Implementing Mobile Phone Solutions for Health in Resource Constrained Areas: Understanding the Opportunities and Challenges

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Abstract. This paper presents results from a study on mobile phone use to connect two rural hospitals in Malawi with community health workers (CHWs), the hospitals work with. Mobile phone use at the hospitals has helped reduce the need for face-to-face communication to permit patient information exchange, meetings and appointments scheduling, as well as work coordination. On the other hand mobile phone use has proved paradoxical as it has introduced users to challenges, like recharging of phone batteries, they did not anticipate. The paper highlights use context-centric and solution based opportunities and challenges associated with mobile phone use in rural settings.

Keywords: mobile phones, use context, paradox, opportunities, challenges.

1 Introduction

Mobile phones have become an increasingly important information and communication technology. For example, 22 percent of Africa's population owned mobile phones at the end of 2006, compared to 3 percent with fixed telephone lines and 5 percent with Internet [18]. Furthermore, unlike personal computers and fixed line phones, mobile phones provide users with a high degree of independence, mobility and flexibility [2].

On the other hand, despite providing users with various benefits, mobile phone use also presents users with various unintended consequences (see [2] and [10]). Compared to static computing terminals, mobile phones are more susceptible to loss or damage, are resource-poor, have limited battery power, and their performance is highly variable due to gaps in network coverage (see [16] and [10]).

This paper is based on a study of mobile phone use to support health information exchange at two rural mission hospitals in Malawi. The hospitals, St. Gabriel's hospital and St. Martin's hospital, serve a total population of over 240 000 people, between them. At the hospitals mobile phones are currently being

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used to coordinate tasks and meetings, request urgent medical help, provide support to community health workers (CHWs), and relay patient updates between the hospitals and CHWs.

The paper addresses the following questions: How does the use context influence mobile phone use?; What opportunities and challenges are associated with the use of currently existing mobile phone solutions?

2 The Research Study

The study took a qualitative case study approach and was informed by the interpretive paradigm. Study data was mainly collected through semi-structured interviews. Additionally, document analyses, observations, and SMS log analyses were also used to gather additional data and cross-check data validity.

3 Literature Review

Some previous studies have shown that effectively working health information systems are necessary to ensure good health management (see [14] and [6]). For instance, providing timely and accurate data to managers in the health sector can enhance effective resource allocation and epidemic monitoring and control (see Lippeveld et al. [13] and [1]). However, the poor state of ICT infrastructure in developing countries limits successful ICT projects implementation [4]. This coupled with unreliable physical (e.g., roads and power supply) and communication infrastructure contributes to the underperformance of health management information systems in developing countries [11].

However, despite such challenges, mobile technologies can be used to enhance timely access to information at the point of care and enable health care professionals prescribe proper treatment [12]. It is critical, though to understand the context of operation when implementing mobile technology-based solutions. Their mobility and multiplicity of use contexts means multiple factors can positively or negatively influence their use [17]. Besides, understanding the local context of use is crucial in any technology's implementation process [19].

4 Conceptual Background

When implementing mobile phone solutions it is critical to realise that user interaction with such solutions is not independent of the use context's gravitational pull. According to Jarvenpaa and Lang [10] mobile phone use is influenced by, and influences, multiple situational factors that are technological, personal, organisational, and cultural in nature.

This paper builds on the argument that the use of mobile technologies gives rise to both intended and unintended consequences, and is therefore paradoxical. For example, *mobile technologies empower people and create new forms*

of enslavement (empowerment/enslavement paradox). The use of mobile technologies *fulfils users' needs, but also creates needs* (fulfils needs/creates needs paradox). Furthermore, ownership of mobile phones can *create illusions of expectation* which if not met can lead to *user disillusionment* (illusion/disillusion paradox) (see [2] and [10]).

4.1 Information Infrastructure Theory

The paper also uses the concepts of *installed base* and *heterogeneity*, from the Information Infrastructure Theory (see [7] and [8]). The *installed base* concept emphasises that information infrastructures are not built from scratch, but rather from what is already in existence [7]. An *installed base* can, for example, comprise various integrated services and applications, their users and developers, as well as work practices that an infrastructure aims to support and embed [8]. *Heterogeneity* emphasises that information infrastructures are made up of a varied range of interdependent socio-technical components that are linked to conventions of practice, they influence and are influenced by [3].

5 The Case Study

The hospitals under study are currently using mobile phones to enhance communication between medical personnel and CHWs. This is being done in an environment where ICT infrastructure, with the exception mobile telephony networks, is poorly developed.

5.1 Mobile Phone Communication Setup and Management

The two hospitals have given out mobile phones to CHWs and some medical personnel to permit communication. Currently, St. Martin's hospital uses voice calls and St. Gabriel's hospital uses SMS to permit information exchange. Furthermore, St. Gabriel's hospital uses FrontlineSMS, an SMS management system, to log incoming and outgoing text messages.

Home Based Care (HBC) coordinators at the two hospitals link communication between CHWs and medical personnel. They monitor incoming and outgoing voice calls and text messages, and then re-route them to the appropriate addressees.

Besides providing a communication base the hospitals also set the tone for correct mobile phone use as illustrated in quote below:

> *"We were instructed to use this phone to call for an ambulance, when someone is sick." (CHW - St. Martin's hospital, 2008)*

5.2 Current Use of Mobile Phones

Currently mobile phones are, among other things, being used to reduce the need for face-to-face communication, to permit information exchange, between

CHWs and the hospitals. For example, CHWs are now able to remotely update the hospitals on their work and patients' medical status. Further to this, mobile phone use has also helped reduce the need for people to walk or cycle to distant villages, to announce arrangements for, or cancellations of, meetings and other appointments. The following quotes underscore these points:

> *"Previously we had problems submitting reports. Sometimes we had messages that needed to be communicated to the hospital on the same day. We, therefore, had to cycle to the hospital. Those who did not have bicycles would walk to the hospital." (CHW - St. Gabriel's hospital, 2009)*

> *"Currently, the hospital can communicate with us more easily. For example, I got the message for this meeting when I was out in the field gardening." (CHW - St. Gabriel's hospital, 2009)*

Furthermore, mobile phone use now permits medical personnel and CHWs to plan and share workload when organising patient follow-ups. For instance, voice calls or text messages are used to coordinate patient tracking and referrals, as indicated in the quote below:

> *"Please track patient A. The patient is not coming [to the hospital] for appointments." (HBC coordinator-St. Martin's hospital, 2008)*

More than this, mobile phones are also being used to remotely provide CHWs with expert medical advice on how to handle certain medical cases. In addition, at St. Gabriel's hospital, CHWs can now get reminders on how to administer various drugs via SMS. This is done by sending already fixed code-words, for various drugs, to the hospital's SMS management system.

5.3 Challenges Being Faced

Although mobile phone use has enhanced how the hospitals and CHWs interact and work, challenges exist. The challenges relate to *technological, organizational, personal, and cultural factors,* which together make up the use context.

Technological Factors

Existing technological challenges include lack of electricity connection in the homes of most CHWs, forcing them to walk long distance to recharge their phones; the existence of pockets with no cellular telephony network coverage and intermittent phone services; and the existence of poor road networks, which make it hard for people to access community phones or for the hospitals to quickly get to patients. The last two points are illustrated by the following statements:

> *"Another problem is the network especially for those who are coming from very far. You can text them an emergency message 'Please, can*

you come for a meeting tomorrow?' If there is no network they receive that message, maybe, two days later." (HBC coordinator- St. Gabriel's Hospital, 2008)

"Our villages are located in a remote area where roads are seasonal, so it becomes very, very difficult to travel from this village to the other...Transportation is one of the biggest problems." (HBC coordinator- St. Martin's hospital, 2008)

Organisational Factors

Existing organisational challenges include lack technical capacity to repair broken phones or further customize implemented mobile phone solutions, to meet changing needs; existence of weak monitoring and evaluation frameworks for measuring project impact and outcomes; and the cost of hiring an ambulance at St. Martin's hospital acts as a deterrent to community phones use, even though people can use the phones for free when calling for an ambulance. A CHW from St. Martin's hospital had this to say, in line with this:

"We told people in the villages that if they have a patient they can come to me so I call the hospital for help [an ambulance]. They don't come though. They are transported to the hospital by relatives who own cars, because the ambulance service is not free. People would not allow to be transported to the hospital using an ambulance when they can be transported there for free by their relatives. "(CHW - St. Martin's hospital, 2008).

Here the cost the cost of hiring an ambulance acts as a deterrent to an otherwise free service.

Personal Factors

At personal level, some community health workers at St. Gabriel's hospital have problems using free-form texting because they posses inadequate writing skills. At times, it is hard to decipher the meaning of text messages sent in by some CHWs. For example, in the message below a CHW wrote an entire message as one word:

"Mudwelekunokulimatendaenaofunikamutadwelakukaonamunenetsikulodwelazikomo"

Cultural Factors

Finally, at cultural level, Malawian traditional leaders are quite influential as regards what goes on in areas within their jurisdiction. For example, at St. Martin's hospital, chiefs were mainly influential in deciding to locate community phones at trading centres and close to main roads. This has made community phones less accessible to a considerable section of the target population.

6 Discussion

6.1 Influence of Use Context (Installed Base) on Mobile Phone Use

The mobile phone solutions under study here were introduced in an environment with already existing heterogeneous socio-technical systems. Among others, these included existing paper-based record management systems, mobile phone communication infrastructure, as well as organisational, personal, and cultural practices. Such pre-existing components provide the building blocks or installed base [8] on which the phone solutions, under review here, are built.

Organisational factors

These mobile phone solutions have been built on the hospitals' competencies and human as well as financial resources. For instance, the mobile phone solutions have been built on the hospitals' work and communication practices. Furthermore, the hospitals and their expectations help align users' ambitions when using their phones. On the other hand, as presented earlier, the cost of hiring an ambulance, at one of the hospitals, is deterring people from using community mobile phones to request ambulance services.

Cultural factors

Social and cultural characteristics can either enhance or limit ICT use and adoption, through shaping peoples attitudes and subjective norms [5]. For example since chiefs are quite influential in Malawi, involving them in project activities makes it easier to get their subjects on board. This, in turn, eases the rolling out of technologies within their communities. Building on already existing structures makes it possible for new innovations to leverage the installed base's strengths (see [7] and [8]).

On the other hand, relying on already existing components such as cultural norms does negatively influence mobile phone use, as various limitations inherent in the installed base are transferred to the mobile telephony projects. For example, the use of traditional authorities in determining where to locate CBO phones, has resulted in the phones being less accessible to some people.

Technological factors

Unlike stationary computers or fixed line phones, mobile technologies accord users more flexibility as regards when and where use occurs. Since mobile technologies can be carried along by a user they can be used in various places, as and when the user sees fit (see [20] and [9] and [10]). Due to such use flexibility, medical personnel and CHWs are able to communicate and coordinate activities, remotely. They are also able to communicate outside specified working hours.

On the other hand, technological limitations, like small screen sizes and tiny input keys make mobile phones unsuitable for other tasks. Even further, due to their mobility, mobile phones are subject to variations in performance because they rely on limited battery power and varying technical infrastructure to operate (see [16] and [10]). For example, recharging of phone batteries is quite problematic in rural settings like the hospitals where this study was conducted, as most people do not have electricity at home. Furthermore, pockets with no GSM network coverage within the hospitals' catchment areas, combined with intermittent mobile phone services, place limitations on *when and where* people can communicate.

Besides these factors, the conditions of other physical infrastructure like roads does enhance or limit the impact of phone use. For example, poor road conditions during the rainy season reduce the effectiveness with which phones can be used. As Hanseth and Lyytinen [8] put it, though heterogeneous, all components of an infrastructure are interdependent.

Personal factors

As has been previously put, the mobile phone solutions under study build on people's competencies to communicate. SMS-based communication, for example, relies on users' writing skills. Messages from users with low writing skills are potential error sources, as messages they write are hard to decipher. Moreover, it is difficult to maintain quality in free-form data entry, as inconsistent spelling and other mistakes are common (see Parikh et al. [15]).

6.2 Application-Centric Opportunities and Challenges: Paradoxes of Mobile Phone Use

Mobile phone use does not only end with achieving set user goals. Rather, it also gives rise to contradictory performances (see [2] and [10]).

The Empowerment/ Enslavement paradox

Opportunities: Empowerment
Mobile phone use at the two hospitals now allows users the freedom to communicate at unpredictable times and from unpredictable places. This is demonstrated by the ability of CHWs and medical personnel to communicate and collaborate remotely. Furthermore, at St. Gabriel's hospital, mobile phone use has empowered CHWs by enabling them to increase report submissions and cut down on the number of trips they make to the hospital. Mobile phone use reduces geographical and time barriers to communication, allowing users to communicate anytime, and from various unpredictable places [9]. Reducing the need for face-to-face meetings has enabled medical personnel and CHWs, at the hospitals where this study was conducted, to save on time.

Challenges: Enslavement
In as much as the use of phones empowers users, allowing users constant connectivity fuses work and spare time, as users are unable to separate and keep distance from work. This, then, means that users have less personal time, which can result in increased work pressure (see [9] and [10]). For example, for less experienced community health workers, giving patients anytime access to them, might lead to increased work pressure.

Fulfills Needs/Creates Needs paradox

Opportunities: Fulfilling Needs
As is evident from the case study, mobile phone use at the two hospitals has enabled CHWs to more constantly and quickly provide the hospitals with patient updates. This way the hospitals are better placed to provide better care to chronically ill clients. The use of mobile phones, at St. Gabriel's hospital, to remotely share and coordinate tasks also helps address the negative impacts of having few medical personnel who can conduct patient visitations. Furthermore, mobile phone use helps fulfil CHWs information needs on how to handle certain medical cases and administer medication.

Challenges: Creating Needs
Besides fulfilling various user needs, the use of mobile phones has exposed users to a range of problems. For example, users now have to worry about mastering the mobile phone solutions in use and any extensions that might be made. Furthermore, to be able to communicate, users have to worry about raising money for phone credit. Even further, the hospitals' HBC coordinators need to be constantly accessible due to the role they play in routing information between the hospitals and CHWs. This cannot always be achieved and introduces delays in information exchange, as the HBC coordinators also need to perform other duties.

The Illusion/Disillusion paradox

Opportunities or illusion?
The use of mobile phones brings with it so much promise. For example, owning a mobile phone gives the impression that one can take charge of situations and collaborate with colleagues and clients, *anytime and from anywhere* (see [10] and [9]). Mobile phone use also suggests improved information delivery, and expedited access to healthcare services since one can quickly request medical help. Additionally, the use of software such as FrontlineSMS that supports the redirection of text messages gives the impression that users can share information as and when they please.

Challenges: Illusions and disillusionment
Empirical evidence from the two hospitals under study shows that communication is only possible *sometimes and in some places*, due to incomplete network

coverage in some places. Furthermore, anytime communication requires that communication partners are available at the other end and willing to communicate [10]. To add on to this, at St. Gabriel's hospital, the FrontlineSMS system is switched of at night. This effectively means that text messages sent by CHWs at night remain undelivered until the next morning.

Apart from the factors above, FronlineSMS does not effectively support the notion of anytime anywhere communication. FrontlineSMS is a desktop system, making it harder for the system administrator to access and forward messages to other users, when out of office. Although FrontlineSMS supports text message forwarding to remote email accounts, this requires Internet access.

7 Conclusion

The implementation and successful use of mobile phone solutions in rural areas relies on factors such as the quality of existing infrastructure, cultural practices, and users' competencies. For example, SMS-based mobile phone solutions rely on users' writing competencies. Further to this, the paper has shown that the use of mobile phone solutions in rural settings faces challenges such as poor electricity connections and incomplete GSM network coverage. For example, due to incomplete GSM network coverage and intermittent mobile telephony services, at the hospitals where this study was conducted, it is not always possible for phone users to communicate *anytime and from anywhere*. Rather, they can only communicate *sometimes and in some places*.

In contrast to the above stated challenges, this paper has highlighted that even in areas where most ICT infrastructure is underdeveloped, mobile phone use can enhance communication between medical personnel and CHWs. The paper has also highlighted that mobile phone use has reduced the need for face-to-face communication to permit information exchange and work coordination. Furthermore, by using mobile phones to exchange patient updates with CHWs, and support the work of CHWs, the hospitals under study are now better placed to provide patients with urgent help, when need be.

Above all else, empirical evidence gathered in this study strongly suggests that users are willing to put in a lot of effort towards making mobile phone solutions work, if the solutions directly address their needs. Secondly, another key factor to successful mobile solutions sustainability is sustained and proactive isolation and minimization of user-technology conflict situations.

References

1. Abouzahr, C., Boerma, T.: Health information systems: The foundation of public health. Bulletin of the World Health Organisation 83, 578–583 (2005)
2. Arnold, M.: On the phenomenology of technology: The "Janus-faces" Of mobile phones. Information and Organization 13, 231–256 (2003)
3. Bowker, G.C.: The history of information infrastructures: The case of the international classification of diseases. Information Processing and Management 32, 49–61 (1999)

4. Dada, D.: The failure of e-government in developing countries: A literature review. Electronic Journal of Information Systems in Developing Countries 26, 1–10 (2006)
5. Erumban, A.A., Jong, S.B.D.: Cross-country differences in ICT adoption. A consequence of culture? Journal of World Business 41, 302–314 (2006)
6. Galimoto, M.S.: Integration of health information systems: Case study from Malawi. Department of Informatics. Oslo, University of Oslo (2007)
7. Hanseth, O.: The economics of standards. From control to drift - the dynamics of corporate information infrastructures. Oxford University Press, Oxford (2000)
8. Hanseth, O., Lyytinen, K.: Theorizing about the design of information infrastructures: Design kernel theories and principles. Case Western Reserve University, USA. Sprouts: Working Papers on Information Systems 4(12) (2005), `http://sprouts.aisnet.org/4-12` (accessed October 26, 2009)
9. Hurme, P.: Mobile communication and work practices in knowledge-based organizations. An Interdisciplinary Journal on Humans in ICT Environments 1, 101–108 (2005)
10. Jarvenpaa, S.L., Lang, K.R.: Managing the paradoxes of mobile technology. Information Systems Management 22, 7–23 (2005)
11. Kimaro, H.C., Nhampossa, J.L.: Analyzing the problem of unsustainable health information systems in less-developed economies: Case studies from Tanzania and Mozambique. Information Technology for Development 11, 273–298 (2005)
12. Kushchu, I., Kuscu, M.H.: From e-government to m-government: Facing the inevitable. In: European conference on e-Government (ECEG). Trinity College, Dublin, European conference on e-Government, pp. 253–260 (2003)
13. Lippeveld, T., Sauerborn, R., Bodart, C.: Design and implementation of health information systems, Geneva, World Health Organization (2000)
14. Lungo, J.H.: Data flows in health information systems: An action research study of reporting routine health delivery services and implementation of computer databases in health information systems. Department of Informatics. Oslo, University of Oslo (2003)
15. Parikh, T., Javid, P., Sasikumar, K., Gosh, K.: Mobile phones and paper documents: Evaluating a new approach for capturing microfinance data in rural India. In: Conference on Human Factors in Computing Systems, Montréal, Québec, Canada. Association for Computing Machinery, New York (2006)
16. Satyanarayanan, M.: Fundamental challenges of mobile computing. In: 15th ACM Symposium on Principles of Distributed Computing, Philadelphia, PA. Association for Computing Machinery, New York (1996)
17. Scheepers, R., Scheepers, H., Ngwenyama, O.K.: Contextual influences on user satisfaction with mobile computing: Findings from two healthcare organizations. The European Journal of Information Systems 15, 261–268 (2006)
18. United-Nations, The millennium development goals report, New York, United Nations (2008)
19. Walsham, G., Sahay, S.: Research on information systems in developing countries: Current landscape and future prospects. Information Technology for Development 12, 7–24 (2006)
20. Weilenmann, A.: Negotiating use: Making sense of mobile technology. Personal and Ubiquitous Computing 5, 137–145 (2001)