Infrastructures and Public Trust of Chinese Telemedicine

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Fable of Tomorrow

Dear Mother,

You have been very much on my mind lately. I am heartbroken that I cannot be physically with you back in the village in Hebei. Work has been really tough lately at the construction site here in Beijing, and I miss your cooking more than ever. Father has told me that your health has taken a turn for the worse, and the idea that your heart continues to fail makes the distance all the more difficult to bear.

I'm writing to you today because I recently found out my good friend Andrew's aunt also suffers from heart failure, but she has benefited greatly from the use of telemedicine in her treatment. I know we had a conversation about how you don't want to use this technology because bad people can potentially steal your health information to do bad things, and that you are afraid the treatments doctors give you online might not be as good, but I strongly urge you to reconsider.

I did some research on telemedicine, and I really think it is something worth looking into. Nowadays, telemedicine has become very trustworthy, reliable, safe, and cheap. It is very widely used in society, especially among the younger people. These online platforms actually has extremely safe security features and regulations, so you can rest assured that your health information will be safe there. The current heart doctor that you've been following up with also has amazing reviews online for her telemedicine services, so there's really nothing to worry about. We as a family make a very humble living, and using telemedicine to continue your treatment can not only save you the time and trouble from traveling far into the big city to see the doctor every so often, but it can also save us a decent amount of money as well.

Being so far from you, I worry night and day about your health condition, and it'd really ease my worries if you could start using telemedicine in your care. If it could make the difference between seeing you this coming Chinese New Year or not, you know how much this must mean to me.

Sincerely,
Your worried son

INTRODUCTION & BACKGROUND

Telemedicine, under the recent Healthy China 2030 blueprint, is at the center of China's focus for development and innovation (Tan et al., 2017). In March 2019, with the world's first 5G-powered remote brain surgery on a human patient performed in China, this vision of improving healthcare through telemedicine is now becoming a reality (CGTN, 2019). In this groundbreaking milestone, with the newest developments in 5G technology and infrastructure, doctors were able to control robotic arms from 3000 km away with micrometer precision and almost zero lag. The innovations in telemedicine are very exciting in that they serve to help improve patient accessibility to healthcare as well as hospital efficiency, which embody the future of healthcare.

Even though telemedicine brought enormous benefits to the healthcare field, many unforeseen issues also surfaced. Many policy makers are still debating on issues of hospital administration, data security, physician-patient interactions, as well as ethical concerns including patient privacy. Perhaps one of the biggest issues facing Chinese telemedicine is the issue of public trust. As reported by the Los Angeles Times, many Chinese patients distrust China's healthcare system altogether, and they turn to telemedicine apps that connect them instead to US doctors (Meyers, 2018). Without public trust in the system, Chinese telemedicine will encounter many roadblocks before widespread acceptance. Therefore, it is important to develop an understanding of public trust of Chinese telemedicine, which is an important research question that will be explored in this STS thesis.

Behind the rapid development of Chinese telemedicine, many relevant social, technological, and political infrastructures, as well as ethical concerns, must be in place for the realization of this nation-wide initiative. For example, technological innovations such as 5G broadband network are pivotal in driving the advances in telemedicine. However, without the government's push in implementing the necessary legislations, the achievements in telemedicine cannot be reached. To dissect this complex socio-technical system and analyze these relevant infrastructures and stakeholders, I will adopt the Social Construction of Technology (SCOT) framework to fully comprehend the factors that contribute to the development of Chinese telemedicine.

Specifically, in this thesis, I will conduct a case study on Ping An Good Doctor, China's largest telemedicine platform with more than 300 million registered users. Through exploring the relevant infrastructures and specific functions that led to its success, as well as gauging for its public perception, I will gain a greater understanding of where telemedicine situates in the Chinese society at its status quo.

LITERATURE REVIEW

Since the 1980's, telemedicine has been explored in China, which paved the way for today's innovations. Z. Wang & Gu (2009) outlined many milestones in the history of the development of Chinese telemedicine. The first telemedicine networks were telegraph and email-based systems, where information must be stored and then transmitted. Gradually, as technology started advancing, telemedicine networks started migrating towards the internet, satellite, wireless systems, and later, mobile phone-based systems. Evidently, China has decades of history developing telemedicine, which played an important role in setting up systems and infrastructures seen today.

In recent years, the government has announced multiple legislations to push for the development of Chinese telemedicine. In October of 2016, the "Healthy China 2030" blueprint

was released, which placed the development and innovation of healthcare as a priority in policy implementation (Tan et al., 2017). Two years after Chairman Xi made this announcement, Premier Li went on to reinforce the initiative by promoting "Internet Plus healthcare" in April of 2018 (Xu, 2018; 国务院办公厅, 2018a). In the same year, the National Health Commission released three "Measures" regarding the administration of internet-based diagnosis and treatment, internet hospitals, and telemedicine, which serve to be the major driving force for the future development of Chinese telemedicine (K. Wang, 2018; 国务院办公厅, 2018b). In my research, I will continue to discover the impact of these policy infrastructures.

To thoroughly contextualize the social construction of Chinese telemedicine, one must achieve an understanding of all the stakeholders involved with the issue. Zhan et al. (2011) identified five main stakeholders in the development of Chinese telemedicine: patients, medical professionals, government agencies, vendors for telemedicine technologies, and educational institutions. In their analysis, each stakeholder possessed a unique perspective that contributed to their support/opposition of telemedicine. This stakeholder analysis provides a solid foundation for my analysis of the factors at play in Chinese telemedicine, and I will further the research of Zhan et al. (2011) by analyzing these relevant infrastructures using the SCOT framework.

The issue of public trust has not been extensively studied in the field of Chinese telemedicine. However, similar studies exist that explore factors that contribute to its implementation. Broens et al. (2007) identified 5 key criteria that influence the development of telemedicine: technology, acceptance, financing, organization, and policy and legislation, but trust was not specifically spelled out. Another approach was probing for the satisfaction rate of users. Cai et al. (2016) conducted research on the satisfaction rate after implementation of telemedicine in Gansu Province, a poor, mountainous region with a low level of access to healthcare. Through surveys and questionnaires, the authors were able to collect primary data on the satisfaction of patients, physicians, and healthcare administrators upon using telemedicine platforms. Cai et al. (2016) provided a great methodology in gauging the satisfaction rate of telemedicine in Gansu. In my research analysis, I will adopt similar surveys and questionnaires in my study of public trust of Chinese telemedicine.

The public perception and trust of telemedicine, however, has been extensively studied in the western context. In Germany, 95.2% of people fear for the misuse of their health data on telemedicine platforms, and old age and low education were identified as key predictors of refusal to using the technology (Paslakis et al., 2019). While in the United States, a majority of people states that they would not pursue telemedicine unless they have met them in person first (Welch et al., 2017; Wicklund, 2015). Furthermore, 75% of people reported that they do not trust the accuracy of online diagnoses compared to in-person versions. In another study, it was found that American patients generally do not feel comfortable talking about their health through social media platforms or texts, while they do support communication through either email or phone calls. Evidently, in the western world, telemedicine still has room to grow before gaining the public trust. In this thesis, I will explore the issue of public trust in Chinese telemedicine.

STS FRAMEWORK & RESEARCH METHOD

The STS research project involves three specific research methods: SCOT analysis, surveys, and a case study. To study the social, technological, and political infrastructures that aided the development of Chinese telemedicine, I will combine further literature review with analysis under the SCOT framework to break down the relevant stakeholders involved, and their

social interests in shaping the design and implementation of Chinese telemedicine. The SCOT framework is ideal for the purposes of the present thesis because telemedicine is still a new and blooming field in China, and many stakeholders are involved in its making process in the larger society. Inevitably, different relevant social groups will have a different understanding of the technology and its purpose (interpretational flexibility), and the different stakeholders will each carry out its own set of actions that will serve to influence the characteristics of the technology that is adapted by the society in the end (design flexibility)(Bijker et al., 1970).

In order to fully understand the social forces around the development of Chinese telemedicine, I will implement the following two methods for data collection:

1) Survey: I have designed a survey to be distributed among the Zhejiang University students. Based on my research findings from studying the infrastructures and public trust, I will also attempt to gauge the public perception and trust of Chinese telemedicine. The survey will serve as a way to understand the firsthand understanding and trust that Chinese citizens have in the developing technology that is starting to gain widespread attention.
2) Case study: I will conduct my case study of Ping An Good Doctor under the SCOT framework. I will explore the relevant sociopolitical infrastructures during the founding of this company and analyze the relevant stakeholders that were involved in bringing this mobile platform to its success today. By analyzing the factors that led to this company's rapid success in a sea of telemedicine startups in China, the case study will serve as an excellent gateway into understanding the social setting behind Chinese telemedicine.

Using knowledge gained from the case study as well as results from the survey, I will then make a connection between the infrastructures that were set up and the public perception of the app.

SOCIAL INTERESTS AND INTERPRETATIONS OF "TELEMEDICINE" IN CHINA

To begin conducting a sociotechnical analysis on telemedicine, it is important to first provide a good definition to avoid misconceptions. The World Health Organization has defined telemedicine as "the delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities" (World Health Organization, 2010). I would like to adopt this definition for this thesis.

For a new technology to be brought into market and adopted by the greater society, it is very important to have right preexisting conditions that are suitable for its development and growth. In the case of telemedicine, China's current sociopolitical condition is very suitable for its introduction and development. To demonstrate China's need for telemedicine, I will first delve into traits of China's current healthcare system.

China's Healthcare Dilemma

Having to take care of a large population of 1.4 billion people, the Chinese healthcare system is heavily burdened. By the year of 2050, China is projected to have 330 million people over the age of 65, which is almost a quarter of the entire population (*China's Aging Population Is a Major Threat to Its Future | Time*, 2019); This will surely further exacerbate the healthcare burdens that China has currently. China also currently has a shortage of doctors to serve the massive population in need of medical care, at 2.0 doctors (per 1000 inhabitants) in 2018

compared to the Organization for Economic Co-operation and Development (OECD) average at 3.4 doctors (*Health Resources - Doctors - OECD Data*, 2018). Additionally, in the current Chinese healthcare system, there is an uneven resource distribution between rural and urban hospitals that places an even heavier burden for the hospitals in big cities (*China Is Building The Ultimate Digital Health Paradise. Or Is It?*, 2019; Schmid, 2018). In China's three-tier hospital system, only 8% of hospitals are rated top-tier as class-III A, but they have to take on 50% of all patients (Schmid, 2018). This is largely because of the lack of a functional primary care system as gatekeepers for big hospitals (Wu & Lam, 2016). Without this important gatekeeping mechanism for general health inquiries, both rural and urban patients flock to big hospitals and rely on specialists to perform otherwise mundane general medical care (Wee, 2018). The lack of a streamlined process in hospitals further complicates the issue, as patients have to wait on long lines for each step of the care process, including making the appointment (guahao), paying consultation fees, paying for prescription, and finally picking up the medicine ("How Tencent's Medical Ecosystem Is Shaping the Future of China's Healthcare · TechNode," 2018; Wee, 2018). As a result, city hospitals are overcrowded, wait times are unreasonably long, and rural patients have to travel long distances to get quality healthcare (Schmid, 2018).

One contributing factor to the shortage of primary care physicians is the lack of respect patients have for them. Generally, there is a common notion that specialist doctors get paid more, and therefore all the more skilled doctors are specialists, which leads to a lack of incentive for medical students to choose primary care (Wee, 2018). Moreover, there have been reported violent cases against doctors, which further exacerbate the issue of having a shortage of doctors (Fifield & Li, 2019; Guo, 2017; Yu, 2019). Combining the factors of the aging population and increased medical need, shortage of doctors, lack of access to quality healthcare in rural areas, and overburdened big city hospitals, China is in need of a healthcare reform.

The Government Directs Policy Development

In the socialist nation of China, the central government plays a pivotal role in directing its national visions and policies. The Chinese healthcare reform, naturally led by key legislations from the central government, has experienced several major phases over the years. Partially driven by the turmoil created by SARS, the Chinese government started emphasizing the importance of granting everyone an "affordable access to basic healthcare" in 2006, which paved way for a new wave of reform starting in 2009 (Tang et al., 2014; W. Yip & Hsiao, 2015). The reform plan released in April 2009 included goals of achieving basic health insurance coverage for 95% of the population by 2020, increasing accessibility of healthcare to all people (with focus in rural regions), establishing a primary care system, and initiating public hospital reform to increase efficiency (W. C.-M. Yip et al., 2012; W. Yip & Hsiao, 2015). Although the program is successful in increasing financing for healthcare, reaching the 95% insurance coverage in 2016, and reducing the gap between the rich and the poor in accessing healthcare, much work is still needed as the public hospital healthcare delivery system is still dysfunctional (W. C.-M. Yip et al., 2012; W. Yip & Hsiao, 2015).

From 2013 to 2016, a new period of reform China entered another period where there was an increased effort to reform the healthcare delivery system. In this period, the government introduced the three-tier hospital system, where the primary care facilities would be in charge of the most basic family health care, while the tertiary hospitals would be highly specialized and capable of providing the best health care. Additionally, to boost the primary care delivery system, China vowed to register all citizens with a designated family doctor by 2020 (W. Yip et

al., 2019). Moreover, to address some of the current issues of public hospitals, China turned to the private sector to try to not only increase the number of private hospitals, but also to encourage private health insurances (W. Yip & Hsiao, 2015). Although these measures improved accessibility to healthcare in both rural and urban areas, poor distribution of resources among the three hospital tiers resulted in an uneven quality of care, which led to an overflooded tertiary hospital system and a common distrust of the primary healthcare (W. Yip et al., 2019).

Recognizing the successes and areas of improvement of the past reforms, Chairman Xi of China released the "Healthy China 2030" blueprint in 2016, which placed healthcare at the epicenter of China's future development as a nation. The blueprint centered around 4 major principles: health priority, innovation, scientific development, and fairness and justice (Tan et al., 2017). To actualize the vision, China soon started to introduce the "Internet Plus Healthcare" initiative in hopes of addressing the long-standing problems of inaccessible and expensive healthcare (Xu, 2018). The initiative was made possible through a prior legislation of the "Internet Plus" initiative that was released in 2015, which pushed for the integration of internet, cloud computing, and big data with major industries to promote innovation and growth (国务院, 2015). The initiative unleashed a new spirit of innovation in the private sector that drove the technology industry forward, which paved way for the integration of healthcare and internet.

In 2018, the National Health Commission of China released 3 key documents that outlined the specific rules and regulations on telemedicine for the first time, which opened doors for its further development. The new legislation outlined measures for internet diagnosis and treatment, internet hospitals, and remote medical care (Chen & Balzano, 2018; 国务院办公厅, 2018b). Some of the key provisions include only licensed medical practitioners are allowed to provide medical care online; patients can only use telemedicine for follow-up visits for common or chronic diseases, not for first-time visits; no narcotics can be prescribed online; tertiary hospitals are to provide training and support for lower class hospitals to help set up telemedicine services; telemedicine is to be regulated and monitored at the province level (Chen & Balzano, 2018; 国务院办公厅, 2018b). With the central government backing the development of telemedicine, the door to innovation is officially opened.

Technology Industry Drives Spirit of Innovation

Under Chairman Xi's leadership, China has developed into a powerhouse in terms of economy, technology development, and innovation. As part of the 13th Five Year Plan, becoming a technology leader is now at the focal point of China's development goals. As outlined in the "Made in China 2025" policy, China has placed a new emphasis on the upgrade of the Chinese industry towards more innovative and advanced technologies in order to rejuvenate the Chinese economy (Kania, 2019). In order to focus on the development of high-tech industries, China not only increased the hiring of overseas experts in industries such as AI and big data, but also focused on buying out foreign companies in these industries as well in an attempt to learn the technology and innovate further (Li, 2018). Additionally, China's huge market is an inherent point of attraction for foreign high-tech industries, and it is ideal for the growth of innovation because of the abundance of potential investors and consumers (Li, 2018). Additionally, similar to many other cases in China, when the government pushes for an area of growth, especially in the industry, the spirit of innovation and growth becomes tremendous as businesses and entrepreneurs see a perfect opportunity for money making. Combining the recent push and

innovations in big data, robotics, and artificial intelligence, the Chinese technology sector is an enabling factor that is very important in making possible to development of telemedicine.

5G Broadband Network Coverage

In order to push forth a major widespread implementation of telemedicine as a real form of healthcare to address the current problems in Chinese healthcare, a fast broadband internet is pivotal. The reasoning is simple, for an online platform that is the basic nature of telemedicine to work, the access to sufficient internet is a basic necessity, without which the platform cannot be possible, especially for the rural communities that traditionally have less internet coverage. Along with the new wave of technology revolution, China has increased its efforts in extending a vast 5G network for the whole nation. In 2013, only 17% of the Chinese population had access to fiber internet, but in 2019, this number jumped to 86%, while the US only has 25% in comparison (Cooper, 2019). In terms of the rural communities that have an increased need for faster internet, 96% of the communities are covered in the study (Cooper, 2019), which further highlights the impressive progress that China has made to set up the stage for its technology innovation. As more and more people in society are used to the convenience of online technology, there will be less reluctant forces that are opposed to big changes that online medicine platforms can bring. Furthermore, the uniform access to broadband will level the playing field in terms of addressing the uneven distribution of healthcare resources that China currently has, which will help improve the state of Chinese healthcare.

Healthcare Systems & Providers

Healthcare systems are considered drivers for the technology for several reasons (Zhan et al., 2011). First, telemedicine can serve to help increase communication of ideas and medical knowledge among the medical professionals, so that physicians in rural areas, or those with less experience and skill, can now have the opportunity to reach out to the more experienced physicians to increase their quality of care. This will not only benefit the doctors but ultimately the patients as well. Second, moving much of the health records to an online electronic format can help increase the efficiency of work for the doctors, so that they can see more patients. Hospitals will have an easier time accessing health records and prescriptions of patients when transferring hospitals as well. Third, with the appearance of online health apps, many physicians now have the ability to work remotely, which often involves easier tasks such as answering common health questions. This is a mutually beneficial situation as the doctors have the opportunity to earn more income, and patients have a way of getting health questions answered easily. Although the transition to telemedicine is not without its own set of challenges, but healthcare systems ultimately will be in support of the development due to the immense benefits it can bring.

Public Trust

To gain a deeper understanding of the public trust of telemedicine in China, a survey has been distributed to students within Zhejiang University. 14 total responses have been recorded from the survey. All but one survey participant was in their 20's, with one participant in his 50's. 10 of the participants were male, 2 of the participants were female, and 2 preferred not to answer.

The first purpose of the survey was to gauge the Chinese students' understanding of what is telemedicine. In terms of concepts best associated with telemedicine, the most popular choices selected by participants were: video call with doctor (78.57%), online medical education

(64.29%), online pharmacy (71.43%), the use of artificial intelligence (57.14%), medical care at a distance (57.14%), online patient records storage (57.14%), online doctors' appointment booking (57.14%), transfer of electronic patient health records from hospital to hospital (50%), and remote patient monitoring (78.57%). The choices are consistent with the functionalities of telemedicine that have been implemented in China and the US. Surprisingly, less than 50% of participants selected delivery of drugs to your home, self-diagnosis by reporting symptoms online, remote robotic surgery, which are other currently implemented forms of telemedicine. In the question asking about the demographic that can benefit from telemedicine the most, the participants believed that telemedicine an best benefit an older, lower-class, and rural communities, which is interesting because they might not have sufficient access to the internet to take advantage of the technology (Table 1). This can potentially be attributed to the internet revolution of China, where the 5G broadband internet coverage has been greatly expanded over the past years under the heavy governmental push.

Table 1: Perceived demographic that can benefit the most from telemedicine

Choices	Count	Percentage
Rural residents	9	64.29%
Urban residents	6	42.86%
Children (<18)	2	14.29%
Young adults (18-40)	3	21.43%
Middle age adults (41-65)	4	28.57%
Older adults (>65)	10	71.43%
Lower class	8	57.14%
Middle class	5	35.71%
Upper class	3	21.43%
Male	0	0%
Female	1	7.14%

Of the diseases provided in the survey, the participants selected two that are suited for telemedicine: pneumonia and flu (64.29%) and chronic illnesses. The health conditions that are least suited for telemedicine are perceived to be physical injuries (64.29%) and mental illnesses (57.14%).

In the second section of the survey, several questions were designed to collect the public opinions of Chinese telemedicine as a form of healthcare. In the question whether telemedicine improves the accessibility of healthcare, 57.14% of participants answered "somewhat yes", while 7.14% of participants answered "definitely yes" (Table 2). Furthermore, 78.57% of participants

believed that telemedicine can improve the speed of healthcare delivery, which shows signs of trust in telemedicine's ability to improve the speed and accessibility to healthcare.

Table 2: Participant answer to whether telemedicine improves accessibility of healthcare

Choices	Count	Percentage
Not at all	1	7.14%
Somewhat no	2	14.29%
Neutral	2	14.29%
Somewhat yes	8	57.14%
Definitely yes	1	7.14%

When the participants are asked if they think if telemedicine is good for the first visit vs. follow-up visits, the positive responses increased from 28.57% to 57.14%, which shows a general sentiment of doubt toward the capabilities of telemedicine. This sign of doubt is further highlighted in the responses to the question "Are you worried that your personal health data might be leaked by using telemedicine platforms," where 71.43% of participants showed a positive response, showing signs of distrust to the data security systems within telemedicine (Table 3).

Table 3: Participant response to if they are worried about health data leaks with telemedicine

Choice	Count	Percentage
Not at all	0	0%
Somewhat no	1	7.14%
Neutral	3	21.43%
Somewhat yes	4	28.57%
Definitely yes	6	42.86%

All other questions in this category seemed inconclusive, as the responses seem to be split between positive and negative responses. These questions include the reliability, effectiveness, safety, accuracy of online diagnoses, and the accuracy of symptom reporting tools.

In the next section of the survey, participants are asked to respond to several different questions regarding Chinese vs. American telemedicine. Given the choice between consultations with Chinese doctors vs. American doctors, while 57.14% of participants responded "no preference", the remaining 42.86% selected "Chinese doctors". This result disproved Meyer's article in the Los Angeles Times that reported Chinese patients distrusts the Chinese healthcare

system and that they prefer American doctors instead (Meyers, 2018). This trend continues with more participants preferring telemedicine platforms designed by Chinese companies (42.86%) over American companies (7.14%), while the remaining 50% reported “no preference”. Finally, comparing Western medicine vs. Chinese traditional medicine, 71.43% of the participants did not have a preference in terms of telemedicine delivery.

In the final question, the participants are asked to select functions that they would personally use if they were to use telemedicine. Results show that every choice was selected by more than 50% of participants, with online medical education and online appointment booking as the most frequently selected options (Table 4). Interestingly, despite self-diagnosis not being one of the options participants felt belonged under the telemedicine definition, 64.29% of participants still decided they would pursue it. Furthermore, despite the mixed reviews on the accuracy of diagnosis delivered online and they worries of personal health data leakage, 71.43% of participants still decided they would personally pursue “online medical consultation, diagnostic, and prescription”, which might suggest an actual trust in the system.

Table 4: Functionalities of telemedicine participants would personally use

Choice	Count	Percentage
Symptom search & self-diagnosis	9	64.29%
Online consultation, diagnostic, and prescription	10	71.43%
Health education	12	85.71%
Quick health question & answer	8	57.14%
Online doctor's appointment booking and patient registration	11	78.57%
Doctor & hospital search	8	57.14%
Other	2	14.29%

Overall, the results collected from the survey provided very valuable insights on the public opinions on Chinese telemedicine. In terms of the understanding of the definition of telemedicine, results seemed to show that the Chinese participants have a similar definition in mind as the current major telemedicine platforms implemented in Chinese and American societies. The perceived beneficiary demographic from the implementation of telemedicine is the more disadvantaged communities of the rural, older, and lower-class populations. Of all the health conditions, the Chinese participants believe that pneumonia and flu and chronic illnesses are most suited to healthcare with telemedicine, while the least suited are physical injuries and mental illnesses. In general, the participants believe that telemedicine can improve the speed and accessibility of healthcare, which shows a trusting sentiment to the capabilities of telemedicine. The major sign of distrust is exhibited through the fear that personal healthcare data can potentially be leaked from using the technology. However, despite this fear, participants still responded that they would use telemedicine’s multitude of functionalities personally, which

might suggest that the participants feel that the benefits of using telemedicine outweigh the harm. Finally, the participants typically had no preference in terms of Chinese vs. American telemedicine, but some participants do prefer Chinese doctors over American doctors.

CASE STUDY: PING AN GOOD DOCTOR

Ping An Good Doctor, the world's largest telemedicine company with 300 million active users, is not only one of the most successful Chinese telemedicine startups, but also the fastest growing (Ping An Healthcare and Technology Company Limited, 2019). From its inception in 2015, Ping An Good Doctor quickly rose to the top within the span of 4 years. For such a rapid growth to occur, many relevant social forces must work together to achieve such a feat. In this case study, to gain a deeper understanding of the social settings of Chinese telemedicine, I will analyze the reasons how this company surfaced to the top while many others failed.

As a business, Ping An does not only offer only an online platform. Instead, it develops an entire network as part of its business strategy. As a large insurance corporation with a vast amount of capital, Ping An is also able to develop its own physician network, set up internet hospitals, as well as forging partnerships with other insurance companies, hospitals, and pharmacies (产品纪, 2020; 夏以勋, 2019). In terms of the doctors who are recruited onto the platform, they are all the best doctors from class-III A hospitals in China, which boost the platform's credibility and help increase patient trust. Ping An also offers a VIP personal doctor service, where the system pairs each patient with a doctor, who can offer an all-inclusive medical service from monitoring patient health through physical checkups, managing online patient health files, to offering online diagnoses (Ng, 2020). This service is not only popular among patients for its quality of care but also the physicians as well because of its lucrativeness. For patients in need of extra care, the app even offers trained personal assistants to help patients with every step of the care process from making an appointment to picking up prescriptions. By developing its own hospital and partnering with the largest hospitals in China, Ping An also has the resources and capability to make its healthcare delivery streamlined, efficient, and high-quality. By offering services such as making appointments and initial consultations online, Ping An is able to reduce the number of steps and amount of wait time patients have to go through at the hospital, all while ensuring the patients are each paired to the best doctors available to them. By developing its own chain of services and partnering with other stakeholders, Ping An develops an ecosystem that is friendly to its growth, which makes possible the improvement of the quality of care to relieve one of the woes of Chinese healthcare.

Another big advantage that Ping An holds is the use of AI as a form of primary healthcare (产品纪, 2020). In its app design, when users are first making inquiries to their symptoms, they first interact with the AI system. The use of AI holds several advantages in telemedicine. First, by relying on a trained computer algorithm for the initial consultation, care can be delivered 24/7, and time is saved because the computer can connect the patients to the right doctors automatically. This will ease the burden of big city hospitals since the system can help allocate the patients to the right clinics. In certain commonly seen illnesses, the computer algorithm can even make diagnoses and prescribe courses of treatment, which lessens the doctors' burden. Second, the more streamlined service enabled by the use of AI will save time for both the doctors and the patients, which addresses the long standing problem of long patient wait time. Third, it improves the system of communication among hospital systems, and even

within the same hospital among different departments, which improves the hospital operating efficiency.

As can be observed, Ping An Good Doctor emerged successful because it largely fills in almost all of the major gaps that is needed in society and works well with all the relevant social groups. The traditional Chinese healthcare problems of poor quality, expensive care, long wait times, as well as the uneven distribution of resources are adequately addressed with the implementation of AI in its algorithm and the development of its own hospitals. By improving accessibility of healthcare, improving the quality of care, and streamlining the healthcare process, both patients and doctors benefit from the situation, which in the end lessens the burden of the government as well. By actively setting up partnerships with other technology leaders, hospitals, and insurance companies, Ping An is building an ecosystem that also aids its development. From this, we can see that Ping An has wisely aligned the interests of all the relevant social groups, which is pivotal to its success thus far.

DISCUSSION

In this thesis, through literature review, conducting surveys, and a case study, I delved into the infrastructure and public trust of Chinese telemedicine. The relevant social groups in play for telemedicine that were analyzed included the central government, the patients in need of better healthcare, the technology providers in the private sector, the 5G network agencies, and the healthcare providers who have historically been mistreated and are in need of better compensations. Upon further analysis, these social groups all exhibited a different amount of influence on the development on Chinese telemedicine through their actions and beliefs. In light of a large need for an improved healthcare system in society, the central government responded by initiating the spirit of innovation and the drive to push forward the development of telemedicine as a way to address the shortcomings of the current system. As part of the government's development plan, China also emphasized the increase in 5G broadband internet coverage for the whole nation, which paved way for the information and internet revolution. As a response, the private sector saw the opportunity for business development and moneymaking, and many companies took the opportunity and developed many telemedicine platforms. In the process, companies such as Ping An Good Doctor formed partnerships with hospital networks and created further monetary incentives for healthcare providers to jump on board in the development of a larger multi-party ecosystem. Every relevant social group is ultimately important in shaping and pushing forward the development of Chinese telemedicine, as the interests of all parties involved aligned perfectly.

While it is noted that the social, technological, and political infrastructures have been set up for the fast growth of Chinese telemedicine, the issue of public trust on the system is also important to discuss. From the results of the completed surveys, I have found that while trust issues do exist in several areas within telemedicine, there is a general optimism in the future of its implementations as a real solution to the current needs of Chinese healthcare. Evidently, the participants believed that the older, rural, and lower-class residents, who demonstrate real need for an improved healthcare, can benefit the most from the implementation of telemedicine. This could be the direct result from their belief that telemedicine is able to improve the speed, accessibility, and cost of healthcare delivery. Similar to the concerns provided in the literature review, some participants expressed similar signs of distrust in areas of using telemedicine for follow-up visits as well as health data leakage. While these concerns are certainly valid and could become roadblocks in the societal implementation, most participants would still personally

use the multitude of functionalities provided by telemedicine platforms. This could potentially be attributed to the perceived benefits of telemedicine greatly outweighing the unforeseeable harms. While the results are promising, the survey research is not without its limitations. Since only 14 responses are recorded in the survey, and all participants are Zhejiang University students, the results can be biased. Therefore, further analysis with a larger testing population is still needed to draw more definitive conclusions.

CONCLUSION

Since the announcement of the Healthy China 2030 initiative, under the guidance and encouragement of the government, the development of Chinese telemedicine has occurred rapidly. With more and more social groups buying into the benefits of widely implementing the technology in the Chinese society, a thorough sociotechnical analysis is needed to gain a deeper understanding of this rapid development. By performing an analysis on the relevant infrastructures using the SCOT framework, conducting a survey on the public trust of Chinese telemedicine, and conducting a case study on the most successful telemedicine platform in China, Ping An Good Doctor, I have developed a deeper understanding of the importance of relevant social forces in shaping the development of a technology. Through this endeavor, several key observations can be made. First, the central government in China plays a crucial role in the overall policy development as well as creation of new initiatives. Second, when the government pushes an agenda, every other sector will follow suit and make adjustments accordingly. Third, when the interests of relevant social groups align, the coordinated effort can push forward the development of a particular technology at a very rapid rate. Fourth, when many social groups express optimism toward a technology as a means to address a real need, this optimism can be passed to the society members in the form of public trust, even if flaws remain to be addressed. Finally, private businesses can take advantage of the alignment of social and political interests and create a favorable ecosystem that can propel itself towards success. From these observations, we can see that although much more work is still needed for telemedicine to be fully implemented in society, China is on the right track. With many of the relevant social groups placing their faith in this technology, telemedicine holds a bright future as a growing field. Overall, telemedicine will certainly play a more important role in transforming Chinese healthcare in the not-so-distant future, and its impact could be world-changing.

WORKS CITED

Bijker, W., Bonig, J., & van Oost, E. (1970). The social construction of technological artefacts. In *The Story of the Bicycle*. Routledge Kegan & Paul.

Broens, T. H. F., Huis in't Veld, R. M. H. A., Vollenbroek-Hutten, M. M. R., Hermens, H. J., van Halteren, A. T., & Nieuwenhuis, L. J. M. (2007). Determinants of successful telemedicine implementations: A literature study. *Journal of Telemedicine and Telecare*, *13*(6), 303–309. https://doi.org/10.1258/135763307781644951

Cai, H., Wang, H., Guo, T., & Bao, G. (2016). Application of Telemedicine in Gansu Province of China. *PLOS ONE*, *11*(6), e0158026. https://doi.org/10.1371/journal.pone.0158026

CGTN. (2019, March 18). *China performs first 5G-based remote surgery on human brain—Chinadaily.com.cn*. https://www.chinadaily.com.cn/a/201903/18/WS5c8f0528a3106c65c34ef2b6.html

Chen, C., & Balzano, J. (2018, October 12). *China Expands Regulations on e-Healthcare Issues*. Covington Digital Health. https://www.covingtondigitalhealth.com/2018/10/china-expands-regulations-on-e-healthcare-issues/

China Is Building The Ultimate Digital Health Paradise. Or Is It? (2019, February 19). The Medical Futurist. https://medicalfuturist.com/china-digital-health

China's Aging Population Is a Major Threat to Its Future | Time. (2019, February 18). [News]. Time. https://time.com/5523805/china-aging-population-working-age/

Cooper, T. (2019, December 3). China's Fiber Broadband Internet Approaches Nationwide Coverage; United States Lags Severely Behind. *Broadband Now*. https://broadbandnow.com/report/chinas-fiber-broadband-approaches-nationwide-coverage/

Fifield, A., & Li, closeAnna F. bureau chief E. (2019, December 31). *A Chinese doctor is stabbed to death at a hospital on Christmas Eve, leaving a nation aghast*. Washington Post. https://www.washingtonpost.com/world/asia_pacific/a-chinese-doctor-is-stabbed-to-death-at-a-hospital-on-christmas-eve-leaving-a-nation-aghast/2019/12/31/a1f4e1d6-2b94-11ea-bffe-020c88b3f120_story.html

Guo, J. (2017, March 28). *How does healthcare in the U.S. compare with China's?* SupChina. https://supchina.com/2017/03/28/healthcare-us-compare-china/

Health resources—Doctors—OECD Data. (2018). TheOECD. http://data.oecd.org/healthres/doctors.htm

How Tencent's medical ecosystem is shaping the future of China's healthcare · TechNode. (2018, February 11). *TechNode*. https://technode.com/2018/02/11/tencent-medical-ecosystem/

Kania, E. B. (2019, February 1). *Made in China 2025, Explained*. The Diplomat. https://thediplomat.com/2019/02/made-in-china-2025-explained/

Li, Y. (2018, August 3). *Understanding China's Technological Rise*. The Diplomat. https://thediplomat.com/2018/08/understanding-chinas-technological-rise/

Meyers, J. (2018, January 11). *Distrusting China's medical system, patients turn to U.S. doctors online*. Los Angeles Times. https://www.latimes.com/world/asia/la-fg-china-cancer-us-20180111-story.html

Ng, E. (2020, February 12). *Ping An Good Doctor reports jump in users amid coronavirus outbreak*. South China Morning Post. https://www.scmp.com/business/article/3050074/ping-good-doctor-chinas-largest-health-care-platform-reports-jump-users

Paslakis, G., Fischer-Jacobs, J., Pape, L., Schiffer, M., Gertges, R., Tegtbur, U., Zimmermann, T., Nöhre, M., & Zwaan, M. de. (2019). Assessment of Use and Preferences Regarding Internet-Based Health Care Delivery: Cross-Sectional Questionnaire Study. *Journal of Medical Internet Research*, *21*(5), e12416. https://doi.org/10.2196/12416

Ping An Healthcare and Technology Company Limited. (2019, September 23). *Ping An Good Doctor Has Become the First Online Healthcare Platform with More Than 300 Million Registered Users*. https://www.prnewswire.com/news-releases/ping-an-good-doctor-has-become-the-first-online-healthcare-platform-with-more-than-300-million-registered-users-300923026.html

Schmid, C. (2018, October 10). *What can Digital Health do for China?* Credit Suisse. https://www.credit-suisse.com/microsites/conferences/china-investment-conference/en/blog/what-can-digital-health-do-for-china.html

Tan, X., Liu, X., & Shao, H. (2017). Healthy China 2030: A Vision for Health Care. *Value in Health Regional Issues*, *12*, 112–114. https://doi.org/10.1016/j.vhri.2017.04.001

Tang, S., Brixi, H., & Bekedam, H. (2014). Advancing universal coverage of healthcare in China: Translating political will into policy and practice. *The International Journal of Health Planning and Management*, *29*(2), 160–174. https://doi.org/10.1002/hpm.2207

Wang, K. (2018, September 26). *China's Health Authorities Issue New Rules on Telemedicine*. Ropes & Gray. http://www.ropesgray.com/en/newsroom/alerts/2018/09/Chinas-Health-Authorities-Issue-New-Rules-on-Telemedicine

Wang, Z., & Gu, H. (2009). A review of telemedicine in China. *Journal of Telemedicine and Telecare*, *15*(1), 23–27. https://doi.org/10.1258/jtt.2008.080508

Wee, S.-L. (2018, September 30). China's Health Care Crisis: Lines Before Dawn, Violence and 'No Trust.' *The New York Times*. https://www.nytimes.com/2018/09/30/business/china-health-care-doctors.html

Welch, B. M., Harvey, J., O'Connell, N. S., & McElligott, J. T. (2017). Patient preferences for direct-to-consumer telemedicine services: A nationwide survey. *BMC Health Services Research*, *17*. https://doi.org/10.1186/s12913-017-2744-8

Wicklund, E. (2015, July 15). *American public still skeptical about telemedicine*. MobiHealthNews. https://www.mobihealthnews.com/news/american-public-still-skeptical-about-telemedicine

World Health Organization (Ed.). (2010). *Telemedicine: Opportunities and developments in member states: report on the second Global survey on eHealth*. World Health Organization.

Wu, D., & Lam, T. P. (2016). Underuse of Primary Care in China: The Scale, Causes, and Solutions. *The Journal of the American Board of Family Medicine*, *29*(2), 240–247. https://doi.org/10.3122/jabfm.2016.02.150159

Xu, W. (2018, April 12). *Nation to promote Internet Plus healthcare*. The State Council of the People's Republic of China. http://english.www.gov.cn/premier/news/2018/04/12/content_281476109872514.htm

Yip, W. C.-M., Hsiao, W. C., Chen, W., Hu, S., Ma, J., & Maynard, A. (2012). Early appraisal of China's huge and complex health-care reforms. *The Lancet*, *379*(9818), 833–842. https://doi.org/10.1016/S0140-6736(11)61880-1

Yip, W., Fu, H., Chen, A. T., Zhai, T., Jian, W., Xu, R., Pan, J., Hu, M., Zhou, Z., Chen, Q., Mao, W., Sun, Q., & Chen, W. (2019). 10 years of health-care reform in China: Progress

and gaps in Universal Health Coverage. *The Lancet*, *394*(10204), 1192–1204. https://doi.org/10.1016/S0140-6736(19)32136-1

Yip, W., & Hsiao, W. C. (2015). What Drove the Cycles of Chinese Health System Reforms? *Health Systems & Reform*, *1*(1), 52–61. https://doi.org/10.4161/23288604.2014.995005

Yu, N. (2019, March 21). Policy and Technology Development in Healthcare: The Case of Telemedicine in China. *The Duke Student Global Health Review*. https://dsghreview.org/2019/03/21/policy-and-technology-development-in-healthcare-the-case-of-telemedicine-in-china-copy/

Zhan, C., Lin, L., & Wang, T. (2011). A Stakeholder Analysis for Telemedicine in China. *2011 International Conference on Information Management, Innovation Management and Industrial Engineering*, *2*, 492–495. https://doi.org/10.1109/ICIII.2011.264

产品纪. (2020, March 9). 拆解平安好医生 | 谈谈互联网医疗的真面目 | 人人都是产品经理. http://www.woshipm.com/evaluating/3480385.html

国务院. (2015, July 4). *国务院关于积极推进“互联网+”行动的指导意见（国发〔2015〕40号）_政府信息公开专栏* [Government]. 中华人民共和国中央人民政府. http://www.gov.cn/zhengce/content/2015-07/04/content_10002.htm

国务院办公厅. (2018a, April 28). *国务院办公厅关于促进“互联网+医疗健康”发展的意见（国办发〔2018〕26号）_政府信息公开专栏*. 中华人民共和国中央人民政府. http://www.gov.cn/zhengce/content/2018-04/28/content_5286645.htm

国务院办公厅. (2018b, July 17). *卫生健康委 中医药局关于印发互联网诊疗管理办法（试行）等 3 个文件的通知_2019 年第 2 号国务院公报_中国政府网*. 中华人民共和国中央人民政府. http://www.gov.cn/gongbao/content/2019/content_5358684.htm

夏以勋. (2019, July 29). *平安好医生（01833.HK）与多家保险公司达成合作 _ 东方财富网*. http://hk.eastmoney.com/a/201907291190388928.html