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Abstract

Healthcare service is the core of the social welfare system, and has been widely focused by the governments, media and the public. The rapid development of e-commerce and the wide application of ICT have accelerated their uses in healthcare service. China welcomes e-health service as it is developing globally, but like many other nations it encounters both opportunities and challenges. Therefore, the assessment of e-health is becoming more important. We analyze the current situation in China and assess its goals of realizing e-health and the challenges of developing e-health.

Keywords: e-health; ICT infrastructure; electronic health record (EHR); China; e-commerce

1 Introduction

The World Health Organization (2003) defines e-health as “being the leveraging of the information and communication technology (ICT) to connect providers and patients and

governments; to educate and inform healthcare professionals, managers and consumers; to stimulate innovation in care delivery and health system management; and, to improve our healthcare system" (Wickramasinghe et al., 2004). Hence, e-health is a very broad term encompassing various activities in a developing field. As such, for practical reasons, in this paper we accept the assertion that e-health is basically enabled and driven by the use of ICT in healthcare with the potential to change the healthcare industry worldwide in terms of infrastructures as well as the costs and quality of services (Wickramasinghe and Goldberg, 2004; Wickramasinghe and Misra, 2004).

According to the World Health Organization, e-health evaluation may be carried out during planning, development, or operation of an e-health system (Brender, 2006). The purpose is to provide the basis for the decisions about an e-health system under investigation or its implementation context. This paper will assess e-health in China to evaluate the risks and benefits for government, medical institutions and patients.

2 e-Health in China

Globally healthcare services are considered to be the biggest service industry, and they are taking top priority, receiving enormous investments, and are growing at a rapid pace in most developed countries (Mitchell, 2000; Pan American Health Organization, 1999). In China, the current focal point is the basic healthcare services in the rural areas. In 2008, the government focused its effort to expand domestic demand and promote economic growth in 10 measures, including Article IV stating the importance of "strengthening basic healthcare service system". According to the China Development and Reform Commission statistics, at the end of 2007, the central public finances have invested 9.4 billion RMB special funds to transform and build needed healthcare infrastructure. The positive attitude of the healthcare services reflects the e-health development potential in China.

Since the emergence and the growth of ICT it has brought opportunities and challenges to China. China has what is likely the world's largest untapped pool of ICT skills. One of the more impressive forecasts is that the number of Internet users in China is expected to exceed 360 million by the end of 2009. Table 1 provides the number of Internet users and highlights China's role in e-commerce and ICT development. Both, the central and regional governments, are strongly committed to provide the incentives and public goods needed to support e-commerce development in China. Consequently, the e-commerce sector grows at an unprecedented rate and exerts major impact on the economy in China.

Each country is positioned differently and has varying potential and preparedness regarding embracing e-commerce technologies generally and e-health in particular (Wickramasinghe, 2005). China has steadily carried out the development of e-commerce, which yields the opportunity for the advance of e-health. While e-health is increasing its efficiency in the healthcare services and ICT infrastructures, it may also bring risks. For example, information technology may be applied improperly, occurrence of errors, collapse of the information systems, etc. e-Health can bring serious consequences, so it is necessary to make an assessment. Given the macro level nature of issues pertaining to the development of e-health (Alvarez, 2002) and to be more effective in their e-health initiatives, it is

valuable to have an integrative framework that enables the assessment of e-health in China. A necessary first step is to identify the goals of e-health in China.

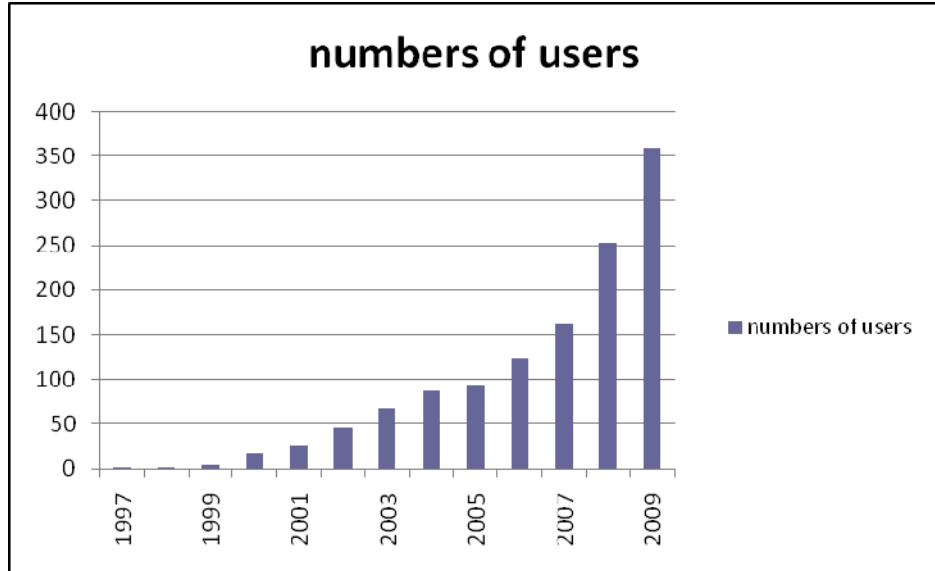


Table 1: 1997-2009 The number of internet users in China (million)
(Source: CNNIC)

2.1 The goals of e-health

E-Health in China aims to improve the traditional healthcare services. So, the goals are to remove the inequities, inefficiencies, poor quality, shortage of health resources, and improper distribution of health resources. They match the goals of e-health, which are efficiency, quality of care, evidence-based, empowerment of consumers and patients, education of physicians, widening the scope of healthcare, ethics and equity (Wickramasinghe et al., 2004).

The Ministry of Health in China has included e-health in the national long-term scientific and technological development plans, and is the main objective of the "The Eleventh Five-Year Plan "of China's health information (2005). In 2009, China published policy documents focusing the medical and health information technology on establishing a unified electronic health record (EHR) and national health information data dictionary. In summary, the following three goals for China's e-health include:

- **Every citizen holds a safe and effective e-health record.**

EHR is a necessary clinical information resource that modern medical institutions require to develop efficient, high-quality clinical practice and medical management. EHR can improve the quality and efficiency of medical and health services, prevent and reduce medical errors, control and reduce medical and health costs.

- **Every citizen enjoys the disease prevention (immunization), healthcare and health counseling services, which can be multi-agency, cross-regional, inter-departmental and cross-ownership.**

The development of health information technology development should support sharing of health information to improve healthcare efficiency and quality, to improve healthcare access, to reduce healthcare costs, and to reduce medical risks (Ma and Zhu, 2005). Health information sharing depends on the computer and network technology in place. Overall when compared to other industries the e-health is still fragile in this regard. E-Health information is inevitably forming a large number of silos which significantly slows down the information sharing process of the health sector. It is essential to improve healthcare structures so that they are multi-agency, cross-regional, inter-departmental and cross-ownership which will in turn enable health information to flow more seamlessly with the end result being that every citizen can enjoy the disease prevention (immunization), healthcare and health counseling services.

- **Every citizen gains the corresponding food security and health insurance.**

E-Health must be connected to the national information database. It will become an efficient management and monitoring information platform in the market and knowledge-based economy.

2.2 Key challenges of e-health in China

To develop optimal partnerships between consumers and other groups of healthcare stakeholders, the key challenges in China include

- meaningful collaboration with healthcare recipients,
- efficient strategies and techniques to monitor patterns of Internet use among consumers,
- preparation for upcoming technological developments,
- balancing between connectivity and privacy,
- better understanding of the balance between face-to-face and virtual interactions,
- equitable access to technology and information across the globe.

When we consider the domain of e-health at the macro level, three important issues must be carefully considered (Cyber Dialogue); namely procurement, connectivity and benefits.

2.2.1 E-procurement

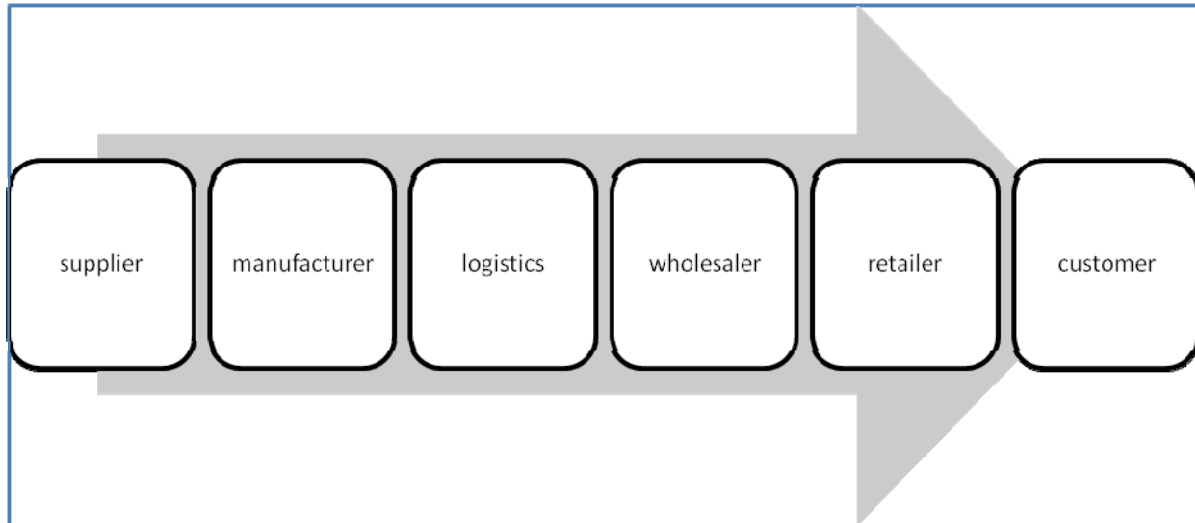


Figure 1: Pharmaceutical supply chain in China

According to China's pharmaceutical supply chain model, the pharmaceutical manufacturers cannot directly sell drugs. This is illustrated in Figure 2. Pharmaceutical wholesale businesses are the intermediaries for the sales, especially for hospitals. Since the hospitals make up to 80% of the total drug sales in China, e-procurement mainly takes place between the wholesalers and the hospitals. In 2008, there were 19,712 general hospitals in China. There are a large number of pharmaceutical businesses and they are each of small scale. According to the national bureau of statistics of China, there are more than 25,000 wholesale enterprises. Less than 5% of these enterprises have annual sales of more than 20 million RMB, and the top 10 wholesale enterprises account for 20% of the total sales (Li and Duan, 2003). This situation leads to drug operation disorder, bribery, kickbacks and other unethical practices, hence increasing the cost throughout the pharmaceutical supply chain.

Modern e-commerce tools enhance the transparency of the medical market and vigorously strengthen the information technology, thus allowing for better connection with government, market, and consumers. At the same time, under all levels of law enforcement supervision, the channels of all medicine selling and buying will be recorded by means and processes through the appropriate government agencies. Such market channels and the corresponding trading patterns will not only improve the efficiency of drug distribution, but reduce the costs of medicine in circulation.

Over the past decade, SeaRainbow Holding Corp, who had researched and developed SeaRainbow Medical E-commerce Solutions 2.0, had set up e-commerce business and quickly becomes the largest e-commerce platform in China. Its medical e-commerce revenue has reached \$845.6 million in 2009. More and more pharmaceutical companies such as SeaRainbow Holdings Corp are actively operating on e-commerce of the medical market in China, who has accelerated the development of e-commerce of the medical market. However, most of these enterprises are also very conservative. Since the existing

B-to-B e-commerce model has remained largely confined to providing medical information search and publishing platform, protecting trade secrets, and other considerations, the information released is limited to pharmaceutical companies on price and volume of transactions. So, the traditional procurement method is still preferred as the final means.

The current situation of B-to-C e-commerce in China is a stumbling block to the development of e-health. There are only 11 qualified online pharmacies and they are insignificant compared to China's vast pharmaceutical market. The primary reason for this is that the government strictly limits the online pharmaceutical market; i.e. the State Food and Drug Administration issues the "Certificate Internet Drug Information Service Qualification Certificate" and the "Internet Drug Transaction Services Qualification Certificate" which are very difficult to obtain. Drugstore chains are in fierce competition, yet the network monitoring is weak. Hence we contend that it will be a great challenge to establish e-procurement in China.

2.2.2 E-connectivity

In 2009, the Ministry of Health of China issued the "Health Profile of Basic Architecture and Data Standards (for trial implementation)". The purpose of the implementation is to make personal health records more uniform and standardized. The provincial cities have been gradually implementing EHRs, and its footprint has gradually expanded to every province in 2009. However there are several difficulties in the rural areas. For example, the Hainan Health Department announced that in 2009 EHR coverage in the city had reached 30%, but in rural areas the archiving rate reached only 5%.

EHR informative sources can be found in: 1. the process of health services in a variety of services records; 2. the regular or irregular physical examination records; 3. thematic survey records of health or disease. Urban residents can go to a general hospital or the community hospital to establish their EHRs, but this is difficult in rural areas. The rural healthcare infrastructure is lagging behind and is burdened by obsolete infrastructure and medical equipment which exacerbates the low utilization rate.

EHR requires a multitude of professionals, but according to a survey only 19.3% of the specialists in the rural hospitals have a technical secondary school diploma or above. Thus a substantial investment on the personnel training, a personnel training system and re-learning scheduling is vital as well as addressing the deficiencies with the current ICT infrastructure. The 2008 China Statistical Yearbook shows that there are 721 million in rural population, so to develop an EHR for everyone will be difficult if not impossible given the current state.

2.2.3 E-benefits

Since the launch of the new cooperative health cards and health insurance cards, e-commerce in healthcare service has been receiving much attention. The basic health insurance system uses the health insurance cards for every citizen. The health insurance card is identified by the ID card issued by the government. It stores the name, gender, transferred account payment, consumption patterns, etc. The employer allocates money to employees' health insurance card through a bank. One can use the health insurance card in designated hospitals and drug stores. While visiting a doctor and buying medicine, the

health insurance card can be used with authentication except to withdraw or transfer cash. Many cities in China have commenced providing social security cards and gradually replacing the health insurance card. It is not only for paying medical bills, but also for the retirement payment, job registration and unemployment registration.

If every Chinese has a health insurance card, it will greatly accelerate the development of e-health. However, China has a different development between urban and rural areas. The Statistical Information Center of The Ministry of Health of China issued the "China's health development in 2008 Statistical Communiqués" which shows that in 2006 the nation's total health costs amounted to 984.3 billion RMB. Urban health costs accounted for 67% of total health costs and rural areas accounted for 33%. In the same year, the population was 1.314 billion, 44% were urban residents, and 56% were rural residents. Urban per capita health expenditures were 1,145 RMB, rural per capita health costs were 442 RMB. There has been a significant difference between urban and rural health and medical services. The main reasons are due to: 1. The urban-rural dual standards - Major investment of the government is focused on urban workers, along with individual investments to supplement the health insurance. Rural cooperative healthcare is primarily dependent on individual investments and small government support. 2. The government financial system - The financial resources of governments at all levels is uneven, the health investment cannot be guaranteed simply by transferring or sharing the resources. 3. Outdated market - Most of the peasants lack the purchasing capacity, causing the rural health service system to be deteriorated with poor regions being in a critical state.

3 Assessing e-health potential in China

We use the framework published in Wickramasinghe et al (2004) to assess the e-health potential and preparedness of nations. The framework takes a macro perspective containing four main pre-requisites, four main impacts, and the implications of these pre-requisites and impacts to the goals of e-health. ICT infrastructure, standardization policies, user access infrastructure and governmental regulation make up the four essential prerequisites while the four key impacts are on IT education, morbidity rate, culture and economy. By examining both the pre-requisites and the impacts we can assess the potential of China and its preparedness for e-health as well as its ability to maximize the goals of e-health.

3.1 Prerequisites for e-health

In sum, the four critical pre-requisites for any successful e-health initiative include ICT architecture/infrastructure, standardized policies, protocols and procedures, user access and accessibility policies and infrastructure, and finally government regulation and control.

3.1.1 ICT architecture/infrastructure

China's medical ICT has new applications, e. g. telemedicine, follow-up treatment, the patient data management, drug tracking, cell phone for help, the patient data collection, medical waste tracking and messaging communication. These new applications are supported by current ICT infrastructure.

By October 2009, the number of broadband Internet users exceeded 103 million. By December 2009, the Chinese mobile phone users exceeded 747 million (date resource from

Ministry of Industry and Information Technology of China). The 3G network has already been in full swing in China since 2009, the investment in wireless infrastructure rose 13.2% from 55 billion U. S. dollars in 2008 to 62 billion in 2009 (Kong, 2009). In May 2008, the Chinese government has finally announced that it would issue three 3G licenses as part of its overall redevelopment plan. In the reconstruction program, the government plans to set up three telecommunication service providers - China Mobile, China Netcom (GSM) and China Unicom/ Telecom. Each provider offers not only fixed-line but also mobile services. China Mobile has already built up TD-SCDMA trial network in some major cities. China Unicom and China Telecom gained the official 3G in the first quarter of 2009. China Unicom in 2009 has launched its W-CDMA and China Telecom is ready to expand its 3G CDMA2000-1x-EV DO network (Kong, 2009).

In spite of this, the development of ICT infrastructure is still behind other nations. The mainland of China has only a 21 % broadband penetration rate which ranks 43rd in the world. Chinese cable broadband (ADSL and cable modem) cannot keep pace with the demand for broadband access users. In 2007, the average network downlink transmission rate of major nations reached 17.4 MB, while China had less than 4 MB. So, transmission has become a bottleneck in the development of broadband. Currently, China's broadband development is mostly dependent on the market behavior of the telecom operators, less government involvement. Government's deployment of broadband will be a key step towards stimulating domestic demand by the state-led development strategy to promote broadband. The usage of Wi-Fi, CDMA, EV-DO, PHS and other wireless broadband technologies will lead to a better network coverage in China. The implementation in ICT infrastructures will gradually lead to the large-scale development of e-health.

3.1.2 Standardization policies, protocols and procedures

To enable such a far reaching coverage, significant amounts of document exchanges and information flows must be accommodated. Standardization is the key to this (Wickramasinghe, 2005). In China, the medical reform proposed in 2009 was to establish the sharing medical and health information. The Ministry of Health also drafted a "Health Profile of Basic Architecture and Data Standards (for trial implementation)". The implementation of the program has three objectives: 1. establish a national unified, standardized health record of the population; 2. establish the basic framework for national EHRs and data standards; 3. establish the national health information data dictionary. The new standards require five types of EHRs to be standardized; they are the basic personal health information record, disease control record, maternal and child health record, medical services and community health record. Today, there are 35 cities, 2,406 community health service centers and 9,726 community health service stations in China who have established EHRs for a vast number of community residents. The content of EHRs and data structures strictly abides the uniform national norms and standards. The standardization of EHRs is to achieve integration of different sources of information, accessibility and sharing of mobile use, the necessary safeguards to eliminate information silos. It shows that the government strongly supports the development of China's EHRs.

However, there is a lack of the uniform "Community Health Service Information Management Systems" software. People rely on the hospital HIS system to establish EHR, therefore standardized health records do not exist since different software developers and

software contractors create different hospital HIS systems. It is not the best choice for the community or general hospitals to establish EHR. Using Internet technology and the support from hospitals and community health service centers, a region which has independent financial support and a complete medical and health system of administration (The ministry of health of China, 2009) can establish a network information service center. The center can collect EHR of personal lifetime health and non-health information. At present, China has established a digital resource in regional data centers, such as Wuhan digital resources (regional data centers). The regional health information systems can connect hospital HIS systems and home health care service systems so that hospitals, patients, and community health service centers are able to connect to each other with authentication.

3.1.3 User access and accessibility policies and infrastructure

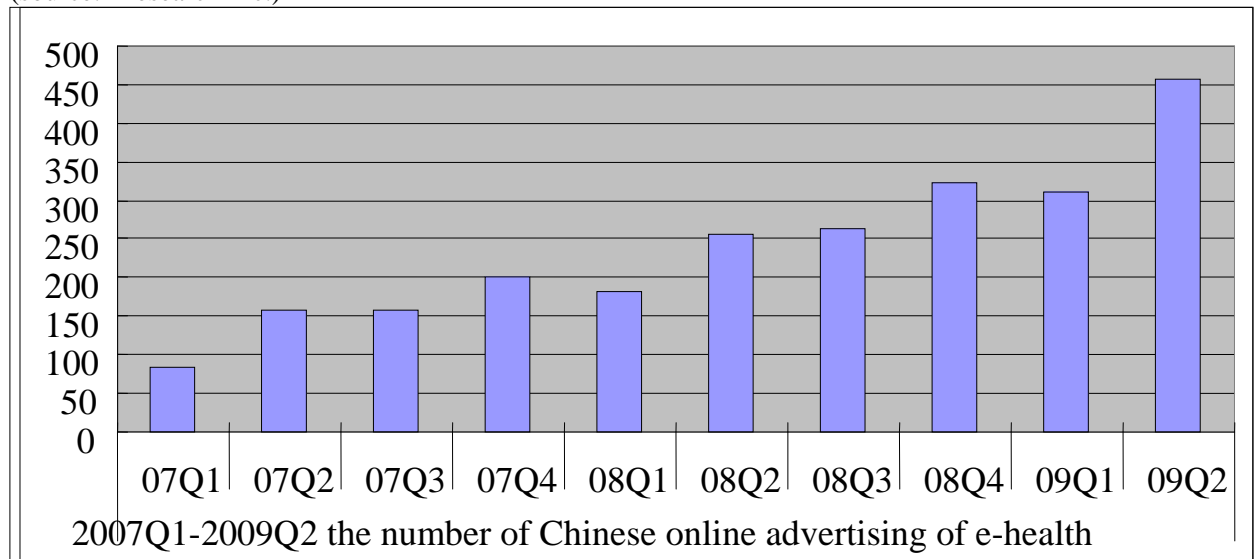
Access to e-commerce is defined by the WTO (World Trade Organization) as consisting of two critical components

- Access to Internet services
- Access to e-services (Panagariya, 2000).

The former deals with the user infrastructure and the latter refers to the commitments of electronically accessible services. E-Health is often established with a focus on user infrastructure (Wickramasinghe et al., 2004), in particular including pharmaceutical companies. Survey shows that in China pharmaceutical companies have 30 or more computers for every hundred employees accounted for 14.55%; 20-29 every hundred units accounted for 9.1%; 10-19 every hundred accounted for 28.20%; 0-10 every hundred units accounted for 42.73%. 95.45% of the pharmaceutical companies are connected to the Internet and 80.91% have an internal LAN; 54.5% of corporate websites have a basic company profile, product descriptions, contacts, online message or customer services; 67% update their websites at least once a week. Overall, more and more enterprises increase their expenditure on infrastructure. Compared to 2003, it has increased 3% in 2004 and 5% in 2005 (data source from Operation Analysis of the pharmaceutical industry in 2004 and 2005 Development Forecast, 2005).

At the same time, web investment has also gradually increased. Table 1 shows that the number of Chinese online advertising of health during 2007Q1-2009Q2 based on more than 170 web-media.

Table 1: 2007Q1-2009Q2 the number of Chinese online advertising of e-health (source: iResearch Inc.)



The situation of hospitals HIS is as follows: In 2002, the Ministry of Health of China showed that out of 6,921 hospitals 2,179 of them built HIS, which accounted for 31 %. Hospitals in the east coastal China accounted for nearly 80 % of the nation. In general, China's pharmaceutical companies and hospitals are working forward to implement e-health.

In addition to pharmaceutical companies and hospitals, e-health cannot happen without the support of Internet users. China has the largest number of potential Internet users in the world, but its Internet penetration is low. In the 2010 "Social Blue Book" reported that China's Internet penetration rate has reached 26 %, which is more than the world's average. However, this penetration rate is far lower than that of the developed nations. This will be a barrier to the e-health development. The gap between rural and urban Internet penetration is still big. Fiber optic has not reached rural areas. Furthermore, education and living standards are low in rural areas which also impacts e-health initiatives.

3.1.4 Governmental regulation and control

Government regulation aims to contribute to the healthy development of pharmaceutical e-commerce management systems, which strengthen market supervision, regulate online drug transactions, ensure information security, and safeguard the normal order of e-commerce activities. China has promulgated the "Computer Information Network and the Internet Management Interim Provisions of China" and the "Computer Information Network and the Internet Security Protection and Management Measures".

If China can further protect the privacy of the e-health information, the law will be a strong guarantee for privacy protection (Mao and Xiang, 2008). For example, the "International conventions of tele-medicine and tele-health" and the United States "Health Insurance

Portability and Accountability Act" (HIPPA) specifically focus on the confidentiality and privacy of electronic information management. They play a positive role in protecting the privacy of e-Health information. We assert that by combining the "International conventions of tele-medicine and tele-health" with the specific goals, China can develop appropriate national laws and regulations for e-health to guard its development.

3.2 Key impact of e-health

E-Health will not only bring benefits to China, it will also have drawbacks. In this section, we discuss the effects based on the framework of Wickramasinghe et al. (2004).

3.2.1 Impacts of IT education

China has a large number of consumers with a low level of IT education in rural areas, most of them are quinquagenarian. It is difficult for them to learn e-health and telemedicine skills in a short term. The IT education and e-health are highly correlated. The development of an e-health market will lead more people to use IT technology, and the more IT education availability will support the development of e-health.

The vast majority of young people grew up in the information age. They have received an extensive IT technology education which they use at their work. More and more young people also begin using computers, searching online and shopping online. From a long-term perspective, young people are the mainstay of the e-health market in the future. In order to develop e-health, China needs to educate the nation and increase the awareness of the concept of e-health and e-consumption.

3.2.2 Impact of morbidity rate

China is a country with a higher morbidity rate, according to the statistics of the Ministry of health of China in 2008, the hospitalization rate of residents was 0.684 % and the hospital bed occupancy rate had increased to 74.6 %. These statistics show that more investments are needed in medical infrastructure. The government and the public hospitals are the dominant players in the medical infrastructure, and will like to see e-health infrastructure developed HIS, EHR, and a series of supporting infrastructures. In China, e-health construction financing is primarily decided by the government's investment.

3.2.3 Impact of cultural/social dimensions

People accept western medicine but traditional Chinese medicine has a bigger market share in China. Face-to-face therapy session with a doctor is always preferred to telemedicine. In addition, since China's two previous healthcare reforms have failed, e-health is more likely to be used as a technology-based or information-oriented direction, rather than the core of the entire medical system, and this is a challenge that e-health must address. Whether e-health can access appropriate levels of government financing and grow quickly depends on what role it will play in the healthcare reform.

3.2.4 Impact of world economic standing

China's rapid economic development provides a good opportunity for the development of e-health in China. There are a number of economic risks the Chinese e-commerce industry has to deal with. China's long-term economic risks exist (Wang, 2005): economic structure

is irrational; economic recovery will take time for the financial crisis. Pharmaceutical and medical market risks are accompanied with economic risks. The efficiency of the medical control system, the government medical institutions, corruption, and disarrayed healthcare market are all factors that bring constraints to the development of e-health in China.

4 Discussion and Conclusion

According to the WHO China has one of the most unfair healthcare systems in the world. One of the most surprising aspects of the system is that the majority of the expense related to healthcare is paid directly by the patient and there are few provisions for people who cannot afford healthcare treatment. It is believed that e-health and the delivery of healthcare solutions will play a key role in addressing key problems that currently impact healthcare delivery in China including a growing ageing population, epidemics, the growing prevalence of “western illnesses” and an increasing gap between rural and urban, rich and poor. As we have described in the preceding analysis this is only possible if effective e-health initiatives are introduced and this can only occur if investment is targeted at education and training as well as the design and establishment of appropriate infrastructures across the country.

Based on the grid (Figure 2) for assessing e-health preparedness (Wickramasinghe et al, 2004) we analyze China with respect to our key parameters for e-health success in an attempt to highlight the key areas. There are the four main pre-requisites above-mentioned, namely, the ICT infrastructure, the standardization policies, protocols and procedures, the user access and accessibility policies and infrastructures, governmental regulations and the role as well as the impact of IT education, the impact of the morbidity rate, the impact of the world economic standing and the impact of cultural/social dimensions. In summary, the current e-health in China has:

1. The level of the China ICT infrastructure is in its beginning phase.
2. Standardization policies, protocols and procedures are coming along.
3. It has the most netizens in the world but with a low penetration rate.
4. The government is commendable for the high level of regulations and control.

Therefore, China has a high standardization and a high government regulation, and simultaneously a low ICT infrastructure and penetration rate on PC with respect to the four pre-requisites for e-health potential. Therefore, China maps to the medium preparedness quadrant.

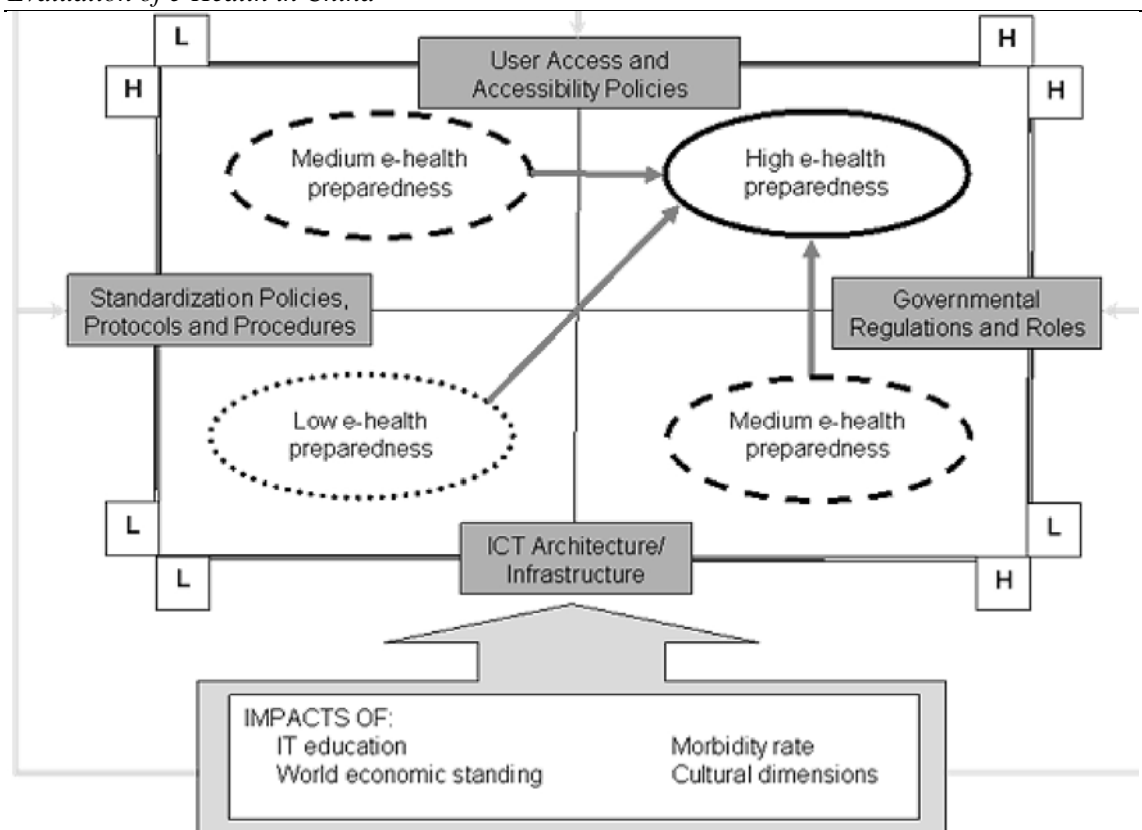


Figure 2: e-Health preparedness grid

E-Health is a realization of a people-oriented national health service and information technology management platform. Technically, e-health has not only achieved a combination of information technology and digital technology in healthcare, but also hospital information and social information. China has basically acquired the fundamental conditions for implementation of e-health, including the good governance, uniform medical diagnostic standard, hardware and software equipment and information networks, digital medical treatment equipment, manufacturing capacity, the initial EHR and electronic medical records experience. It is now vital that appropriate investment is targeted and the critical areas so that an effective e-health initiative can be realized that will indeed address the pressing problems currently plaguing healthcare delivery in China.

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