twenty people and sent out invitation emails to all of them. I received fifteen positive responses to my invitation. Five of them were excluded either because they did not meet all of the above criteria, or they did not want to participate in this study. Then I asked individuals whether they knew someone who had worked as volunteers or other positions in the health surveillance system of Health Code and if they were willing to pass on the recruitment materials and

contact information so that other potential informants could contact me if interested. Then I received feedback from one person who worked at the checkpoint of malls, two volunteers in local communities, and one worked directly for monitoring the implementation of Health Code. In total, twelve citizen participants and four citizen-supporters participants were included in this project.

Interview Process

Due to the COVID-19 pandemic, all my interviews were conducted remotely using online video-conferencing applications. Upon a thorough examination and comparison of existing available applications, I used Zoom 5.0 because of its popularity and recommendation from SFU IT services. I also followed the SFU ethics board Zoom guidance to proceed with online interviews. All my interviews were semi-structured, 30-120 minutes in length and conducted in mandarin or Wuhan dialect between January and February 2020. I transcribed the data and translated them into English for analysis. This resulted in roughly 40 pages of single-spaced text.

Once an informant had viewed the consent form and given consent, I would schedule an appropriate time to conduct the virtual interview. Prior to conducting the interviews with citizen informants, I first formulated a set of questions in my preliminary interview guide based on my research objectives and my initial understanding and perceptions of Health Code (see Appendix D). The majority of interview questions focused on things such as how interviewees came to know about Health Code; the procedures for using Health Code; their everyday use of Health Code; their feelings about and insights about the use of Health Code and related institutional texts; their experiences of using Health Code for health surveillance.

A slightly different interview guide was used when conducting interviews with citizen-supporter informants. These interviews not only focused on their work experiences but also on their insights into and views about Health Code and its related texts which had arisen from their daily work and reflections. Questions addressed topics such as how the health surveillance system worked; what the process was when they identified someone without a green health code; the textual links and connections between policies and their work duties; their insights and perceptions about Health Code and other coordinated parts of Health Code's health surveillance system. Interviews ended with open discussion of anything interesting or important related to Health Code,

and drew on their reflections (see Appendix D for a sample of questions specifically used for citizen-supporter informants).

IE interviewing cannot be fixed or standardized, rather "each interview provides an opportunity for the researcher to learn about a particular piece of the extended relational chain, to check the developing picture of the coordinative process, and to become aware of additional questions that need attention" (DeVault & McCoy, 2002, p. 9). Both interview questions with citizen or citizen-supporter informants were not fixed but began with the interview guide and elaborated upon as interviews proceeded in order to address questions emerging from responses as the interviews were being conducted. When I found a particular experience or perspective with one informant, I would follow up with other informants I had already interviewed about whether or not they had similar insights. During the interview process, I would also probe informants following responses which addressed issues I found particularly interesting, as well as aspects of experiences or knowledge of Health Code I sought more information about, based on their answers.

4.5. Analytic Strategies

The "analytic core" (Campbell & Gregor, 2002, p. 59) in IE relies on the "empirical discovery, description, and explication of the ways the lives of the people who occupy the standpoint position are being hooked into overlapping institutional relations of ruling" (Rankin, 2017, p. 2). In this project, I employed several analytic strategies that were commonly used in IE studies: tracing, mapping, indexing; and writing accounts (Rankin, 2017). The initial step in analysis was discovering the traces of the broad institutional relations, tensions and contradictions in the data by making notes on the transcripts and institutional texts. The mapping technique was applied to create analytic diagrams to depict the features of work processes and their relationships within the health surveillance system (Rankin, 2017). After the preliminary mapping of the system, the data were organized and analyzed to index several key subjects: system architecture and institutional processes of Health Code; citizens' everyday experience of Health Code and their daily activities; citizens' perceptions of Health Code and biological identities; ruling notions. I also started with the informants' standpoints, selected instances from the interview data, and wrote analytical accounts that described how local activities were socially organized (Rankin, 2017). The whole analysis process was

reflexive and iterative as I examined the data, taking notes, discovering new points, and revising my analysis. I describe the analysis strategies in detail in the following sub-sections.

4.5.1. Tracing and Mapping

Prior to the analysis, my previous assumptions and judgements about Health Code could be great barriers to me when I tried to discover tensions and contradictions in the social organization of Health Code. For example, since I had no experiences with Health Code, I previously assumed Health Code as an unnecessary disease control tool, but my participants might not agree with that. Therefore, to avoid my own assumptions and judgements about the system and people's experiences, I aligned myself closely with informants' standpoints during the analysis. From their standpoints, I was able to identify embedded tensions and contradictions of the system through reading the data. Tracing institutional relations in the data was an important process in the preliminary work with the data. It required that I develop my ability to "hear" traces of institutional relations that were often part of the taken-for-granted social organization in informants' words and texts (Rankin, 2017). Moreover, after tracing embedded conflicts in the data, another mapping method could provide a clear description of how the system works and helped guide the following analysis (Smith, 2010). In this project, I depicted the organization of Health Code in regulating people's mobility and the citizen and citizen-supporter informants' activities associated with the system. By looking at technical standards that described the organization architecture of Health Code and the policy documents indicating how Health Code worked as part of the pandemic control regulations in Wuhan, I discovered the relations and structures reflected in these texts.

4.5.2. Indexing

"Indexing is a tool that can be used to cross-reference across work processes, people, and settings" (Rankin, 2017, p. 6). For IE research, indexing is a way of thinking and organizing data in IE that helps to avoid drifting towards thematic analysis (Rankin, 2017). The major difference between IE research and thematic analysis is that IE research is grounded on the standpoints of individual's experiences, while thematic analysis seeks to make sense of collective or shared meanings across data by developing themes and categories (Rankin, 2017; Braun & Clarke, 2012). As opposed to

abstracting patterns from the data, indexing is a strategy that is used to discover linked relations and activities around "empirical happenings" (Rankin, 2017, p. 6). "Empirical happenings" refer to activities and work processes noticeable in the data that contributes to particular subjects, such as institutional processes of Health Code, people's daily activities related to Health Code, etc. Indexing is a way of organizing the data that helps IE researchers to stay grounded in IE's core materiality instead of leaving the particularities of people's experiences behind. Hence, to keep the analysis from drifting toward a thematic analysis that develops themes and categories abstracted from the data, I applied indexing as a useful tool to discover linked practices and relations in the data from institutional texts to ethnographic data. I worked on the data to index four subjects, as discussed below in details.

System Architecture and Institutional Processes of Health Code

Texts in institutional settings provided a means of observing the institutional work processes and design features of the system. Smith (2005) explained how texts coordinate in institutional settings:

> That is, there is a two-way coordination, one that is involved in coordinating a sequence involving more than one individual in an institutional course of action and the other with those responsible for overseeing the process and for ensuring that what is done meets regulatory requirements. (p. 170)

To unpack the complex coordination texts organized in the system, I looked at technical standards, regulatory requirements and policies of Health Code. Texts were seen as inserting the institutional into people's activities (Smith, 2005) to trace connections that might otherwise be invisible. I also integrated the working experience of citizen-supporter informants (they often work as part of the regulatory body of Health Code) in order to see how texts and citizen-supporters worked together to produce health security. This allowed me to see how citizen-supporters took up their work in relation to the texts.

Citizens' Everyday Experience of Health Code and Their Daily Activities

I located the language of everyday life used by citizen informants as they talked about their lived experiences and their daily activities. The previous step of tracing provided a general review of the data for looking for traces of social organization. In this indexing, I conducted an intensive reading of transcript data and identified the terms and languages informants used for describing their experiences. Social organization was not

a context for the use of such terms, rather, the meanings of these terms were given in a particular setting that was integral to coordinating people's work processes (Smith, 2005).

Institutional ethnographers rely on people's own knowledge of their practices to produce "work knowledge" (Smith, 2005, p. 210) which is descriptions and explications of what people know by what they do. Informants' daily activities and work processes of Health Code provided expert knowledge in understanding the system. In terms of locating informants' work processes, I used a generous conception of work "that applies to anything people do that takes time, depends on defined conditions, is done in particular actual places, and is intentional" (Smith, 2005, p. 210). This generous conceptualization of work allowed me to include work processes that might seem invisible at first sight, such as shouldering an emotional burden, as well as some trivial work processes (e.g., opening an app).

Citizens' Perceptions of Health Code and Biological Identities

This part focused on exploring informants' perceptions of their personal health codes and of Health Code as a digital health surveillance system. In the interview processes, I asked informants to reflect on how Health Code had changed their daily lives and what health codes meant to them. For example, many of the citizen informants talked about how health codes had become a form of their personal health identities. This triggered my interests, and I went back to institutional texts to look for traces of institutional logic that perhaps contributed to and guided this thought. This analysis process identified informants' thoughts and ideas of Health Code and their identities. I looked at how informants did and did not talk about their feelings and knowledge of Health Code and whether institutional texts informed those.

Ruling Relations

By examining the data about the organization of the system, I aimed at discovering traces of institutional processes involved in power relations. This included looking at the following aspects of the data: specialized terms and language that informants used to talk about the system; when and where and how institutional power entered the work processes of Health Code; terms and language that indicated a power

relationship (e.g., require, must, follow, obey, etc.); and how the knowledge and information was presented in the data.

The theoretical body of this project (see the theoretical approach in Chapter 3) has directed my attention to look at what notions, concepts, and categorization were negotiated and communicated in the institutional texts and processes of Health Code. Therefore, I investigated how the notions of security, health, and categorization organized the institutional texts and were reflected in the design and implementation of Health Code. This was achieved by analyzing the institutional way that the Health Code system was explained, and reviewing recurrent use of particular keywords used in conveying the notions. I was also interested in whether the ruling notions of Health Code could generalize and standardize informants' perceptions and their knowledge. In doing so, I focused on the interview data to examine how informants thought about these notions, whether they have adopted such ideological accounts, and if there were any disjunctures between their own lived experiential knowledge and the ruling notions. By moving back and forth between analyzing texts and transcripts, I was able to unpack the institutional ways of thinking about security and health in the system and look for traces of ruling notions in informants' knowledge and perceptions.

4.5.3. Writing

"The thinking and writing illuminate nuanced practices that expose links into the institution that are not evident at the outset" (Rankin, 2017, p. 10). The analytical accounts focused on building up a depiction of informants' experiences and the invisible institutional processes in the experiences. Towards this end, I then linked the descriptions of the problematic to these writing accounts to uncover how informants' experiences were socially organized. Writing "analytic chunks" (Rankin, 2017, p. 6) allowed me to look into the particular actualities of informants' lived experiences and provide useful insights to the analysis.

4.6. Research Validity

Qualitative research is often defined by uncertainty, fluidity, and emergent ideas, therefore, validity criteria in qualitative research must give credence to these efforts (Whittemore et al., 2001). Whittemore et al. (2001) proposed a contemporary synthesis

of validity criteria in qualitative studies: credibility and authenticity (Lincoln & Guba, 1985; Sandelowski, 1986; Maxwell, 1996), and criticality and integrity (Marshall, 1990; Hammersly, 1992) as primary criteria. Credibility and authenticity highlight the validity in description and interpretation of the data, while criticality and integrity require a critical appraisal of the findings, examining ambiguities and biases, and valid interpretation grounded within the data (Whittemore et al., 2001).

As a young scholar raised in Wuhan and interested in public health and surveillance studies, my standpoint might encompass a personal perspective towards the Health Code system. Therefore, to avoid bias and enhance the validity of my research, I followed the above four primary criteria for the reporting of my research. This included a set of techniques and measures: 1) Conducting interviews with informants in their native language to ensure they can express themselves in a more accurate and profound way; 2) Writing verbatim transcriptions of the interview data; 3) Full interpretation and analysis of the data; 4) Member checking with informants about my findings; 5) Writing a reflexive journal to record my experience as a researcher and my reflections throughout the course of my research; 6) ongoing discussion with and comments from my supervisory committee members.

4.7. Ethical Considerations

Prior to conducting research, this study obtained the ethical approval from Simon Fraser University (SFU) Office of Research Ethics. After I received ethics approval, I reached out to prospective participants and obtained either written or verbal informed consents from every individual participant before interviewing. This study was conducted during the COVID-19 pandemic, therefore, I strictly followed guidelines and instructions on how to conduct interviews remotely released by SFU Office of Research Ethics. I acknowledged that some primary participants might experience strong emotional reactions or resistance in terms of talking about their personal experiences of Health Code. To avoid this type of situation from happening, I wrote this potential risk in the consent form and informed participants about this possibility at the beginning of the interviews. I also applied measures to protect participants' confidentiality, including removing all identifiable information of participants and anonymizing the data.

4.8. Conclusion

As shown in the above sections, this thesis seeks to examine how individual's daily activities and experiences are socially organized and managed through the institutional processes and system logics of the health surveillance system applied for pandemic control in Wuhan, China. In this respect, IE as an approach that sets out to study the institutional arrangements and ruling relations from the standpoint of individual's experiences, and is a useful method for achieving the research objectives of this thesis. This thesis, therefore, employs analytic strategies informed by IE approach to analyze the data.

The next chapter will present my primary findings and discussion, illustrating how the Health Code system worked as a health surveillance tool in managing and coordinating people's daily practices and reshaping knowledge and perceptions of their biological identities.

Chapter 5. Findings and Discussion

5.1. Introduction

My IE analysis of the institutional texts and interview transcripts revealed how Health Code worked as a digital health surveillance system as part of pandemic control, and showed a wide variety of experiences and perceptions of Health Code from citizens and citizen-supporters in Wuhan. This chapter presents and discusses my primary findings of the analysis and shows the underlying ruling relations of Health Code. First, I describe the system architecture, implementation in pandemic control in Wuhan, and organization of Health Code through an analysis of technical standards, policy documents, and quotes from citizen-supporters. I show how the COVID-19 crisis facilitated unusual collaborations among governments, public health authorities, and technology companies to assemble new networks and organizations for the flow of data and decision-making, creating instability around actors' roles and power relations. In the technical architecture of Health Code and the broad network it is integrated into, classification decisions are always political and never neutral or objective, reflecting a series of hierarchical judgements. The structural architecture of Health Code implies the flexibility and possibilities for emerging uses and variations of such systems and cannot be perceived as merely static with respect to ethical and social implications. The normalized use of Health Code in Wuhan has outlasted its initial reasons of being, generating new sorts of insecurities so as to maintain its role.

Second, using evidence from interviews with citizens and citizen-supporters, I show how new biosocial identities emerged in citizens and citizen supporters of Health Code, through their perceptions about and experiences with Health Code. Reflected in these new biological identities is the adaptive rationalization of social norms and values tied to broader imaginations of security and health, as well as beliefs of the value of data-driven knowledge. Looking at texts and transcripts, I was able to reveal how the participant citizens' coping practices of digital health surveillance which emerged during the pandemic were socially organized and coordinated by the dominant ruling notions of health security embedded in texts, as well as in the ways that citizens talked about their experiences. These findings are interconnected which reveal how the digital health surveillance system has become a shared platform for justifying, legitimizing, enforcing,

and reconfiguring ruling relations, mediating the many judgements and decisions in everyday settings.

5.2. Findings: Health Code as a Health Security Practice

Emerged from crisis conditions with unprecedented collaborations among varied stakeholders, Health Code represents an innovative digital health surveillance assemblage that integrates new networks and power relations for pandemic control. Embedded in this surveillance system is a set of political classifications, judgements and decisions made through data and algorithms that seeks to securitize health. Moving beyond the architecture and design of Health Code, I also investigate how the digital system has blended into the community-based surveillance structure (Boeing & Wang, 2021). By doing so, I seek to examine how the surveillance system has outlasted its original reason for use and is now being sustained as a normative and consolidated necessity for post-pandemic society. This section of findings asks explicitly how this system is structured, implemented, and normalized in a way that appears to justify and legitimize its use of digital surveillance techniques in public health surveillance. In examining what kinds of notions and beliefs towards health and security were cultivated via the use of Health Code, this section situates Health Code in the institutional landscape from which it emerged, and looks into the detailed technical and institutional processes of this system.

5.2.1. Design Features

Before presenting the design features and processes of Health Code, this section first provides background information illustrating the social conditions that facilitated the use of digital tools for pandemic control. Beginning in late December 2019, the severity and rapid spread of the COVID-19 pandemic in China had the national and local governments operating in a context of radical uncertainty faced with complex public health and social challenges. Since traditional epidemiological investigations often require a formal structure in the systematic reporting of certain diseases, which is largely limited by time and resource constraints, digital tools and measures that could strengthen contact tracing and health surveillance were strongly sought after by local governments and Health Administration Departments amidst these circumstances

(O'Shea, 2017). Technology companies also saw the possibilities of engaging in pandemic control and entrenching themselves in public life by developing efficient and effective technological applications to aid in public health surveillance and social management during the crisis.

Motivated by the goal of meeting the emergent social need for contact tracing, local governments and health administration departments started to collaborate with technology enterprises and research institutes in pursuit of new digital solutions. In early Spring 2020, technology-centric cities such as Shenzhen and Hangzhou had already started piloting digital health code systems for contact tracing and maintaining social activities in the pandemic. To promote the use of such digital health surveillance systems in response to the pandemic, local technical standards were established in Shenzhen and Hangzhou. The Shenzhen standard first highlighted the importance of the digital approach aiding the response to the public health crisis:

> In responding to the emergent new coronavirus pandemic, we have seen the urgent needs in all regions of the country for applying a new generation of information technology to help societies fight against the pandemic and support local businesses to resume work and production. … Information technology companies used their technological advantages in the prevention and control processes of this pandemic and launched the "passcode" technology accordingly. This system effectively supported local communities in coping with the difficult situation. Since its launch, it has played a vital role in the precise and effective control of the pandemic and the safe business resumption. (Shenzhen standard, 2020, p. 2)

Similarly, in Hangzhou, the normalized use of the digital health code system was strongly promoted by the local government and health administration department. The Hangzhou standard was developed to set up health code's assignment rules and application processes to standardize the use of this system.

In the following months, digital health code systems were quickly adopted in other cities in China. However, without a unified solution for the technical standards of Health Code, multiple system omissions and failures were found in the implementation and utilization processes in many cities, including insufficient technological knowledge, redundant development, asynchronous communication, and so forth. Local technical standards were not sufficient for guiding the application of Health Code in the whole country. Accordingly, the E-government Office of the General Office of the State Council, in conjunction with various regions and relevant departments, promoted an

establishment of a cross-provincial mutual recognition mechanism for digital health code systems, and realized the sharing of pandemic prevention and public health information relying on the integrated online government service platform. In the interest of consolidating the construction results of the digital health surveillance landscape and improving the functionality of digital health code systems throughout the country, the E-government Office of the General Office of the State Council requested that SAMR initiate a national project dedicated to formulating the national standards for digital health code systems following the emergency procedures. Hence, the national standards were issued by SAMR with cooperation among other levels of governments, technology companies, and research institutes for special application scenarios of digital health surveillance during the pandemic. With reference to the pioneering digital projects in Shenzhen and Hangzhou, the official national standards were constituted by three parts, which focused on explaining the assignment rules, display models, and data formats of digital health code systems, respectively. These national documents combined to form a standardized design and operation rules of Health Code on a national scale, aiming at setting the norm and enhancing local governments' coordination and organization capabilities.

As mentioned above, digital health code systems in China emerged from the urgent need to respond to the novel pandemic. Unusual collaborations among public health authorities, governments, and private technology companies were formulated for the development of new digital systems for health surveillance. Such collaborations opened the possibilities for assembling new governing networks, as well as rules and standards to create windows for negotiation around varied actors' roles and power dynamics. What is reflected in the social context of Health Code is the common vision and assumption that data-driven technology is superior for facilitating an integrated solution that encompasses supports from public health agencies and digital technologies. Despite the fact that the collaborative goal of mitigating the spread of the pandemic is alluring, the underlying values and beliefs of health and security reflected through the design and architecture of the system requires further investigation. In the remaining parts of this section, I will present my examination of the design features of the system to explore the surveillance implications of such systems.

Conceptions of Health Code

Technical standards are formal documents that establish norms, processes, and practices to normalize and promote a unified understanding towards a new technology. Different definitions of the digital health code system given by these documents reflected the varied perceptions and values of this innovative technology. Prior to the issuance of the national standards, two local technical documents offered distinct conceptions.

Anti-epidemic Pass Code

The Shenzhen standard (2020) defined the digital health surveillance system as the "Anti-epidemic Pass Code" that allowed residents to use the QR codes issued by the system as e-passcodes for accessing and leaving different public venues during the pandemic. This definition aimed at emphasizing the use of such a system as a digital solution to socially enclosing and managing traffic monitoring of road network gateways during social emergencies. This standard configured three main roles within the system according to different responsibilities and power: citizens, contact tracers, and supervisors. This configuration of the three main roles reflected a deployment plan in which Health Administration Departments and local Centers for Disease Prevention and Control were conceived as the supervisors equal to other administrative departments such as local community committees.[2] Such configuration of roles reflected the underlying power relations of the system that public health authorities held the same level of power as administrative departments, which is often not the case in public health surveillance systems. In traditional health surveillance tools, public health authorities are responsible for supervising the infectious disease control processes (Simonsen et al., 2016). Such a deployment plan of the power distribution of the digital health surveillance system could be interpreted as an act of decentralizing the power of public health authorities in health surveillance to other administrative agencies, which in a sense inevitably undermines the power of public health agencies in dealing with pandemic crises. Additionally, the intervention of administrative departments in health surveillance politicizes the system as a security tool for social monitoring of individual's mobility more than that specified for public health purposes.

[2] Local community committees are the smallest administrative agencies developed for providing services to local residents.

Health Code

The current widely known name “Health Code” used to refer to China’s digital health surveillance system first appeared in the Hangzhou standard (2020):

> Health Code represents a personal digital health account established by the administrative departments through personal identity identification, or the unified health account of an organization formed on this basis. Health Code is a colored QR code generated by risk grading regarding the health status of the specific scene. (p. 1)

Unlike the definition provided by the Shenzhen standard that mainly described the system regarding its social surveillance functionality in human mobility control, the Hangzhou standard recognized its value in health risk grading and defined it through its use in the public health field. The Hangzhou Municipal Health Commission played the leading role in establishing this standard, reflected in the document (Hangzhou standard, 2020) the committee produced. During the pandemic or other public health emergencies, Health Code assigns different colored QR codes indicating the risk status of individual residents in accordance with relevant disease control guidelines and regulations. Public health agencies and local governments thus can use Health Code to conduct epidemiological investigations of cases and clustering outbreaks. In the occurrence of Class A level infectious disease epidemics, Health Code enables key stakeholders to identify, monitor and manage infection sources and close contacts. In terms of long-term public health management during pandemics, the Hangzhou standard (2020) specifically described three main applications of Health Code:

- 1) Health Code can be applied to identify, analyze, and warn of public health safety risks. Public health agencies and local governments can use the data provided by Health Code to evaluate the pandemic risk level of a group or region for the need to implement corresponding prevention and control measures.
- 2) With Health Code, the administration can conduct examination of regional pandemic situations, monitoring the health condition of populations, conduct multidisciplinary research, and target precise health promotion related education, and so forth.
- 3) Public health agencies can utilize relevant data and information aggregated by Health Code to establish time, space, and population infectious disease symptom monitoring models for early warning of public health emergencies. (p. 4)

The Hangzhou standard situates Health Code as a digital health tool that can add to the resilience of existing public health infrastructure in response to pandemics. While the name “Anti-epidemic Pass Code” puts forward a technical perspective of how the system works in surveillance during emergencies, “Health Code” refers to a more specific and distinct purpose of this system in public health surveillance. Additionally, the definition of Health Code itself implies not only its use as a digital health surveillance practice in public health crisis settings on the institutional level, but also the underlying potential of the system as a personal digital health management platform that can provide healthcare services in the post-pandemic phase (Hangzhou standard, 2020). Still, both conceptions of the digital health surveillance system presented in different documents suggested the integrated solution of health surveillance with the collaboration of governments and public health authorities.

The name “Health Code” was officially adopted and promoted in the national standards issued in late April 2020. Besides the main purpose for emergent pandemic control, the national documents describing Health Code also concentrated on the sustainable development of this technology for meeting digital healthcare needs in the future. Building on local standards of the digital health code system, the national documents defined Health Code slightly differently from how the Hangzhou standard did:

> Health Code is a sequence of numbers or letters that are linked to the Cyber Trusted Identity (CTID),[3] which carries the user’s consent to others or organizations to temporarily access specific personal health information. Health Code usually uses QR codes as its storage medium. (Reference Model, 2020, p. 2)

The common features of these two definitions of Health Code are that they both acknowledge the connection of Health Code with identity verification systems. What differentiates the national interpretation from the Hangzhou one is that the national definition removed the part stating that Health Code also applies to presenting a unified health account of an organization. This change further ties Health Code closer with CTID, making Health Code a Personal Health Code. On top of that, the national standards take into account the protection, sharing and use of personal information and personal health information, formulating the basis for mutual recognition of all kinds of

[3] Cyber Trusted Identity (CTID): This is an electronic credential used to prove the personal identity of residents in cyberspace. It has correspondence with residents’ identity documents.

real-name personal information in the long run (Reference Model, 2020). Therefore, Health Code implies a highly interconnected supervising network among administrations and public health agencies. The close integration of the digital health surveillance system and the digital identity verification system manifested in the case of Health Code not only blurs the boundaries between public health surveillance and normal digital surveillance, but also denotes the evolving mutual dependency of health surveillance and other surveillance systems. In this respect, Health Code cannot be perceived as a static and closed system, but rather an open-ended and flexible one embedded in other technologies, with social implications. Still, the innovative conception of Health Code seems to suggest a new possibility of responding to emergent public health crises with hybrid digital solutions. In the following sections, I will present the architecture details and system processes of Health Code to illustrate how health surveillance is achieved through the hierarchical and political decisions and processes embedded in the system.

Architecture of Health Code

Structure of the Integrated Pandemic Prevention and Health Information Service System

Health Code is not a single digital application that operates on its own. Instead, it is built inside a centralized health surveillance system that includes other services complementing the Health Code's operation. In the network of health surveillance, Health Code operates according to a set of instructions and guidelines given in the hierarchical order. This mechanism is supervised by the national pandemic prevention and health information service system (abbreviated as the national platform in the rest of the thesis), a national health information platform dedicated to managing the local Health Code applications nationwide. The national platform can aggregate pandemic prevention and health information data across the country. It serves as the center hub, providing pandemic prevention and control information services and interfaces for data comparison and analysis and connects individuals and relevant agencies through varied local Health Code applications for outbreak warnings. The integrated pandemic prevention and health information mechanism is built on the data sharing advantages of the national e-government platform, the Integrated Online Government Service Platform

(IOGSP).[4] The whole structure of this integrated pandemic prevention and health information service system (Figure 5.1) can be divided into three tiers: the data tier, the application tier, and the presentation tier (Reference Model, 2020).

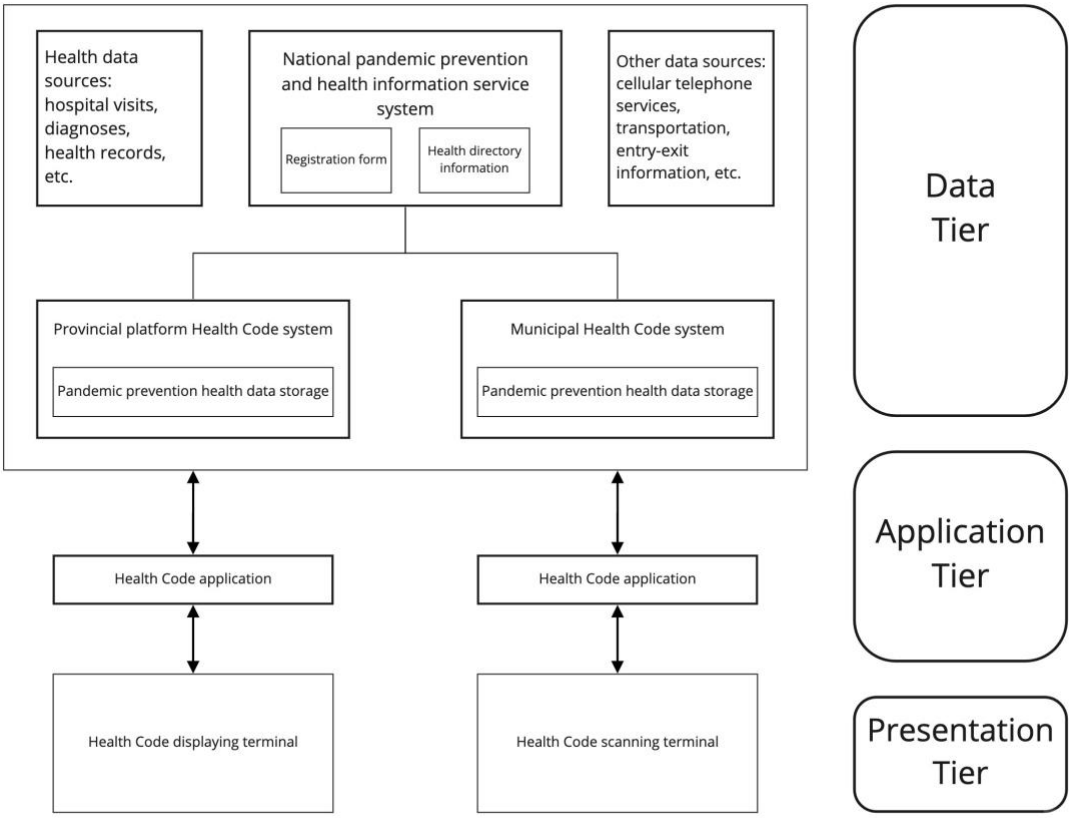

Figure 5.1 Structure of the Integrated Pandemic Prevention and Health Information Service System

The data tier is the foundation tier of the integrated system and includes the functions of data storage and data access. This layer stores all the pandemic prevention and public health related data collected from different levels of Health Code systems or from other sources. As shown in this figure 5.1, the data sources on which the pandemic prevention and health information system is based include two kinds of data: health-related data sources and the non-health-related data sources. The health-related data sources

[4] Integrated Online Government Service Platform (IOGSP): An information system for the provision of online government services that is coordinated and constructed by the General Office of the State Council, various departments, and various localities. It is an important infrastructure in the field of national e-government, with basic advantages such as unified identity authentication, unified electronic seal, and unified data exchange nationwide.

encompass data from hospital visiting records, diagnosis records, and other health information records. Other data sources consist of cellular telephone services provider records, information from transportation systems (information border entry and exit), etc. The access to such a complex big data network behind the Health Code systems implies the interconnection and cooperation among varied agencies (and departments within those agencies) such as public health agencies, medical institutions, local governments, transportation departments, etc.

Three types of systems are involved in the data tier: the national platform, the provincial Health Code systems, and the municipal Health Code applications. The national platform is the backbone of this integrated health service system in that it empowers local Health Code systems with big data analytics for digital health code verification and cross-regional information queries. The provincial and municipal Health Code systems are both considered as the local Health Code systems and are connected under the supervision of the national platform. The health directory information gathered through the local Health Code systems is aggregated in the unified national platform. Each local Health Code system, provincial or municipal, ought to register in the national platform to acquire its unique platform identity. The unified connection enables mutual trust and recognition among various local Health Code systems based on the national platform. The national platform thus can provide cross-regional pandemic prevention and health information query services for local systems. Additionally, both provincial and municipal Health Code systems have their own health information databases. Each region can combine these local data sources with the national health information data to carry out its own risk classification and assessment locally. What is worth noting is that though the national platform occupies a supervisory role in the integrated system and provides a mechanism for handling cross-regional health code recognitions, it does not directly interfere with local management of Health Code systems (Reference Model, 2020). Local systems make their own decisions about whether to set risk ranking rules and how to use risk assessment data in pandemic control.

The application tier is the middle tier between the backbone systems and the presentation tier. This tier manages data analysis and the system rules of transforming and translating data between those two tiers. As shown in Figure 5.1, there are two bidirectional arrows indicating interactions between the integrated pandemic prevention and health information platform and Health Code digital applications. In the presentation

tier, user terminals provide direct services for users in the integrated system. According to the Reference Model (2020), the users of pandemic prevention and health information services are divided into two categories: individual residents and contact tracers. Health Code applications provide two different user terminals for residents and contact tracers, specifying or segmenting how each group uses the Health Code system. The two user terminals are (1) displaying terminals for residents, and (2) scanning terminals for contact tracers. The idea behind such a categorization is to support distinct services for users based on their different roles in digital health surveillance. For example, individual residents use the Health Code displaying terminal to declare their health information to the application and acquire their health codes. In contrast, contact tracers use the scanning terminal instead for scanning individuals' health codes to inquire about individuals' personal health information and report traces for future contact tracing.

A national health surveillance structure has established for monitoring and guiding the digital pandemic control in the country. The structure of the integrated pandemic prevention and health information system in which local Health Code systems are incorporated presents a general layout of the hierarchical and centralized management of digital health surveillance on a national scale. The integrated system is enabled by the data sharing advantages of IOGSP to aggregate data from the public health arena and other agencies, constructing an evolving ecology of a health surveillance network open for secondary or emerging uses.

Backend Architecture of Health Code Applications

Having examined the whole architecture of the integrated pandemic prevention and health information service platform, I now extend my discussion of the application tier and presentation tier of the integrated platform to illustrate the backend architecture of Health Code digital applications for identifying the embedded design logics.

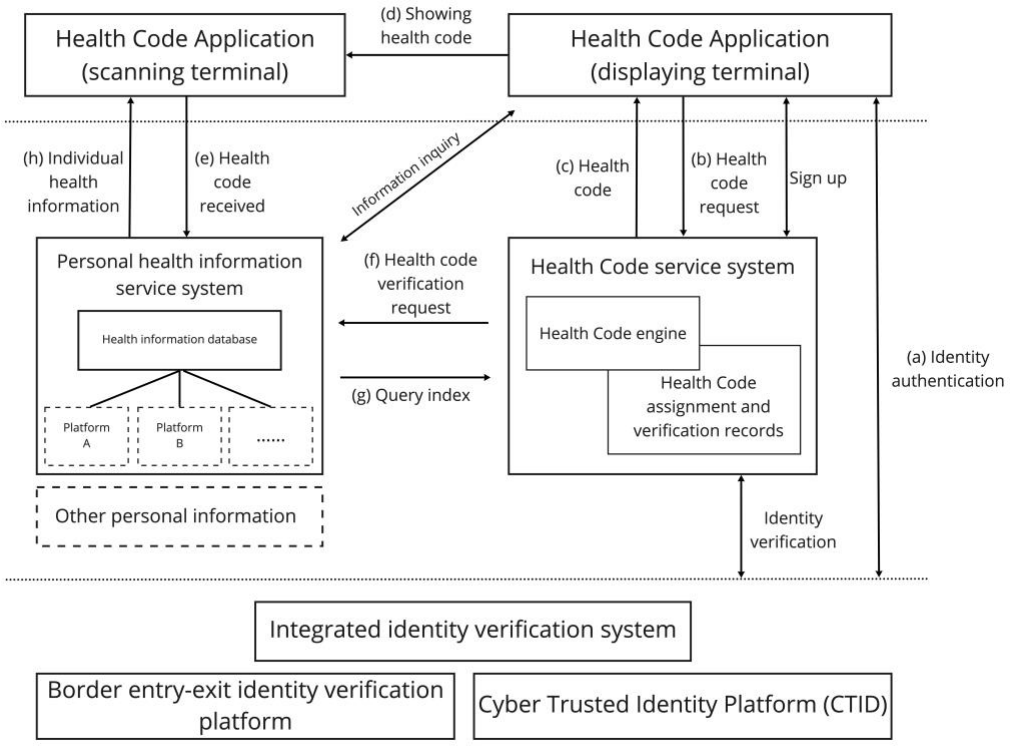

Figure 5.2 Backend Architecture of Health Code Application System

In the backend architecture shown in Figure 5.2, there are four main parts: multiple identity verification systems, the Health Code application displaying terminals and scanning terminals, the Health Code service system, and the personal health information service system. Each part of the structure plays a distinct role in the structure. Identity verification systems are responsible for conducting user identity authentication and verification to guard the security of user's personal health data. Actions regarding the personal health code application, personal authorization for displaying a person's health code, and scanning of health code queries are completed through the Health Code application terminals. The key function module of the Health Code service system is the Health Code engine that takes charge of the production and verification of health codes. The Health Code service system also stores records of production and verification for future inquiries. The personal health information system can be seen as a health information database that collects and manages personal health information declared by individuals or held by relevant organizations from different levels of Health Code platforms. The personal health information system adopts a hierarchical management model. Under the framework of pandemic control principles and regulations, the personal health information system responds to query requests for personal health

information based on the identity credential or authorization of the personal information subject (individual user of Health Code application). Beyond that, in emergent situations, the personal health information system also controls personal information and is connected to other personal information controllers for acquiring other information for data sources or reference value of its service (e.g., cellular telephone services provider).

System flows (shown in Figure 5.2) within the Health Code application system show the activities and decisions that this system executes. Solid lines with arrowheads indicate activities and processes in the system. The range enclosed by two dotted lines represents all the interactions among varied sectors. The Health Code application displaying terminal serves as the entry for individuals to the system, and access to the system requires credible user identity authentication first. System flows include the following activities:

- 1) The individual user (residents) enters the Health Code application through the displaying terminal to complete the real-person authentication and activate the personal health code function. The authentication is done by the Integrated Identity Verification System, including the Border Entry-exit Identity Verification System and CTID platform.
- 2) Once user identity is verified, the Health Code application displaying terminal will send the request to the Health Code service system for creating a personal health code. The production record will be stored in the system for future references.
- 3) The Health Code service system sends back a generated personal health code to the displaying terminal.
- 4) The displaying terminal encodes the returned personal health code into the QR image and then displays it to the Health Code application scanning terminal used by contact tracers.
- 5) The personal health code is decoded by the scanning terminal to obtain the health code information. Then the scanning terminal initiates a query request to the personal health information service system with the personal health code as a parameter for verification. When making a query request to the personal health information service system, the user (contact tracers) at the scanning terminal must provide an identity authentication certificate[5].
- 6) After receiving the inquiry request, the personal health information service system will then send a request to the Health Code service system for further verification of the personal health code.

[5] This process is not specified in Figure 5.2 but is mentioned in the Reference Model (2020).

- 7) The Health Code service system starts to process the received personal health code with identity verification and health information verification procedures. This verification record will also be saved for future references and verifications. The Health Code service system then returns the information query index or other information to the personal health information service based on the verification result.

- 8) The personal health information service system receives the query index from the Health Code service system and initiates the search for personal health information and other personal information included based on the query index. Once the personal health information service system finishes retrieving the private health information from its database, the packaged health information will be returned by the system to the scanning terminal, giving out health risk-indicating health information. The user (contact tracers) of the scanning terminal of the Health Code application determines the use of the returned health information according to their application goals and local public health requirements and policies.

The cooperation between the personal health information service system and the Health Code service system enables the smooth running of the mechanism for providing digital health surveillance services. It is interesting to note that though the Health Code service system produces digital personal health codes according to the health information it received, it cannot directly interfere in processing any personal health information. The actual support behind the Health Code application is the personal health information service system which was defined by the Reference Model (2020, p. 3), as “the emergent system that collects and manages the personal health information database and has access to other personal information collected in the system if needed.” The Reference Model (2020) also specified that the personal health information service system can provide other information services such as big data analysis, health risk reminders and so forth based on each application’s determination according to the actual needs. In a sense, the digital Health Code service is only one manifestation of the many surveillance possibilities of using the personal health information aggregated in the system. This functional structure of the Health Code application represents the positional power of authorities to establish the emergent health data controlling system to enable variants of health surveillance tools to act upon the existential threat of pandemics.

Furthermore, as is shown in Figure 5.2, the overall backend architecture of the Health Code application appears automated and free of human decisions in the data analysis and interpretation processes of personal health codes. However, the underlying

system rules and algorithms of the encoding and decoding in the health code creation procedures are made according to risk assessment classification rules established by local governments and public health authorities (Reference Model, 2020). The back-and-forth identity verification and authentication processes in the Health Code application ensure the validity of people's identities and the accurate issuance of personal health codes. Additionally, personal health codes are not merely carriers of personal health information of individuals, as suggested in the document (Reference Model, 2020). Instead, digital health codes are the end results of the classification and evaluation of people's health information based on the political decisions made through algorithms and code assignment rules.

Data Collection Structure

The previous description of the Health Code architecture has uncovered the vital role of the personal health information service system as the data controlling system in collecting, storing, and processing the data. What kinds of information about individual users is aggregated and how is the data stored in Health Code? As documented in the Data Format (2020), the data collection of Health Code includes personal health codes and data about personal information subjects (individual users of Health Code). The data storage and representation of the information follow a logical data model represented in Figure 5.3.

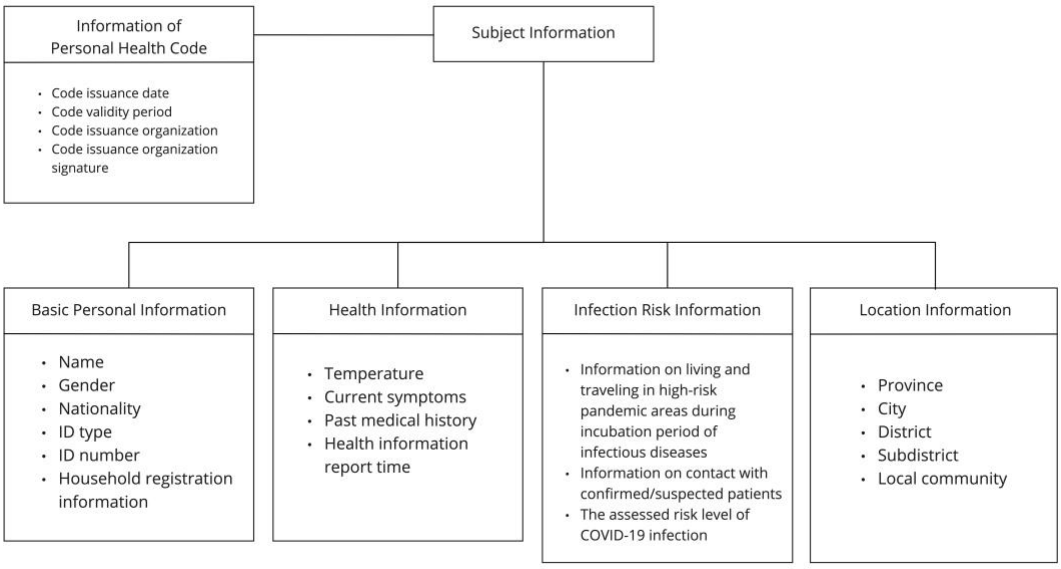

Figure 5.3 Data Model Structure

This data model represents the structure of data collected about each personal information subject and the subject's health code. As shown in Figure 5.3, there are two primary entities: information about personal health codes, and data about personal information subjects. The information about personal health codes is composed of five attributes: the code issuance date, validity period, issuance organization, and the signature of the issuance organization. The data about the personal information subject includes four sub-entities: basic personal information, health information, infection risk information, and location information. The health information sub-entity stores data about the subject's temperature (collected in checkpoints of places or by self-declaration), current symptoms of COVID-19, past medical history, and the report time of the above health related information. Under the entity of subject information, the data model also designates a sub-entity to manage data of the subject's infection risk of COVID-19. This sub-entity includes information about living and traveling in high-risk pandemic areas during the incubation period of COVID-19, as well as information about contact with confirmed/suspected patients, and the assessed risk level of COVID-19 infection. During the pandemic, all the data collected and stored in the local personal health information service system should be synchronized to the superior management system on a timely basis (Data Format, 2020).

Hence, in the Health Code system, the ongoing data collection about each person involves the combination of personal identification information, information about

health status and infection risk, and location-based data. The Health Code system ensures broad coverage in collection of other non-medical related data on individual subjects, which helps form individual-based datasets for conducting epidemiological investigation and contact tracing. Though the health information datasets of Health Code are newly formed and independent from existing public health systems, the data collected in the Health Code system are constantly verified and examined with formal medical data from public health agencies for enhancing results validation (Reference Model, 2020).

Traditionally, surveillance in public health is justified and distinguished from other digital surveillance practices in that it applies to diseases instead of individuals (Langmuir, 1963). The data collection of conventional public health surveillance is achieved through formal reporting of disease infection data on the population level. Nevertheless, the Health Code system has extended the notion of public health surveillance from disease-focused to individual-focused by formulating and enacting a new individual-focused digital health surveillance tool compared to the old disease-centered health surveillance measures commonly used in public health.

Risk Assessment Process

How is risk negotiated and defined through the system processes? The Hangzhou standard (2020) offered a set of digital health code assignment rules for the reference of local governments and public health agencies. In the Hangzhou standard, a red health code indicates high-risk status and is assigned to people if they are confirmed or suspected cases; close contacts with confirmed or suspected cases or have been to high-risk pandemic areas. Yellow health codes are issued to people who have symptoms of COVID-19, and is used to indicate moderate-risk. Green health codes imply a low-risk status. These preliminary rules set the stage for defining infection risk, but the challenge of operationalizing and crystalizing the rules into local real-life risk evaluation of the system remained.

In the national standards of Health Code, although it did not offer fixed digital health code assignment rules nationally, they presented a logical risk assessment process for local systems. In the Health Code system, the risk assessment process is done through a loop (Figure 5.4).

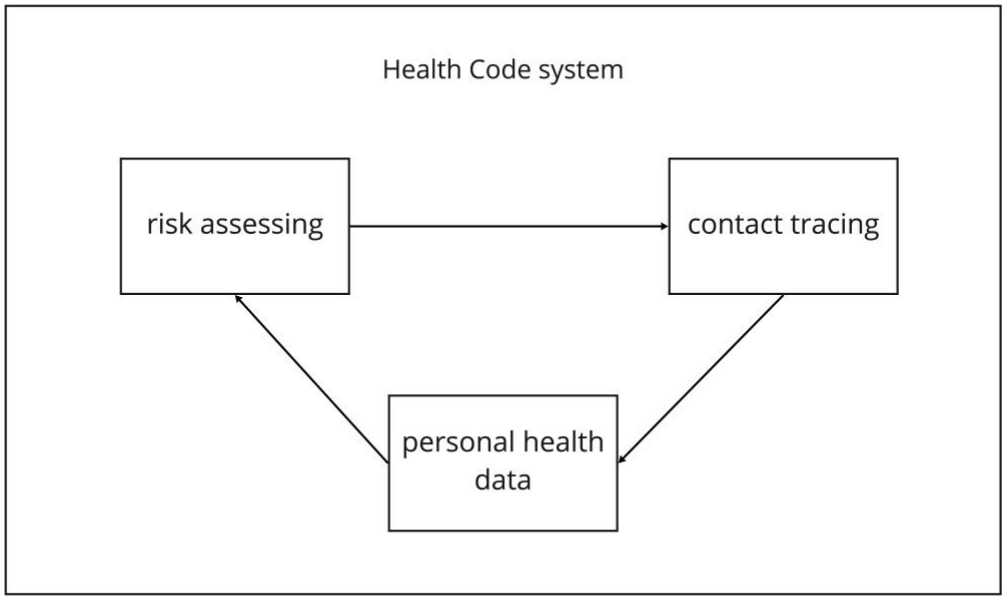

Figure 5.4 Infection Risk Assessment Loop

In the data processing loop, the algorithm first retrieves the subject's personal health data for identifying the subject's infection risk of COVID-19 (Application Programming Interface, 2020). The risk factors consider the subject's health status, contact with other confirmed or suspected cases of COVID-19, and information on living or traveling to pandemic areas. Based on the analysis, the subject then will be classified as high-risk, moderate-risk, and low-risk. The system will then conduct contact tracing according to the subject's risk level. For example, if a local Health Code system encodes confirmed cases as high-risk level and subject A is a confirmed case of COVID-19 infection, the system will investigate the personal data of subject A to identity subject A's recent traveling and living history and contact with other people. Then the system will find subject A's close contacts and look deep into their personal health data (stored in the personal health information system) for evaluating their infection risk respectively. The risk assessment loop follows the criteria set up by local public health agencies and governments and conducts risk evaluation of each personal information subject in the system on a timely basis.

In the Health Code system, the dynamic and instability of the definition and evaluation of risk create places for negotiation and discussion among local authorities. The risk assessment processes done in the Health Code system represent the political and social judgments made through the classification. The iterative risk assessment

processes reflect a security-informed logic in the digital health surveillance system (Cecchine & Moore, 2006). In the processes, each subject is regarded as a potential threat. By conducting the repetitive risk assessment activities, the system aims at ruling out the “risky” subjects according to the embedded classification rules and algorithms. In this respect, the Health Code system shares similar security logics with other digital surveillance systems.

Privacy Protection

In terms of data and privacy protection, the national standards of Health Code also stipulate multiple requirements in regulating the collection, processing, and utilization of personal health information in the Health Code application system:

- 1. A digital health code is specified as valid for five minutes.
- 2. The digital health code uses algorithms that compound national password management requirements to encrypt and save data.
- 3. The Health Code service dynamically monitors requests and behaviors, and cuts off related services and responses when abnormal conditions occur.
- 4. The collection, processing and utilization of personal health information shall comply with the Information Security Technology – Personal Information Security Specifications, which are a national standard.
- 5. When personal health information services and their applications collect data, they should obtain the user’s authorization and consent, and promise to keep the relevant privacy content confidential.
- 6. Health Code operators and personal health information controllers should follow the national standard Information Security Technology – Big Data Service Security Capability Requirements to establish a data security protection system and implement necessary data security technical measures.
- 7. Personal health information controllers should regularly back up data to improve disaster recovery and backup capabilities. (Questions and Answers on National Standards, 2020, p. 3)

5.2.2. Health Code Implementation and Normalization Processes in Wuhan

The implementation of Health Code in Wuhan since the lockdown has undergone a transformation from the initial emergent application to normalized use, reflecting the sustained health securitization processes. In this section, I now turn to Health Code’s

application and implementation in Wuhan in coordination with the existing community-based surveillance network during the lockdown, and how it has sustained its existence and become a necessity for the post-pandemic social world.

Wuhan, as the world's first city hit severely by the COVID-19 pandemic, experienced rapid exhaustion of public health resources and massive panic among citizens at the initial stage of the outbreak (Boeing & Wang, 2021). In consideration of the possible harm that this novel coronavirus could cause to population health and society, the central government of China imposed a lockdown in Wuhan to quarantine the whole center of the outbreak on 23 January 2020. This unprecedented lockdown in public health history reflected a determination to eliminate this virus for the security of the nation (National Health Commission of the People's Republic of China, 2020). In response to the national call for containing the spread of the COVID-19 pandemic, the Wuhan municipal government, in cooperation with the Wuhan Municipal Health Commission and relevant departments, decided to set up a special pandemic control department, the Wuhan taskforce, to control COVID-19. Its mandate was to instruct and manage the city's pandemic prevention and control works (MLPD17, 2020).

Prior to the application of any digital health surveillance tools, Wuhan established a closed pandemic control mechanism based on the administrative hierarchy that precisely acted upon the management and monitoring of each local community during the lockdown. The roles of various administrative actors were specified in MLPD17 (2020):

> Sub-district offices should organize and guide community residents' committees and other social organizations in their jurisdictions to adopt disease control measures in accordance with the unified deployment of pandemic prevention and control. … Community residents' committees shall strictly conduct the 24-hour closed grid management on each community and collect, verify, and report pandemic control information within the community in a timely and accurate manner. (p. 1)

Contact tracing and other health information report work is usually done by public health officials. However, under emergency circumstances, it was impossible for public health officials to conduct such extensive and detailed contact tracing in each local community of this megacity. Wuhan's population in 2018 was over 11 million (Jia et al., 2020) while

the population of British Columbia, Canada in 2020 was estimated at 5 million.[6] Hence, as issued by the Wuhan taskforce to control COVID-19, contact tracing and relevant report work was transferred to each community residents' committee. Generally, in this closed pandemic management mechanism, urban areas of Wuhan were divided into sub-districts and a sub-district was then sub-divided into several residential communities or neighborhoods managed by community residents' committees. Residential communities were blocked, and physical barriers were set up at the entry of residential neighborhoods to minimize physical movement. In the meantime, citizens and residents were divided into community grids based on the boundaries among communities as the basic unit for contact tracing and health status monitoring. Any violation of the pandemic control measures and policies was punishable according to relevant laws and regulations (MLPD17, 2020). One participant who worked in monitoring the physical barriers of residential neighborhoods stated:

> During the lockdown period, local communities required all residents to not leave the neighborhoods unless you are volunteers or contact tracers. I worked in supervising the checkpoints at the entry of each neighborhood within the district to make sure there are no violations. (CS1)

The strict quarantine measures associated with the lockdown policy ensured the minimization of physical movements in Wuhan for containing the further spread of the COVID-19 pandemic. Nevertheless, uncountable possible infections already spread in the city before the lockdown was issued in January 2020. Because of the perception of Wuhan as the epicenter of the pandemic, in addition to quarantine measures and lockdown that worked to control the continuing spread of COVID-19, the city was in desperate need of an internal surveillance system that could identify, trace and report all the infected patients within the city.

The Emerging Use of Health Code during the Wuhan Lockdown

After seeing the use of digital tools in pandemic control in technology-centric cities such as Hangzhou (introduced in February 2020) and Shenzhen (February, 2020), the National Health Commission recognized and officially promoted the potential effective use of digital health surveillance technologies in supporting existing pandemic

[6] Population estimates data of BC found on the official website of BC government. Retrieved from: https://www2.gov.bc.ca/assets/gov/data/statistics/people-population-community/population/pop_subprovincial_population_highlights.pdf

prevention and control infrastructure in a notice about pandemic control policies, in February, 2020:

> Encourage the implementation of digital dynamic health status reporting systems: Encourage areas with technological advantages to promote digital health code systems and other similar digital health surveillance platforms. Areas that do not have adequate technological supports for developing digital systems can use manual health declaration measures instead. Residents can apply for electronic health codes through digital platforms or apply for paper version health codes (as pass cards) through communities for obtaining qualifications for traveling and resumption of work. Local governments, public health agencies and relevant departments should estimate the risk level of health status and establish digital dynamic health status reporting systems in emergent periods. (NLPD5, 2020, p. 2)

The Health Code system was first implemented in Wuhan on 22 February 2020, when Wuhan was still in lockdown. It was presented as a more efficient and safer digital option for reporting health information of each community than manual reports (MLPD1, 2020). While local communities were still in closed management, Health Code served as a digital health data collection tool to aggregate personal health information of citizens on a large scale. Citizens can access Health Code through two digital applications developed in China and in common use: WeChat and Alipay.[7] The first time people applied for a digital personal health code, individuals were required to first provide identification information for identity verification (e.g., ID number, verified cell phone number, domicile address, information of family members), and then they had to fill in relevant health information (e.g., current temperature, COVID-19 related symptoms, contact with confirmed/suspected cases). The personal health codes assigned to individuals were used to indicate their infection risk of COVID-19. The health information declared by individual citizens was then aggregated and stored in the personal health information service system of Health Code.

The Wuhan Health Code system offered a different functionality for sub-district supervisors and community contact tracers to collect, manage and report pandemic control information. Sub-district supervisors were divided and designated by the sub-district office (the sub-district's administrative agency) to manage local communities (MLPD4, 2020). Community contact tracers were composed of public servants and volunteers assigned to local community grids and managed by sub-district supervisors.

[7] Both WeChat and Alipay surpassed over 1 billion users in 2019.

During the lockdown period, community contact tracers served as the frontline workers who offered supports and services to community residents. Their main tasks included conducting detailed house-to-house surveys of household health conditions, coordinating and dispatching life supplies (e.g., foods, masks, etc), and identifying local infections. Because of the closed-end management of communities and public health resources insufficient to meet the demand, individual residents with COVID-19 symptoms were not able to directly seek medical services. At this point, contact tracers also supported medical services by collecting and reporting the medical needs of residents with local infections to upper-level sub-district supervisors through the big data analytics system (MLPD2, 2020). In the digital surveillance system, sub-district supervisors could aggregate information about the medical needs and infection conditions of communities under their supervision. Under the guideline of the Wuhan taskforce to control COVID-19, medical institutions and quarantine centers shared the disease control information with local sub-district offices. Hence, sub-district offices and affiliated community contact tracers were able to organize and coordinate the medical needs of community residents and transfer residents with COVID-19 symptoms to hospitals and quarantine centers. Health Code thus enabled a detailed data collection of infection conditions on a community-level and assisted in organizing public health resources and medical service deliveries. Moreover, local governments and public health agencies compared and evaluated the collected information of local infection conditions with administrative databases to assess the risk level of infection within local communities and conduct timely corresponding disease control measures such as quarantines (MLPD3, 2020).

Since one of the prerequisites of transferring the manual health data collection measures to the digital equivalent was to ensure the full user coverage of Health Code in Wuhan, the Wuhan taskforce to control COVID-19 promoted the use of Health Code as the officially released health surveillance application with the endorsement of local government and public health agencies:

> The implementation of health code management is an important weapon for our government to fight against the COVID-19 pandemic. … It is necessary to accelerate the implementation progress and ensure full coverage in Wuhan. … We need to quickly adopt the Health Code system to the current closed community management. Also, Health Code can play an important role in resuming social orders and supporting public health management in the future. (MLPD5, 2020, p. 1)

For local government and public health agencies, Health Code could be applied for identifying infected patients in the close-ended community management system, and as a digital health tracking platform to aid in the long-term public health surveillance once the lockdown ends.

The notions of the "novel" and "emergent" in the authorities' understanding of COVID-19 references insecurities and threats that seem to justify the urgent need for security-informed disease control measures (MacGregor, 2020), and appears to be one of the largest attempted cordon sanitaire in human history (Tian et al., 2020), this massive Wuhan lockdown was one way of coping with the uncertainties and threats through the spatialization and localization of the sick (Füller, 2016). "Security knowledge is always knowledge about dangers, about what and how we should fear" (Wæver, 1995, p.56). With the cooperation of public health authorities and local government, the establishment of a special Wuhan taskforce to issue regulations and instructions for control of COVID-19 reflected a determination to securitize COVID-19. The closed-ended strict monitoring during the lockdown introduced a reporting system that could directly act upon each community. The implementation of Health Code as an emergent digital health surveillance system strengthened the existing community grid management network and ensured the precise and accurate identification and reporting of infected patients. Although securitization can raise the alarm over pandemics, the security-informed digital responses often risk locating the pandemic within a government-centric framework, where local government extends its power and directly interferes with public health issues (Elbe, 2006).

The Normalized Use of Health Code after the Wuhan Lockdown

As Wuhan gradually recovered from the initial outbreak and the Wuhan lockdown had come to an end in early April 2020, the role of Health Code had shifted towards monitoring residents' daily movements in the city to ensure a safe COVID-19 exit strategy. As one participant recalled:

> I think it was about the end of March, the policy or news I cannot recall, but there are sources saying that once the lockdown is lifted, you need to show your digital health code for entering or leaving public places. Because I worked in the pandemic prevention and control system, I was able to go out during the lockdown. I remembered when I came out on patrol and saw the signs [about] and instructions [on use] of Health Code posted almost everywhere. For example, besides the entrance of communities, you could

> see the signs at the entrance of supermarkets, restaurants, and so on. (CS1)

What the participant saw echoes what was in the plan which laid out the normalized use of Health Code proposed by authorities. The successful application of the digital health surveillance system in identifying hidden infected cases was recognized by the local government and public health authorities. When planning for consolidating the pandemic control results and safely resuming social contact and activities, the continued application of Health Code was the first choice. Though Health Code had already been used as a pandemic control tool during the lockdown, the problem of how to engage residents in using their digital health codes as health passports to prove their health status in commercial or public spaces remained. Multiple communication channels were used to educate citizens about the continued use of the system:

> The digital health code was the important [system]. Social media and local communities were all promoting the necessity of this thing on a daily life basis when the lockdown ends. That is, you need to bring and show your personal health code before you can enter or leave any public places. Let us say, if you want to go to the supermarket, you must scan the poster with a QR code on it, and then you can show your phone with your health code to the guy at the entrance. Otherwise, you will not be able to enter the supermarket without a health code. All information sources, including some broadcasts of community neighborhood committees, were promoting Health Code, telling you about its function and how it was necessary for ensuring the safety of everyone and preventing and controlling the pandemic. I remembered later in mid-April, I also participated in the community's pandemic prevention and control work. We [volunteers or civil servants] were all added in some WeChat group chats. Important information would be communicated in these groups. These messages were also emphasizing the importance of Health Code and how this new thing would replace the previous paper-version passport. (CS2)

The emergent use of Health Code during the lockdown had already achieved broad user coverage and familiarized citizens with the system, which formed the basis for the sustained use of it. Besides, the propagation of the application of Health Code, including both traditional and digital sources, ensured authorities' instructive message about the long-term pandemic control plan would reach all residents. Policies (MLPD9, 2020) also officially pointed out the need of the digital health surveillance management after the lockdown:

> After the travel restrictions are lifted, it is still necessary to advocate for individuals to not go out unless necessary. At the same time, the strict

> digital health code management is of great importance for safety. Individuals should present green health codes in public venues in order to ensure the safe and orderly movements of everyone in the city. It is also essential to continue to strengthen the strict management and control of fever clinics. (p. 2)

The promotion strategy of the continued use of Health Code connected the daily use of the system with essential qualities of security and safety to convince citizens of the necessity of digital health surveillance management, and was an important aspect of normalizing its use. When the COVID-19 restrictions were finally lifted after the lockdown, the continued application of Health Code in everyday settings was strictly monitored:

> After the lockdown, [I was] still responsible for monitoring checkpoints. I mainly checked the entrances of communities and crowded places to see whether there were contact tracers checking people's health codes. The main thing [for me to do] was to check if contact tracers had fulfilled their duties. When I arrived at a checkpoint, I monitored the whole process [of scanning health codes] and reminded individuals to cope with the instructions for the safety of everyone. (CS1)

As mentioned by the participant above, the rigorous monitoring process of the daily Health Code application ensured the achievement of a digital health surveillance system. It raised public awareness about the prevailing threat of the COVID-19 pandemic, and at the same time cultivated individuals to cooperate with the ongoing and normalized use of Health Code endorsed by governments.

The continued use of Health Code after the Wuhan lockdown ended reflected a governing shift in digital pandemic control from emergent response to normalized surveillance. COVID-19 was reshaped as a long-term risk to health security rather than as an emergent threat. In this normalized biopolitical health surveillance, Health Code made possible the "proliferation of mini-panopticons, where all individuals become active components in the fabric of control, and where 'border controls' are everywhere" (Lacy, 2008, p. 334). Looking at how authorities constantly referred to the possibilities of re-emergent outbreaks in policies and the way that citizen-supporters described their work duties, we can see that the very meaning of making health "secure" is achieved by making continuous reference to the idea of insecurity. Surveillance and health security practices like the Health Code system, once used as an emergent tool, often tend to secure their reason for existence by generating new forms of insecurities and risks after

emergent times. The promise of a “pandemic-free” social world via the sustained use of digital health surveillance systems needs to constantly connect to the imaginations of insecurities so as to retain its existential meaning.

In the normalized use of digital health surveillance systems in everyday settings, individual citizens are all “becoming bombs, as the mobility of everyday life is read as an immanent threat” (Muller, 2008, p. 204). Through the cultivation of individuals as active components in surveillance society, the prevalence of biopolitical health surveillance systems seeks to tame the invisible risk and govern the risky human mobility in the biometric society.

5.2.3. Discussion: Health Code as a Health Security Practice

Fueled by a vision to contain the spread of the emergent COVID-19 pandemic and efforts to improve social management capabilities, Health Code was a social innovation produced and endorsed by governments and public health authorities introduced during the emergence of the pandemic, during turbulent times. The unprecedented collaboration among governments, public health authorities, and technology companies for developing a new digital health surveillance system reflected a security-informed orientation of responding to the COVID-19 pandemic in which COVID-19 was considered a threat to health security that required emergent response measures. In China’s digital response to the COVID-19 pandemic, local digital health code systems are integrated into a centralized national digital health surveillance network overseen by governments and public health agencies hierarchically. The integrated surveillance network allows for the flow of data and decisions being made through the communication and negotiation of power relations.

Besides its role of digital contact tracing, Health Code is more of an individual-centered digital health surveillance technology that has extended beyond the power of public health agencies in public health surveillance. Existing literature about digital contact tracing apps found that the Health Code system in China has a centralized architecture and is location-based with a QR code (Wen et al., 2020), which only revealed part of the design logic of Health Code on the application level. My analysis uncovered that the main functionality of Health Code is for the ongoing collection and storage of data concerning personal health and related issues such as movement of individual

subjects. The continuous data aggregation on each personal information subject includes a wide array of non-medical related information and health information collected from varied agencies and departments and is verified against formal medical data from public health systems to ensure validation. The massive ongoing data collection from diverse sources on each person distinguishes Health Code from traditional public health surveillance in that it is individual-focused instead of disease-focused. With the personal health information database established within the Health Code application, the digital Health Code service only represents a single manifestation of how to use the data. Variants of the digital application might be possible in response to future public health (or, for that matter, other) crises. The flexibility and dynamic structure design of Health Code opens up new possibilities for secondary uses of the system, which implies that the system is not a close-ended or fixed one but interacts with other surveillance domains in the evolving network of health surveillance. Moreover, though Health Code seems to be automated and neutral in operation, in fact, its operation depends upon political decisions reflected in classification systems and algorithms. Risk is defined and operationalized into rules and evaluation processes. The system conducts risk assessment on each person through the repetitive categorization of each individual subject into colored codes determined by the assignment rules established by local authorities. Digital health codes thus are the results of the political classification and determination of individual's health conditions achieved via the algorithms and code assignment rules.

The functionality in health data aggregation and health categorization of Health Code made it the perfect surveillance tool for coping with the pandemic in Wuhan during the outbreak. During the Wuhan lockdown, the initial implementation and normalization of Health Code in Wuhan blended the existing closed-end management of local communities forming a community-based digital health surveillance system (Boeing & Wang, 2021). Health Code was promoted as the mandatory system for securitizing COVID-19 endorsed by local authorities that required active participation of each citizen. In this closed-ended management of local communities, Health Code served as an internal surveillance tool for aggregating personal health information of individual citizens and identifying infected cases. The role of Health Code shifted towards a long-term health surveillance technology for human mobility monitoring used to ensure the safe restoration of social activities by restricting the mobility of "risky" individuals after the

lockdown ended. In the biopolitical digital health surveillance in post-pandemic city, everyone is perceived as a threat to the health security, thus needs to be assessed through the constant and normalized classification of the healthy and the sick.

5.3. Findings: Citizen Perceptions and Experiences of Health Code

My analysis of interview transcripts and my own reflexive journal revealed citizens' perceptions and experiences of their personal health codes and of Health Code as a digital health surveillance system. I examined the underlying discourses embedded in the ways that citizens talked (and did not talk) about their embodied experience and knowledge of the system. My results showed that citizens' perceptions of the digital health surveillance system were shaped by senses of responsibility and obligation. The functionality of Health Code in categorizing human bodies based on their infection risks of COVID-19 deeply influenced the way that individuals perceived themselves and others during the pandemic period. Driven by the rationalization of the collective values of securitizing health and the valorization and stabilization of data-driven knowledge, citizens actively cooperated with the health surveillance system. With new biological identities based on the health status of individuals emerging via the normalized use of Health Code, certain groups of people were classified as the less healthy, and thus rendered invisible in the social world. As the COVID-19 threat still prevailed after the lockdown, the digital health surveillance system was strongly sought after by individual citizens because the giving of data eased people's fears and anxieties of living with insecurities.

5.3.1. Responsibility and Obligation

Participants reported that after Health Code launched in Wuhan, they felt obligated to use the Health Code system for coping with the pandemic control measures for the overall wellbeing of population health. The use of Health Code was endorsed by local government and public health authorities. As this participant recalled:

> The first time I heard about Health Code [I think it] was on the news, saying that this system was launched for the need of pandemic prevention and control. Through this system, authorities could understand the pandemic

> condition of Wuhan and infected patients could be detected and treated in time. (C6)

The endorsement of Health Code by authorities made citizens feel responsible to cooperate with the pandemic control policies and use the system. The senses of responsibility and obligation to contribute to COVID-19 control were the strongest during the lockdown:

> You would not dislike it [Health Code] for recording and registering your information and health conditions under that circumstance. First, this thing was made by the government. The interface [of the system] gave you the feeling that this is your obligation. This is a very formal and authoritative system. Then you would feel that this is what you should do. The more detailed the system can read my information, the better. If it had a hundred blanks to fill in, I think I can do it all. Who doesn't want the pandemic to be under control earlier, so we can end the lockdown? (C4)

As this participant recounted the situation during the lockdown, the overwhelming concern of the lockdown made individual citizens inevitably prioritize the collective benefit of containing the spread of COVID-19 since there was no other way out. At the time of crisis, the tension and severity of the outbreak made it easier for individuals to adapt to the emergent health surveillance mechanism. Other participants also reported that as citizens they believed they were responsible for actively responding to the state-organized governing of COVID-19 digital contact tracing after the lockdown was lifted:

> The health code application had become a daily necessity. I felt that it was more of a sense of social responsibility, and I believed I should let the system record my movement history. It is all for pandemic control and to protect everyone in the city. (C7)

Indeed, when I asked participants whether they were worried about privacy invasion and data leakage while using Health Code, their responses echoed the same thought: that the aggregation of personal mobility data was for the collective good and public health security. As one participant said:

> It is like the system is doing epidemiological investigation on everyone and it is for [the wellbeing of] society. The reason why COVID-19 became a serious problem was that public health officials had to spend a long time on finding potential infected cases. Health Code collected individual's data daily [and] could probably make things easier for authorities. We cannot control the whole thing, but at least, the system could help contain the further spread. (C7)

Even though at times when Wuhan achieved zero COVID-19 new cases, the senses of responsibility and obligation to use Health Code still existed among citizens, because "you never know when the next outbreak will come." (C2)

5.3.2. Knowing the "Truths" for Themselves

Besides the feelings of responsibility and obligation, many participants stated that the digital health surveillance system offered a way of knowing and confirming the health status of themselves and others, building mutual trust in the social world. In their way of seeing, digital technology seemed to offer objective knowledge. During the Wuhan lockdown, the mass media's depiction of the public health crisis exacerbated fears and anxieties among Wuhan citizens. With little known about the novel coronavirus, individual citizens were driven by the curiosities and anxieties associated with the lockdown to register in the system and find out the assessment of their health status. One participant told me:

> Because in fact, everyone was panicked at that time. You know, the city was in a closed state. The terrible news was all over the Internet, I could always see information updated about how many people were infected daily in the city. At that time, I was very worried because I followed my dad as a volunteer to help deliver supplies and [we] needed to go out often. Every time after we got home, we would always sanitize ourselves everywhere. But at that time, we did not know if we had been infected when we went out. Even if I took my temperature every day, I still felt the sense of panic and uncertainty. Then with the Health Code system, at least it can provide a sort of comfort or assurance about your condition. When you looked at the green code shown on the screen, you would know that you were not infected, and you were still safe. If there was no such system, I guess I would probably struggle a lot more during that period. (C4)

The giving of data to Health Code eased people's anxieties and fears of COVID-19, without much consideration of the accuracy and validity of the results. In a situation where the knowledge of the novel coronavirus was limited, Health Code served as a seemingly neutral system that could deliver what appeared to be objective information about one's health condition, which was vigorously sought after by individuals.

Study participants also reported that knowing the health status of themselves did not sufficiently assure them safety in the post-lockdown period, as more people started to move around in the city. Many believed that knowing other people's health information was necessary at this point. The continued use of Health Code achieved this goal in

sustaining a rather healthy and safe environment through the equal health surveillance of everyone. One participant's experience reflected this thought:

> When I went out for the first time after the lockdown, I was going out to buy some daily supplies. At the gate of the supermarket, one person took my temperature, and another person asked me to scan the QR code on the poster. After I displayed the green code on my screen, I was then allowed to enter the supermarket. These were all required processes of Health Code in its daily use. I thought these were good practices to ensure that the people I met inside the supermarket were all the same as me. We all had green codes, and normal body temperatures. There were not infected people allowed to enter inside. I felt safe because the people around me were all in a healthy state. (C5)

In this sense, the Health Code system was perceived as a "health security system" (C9) that worked in assigning health codes indicating people's health status, and managing and monitoring human mobility to prevent certain groups of "dangerous" people from infecting the majority.

Following this line of thought, I asked participants whether they believed Health Code could provide "truthful" information about one's state of health. A curious contradiction was revealed in the participants' talk. Some participants were skeptical towards the function of Health Code in evaluating individual's health condition, because "the health-related information of individuals the system collected was relatively limited" (C2), "most of the information was declared by individuals and the information might not be accurate" (C8), and "the system did not require individuals to update health information on a timely basis" (C7). Despite the fact that some participants questioned the ability of Health Code in providing valid and accurate assessment of an individual's health condition, they still believed that the system revealed a relatively objective and "truthful" reference. "This digital personal health code lets me know that I am in a relatively safe and healthy condition. It has reference values to me and to others because the data will not lie." (C7)

Health Code offered a new regime of truth regarding people's health status based on the evaluation of exposure risks of COVID-19. Though some citizens did not think the personal health code could show valid assessment of one's state of health, since it was not a medical record or something, most participants agreed that the personal health code offered a relatively objective and "truthful" reference to one's health status. Based on the consensus, for citizens, knowing and conforming each other's

health codes became a vital prerequisite in building mutual trust and ensured the security and safety for everyone in a geographically based social world.

5.3.3. Colored Health Codes – New Biological Identities

With different colored codes suggesting varied infection risk levels of COVID-19, the health codes to some extent have become important elements contributing to the formation of people's health identities. The colored health codes issued by the digital Health Code system represented a new set of biological identities related to the exposure risks of COVID-19. Acquiring a green health code was strongly desired by individuals at the initial launch of Health Code:

> Because the system tells you clearly that the red code means you need to be isolated immediately, the yellow code means your condition is in a moderate dangerous state, and the green code means you are healthy and safe. … Everyone wanted to get a green code to be recognized and proven to be healthy. (C10)

Green health codes offered an assurance and confirmation to individuals that their conditions were healthy and safe. And as the Health Code system was internally connected to identity verification systems, people were vulnerable to having their identities shaped by their understandings of identities and relations with themselves in terms of the colored health codes. As one participant revealed:

> Because of your personal health code, it may now be like your electronic ID card, which you carry anytime. I feel that this health code can prove your health identity. And it is also tied to the two software [apps] WeChat or Alipay, and the registration and use of these two software [apps] requires binding your personal information. Also, when you apply for a health code through the system, you must first verify your identity. So relatively speaking, the colored health code is also like an ID card related to health, and it is also a label and carrier for recording personal health information. (C8)

This idea also resonated with other participants, who stated that personal health codes have become identity traits related to health status that influenced people's perceptions and senses of themselves. Additionally, the beliefs and qualities embedded in green health codes contributed to people's understandings of themselves as healthy and able beings. For some participants, they gradually developed affection and intimate connection towards their green codes:

> In a sense, when it was particularly difficult [during the lockdown], the green code made me feel secured. In fact, I believed that I gradually developed a kind of dependence and intimacy towards the code. Because the green code implied something about me. In the most painful and darkest days at that time, this code had been with me all the time, at some points, it was almost like a manifestation of my condition and my identity. There was a subtle sense of connection [between me and my health code]. It [health code] is like another symbol of my health status. (C5)

The intimacy between people and their health codes implies strong feelings of belonging and wanting to be identified as healthy individuals during the crisis. Personal health codes helped individuals re-shape their perceptions and knowledge towards their forms of life.

As Wuhan gradually returned to a normal state, green health codes became the primary characteristic of a collective healthy identity shared by citizens with green health codes. Only individuals with green health codes were able to freely access public venues, while citizens with yellow or red health codes were rendered invisible in the city. Many green health code owning participants told me that they never met or knew someone with a yellow or red health code. When asked about how they think about the collective healthy identity, one participant recounted:

> When I first got the green health code, I joked with my friends, asking whether they had green codes. [chuckle] And we all had green codes, we were the same. Everyone around me got the green code. … The Health Code system played an important role in classifying people based on health conditions. This protects us from getting infected by patients or close contacts. You would not want to run into someone infected on the street, right? (C11)

For these participants with green health codes, the shared identity assembled around the ownership of green health codes is something that ought to be defended for the collective benefit. Ironically, as another participant who had been issued with a red code recalled:

> I was one of the cured COVID-19 patients. I guess it was because of my condition, after I applied for the personal health code, I was issued with a red health code directly. And I was not allowed to leave the house until my health code was re-assessed as the green one. … When I got the green code for the first time, I was very happy. I could finally go out. And it made you feel like you are one of them [healthy citizens with green codes]. And other people could not know what kinds of special experiences you had. Everyone would not assume you are a threat. (C3)

The experience of this participant uncovered the bifurcated consequences of such groupings. On the one hand, the way Health Code classified people into different risk groups formulated the foundation of a mutually recognized collective healthy group of people, which assured individuals with a safe and secure social world. On the other hand, such classification inevitably signified and narrowed the threat of COVID-19 down to certain bodies, denying their belonging to the healthy collective identity, and thus rendered them invisible in society until being recognized as healthy again.

5.3.4. Discussion: Citizen Perceptions and Experiences of Health Code

The prevailing insecurities and anxieties brought with the increasing threats from pandemics require individuals to responsibly adapt to state-organized health surveillance systems. In a risk averse society, besides issues around the trade-off between digital privacy and security, as my findings show, individuals are driven by what Rose (2001) refers to as the ethopolitics (a form of neoliberal self-government and the individualization of risk) to actively make adjustments and act upon themselves to acquire information about their health status (Rose, 2001). Health Code, as a digital health surveillance technology, provided a new regime of “truth” regarding people’s state of health for navigating and taming the threat of pandemics in society. The digital health surveillance mechanism thus enabled the mutual trust among citizens and ensured the security and safety for everyone in the social world.

Moreover, new biological identities emerged from the digital health categorization of people into different risk groups. The formation of such biological identities has implications for individuals and collective groups. For individuals, acquiring a green health code represents a healthy identity, with beliefs and values of health attached to it. With new forms of biosocial groups are established based on judgement of health conditions, a shared identity representing the healthy and the normal becomes tied to the broad imagination of wellbeing that ought to be defended (Rabinow, 1996).

5.4. Findings: Ruling Relations Embedded in Texts and Experiences

A vast network of institutional processes and organizations were designed to manage the everyday practices of individual citizens in a risk-based logic using a biopolitical categorization technique. People's perceptions and experiences of Health Code as a digital health surveillance system were socially organized by ruling relations within the digital health surveillance mechanism. In this network, citizen-supporters including contact tracers, sub-district supervisors, volunteers, or employees working at the checkpoints of public venues were involved, as well as individual citizens. In this section, I showed how the surveillance system has provided a shared site for legitimizing, implementing, and reconfiguring the ruling relations in everyday settings, mediating and managing judgements and decisions in the everyday practices.

5.4.1. Digital Health Codes Application and Assessment Processes

Individual citizen's experiences with the digital health surveillance system began with registering in the Health Code system and filling in related information. The initial digital health code application process did not require much effort besides filling in personal and health-related information:

> When applying for this health code, I remembered that this system was bound to the identification system. You needed to fill in your ID card number and the detailed personal address. Then you would need to fill in the health-related information. The system would ask you a set of questions, including your and your family member's health status, your recent travel history, whether you had COVID-19 symptoms, such as fever or cough, etc. Once you filled in all the information, the system analyzed your health status based on the data. And if you did not have any of those issues, you would be given a green code. (C6)

The initial personal information and health data collection about each citizen helped establish an individual health database in the system for reference by governments and public health agencies. However, the one-time data collection was not enough for identifying patients who were in the incubation period of COVID-19. After the initial application process, the digital Health Code system had another temporary function called "check-in service," requiring individuals to input information about their health status on a daily basis for around a week:

> At that time, this check-in function lasted for about a week, it mainly requested you to fill in whether you have been in contact with some with a fever and whether your body temperature is normal. One day I had a mild fever. During the check-in process, I filled out that I had a mild fever and shortly after, my health code turned yellow. Then the community and the nearby hospital found me and called me to confirm if I had the fever. They asked me to do the COVID-19 test as soon as possible. … After my test results turned out to be normal, I was still isolated at home for a month. After my body temperature returned to normal at that time, this code was still yellow. It was not until I reported normal body temperature to the system for a few days that my health code returned to green. (C5)

As reported by this participant, the check-in function worked in collecting health-related data from individuals to detect and identify potential patients. This participant's experience revealed the interconnection and sharing of data among local communities, medical institutions, and the broader Health Code system. The Health Code system enabled the communication and cooperation between local communities and medical institutions, forming an ecology of health surveillance. In this ecology of monitoring, local communities served as the intermediary between individuals and medical institutions. Another participant's experience also demonstrated this point:

> I was cured before the Health Code system was launched. From the time I was infected until now, the staff and doctors in my community have been monitoring my health status. Around every one or two months, the community doctor would call me and ask me how I am now. … The first time I applied for the digital health code, I got a red code. So, I contacted the community and asked how I could convert it to a green one. Then, the people in the community asked me to go to the hospital for a checkup. After I had done the checkup, a few days later, it [the health code] did not change. After that, I contacted the staff in the community again and told them I had done the checkup. They might have found my records or something. Finally, after that visit, I finally got my health code transferred to the green color. (C3)

Local communities as the smallest administrative agencies can connect directly with residents within their administrative divisions. With the Health Code system as a shared platform, the collaboration between local communities and medical institutions facilitated precise health surveillance of local residents.

5.4.2. Power Relations in Daily Monitoring Processes

As the Wuhan lockdown ended and the city was gradually restored to its normal state, under the guideline of COVID-19 control policies (MLPD9, 2020), the digital Health

Code system was used for monitoring human mobility and contact tracing. The digital green health codes became essential health certificates for individuals to prove their health status in commercial or public places. In this digital contact tracing mechanism, the risk and threat of COVID-19 infection were narrowed down to people with yellow or red health codes. As one participant worked at the checkpoint of a supermarket recalled:

> For me as a supermarket manager, I don't have a comprehensive understanding of medical knowledge. I must check the health code and body temperature of each customer before I let the person in. One time, there was a customer who wanted to come in, but his temperature was relatively high, so we stopped him. Instead, we invited him to a temporary isolation point, which was in an open area, to rest for a few minutes, considering the high temperature might be caused by movements. After the rest, we checked his body temperature again, but the temperature was still high, then we asked him to rest again. We tried three times. Even if his health code was green, we reported to the corresponding community hospital about his condition. Additionally, there was another case. The customer was just returned from a field hospital. His temperature was normal, but his health code was not green. I remembered he even took out his COVID-19 test result done within 14 days. Still, we did not let him in. (CS4)

Under the guidelines of the pandemic control policy, the strict requirements and monitoring processes mentioned and practiced by the participant were in need for "strengthening the comprehensive social management and pandemic control." (MLPD10, 2020, p. 1) Nevertheless, such stringent health surveillance practices inevitably placed certain groups of people under restrictions in their daily lives. One participant told me:

> I have always used the Health Code system on Alipay. But when I went back to the school, I found out that my school only used the Health Code program on WeChat. That was the first time I used the WeChat Health Code. I filled in my information to apply for the health code. Because I was a confirmed case before, after I applied through the system, the system issued me with a red code instantly. I was terrified and I broke down into tears. There was no way for me to explain anything. Everything changed. I was not allowed to enter the school. Because my red code was recorded with the location data of the school, I had to do a COVID-19 test and CT scans urgently. (C3)

The participant expressed the emotional stress and pain of being identified by the Health Code system as a threat accidentally. The participant's experience also uncovered the governing logic of such a health categorization system from an individual citizen's perspective. The protection and health security for the public provided by the Health

Code is based on the subjugation of certain groups of people classified as the threat and the pathological. The subjugation is achieved through the regulatory body of the health surveillance system formed under the pandemic control guidance of the local government and public health authorities. In the normalized use of the health surveillance system, numerous checkpoints served as the rudimentary surveillance level in performing monitoring processes accordingly.

For elderly people without access to the digital health code technology, local community committees offered a solution:

> In fact, there were many elderly people in the community who were not good at using some mobile phone software, and then the community still issued a paper certificate for them, and then they were able to enter and leave the community with this certificate. Then other people without special circumstances must use the health code to prove their health before they can travel. (CS2)

As illustrated by the participant, elderly people were given paper health certificates instead by local community committees as an alternative to indicate their health status in public venues. However, the paper certificates did not hold the same value as the digital health code, and thus increased the risk of social isolation of elderly people in everyday settings. As another participant recounted:

> When I took my grandfather to the supermarket downstairs to buy some food, his mobile phone was not a smart phone, and he could not access any health code system. Instead, he brought the health certificate issued by the community with me. Theoretically, if the temperature monitoring was normal, he could enter public places. However, because he did not have a green health code, and the supermarket received a large flow of people at that time, the supermarket did not let people in without a green code. So, at the time, my grandfather ended up waiting outside the supermarket for me. (C5)

The continued application of Health Code for the long-term pandemic control and social management prioritized the digital health codes as the primary health certificates recognized by surveillance checkpoints. As post-lockdown society operated in accordance with the regulation of Health Code, populations with special needs could be neglected in daily surveillance processes, reflecting digital divides which have long been a topic of concern as new technologies take on ever greater roles in our social worlds.

5.4.3. Discussion: Ruling Relations Embedded in Texts and Experiences

My analysis revealed that the health surveillance mechanism centered around the digital health code system, and organized and coordinated individual citizen's everyday life through the normalized use of Health Code for pandemic control. In the hybrid health surveillance system, Health Code systems enabled the collaboration among administrative agencies and public health authorities. In the risk-based logic realized via the digital biopolitical categorization of people into different risk groups, certain populations were classified as the threat and the pathological, and thus rendered into subjugation in order to achieve public health security. Health Code and its implementation in normalized pandemic control enabled the legitimization and reconfiguration of power relations in terms of mediating and managing the choices and classifications in the everyday. In the normalization and routinization of health surveillance techniques in social worlds, "everywhere will become part of systems of control, driven by the desire to fight all types of risk and insecurity" (Lacy, 2008, p. 339). As the ecology of health surveillance control gradually is benignly woven into our lives, individuals will inevitably become more adaptable to health surveillance driven by the desire of being categorized and recognized as the normal and healthy.

5.5. Conclusion

In this chapter, I have presented and discussed my findings based on the analysis of both institutional texts and interview transcripts from citizens and citizen-supporters. The results were divided into three sections reflecting three sets of findings. In the first section, I revealed how Health Code, the digital health surveillance system, represents an innovative health security solution to the overwhelming threats of pandemics with the unprecedented collaborations of governments and agencies, creating new networks and processes for political judgments and reconfigurations of power relations. The system architecture as explained in the technical standards of Health Code is designed to be flexible and open to possibilities of variations for emerging uses, producing networked relationships with other surveillance systems. I argued that the health surveillance system cannot be seen as merely static and close-ended, but should rather be viewed as evolving and adaptive to maintaining its reason for existence. Risk is defined and negotiated through the algorithmic processes

embedded with political classifications and decisions. Furthermore, with a detailed examination of the implementation and normalization processes of the Health Code system in Wuhan, I uncovered how Health Code served as the mandatory surveillance tool with the endorsements of local governments and public health authorities in securitizing COVID-19 from its original emergent application to normalized use. Through generating new forms of insecurities and threats, the health surveillance system sustains its role in securitizing health in the post-pandemic city. The second set of findings illustrated individual's perceptions about and experiences with the Health Code surveillance technology. The results uncovered how the "new regime of truth" regarding people's health status established and promoted by Health Code became a vital standard individuals had to navigate in the prevailing threat of pandemics in society. New biological identities based on the health status of people emerged out of the digital health categorization, reflecting the rationalization of social norms and the valorization and stabilization of data-driven knowledge. The shared identity of being the healthy and the normal among citizens become tied to the broad value of security that should be defended in society, even as government sought increasing information from individuals. Furthermore, I also investigated how individual's daily experiences and practices were "hooked-up" into the institutional arrangements and ruling relations embedded in the health surveillance assemblage. My results showed that the ruling logic of such mechanism classifies certain groups of people as the threat and the risk to the health security, and at the same time renders these people into subjugation of negative conditions. In the everyday settings, Health Code becomes a shared site where multiple actors are at play in justifying, enforcing, and reconfiguring power relations, mediating judgements and decisions at the micro level. The normalized control of health surveillance technology represents "an intensification of efforts directed toward management of incalculable risks of life-threatening events of potentially catastrophic consequence" (Diprose, 2008, p. 268) which requires individuals to be more adaptable to future pandemics.

Chapter 6. Conclusion

As the COVID-19 pandemic continues to pose significant threats to states and people globally, we have entered a new era of deep microbial unease in which unpredictable emergent pathogenic risks and the questions of how to govern them have become a severe challenge for public health authorities, governments, and societies (Elbe, 2012). The growing tendency to articulate infectious diseases as security issues threatening states or people is best exemplified in the novel COVID-19 pandemic. With the advances in digital epidemiology and surveillance technologies, innovative digital health surveillance systems have been put to use for urgent pandemic control.

The development and implementation of China's Health Code system for pandemic control is an exceptional and emergent health security practice. The crisis condition allows governmental actors and public health agencies to quickly assemble and construct new networks for decision-making in pandemic control. The correlation of Health Code with identity verification systems implies that Health Code is not a static or close-ended system, but rather an evolving surveillance assemblage interacting with other classification systems. The system processes and architecture are not neutral or objective, rather are embodiments of political classifications and decisions made through algorithms. The surveillance functionality of Health Code has extended beyond the disease-focused notion of public health surveillance, constructing a new individual-based digital health surveillance network overseen by governments and public health agencies. The staging of COVID-19 as an existential threat and issue in politics lifts the corresponding response measures above the normal disease control measures in public health, and locates them within a state-centric framework (Buzan et al., 1998). In the state-centric framework of dealing with pandemics, as in the case of China's Health Code system, government actors inevitably are primarily concerned with maximizing power and proliferating security (Elbe, 2006). This is reflected in how the development of Health Code is accompanied by the establishment of a centralized health surveillance structure – managed by the national government and independent from existing public health systems – to manage and store personal health datasets of human subjects. The digital Health Code application is designed to embrace the new possibilities for secondary uses and only represents one manifestation of how to utilize the data, and

variants of the application might be desirable for governing future public health (or other) crises.

Such a security-informed approach to pandemic control implements the imbalanced power relations in practice and expects the active participation of individuals in surveillance. Another main purpose of this thesis has been to explore the experiences and perceptions of the surveillance subjects within the digital health surveillance assemblages, contributing to our understanding of subjects' experiences of surveillance. By examining health surveillance practices in Wuhan, this thesis revealed that when faced with the prevailing anxieties and insecurities of the COVID-19 pandemic, individuals were driven to actively participate in the state-organized health surveillance technology through the rationalization of collective values and the valorization and stabilization of data-driven knowledge. The regime of knowledge regarding people's health status served as the vital tool for people to navigate in a society full of health risks. With new forms of biological identities which emerged out of the classification of individual's health conditions, the shared identity that represents the healthy and the normal becomes tied to the collective value that should be protected in societies. People's daily activities and experiences are organized and mediated through the legitimization and reconfiguration of power and ruling relations via the surveillance system. Public health security is realized through the subjugation of "risky" individuals categorized by the biopolitical health surveillance assemblage. As the governing logic reflected in the digital health surveillance tools is gradually woven into our daily life, individuals will inevitably become more adaptable to health surveillance in the risk-averse society.

What are the implications of such digital health surveillance practices? The idea of a "sociotechnical imaginary" proposed by Jasanoff (2015) helps shed light on the discussion. "Sociotechnical imaginaries" refer to "collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology" (Jasanoff, 2015, p. 5). For this thesis, at the heart of the security-informed innovative health surveillance technology lies a sociotechnical imaginary concerning the aim of governing the ungovernable infectious disease outbreaks with digital solutions to predict and tame future public health risks (Jasanoff, 2015; Lakoff, 2015). Moreover, for surveillance subjects, the beliefs and

fantasies that the continued use of Health Code would ensure the restoration of normal social activities are in fact a type of "cruel optimism" (Berlant, 2011). Berlant (2011, p. 1) uses cruel optimism to illustrate a relation in which "something you desire is actually an obstacle to your flourishing." As my discussion in sections 5.3 and 5.4 shows, the qualities and beliefs embedded in the personal health codes reshape people's knowledge and perceptions of their health conditions and identities, which in turn, builds intimate connections between individual citizens and their personal health codes. For many citizen informants in this research, the feelings of belonging and emotional attachments to their personal health codes make them vulnerable to compromise with the sustained use of digital health surveillance for the fantasies of normal social lives. Under the circumstances, Individual citizens fall into "a relation of attachment to compromised conditions of possibility whose realization is discovered either to be impossible, sheer fantasy, or too possible, and toxic" (Berlant, 2011, p. 24). The insecurities and anxieties following the mandatory implementation of digital health surveillance technology exacerbates the fear of being classified as sick and the threat among people, and thus leads them to embrace the current situations and actively act upon the existing surveillance system, even as they might realize it could be toxic and disturbing.

Admittedly, this thesis has its limitations. At the time of writing, the world has witnessed the emergence of many more digital tools developed and implemented for pandemic control that share similar functionality with China's Health Code system. For example, in British Columbia, Canada, the use of the BC Vaccine Card as a proof of COVID-19 vaccination has become mandatory in maintaining social activities.[8] The empirical research conducted in this project solely focused on the Chinese context, and it could be different from conditions in Western countries such as Canada. Future research could point to the differences and similarities of digital health surveillance technologies globally for more comprehensive understandings. In addition, this thesis only briefly touched upon the guidelines mentioned in the technical standards of Health Code to ensure privacy protection. It would be interesting for future studies to examine the privacy protection by design in varied health surveillance systems.

[8] Individuals need proof of vaccination (BC Vaccine Card) to access some events, services and businesses. Source from the official website of BC government: https://www2.gov.bc.ca/vaccinecard.html

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Appendix A.

List of Technical Standards Reviewed

Table A1. Shenzhen Standard

Name	URL	Date of Publication	Format	Page
Reference Architecture and Technology Guide of Health Code	http://www.ttbz.org.cn/StandardManage/Detail/33818/	2020/03/05	pdf	11

Table A2. Hangzhou Standard

Name	URL	Date of Publication	Format	Page
Guide to Management and Service of Hangzhou Health Code	http://dbba.sacinfo.org.cn/stdDetail/c14e8fc23d7ae036278506ba10211ad56f5cd02a18f51ed779d3f566db323fc7	2020/04/09	pdf	11

Table A3. National Standards

Name	URL	Date of Publication	Format	Page
Personal Health Information Code – Reference Model (abbreviated as Reference Model)	http://openstd.samr.gov.cn/bzgk/gb/newGbInfo?hcno=ED391A20971F017E8DBC265ECD66CCCE	2020/04/29	pdf	19
Personal Health Information Code – Application Programming Interface (abbreviated as Application Programming Interface)	http://openstd.samr.gov.cn/bzgk/gb/newGbInfo?hcno=09EBF512C9729D09237B646E7DBE1652	2020/04/29	pdf	20
Personal Health Information Code – Data Format (abbreviated as Data Format)	http://openstd.samr.gov.cn/bzgk/gb/newGbInfo?hcno=672AF632394BC01A8D07B221C799923E	2020/04/29	pdf	17
Questions and Answers on National Standards of Personal Health Information Code Series (abbreviated as Questions and Answers on National Standards)	www.nits.org.cn/getIndex.req?action=quary&req=modulenvpromote&id=3244&type=0&moduleId=81&sid=5	2020/05/08	pdf	4

Appendix B.

List of Policies and Related Documents Reviewed

Public policies and documents related to Health Code were collected from the official website of Wuhan Municipal Health Commission (http://wjw.wuhan.gov.cn)

Table B1. National level policies and documents (NLPD)

ID	Name	URL	Date of Publication	Format	Pages
NLPD1	Informatization construction and application guidelines for community prevention and control of the COVID-19 pandemic	http://wjw.wuhan.gov.cn/front/web/showDetail/20200030609966	2020/03/06	website	7
NLPD2	Notice on the COVID-19 testing and health management of Wuhan citizens leaving the city	wjw.wuhan.gov.cn/ztzl_28/fk/tzgg/202004/t20200430_1198119.shtml	2020/04/20	website	2
NLPD3	Instructions from The State Council's Joint Prevention and Control Mechanism in Response to the COVID-19 Pandemic on the normalized prevention and control of the COVID-19 pandemic	wjw.wuhan.gov.cn/ztzl_28/fk/tzgg/202005/t20200509_1263162.shtml	2020/05/09	website	4
NLPD4	Notice on the gatekeeping function of medical institutions in the normalized prevention and control of the COVID-19 pandemic	wjw.wuhan.gov.cn/ztzl_28/fk/tzgg/202006/t20200612_1376394.shtml	2020/06/12	website	2
NLPD5	Notice on the prevention and control of the COVID-19 pandemic in a scientific and accurate manner in accordance with the law	http://wjw.wuhan.gov.cn/front/web/showDetail/20200222609794	2020/02/26	pdf	98

Table B2. Provincial level policies and documents (PLPD)

ID	Name	URL	Date of Publication	Format	Pages
PLPD1	Notice from *the Hubei Provincial Headquarters for Prevention and Control of the COVID-19 Pandemic*	wjw.wuhan.gov.cn/ztzl_28/fk/tzgg/202004/t20200430_1197233.shtml	2020/03/11	website	3
PLPD2	Guidelines for the normalized prevention and control of the COVID-19 pandemic in Hubei Province	wjw.wuhan.gov.cn/ztzl_28/fk/jkkp/202005/t20200522_1326082.shtml	2020/05/22	pdf	49
PLPD3	The Provincial Prevention and Control Headquarters held a special meeting, downgrading without degrading prevention, always tightening the string of pandemic prevention and control, and normalizing scientific and precise prevention and control	wjw.wuhan.gov.cn/ztzl_28/fk/fkdt/202006/t20200616_1378979.shtml	2020/06/16	website	2

Table B3. Municipal level policies and documents (MLPD)

ID	Name	URL	Date of Publication	Format	Pages
MLPD1	Wuhan Health Code is officially launched	wjw.wuhan.gov.cn/ztzl_28/fk/tzgg/202004/t20200430_1198629.shtml	2020/02/23	website	2
MLPD2	A letter to all citizens of Wuhan	wjw.wuhan.gov.cn/ztzl_28/fk/tzgg/202004/t20200430_1198604.shtml	2020/02/24	website	2
MLPD3	Wang Xiaodong presided over the special meeting and requested for the utilization of big data system to combat the COVID-19 pandemic and providing services for people stranded in Hubei province	wjw.wuhan.gov.cn/ztzl_28/fk/fkdt/202004/t20200430_1198497.shtml	2020/03/01	website	2
MLPD4	Notice on the differences among national Health Code, Hubei Health Code, and Wuhan Health Code	wjw.wuhan.gov.cn/ztzl_28/fk/tzgg/202004/t20200430_1198741.shtml	2020/03/03	website	9
MLPD5	Our city held a special meeting on the promotion of Health Code application to enrich application scenarios and promote it to become a citizen's health management platform	wjw.wuhan.gov.cn/ztzl_28/fk/fkdt/202004/t20200430_1198788.shtml	2020/03/05	website	2
MLPD6	Ying Yong presided over the work meeting of the Provincial Prevention and Control Headquarters, adhering to the prevention and control strategy of "preventing internal and external spread" and advancing the precise management of "divisions and categories of places and time periods"	wjw.wuhan.gov.cn/ztzl_28/fk/fkdt/202004/t20200430_1197119.shtml	2020/03/10	website	2
MLPD7	Ying Yong attended the video dispatch meeting of the Provincial Prevention and Control Headquarters and emphasized that he has fully implemented the important requirements of General Secretary Xi	wjw.wuhan.gov.cn/ztzl_28/fk/fkdt/202004/t20200430_1197444.shtml	2020/03/13	website	3

	Jinping, and coordinated the fight for pandemic prevention economic and social development				
MLPD8	Wang Zhonglin went to the airport and railway station of Wuhan for the management and monitoring work of the reopened traffic after the lockdown, using joint prevention and control to ensure no further spread of the COVID-19 pandemic in Wuhan	wjw.wuhan.gov.cn/ztzl_28/fk/fkdt/202004/t20200430_1198332.shtml	2020/04/07	website	2
MLPD9	Ying Yong presided over the meeting of the Provincial Headquarters for Prevention and Control to lift the lockdown and reopen the traffic of Wuhan in a safe and orderly manner and to effectively and scientifically prevent and contain the spread of the COVID-19 pandemic	wjw.wuhan.gov.cn/ztzl_28/fk/fkdt/202004/t20200430_1198399.shtml	2020/04/08	website	2
MLPD10	Wang Zhonglin presided over the video dispatch meeting of the Municipal Prevention and Control Headquarters and emphasized to learn by analogy, refine and improve normalized prevention and control measures, and continue to consolidate the effectiveness of pandemic prevention and control	wjw.wuhan.gov.cn/ztzl_28/fk/fkdt/202005/t20200512_1311426.shtml	2020/05/12	website	2
MLPD11	Notice on COVID-19 testing on all Wuhan citizens	wjw.wuhan.gov.cn/zwgk_28/fdzdgknr/qtzdgknr/hygq/202012/t20201201_1523997.shtml	2020/05/21	website	1
MLPD12	Inquiry and feedback of COVID-19 testing on all Wuhan citizens	wjw.wuhan.gov.cn/jlhd_28/zxts/lxxd/202006/t20200605_1363745.shtml	2020/06/05	website	1
MLPD13	Notice of the Municipal Health Commission on effectively promoting the	wjw.wuhan.gov.cn/zwgk_28/zc/qtbmwj/202012/t	2020/07/29	website	4

	Interconnection of all types of medical institutions at all levels with the municipal health information platform of Wuhan	20201201_1524566.shtml			
MLPD14	Urgent notice	wjw.wuhan.gov.cn/ztzl_28/fk/tzgg/202010/t20201026_1476331.shtml	2020/10/26	website	2
MLPD15	Implement the main responsibility of the government to run medical services and increase the input of primary medical resources	wjw.wuhan.gov.cn/zwgk_28/fdzdgknr/qtzdgknr/jytabl_1/202010/t20201030_1487869.shtml	2020/10/30	website	5
MLPD16	Notice of the Municipal Health Commission on effectively utilizing information technologies to support the normalization of pandemic prevention and control measures	http://wjw.wuhan.gov.cn/zwgk_28/zc/qtbmwj/202012/t20201201_1524580.shtml	2020/08/17	website	4
MLPD17	Decision of the Standing Committee of the Wuhan Municipal People's Congress on fighting the Wuhan defense war against the COVID-19 pandemic in accordance with the law	http://wjw.wuhan.gov.cn/front/web/showDetail/20200021909676	2020/02/19	website	3

Appendix C.

Summary of Demographic Characteristics of Interview Informants

Interview informants include twelve citizen and four citizen-supporter participants.

Table C1. A summary of demographic characteristics of citizen participants

Interviewee ID	Age	Gender Pronoun	Occupation	Geographic Location in Wuhan
C1	24	She/her/hers	Officer	Hanyang District
C2	26	He/him/his	Student	Hankou District
C3	25	She/her/hers	Doctor	Hankou District
C4	25	He/him/his	Officer	Wuchang District
C5	24	She/her/hers	Officer	Wuchang District
C6	26	He/him/his	Officer	Hankou District
C7	27	She/her/hers	Doctor	Hankou District
C8	48	He/him/his	Manager	Wuchang District
C9	50	He/him/his	Manager	Hanyang District
C10	31	She/her/hers	Self-employed	Wuchang District
C11	28	She/her/hers	Officer	Wuchang District
C12	26	She/her/hers	Officer	Wuchang District

Table C2. A summary of demographic characteristics of citizen-supporter participants

Interviewee ID	Age	Gender Pronoun	Occupation	Geographic location in Wuhan
CS1	27	He/him/his	Subdistrict Supervisor	Wuchang District
CS2	55	She/her/hers	Community Volunteer	Hankou District
CS3	26	She/her/hers	Community Volunteer	Wuchang District
CS4	54	He/him/his	Mall Manager	Wuchang District

Appendix D.

Interview Guides

Below is a set of suggested questions and topics to be asked and discussed in the interviews with citizen participants:

1. Prior to the implementation of Health Code in Wuhan, what were the pandemic control policies and measures during the lockdown?
2. How did you think about the pandemic control measures during the lockdown?
3. What was your daily life like during the lockdown?
4. How did you learn about Health Code for the first time?
5. What were your first thoughts on Health Code?
6. How did you apply for your personal health code?
7. What were the functions of Health Code during the lockdown?
8. After the lockdown ended, how was your daily life changed?
9. Was Health Code still used after the lockdown? What was its functionality?
10. What were the procedures and processes for using Health Code on a daily basis?
11. How was your everyday use of Health Code?
12. What were your feelings and thoughts about the digital Health Code system?
13. What were your thoughts on your personal health code?
14. Do you feel secure while using the system? If so, can you tell me more about your thoughts?

15. What were the most unforgettable experiences associated with Health Code?

16. Do you wish the system to be continued used in the future? Why?

Below is a set of suggested questions and topics to be asked and discussed in the interviews with citizen-supporter participants:

1. How would you describe your work responsibilities?
2. Prior to the implementation of Health Code in Wuhan, what were the pandemic control policies and measures during the lockdown?
3. How did you think about the pandemic control measures during the lockdown based on your work experiences?
4. Did you work during the lockdown? If yes, what were your job responsibilities during the lockdown?
5. How did you learn about Health Code for the first time?
6. What were your first thoughts on Health Code?
7. How did you apply for your personal health code?
8. How were the functions of Health Code related to your work experiences during the lockdown?
9. After the lockdown ended, was there any changes to your responsibilities? What were the changes?
10. Was Health Code still used after the lockdown? What was its functionality?
11. What were the procedures and processes for managing and checking personal health codes on a daily basis?
12. How was your everyday use of Health Code?
13. What were your feelings and thoughts about the digital Health Code system?
14. What were your thoughts on your personal health code?

15. Do you feel secure while using the system? If so, can you tell me more about your thoughts?

16. What were the most unforgettable experiences associated with Health Code based on your work experiences?

17. Do you wish the system to be continued used in the future? Why?