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ADOPTION, USAGE AND IMPACT OF FAMILY FOLDER COLLECTOR (FFC) ON A MOBILE ANDROID TABLET DEVICE IN RURAL THAILAND

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Abstract
The area of mobile healthcare (mHealth) is a growing field in developing countries (Chib, 2010; Chib & Chen, 2011; Vital Wave Consulting & Vodafone Foundation, 2009). This paper examines the implementation of a Family Folder Collector (FFC) healthcare application used on the Samsung Galaxy Tab in the province of Ubon Ratchathani, Thailand.

Using the Extended Technology-Community-Management (TCM) Model (Lee & Chib, 2008), we examine the impact of the device. 41 qualitative in-depth interviews were conducted with Community Health Workers (CHW), volunteers, patients and project administrators.

Our research has shown that the tablet PC is sustainable in rural healthcare. Findings revealed that community factors like needs, training, and ownership were crucial in CHW's usage of the FFC, and contributed greatly to the success of the project. Managerial factors like finance and partners played a bigger role than regulations in its impact on FFC. Socio-cultural vulnerabilities were observed to not exist in this programme. It is shown that even with sustainability; the impact of the initiative is limited and not yet being maximised to its fuller potential.

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INTRODUCTION

In developing countries and rural areas where the income of the population is generally lower, several health indicators reflect a poor health landscape. According to the World Health Organization Annual Report 2011 on global health, the life expectancy of the low-income group is significantly lower than the global life expectancy (57 years vs. 68 years). The mortality rate of populations [per 100,000] in the low-income group is significantly greater than the global mortality rate due to diseases such as HIV (163 vs. 33), malaria (58 vs. 12) and tuberculosis (49 vs. 20). This trend holds true for the infant mortality rate as well (36 vs. 24 per 1000 live births) (World Health Organization, 2011b).

The state of healthcare can be attributed to the major issues surrounding health in rural areas of developing countries including the shortage of healthcare professionals and resources to develop them (Kuehn, 2007; Naicker, Plange-Rhule, Tutt, & Eastwood, 2009); difficulties faced in attracting and retaining healthcare workers (Stilwell et al., 2004; Willis-Shattuck et al., 2008; Zollo, Kienzle, Henshaw, Crist, & Wakefield, 1994); high costs of transportation and availability of healthcare services (Ivatury, Moore, & Bloch, 2009); the standard of quality provided in healthcare facilities (Lehmann, Dieleman, & Martineau, 2008); and the absence of facilities and medicine (Ivatury, et al., 2009; Lehmann, et al., 2008).

From these major issues, we can identify two significant problems: Firstly, there is a general lack of resources in rural healthcare. In a study conducted in India for example, it was found that 89% of the rural population had to travel about 8km to the nearest health service provider and the remaining even further (Bagchi, 2006). Other than physical resources, human resource is also lacking in rural healthcare, as insufficient training programmes exist to train them (Anyangwe & Mtonga, 2007; Ivatury, et al., 2009). The imbalance of health personnel in urban and rural areas further aggravates these issues as it results in huge differences in the general health situation of the rural and urban population. With a severe lack of sufficient healthcare workers especially in rural areas, it is therefore in the most remote areas where healthcare is not readily available (Schellenberg et al., 2003) and where health problems are more prominent (Dussault & Franceschini, 2006).

Secondly, timely health data must be able to be collected from effective health systems to allow for effective control of the health condition of the community through improved and updated surveillance system implemented worldwide (World Health Organization, 2000, 2010). Many health problems and diseases presented in rural health are hence directly affected by the collection of data. Much of the health data collected in rural areas are limited in providing health information in the community because of limitations in the surveillance systems, and also because of the fact that communities have limited access to health facilities (Oum, Chandramohan, & Cairncross, 2005).

An appropriate example apt to illustrate this point would be the case of the Severe Acute Respiratory Syndrome (SARS) worldwide epidemic in 2003. After the first case was discovered in Guangdong province, it spread rapidly beyond the control of the health

authorities all over China. Because news regarding this was withheld, the international community and the World Health Organization (WHO) were unable to determine the extent of the epidemic (Atun, Sittampalam, & Mohan, 2005). It can be seen from this situation the importance of better management and handling of data for early measures to be put in place.

With our study situated in Thailand, it is important to look at the healthcare situation there as well. The limitations to the provision of proper medical care to rural areas of Thailand stems from maldistribution, or an insufficient amount of doctors and healthcare workers (Wiwanitkit, 2011). There are more doctors and nurses working in urban areas than in rural areas, despite the fact that the 65.7% of the population reside in rural areas (Pagaiya & Noree, 2009).

This maldistribution in Thailand is further aggravated due to several factors. Firstly, there was an increase in demand for healthcare in rural areas after the implementation of the universal coverage scheme in 2001(Pagaiya & Noree, 2009). A new health insurance scheme that allowed all registered members to get treatment by co-paying 30baht, it provided universal coverage with comprehensive benefits (Hughes &
Leethongdee, 2007). This caused an increased workload for healthcare workers in rural areas and much dissatisfaction (Wiwanitkit, 2011).

Secondly, the expansion of the private healthcare industry required doctors and healthcare workers resulting in many of them moving to the private sector and less staying within the public sector (Pagaiya & Noree, 2009; Pagaiya et al., 2011). In 1997, the loss of doctors from the public to the private sector was so severe that 21 district hospitals had to manage without a full time doctor on staff (Suwit & Paichit, 2003).

To improve this discrepancy, the Thailand Mandatory Rural Health Service system was implemented (Wiwanitkit, 2011). Students who intend to specialize must complete their residency in rural areas (Suwit & Paichit, 2003). However, forcing them to work in rural areas can make them lose their morale. Furthermore, this system is not long term. It does not answer the problem of keeping these doctors in these rural parts of Thailand after their bond has ended (Wiwanitkit, 2011) as it is difficult to attract and retain them in the rural areas (Pagaiya, et al., 2011).

However, other measures can produce fruitful outcomes. The introduction of information and communication technologies (ICTs) such as mobile technologies may help rectify these issues mentioned. One such programme implemented in Thailand was the Better Border Healthcare Programme (BBHP) (Kaewkungwal et al., 2010). The programme's aim was to develop a smartphone ICT intervention that improves the accessibility of health services. The BBHP was successful in getting mothers to come to the clinics at the stipulated time for vaccinations through SMS technology, and better detection and management of malaria cases (Kaewkungwal, et al., 2010).There is however, a need to investigate mHealth programmes such as the BBHP in terms of success factors and barriers, in order to get a good sense of the Thai situation.

LITERATURE REVIEW

mHealth: Mobile Health

The rise of mobile technologies has also provided opportunities for increased communication, coordination and partnerships to be conducted especially in the healthcare sector (Chib, Lwin, Ang, Lin, & Santoso, 2008; Iluyemi & Briggs, 2008). Through the various communication means, mobile communication aims to drastically improve healthcare by utilizing mobile and multimedia technology in healthcare systems. This is known as mHealth (Chib, 2010; Istepanian & Lacal, 2003; Mechael, 2009; Vital Wave Consulting & Vodafone Foundation, 2009).

The five main goals of mobile healthcare are: to improve accessibility for patients, especially in rural parts of the world (World Health Organization, 2011a); to better worker's ability to diagnose and manage illnesses (Prgomet, Georgiou, & Westbrook, 2009); to better the quality of service provided in a more effective manner (Willis & Miertschin, 2004); to obtain public health data in a more timely and actionable manner (Lemaire, 2011); to increase medical education and training for health workers (Mechael et al., 2010; Vital Wave Consulting & Vodafone Foundation, 2009).

With ICTs, the quality of healthcare for rural communities has seen improvement (Chandrasekhar & Ghosh, 2001). In India, for example, the Sana programme uses smartphones with camera functions to screen for oral cancer, Diagnosis can be made by a software that is installed or can be sent to specialists for advice and treatment options (Bettex, 2010).

Advancements in telecommunications, together with the quick uptake of mobile communication technologies, have resulted in increasing interest in providing healthcare on the go (Caspary & O'Connor, 2003; Istepanian, 2004; Mechael, 2006; Mechael, et al., 2010). With a wide range of mobile technologies to support healthcare services, healthcare workers become better equipped to respond to health situations (Mechael, 2009). Devices such as laptops, Personal Digital Assistant (PDAs), smart phones, and mobile phones are common devices that allow users to work on the move (Bardram, Kjaer, & Nielsen, 2003; Caspary & O'Connor, 2003; Germanakos, Mourlas, & Samaras, 2005).

The CA:SH project in Ballabhgarh India, for example, uses a Personal Digital Assistant (PDA) device for electronically recording data. It is synchronized with the central database and replaces the need for healthcare workers to physically travel to the central server to synchronize and update such data (Anantraman et al., 2002; Chib, 2010). This is a pertinent example of how such mobile technologies are able to solve the fundamental problems of accessibility and also improve the effectiveness of health surveillance.

With mHealth, we can hence hope for the improvement and betterment of the condition of rural healthcare through various technologies

Mobile Devices

The early phases of the mHealth field saw the rise of technologies like VHF radios. By using VHF radio communication solutions at health sites, the capacity of health sites was increased, as was the efficacy of the healthcare processes in the EHAS project (Martínez, Villarroel, Seoane, & Pozo, 2004). This meant that more people could be serviced at the same given time (Wood, 2004).

Mobile healthcare today can be achieved through three main forms of mobile devices. (1) Mobile computers like laptops and notebooks, (2) palmtop or 'personal digital assistant', and smartphones (3) tablet computers.

Our study is unique and innovative as we examine the most emergent of mHealth technology—Tablet computers. The tablet computer is defined as "a type of notebook computer that has an LCD screen on which the user can write using a special-purpose pen, or stylus. The handwriting is digitized and can be converted to standard text through handwriting recognition, or it can remain as handwritten text" (Webopedia Computer Dictionary, 2004). Usually the size of laptops, they are convenient, portable, efficient and user-friendly (Straker et al., 2008). It is also a handheld device that allows users to easily search, organise, analyse information while on the go (Willis & Miertschin, 2004). Apart from the advantages of being a computer-based system that is easily carried around, tablet PCs also provide an alternative input system via handwriting that provides ease of usage.

The reduced size, together with the increased processing power of the tablet pc differentiates it from a personal digital assistant (Willis & Miertschin, 2004). In comparison to a laptop, tablet PCs remove the barrier of the screen between the user and the other person (Cicchino & Mirliss, 2004). Most data collection is conducted using paper questionnaires followed by manual input, which is tiring; time consuming, error-prone and expensive. (Seebregts et al., 2009). The use of tablet PC applications however, allows data collected to be immediately monitored, allowing immediate decision making to be done, thus improving quality of patient care (Richter et al., 2008).

Tablet PCs combines the features of a notepad, a laptop and touch sensitivity device that is a perfect alternative for PDAs (Black et al., 2011). Unlike the PDAs and mobile phones, the tablet PCs has a larger screen that is optimal for image viewing. It is capable of wireless connections but it is without phone call capabilities (Mirza, 2007).

However, tablet PCs also face the problem of limited battery life (Martins & Jones, 2005). Tablet PCs are also expensive devices that are also fragile. This can however, be overcome by protective cases (Mirza, 2007).

In view of the benefits and limitation of mobile technologies like the tablet PCs, we situate our study in the context of Ubon Ratchathani, Thailand, where the use of the Family Folder Collector (FFC), an ICT based health intervention is being investigated (Boonruang, 2011). The FFC programme makes use of the Samsung Galaxy Tab, a form of tablet PC.

Family Folder Collector (FFC)

Launched in April 2011, the Family Folder Collector (FFC) is a mobile application developed by the National Electronics and Computer Technology Center (NECTEC) of Thailand, that can be used on an Android based device. It complements the use of the Java Health Center Information System (JHCIS), which is the database of primary care units (Boonruang, 2011; Pornwasin, 2011).

The purpose of this application is for health workers to collect household information when going out to the villages by allowing health care workers to use a tablet personal computer to access patients' health records instead of lugging around paper records (National Electronics and Computer Technology Centre, 2011). The data can be input onto the Android device and synchronized with JHCIS database by FFC Autosync 2011 programme on server.

The application makes use of Google map and the GPS system to locate and mark households in the village, and is able to display genogram of a household unit. Monitoring of diseases is hence possible. The application is capable of collecting data such as weight, height, blood pressure and BMI levels. Diagnosis can be made on the application using ICD-10 standards (National Electronics and Computer Technology Centre, 2011).

Data can be obtained from the ground in a timely manner. This will help the government get a clearer understanding of public health in close to real time and hence improve their decision making process (Pornwasin, 2011). Through FFC, this helps solve the issue of lack of timely health data being collected. This application is currently under testing in 8 of the 25 districts (123 health centres) in Ubon Ratchathani (Boonruang, 2011).

We have based our study in this context where efforts to better manage and handle data is attempted to improve the general healthcare in the area. It also shows the benefit of using a tablet device in data collection in rural areas as compared to prior data collection methods.

Technology-Communication-Management (TCM) Model

Our analytical approach to this study would be in the context of the Extended Technology-Community-Management (TCM) Model (Lee & Chib, 2008). This model proposes that a successful and sustainable ICTD intervention is possible at the intersection of various dimensions including: technological infrastructure comprising of both hardware and software support; financial viability and management of the projects; support from various partners and stakeholders involved; regulations surrounding the use of communication technologies in the context of ICTD projects; involvement of the community. This model was developed in other studies such as the Revised TCM Model (Chib & Komathi, 2009; Chib & Zhao, 2009) to include social factors in determining the concept of sustainability (See Figure 1). We will look into the various dimensions of the Extended TCM Model.

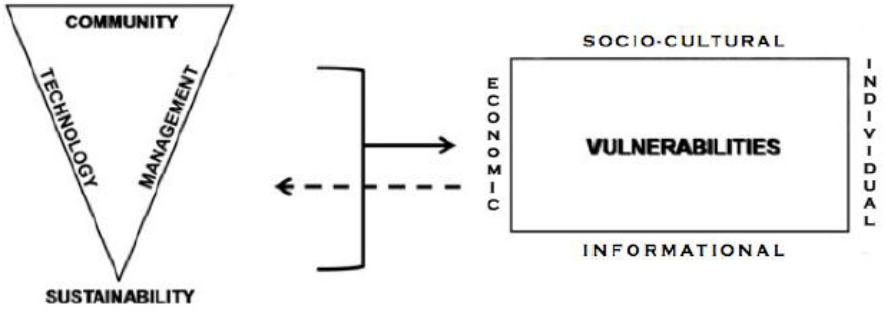

Figure 1. Extended TCM Model

Technology

The substantial developments in information technology hardware and software capabilities over recent decades create much potential for the application in aspects of healthcare provision (Black, et al., 2011). The TCM model (Chib & Lee, 2008; Chib, Wilkin, & Hoefman, Forthcoming) proposes that the intersection of ICT characteristics of technology, along with the dimensions of software and hardware, project management dimensions of financial requirements, the regulatory environment, and stakeholder involvement, along with local community participation, will ultimately lead to sustainable ICTD interventions (Chib & Zhao, 2009).

Applications in the software should meet the needs and demand of the users and the community rather than existing for the reasons from supply side (Blattman, Jensen, & Roman, 2003). It must also be easy to use and it should be customized and adapted to the local community (Chib & Lee, 2008). As such, responses and comments from the community are important to the development (Chib, 2007).

Software applications such as email, audio or video calls and text messages are great alternatives to fixed line telephony and traditional mail in terms of communication (Best & Maclay, 2002). Input and formatting errors are also reduced through data type and range

checking at the time of capture and by use of selection lists which restrict data entry to pre-defined options (Seebregts, et al., 2009)

The choice of hardware is important as well, as it has to be utilized in rural areas where weather and geographical conditions may be harsh. Existing infrastructures such as network, electricity and transport are also factors to be considered as they may affect the use of the hardware (Mayanja, 2003).

As compared to fixed-line telephony and other wired form of communication, wireless technologies do not require an elaborate physical infrastructure and is dependent on one that is less rigid (Chib & Lee, 2008). By focusing on the scope of the community, projects can achieve sustainability by sharing access within the community itself in various sites (Ernburg, 1998).

Management

There are three major variables that are important in the managerial aspect of wireless projects: finance, partners, and regulation (Chib & Lee, 2008; Tierney, Kanter, Fraser, & Bailey, 2010). An ICT initiative opens doorways for multiplicity in partnerships and lowers regulatory hurdles in deployment processes (Galperin, 2005).

Financial sustainability is often regarded as the most critical determining factor for overall sustainability (Chib & Lee, 2008). One of the most common challenge and limitation of an ICT initiative is to show that the benefit it brings about justifies the cost of the initiative (Mechael, et al., 2010) and/or maintaining a steady funding for the initiative. Many of the ICT programmes are still at a relatively new stage of implementation, with insufficient studies to establish their relevance, applicability or cost effectiveness making it difficult for governments of developing countries to determine their investment priorities (Callan, Miller, Sithole, Daggett, & Altman, 2011; Chetley, 2006). It also makes it hard to identify cost savings because most involve providing additional support and information to healthcare workers or individuals rather than replacing existing services.

Also, the nature of ICT projects involves skilled expertise to develop a successful ICT programme, which contributes to a high start up cost (Caspary & O'Connor, 2003; Vital Wave Consulting & Vodafone Foundation, 2009). Other costs include transport, maintenance and training of local staff (Mechael, 2006; World Health Organization, 2010). Most ICT initiatives start out with funding from international philanthropic organizations or as part of a corporate social responsibility initiative by companies (Tella & Olorunfemi, 2010). Funding is also given through government and non-governmental research grants (Vital Wave Consulting & Vodafone Foundation, 2009).

However, such initial funds are usually used up before it develops to be adequately sustainable and scalable, and the projects are forced to come to an end (Rashid & Elder, 2009; Vital Wave Consulting, 2008; Vital Wave Consulting & Vodafone Foundation, 2009)). Moreover, it is also possible that a government-funded programme will lose its funding if the political and economic situations change (Ivatury, et al., 2009; Tierney, et al., 2010). Conversely, a number of pilot projects have demonstrated improvements such as a 50% reduction in mortality or 25-50% increase in productivity within the healthcare system; contributing evidence to the worth of an ICT initiative (Callan, et al., 2011).

As such, there is a need for a business or funding strategy for such initiatives which involves all stakeholders (Gerber, Olazabal, Brown, & Pablos-Mendez, 2010). The sustainability of projects is built not only on financial feasibility but also on continued organisational, social and political support (Barrington, Wereko-Brobby, & Ziegler, 2010; Chib & Lee, 2008). Stakeholders of an ICT programme can range from government organizations to non-governmental organizations (NGOs) and institutions (Mohd Salleh, 2004; Qiang, Yamamichi, Hausman, & Altman, 2011); especially with the presence of a
local organization, the potential sustainability of an ICT initiative can be increased (Aral, Marcela, & Randal, 2001; Patrick, Griswold, Raab, & Intille, 2008). It is important that the government supports the mHealth projects and focus on initiatives that can be incorporated into the current healthcare system (Patrick, et al., 2008). Following suit, donor funding should align their initiatives with that of the governments (Akinsola, Herselman, & Jacobs, 2005). These stakeholders must come together in a coordinated fashion that would contribute to the growth of the industry. Telecommunication providers and manufacturers can also support funding, and with their knowledge and expertise, make it profitable as well (Etzo & Collender, 2010). It is crucial for a sustainable business model to be developed so that the project may eventually become financially independent (Mechael, et al., 2010).

An example is the Uganda Health Information Network (UHIN) Project. It started as a pilot programme in 2003 and is considered self-sustaining as the Ministry of Health covers its operating costs. The overall aim of UHIN project was to complement the Ministry of Health of Uganda and help reduce mortality and morbidity rate from chronic diseases with the help of a communication infrastructure that can provide accurate information, and also a data collection system that will bring up the national healthcare standards quality (Ladd, 2007; Tumwesigy, 2010). The project had positive results were sustainable through various stakeholders working together: Funds for the PDA devices comes from International Development Research Centre, Canada (IDRC). Uganda Charted Healthnet, Makerere Medical School faculty, and District Health Services dealt with and maintained the database. Satellife provided implementation and training to develop and maintain electronic forms and content (Vital Wave Consulting & Vodafone Foundation, 2009).

Also, the Text To Change (TTC) project was one that provided AIDs awareness through an SMS based quiz to 15000 mobile phone subscribers in Uganda (Etzo & Collender, 2010). Mobile carrier Celtel and a local NGO Aids Information Centre (AIC) were involved in this project. Other than an increase in patients who tested for HIV/AIDs, the mobile carrier now reaps the benefits from a CSR perspective and also the publicity of its SMS services. The increase in number of tests conducted also gives them an edge to receive more funding. They also receive a steady funding that allows steady implementation and growth (Vital Wave Consulting & Vodafone Foundation, 2009).

In the tsunami-affected region of Aceh Besar, Indonesia, mobile phones were distributed to 223 rural midwives and were monitored on the quality of their services. The midwives of the rural community would deliver medical information of their patients for diagnostic purposes via SMS into a central database. Permitting new ways of bypassing timely constraints, the project received financial support from the United Nations Children's Fund (UNICEF), the United Nations Population Fund (UNFPA), and the implementing agency, World Vision (Lee & Chib, 2008). Apart from the above organizations, external support from the local organizations contributes to the project's relevance to the local community.

Policy implementations can also affect the management of an ICT initiative with the entry barriers, financial bursaries and technical constraints (Lee & Chib, 2008). The presence of regulatory systems poses to be a major hurdle during the implementation stage of an ICT initiative. The use of unlicensed spectrum for Wi-Fi varies significantly in different countries, licensing rules range from conditional license exemption to license-required policies (Best, 2003). Albeit crucial for the implementation of a ICT programme, it is found that in over 50% of the developing world, there is a lack of rules for license-exempt bands (Lee & Chib, 2008),

Another issue is the development of international IP traffic that mostly caters to developed nations and differs from the needs of the developing world (Galperin, 2005). Since regulations impact financial conditions, the position of a governmental body is essential for creating a suitable environment (Mayanja, 2003).

A case study in South Africa notes of the Universal access provider (UAP) licenses which significantly lower license fees in

underserved areas to “allow barrier- free entry for small entrepreneurs” (Best, 2003). Also, in Latin America, universal service funds are sometimes expanded to subsidize community tele-centres (Galperin, 2005). Favorable interconnection pricing policies influence project finance. Overall, it is argued that policies supporting pro-poor mechanisms, and providing transparent, market-based subsidies to suppliers are important (Lee & Chib, 2008)

Community

A frequently overlooked factor of a ICTs project’s sustainability is community engagement. Most of the time, initiatives are being developed without the end-user at the table. However this is crucial when developing mHealth initiatives for sustained demand and should be achieved by working with local communities in addition to Ministries of Health (Mechael, et al., 2010). Local involvement and commitment at the community level significantly affects the introduction and functioning of ICTs, as well as the resultant social transformations that occur (Chib & Zhao, 2009). It must be noted that the sustainability of mHealth is heavily dependent on the workforce and the tools they have been given. Literacy, language barriers, and perceptions about western medicine are other factors unique to each community that need to be addressed during the introduction of mHealth projects (Mechael, et al., 2010).

A study conducted by the Vital Wave Consulting and Vodafone Foundation (2009) revealed that literacy is an obvious obstacle to overcome given the advanced technology and amount of funding pumped into the development of ICTs for mHealth projects around the world (Vital Wave Consulting & Vodafone Foundation, 2009). For example, Microsoft developed HealthLine, a speech recognition-based information system, to train semi-literate community health workers and let them access critical information (Sherwani et al., 2007).

Another barrier to improving health outcomes and overall development in developing nations, is the shortage of trained healthcare workers (Callan, et al., 2011). An example of the benefits of training can be seen in the Community Health Information Tracking System (CHITS) where the open source community believes such training will provide them with an understanding of the situation where they can take the initiative to encourage others to do so similarly. It has shown from this study that such training is effective in improving the health situation (Vital Wave Consulting & Vodafone Foundation, 2009). From CHITS, it is evident that “training” the community is equally as important as having their cooperation and support; which is important for sustainability.

Ownership is another crucial aspect of the community end-users. A study conducted in rural Nepal found that “the most powerful applications of technology…are those that decentralize ownership of the information and effectively expand the pool of “experts”” (Maru, Basu, Andrews, Acharya, & Khoshnood, 2008). To address the issue of ownership, it is almost inevitable to consider the influence of culture. In some African countries, the collectivistic nature of the community influences the culture of sharing; although a mobile phone may actually belong to a person, it is regarded as the property of the community (Eaton & Louw, 2000; James & Versteeg, 2007).

The provision of the ICT device to health workers might also pose another question of ownership as in specific cases; the health worker is not seen as a local of the village. In the perspective of these qualified health workers, they do not regard the ICT device to be "essential" to their primary task of healthcare provision (Iluyemi, Briggs, & Adams, 2007).

Apart from healthcare workers’ ownership of a handheld device, we must keep in view the community’s ownership of the ICT project in their village. Local participation generates a sense of ownership of the project, creating less dependence and more self-reliance. And with this independence, the project will start to evolve and develop specific traits that are applicable to individual rural communities.

Another important aspect of community factors is to allow an ICT programme to be embraced by the community by ensuring the assimilation of the community’s culture into the project. There is no one formula that can be applied to a programme and that can guarantee success across all borders. Therefore, both the communal and individual needs shape the development and sustainability of an ICT programme.

For example, China‘s long struggle with healthcare coverage in rural areas went back for decades, when the "barefoot doctors" programme became a national policy. The focus was on training paramedics quickly in order to meet pressing rural health needs (Sidel, 1972). Despite under-developed techniques
and limited medical instruments, these rural doctors were able to provide timely treatments for sanitation, immunisation, and delivery for pregnant women (Chib, Chia, Ng, & Tran, Forthcoming).

However, the needs of villagers have seen a lateral shift as they no longer demand for health provision but also efficiency. In order to maintain standards, the central government introduced a medical licensing system in which village medical practitioners could be certified as "rural doctors" (Chib, Chia, et al., Forthcoming).

There is a constant need for improvement and development of services provided as villagers might start to expect more in the quality of healthcare they receive (Kane, 1969). If an ICT project is developed top-down, there is much time wasted on the transmission of information between managerial tiers, leading to both a waste of resources and chance of misconstrued information.

Apart from the community‘s demands for healthcare provision, ICTs are capable of supplementing educational content in a user-friendly context. In a report from the World Economic Forum, “gaming, entertainment and social communities are viewed as powerful forces for change and a fundamentally important way to motivate and engage individuals in pro-health behaviours” (World Economic Forum, 2010).This is especially so for garnering the attention and trust of the youth in a community. Healthcare workers can use ICT to visually educate and entertain youths on healthcare issues.

A user-friendly interface is needed to make mobile applications as simple to interfere with as possible so that people do not have to key vast information in (Mirza, 2007). As medical observations are detailed and repetitive, tick boxes can be used to check the apparent symptoms a patient displays.

Based on the technological, community and managerial factors presented in this model, we develop our first research question:

RQ 1: What are the Community and Managerial factors affecting the impact of the FFC mHealth programme?

To measure impact of mHealth projects, we can look at how Community and Managerial factors affect these two aspects: the overall improvement of the health of the community and the improvement of the healthcare system.

The improvement of the health of community may come in three forms: (1) better compliance by community members to health solutions or recommendations, (2) raised public awareness of health service, and (3) better management and monitoring of diseases. Improvement of healthcare system is largely based on improvements in efficiency in the system and redistribution of resources to better benefit the community. (Vital Wave Consulting & Vodafone Foundation, 2009)

For the FFC programme, CHWs were trained to use the tablet for data collection on the FFC application. The training revolved around working the basic functions of the device, such as the camera and FFC application, instead of using communication technology such as Skype or ooVoo. This could attend to the community’s need for immediate and expert healthcare provision a typical CHW is incapable or allowed to practice. However, here comes the consideration of the coordination with doctors at the public hospitals. There, doctors are in the

position to impart professional medical advice in an emergency medical situation but project facilitators have to involve and allocate them to specific healthcare centres in order for a system to come into place. Therefore, apart from equipping CHWs with more technologically relevant skills, we must also consider the coordination between healthcare practitioners to witness the impact of the FFC programme.

Another factor to consider is the aspect of finance. Although the FFC project receives sufficient funding from the public hospitals to launch this pilot initiative, more support is required for the impact to resonate with the community and improve the overall healthcare system. As observed in our findings below, CHWs experience wireless connectivity disruptions in rural areas and are unable to exploit the full benefits of the tablet. Network connectivity is low in rural areas and this can be overcome by erecting network infrastructure in rural areas. However, this brings about the issue of government regulations with
the extension of wireless connectivity to rural areas. According to Leblois (2003), there is a lack of rules for license-exempt bands in over 50% of the developing world; and this is evidently a hurdle to overcome to improve rural healthcare provision in rural Thailand (Lee & Chib, 2008).

RQ 2: What are the barriers affecting the impact of the FFC project?

The Extended TCM Model establishes vulnerabilities as barriers. The four key extensions are: economic, informational, socio-cultural and individual.

Socio-cultural vulnerabilities refer to vulnerabilities resulting from the relationships between individual in a social environment. This can come in the form of social hierarchies that stigmatises individuals based on gender, age, religion, ethnicity and classes. In rural India for example, the National Rural Health Mission programme makes sure that one woman from each village serves the community as an Accredited Social Health Activist (ASHA). Their job is to persuade pregnant women to make use of health services with the help of mobile phones. However, due to low educational level and lack of social status, there is a limit to the effectiveness of the programme.(Garal & Ganesan, 2010; Ramachandran, Canny, Das, & Cutrell, 2010)

Economic vulnerabilities can be seen in Uganda for example, where the need to provide for their children in poverty conditions drives many women to undertake sexual businesses that are dangerous and risky(Chib, Wilkin, et al., Forthcoming; Miller et al., 2011)

Informational vulnerabilities on the other hand, address factors such as accessibility to important health information. In some developing countries for example, healthcare systems are not well integrated and in times of emergency, the community may not even have an idea about who to contact and how to contact them. (Mechael, et al., 2010)

Lastly, on the individual level, individual vulnerability addresses cognitive and physiological factors that affect individuals' response to the mHealth initiatives. This largely attributes to differences among individuals that result in different behaviors and attitudes towards the projects. In Uganda, the increase in awareness of HIV campaigns brought about by the increase in campaign efforts did not translate to actual screenings. Only about one-fifth of the population got screened. (Government of Uganda, 2010)This could be due to factors like fear or embarrassment. (Chib, Wilkin, et al., Forthcoming)

These four vulnerabilities develop a multi-dimensional relational whole where multiple or specific factors influence each other. The issues raised in the evaluation of our first research question overlaps with the economical and informational dimensions of the Extended TCM Model; therefore, we will discuss the impact of socio-cultural and individual factors, which are more relevant to our second research question.

METHODOLOGY

The nature of our research study is an investigative and exploratory research study as it will be one of the first few studies in this emergent field. Guided by the TCM framework, we are investigating the various factors important to this application. In-depth qualitative interviews are more suitable as it allows us to explore into possible unknown factors that could affect this project. The interviews use a main interview questionnaire as a guide, but are subjected to the interviewer's elaboration on the response or questions.

The interview questionnaire would be grouped according to themes that our research is based on i.e., technology, community, management etc. In the technology section, we asked interviewees if it was difficult for them to learn to use, and if they faced problems in usage. A sample question is "Is the device easy to use?" In the community section, we looked at how the introduction of the device into the community was. E.g. "How do you feel when you use the device in front of the patients?" The issue of ownership was also covered, asking interviewees "Do you feel the device is yours?" In the management section, we asked interviewees questions about finance, asking them "do you have to pay for the device initially? What if it is faulty? What if it is lost?"

We engaged in one-on-one interviews with our participants for our study. The nature of our RQ puts the health workers at the center of our study. Since they are the direct users of the FFC application, observations will be important, and primary data on behavioral aspects can be collected.

We used one-on-one interviews and not focus group discussions because the limitations of language make focus group discussions very risky and difficult to conduct. The barrier of language might risk our data being inaccurate due to the lag in what respondents may actually respond and how moderators can accurately convey that meaning across to us.

We interviewed and observed a total of 41 respondents in a 3-week time frame. Out of these respondents, a large proportion of them are health workers who are the direct users of the FFC programme device. Other respondents include the volunteers, patients, project managers and executives. These four groups are important as they make up the various groups in contact with the implementation of the FFC programme device. This provided us with a complete picture of the project and allowed us to understand it from the viewpoints of all the stakeholders in the programme.

The breakdown of the respondents is as follows:

	Male	Female	Total
Health Workers	10	14	24
Volunteers	0	3	3
Project Managers/ Administrators/ Developers	5	1	6
Members of local community	3	5	8
			41

These health workers come from 4 different districts of the Ubon Ratchathani Province: Det Udom, Trakan Phuet Phon, Na Yia, and Mueang Ubon Ratchathani. Each health worker is from a different sub district in the above-mentioned district. Each subgroup was

interviewed based on a different set of questions specific to their interactions with the device.

A moderator/translator was engaged to assist in conducting the interviews since many of the respondents are not able to speak English. The moderator was proficient in Thai and able to proficiently translate Thai responses to English, and convey English meanings in Thai to respondents. The moderator was briefed beforehand about the study and also trained to present the questions to the respondents as accurately as possible.

Apart from these considerations, we had limited interactions with Thais and this handicapped our ability to comprehend their body language and supposed "socially acceptable" behaviour. Therefore, to counter this limitation, we maximised our three- week stay in Ubon Ratchathani and took this opportunity to learn their language and enquire on their culture and behaviourism. Our translator was also briefed to insert aside comments on the body language of our interviewees.

The interviews with health workers, volunteers, and project administrators are conducted at the health centres itself. The average length of each interview was one hour and was conducted in English and Thai with the interviewer and the moderator. Audio recording devices were used to collect the data that was later translated and transcribed.

Before each interview/focus group, we explained the purpose of the study and also reassuring their rights to confidentiality. We also handed them a consent form, which they had to sign and authorise the interviewer to conduct the interview.

FINDINGS

From our interviews conducted, we have categorised our findings according to: community factors affecting usage, managerial factors affecting usage, the short and long term impact of the FFC project, the barriers affecting the impact of the FFC project.

Community factors

In general, our findings displayed that community factors were very important in the design of the FFC programme. The programme demonstrated that community needs, training programmes, and ownership are important factors contributing to the success of an mHealth initiative. However, from our interviews, we were able to gather shortfalls of the FFC programme in fully addressing each community factor of the TCM Model.

Needs

The community factors allow for the FFC programme to have a socially-sustainable usage aspect for CHWs. The needs of health care workers have only been accomplished to a partial extent by the FFC programme.

As suggested by interviewee #21, a 48 year old female CHW, "[the device] is not good enough to benefit our work that much. If for example this device has capacity to store information of many villages, it will benefit our project.

The main benefit that CHW experienced with the implementation of the device is the savings of time. Interviewee #18, a 28 year old female CHW, mentioned that the device aided in "transferring information [as] it is quite a time-saving process". Another factor is convenience and portability of patient's data during house visits. As compared to carrying multiple folders, the device makes it more "convenient in collecting data and it is easier." The 32 year old female CHW, interviewee #24, also commented that "[there is no] need to bring out paper folders to the community." While most acknowledged the benefits of the device, they also stated that they could do without it with the previous paper version of FFC. As quoted from interviewee #28, a 28 year old female CHW, whose view echoes many, "Yes we can do [health visits] without [the device]. We just use the paper folder".

As observed, most of them answered that although there will be a change in the time required to complete the job, it would basically, make no difference to their job scope. However, apart from merely using the device for data collection, CHWs relied on the device to map out patient's homes on the map. As interviewee #4, 22 year old female CHW comments, "the mapping system is quite good for [their] work" as it "provides a system for [them] to mark the household." She also adds, "I can see which household has patients who are serious and need more care. It is marked with a red house. If the previous person did any change on the mark, the next person who uses the device will know that this person has a serious condition."

Other benefits of the map application were attributed to planning their route with ease and saving transportation time and resources. This is stated by interviewee #13, a 25 year old male CHW, "…in the past when there is no map in the folder, I didn't know where the family is and I have to have another person accompany me in order to find the household." Interviewee #14, a 34 year old male CHW, commented that with "the Google map in the device we can directly go to the patients' house without consulting the volunteer…And so this saves times."

Although CHWs frequently faced issues with Internet connectivity that affected the map application, it was still deemed as useful and addressed their needs. This leads us into our findings for training and ownership of the device.

Training

The presence of a training programme aids the CHWs in maximising the potential of the device. Especially with a relatively new piece of technology, CHWs require information on how to use the FFC application with an Android interface which differed greatly from the folder FFC. The training taught

CHWs the basic functions such as the camera and application use; the floor was also opened to CHWs to ask questions which made the training more interactive. From our interviews, it is evident that the training programme was useful as the only thing CHWs wanted was more.

In the training, the trainees were given the manual of the device and were taught how to operate the device. Interviewee #2 told us that "the trainer provided us with a manual during the training. It's the guideline that I use to work on the device." Interviewee #9 also mentioned that they "got a manual book to consult."

In addition to that, they were also taught how to make use of the FFC application in the device for data collection. They learnt how to collect the data within the application itself, and also how to synchronise the collected data with the JHCIS server. "We were trained on the installation process, how to use, and how to transfer information" (Interviewee #4). "They [also taught] us how to transfer the information into the database and how to use the information in order to visit the family" (Interviewee #6).

The interactive nature of the trainings allowed for trainees to ask questions and clarify any doubts that they had and this reassured the effectiveness of the training programme.

Yes we can raise our hands and ask questions [during the training]. There will be 4-5 people available at that time and they will come and see the situation and show them how to solve the problem and sometimes they ask them can you do this can you do that. (Interviewee #11)

"We can raise our hands to ask questions any time during the workshop. Programmer or trainer will come back to answer any

questions we have" (Interviewee #17).
As observed through several CHWs response, the training session had a class size of about 100 people and 4 trainers. As the training lasted for only one day, a few health care workers mentioned that there was not enough time for them to fully comprehend the device in the training and learn useful information with regards to using the device. Interviewee #21, a 48-year-old female CHW elaborated,
I was in the training workshop but I still feel that there are some difficulties in using this device. It is easy to use but there are some other problems for me to solve as well. The way to solve the problems is to contact the person to know how to cope with the device.

CHWs were given opportunities to clarify any doubts they had post-training through the contact information that was given to them during the session; ensuring that support is available at all times and a learning experience that extends beyond the classroom. By adopting this method, CHWs will not feel neglected if they encounter any problems with the device. "After the training workshop we were provided with name list of people who we can contact if we have any problems (hand action: we can call them)" (Interviewee #18). "After the workshop I still have some questions. However the IT team from the district level they organised another meeting in order to review what they have done before" (Interviewee #13). "When we came back and started to use the device, I had some questions about the programme. However I solve[d] the problem by consulting the web boards provided the public health office" (Interviewee #14).

Aside from the positive feedback from CHWs and the resourcefulness of the trainers, many CHWs suggested for more training workshops. They raised the issue that only one healthcare worker attends the training workshop; while the rest are indirectly trained. As mentioned by interviewee #22, a 24 year old female CHW,
It would be better all healthcare workers will be in the training workshop because they would be able to learn how to operate this at the same time. It is better…because what they learn in the training workshop may not be same as what others learnt.

While the healthcare workers were taught how to basically operate the device and also use the FFC application, there were minimal traces of efforts to educate them on using other functions of the device including emails, social media platforms like Facebook, audio and visual communication tools like Skype and ooVoo, which can be potentially useful to their jobs.

Interviewee #22 mentioned that in terms of contacting doctors, "I think it's better by using Skype because using Skype allows us to see moving images and sound and it's better than the phone." However, she also mentioned, "In our work we don't use Skype as the main form of communication." Many observed the potential benefits of these communication tools but did not have the skills or knowledge to activate it on the device. Interviewee #24 stated, "I was in the training workshop I was not informed on this [Skype's benefits]. I believe that this will help the patient."

Ownership
For the FFC programme, only one device is allocated to each healthcare centre to be shared amongst CHWs. There is collective ownership of the tablet and this brings about costs and benefits alike. According to Chib and Zhao (2009), ownership at a collective level requires a leaders' involvement to ensure success. However, with respect to the FFC programme, the leadership role is blurred as CHWs attribute ownership of the device to the organisation (Chib & Zhao, 2009).

When asked if the device felt like it belonged to them as an individual, most CHWs had a common understanding that they do not own the device. "I feel that it belongs to the organisation" (Interviewee #26). Interviewee #4 also feels the same way, "I don't feel that it is mine…it is the organisation's and the organisation belongs to the people. But I am supposed to be responsible for the device." In such a scenario, there is no clear string of command from the organisation to CHWs. Therefore, if CHWs experienced difficulty, they were advised to post their questions on NECTECs Facebook page where CHWs and NECTEC trainers provided assistance. Many were quick to adapt to the digital FFC and there were instances of multiple CHWs sharing one tablet and yet helping one another if anyone experienced difficulties with the device. One such instance is described by interviewee #2, "There is only one device in the health centre and we share it among the health care workers. When any person got new information about the device we will share the information to one another. For example, how to upgrade."

However, such collective ownership mind-set is not a default; for most health centres, especially the smaller ones, only one health worker uses the device. As such, the individual ownership mind-set takes over in terms of taking care of the device, occasionally keeping the device and also personal use of the device. Interviewee #6 is one of them. "I feel it belongs to me. Because I always have it with me. Only sometimes that I have this with other people to do the work." Interviewee #13 also mentioned, "I feel like it is mine and I have to take care of it."

With a greater degree of individual ownership, CHWs are allowed to spend more time with the device, increasing familiarity and knowledge on usage. This is apparent in the statement of interviewee #17, a 25 year old female CHW, "I did not understand how to use it at the very first time. After that I tried to use it more often so I became more familiar with the device." Interviewee #5, 47 year old female CHW, has similar views as she states that although the device "is quite new to me… more I used it, the lesser problems we had".

Managerial factors
Our findings showed the dynamic relationship between financial factors and partnership factors involved in the FFC programme. It was inevitable that these two dimensions of management were interrelated as most of the partners involved in the FFC programme were directly and indirectly involved in financing the project or contributed to determining the cost of the programme. We found that regulations played a smaller role in impacting the programme in general.

Finance
From our findings, it was apparent that financial factors were important for the FFC to reach its desired impact. Without the financial support from the Ubon Rathchathani Provincial Public Health Office, the FFC programme would cease to exist.

We noticed from project administrator, interviewee #30 that the entire budget comes from Ubon Ratchathani Provincial Public Health Office. As she mentions "All of the funds are from this office." However, these funds are not allocated from the Ministry of Public Health Thailand. Instead, they come from the profits of hospitals in the province. As mentioned by Interviewee #40, "Extra funds…come from extra health service[s] in each hospital. Ubon Ratchathani Provincial Health Office doesn't earn this money…every government hospital in province is functioned under Provincial Health Office."

Profits from hospitals are managed and allocated to this programme under the institutional office of the Provincial Public Health Office. As such, there is a guaranteed source of funding provided for the implementation and sustenance of the FFC programme. Without this source of funding, there is a limit to what the FFC can do. Interviewee #39 responded, we understand that the cost of developing the FFC programme is "sponsored by Information Technology and Communication Centre, Office of Permanent Secretary Ministry of Public Health"

While the funds for this programme come from the local district health office, we also understand from Interviewee #29,
Every year there will be money allocated to this provincial health office by the national health office from Bangkok in order to develop any kind of materials or device in order to get information regarding their healthcare service and support this project. We use this money to support this project.

The importance of the Ministry of Public Health Thailand and NECTEC is further emphasised in the next section.

Partners

It is imperative to engage several partners in a pilot mHealth initiative to partake in various roles of brainstorming, execution, maintenance and assessment (Lee & Chib, 2008). Each role contributes to stimulating development as each have invested a great amount of risk to participate in a project. The importance and significance of partnership is illustrated in our findings as we observe the relationship between the Ministry of Public Health Thailand, the Ubon Ratchathani Provincial Public Health Office and NECTEC. Our findings suggest that the FFC programme is possible due to a few strong partners supporting this project.

Although the Ubon Ratchathani Provincial Public Health Office enjoys a relatively high level of independence from the Ministry of Public Health Thailand, the latter still supports the former. With our interview with Project Administrator, Interviewee #40, it is also understood that the Ministry of Public Health Thailand oversees this project on a national level. With an influential partner, this project is probably less likely to encounter political restrictions. The Ministry of Public Health Thailand also supports this programme in very practical ways:

Information and Communication Technology Center (ICTC) developed JHCIS (Health Center Information System) for every government health center in each sub-district. This application licensed under Thailand's Ministry of Public Health and collect[ed] many information about health status and situation on each sub-district. So, the FCC's developer and JHCIS's developer must share and merge in both applications' data (Interviewee #40).

Another project administrator, interviewee #29, mentioned the other main organisations involved in the project,
Firstly, NECTEC centre which belongs to the Ministry of Public Health. Second, NECTEC who developed the programme. Thirdly, it is the Ubon Ratchathani Authority organisation. In Ubon Ratchathani we are the main ones responsible for the overall supervision of this project.

With NECTEC as their partner, the project can ensure constant development and upgrading technologically to suit the needs of the programme and the community.

Although the devices used in this project is the Samsung Galaxy Tab, there were no plans to seek partnership with Samsung for cost reduction purposes. One reason given was that there were plans to explore other tablet devices such as Apple's iPad which was mentioned by Project Manager, Interviewee #30. She confidently explains developments of the FFC programme,

Now we are working on comparing capacity of iPad and this Android tablet to see the strength and weakness on each device…We will let the other 15 districts to choose which one they would prefer to use in their work in their house visit.

The support from the Ministry of Public Health Thailand gives leeway for experimentation as liabilities are minimised. The presence of an overriding authority for the rural health centres to report to and a governing force to spearhead the project supports the TCM framework: that the involvement of a governmental body and external stakeholders can sustain the project in the long run.

Regulation

The regulatory environment with regards to the use of the device is also one that enjoys a relatively high degree of freedom. From our interviews with the healthcare workers, we understand that there are no regulations concerning the use of the device except that the data collected must be kept confidential to only the patients and the healthcare workers. As interviewee #3, a 38 year old male CHW states, "There are no rules about how people can use the device", interviewee #2, a 37 year old male CHW, agrees that there are "no rules or laws [are in place for] the use of the device." This is ensured by security measures such as passwords that are being installed in both the FFC programme and the JHCIS database.

Impact

Our findings revealed that there were more positive short-term impacts that were applicable to the improvement to the health systems and were more obvious in the response of our interviewees. Although this could be attributed to the pilot stage of the FFC programme, we have to consider why the improvement of the community's health in general was something that was less perceived in the response of our interviewees. If any, the positive impacts on the health of the community can be observed in the long-run where distribution of resources are more evident when more data in collected for a particular village. Some examples would be the effect of the mapping system, where critically ill patient's households are easily identifiable amongst the normal households. This would improve follow-up sessions, prioritisation of households during health visits and ultimately the distribution of medical resources to specific cluster in each village.

Overall improvement of health of community

In terms of the health outcome of the patients, we asked the healthcare workers if they were able to see the direct link between the device and the patients. However, most of the healthcare workers were not able to respond to this question. Interviewee #21, a 48-year-old female CHW, mentioned "it just benefits us [CHWs] in a way that we don't need to carry the paper folder to visit the families." She, together with many other CHWs, was able to see how the information collected can help the management and monitoring of diseases.

However, when we asked them how was that different from using the paper folder, they were again unable to see the benefits of it with relation to the paper folder. In fact, interviewee #31 commented, "For the patients, it is the same; nothing is the same or is better. The implementation of the device is to focus on the work of the health care worker and not the patients."

Because the users of the technology are the healthcare workers themselves, compliance to health solutions or recommendations are not applicable to the evaluation of impact for this programme. However, a few healthcare workers did mention that the device was helpful in helping them to follow-up with the last health status or conditions of the patients. With the help of the volunteers, CHWs are able to "follow-up and check if they are taking their medicine regularly", as mentioned by interviewee #23, a 27 year old female CHW. This was reiterated by interviewee #13, a 25 year old male CHW, who commented that the "information will be used in the database as a long-run services to the patient for example, we know how many times a patient have visits with us and also it will beneficial for us to follow up on that patient."

Lastly, in terms of raised public awareness, the nature of the application makes this criterion less applicable. However, a few healthcare workers mentioned that better management of the general health data leads to improved health activities that are being planned for the community, and a better understanding and awareness of health. As mentioned by Project Manager, interviewee #30,
Based on this info [from the database] we will be able to initiate some activities to change their behaviour like eating and exercises. We

would like to have the community involvement by getting the budget from them (local authority organisation) to support us with this activity.

Improvement of healthcare system

In terms of improving the efficiency of the healthcare system, this device has notably improved the distribution of resource. Many health workers noted that with the device, less CHWs were required to go on visits and more can stay in the health centres. Interviewee #13 gives one such example, "…in the past when there is no map in the folder, I didn't know where the family is and I have to have another person accompany me in order to find the household."

The time saved from entering data from the paper folder into the JHCIS system also increases efficacy in the job scope of a health worker and allow them to spend more time on other processes. "The device helps to save time because it is very fast when transferring information to the JHCIS" (Interviewee #20). "The device is faster because I don't need to retype the info into JCHIS. But with the folder I need to do that... We save paper and save time" (Interviewee #19).

Also, the picture-taking function of the device allows health workers to be able to identify records of patients immediately, reducing any possible errors. As interviewee # 11 puts it, "The benefit of the device is that it has the camera function and can take photo and can solve the problem when they can recognise the patient." And supported by interviewee #4, "This device is better because they will take photos of the patient, so it is easier for them to recognise the patient because they have the photo when they visit the patient"

One of the long-term benefits of the device is that it allows CHWsto have previously collected information readily available for further follow up. Interviewee # 39 mentioned that "it will be more convenient for the healthcare workers to make use of the previous information regarding the medical records as well as the prescriptions for the next diagnosis." Another healthcare worker also mentioned about the usefulness of the information that is synchronised with the JHCIS database. "The info saved in the JHCIS will be in our database for the next visit for us to follow up on a particular patient because we know that we already visited a particular patient for how many times a year" (Interviewee #11).

Next, the mapping function that allows for marking and locating of current and new households immediately with Google maps was also useful to the healthcare workers. Interviewee #20 provides an example of how it is useful, "After transferring the information into the device, for example…if don't know the house of the granny. I have to consult the map in the device to get to the granny's house". Interviewee #28 further compares this benefit with using the paper folder. "We consult the map from the device to see where the house is… Also we can consult the map on the device (red house/green house) in order to know which house to go to." Interviewee #30 also affirms that by observing, "The Samsung galaxy is better at presenting the workers with a very clear map. [For] The paper one, the households in the map cannot be linked together so they cannot see the overview of map through the traditional method."

Another additional benefit related to the mapping function is also the family tree that is being presented in each household. Interviewee #30 elaborated on this function;

By using the tradition method we need to draw the family tree, and we cannot see immediately which one in the family has health problems…But for the application the patient in the family tree will be shown with a red face icon so it is easier for us to know immediately.

Interviewee #5 also mentioned "[the] head of the family is indicated with a star [on the] house and patient with chronic illness [is indicated by] a red face."

The limitations that are not addressed by this device are still, however, apparent. The device with its excellent communication capability is capable of high technology video communication in emergency cases and communication among health workers with its mobile technology. It boasts connectivity like a phone but with a screen size that enables visual information to be transmitted at real –time. However, many of them are not equipped with the knowledge to make full potential of the device.

For example, some CHWs use the Internet to search for work-related information. "I use Internet to benefit my work for example I use the Internet to search for the information about the condition of the patient when I am not sure after examining the patient" (Interviewee #11). Some use the device for audio or visual communication between co-workers through applications like Skype, ooVoo, calling and short messaging. However, while health workers like interviewee #8, who mentioned that [ooVoo] is the main method of comm. If there is emergency case for any disease, this information will be posted on web board of district office. And we are to use ooVoo to keep us alert and get information from one another.

Many also expressed their lack of knowledge in using such application. "We are not using ooVoo [because] we don't really know how to operate it" (Interviewee #23). In fact, when asked if any other applications are being used on the device, interviewee #22 answered, "No nothing else. Only FFC."

Interviewee #22, a 27 year old female CHW, suggested that she "hope[s] that we [they] will be able to access to the database directly from this device even if we [they] are somewhere else in order to consult the database to benefit the patient". The JHCIS server is not being made online and limits the capability of the device accessing the database online. However, this has to be done only when there is improved internet infrastructure, especially in rural areas where connection is low.

Barriers affecting the impact of the FFC programme

The FFC programme, in its pilot stage, still faces barriers affecting the impact on rural healthcare provision. These barriers are adopted from both the TCM and Extended TCM model, where community, managerial, economical, informational, socio-cultural and individual vulnerabilities are evaluated against the ICT initiative. Being a new introduction to rural healthcare provision, CHWs enjoyed working with the device but are not entirely dependent on it due to several factors. CHWs encountered wireless connectivity issues in rural areas and some wanted more use out of the device; especially with respect to the FFC application. If this frustration is neglected by the management, the communal support and confidence will be lost in the programme; which will then shake the foundations of the ICT initiative.

Asked if it would make any difference to their work if the device was taken away tomorrow, majority of CHWs interviewed shared the view of our 28 year old male CHW, interviewee #32, "it is the same; there is no difference between the paper and the device." This can be attributed to the poor wireless connectivity in rural areas and storage space on the device. Interviewee #21 mentions, "This is a good thing for us but right now we are having a lot of limitations when we are using it in the rural areas and we want to use the Internet access." The management has to conjure more funding to develop network infrastructure in rural areas to address this issue.

This is crucial to improve the provision of rural healthcare as CHWs can contact doctors directly via Skype in the case of a critically ill or injured villager seeking immediate medical attention. Interviewee #22, a 27 year old female CHW, mentions her desire to see such network improvements, she explains:

I would like to have the immediate effect. E.g. when I went out to visit the patients and the information is collected in device; I hope that other users can access the data immediately…We can save patients life if we have this immediate system.

She goes on to cite an example of a chronically ill patient, who might fall prey to the system's inefficiency,

If a patient has cancer, they [the hospital] will send the document regarding that patient health condition to us but it's quite slow. We only receive the documents one week after. When we visit the patients we found out the patient is already in hospital and is about to die. If we have this system to help us transfer info from hospital to us and vice versa it can help the patients.

She shares her frustration that with such advanced technology available, why are such systems not put into place to drastically improve the provision of rural healthcare. Majority of CHWs, however, also notice that the reach of the programme's benefits lie closer to the CHWs than villagers. The individual vulnerability aspect could be detected from the statement made by interviewee #21; "It just benefits us [CHWs] in a way that we don't need to carry the paper folder to visit the families," And reiterated by

interviewee #31, "For the patients, it is the same; nothing is the same or is better. The implementation of the device is to focus on the work of the health care worker and not the patients."

Here we are also presented with the limitations of technology; in the development stage of the FFC programme, some health workers resorted to writing additional information on paper while collecting data because they could not find suitable fields in the application. As elaborated by interviewee #1, a 36 year old male CHW, the diagnosis of "pregnant woman has to be jotted down separately and keyed into the system as there is no option for us to key in this information in the galaxy tab." He also noted that post-natal management is another field that is not available in the application.

DISCUSSION

This study is amongst the first to examine the use of tablet PCs to improve rural healthcare provision in developing countries. We found that the device improves the efficiency of CHWs and the overall healthcare system, albeit in an indirect manner. Usage of the device as compared to previous studies done with mobile phones provides a key benefit, as information can be easily collected, kept and easy accessed (Abernethy et al., 2008). Users also get an increased sense of ownership (Sharples, Corlett, & Westmancott, 2002). Our research also aims to address and possibly resolve the barriers present in new mHealth programmes with the extension of the TCM theoretical framework.

The introduction of the tablet witnessed several changes in the healthcare system; however, the outcomes of ICT implementations never exist as pure benefits or constraints (Chib & Chen, 2011). Although timesaving and convenient, the tablet is a new piece of technology and the experiences and preferences of CHWs vary in several aspects. For example, we have found that providing comprehensive training is essential to aid the healthcare workers in maximising the potential of their usage of the device. For some of the healthcare workers interviewed, the implementation of the device only provides some convenience; they can continue house visits without the device. Further studies should take a more in-depth look at how community and management factors affect the implementation of tablet devices.

The tablet is digitally and physically compact, addressing CHWs needs to carry around more data without physically bearing the weight of bulky paper folders. As compared to the PDA or a smartphone, the screen size of the tablet PC enables CHWs to work with ease. The transferring of data is increased and human error reduced giving CHWs more time to assist the medical centre and improving the quality of data collected.

Also, the speed of which data is transmitted to the Provincial Health Office for evaluation is drastically reduced while the quantity and quality of data improves. However, transmission of data is still confined to the healthcare centre as CHWs experienced limited wireless connectivity.

In addition, training can be conducted to address the needs of CHWs to use other communication applications like Skype or ooVoo to provide immediate healthcare provision during critical emergencies. If this aspect of the programme is not tapped into, the potential for this project to impact the community's health might be stunted. Undeniably sustainable, the management should consider tackling the issues at hand, for example, limited wireless connectivity and storage space, before making far-sighted plans to change the operating platform to the iOS.

Our study plans to exhibit the potential successes of the FFC programme to seek sponsorship from public organisations, for example, local or international telecommunication network operators. With greater monetary support, together with existing governmental support, substantial improvements can be made to the healthcare situation in rural areas. With the inclusion of sponsorship from telecommunication network operators, the erection of communication and network infrastructure in rural areas would be a feasible task that will solve the issue of poor wireless connectivity.

The FFC programme has been considered using the three main dimensions of the TCM Model, and we have extended our evaluation of barriers according to the socio-cultural and individual vulnerabilities of the Extended TCM Model (Chib, Wilkin, et al., Forthcoming).

In light of the possible socio-cultural vulnerabilities, we observed that no such issue exists in the existent system. The tablet was shared amongst CHWs and not specifically allocated to a male or the most senior CHW. The lacking presence of a hierarchal structure exhibits communal effort, which will help sustain FFC programme. However, the individual vulnerability brings about an enlightening view from the CHWs perspective. Handed a new device, CHWs were instructed and trained for data collection purposes. However, as they were not trained to explore other functions and applications, some CHWs were unaware of how much more the device could improve healthcare provision. Only aware of the benefits the device brings about to data collection, CHWs must acknowledge that the aim is to better the quality of healthcare provision to the community.

CONCLUSION

With much effort to improve and address the issues of rural healthcare through mobile technology intervention, the problems of maldistribution of workers and lack of a reliable data system may be overcome. Our research has shown the sustainability of an emerging technology—the tablet PC—in rural healthcare. The TCM model evaluates the project based on the 3 dimensions: Technology, Community and Managerial factors while the Extended TCM model addresses the barriers affecting the impact of an ICT initiative. We showed that the project was sustainable and also examined the short and long term impacts of the project, an area that is not covered by the TCM model. It is shown that even with sustainability; the impact of the initiative is limited and not yet being maximised to its fuller potential. These are due to barriers like maximising the use of a mobile device, and also mobile technology infrastructure that hampers the improvement of the health system brought about by the technology. However, we also took into considerations the fact that this initiative is still in its pilot stage and is still being explored today.

Our findings for the study have many implications for the healthcare sector in Thailand and other rural areas, especially in Asia.

We also added and contributed to the literature of this emerging field of the use of tablet computers for rural healthcare, based on the TCM model. While there are limitations to our study, we have provided a stepping-stone for future researchers to study more in depth about the use of new mobile technologies in the provision of rural healthcare.

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