Possibilities for mobile-phone-based remote health care in China

Doing Business in China Project

Iiro Jantunen
Kasimir Lehmäslaiho
Jarkko Forsberg

30.9.2009
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1 Introduction

The number of people with chronic diseases is rising in China. Around 260 million Chinese (20% of the population) are reported to suffer from chronic diseases such as heart disease, hypertension and diabetes. The numbers are on a rise with a 4.9 percent increase compared to 2003 [1]. This means a huge challenge is facing the Chinese health care industry. For instance the affordability and access to quality health care will become increasingly challenging. This paper examines remote health care or e-health as a partial solution to the problems mentioned above. Focus is especially on how communication technologies could support health care to make it more accessible and affordable in China. Substantial research has already been conducted in Europe to design health care applications on mobile phones with varying results [2], [3].

Chinese have widely adopted mobile communications and the Internet. There are over 640 million mobile cellular subscribers [4] and over 298 million Internet users [5]. It is believed that affordable and accessible basic health care services for patients with chronic diseases can be provided with mostly existing networks and devices combined with some new software and some new products. Challenges include making these services compatible with existing devices and regulations, easy to use and accepted by the end-users.

The aim of this paper is to study the feasibility of providing distance spanning health care in China with the help of existing mobile networks and devices. The study is based on a background survey of theory and current developments and a case study of an e-health service.

The structure of the paper is as follows: Section 2 provides background of telecommunications in China and remote health care. Furthermore some theory on making sustainable mobile services is reviewed. Section 3 examines the future prospects for delivering remote health care through wireless networks. Section 4 presents a case study of a simple e-health service. In section 5 conclusions regarding the feasibility and future prospects of e-health in China are discussed.

2 Background

2.1 Telecommunications in China

China is the worlds largest cellular market. [7] Apart from the high adoption rates for mobile communications and Internet in China, developments are taking place rapidly in the network side. 3G communications providing for more data intensive services are starting to pick up. Telecommunications industry is closely regulated by the Ministry of Information Industry (MII).

China has 155 million mobile internet users, the increase in numbers has been dramatic after the introduction of 3G services with 32.1% increase in the half year from January 2009 to July 2009. [8]. Network coverage is good. For instance China Mobile operates the worlds largest mobile
network and subscriber base (457 million) [9]. Network coverage is of high quality, especially in the eastern half of China. GPRS technology is used in these networks for data connectivity [10].

In the value added service side, companies previously operating in the fixed Internet are forwarding interest towards mobile markets. For instance search provider competitors Baidu and Google are shifting their battle towards mobile where expected growth potential is huge. The shift is directly related to the rising popularity of smartphones and 3G data communications. A challenge for many companies wishing to enter mobile markets is to establish a viable business model as business models in the fixed Internet markets are not automatically viable in mobile markets [11].

Overall, the industry developments in China appear favorable for companies wishing to provide mobile services. Nevertheless companies need to tackle various uncertainties such as those related to business models and regulatory and technological challenges.

2.2 Health care system in China

The development of modern health care system in China can roughly be divided into three phases: time before the health care system reform in the middle of the 1980s, the current Chinese health care system and the new era of health care in China. The common factor to all the phases is the inequality between urban and rural areas.

Before the mid 1980s health care reform, there was so called free public medical care system that was employment based and due available for the urban residents. The system covered 100% of medical treatment and prescription drug expenses but also 50% of these costs for all dependents of beneficiaries. This system enabled basic health care services for even the poorest of people due to government ownership, price control and heavy subsidies. In rural areas at the same time, however, medical care was covered by the Cooperative Medical Scheme system. The system was financed by local communes and it had three levels, tiers. At the first tier, part-time barefoot doctors provided primary care for free. At the second tier junior doctors provided health services in commune health centers. More serious illnesses were treated at the tier three in county hospitals by senior doctors. Drugs and hospitalization were partly compensated.

The economic reform in 1979 and the health care system reform in the middle of the 1980s had huge impacts on health care services both in urban and rural areas. In urban areas health care services shifted from government controlled to cost-sharing and later to urban based social health insurance scheme. This system was financed by both employees and employers but it left the rural-urban workers out of coverage. The health care coverage actually dropped to 57% for urban residents in 2003 according to latest estimates. Naturally, the poorest suffer the most reduction.

For rural areas the economic reform of 1979 meant the end for barefoot doctors and the beginning of fee-for-service system. Consequently, this led to situation where the health care services became too expensive for majority of people. The access to medical care dropped from over 85% in 1975 to less than 10% in 1997. Again the poorest of the people suffered the highest decrease in access to health care services. The Chinese government have tried to re-establish the Cooperative Medical Scheme system but the results have not been very couraging, mostly because it does not cover the most common generic nor chronic diseases. [12]
2.3 Creation of sustainable mobile services

Bouwman et al. [13] provide a theoretically grounded, yet practical approach to designing business models especially for electronic services including mobile services. The approach is based on theoretical research and numerous case studies.

Figure 1 presents an overview of the business model based on Bouwman's approach. It is affected by market developments, technological developments and legislation's. The interrelated domains of service, technology, organization and finance are in the core focus of the business. Service domain describes the value proposition and market segment, technology domain the necessary functionality, organizational domain the structure of the value network and financial domain the cost structures and financial feasibility. Business models should provide two kinds of value. (1) Customer value for the user of the service. Customer value is affected by ease of use, costs and experience. (2) Network value for network of participants that cooperate to provide the service. Network value is affected by division of revenues and access to resources among others.

![Figure 1: Business model framework for mobile services](image)

In the case of e-health in China the following critical success factors in creating customer value have been identified:

*Value proposition* - the patient and user of the service has to benefit significantly from the e-health service compared to a traditional visit to a doctor. The service should result to reduced cost and increased convenience for the patient without risking the quality of health care.
Quality of service - The utmost care should be taken so that the service technologically works to a satisfactory extent. Issues to consider are network quality and reach, stability of equipment, compatibility of equipment, battery life etc.

Usability - A great challenge is making the services easy to use for patients and hospital staff that possibly have very little experience in using mobile communications equipment for health care purposes.

In the case of network value the following critical success factors have been identified.

Benefit for all participants - The user/patient groups, hospitals or health centers, service provider and equipment/software providers each need to reach an agreement that guarantees a win-win situation for all participants.

Management of risks - If the service fails, consequences can be terrible. How are participants responsible in such a case? Risks should be minimized and liability balanced in a way that is satisfactory to all participants.

Division of roles - What aspects of the service is the provider responsible of and what part of service is the hospital responsible of? These roles need to be divided in a clear manner.

Resistance - Some patients, hospitals and/or government bodies might take a conservative stance towards remote health services as face-to-face contacts are likely more valued and novel risks are involved.

It is considered that designing e-health services in a way that the above success factors can be evaluated positive is crucial. In section 4 these success factors are evaluated based on an e-health case service.

3 Future prospects

3.1 Health care system in reformation

The health care system in China has gone from a government-managed system to a market oriented system since the economic reform. The government-managed system used to provide affordable basic health care to all citizens but as market powers have taken over, the Chinese people have suffered a remarkable decline in access to health care services. These problems show off very clearly in the rural areas as 80 percent of health care resources are located in cities. Also the majority of the medical care expences of the elderly are still paid by the family members.

China has started a massive health-care system reform just recently. The goal of the reform is to build a network of modern standards health services to urban and rural areas by 2020. This means that by the time there should be affordable health services for all 1.3 billion Chinese [14]

The cost of reform is estimated to reach 850 billion CNY. This money will be used in building an essential medicine system, improving primary health care services, and refashioning basic
public health services and pilot reform of state-run hospitals. There are in total of 300,000 hospitals in China, thus very lucrative market for medical IT system providers [15]. Lu Zhaoxia (senior vice president and chief operating officer at Neusoft) expects that out of the total 850 billion CNY reform, 16 billion CNY will go to hardware and 10 billion CNY for software investments.

25% of the Chinese will be over 65 years old within the next decade [16]. Shortage of beds in the hospitals, high cost of medical professionals and rapidly aging population will put the traditional health care system under enormous pressure. Besides, due to the Chinese Confucian tradition, the elderly people prefer to stay close to their families and friends rather than living in medical institutions [17]. This development of population with traditions will create a significant demand for remote health care services in China in the future. This is, however, becoming difficult in many cases as the young people migrate from the countryside to big cities, possibly thousands of kilometers away from their parents, sometimes even abroad. Single child policy also causes an unprecedented load on the offspring that may have 2 to 4 grandparents to take care of.

Taking these facts into account, there are indisputable facts favoring the adaptation of mobile health care services. Hospitals and institutions running them can achieve remarkable cost savings by providing home care, for instance via mobile, for their customers instead of a human assistance [18]. The health care system reform is hoped to make a difference to almost chronic imbalance between the urban and the rural areas.

4 Case - smart pillbox

4.1 Introduction

Many types of medication require compliance to be effective. Physician or nurse is not available at home everyday (or many times a day) to deliver the medication. People often forget or overlook taking medicine unless symptoms are felt resulting in harmful response to the medication or null effect.

One possibility to help patients with their medication at home is to use an electronic calendar to remind them to take the medication. This calendar would notify the patient with sound and text or picture on display, and require acknowledgment by pressing a key. If there is no reply by the patient, the software can redo the alarm with a pre-set interval, until response is given.

In some cases, the consequences of not taking the medication can harm the patient irrevocably or even be fatal. Not replying the phone alarm may also be a sign of trouble, e.g., the patient can be immobilized by falling on the floor or stairs and not be able to rise. Thus, if the alarm is not replied in a pre-set time, the phone could send a message to the health care service, and a nurse can call the patient by phone, to hear if everything is alright. If the phone call is not answered, however, this may be a case when help (nurse, ambulance, or such) would be sent to investigate.

This is enough for many cases, but for some patients, especially elderly ones, there are further needs. First of all, the setup could be arranged so that it is enough that the patient takes the medication, with no need to press a button. Also, for patients with even normal memory, there is
a possibility that something interferes with taking the medicine, and even though the phone got a reply from the patient, the medication was not taken.

There are solutions being studied and some also commercially available. Of the former, an example is the smart pillbox being developed in MINAmI project by Aardex (Fig. 2) [19]. Of the latter, an example is Stora Enso's Pharma DDSi package (Fig. 3) [20]. From the user's point-of-view, these solutions have notable differences, but also common properties, as shown in Table I.

Table 1: Aardex Smart Pill Box compared to Stora Enso Pharma DDSi - user point-of-view

<table>
<thead>
<tr>
<th>Aardex Smart Pill Box</th>
<th>Stora Enso Pharma DDSi</th>
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<tbody>
<tr>
<td>Pill-box with screw top</td>
<td>Carton box containing blister pack of pills</td>
</tr>
<tr>
<td>Re-usable</td>
<td>Disposable</td>
</tr>
<tr>
<td>Actively communicates with the mobile phone</td>
<td>Mobile phone must move to touch the package to read the contents</td>
</tr>
<tr>
<td>Only knows the package has been opened</td>
<td>Knows which specific pill has been removed from the package, also the number of pills</td>
</tr>
<tr>
<td>Logs the time&amp;date of pill removal</td>
<td></td>
</tr>
<tr>
<td>Does not know if a pill is accidentally dropped to floor and not taken</td>
<td></td>
</tr>
<tr>
<td>Can interact with phone calendar function</td>
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</tbody>
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Many of the properties of these solutions are defined by the technology used in the package.
### Table 2: Aardex Smart Pill Box compared to Stora Enso Pharma DDSi - technology developer point-of-view

<table>
<thead>
<tr>
<th></th>
<th>Aardex Smart Pill Box</th>
<th>Stora Enso Pharma DDSi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery-powered</td>
<td>Powered by energy scavenging, no battery</td>
<td></td>
</tr>
<tr>
<td>Bluetooth - works with most of the available phone models</td>
<td>Inductive link (NFC) - phone models supporting this not common yet</td>
<td></td>
</tr>
<tr>
<td>Communication range 10m</td>
<td>Communication range touch</td>
<td></td>
</tr>
<tr>
<td>Phone client software needed</td>
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For a patient with trouble using instruments like mobile phones, the Aardex Smart Pill Box holds the advantage of communicating independently with the phone. In the case of Stora Enso Pharma DDSi, to provide the remote health care service notifications that pills are taken in correct time, the user needs to touch the medication package with the phone each time he or she is taking the pill. The information is only transmitted when the package is read with a phone or other reader device (e.g. at nurse's visit or doctor's appointment).

Both solutions can be advanced to using also sensors to measure patient response, e.g. blood pressure sensors connected to mobile phone via Bluetooth. Even though this would make the solution more complex to use and expensive, it would also induce even greater benefits to the treatment of the patient, and possibly also induce savings in the health care system by optimizing treatment and replacing need for home visits by nurses.

The Pharma DDSi medication package can also contain buttons for patient feedback [21][22].

#### 4.2 Evaluation

Figure 4 presents a proposal for how the value network for a smart pill service could operate
Service provider – The service provider will buy hardware and software from suppliers. Some core software can be developed in house. The service provider sells cost savings to hospitals in the form of the smart pill service solution. The service is adjusted to the needs of hospitals based on information provided.

Hospitals – Hospitals receive the smart pill solution and training from the service provider. Hospitals are mainly responsible for deploying the service to patients homes. Support when needed is provided by the service provider. Hospitals receive feedback from patients and forward it to service provider.

Patients – Patients who might benefit from a Smart Pill service are screened by the hospital. These patients are invited to benefit from the service. Benefits include reduced risk of serious medical problems and possibly reduced visits to doctor and reduced cost of health care.

Following is an evaluation of the critical success factors covered in section 2.3 assuming the mode of operation described above.

Customer value:

Value proposition – Positive, the safety of the patient is increased, which results to less doctor visits and costs.
Quality of service – Uncertain, various issues can lead to a poor quality of service. For instance houses in big cities might be located in network blind spots. Same goes for houses in rural areas. Wireless networks are sensitive to disturbances, while network equipment is also occasionally prone to failure. Mobile phones can malfunction and their batteries can deplete without warning.

Usability – Uncertain, one of the biggest uncertainties. This can be evaluated positive only if the service is designed well enough that minimum skill is required from the patient and medical staff.

Network value:

Benefit for all participants – Positive, the proposed high-level value network results in a win-win for all participants. In practice a more detailed evaluation is necessary.

Management of risks – Negative, for instance what happens if phone battery runs out and it results in the patient not taking medication? Who is responsible? This issue requires more consideration. This must, however, be compared to the risk the patient faces if there is no reminding device whatsoever.

Division of roles – Positive, sufficient if all value network actors agree with the roles proposed above.

Resistance – Uncertain, patient acceptance, hospital acceptance, regulator acceptance are issues that require more consideration.

5 Conclusions

The number of chronically ill patients is rising fast in developing countries, including China. This is due both the age structure of these countries and longer lives, and also due to changing nutrition. If it ever was possible to treat all chronically ill patients in hospitals, it will not be so in the future. There need to be different levels of home health care available to the elderly and chronically ill people.

Home health care also needs a lot of labor, but the amount of labor can be reduced by using new technologies available, such as mobile phones. The mobile phone provides local and network wireless connections, user interface, and processing power. As most of the people will anyhow own a mobile phone, the device does not have to be counted as an expense to the service. Add-on software cost can be reduced by using commonly usable software platforms and components.

Remote health care service can extend to complex monitoring systems taking care of the patient, but also simpler and cheap solutions can reduce the amount of labor needed in home health care. An example presented in this paper is a smart pill package which logs in the times the medicine is taken and contacts health care professionals for help if needed.
The aim of this report was to study the feasibility of remote health care in China. We used a cell phone e-health service as a case. The study provided various insights on the prospects of the topic matter and a basis for further research.

Further research will be done to study the needs of prospective customers in China (patients, health care professionals) for the smart medication package service. Research is also required on the critical success factors identified in this report. The research will be done by questionnaire surveys.

References


