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Acceptability and use of mHealth tools by auxiliary midwives in Myanmar: a qualitative study

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Résumé

Le manque de sages-femmes au Myanmar a engendré une transition vers la prestation des soins pré et postnataux par des sages-femmes auxiliaires (SFA). La qualité de leurs services est cependant compromise par une formation et une supervision propice limitées. Afin d'améliorer leur performance, une ONG a implanté un projet de mSanté en 2014 dans la commune de Dala, donnant accès aux SFA à des téléphones intelligents munis d'un système électronique d'enregistrement de clients et d'aide à la décision clinique (eADC) sous forme d'application mobile. Les théories du changement de comportement suggèrent que la modélisation du soutien à la décision clinique basée sur des algorithmes pourrait contribuer à un meilleur respect des bonnes pratiques cliniques, qui à son tour pourrait améliorer la qualité des soins et, ultimement, mener à une diminution de la mortalité maternelle. Étant donné qu'il s'agissait au Myanmar du premier projet de mSanté en point de service, l'objectif de la présente étude fut d'explorer si les SFA accepteront et utiliseront ces outils de mSanté (option d'appel et application mobile).

Un devis de recherche qualitative a été appliqué pour explorer les perceptions de l'ensemble des SFA ayant participé au projet pilote (n=20) et ce, par le biais d'entretiens semi-structurés et de *focus groups*. Le cadre conceptuel ayant guidé cette étude, basé sur les théories d'acceptation des technologies qui ont pour prémisse que si les outils de mSanté sont perçus comme faciles à utiliser, utiles et ayant une influence sociale positive, les SFA les accepteront (l'acceptation étant un prédicteur de l'utilisation), alors que les barrières et facteurs facilitants relatifs au contexte d'implantation influenceront directement l'utilisation des outils de mSanté. L'approche «Framework» fut utilisée pour l'analyse des données.

Les résultats montrent que les outils de mSanté sont généralement perçus comme étant faciles à utiliser, utiles et les personnes importantes dans l'environnement social des SFA étaient généralement en faveur de leur utilisation par les SFA. Ces résultats suggèrent que l'acceptation des outils de mSanté par les SFA de la commune de Dala sera élevée. Cependant, celles-ci ont admis avoir besoin de formation et de soutien technique continus, en plus d'une supervision soutenue. Une barrière contextuelle clé fut les problèmes de réseau Internet, mais des facteurs facilitants inattendus de nature socioéconomique dans la commune de Dala ont également eu une incidence favorable sur l'utilisation des outils de mSanté.

L'étude met surtout en lumière, cependant, que l'acceptation et l'utilisation des outils de mSanté par les SFA étaient notamment déterminées par leur croyance en la mSanté et par leur professionnalisme à caractère public qui à leur tour étaient renforcés par un soutien politique en faveur de la mSanté et d'une éthique du service. Malgré les barrières rencontrées, les SFA furent déterminées à adopter les outils de mSanté, car elles les estiment supérieurs aux systèmes traditionnels, comme constituant la norme de l'avenir et comme étant dans le meilleur intérêt de leurs communautés et du système de santé.

Mots-clés: mSanté, acceptation, eADC, Téléphone intelligent, sage femmes auxiliaires, théories d'acceptation de technologie, Myanmar, approche Framework

Abstract

Myanmar's lack of midwives led to shifting of pre- and postnatal care tasks to auxiliary midwives (AMWs). However, the limited training and supportive supervision AMWs receive compromise the quality of their services. To improve their performance, an NGO implemented an mHealth project in Dala Township in 2014, providing Smartphones to AMWs with an application consisting of electronic patient registration and electronic clinical decision-support (eCDS). Behavioral theories suggest that algorithm-based clinical decision-support modeling may contribute to improved clinical compliance, which may increase the quality of care and, ultimately, decrease maternal mortality. As it was Myanmar's first point-of-care mHealth project, the study's objective was to explore whether AMWs would accept and use the mHealth tools (call option and application).

In a qualitative explorative design, perceptions of all AMWs participating in the pilot (n=20) were explored through semi-structured interviews and focus groups. The Framework approach was used for data analysis. The study was guided by a conceptual framework based on technology acceptance theories that claim that acceptance predicts use. The framework's premise is that AMWs will accept mHealth tools if they are perceived as easy to use, as useful, and when important others in the social environment of AMWs support their use. However, barriers and facilitators in the implementation context are expected to influence the use of mHealth tools directly.

Our study suggests that acceptance of mHealth tools by AMWs in Dala Township was high. mHealth tools were generally perceived as easy to use, useful, and important others in the social environment of AMWs were mostly supportive of AMWs using mHealth tools. However, AMWs admitted needing ongoing training, technical support, and supervisory support. Internet network problems represented the key contextual barrier, but unexpected socioeconomic facilitators in Dala Township facilitated the use of mHealth tools. This study especially highlights, however, that acceptance and use of mHealth tools by AMWs in Myanmar were notably determined by their belief in mHealth and their public-spirited professionalism, which were in turn reinforced by an ethos of service and political support for mHealth. Despite the barriers they encountered, AMWs were determined to embrace mHealth

tools, as they believed them to be superior to the traditional system, the future norm and in the best interest of their communities and health system.

Keywords : mHealth, acceptance, eCDS, Smartphone, auxiliary midwives, technology acceptance theories, Myanmar, Framework approach

Table of contents

List of figures

List of acronyms

AMW	Auxiliary Midwife
ANC	Antenatal Care
App	Application
CHW	Community Health Worker
DHIS2	District Health Information System 2
eCDS	electronic Clinical Decision-Support
LMIC	Low- and Middle-Income Countries
mHealth	Mobile Health
MOH	Ministry of Health
PDA	Personal Digital Assistant
PI	Principal Investigator
PNC	Postnatal care
PUI	Première Urgence Internationale
RHTO	Reproductive Health and Training Officer
TAM	Technology Acceptance Model
TSF	Télécom Sans Frontières
TRA	Theory of Reasoned Action
UTAUT	Unified Theory of Acceptance and Use of Technology

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Chapter 1: Introduction

Myanmar witnessed a substantial reduction of its maternal mortality ratio between 1990 and 2015: from 453 maternal deaths per 100,000 livebirths in 1990 to 178/100,000 in 2015. It remains among the highest in Southeast Asia, however. In comparison, neighboring Thailand's maternal mortality ratio in 2015 was 20/100,000 (WHO, 2015).

High maternal mortality ratios are often seen as a key indicator of poor functioning health systems that fail to supply adequate skilled birth attendance (Borghi, Ensor, Somanathan, Lissner, & Mills, 2006; Fraser, Kamal-Smith, & Watkins, 2004). Myanmar suffers workforce shortages, with midwives covering as many as five to eleven villages (MOH Myanmar, 2010). This led to task shifting of pre- and postnatal activities to auxiliary midwives (AMWs) who are specialized community health workers (CHWs) (MOH Myanmar, 2010). The limited training and supportive supervision AMWs receive compromise the quality of care (Lehmann & Sanders, 2007). However, mHealth (mobile health) may help CHWs to overcome these barriers (Braun, Catalani, Wimbush, & Israelski, 2013).

Istepanian and Lacal (Istepanian & Lacal, 2003) coined the term mHealth, which is generally defined as public health practice that is supported by mobile devices such as mobile phones (Kay, Santos, & Takane, 2011). mHealth strategies may improve maternal and newborn health in developing countries through improved communication between health workers, clients, peers, and supervisors, through more effective and efficient organization of referrals, and through applications that support clinical decision-making (Braun et al., 2013; Tamrat & Kachnowski, 2012). The latter in mHealth jargon is called electronic clinical decision-support (eCDS). Its effectiveness hinges on the ability to provide algorithm-based automated prompts with actionable recommendations that are delivered at the time and place of decision-making (Garg et al., 2005; Kawamoto, Houlihan, Balas, & Lobach, 2005; Rooij & Marsh, 2016). mHealth may therefore contribute to improved clinical compliance, which in turn may increase the quality of care (Patel, Arocha, Diermeier, Greenes, & Shortliffe, 2001) and, ultimately, decrease maternal and neonatal mortality.

With this rationale, the French NGO Première Urgence Internationale (PUI) implemented Myanmar's first point-of-care mHealth project to support improved clinical decision-making by AMWs in Myanmar. In collaboration with Télécom sans Frontières, a Smartphone application including patient registration and eCDS for antenatal and postnatal care (ANC & PNC) was developed. In August 2014, the project was piloted in Dala Township with 20 AMWs and 10 of their supervising midwives. The NGO wanted to know whether AMWs would accept and use the mHealth tools (Smartphone and the application) and asked the Principal Investigator (PI) to help them with this investigation.

1.1. Relevance of the topic

This study is the first known point-of-care mHealth study in Myanmar. The implementing organization needs the formative information gleaned from the findings, as it intends to scale out their pilot project to other areas in Myanmar. Moreover, findings will inform other stakeholders in Myanmar, such as the Ministry of Health (MOH) and other mHealth program developers and implementers, as mHealth program development surged since international telecom development started.

During 50 years of military rule in Myanmar, cellphones had been unaffordable and connecting to unauthorized Internet networks punishable by prison. Recently transitioned into democracy, Myanmar has started encouraging independent research. I believe that both the research community and practitioners might benefit from knowledge about this unchartered context and study population. Moreover, our exploratory investigation is guided by technology acceptance theories, something that, to my knowledge, has not yet been done in low- and middle-income contexts.

1.2. Structure

I first review the literature on acceptance and use of mHealth applications and present the conceptual framework that we use for our investigation and analysis. This is followed by a description of the methodology. The results chapter is presented in article form in which I report and discuss major findings and limitations of the study. The discussion chapter offers a deeper level of interpretation and analysis of findings. In a short additional results chapter we

briefly report additional findings that are being developed into a second article, but are not part of this thesis. After the conclusion and references, annexes are found for the interview guide, the thematic coding framework, the AMW characteristics, the Central Chart (matrix for cross analysis of data), the program rationale of the mHealth project, a visual presentation of the CommCare application (English version) that was used by AMWs at the time of data collection, and ethical approvals from the Ethical Review Committee in Myanmar and the Comité d'éthique de la recherche en santé de l'Université de Montréal.

Chapter 2: Literature Review

2.1. Introduction

To learn whether AMWs in Myanmar would accept and use the mHealth tools, we first reviewed the literature on mHealth in general and how it was used in low- and middle-income countries (LMIC). We subsequently looked for theories and frameworks about acceptance and use of new technology, as using existing theory could help focus on studies that would be particularly relevant for our study, while providing for a framework to make sense of what we would see (Maxwell, 2012). Before we report our search strategy and review of more detailed substantive findings, we briefly address the theories on acceptability and use of technology we used for our literature review.

2.1.1. Theories on acceptability and use of technology

User acceptance theories assume that decision-making is based on the assumption that rational individuals consciously make choices in their best self-interest (Scott, 2000). According to Fishbein and Ajzen's Theory of Reasoned Action (TRA) (M. Fishbein, 1975), acceptance is behavioural intention to use. Davis's Technology Acceptance Model (TAM) (Davis, 1989) is an adaptation of the TRA, tailored to fit the context of information systems (Hillmer et al., 2008). The original TAM consists of two constructs that determine behavioural intention to use: perceived ease of use and perceived usefulness (Davis, 1989).

In an elaboration of the TAM, Venkatesh et al. developed the Unified Theory of Acceptance and Use of Technology (UTAUT). The UTAUT-model is based on a meta-analysis of eight technology acceptance models. It demonstrates that, on top of the two TAM constructs, acceptance is determined by social influence (Venkatesh, Morris, Davis, & Davis, 2003). Moreover, the UTAUT demonstrates that factors in the implementation context predict use but not acceptance (Venkatesh et al., 2003).

Informed by the TAM and UTAUT, we reviewed the literature for acceptance and use of mHealth tools, focusing specifically on above-mentioned constructs.

2.1.2. Search Strategy

A systematic literature search of three electronic and online databases (Web of Knowledge, PubMed, Google Scholar) was undertaken in March 2016. A combination of the following search terms was used: mHealth + acceptability, acceptance, adoption, technology, decision support, barriers, facilitators, auxiliary midwives, midwives, community health workers, frontline health workers.

Studies and conference proceedings were included if they provided data regarding health workers' perceptions of an mHealth application on a mobile device (keypad phones, Smartphones, PDA's). Additionally, studies providing data on barriers and facilitators in the implementation context were included. Studies had to be published in English and pertaining to LMIC. Book chapters, commentaries, and abstracts without full text were excluded. The search yielded 2360 titles that were checked for relevance and duplication. A total of 422 papers were retained for abstract review, after which 67 papers were selected for full text review.

As this study's objective was to inform the implementing organization, it was important to look further than perceptions alone. References of included papers were therefore checked for identification of publications reporting results of, and experiences with actual ease of use and usefulness of mHealth tools and social influences. As a result, we looked at the full range of studies regarding acceptance and use of mHealth tools. These include usability and feasibility studies that provide insight in health workers' expectations prior to implementation of an mHealth intervention, research papers that provide feedback on mHealth projects after these have been implemented, as well as quantitatively measured results, i.e. actual ease of use or usefulness.

We focused on the following mHealth tools: i) the voice option of mobile phones (calling), ii) electronic clinical decision-support (eCDS) applications, or iii) the SMS functionality in LMIC. With regard to the effect of social influence, we investigated what the literature reported about expected and actual feedback on the use of mHealth tools from patients, the community, peers and supervisors, as well as what effect this feedback might have had on health workers. Our review of contextual facilitators and barriers included papers with information on infrastructural, organizational,

socioeconomic, and political factors that might have affected the use of mHealth tools. Many studies reported findings on the use of mHealth tools without specifying acceptance. In such cases, we reported these findings under the construct that seemed most appropriate. As AMWs are community health workers (CHWs), we mainly focused on acceptability and use of mHealth tools by other CHWs, although we have included the occasional study on nurses' perceptions. We report findings from the literature review for each of the technology acceptance theories' constructs mentioned above.

2.2. What does the literature tell us about the main constructs under study?

2.2.1 (Perceived) Ease of Use

Davis (1989) defines "*perceived ease of use*" as *"the degree to which the person believes that using a particular system would be free of effort*" (Davis, 1989) (p.320), which predicts the system's acceptance and its actual use. mHealth tools can be qualified as easy to use if they require little mental effort, if only few errors are made, if interaction with mHealth tools is flexible, and when the technology is easy to understand and remember. Thompson et al (1991) add that using the system should not take too much time from normal duties (Thompson, Higgins, & Howell, 1991). Ease of use is considered an important adoption factor for early adopters in Roger's Innovation and Diffusion Theory but its effect decreases with experience in using the innovation (Rogers, 2003). Applied to mHealth tools, for phone calling we think of how easy or difficult it may be to execute basic tasks such as switching the phone on and off, or checking for roaming and battery power. With regard to the ease of use of the eCDS application or SMS technology, we look for simple and intuitive functionalities that facilitate easy understanding, learning, and remembering how to use these tools. Both hard- and software should be user friendly, i.e. adapted to the target group and to the context in which mHealth tools are used. In contrast, if mHealth tools are in any way difficult to use it is likely that users will not accept, and therefore not use them.

In a pre- and post-test evaluation of knowledge and skill acquisition, Lori et al (2012) report that after a 3-day training on SMS use, 99 low- to non-literate traditional birth attendants in Liberia had no problems executing basic tasks, such as turning on the phone, check for roaming, and verifying whether the phone is charged. With more complex tasks such as creating and sending of SMS text messages, or adding credit with a top-up card, traditional birth attendants who already had cellphones in their families scored significantly better in the post-test (Lori, Munro, Boyd, & Andreatta, 2012).

CHWs in India adapted to using eCDS in multi-media smartphones in just two days, with one AMW with low literacy skills scoring the highest compliance score for fever, diarrhoea and respiratory protocols (Gautham, Iyengar, & Johnson, 2014). In Columbia, a voluminous clinical guideline (Integral Management of Childhood Illnesses) was presented to CHWs as an eCDS application on a Smartphone with 220 encoded steps (Florez-Arango, Iyengar, Dunn, & Zhang, 2011; Iyengar & Florez-Arango, 2013). The breaking-down into small steps of this complex medical advice reduced the cognitive overload (Iyengar & Florez-Arango, 2013), which led to a 33.15% reduction of errors ($p<.0001$) and increased protocol compliance by 30.18% ($p<.0001$) (Florez-Arango et al., 2011).

However, attention needs to be given to the adaptation of mHealth applications to the local language and context (Blanas et al., 2015; Chib, Lwin, Ang, Lin, & Santoso, 2008; Gautham et al., 2014; Jennings, Ong'ech, Simiyu, Sirengo, & Kassaye, 2013; Mwendwa, 2016; Praveen et al., 2014; Raghu, Praveen, Peiris, Tarassenko, & Clifford, 2015). For example, in a study exploring acceptability of potential mobile phone use for community case management of malaria, CHWs in Senegal stressed that the application would need to be in French (Blanas et al., 2015). CHWs in India complained about font issues and local language being rendered inaccurately in an eCDS application developed for cardiovascular diseases (Praveen et al., 2014). The Smartphone eCDS application that had been developed for CHWs in Ethiopia to improve maternal and child health had been appropriately adapted to both local language, Tigrinya, and the local calendar (Julian instead of Gregorian) (Little et al., 2013). However, local language and context considerations alone do not guarantee ease of ease. Indeed, although the Ethiopian CHWs reported that the application was easy to use, upon closer inspection, many reported

having experienced basic problems entering their username and password (21%) and a third reported accidentally deleting electronic forms (Medhanyie, Little, et al., 2015b). Considering the high error rate in execution of basic tasks, remembering details to continue using technology correctly may remain challenging for CHWs.

Palazuelos et al. (2013) report that having to learn a new technology in itself was perceived as a barrier by CHWs in Mexico and Guatemala who compared an electronic medicine-dosing tool with the paper alternative. Not only did CHWs prefer paper to the mHealth application for search and viewing functions, because of its alphabetized indexation, searching the range of potential diagnoses and treatments was considered to be easier in the paper-based system than in the electronic tool. Moreover, CHWs preferred viewing all related dosing info at the same time instead of the step-by-step viewing of the dosing information in the mHealth tool (Palazuelos et al., 2013). In contrast, CHWs in South Africa considered a mobile screening tool to detect cardiovascular diseases as easy to use, automated calculations as more accurate, and the electronic process was three or four times faster than the paper process. Despite these benefits, however, the South African CHWs rather calculated the CVD risk with the paper chart, as it allowed them a better comprehension and insight in contributions of risk. In addition, the visual representation of risks in paper charts were perceived to be more effective in communications with patients (Surka et al., 2014).

Furthermore, perceptions of ease of use can be influenced by hard- and software issues or the type of technology used. A usability study in rural Ghana evaluated a prototype of a CDS application for midwives on both keypad and touch phones, but users struggled with both devices: the keyboard on keypad phones was judged too small and with touch phones they did not like to scroll down (Vélez, Okyere, Kanter, & Bakken, 2014). Touch screen technology could be intimidating because of its novelty. Indeed, unfamiliar with touch screen technology, users of an mPneumonia CDS application in Ghana were hesitant to use it initially and struggled to get the application started (Ginsburg et al., 2015). What seems to matter especially is the keyboard size, as several studies report that even when eCDS is presented on (larger) tablets, developers still had to increase the size of the electronic keypad (Dunsmuir et al., 2014; Ginsburg et al., 2015).

Finally, age seems to influence ease of use with older users experiencing more difficulties with the application than their younger colleagues (Kaphle, Chaturvedi, Chaudhuri, Krishnan, & Lesh, 2015; Medhanyie, Moser, et al., 2015; Smith et al., 2015)., After observing that young CHWs seemed to use the application more frequently and make less errors than their older colleagues, researchers in Ethiopia suggested that younger CHWs might have been more eager to learn a new technology, whereas the older ones might have resisted adapting and using it (Medhanyie, Moser, et al., 2015).

In sum, although the literature suggests that mHealth tools may be easy to understand, learn and use, and eCDS may reduce cognitive overload, there may be challenges to remember and sustain a correct use of mHealth tools. In addition, physical issues such as small screens, small keypads, or touch screen technology may be perceived as challenging or intimidating because of its novelty. Attention to localized content, such as local language and calendar may facilitate ease of use. Yet, compared to paper, mHealth applications might remain more challenging when visual queues or search functions for information are used. Finally, older users seem to experience more difficulties using mHealth technology than their younger colleagues.

2.2.2 (Perceived) Usefulness

"Perceived Usefulness", according to Davis (1989) is *"the degree to which the person believes a particular system would enhance his or her job performance"* (Davis, 1989) (p.320). Perceived usefulness is generally regarded in terms of outcome improvement. mHealth tools are considered to be useful if they improve efficiency, productivity, quality, effectiveness, or when mHealth tools support critical aspects of the job (Davis, 1989). However, if using mHealth tools contributes to improved knowledge and self-efficacy, performance outcomes such as quality or efficiency are likely to be positively affected, in which case mHealth tools would be perceived as useful as well. As stated above, we included again both prospective mHealth interventions with usability and feasibility information, and papers that present actual feedback, experiences, or results of usefulness of mHealth tools.

Many studies report that health workers perceive improved communication with peers, supervisors, and clients when using the voice option of mobile phones (Battle, Farrow, Tibaijuka, & Mitchell, 2015; Chaiyachati et al., 2013; Chang et al., 2011; Chang et al., 2013; Chib et al., 2008; Mechael et al., 2012). Another major perceived benefit of the voice option of mobile phones is the quick and effective organization of emergency obstetric referrals (Battle et al., 2015; Lund et al., 2012; Mechael et al., 2012; Tamrat & Kachnowski, 2012). For example, CHWs in Zanzibar report that calling both drivers and health facilities ahead of time was efficient and contributed to more timely care for pregnant women (Battle et al., 2015). Some studies mention that the portability of mobile phones is considered as useful (Battle et al., 2015; Neupane et al., 2014; Stanton et al., 2015). CHWs in South Africa, for example, stated that carrying piles of paper was burdensome since they always had to walk to reach households (Neupane et al., 2014). Similarly, in Uganda, CHWs expected to reduce the paper burden with mHealth tools, while allowing them to better keep track of patients (Chang et al., 2013). Moreover, the speed, effectiveness and efficiency of data transfer and sharing are reported by several studies as being considered useful (Blaya, Fraser, & Holt, 2010; Neupane et al., 2014; Thondoo et al., 2015). Compared to manual data transfer and calculations, an mHealth application in South Africa provided automated calculation and aggregation functionalities, thereby reducing human error, improving quality, and saving time (Neupane et al., 2014).

Other forms of time efficiencies were perceived by midwives in Indonesia who could monitor patients by mobile phone instead of having to physically remain with the patient until delivery. Moreover, they considered sending patient data directly from the mobile phone instead of hand-delivering it to the health center as both time- and cost-saving (Chib et al., 2008). Although not interested in the eCDS functionality, midwives in Ghana similarly expected that electronic patient records would be timesaving when preparing reports (Vélez et al., 2014).

However, time issues are sometimes seen as a constraint: it took a longer time to register patient data electronically (Florez-Arango et al., 2011; Gautham et al., 2014), and navigation between menus was perceived as time consuming by CHWs in India (Gautham et al., 2014). Midwives in Ghana considered the manual input of electronic

clinical notes as burdensome (Vélez et al., 2014). A review on mobile CDS systems and applications therefore appropriately recommends considering time issues by reducing manual input as much as possible (Martínez-Pérez et al., 2014). That the use of eCDS may lead to a considerable increase in consultation time is demonstrated by Ginsburg and colleagues (2015), who studied the usability and acceptability of an eCDS application for childhood illnesses in Ghana. They found that the length of consultation had increased from 8.2 to 43 minutes per consultation (Ginsburg et al., 2015). In contrast, when Mensah et al (2015) investigated the workflow of an eCDS system in Ghana and Tanzania in a time-and-motion study, they concluded that the total time spent on ANC had not significantly increased, as increasing trends in registration and history taking were levelled with decreasing trends in physical investigations and lab exams. However, more importantly, time spent on ANC in control areas had increased as well because of quality improvement activities initiated by the government (Mensah et al., 2015). This suggests that any effort to improve quality of ANC services, including electronic efforts, will likely result in increased consultation time.

We stated earlier that mHealth tools positively affect quality or efficiency through improved knowledge and self-efficacy. A systematic review by Braun et al (2012) report indeed that a third of the articles under review cited learning as an outcome, with mHealth tools contributing to a perceived increase in self-efficacy and knowledge (Braun et al., 2013). CHWs in Zanzibar felt more confident referring pregnant women to the hospital with the CDS application guiding them through the process (Battle et al., 2015). Nurses in Western Kenya felt similarly empowered by the treatment recommendations given by the eCDS for hypertension management and used it to justify their referrals. They liked the compulsory filling out of all screens, as it reduced missing clinical observations (Vedanthan et al., 2015). In Malawi, perceptions of self-efficacy had increased so much that CHWs continued using their mobile phones, even when airtime was no longer compensated (Campbell et al., 2014).

In an exploration of the potential use of a mobile phone application in Senegal, CHWs concurred that its acceptability would depend on the extent to which it would address their heavy and uncompensated work burden. They especially hoped that

mHealth tools would contribute to reducing their transportation and reporting burden (Blanas et al., 2015).

Mahmud et al. (2010) demonstrated that mHealth solutions contributed to reduced transportation indeed. In a retrospective observational study in Malawi they evaluated a hospital intervention using an SMS network, which was used by 75 CHWs. The CHWs had been supplied with cell phones and trained to use the platform for patient adherence reporting, appointment reminders, and physician queries. Over a period of 6 months, the resulting gains included 2,048 hours of worker time saved and US$2,750 saved in fuel costs, as the supervisor did not have to drive around to collect paper reports anymore. Moreover, data reporting by CHWs increased considerably (from 25 per month to 67 adherence reports per week) and time freed from travelling could now be dedicated to care, resulting in a doubling of patient intake (from 100 to 200 patients) (Mahmud, Rodriguez, & Nesbit, 2010).

In sum, users of mHealth solutions perceived time and cost efficiencies when using mHealth tools. mHealth tools improved communication with patients, peers and supervisors, and contributed to organizing referrals more effectively and efficiently. Automatic calculation and aggregation functionalities were not only time saving, they contributed to more effective data sharing and improved data quality. Using eCDS contributed to perceptions of increased knowledge and self-efficacy, thereby contributing to improved effectiveness and quality of care. Time efficiencies as a result of using mHealth tools may even contribute to increased delivery capacity of health programs. However, several studies reported that the use of eCDS was perceived as time consuming, resulting in much lengthier consultation times, although time increase may be inevitable when improving quality of services.

2.2.3 Social Influence

In addition to the two TAM-constructs, Venkatesh et al. (2003) introduced "*social influence*" as a direct determinant of behavioural intention and defined it as "*the degree to which an individual perceives that important others believe that he or she should use the new system*" (Venkatesh et al., 2003) (p.451). Social influence is the explicit or implicit notion that user behaviour is influenced by the opinions and attitudes of people in

the users' social environment. Venkatesh et al. (2003) base this construct on Fishbein and Ajzen's (1975) "*Subjective Norm*", the "*Social Factors*" of Thompson et al. (1991), and the "*Image*" construct of Moore and Benbasat (1991). Whereas "*Subjective Norm*" refers to important others in more general terms, the "*Social Factors*"-construct refers to settings where others have the ability to punish or reward desired behavior, i.e. coworkers, supervisors or senior management being supportive of the use of the innovation. The "*Image*"-construct highlights another element of social influence, which is whether using the innovation enhances one's image, i.e. whether the system is perceived as a status symbol, or the people that use it as prestigious or high profile (M. Fishbein, 1975; Moore & Benbasat, 1991; Thompson et al., 1991; Venkatesh et al., 2003).

Applying these interpretations of social influence to the social context of CHWs, we add patient and community influence to the definition of social influence. CHWs are part of the community they serve, they are often even selected by their community, and accountable to their community (Lehmann & Sanders, 2007). Hence, we expect that the opinions of the community in general and patients, as individuals of the community, in particular, will influence whether CHWs accept to use mHealth tools.

We therefore reviewed the literature for perceptions, experiences, and behavior of patients, the community, peers and supervisors regarding health worker use of mHealth tools. We investigated how health workers perceive the effects and feedback from these groups that make up their social environment, and report how it affected their acceptance of mHealth tools.

Many studies report that health workers felt that mHealth tools contributed to improved relations with patients and community (Campbell et al., 2014; Chang et al., 2011; Chib et al., 2008; Gautham et al., 2014; Jones et al., 2012; Mwendwa, 2016; Ngabo et al., 2012; Palazuelos et al., 2013; Praveen et al., 2014; Thondoo et al., 2015). As mobile phones allowed village midwives to access expert advice, mHealth tools in Indonesia improved patient respect and trust in village midwives (Chib et al., 2008; Mwendwa, 2016). Nearly 94% of patients subjected to a consultation with eCDS in India reported that the use of the application increased their confidence in the health care

provider (Gautham et al., 2014). In Kenya clients perceived that SMS-messages improved the quality of care (Jones et al., 2012). Ngabo et al (2012) report that pregnant women in Rwanda were so enthusiastic about the mHealth project that they wanted to be registered in the system and thus started attending ANC. Authors state that CHWs felt more trusted and respected by the community, as they were now able to call an ambulance when necessary (Ngabo et al., 2012). Although outcomes had not improved, the mHealth intervention for peer HIV workers in Uganda found broad and profound support among the health workers and patients, as mobile phones increased their sense of empowerment while reducing their sense of isolation (Chang et al., 2011). Likewise, in Zanzibar mothers reported feeling safe and less lonely knowing that their CHW was just a call away (Battle et al., 2015). Health workers in Malawi and Ghana, trained to detect lymphatic filariasis and report cases with SMS, expressed feeling happy to assist their community this way and making their communities' disease burden known (Stanton et al., 2015).

However, some negative consequences of mHealth use in relation to patients and community deserve mention as well. In Kenya, nurses felt that the eCDS process interrupted the patient-provider relationship, as it lead to a greater focus on the tool rather than on the client (Vedanthan et al., 2015). Praveen et al (2014) highlight the dependence on a wider system of service delivery improvement when introducing eCDSS. After an eCDS application for cardiovascular disease management had indicated that the patient should be referred, patients faced issues accessing physicians, which led to a decrease of the community's confidence in their CHWs as well (Praveen et al., 2014).

With regard to peer influence, mobile phones seem to contribute to improved communication, information exchange, and support among peers. Mobile phones changed the role of CHWs in Malawi from passive recipients of information to active agents seeking and providing information among each other (Campbell et al., 2014). Similarly, an mHealth study in Aceh-Besar, Indonesia, reports that mobile phones increased access to peer advice, thus improving relationships between village midwives (Chib et al., 2008). CHWs in South Africa reported feeling more part of a team now they were able to communicate with co-workers. This sense of connectedness was even

perceived as a greater benefit of the mobile phone than the reporting application, which had been the principal reason to start the mHealth intervention (Chaiyachati et al., 2013).

Supervisor influence is an important component of social influence (Venkatesh et al., 2003), however, our review shows that supervisors were not always supportive of mHealth use. In Indonesia, Chib et al (2008 & 2011) report that village MWs were more comfortable calling their colleagues for advice than their supervisors. It took a long time for doctors to call back and village midwives would not necessarily understand their answers. Some doctors would just not pick up when village midwives called, not truly believing in their capacities (Chib et al., 2008; Chib & Chen, 2011). In Kerala, India, Smith et al (2015) explored barriers of an eCDS to manage cardiovascular disease and report that supervisors were hesitant to believe information communicated by mobile phone and preferred to physically examine patients. Moreover, physicians feared that mobile phone use would threat patient care, disturb their work, and infringe upon their personal lives (Smith et al., 2015). In Ethiopia, the virtually non-existent relationship between CHWs and supervisors hampered the integration of an eCDS system in service delivery (Medhanyie, Moser, et al., 2015). In Kenya, nurse-supervisors continued using paper forms, as the MOH required paper reports, which meant that using mHealth tools represented double work for nurses (Vedanthan et al., 2015).

Nevertheless, supportive supervision is considered to be essential in care provision with eCDS (Svoronos et al., 2010) and several studies describe explicit efforts that were undertaken to encourage supportive supervision in mHealth projects. For example in Ethiopia, to assist CHWs manage their patients and workload, individual performance cards had been developed and could be accessed by supervisors to improve supportive supervision. In addition, programmers developed an analytics dashboard for local management teams that included key performance indicators and comparative reports for different supervisory levels (Little et al., 2013; Medhanyie, Little, et al., 2015a). In rural India, pro-active involvement of higher level officials in the project proved to be successful, as they subsequently requested insight in key indicators (Modi et al., 2015). Another successful effort to engage supervisors is the web-user interface of the RapidSMS system in Rwanda that allowed supervisors access to activity reports and error logs of CHWs. It was regularly used for performance monitoring and followed up with

feedback sessions (Ngabo et al., 2012). In contrast, a study in South Africa reports that the supervisory functionality was under-utilized and users never received any feedback, although the supervisor admitted that extracting data from the electronic system was more efficient and timesaving (Neupane et al., 2014).

In conclusion, with regard to the social influence on the acceptability of mHealth tools the key point to remember is that although client and community support seem pervasive, and peer influence positive, supervisors are not always supporting mHealth use. Some supervisors do not trust the skills and capacities of CHWs and others fear that CHWs will call them indiscriminately, thereby infringing upon their workflow or personal lives. Although including supervisory functionalities in mHealth tools may facilitate supervisor uptake of mHealth tools, it does not guarantee supportive supervision. The latter seems to depend on contextual factors such as existing CHW-supervisor relationships and congruence with higher-level reporting. Involving higher-level officials may be an effective approach to change supervisor influence to a more positive influence.

2.2.4 Contextual Facilitators and Barriers

Although users of mHealth may find the tools acceptable, elements in the implementation context may influence the actual use of mHealth tools. Taking this into account, Venkatesh et al (2003) add '*facilitating conditions*' to their theoretical model, which is defined as "*the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system*" (Venkatesh et al., 2003) (p. 453). The construct is based on "*perceived behavioural control*" from Ajzen's Theory of Planned Behavior (Ajzen, 1991), '*facilitating conditions*' by Thompson et al (1991) (Thompson et al., 1991), and Moore and Benbasat's (1991) construct of '*compatibility*' (Moore & Benbasat, 1991), and refers to factors in the environment that influence use of technology. It looks at whether training and resources (physical and human) are available to support technology use, and whether the technology is compatible with workflow and other aspects of the job. Venkatesh et al (2003) demonstrate that this construct affects the *use* of technology but not *behavioural intention* (*acceptability*).

The acceptance theories underlying '*facilitating conditions*' give a narrow interpretation of implementation context, i.e. the organizational context. Applied to LMIC contexts, however, it can be expected that aspects beyond the organizational context will influence actual use of mHealth tools, and that elements in the wider implementation context such as infrastructure, political and socioeconomic context need to be taken into account. Moreover, these elements might impede rather than facilitate use of mHealth tools. We therefore call our construct '*contextual facilitators and barriers*' and review the literature for contextual factors that have influenced, or are expected to influence, the use of mHealth tools. More specifically, we will look at infrastructural components such as Internet connectivity and access to electricity; organizational support like training, material, financial and technical support, as well as socioeconomic, cultural, and political factors that may facilitate or hamper use of mHealth tools.

2.2.4.1. Infrastructural factors

Many studies in LMIC point out Internet connectivity as a key challenge (Khan et al., 2015; Medhanyie, Moser, et al., 2015; Mwendwa, 2016; Praveen et al., 2014; Vedanthan et al., 2015). Other infrastructural challenges include problems with phone charging because of a lack of electricity (Jennings et al., 2013; Mwendwa, 2016; Ngabo et al., 2012; Stanton et al., 2015). Whereas the barrier of Internet connectivity is beyond the capacity of individuals or organizations to influence, charging challenges can be more easily overcome. Several mHealth projects provided solar lamp chargers to CHWs (Campbell et al., 2014; Lemay, Sullivan, Jumbe, & Perry, 2012; Little et al., 2013; Martínez-Fernández, Lobos-Medina, Díaz-Molina, Chen-Cruz, & Prieto-Egido, 2015). Blanas and colleagues (2015) report that although 92% of the CHWs in Senegal did not have electricity at home, 58% found solutions and charged phones with motorbike batteries, generators, solar panels, or would go to a neighbouring village that did receive government supplied electricity (Blanas et al., 2015). Only a few papers report not having encountered infrastructural barriers. In Ethiopia most CHWs had electricity at home (Little et al., 2013), and Soti et al (2015) report that network connectivity or recharging batteries were no issue in Kenya (Soti et al., 2015).

2.2.4.2. Organizational factors

Organizations that implement mHealth interventions can facilitate their success by providing training, material support, develop sound software and provide technical support, or supply health workers with airtime (financial support).

Most mHealth interventions provided initial training to users of mHealth tools when implementing the project with training durations generally ranging from a few hours to a week (Agarwal, Perry, Long, & Labrique, 2015). Several studies report providing refresher training as well (Modi et al., 2015; Ngabo et al., 2012; Soti et al., 2015), but in South Africa CHWs complained about not receiving training after new tools had been added to their electronic monitoring and evaluation system (Neupane et al., 2014). Haberer and colleagues (2010) describe mHealth use by HIV-caretakers and point out that training does not only require continued attention, knowledge gained during training needs to be verified as well, as some of their participants had been hesitant to admit not understanding training content. They furthermore recommend developing a detailed training protocol, over time, and including group or peer training (Haberer, Kiwanuka, Nansera, Wilson, & Bangsberg, 2010).

The cascade training approach in Rwanda seems effective, as the participatory training approach is followed by feedback mechanisms. National trainers who helped developing the training curriculum further were trained first, after which CHW-supervisors received a training of trainers. The CHW-supervisor, subsequently trained 432 CHWs. Training was followed up by supervision, refresher trainings and feedback sessions (Ngabo et al., 2012).

Provision of material resources such as mobile phones, tablets, solar chargers, extra batteries or financial assistance in the form of airtime are pervasive organizational facilitators offered in many mHealth projects (Campbell et al., 2014; Chaiyachati et al., 2013; Chang et al., 2011; Gautham et al., 2014; Lemay et al., 2012; Little et al., 2013; Mahmud et al., 2010; Martínez-Fernández et al., 2015; Medhanyie, Little, et al., 2015a; Modi et al., 2015; Praveen et al., 2014; Raghu et al., 2015; Stanton et al., 2015; Svoronos et al., 2010; Vedanthan et al., 2015). Strachan et al. (2012) found that supplying CHWs with airtime was perceived as a professional motivator. They suggest that providing

mobile phones may contribute to the perception that they are for community use, especially when branded with the program name, which increased the standing of CHWs (Strachan et al., 2012).

Faulty hardware can be a powerful negative motivator to use mHealth tools, as are technical problems with software, and the lack of effective technical support to address these problems. In India, technical problems were related to the limited phone memory (Modi et al., 2015). In neighbouring Bangladesh, half of the village doctors stopped using a telemedicine system because of technical problems (Khan et al., 2015). Electronic systems require regular maintenance (Palazuelos et al., 2013) and trained technical support is therefore essential (Medhanyie, Little, et al., 2015a), possibly even including the availability of round the clock technical support (Blank et al., 2013). A systematic review of eHealth systems in LMIC by Blaya et al (2010) noted that the lack of available technical staff was one of the many contextual challenges in LMIC (Blaya et al., 2010). Indeed, case studies assessing the scale-up of mHealth interventions in Malawi and Zambia faced serious challenges with software maintenance as local software consultants could not be found (Noordam et al., 2015).

To address this lack of available technical capacity in LMIC, Rwanda chose to develop its software locally, which created local expertise to support the project (Ngabo et al., 2012). Medhanyie et al. (2015) recommend developing a user manual for trouble shooting assistance (Medhanyie, Little, et al., 2015a), which was actually developed for an mHealth project in rural India (Modi et al., 2015). Likewise in Ghana, a pocket manual was developed to help CHWs solve basic problems themselves (Ginsburg et al., 2015)..

Several studies report that their research teams provided ongoing technical support to their mHealth projects, which can certainly be considered as an organizational facilitator (Chaiyachati et al., 2013; Neupane et al., 2014). Mensah et al. (2015) for example, have a technical team visit the project every 2 weeks and developed a hotline for immediate and ongoing technical support (Mensah et al., 2015).

2.2.4.3. Socioeconomic Factors

Earlier we reported that mobile phones are perceived as a critical means to improved communication between health workers and patients. Mobile phone ownership and use among the community are expected to influence the use of mHealth tools by health workers. We will therefore look at what socioeconomic factors impede or facilitate the use of mHealth tools.

DeSouza and colleagues (2014) explored the acceptability of mobile phones for health interventions among the population in rural India (DeSouza, Rashmi, Vasanthi, Joseph, & Rodrigues, 2014). The low call tariff contributed to the popularity of mobile phone communication. All participants (n=488) used the mobile phone for voice calling, 69% used it to listen to music, however only 14% used the SMS functionality. If mobile phones would be used for health messages, 86% preferred calls to SMS (DeSouza et al., 2014). Similarly, Jain et al. (2015) report that SMS and Internet functionalities on mobile phones are hardly used by the population in Rajasthan, India, and calling was their preferred means of communication as well (Jain, Singh, Koolwal, Kumar, & Gupta, 2015). In Bangladesh, the main reason for not using SMS was illiteracy or the inability to read English (Khatun et al., 2015). Another study in Bangladesh by Tran et al. (2015) investigates mobile phone ownership by household and found an increase from nearly 30% in 2008 to 56% in 2010. Price competition among telecom providers led to declining service charges and increasing subscriber rates. Growths occurred among the lowest quartiles of the wealth index, which suggests a narrowing of the digital divide. However, rural teledensity in Bangladesh needs improvement still (Tran et al., 2015).

2.2.4.4. Political factors

That political support can be a critical enabler for use of mHealth tools is demonstrated by the study of Ngabo et al. (2012) who describe the active role of Rwandan government in the RapidSMS intervention to monitor pregnancy and reduce maternal and child deaths (Ngabo et al., 2012). The government provided mobile phones and SIM-cards to CHWs (n=432) and covered the costs for SMS communication, after having negotiated a ten-fold price reduction through a public-private partnership. In Tanzania, the Ministry of Health (MoH) successfully planned, implemented and

evaluated a public-private mHealth pilot project to reduce stock-outs of anti-malarial drugs (Barrington, Wereko-Brobby, Ward, Mwafongo, & Kungulwe, 2010). In contrast, in Malawi and Zambia, the lack of government ownership and prioritization were linked to delays in scalability of mHealth programs (Noordam et al., 2015). Islam et al (2015) describe that the implementation of electronic health policies in Bangladesh was hampered by many challenges, such as the lack of common standards of health technology, different methods of data management and sharing, the high costs associated with software and technology infrastructure development, and the lack of highly trained technical staff (Islam & Tabassum, 2015). However, country ownership of electronic health initiatives is essential to ensure accountability, interoperability, equity and quality of these projects (Ashraf et al., 2015). It is therefore critical to establish national level electronic health strategies, policies, and frameworks for both private and public sectors (Fairman, Chigas, McClintock, & Drager, 2012).

2.2.5. Conclusion Literature Review

For mHealth tools to be accepted, they need to be perceived as easy to use and useful, and others in the social context of the user need to encourage their use. For ease of use, the literature shows that although mHealth tools may be easy to learn and use, efforts need to be made to facilitate a sustained use of mHealth tools. In addition, mHealth tools need to be adapted to the prospective user and local context. With regard to usefulness, health workers report that the voice option of mobile phones contributes to improved communication with patients, peers, and supervisors, and a more effective organization of referrals. Perceived time efficiencies and cost savings are pervasive facilitators for acceptability. mHealth tools can contribute to more effective and efficient data sharing, improved data quality, and improved quality of care, but their use may lead to an increase in consultation time. In terms of social influence, client, community, and peer influence seem to be mainly positive, with users enjoying increased self-esteem, self-efficacy, and improved social status in their communities. However, supervisors do not always support the use of mHealth tools. Supervisor functionalities in the application and support from higher-level officials may encourage a more positive supervisor influence.

Regarding the use of mHealth tools, factors in the implementation context may facilitate or impede their use. Infrastructural elements such as connectivity and access to electricity can pose significant barriers, as do problems with hard- and software. Technical support and training are therefore essential elements in mHealth projects. Last, the reduction of telecommunications costs and political leadership and support seem to be key enablers to the use of mHealth tools.

The literature suggests that acceptability by end users of mHealth technology is key for effective uptake, and that many different elements in the user, the mHealth tools, and the implementation context determine the acceptability and use of mHealth technology. These concepts have not yet been studied among AMWs in Myanmar. Technology acceptance theories may help guide qualitative exploration of barriers and facilitators to acceptance and use of mHealth tools.

2.3. Conceptual Framework

Maxwell (2012) states that "the most productive conceptual frameworks are often those that bring ideas from outside the traditionally defined field of study" (Maxwell, 2012) p. 40. Existing technology acceptance theories could provide modules to be used in our research (Becker 2007, cited in (Maxwell, 2012) explaining the key concepts to be studied and “the presumed relationships among them" (Miles and Huberman 1994, cited in (Maxwell, 2012), p. 39. We therefore develop a conceptual framework using the TAM and UTAUT theoretical models to guide this study. We use the TAM constructs of ‘*perceived ease of use*’ and ‘*perceived usefulness*’ and constructs derived from the UTAUT: ‘*social influence*’ and ‘*contextual facilitators and barriers*’.

Of all the models used to study technology acceptance, the TAM is the most widely used in academic research (King & He, 2006). The TAM is easy to apply because of its simplicity and adaptability (Mathieson, 1991) and because it can be used both pre- and post-implementation of the innovation (Venkatesh & Davis, 2000). These are the reasons why we keep the TAM constructs, although the UTAUT has constructs similar to the TAM. The ‘*perceived ease of use*’ and ‘*perceived usefulness*’ from the TAM are renamed in the UTAUT to ‘*effort expectancy*’ and ‘*outcome expectancy*’. Especially the latter seems to point more to performance outcomes, whereas users could perceive a

technological innovation useful because they perceive other benefits, such as improved knowledge, self-efficacy, or because the tools may be useful for others, e.g. patients, the community or the health system in general.

The UTAUT-model is a result of a meta-analysis of eight technology acceptance models (Venkatesh et al., 2003). We include the remaining two UTAUT constructs, '*social influence*' and '*contextual facilitators*' in our conceptual framework as we expect these to be relevant in our study. AMWs are part of the community they serve, so it can be expected that without the support of the community, and clients, as individual members of the community, AMWs would not accept mHealth tools. Moreover, influence of peers and supervisors are expected to influence their perceptions of the mHealth tools as well.

We change the UTAUT construct of '*contextual facilitators*' to '*contextual facilitators and barriers*'. The UTAUT focused specifically on the introduction of technological innovations within an organizational context. Implementation of innovative projects in developing countries requires a broader interpretation of context, and infrastructural, socioeconomic and political factors need to be taken into account as well. We therefore include '*barriers*', being the opposite of facilitators, into the construct of '*contextual facilitators and barriers*'. Although the UTAUT claims that the context related construct influences use, but not behavioural intention to use (acceptance), our literature review shows that contextual factors seem to be closely connected to constructs that influence acceptance directly as well. For example, it seems that initial and refresher training influence the ease with which users learn how to use the innovation as well as the ease to remember how to continue using the technology. While we use the UTAUT premise of the contextual construct influencing use directly, we will keep this association in mind.

However, we have chosen to depict the constructs as they were represented in the theoretical frameworks of the TAM and UTAUT to start our exploration on the basis of tested models. According to Maxwell (2012) concept maps can be used to make the existing theory, its key concepts and presumed relationships, visible and explicit (Maxwell, 2012). The conceptual framework will assist making our study coherent and

facilitate communicating the relevance of findings to readers (Green, 2014). Moreover the role of the conceptual framework in qualitative research, according to Polit and Tatano Beck (2004), is "*to make research findings meaningful and generalizable*" cited in (Green, 2014) p. 37.

However, interpretations and insights should not be made to fit the framework (Maxwell, 2012) and we aim to keep a critical perspective and to challenge the framework with emerging findings or different relationships. The latter is visualized by the circling of the constructs representing their eventual adjustment or adaptation to the specific context of the AMWs in Myanmar, which can be attained through the qualitative approach adopted by the present study.

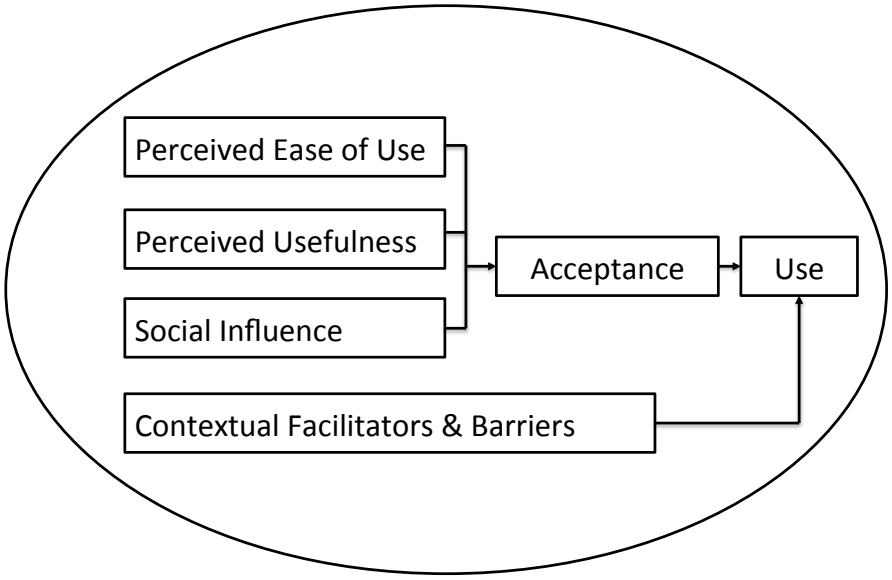

Fig. 1: Conceptual Framework for technology acceptance based on TAM and UTAUT (Davis 1989, Venkatesh et al. 2003)

The definition of these constructs derived from TAM (Davis, 1989) and UTAUT (Venkatesh et al., 2003) will be:

Perceived Ease of Use: the degree to which the AMW believes that using the mHealth tool would be free of effort;

Perceived Usefulness: the degree to which the AMW believes the mHealth tool would enhance her job performance, improve her knowledge, self-efficacy, or may be useful for others;

Social Influence: the degree to which the AMW perceives that important others, such as friends, family, patients, peers and supervisors believe that she should use the mHealth tools;

Contextual Facilitators and Barriers to Use: the degree to which the AMW believes that infrastructural, organizational, socioeconomic and political factors in the implementation context facilitate or impede use of mHealth tools.

Guided by this conceptual framework we will assess whether AMWs in Myanmar perceive mHealth tools as easy to use, useful, and whether important others in their social environment encourage their use, in which case we assume that AMWs accept mHealth tools. Furthermore, we will explore what barriers and facilitators they perceive in the implementation context, which may impede or facilitate the actual use of mHealth tools.

2.4. Research Objective and Questions

The overall objective of the present study is to explore factors that facilitate or impede acceptance and use of mHealth tools by AMWs who participate in the pilot mHealth project of PUI in Myanmar. Based on our conceptual framework, our specific research questions are:

- What factors facilitate or impede AMWs' perception of ease of use and are likely to lead to their acceptance and use of mHealth tools in Myanmar and why?

- What factors facilitate or impede AMWs' perception of usefulness and are likely lead to their acceptance and use of mHealth tools in Myanmar and why?

- How do AMWs in Myanmar perceive the influence of their family and friends, clients, peers, and supervisors and how does this affect their acceptance and use of mHealth tools?

- What factors in the implementation context (infrastructural, organizational, socioeconomic, and political) do AMWs in Myanmar perceive that may facilitate or impede their use of mHealth tools and how does this affect their acceptance and use?

- What other factors facilitate or impede acceptance and use of mHealth tools by AMWs in Myanmar?

Chapter 3: Methodology

This chapter describes the study design, setting, the sampling, and the process of data collection and analysis.

3.1. Study design

A qualitative exploratory approach is deemed appropriate to answer these study's research questions, as qualitative research allows capturing the lived experience of the AMWs, while taking into account the complexity of interactions with both others and the implementation context (Marshall & Rossman, 2011). The study is exploratory in nature as it aims to discover the personal contexts of the AMWs, and to understand how their personal views are embedded within these contexts. An mHealth study in South Africa (Chaiyachati et al., 2013) recommended exploring root causes of mHealth use through qualitative research after a low uptake of mHealth tools was found, despite a quantitatively measured high acceptability. Moreover, a systematic review of CHWs and mobile technology (Braun et al., 2013) recommended using qualitative research to better understand how mHealth tools can improve performance of CHWs.

3.2. Study setting and mHealth project of Première Urgence Internationale

Myanmar recently transitioned into democracy after 50 years of military rule. Previously qualified as one of the worst Internet censors, online censorship ended in 2011 only (Bitso, Fourie, & Bothma, 2012; Kelly, Cook, Truong, & House, 2012). Cell phones, SIM cards and call credit had been unaffordable and international telecom development started just a few months prior to PUI's pilot (Motlagh, 2014). Cellular transmission towers require steady electricity, but only 13% of the population has access to electricity in Myanmar (UNDP, 2013). Moreover, both its number of mobile phone users and Internet penetration was, after Eritrea and the Democratic People's Republic of Korea, lowest worldwide in 2013 (ITU, 2016b). On a more positive note, when international sanctions lifted in 2012, foreign investments skyrocketed, and with 8.5%

economic growth in 2013 and 2014, Myanmar became one of the fastest growing economies in Southeast Asia (WorldBank, 2014).

Dala Township is part of the Yangon Region situated across the river from downtown Yangon, Myanmar's economic capital. It is a peri-urban setting with a total population of nearly 155,000, of which approximately one third is rural (DHO, 2013). There is no piped water and drinking water is collected at a pond. During the rainy season many roads are impassable. Except for Dala town, there is no electricity in the township. Most of the villages have cellular network coverage but Internet coverage is limited. The official maternal mortality rate in 2013 was 150/100,000 and 87.7% of pregnant women received at least one antenatal care visit (DHO, 2013).

The mHealth project is part of PUI's maternal and child health program in Dala Township that aims to improve quality of care by providing monthly training and material support to 20 AMWs and their 10 supervising midwives. The mHealth project is another initiative to improve performance of AMWs. All AMWs and midwives received Huawei Smartphones operating Dimagi's open-source CommCare software (Dimagi, 2016) that are adapted to support client registration and assessment, early identification of risks, and referral. In addition, they received solar chargers and airtime in the form of monthly top-up cards with a value of 5000 kyat (USD 5.00, representing 500 MB of data, which should be more than adequate for most AMWs). A two-day initial training took place and a local IT-officer was recruited and trained to provide technical support. PUI's nursing staff responsible for clinical training provides minor technical support. The Township Medical Officer who supervises midwives directly and AMWs indirectly was not initially part of the pilot and received a Smartphone only a few months into the mHealth project.

3.3. Sampling strategy

3.3.1. Inclusion criteria

All 20 AMWs supported by PUI and participating in the mHealth pilot project accepted to take part in this study. Given the small sample size, and the variation in the

demographic and work related characteristics of AMWs, we decided to include all AMWs in this study.

3.3.2. Recruitment

PUI holds monthly training sessions with the AMWs in their training center in Dala Town. During the September session, AMWs were informed about the upcoming study by their supervisor, the Reproductive Health Training Officer (RHTO). On November 10, the Myanmar ethical review committee approved the information and consent forms for semi-structured interviews and focus group discussions. Subsequently, the Burmese co-researcher gave an official information session to AMWs during the November monthly meeting. The PI was introduced, after which all AMWs received 2 copies in Burmese of each form. The information and consent forms were read out loud and the Burmese co-researcher ensured that the objectives of the study and the expected process of data collection were understood. The voluntary and confidential nature of participation, the non-remuneration, and the choice of interview location were stressed. After the information session AMWs discussed their availability and preference for interview location with the RHTO.

3.3.3. Description of the sample population

AMWs are specialized CHWs, non-salaried staff selected from villages they are supposed to serve (MOH Myanmar, 2010). They receive a six-months' Ministry of Health-certified training after which they care for pregnant women during pregnancy through to post-delivery. Eligibility criteria for AMW-training include age (18 years minimum) and education (high-school level equivalent of 10^{th} grade). Although they work under the guidance of an experienced nurse or midwife, AMWs are often the only trained health provider at village level. On top of first-line maternal care, they provide ambulatory care, health and hygiene information and collect health information and may cover several communities.

3.4. Data Collection

Data were collected in the month of November 2014. Individual semi-structured interviews were conducted from 11 November to 26 November. Three focus groups were held on 27 and 28 November.

3.4.1. Individual interviews

Individual interviews were planned with all 20 AMWs. However, one AMW arrived ill with fever for her interview and was sent home, resulting in 19 AMWs participating to the individual interviews. In order to decrease the burden of participation in this study, it was envisaged to interview AMWs in their homes. However, as travel expenses were reimbursed, all AMWs chose to come to the PUI training center for their interviews. Recorded interviews lasted from an hour to an hour and a half, which was enough to reach sufficient depth while allowing the interviewee to remain focused (Ritchie & Lewis, 2014).

Prior to each interview, the Burmese co-researcher collected the background information of each AMW. Age, profession, years of work experience, workload, number of meetings with her supervising midwife and cell phone experience were noted down on the background information sheet, as well as village information, such as the number of inhabitants and the availability of Internet and electricity.

The individual interviews were face-to-face and semi-structured, with key questions based on the constructs from the conceptual framework. A semi-structured approach was chosen to ensure coverage of the main constructs in each interview while leaving the flexibility to explore emerging themes (Remler & Van Ryzin, 2011). Furthermore, flexibility during the interview was observed by asking follow-up questions that naturally followed from the topic discussed, instead of following a pre-determined order.

The interviews generally started with the more neutral questions, followed by more personal ones when AMWs seemed more comfortable answering questions. Follow-up questions and probes, were extensively used to uncover the participants' perspectives on the constructs (Marshall & Rossman, 2011). Most AMWs spoke their

mind freely, some of them were very outspoken, but there were two or three AMWs who remained reticent until the end of the interview.

The PI interviewed all 19 AMWs. The Burmese co-researcher interpreted 17 interviews. The monitoring and evaluation officer from PUI's program department interpreted two interviews when the co-researcher was called away for an unexpected assignment. The AMWs did not seem to be bothered by the fact that the co-researcher was male, a medical doctor and PUI staff. Responsible for the HIV-AIDS program, he was not directly supervising the mHealth project and his respectful ways and calm demeanour seemed to instil confidence and encouragement in AMWs. The PI stressed that she conducted this research in the capacity of a student and that she was not employed by PUI. After showing photos of her children to the AMWs, many AMWs showed photos and videos of their families as well, enhancing an atmosphere of familiarity, despite the language barrier.

3.4.2. Focus group discussions

All 20 AMWs participated in the focus group discussions that were organized in the last week of data collection. Three focus groups (with 7, 7, and 6 participants) were held in the PUI training center in Dala Town and lasted one and a half to two hours each.

The rationale for using focus groups with the same participants is to obtain respondent validation for preliminary findings (Mays & Pope, 2000), to further explore themes that emerged in individual interviews, and to receive more explanations for findings that had not been clear or seemed contentious. The focus group discussions allowed for a refinement of perceptions, both through the interaction with other participants and because AMWs would have had time to reflect on their individual interview. The group setting offered AMWs a social context where normative influences and shared meanings were reflected, which plays an important role in how the world is perceived (Ritchie & Lewis, 2014). Moreover, when different research methods are used, data can be triangulated, thereby enhancing the internal validity of the study (Barbour, 2001). Some authors, however, see triangulation rather as "*a way of ensuring comprehensiveness and encouraging a more reflexive analysis of the data than as a pure test of validity*" p.51 (Mays & Pope, 2000).

All three focus groups were led by the PI and interpreted by the co-researcher. As nearly all AMWs had spent time with us during the individual interviews, they did not seem to feel inhibited to speak their mind during the focus group discussions. For audio and transcription purposes, each AMW was asked to introduce herself with her code name and to mention this code name when participating in the discussion. For the same reason they were asked to avoid speaking at the same time. However, in the heat of the discussion and despite reminders, AMWs often forgot to mention their code name, which made it impossible to attribute individual contributions to specific AMWs from transcriptions. As modesty is a valued trait in Burmese culture, AMWs were hesitant to affirm positive statements. For example, when asked to comment on the statement that AMWs seem to *want* to accept mHealth tools because of their sense of professional duty and responsibility towards their communities, the affirmation was very clear in their body language, but not in affirmative comments.

3.4.3. Development of the interview guide

3.4.3.1. Initial interview guide

The interview guide is based on the constructs of the conceptual framework. Initially, the interview guide consisted of a question for each of the constructs, complemented with probes:

1. What makes the mHealth tools **easy to use** for you or others? What makes the mHealth tools difficult to use for you or others?
2. What makes the mHealth tools **useful** for your work as AMW? What makes the mHealth tools not useful for your work as AMW? Probe: How could the mHealth tools be more useful for you or others?
3. What do **others** think about you using the mHealth tools? (Family/friends, patients, colleagues/superiors). Probe: How will that affect your relationship with them?
4. Is there anything in your **context** that could affect your use of mHealth tools? (Environmental, organizational, political, socioeconomic factors, etc.).

After receiving a prototype of the Smartphone application on her personal Smartphone, the PI was able to use the eCDS application in a test environment. In October 2014, a Canadian midwife investigated the application, critically assessing it and checking it for possible glitches. She subsequently agreed to an interview to pilot the

interview guide. The interview lasted nearly 30 minutes. Taking into consideration that quite some time would be spent translating questions and answers back and forth, and taking into account that AMWs would possibly need more time to reflect on questions, the attributed time of 1.5 hours for interviews was deemed reasonable. It also became clear that the last question was too general. A division into sub-questions to address contextual factors that could influence using the mHealth tool more specifically seemed more practical.

3.4.3.2. Refining of the interview guide through the operational conceptualization of the research

Program knowledge is essential to formulate the right questions and to understand and interpret the data (Weiss, 1998). The PI therefore studied PUI's program theory and logical framework for the mHealth project as an entry point into understanding the objectives of the program. Subsequently, information was collected about the implementation context, including information on health workforce pertaining to midwives and AMWs, information and communication technology, and Myanmar's reproductive health policies. From March 2014 until the time of data collection in November 2014, the political, economic, and technological landscape in Myanmar changed rapidly. The PI was kept informed about contextual and program developments during regular Skype meetings with the Burmese co-researcher and PUI program and management staff. Together, a detailed theory of change for each of the mHealth tools (voice and application including electronic patient registration and eCDS) was co-constructed. By making every step in the causal pathway explicit, underlying beliefs, assumptions, and implicit intentions were revealed (Weiss, 1998). It became clear that program staff assumed that the eCDS-application would result in transparent decision-making, which would allow midwives to provide distant support. While developing the interview guide, questions with regard to transparency were included as a result of this exercise. Another hidden assumption was found in the expected behavioural mechanism in the group of pregnant women. Improved quality of care, as a result of improved clinical compliance through the eCDS-application, was expected to contribute to increase client confidence in the services of AMWs. The implementing organization expected that

increased client confidence would subsequently result in pregnant women increasingly using the services of AMWs. However, the behavioural change was conditional and expected to occur only if the AMWs would use the eCDS-application during client consultations. Questions regarding perceived client perceptions, client increase, and use of the eCDS during patient consultation were therefore added to the interview guide.

3.4.3.3. Further refining of the interview guide

The first AMW who came in for interview spontaneously picked up her Smartphone and showed which parts of the application she found useful and how she used it. Afterwards, we decided to ask all AMWs to demonstrate how they used the application. It facilitated the discussion with AMWs now that they could show something concrete. Moreover, it permitted observing first-hand how comfortable AMWs truly were manipulating the Smartphone, how easy it was for them to navigate the application, and to observe what specific difficulties they encountered.

An even more detailed interview guide was developed after the first two interview days. The questions proved to be too general and abstract for the AMWs. Asking relatively concrete questions, or closed questions followed with a request to elaborate answers, proved to work better than posing truly open questions. Despite the interview guide becoming longer, the interviews did not necessarily last longer. The final interview guide can be found in Annex I.

3.4.4. Audio recordings, transcriptions & translations

All interviews and focus groups were digitally recorded with an Olympus WS-823 voice recorder. One interview was recorded for the first 43 minutes only. The co-researcher checked whether the Smartphone of the AMW had been repaired, and the PI forgot to press play for the remainder of the interview. However, written notes were made. Conscious efforts were made to make the recorded data anonymous. AMWs were introduced with a number in individual interviews and letters in focus groups. Although we avoided using names, a village name is mentioned occasionally.

PUI organized the transcription and translation of all the data. As typing in Burmese is extremely tedious, with each roman letter on the keyboard representing

several Burmese letters, it was not easy to find typists. PUI therefore decided to have translators both transcribe (verbatim) and translate data. This process proved to be very long, each interview taking a week. For expediency sake, the data was divided in half and given to two different translators. Nonetheless, it took 5 months for all the data to be transcribed and translated.

The PI checked all the translations by reading them while simultaneously listening to the audiotapes. Whenever she had doubts about a translation, she conferred with the Burmese co-researcher who checked the contentious parts. She supplemented verbatim transcriptions with information relevant for data interpretation, such as descriptions of laughter, silence, or the registration of the time that passed when an AMW needed a lot of time to navigate through the application.

The translated verbatim transcripts are considered as the 'raw data' that are used for data analysis in this study. However, some qualitative scholars claim that translated data should be considered 'processed data' as some interpretation took place in the process of translation (Wengraf, 2001 in Marshall & Rossman, 2011). To ensure data accuracy, the Burmese co-researcher, who acted as an interpreter for most of the interviews, checked all translations against the audio recordings, was involved in coding of one of the interviews, and verified the final analysis.

3.4.5. Researcher journal

The PI kept a journal throughout the process of submitting the research protocol for ethical approval until well into the analysis, writing of the thesis, and dissemination of the results. The journal consists of the documentation of the research process, critical reflections about our roles as researchers, regrets and opportunities. It documents as well more analytical issues such as the reasoning behind coding, memos regarding the development of the hierarchy of the thematic framework matrix, and case summaries for each of the research participants. Furthermore, hypotheses, hunches, assumptions, methodological notes and issues regarding reporting and dissemination were noted in the journal.

3.4.6. Ethical considerations

Obtaining ethical approval took a total of six months: three months for the approval by the "Comité d'éthique de la recherché en santé" (CERES) de l'UdeM and another three for approval by the Myanmar Ethical Review Committee (ERC). Both approvals were valid for a period of 1 year. As data transcription and translation took another 5 months, extensions were requested and obtained for another year until December and November 2016 respectively (certificate numbers: 14-103-CERES-D and 2015E-102 –see Annex VII).

The information and consent form that was approved by the CERES was translated into Burmese, back translated into English, and translated into Burmese a second time. Following instructions from the Myanmar ERC, separate information and consent forms were designed for individual interviews and focus group discussions.

Prior to each interview recording, 2 copies of the information and consent form for the semi-structured interview were signed by the AMW, the researcher and the co-researcher, of which one copy is kept by the AMW and the other by the research team. Researchers repeated that recordings can be stopped at any time during the interview and that data will be made anonymous.

The same process was repeated prior to each focus group discussion. However, with regard to confidentiality, AMWs were explained that the opinions expressed during a focus group were not confidential, as their colleagues in the focus group would observe who said what. We did explain that data would be made anonymous for publication and data management. To that end, name cards with code names (letters) were provided.

The voluntary nature and non-remuneration of participation were stressed. We reimbursed travel expenses and the PI brought goodie bags from Canada for each research participant.

As mentioned above, conscious efforts were made to anonymize the data in the electronic recordings. However, the recordings were shared with the PUI managers, as the implementing organization was responsible for data transcription and translation. The translators have copies of the original data as well. Despite the fact that we asked all of

them to destroy the data, it cannot be guaranteed that this was actually done. Both physical and electronic analysis outline forms, the researcher journal and the demographic/work data of AMWs are in the sole possession of the PI. The electronic data is password protected and the physical data is stored in a locked cupboard at the PI's home. Last, this study refers to AMWs through pseudonyms that consist of common Burmese names made up by the Burmese co-researcher.

With regard to restitution to research participants, the sharing of results from the preliminary analysis with AMWs during the focus group discussions in November 2014 had been a first step. Additionally, thanks to a generous dissemination grant, the PI was able to present the final research findings to research participants during her visit to Myanmar in August 2016. After the main findings had been translated to Burmese and shared with the AMWs, substantial time was dedicated for restitution, including time for feedback, discussion and sharing of a communal lunch. .

4. Data Analysis

A thematic framework approach was used for the analysis of data, supported by Nvivo 10 software. Nvivo is a computer-assisted qualitative analysis software that was developed for Framework analysis (Ritchie & Lewis, 2014). It supports systematic and transparent organization and classification of data, and allows analyzing data at the different levels in the hierarchy.

4.1 Field analysis: preliminary analysis

As the focus group discussions were planned immediately after the individual interviews, it was impossible to fully analyze all interview recordings. We therefore developed analysis outline forms consisting of the interview guide questions, personal impressions, observations, and comments that we used as the basis for a preliminary analysis. Whereas answers to interview questions were written down during the interviews, observations, impressions and comments were added after interviews took place.

The PI summarized responses per construct and added emerging themes and impressions. Subsequently, the PI and the Burmese co-researcher discussed the preliminary findings, prior to presenting them to research participants for member checking and further exploration during focus group discussions. According to Lincoln and Guba, member checking, or respondent validation, is the most crucial technique for establishing credibility, or internal validity (Lincoln & Guba, 1985).

4.2 Desk-analysis: Framework approach

Once the data verification process was finished (see paragraph *3.5.4. Audio recordings, transcriptions & translations)*, the PI started the in-depth analysis of raw data. Ritchie's "Framework" approach was used to guide this process (Ritchie & Lewis, 2014). Framework comes from thematic framework and is a matrix-based method in which data is classified hierarchically, with key themes divided into related subtopics. We used a template strategy, whereby the conceptual framework is used to develop a preliminary analysis framework, with each construct representing a theory-generated key theme (Marshall & Rossman, 2011). Constructs from the conceptual framework were the theory-generated key themes in the framework, which were subsequently divided into categories, and sub-categories.

4.2.1. Coding

For first cycle coding, interviews were coded descriptively, with short phrases identifying the topic, thus remaining close to the raw data. Instead of line-by-line coding, we rather attempted to grasp the basic issue, also called holistic coding (Saldaña, 2012). The framework approach allows to sort and synthesize data almost simultaneously (Ritchie & Lewis, 2014). The descriptive codes were immediately translated into a more conceptual classification, representing the lowest level in the analytical hierarchy of the thematic framework.

When new codes were identified, previously coded interviews were checked against these new codes to ensure a systematic application of codes.

For second cycle coding an "Axial Coding" approach was used. Axial coding aims to strategically reassemble data that was split during the first cycle coding (Strauss & Corbin, 1998). Codes were regrouped in broader sub-categories, subsequently in even broader categories and themes until ultimately grouped under a key theme. This was an iterative process whereby the properties of each (sub-) category and theme were being refined, until the categories were internally consistent but externally distinct from one another. Although axial coding is normally associated with a grounded theory approach, whereas this study uses the framework approach, we consider axial coding appropriate, as it provides the flexibility to identify emergent themes on top of the theory-generated key themes (i.e. one of the constructs from the conceptual framework).

Additionally, one of the supervisors checked the coding of one interview in its entirety. We made use of a multiple coding method for another interview: both the PI and the Burmese co-researcher coded the interview independently (Barbour, 2001). The coding results were very similar, but where coding diverged, researchers discussed and agreed upon the better code or classification.

After all interviews and focus group discussions were coded and classified once, the PI discussed the 'final' thematic framework with her supervisors to assess the coherence of the framework. Advice was obtained regarding the grouping of elements that had been inductively derived from the data to form emergent key themes. The resulting framework represented a solid basis for a second round of coding of all interviews and focus group discussions. This second round of coding ensured a systematic and rigorous application of all codes, a consistent regrouping under the different categories and themes, and a deep familiarization with the data.

As AMWs did not consistently mention their code names during focus group discussions, it was impossible to assign contributions per respondent. Focus group discussion data were therefore treated in a 'whole group analysis'-approach, which means that the focus group data is treated as a whole without delineating individual contributions. As the unit of analysis is the group as a whole, the focus group data were treated the same as a unit of individual data (Ritchie & Lewis, 2014).

The final thematic framework can be found in Annex III.

4.2.2. Thematic analysis using the Framework approach

After all interviews and focus group discussions were coded and classified in the hierarchical thematic framework matrix, the framework was critically reviewed to ensure internal convergence and external divergence of all (sub-) categories and themes. While refraining from too much interpretation, findings summarizing key themes were written up.

Subsequently, we looked for patterns and explicit explanations found in the data, as well as implicit reasons, possibly derived from behavioural or contextual factors. To uncover the underlying logic, we investigated hunches and hypotheses by juxta-positioning several findings against each other, or through comparison with participant characteristics. We used our experience and training, and made comparisons with the literature and technology acceptance theories. The entire process was a mix of studying patterns, thinking about the data, investigating hypotheses, and re-reading synthesized data. Full transcripts were reread when more insight in the context of the data was required. Associations were verified across the entire dataset. Patterns of associations were interrogated, notably by looking at discordant cases, as for causal reasoning the search for "*deviant cases that falsify emerging causal propositions should ... be central to qualitative researchers' efforts*" (Seale, 1999) (p.40).

To support this process, we developed a central chart, a matrix in which demographic and work related characteristics of the AMWs were compared with their perceptions, their reported use of mHealth tools, and their reported experience with technical issues. This facilitated investigating potential links, for example between the different levels of workload of AMWs with their reported use of the application. We juxta-positioned our observations against the reported ease of use in a similar way of "cross-analysis".

Finally, in the write up of the article (chapter 4), findings were reported and interpreted per conceptual framework construct and the emerging construct. Linkages were made with the published literature and between constructs. In Annex IV the central chart can be found.

Chapter 4: Results and Discussion

Title:

Acceptance, Contextual Facilitators, and Public-spirited Professionalism: Exploring Acceptance and Use of mHealth Tools by Auxiliary Midwives in Myanmar

Short Title:

Acceptance and Use of mHealth Tools by Auxiliary Midwives in Myanmar

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Abstract

Myanmar's lack of midwives led to shifting of pre- and postnatal care tasks to auxiliary midwives. However, lack of supportive supervision and the limited training auxiliary midwives receive compromise the quality of their services. To improve their performance, an NGO implemented an mHealth project in Dala Township, providing Smartphones with electronic clinical decision-support. As it was Myanmar's first point-of-care mHealth project, the study's objective was to explore whether AMWs would accept and use the mHealth tools.

Perceptions of all AMWs (n=20) were explored through semi-structured interviews and focus groups. Data were analyzed with the Framework approach. The study was guided by a conceptual framework based on technology acceptance theories. Its premise is that if mHealth tools are perceived as easy to use, as useful, and the social influence is positive, AMWs will accept mHealth tools, with acceptance being a predictor for use, whereas barriers and facilitators in the implementation context influence the use of mHealth tools directly.

mHealth tools were generally perceived as easy to use, useful, and important others in the social environment of AMWs were mostly supportive of AMWs using mHealth tools. Internet network problems represented the key contextual barrier, but unexpected socioeconomic facilitators in Dala Township positively affected the use of mHealth tools. This study highlights that acceptance and use of mHealth tools by AMWs in Myanmar were especially determined by their belief in mHealth and their public-spirited professionalism, which were in turn reinforced by political support for mHealth and an ethos of service. Despite the barriers they encountered, AMWs were determined to embrace mHealth tools, as they believed them to be superior to the traditional system, the future norm and in the best interest of their communities and health system.

Background

Myanmar witnessed a substantial reduction of its maternal mortality ratio between 1990 and 2015: from 453 maternal deaths per 100,000 livebirths in 1990 to 178/100,000 in 2015. It remains among the highest in Southeast Asia, however. In comparison, neighboring Thailand's maternal mortality ratio in 2015 was 20/100,000 (WHO, 2016).

High maternal mortality ratios are often seen as a key indicator of poorly functioning health systems that fail to supply adequate skilled birth attendance (Borghi et al., 2006; Fraser et al., 2004). Myanmar suffers workforce shortages, with midwives covering as many as five to eleven villages per midwife (MOH Myanmar, 2010). This led to task shifting of pre- and postnatal activities to auxiliary midwives (AMWs) who are specialized community health workers (CHWs) (MOH Myanmar, 2010). Although the limited training and supportive supervision AMWs receive compromise the quality of care (Lehmann & Sanders, 2007), mHealth (mobile health) may help CHWs to overcome some of these barriers (Braun et al., 2013).

Istepanian and Lacal (Istepanian & Lacal, 2003) coined the term mHealth, which is generally defined as public health practice that is supported by mobile devices such as mobile phones (Kay et al., 2011). Several studies have described the potential or effectiveness of mHealth strategies to improve maternal and newborn health in developing countries. mHealth contributed to improved communication between health workers, clients, peers, and supervisors (Chib et al., 2008; Chib & Chen, 2011; Mwendwa, 2016; Ngabo et al., 2012) and more effective and efficient organization of referrals (Battle et al., 2015; Lund et al., 2012). mHealth strategies to improve maternal health include applications that support clinical decision-making (Battle et al., 2015; Little et al., 2013; Medhanyie, Little, et al., 2015a; Medhanyie, Moser, et al., 2015), which in mHealth jargon is called electronic clinical decision-support (eCDS). Its effectiveness hinges on the ability to provide algorithm-based automated prompts with actionable recommendations that are delivered at the time and place of decision-making (Garg et al., 2005; Kawamoto et al., 2005; Rooij & Marsh, 2016). mHealth may therefore contribute to improved clinical compliance, which in turn may increase the quality of care (Patel et al., 2001) and, ultimately, decrease maternal mortality.

With this rationale, the French NGO *Première Urgence Internationale* (PUI) implemented Myanmar's first point-of-care mHealth project. In collaboration with *Télécom sans Frontières*, a Smartphone application including an eCDS for antenatal and postnatal care (ANC & PNC) was developed to support improved clinical decision-making by AMWs in Myanmar. In August 2014, the project was piloted in Dala Township with 20 AMWs and 10 of their supervising midwives, but the NGO needed to know whether AMWs would accept and use the mHealth tools (voice option Smartphone and eCDS).

A recent systematic review about mHealth adoption by health care professionals found that ease of use and perceived usefulness were the most frequently mentioned adoption factors (Gagnon, Ngangue, Payne-Gagnon, & Desmartis, 2016). Several systematic reviews report that mHealth tools contributed to positive outcomes such as improved communication with stakeholders, effective and timely data collection (Blaya et al., 2010), increased support networks, and improvements in clinical compliance and adherence (Aranda-Jan, Mohutsiwa-Dibe, & Loukanova, 2014). Time and cost efficiencies were reported (Betjeman, Soghoian, & Foran, 2013), as well as higher self-efficacy and improved knowledge (Braun et al., 2013).

Patients and communities supported the use of mHealth tools by CHWs because they facilitated contacting their CHWs when necessary (Battle et al., 2015). mHealth tools improved patient respect and trust, as mobile phones allowed CHWs to access expert advice (Chib et al., 2008; Mwendwa, 2016), or because they trusted the eCDS application itself (Gautham et al., 2014).

However, limitations in actual implementations are also important. Although mobile applications could enhance supportive supervision with nearly real-time performance monitoring possibilities (DeRenzi et al., 2011), they were under-utilized in South Africa, and users never received feedback (Neupane et al., 2014). In contrast, supervisory functionalities in Rwanda were embraced by CHW-supervisors, who followed up CHW performance reports with feedback and guidance (Ngabo et al., 2012),

Internet connectivity issues were pervasive (Khan et al., 2015; Medhanyie, Moser, et al., 2015; Mwendwa, 2016; Praveen et al., 2014; Vedanthan et al., 2015), as were challenges with access to electricity (Jennings et al., 2013; Mwendwa, 2016; Ngabo et al.,

2012; Stanton et al., 2015). In addition, many developing countries lack the human resources to develop and maintain software locally or to provide technical support to users (Blaya et al., 2010; Noordam et al., 2015). Government support was a critical enabler to the success of Rwanda's mHealth project (Ngabo et al., 2012), but lack of government ownership and prioritization were linked to delays in scalability of mHealth programs in Malawi and Zambia (Noordam et al., 2015).

To conclude, the literature suggests that characteristics of the mHealth tools, performance outcomes, and social, organizational, and political factors in the implementation context are important determinants of acceptance and use of mHealth tools in developing countries. To our knowledge, a comprehensive assessment of mHealth in practice has not yet been undertaken in the context of Myanmar. Our research objective was therefore to explore whether AMWs in Dala Township would accept and use the mHealth tools that PUI introduced.

Conceptual Framework

To assess whether AMWs will accept and use mHealth tools, we operationalized a conceptual framework based on technology acceptance theories. Davis' Technology Acceptance Model (TAM) (Davis, 1989), is an adaptation of the Fishbein and Ajzen's Theory of Reasoned Action (M. Fishbein, 1975), tailored to fit the context of information systems. TAM's premise is that if mHealth tools are perceived as easy to use and useful, AMWs will accept mHealth tools; acceptance being the predictor for use. In an elaboration of the TAM, Venkatesh et al. developed the Unified Theory of Acceptance and Use of Technology model (UTAUT) (Venkatesh et al., 2003). The UTAUT posits that, on top of the two TAM constructs, acceptance is predicted as well by social influence, or the degree to which important others in the social environment of AMWs support its use (Venkatesh et al., 2003). Moreover, the UTAUT demonstrates that factors in the implementation context predict use directly. We therefore added contextual facilitators and barriers to our conceptual framework. The framework (Fig 1.) is open to emerging themes, visualized by the circle around the constructs.

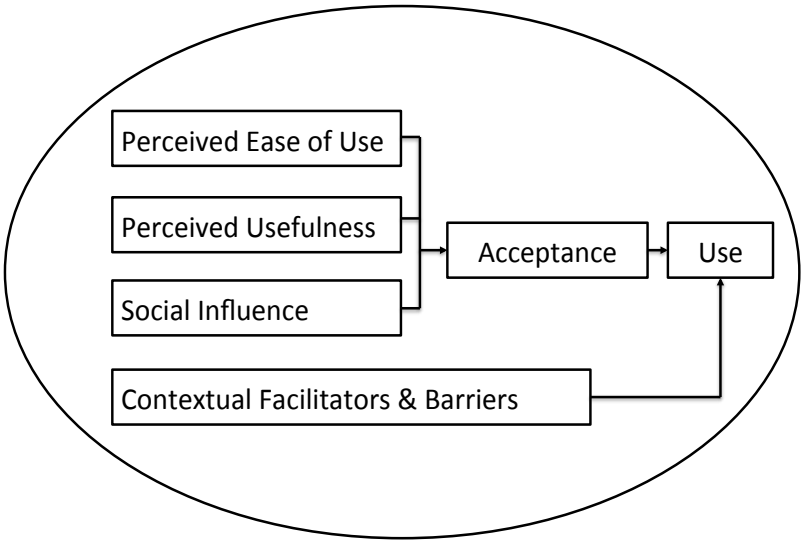

Fig 1. : Conceptual framework for acceptance and use of mHealth tools based on TAM (Davis, 1989) & UTAUT (Venkatesh et al. 2003) (Davis, 1989; Venkatesh et al., 2003)

Guided by this conceptual framework, we specifically assessed whether AMWs in Dala Township perceive the mHealth tools as easy to use, as useful, and whether important others in their social environment (family and friends, clients, peers, and supervisors) support their use. In addition, we explored what barriers and facilitators they perceive in this implementation context, focusing especially on infrastructural, organizational, socioeconomic, and political factors.

Methods

Study design

To answer the research questions we used a qualitative explorative design, as a study in South Africa (Chaiyachati et al., 2013) recommended exploring underlying causes of mHealth use through qualitative research after a low uptake of a mHealth tools was found, despite a quantitatively measured high acceptance. Moreover, a systematic review of CHWs and mobile technology (Braun et al., 2013) recommended using qualitative research to better understand how mHealth tools can improve performance of CHWs.

Study Setting, sample population, and PUI mHealth project

Dala Township is part of Yangon Region situated across the river from downtown Yangon, Myanmar's economic capital. It is a peri-urban setting with a total population of nearly 155,000, of which approximately one third is rural (DHO, 2013). There is no piped water and, except for Dala town, there is no electricity. Most of the villages have cellular network coverage but Internet coverage is limited. The official maternal mortality rate in 2013 is 150/100,000 and 87.7% of pregnant women received at least one antenatal care visit (DHO, 2013).

AMWs receive a six-months' Ministry of Health-certified training after which they care for pregnant women during pregnancy through to post-delivery. Additionally, they provide ambulatory care and collect health information. Eligibility criteria for AMW-training include age (18 years minimum) and education (high-school level equivalent of 10^{th} grade).

The mHealth project is part of PUI's maternal and child health program in Dala Township. The program aims to improve quality of care by providing monthly training and material support to 20 AMWs and their 10 supervising midwives. The mHealth project is another initiative to improve performance of AMWs. All AMWs and midwives received *Huawei* Smartphones operating *Dimagi's* open-source *CommCare* software (Dimagi, 2016) that are adapted to support client registration and assessment, early identification of risks, and referral. In addition, they received solar chargers and airtime in the form of monthly top-up cards with a value of 5000 kyat (equivalence of 5 US$, representing around 500 Mb of data transfer). A a local IT-officer was recruited and trained to provide technical support. PUI's nursing staff responsible for clinical training provide minor technical support. AMWs received a two-day initial training to use the different functionalities in the Smartphone (the voice option and the CommCare application including electronic patient registration and eCDSS). The township doctor who supervises midwives directly and AMWs indirectly was not initially part of the pilot and received a Smartphone only a few months into the mHealth project. All 20 AMWs participating in the pilot accepted to take part in this study.

Data collection

An interview guide was developed to elicit information on the four constructs of the conceptual model: *ease of use, usefulness, social influence, and contextual facilitators and barriers*. After testing, data was collected in November 2014, three months after the pilot started. We conducted 19 semi-structured face-to-face interviews, as one AMW was ill. Prior to the interviews, demographic data, work-related information (years of work experience, workload and other jobs), and contextual information were collected. All AMWs chose to be interviewed in the PUI training center in Dala town and interviews lasted 60 to 90 minutes. During the interview, AMWs were asked to demonstrate how they used the application, which generated observational data on ease of use. Three focus group discussions were organized with all AMWs (n=20). Interviews and focus group discussions were digitally recorded.

Data quality and analysis

After interviews, findings of a preliminary analysis were presented to AMWs in subsequent focus group discussions for respondent validation and further exploration of emerging themes. Recorded data were transcribed in Burmese, and translated verbatim into English. For data analysis we used the Framework approach and QSR Nvivo 10 software (Ritchie & Lewis, 2014). The coding framework consisted of technology acceptance constructs and emerging themes. Findings were subsequently cross-analyzed with demographic and work-related data, and triangulated with observational data. We deliberately sought contradictory evidence. Authenticity and fairness concepts were addressed through the use of direct quotes of AMWs representing these varying views and interpretations.

We report findings by conceptual framework constructs and emerging themes and have integrated results and their interpretation in light of the literature as is customary in reporting qualitative research (Marshall & Rossman, 2011).

Ethical considerations

We received ethical approval from both Myanmar's Ethical Review Committee and the University of Montreal's Comité d'Éthique de la Recherche en Santé. All AMWs gave written informed consent for participation in the study and audio recording of the

interviews and focus group discussions. AMWs were asked to keep individual contributions in focus group discussions confidential. Data have been anonymized and AMW names used in this paper are newly created.

Findings and Discussion

Description of research participants

All AMWs are female, aged between 21 and 56 years and with 2 to 35 years of work experience. Their workload varies considerably as well: from 1 to 48 deliveries per year and 8 to 432 ANC/PNC visits per year. Most AMWs meet their supervising midwife on a weekly or bi-weekly basis and their township doctor once per month. Eighteen out of 20 AMWs owned a cell phone prior to the pilot, of whom 12 owned Smartphones. Five AMWs have access to electricity and 18 have Internet access, though only three qualify it as good. The total population of the villages that AMWs cover ranges from 110 to 3,300. Around half of the AMWs report having a regular job besides their AMW activities. They work as rice cultivators, seamstresses, shop owners, market sellers and preschool teachers.

Table 1. AMW Characteristics

Ease of use

Nearly all AMWs perceived the voice option (calling) as easy to use. Most AMWs reported that the application is easy to use as well. The few AMWs who reported that the application was not easy to use were older with heavy workloads. One young AMW had assisted to a single delivery earlier in the year, but did not have any clients since the start of the pilot, and therefore not the opportunity to use the application. Several AMWs reported that the application was difficult to use in the beginning. Never having been exposed to anything comparable before, some felt intimidated by the application. Only one older AMW reported having difficulty with the Smartphone itself and complained about difficulties with reading the text, manipulating the device, and accidentally touching the wrong buttons.

Despite the reported ease of use, most AMWs experienced some technical problem with the application, of which quite a few experienced many technical problems. These were often related to basic things such as forgetting passwords or not knowing how to reboot the application.

Kathy: When I started using it I had difficulties with my password. I was shown how to do it, but when I was back I forgot how to do it.

AMWs reported storing music, pictures and videos on their Smartphones, which caused the Commcare application to crash, after which many AMWs were unable to reboot the application.

Pa Pa: I store music and when there is too much, it slows down and the application does not work well… It works again when the videos are deleted.

Our findings reflect findings of a study in Ethiopia where CHWs reported that the eCDS application was easy to use, although many admitted having problems entering their user names, passwords, and a third of the CHWs accidentally deleted electronic forms (Medhanyie, Little, et al., 2015a). To ensure that AMWs truly feel at ease using the eCDS, refresher training may need to focus more on elementary skills in Smartphone use, and the use of the eCDS application in particular.

(b) Usefulness

Nearly all AMWs perceived the voice option of the Smartphone as useful. The one exception lived in a village without cellphone reception. Calling was considered useful to communicate with supervisors and clients. The voice option facilitated effective and efficient organization of referrals, a finding that has been well documented in the literature for other low- and middle country (LMIC) contexts (Battle et al., 2015; Chaiyachati et al., 2013; Chang et al., 2011; Chang et al., 2013; Chib et al., 2008; Mechael et al., 2012).

Dwae Hla: It is useful that pregnant women from the other village can call me. I can get ready and prepare things for delivery while the motorcycle comes to pick me up.

AMWs called to consult their midwives during problematic deliveries, to rapidly report surveillance or outbreak data, or to receive information about immunization days or visits to the village. AMWs called pregnant women to inform them about appointments and, through AMWs, villagers sometimes requested MW visits for general consultations. AMWs appreciated the portability of the Smartphone, which allows them to access patient information whenever and wherever they need to consult patient data.

Dwae Hla: I can carry the phone wherever I go. One time, I accompanied a patient for emergency referral, but I could not bring the record books. I had the phone in my hand so when the doctor asked me about the patient I could reply, as I had the data in my phone.

Another advantage of the application was found in the easy data sharing with supervising MWs and PUI supervisors.

Moe Moe: In the past, we sent the data on paper each month. Now we send it with this application. It is convenient and fast.

Nearly all AMWs considered the eCDS aspect of the application as useful as well. Medical history taking and the checklists with danger signs were considered useful reminders of what data to collect and some AMWs used them to teach pregnant women about danger signs. Other features that were considered as particularly useful are the automatic calculation of the delivery date and the automatic generation of a summary report with the recommended action to take. Several AMWs expressed feeling supported by the eCDS, feeling more confident when referring a pregnant woman. A few AMWs mentioned that the eCDS helps to convince clients to actually follow up recommendations.

Gant Gaw: The application recommends the action to take. We will know for sure if we have to refer the patients.

Pa Pa: Some patients don't believe me if I recommend by myself. They will say I am not an expert or something… When I tell them what the recommendation part says, they go (for referral).

These findings are in line with results of other recent projects investigating eCDS in LMIC that report increased self-confidence among CHWs, as the eCDS guided them through the diagnostic process, and feelings of empowerment because of eCDS-generated treatment recommendations (Battle et al., 2015; Praveen et al., 2014; Vedanthan et al., 2015).

Similar to our study, nurses in Western Kenya viewed the requirement to complete all screens positively, as it helped to not miss clinical observations (Vedanthan et al., 2015). However, some AMWs in our study did not like that the eCDS prohibited skipping fields and felt that the eCDS was too comprehensive and time consuming with the additional information that had to be collected.

Indeed, the literature confirms that using eCDS may lead to lengthier consultations. For example, Ginsburg and colleagues (2015) found that using eCDS led to an increase from 8.2 to 43 minutes per consultation (Ginsburg et al., 2015). This could be related to manual input, as a review of mobile CDS systems and applications suggests (Martínez-Pérez et al., 2014). However, when Mensah et al (2015) investigated the workflow of an electronic CDS system in Ghana and Tanzania in a time-and-motion study the total time spent on ANC had not increased significantly compared to the control group. Not only were increasing trends in registration and history taking levelled by decreasing trends in physical investigations and lab exams, more importantly, time spent on ANC in control areas increased as well because of quality improvement activities initiated by the government (Mensah et al., 2015). This suggests that any effort at improving quality of ANC services, including electronic efforts, are likely to result in increased consultation time.

That AMWs appreciate the usefulness of the application is reflected in the fact that many AMWs proposed additional functionalities to the current application. The additional functionality they requested most was information on treatment and drugs, followed by an extension of the eCDS to include the under-five and general population. Other desired features include functionalities for family planning, appointment reminders, and data collection (vital, demographic, and surveillance data). Similarly, CHWs in Ethiopia, Ghana, and Kenya requested additional functionalities to mHealth applications or eCDS coverage of other diseases (Ginsburg et al., 2015; Jones et al., 2012; Medhanyie, Moser, et al., 2015). In a perception study of an mHealth intervention aimed to improve community HIV/AIDS care in Uganda, the expectations of some CHWs were qualified as unrealistic, as they expected that mHealth tools would provide them with the capacity to diagnose all diseases (Chang et al., 2013). The desire of AMWs in Dala Township to treat the general population with eCDS might be similarly unrealistic, as the eCDS application remains a tool to support AMWs only in the work they were trained for.

When compared with the paper system, most AMWs preferred the electronic system, as it was considered to be more comprehensive than the paper forms and allowed for more efficient data sharing. Some AMWs reported to even having stopped using the paper forms. On the other hand, an important advantage of the paper system was found in its flexibility, as skipping questions and making corrections were considered to be easier in the paper system. With regard to the reliability of the two systems, opinions were divided. Some felt that the electronic system was more reliable as paper records could be easily lost, destroyed, or get wet in the rainy season. Others trusted the paper system more, as they feared information loss because of connectivity issues, technical problems with the application, or accidentally pressing the wrong button.

Zin Mar: Like in the rainy season, we have places to visit and our papers can be wet in the rain… then I can look up the data in the tool.

(c) Social Influence

For this construct we asked AMWs about the opinions and actions of individuals in their social environment who are most likely to influence their acceptability of the mHealth tools: family and friends, clients, peers, and supervisors.

Family and Friends

Family and friends considered mHealth tools as useful and beneficial for both AMWs and pregnant women and generally like that AMWs use them for their work. A few AMWs report that family and friends support the innovation as they perceive it as an appropriate response to a changing environment that gets more technologically advanced.

Ohn Mar: They like to see me using this phone, because with the IT development it is not ok if we still use books and records; now it is easy for both the patient and me. Patients come to me to ask information right away. So my parents like seeing all this.

Although there was hardly any negative feedback, many AMWs report that family and friends did not say much. This could in part be explained by the low workloads of several AMWs that contributed to their low use of the application at the time of data collection. It might as well have been a reflection of the Burmese culture that values modesty and approval not being expressed so explicitly.

Clients

Most AMWs reported that their clients liked the use of mHealth tools, perceiving improved care, as AMWs spent more time with them using the application. A few AMWs reported that some clients trusted them more because of the application itself, resulting in an increase of clients as pregnant women encourage each other to get registered.

Wut Yi: They feel that I am taking care of them more than before, so they get interested in my services. They think that I am taking good care of them by using the tool.

This finding is in line with findings in SMS interventions in Kenya and Rwanda, where health workers felt that client relations improved because they perceived improved

quality of care (Jones et al., 2012) and pregnant women started attending ANC because they wanted to be registered in the system (Ngabo et al., 2012).

Nonetheless, quite a few AMWs reported not having received much of a reaction from clients, but these AMWs did not use the application during consultations. The few negative reactions from clients related to them being impatient with the lengthy consultations.

Barani: Before, we mainly asked about danger signs but now we have many questions… some patients were impatient to answer all the questions.

Peers

Generally, peer influence was perceived positively by AMWs, because of peer support and learning. For example, when one champion found a solution that prevented overwriting prior weight and blood pressure records, several AMWs adopted her way of documenting patient information. However, unlike village midwives in Indonesia who used their mobile phones mainly to call peers (Chib et al., 2008), AMWs in our study rarely called each other, despite the organization-sponsored airtime. They rather discussed the application when they met in person during monthly training sessions to share their experiences and concerns.

Barani: We talk about the bad Internet connection, and which days were worst, and what went wrong with the Commcare application. We share our worries about being scolded if we inform the office that it was out of order. We also encourage each other.

Supervisors

Although it was expected that mHealth tools would facilitate supportive supervision, AMWs reported that only half of the midwives was interested in the application. Nevertheless, many AMWs reported that the relationship with their supervising midwife had improved, mainly because of improved connectivity.

Hla Hla: The township doctor asked her (midwife) to not record in here and just accept what I register. (Using mHealth tools is) …of course positive. I can contact her in time. She comes to see patients when I call.

The lack of midwife support might be explained by their supervisors' attitude. The township doctor had not been included in the first stage of the pilot, as he supervised AMWs indirectly. However, when the township doctor did not receive a Smartphone, he instructed midwives to not use the application either, as he would be unable to supervise their input. In line with his instructions, quite a few supervising midwives did check the entries that AMWs made, although AMWs rarely received feedback on their entries.

Despite a rocky start, AMWs reported that the township doctor has started to express more interest in the mHealth project and they believe that he should receive a Smartphone with the application to supervise them. Not only would he know their workload, AMWs expect to learn from him and receive direct advice about client management, which would benefit the health system in general and their clients in particular.

FG1: We heard that the township doctor is interested in the device and the application. He wants to know about it. He wants to know what the AMWs do and how they work. We might receive suggestions and advice from him. If a device would be given to the doctor or health assistant, it would be much better.

AMWs in Myanmar seem to hope for more senior level involvement, and to ensure a proper functioning CHW program, eCDS requires supportive supervision (Svoronos et al., 2010). The weak link of supervisor influence should therefore not be underestimated. The objective of introducing mHealth tools is performance improvement, for which supportive supervision is essential. Moreover, linking CHWs to supervisors through mHealth applications contributes to CHWs feeling connected to the health system, which increases their motivation to perform well (Strachan et al., 2012). Our findings suggest that, to ensure a positive supervisor influence, the cadre of supervisors should not be interpreted too narrowly, only focusing on direct supervisors. The mHealth

project in Myanmar might therefore benefit from suggestions made by Modi et al (2015) who, after they reported a low supervisors uptake in an mHealth intervention in India, recommend garnering commitment from higher-level officials (Modi et al., 2015).

Contextual Facilitators and Barriers

Factors in the implementation context may facilitate or impede the use of mHealth tools by AMWs in Dala Township. We therefore report whether infrastructural factors, such as connectivity and electricity issues, hampered the use of mHealth tools or not, whether organizational support that PUI provided was perceived to facilitate use or not, and how larger determinants, such as socioeconomic and political factors were perceived to affect use.

Infrastructural factors: Internet connectivity, cell phone coverage, and access to electricity

Many studies in LMIC demonstrate that Internet connectivity is a key challenge for the use of mHealth tools such as SMS and eCDS (Khan et al., 2015; Medhanyie, Moser, et al., 2015; Mwendwa, 2016; Praveen et al., 2014; Vedanthan et al., 2015). Similarly, in our study, connectivity problems were identified as the main barrier to use the Smartphone application, with respondents complaining about limited connectivity causing prolonged delays in data transmission to the central server. AMWs had to send data at inconvenient times, some sending it late at night or very early in the morning, or they had walk to a place where the reception was better.

Barani: The connection often fails and we cannot send the message during the day. We have to send it early morning or late at night, sometimes at midnight or 1 AM. During the day the network is busy. Sometimes I get discouraged.

All but one AMW reported having cell phone coverage in their village. In contrast to many other studies (Jennings et al., 2013; Mwendwa, 2016; Ngabo et al., 2012; Stanton et al., 2015), access to electricity was not perceived as a barrier in our study. Despite the fact that only a quarter of the AMWs had access to government-supplied

electricity, AMWs pointed out that easy alternatives for phone charging were found. AMWs used private solar systems, village or monastery generators, or charged their phones at their neighbor's or family's house. Only a few AMWs solely depend on the solar panel provided by PUI for phone charging.

Moe Moe: We live in the field and the village does not have electricity, so we have electricity when the monastery switches on its electricity.

Organizational factors: training, technical support, material and financial support

AMWs received a 2-day initial training in the use of the application. Whereas this had been sufficient for the majority of AMWs, quite a few expressed needing refresher training. Some suggested a different training format, in smaller groups for improved learning and focused on specific topics, such as fixing errors. Several AMWs would have liked to receive more general information, such as how to surf the Internet, and how much that would cost, etc.

Cho Cho: It has been explained well… but it would be better if we got more training. Training about fixing minor problems.

FG3: We need refresher training, but 20 in a class is not convenient. We should be grouped and trained, like 3 persons per group… we could understand more.

The basic problems that AMWs experienced using the eCDS application suggest as well that training requires continued attention. Due to infrequent use, AMWs with low workloads may forget how to use the eCDS application. The fact that AMWs asked to receive training in smaller groups could be an indication that they might have had problems understanding how to use the application during the training. It is therefore important to verify and confirm understanding after training, as Haberer et al. (2010) recommended after their discovery that users in Uganda had never admitted to not understand processes during the training (Haberer et al., 2010).

Although quite a few AMWs were satisfied with the technical support they received, many reported that technical assistance could be improved. Many AMWs had to travel for several hours to receive technical support and when the phones were not repaired immediately they had to resort to working with paper forms again. They therefore suggested including a trouble shooting function in the application to guide their independent problem solving. The implementing organization could have thought of an alternative solution, such as the development of a user manual, similar to what had been developed for CHWs in Ghana (Ginsburg et al., 2015).

Inn Gyin: The error message is just a text. I can't call anyone for troubleshooting… it would be better to have a troubleshooting function in the application that suggests what to do when you receive an error message.

The supervising nursing staff of PUI managed many of the minor repairs, but some AMWs wish to have more professional technical support. This suggests that more practical support by the IT officer could be beneficial. It is difficult to find technical support staff in Myanmar, however.

Say Nu: It would be better to have someone who can handle the phone professionally. To repair when Commcare is not working… Sometimes they send it back without fixing. I don't know, maybe they had a lot of phones to fix and sent it by mistake.

The lack of available technical staff is generally noted as one of the many challenges in developing countries (Blaya et al., 2010). mHealth interventions in Malawi and Zambia, for example, faced challenges managing software as local software consultants were lacking (Noordam et al., 2015). In Ghana and Tanzania, on the other hand, technical support was provided through a hotline for ongoing technical support, and bi-weekly project visits by a technical team (Mensah et al., 2015), which might be an interesting support solution for Myanmar's mHealth project as well.

An organizational facilitator was found in the material and financial support that AMWs received in the form of the Smartphone, solar charger, and airtime, although most AMWs already had mobile phones for personal use and only a few AMWs needed the solar charger to charge their phones. AMWs seem to have perceived receiving this kind of support as an acknowledgement of their professional role, similar to what Strachan et al. (2012) suggested when they state that mHealth tools could be "*symbolic signifiers of their role and connection to a respected program*" (Strachan et al., 2012) (p.117). That the community asked AMWs to use the Smartphones to contact midwives for general consultations may be an indication that the community regards the Smartphones and airtime as part of the professional service, and therefore the AMW-role as well.

A few AMWs had problems with the hardware. The Huawei Smartphone heats up and the battery empties quickly. The solar panel that PUI provided charges the Smartphone so slowly that very few AMWs actually used it for phone charging.

Thuzar: The phone becomes hot and the cable as well. When I charge my phone I unplug it after 30 minutes to cool down and then I plug it in again. It gets hot instantly… it was getting hot when I talked on the phone after some minutes.

AMWs seem to perceive the monthly 5000-kyat (around 5 US$) top-up cards for airtime as a financial compensation to support their professional services. It leads to the perception that cost efficiencies are made as they no longer incur costs for copying reports or transportation costs to deliver them by hand.

Wut Yi: With the phone we can send while sitting at home but it will cost us to travel when we use the paper.

A few AMWs report that the amount of subsidized airtime is not high enough, especially when patient communication increasingly takes place through the phone. Several complain about the lack of timeliness of the distribution of the top up cards.

FG1: The amount is insufficient… patients sometimes call us to call the midwives… In the past we had to spent 3 hours per village or more, going door to door for immunization… now we save time, but we spend for calling.

Socioeconomic factors

The socioeconomic change in Myanmar was an interesting facilitator in our study. New telecom developers started operating a few months before the start of the pilot project, and subsequent competitive pricing of telecom services resulted in the affordability of mobile phones, SIM-cards and call credit. AMWs reported that nearly every household had access to a mobile phone and that 40-90% of individual villagers owned cellphones at the time of data collection.

Aye Aye: Before, not many had phones. Only some people could afford to buy phones. But this year, about 80% of the people in my village have phones because of the 1500 Kyat phone cards and the Telenor cards. Handsets cost only 50,000 to 100,000 Kyat, so many people can afford to buy phones now.

Political factors

Around three months before the data collection, , the Head of Department of the Regional Office announced that all reporting for midwives and health workers would be electronic in the future. AMWs report that subsequently, their township doctor started asking questions about the application.

Barani: at first, the township doctor didn't like it (mHealth tools), but now he likes it. Earlier, at the hospital, I heard some people saying that we would have to use the mobile for records, and that these should be sent to the hospital… The Head of Department had the idea to use the electronic system. Midwives and health workers will use electronic reporting for activities related to health.

The political interest that AMWs detected at regional levels was a great motivator to accept and use mHealth tools. That political support can be a critical enabler is

demonstrated by the study of Ngabo et al (2012) who describe the active role of Rwandan government in the RapidSMS intervention to monitor pregnancy and reduce maternal and child deaths (Ngabo et al., 2012). The Rwandan government provided mobile phones and SIM-cards to CHWs (n=432) and covered the costs for SMS communication, after having negotiated a ten-fold price reduction through a public-private partnership.

Public-spirited professionalism and belief in mHealth

We found that acceptability and contextual factors were not the only constructs influencing the use of mHealth tools. AMWs seemed to be deeply motivated by the best interest of their community and the health system in general. Combined with an ethos of service, this may have been a reason why they embraced the mHealth tools despite the challenges they encountered. This sense of public-spirited professionalism seems to be reinforced by positive reactions from client, the developing socioeconomic context, and the political support that AMWs perceived. The latter seems to contribute to the belief that mHealth tools will be the future norm. AMWs felt privileged to participate in this pilot, as it provides them with experience using mHealth tools, which may be an advantage once the government will decide that health reporting will have be electronic.

Say Nu: It (more mHealth development) is already happening now. We can learn because we have it. Otherwise we would know nothing. We get experience.

In addition, as the electronic system is perceived as superior to the paper system, because of time efficiencies, improved sharing of information with others, and improved quality of care, AMWs appear to feel a professional duty to accept and use mHealth tools. We therefore added the emerging construct of 'public-spirited professionalism and belief in mHealth".

This emerging construct seems to be reflected as well in the intention of most AMWs to continue using mHealth tools if PUI were to discontinue its financial contribution.

Ohn Mar: Even if they (PUI) would stop paying, I would use it, because it is for our village and for the villagers, the patients. I am a volunteer and I have good intentions to do my job well.

Similarly, Campbell et al (2015) found that CHWs continued using mobile phones when airtime was no longer supported by the project (Campbell et al., 2014). However, the altruistic statements made by AMWs could well be an expression of gratitude for having received the mobile phone and solar charger, instead of an affirmation of public-spirited professionalism. In the long run, the financial burden to AMWs should not be underestimated, as they are volunteers, and, as Goel et al (2013) state, reimbursement of airtime should be a prerequisite as the use of mHealth tools otherwise would add to CHWs' financial burden (Goel, Bhatnagar, Sharma, & Singh, 2013).

Nonetheless, the determination of AMWs to accept and use mHealth tools was evident. Despite the fact that they admitted struggling with the application, lacking technical or supervisory support, or feeling discouraged because of lack of Internet connectivity, they kept stressing that the mHealth tools were in their community's best interest, good for their health system, and therefore felt a professional duty to accept and use the application.

Ni Ni: Our priority is mother and childcare, so it is important that we fully succeed, isn't it? We can send the data to our supervisors so that they will know our work as well.

Although systematic reviews report that evidence of effectiveness is still limited, authors agree that mHealth shows promise (Agarwal et al., 2015; Betjeman et al., 2013; Blaya et al., 2010; Braun et al., 2013). The high acceptability of mHealth tools by AMWs in Dala Township, their belief in mHealth, and the contextual facilitators in our study similarly reflect this promise.

Strengths and Limitations

Dala Township is a peri-urban setting and contextual findings may not be transferable to strictly rural contexts. Data were collected three months into the pilot project, which might have limited findings of acceptability, for example with regard to AMWs with very low workloads who had might have had little opportunity to use mHealth tools. Because of defective Smartphone applications not all AMWs could be observed in how they used the application. The study would have been further enriched if the perspectives of supervising MWs had been explored as well. The positive findings of our study may have been affected by social desirability bias although we stressed confidentiality, included observation, and encouraged participants to describe real experiences.

Strengths of this study can be found in its foundation in technology acceptance theories and the inclusion of the entire AMW population that participated in the pilot. For future research the reported and actual use of mHealth tools by AMWs in Myanmar needs to be investigated and the perspectives of their supervisors and clients need to be explored.

Conclusion

When PUI implemented Myanmar's first point-of-care mHealth project, it wanted to know whether AMWs would accept and use mHealth tools. We found that mHealth tools were generally perceived as easy to use, useful, and important others in the social environment of AMWs were mostly supportive of AMWs using mHealth tools. As technology acceptance theories claim that these factors determine acceptance, this suggests that the acceptance of mHealth tools by AMWs in Dala Township is high. However, AMWs admitted needing ongoing training and technical support, as well as more supervisory support. Internet network problems represented the key contextual barrier, but unexpected socioeconomic facilitators in Dala Township positively affected the use of mHealth tools. What our study especially highlights, however, is that acceptance and use of mHealth tools by AMWs in Dala Township were especially determined by their belief in mHealth and their public-spirited professionalism, which were in turn reinforced by political support for mHealth and an ethos of service. Despite the barriers that they encountered, AMWs were determined to embrace mHealth tools, as

they believed them to be the future norm, superior to the traditional system, and in the best interest of their communities and health system.

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Chapter 5: Discussion & Limitations

French NGO PUI wanted to know whether AMWs would accept and use the mHealth tools it had introduced in its maternal and child healthcare program in Dala Township, Myanmar, in August 2014. To guide our exploration we used a conceptual framework based on technology acceptance models claiming that ease of use, usefulness and social influence determine acceptance, which in turn predicts actual use of the new technology. Additionally, the construct of contextual barriers and facilitators was expected to influence the use of mHealth tools directly.

The findings of our qualitative study show a high acceptance of both the voice option and the Smartphone application, consisting of the electronic patient registration and eCDS.

5.1 Voice Option

With regard to voice calling, the ease of use is likely explained by most AMWs owning cell phones prior to receiving the PUI Smartphones. Our findings in Myanmar mirror existing literature regarding usefulness and social influence, as AMWs in Dala Township reported that the voice option contributed to effective and efficient organization of referrals and facilitated communication with supervisors and clients, and thus improved their relations with them (Battle et al., 2015; Chaiyachati et al., 2013; Chang et al., 2013; A. Chib, M. O. Lwin, J. Ang, H. Lin, & F. Santoso, 2008; Mechael et al., 2012). Hence our study confirms the established evidence from other LMIC that voice calling is generally perceived as easy to use, useful, socially supported, and therefore accepted and used.

5.2 Application (electronic patient registration & eCDS)

In contrast to the voice option, acceptance of the application seems to be less straightforward. Although the three constructs determining acceptance were generally perceived as positive, acceptance of the application seemed to be strongly determined by AMWs *wanting* to accept the mHealth tools. A complex set of factors appear to contribute to this determination to accept mHealth tools regardless of the challenges they encountered: a

large interpretation of perceived usefulness, a politically influenced belief that mHealth will be the future norm, AMWs' concern for their community, combined with their ethos of service and professionalism. The combination of these different factors is so distinct that we decided to call this emerging construct "*public-spirited professionalism and belief in mHealth*".

5.2.1 Public-spirited professionalism and belief in mHealth

The emerging construct of public-spirited professionalism and belief in mHealth merits a closer look into the different factors contributing to it. AMWs' desire to embrace the innovation seemed to be motivated most by their belief that mHealth tools were useful. This finding is supported by technology acceptance theories that state that usefulness is the strongest predictor of acceptance. Moreover, prior research demonstrated that the usefulness construct remained significant over extended periods of time, whereas both the ease of use and social influence constructs became non-significant after a period of sustained use (Davis, 1989; Venkatesh et al., 2003). Applied to our study, it could explain why AMWs did not seem to be too bothered by the lack of supervisor support and why they reported that the application was easy to use when observation showed otherwise. Indeed, they seemed to trust that with practice the application would be easier to use and that in time, supervisors would come to accept the application as well.

According to technology acceptance theories, perceived usefulness is generally regarded in terms of outcome and performance improvement. Likewise in our study, AMWs perceived that the application improved the quality of their services, their effectiveness and efficiency, and increased their knowledge and self-efficacy. What was especially interesting was how they valued the usefulness of the application beyond their immediate services, into the future and to benefit the larger health system. AMWs believed that mHealth was going to be the future norm and felt privileged to be the "*avant garde"* group to pioneer this technology. Because of the promise the innovation held for them, AMWs seemed keen to overcome technical and infrastructural problems they encountered, and readily forgave the weaker aspects of organizational support, such as the inadequate technical assistance and lack of ongoing training.

This belief in the promise of electronic health was likely fuelled by the electronic health projects the MOH of Myanmar had engaged in. In collaboration with the University of Oslo, the MOH was developing the District Health Information System 2 (DHIS2) at the time of data collection. Additionally, it had started geographic information system mapping to address accessibility of healthcare and its country roadmaps for women's and children's health included e-Health and innovation plans (MOH, 2013). These national electronic health activities seemed to enhance AMWs' perceptions of usefulness, which were further reinforced when the Regional Health Officer announced that all reporting for midwives and health workers would be electronic in the near future.

In addition to contributing to the health system, AMWs seemed to be driven by an ethos of service to offer the best quality of service to their communities. As AMWs judged the electronic system to be superior to the paper system, they felt professionally obliged to accept and use the application. The introduction of mHealth in their service delivery may have reinforced this sense of professionalism, as AMWs in our study perceived the monthly airtime allowance as a financial compensation for their professional services. Strachan et al. (2012) suggested that mHealth tools could be "*symbolic signifiers of their role and connection to a respected program*" (Strachan et al., 2012), and indeed, the requests by the community to use the Smartphones to communicate about general health issues suggest that the airtime and organization-sponsored material (Smartphone, charger, and SIM-card) may have been regarded as an extension of the professional services of AMWs to the community.

The public-spirited professionalism seems to be reflected as well in the intention of most AMWs to continue using mHealth tools if PUI were to discontinue its financial contribution. Similarly, Campbell et al (2015) found that CHWs continued using mobile phones when airtime was no longer supported by the project (Campbell et al., 2014). However, rather than an affirmation of public-spirited professionalism, the altruistic statements made by AMWs might as well have been an expression of gratitude for having received the communication materials. Ultimately, the financial burden to AMWs should not be underestimated. As they are volunteers, reimbursement of airtime should be a prerequisite for the use of mHealth tools to not add to their financial burden (Goel et al., 2013).

Nonetheless, the determination of AMWs to accept and use mHealth tools was evident. Despite the fact that they admitted struggling with the application, lacking technical or supervisory support, or feeling discouraged because of the lack of Internet connectivity, they kept stressing that the mHealth tools were in their community's best interest, good for their health system, and therefore felt a professional duty to accept and use the application.

5.2.2 More useful or less?

That AMWs appreciated the usefulness of the application is further illustrated by all the additional functionalities they proposed. Some of the requested features, such as eCDS applications for diagnosis and treatment of illnesses for the under-five or general populations, are incompatible with the level of training AMWs currently receive. However, other desired features that included functionalities for family planning, appointment reminders, and data collection would better fit the tasks assigned to AMWs. Developing these features could further enhance perceptions of usefulness, as perceived usefulness increases when critical aspects of the job are supported (Davis, 1989).

Given the data collection tasks of AMWs –they collect vital, demographic, and disease surveillance data, it was interesting that AMWs did not request any reporting features. This may be explained by the lack of formalized reporting processes between AMWs and their supervising midwives. Moreover, midwives, and not AMWs, carry the formal reporting burden to district and national health authorities. However, it would make sense for the implementing organization to develop a data collection functionality that would feed into the District Health Information System 2 (DHIS2), and thus contribute to national disease surveillance and health management information systems.

Despite the high acceptance, the application was not without disadvantages. AMWs complained about the inflexibility of the electronic system, had doubts with regard to its reliability and worried about lengthier consultations. Compared to the application, important advantages of the paper forms were its flexibility to skip fields and make corrections. Some AMWs worried about information loss in the electronic system because of connectivity issues, technical problems with the application, or accidentally pressing the wrong button. It could be argued that these disadvantages might diminish in time when AMWs would be more

accustomed to using the application. However, their worry about lengthier consultations requires further scrutiny.

Similar to nurses in Western Kenya, most AMWs appreciated that the eCDS app was much more comprehensive than the paper forms as it helped them to not miss clinical observations (Vedanthan et al., 2015). Moreover, AMWs reported receiving positive feedback from clients who perceived the lengthier consultations as an improvement of the quality of services. On the other hand, some AMWs felt that consultations had become too time-consuming and noticed that clients became impatient. Although the increased consultation time in our study may be explained in part by the lack of familiarity with the Smartphone application, the literature does confirm that using eCDS may result in lengthier consultations. For example, using eCDS in Ghana led to an increase from 8.2 to 43 minutes per consultation (Ginsburg et al., 2015). This could be related to manual input, as a review of mobile CDS systems and applications suggests (Martínez-Pérez et al., 2014). However, when Mensah et al (2015) investigated the workflow of an eCDS system in Ghana and Tanzania in a time-and-motion study, the total time spent on ANC had not increased significantly compared to the control group. Not only were increasing trends in registration and history taking levelled by decreasing trends in physical investigations and lab exams, more importantly, time spent on ANC in control areas increased as well because of quality improvement activities initiated by the government (Mensah et al., 2015). This suggests that any effort at improving quality of ANC services, including electronic efforts, is likely to result in increased consultation time.

5.2.3 Ease of use

Although most AMWs reported that the application was easy to use, observations showed that only a few AMWs were truly confident using the application. The ease of use seemed to result from personal interest in information technology, as some of the 'prodigies' had hardly used the application for professional reasons. Some older AMWs admitted experiencing difficulties and feeling reluctant to use the new technology. This is not surprising, as it is well documented that older users generally expect and experience more cognitive difficulties learning new technologies, have less prior experience with and knowledge of information technology, and may find new technologies less important as they

are satisfied with their established routines (Kaphle et al., 2015; Kim, Gajos, Muller, & Grosz, 2016; Smith et al., 2015; Venkatesh et al., 2003). Several AMWs in our study struggled with basic tasks such as opening the application and entering passwords. This finding mirrors study findings in Ethiopia, where CHWs reported that the eCDS system was easy to use despite having significant problems entering user names and passwords, and accidentally deleting electronic forms (Medhanyie, Little, et al., 2015a). To ensure that AMWs truly feel at ease using the application, refresher training may have to be organized more frequently and technical support staff be made more accessible in earlier stages of the implementation.

5.2.4 Social Influence

With regard to social influence, our findings were mostly positive. Family, friends, peers and clients generally supported the use of the mHealth application. However, an important exception was the supervisor influence. Although it was expected that insight in decision-making would facilitate supportive supervision, AMWs reported that only half of the midwives was interested in the application. The lack of midwife support might be explained by their supervisors' attitude, the township doctor who had not been included in the first stage of the pilot, as he supervised AMWs indirectly. When he did not receive a Smartphone initially, he instructed midwives to not use the application either, as he would be unable to supervise their input. Although supervisor attitudes changed in the course of the project, the weak link of supervisor influence should not be underestimated.

To ensure a proper functioning CHW program, eCDS requires supportive supervision (Svoronos et al., 2010). Not only is supportive supervision essential for performance improvement, the linking of CHWs to supervisors through mHealth applications contributes to CHWs feeling connected to the health system, which increases their motivation to perform well (Chaiyachati et al., 2013; Strachan et al., 2012). Our findings suggest that in order to ensure a positive supervisor influence the cadre of supervisors should not be interpreted too narrowly by only focusing on direct supervisors. The mHealth project in Myanmar might therefore benefit from suggestions made by Modi et al. (2015) who, after they reported a low supervisors uptake in an mHealth intervention in India, recommended garnering commitment from higher-level officials (Modi et al., 2015).

5.2.5 Contextual facilitators and barriers

Apart from a problematic Internet connectivity, the contextual factors in our study were perceived rather positively by AMWs. Admittedly, some organizational facilitators such as training and technical support could be improved. The basic problems that AMWs experienced using the eCDS application suggest that training requires continued attention. Additionally, the implementing organization could have thought of including a trouble shooting function in the application or could have developed a user manual, similar to what had been developed for CHWs in Ghana (Ginsburg et al., 2015).

AMWs expressed as well a need for more professional technical support. It is difficult to find technical support staff in Myanmar, however. The lack of available technical staff is generally noted as one of the many challenges in developing countries (Blaya et al., 2010). mHealth interventions in Malawi and Zambia, for example, faced challenges managing software as local software consultants were lacking (Noordam et al., 2015). In Ghana and Tanzania, on the other hand, technical support was provided through a hotline for ongoing technical support, and bi-weekly project visits by a technical team (Mensah et al., 2015), which might be an interesting support solution for Myanmar's mHealth project as well.

Surprising contextual facilitators in our study were the political and socioeconomic factors. The effect of the positive political climate was noted in relation to AMW's belief in mHealth and has been discussed under the emerging construct of public-spirited professionalism and belief in mHealth. The socioeconomic change in Myanmar was an unexpected facilitator in our study. The inhibitive pricing of communication material had been a serious concern during the development phase of the application. However, Myanmar's openness to foreign investment after its transition into democracy in 2011 turned this barrier into an opportunity. International telecom developers started operating in 2014, only a few months before the start of the pilot project, and subsequent competitive pricing of telecom services resulted in the affordability of mobile phones, SIM-cards and call credit. As a result, Myanmar's mobile phone possession increased from 1% in 2010 to 54% in 2014 (ITU, 2016a). Moreover, as a late participant to information and communication technology, Myanmar leapfrogged into the latest technology, which probably explains why so many of the AMWs owned Smartphones. The AMWs in our study confirmed that mobile phone possession

had increased considerably in their villages in the recent year, which has likely affected the acceptability and use of voice calling and possibly the acceptability of the application as well. With a further increase to 77% in 2015, Myanmar's rapidly increasing mobile phone possession may indicate a desire among its population to catch up with the current state of technology, which may further facilitate the acceptance of mHealth tools.

To summarize, we found that mHealth tools were generally perceived as easy to use, useful, and important others in the social environment of AMWs were mostly supportive of AMWs using mHealth tools. As technology acceptance theories claim that these factors determine acceptance, this suggests that the acceptance of mHealth tools by AMWs in Dala Township is high. Although technology acceptance theories claim that contextual factors determine use directly and not indirectly through acceptance, our study showed more complex relations between the constructs. Organizational support such as training may have influenced the ease of use, the organization-donated material and financial support may have influenced social influence, and political facilitators seemed to enhance perceptions of usefulness. Finally, socioeconomic facilitators may have had some effect on social influence as well.

What our study especially highlights, however, is that acceptance and use of mHealth tools by AMWs in Dala Township were notably determined by their belief in mHealth and their public-spirited professionalism, which were in turn reinforced by political support and an ethos of service. Although systematic reviews report that evidence of effectiveness is still limited, authors agree that mHealth shows promise (Agarwal et al., 2015; Betjeman et al., 2013; Blaya et al., 2010; Braun et al., 2013). The high acceptability of mHealth tools by AMWs in Dala Township, their belief in mHealth, and the contextual facilitators in our study similarly reflect this promise.

5.3 Strengths and Limitations

Dala Township is a peri-urban setting and contextual findings may not be transferable to strictly rural contexts. Data were collected 3 months into the pilot project, which might have limited findings of acceptability, for example with regard to AMWs with very low workloads who might have had little opportunity to use mHealth tools. Because of defective Smartphone applications not all AMWs could be observed in how they used the application. Moreover, the

study would have been further enriched if the perspectives of supervising MWs had been explored as well. Last, the positive findings of our study may have been affected by social desirability bias although we stressed confidentiality, included observation, and encouraged participants to describe real experiences.

Strengths of this study can be found in its foundation in technology acceptance theories and the inclusion of the entire AMW population that participated in the pilot. For future research the reported and actual use of mHealth tools by AMWs in Myanmar needs to be investigated and the perspectives of their supervisors and clients need to be explored. Finally, a quantitative follow up of this study might contribute to a new technology acceptance model that may be better adapted to a developing country setting like Myanmar.

Chapter 6: Additional findings

A critical reader may have noticed that several findings from the thematic framework in Annex III have not been reported and discussed in the article above. Considering the fact that this is a Master's thesis, we have chosen to include only one article to replace the results and discussion chapters. Many more findings emerged from our data collection, however. In this chapter we briefly touch upon some of the findings that we did not address in our first article.

Whereas our first article targets a public health audience, with our second article we aim to write for an mHealth audience. We provide more contextual and technical background information and focus on several practical aspects of the use of the Commcare application. We describe the reported use, as AMWs used the eCDS application in different ways. A few AMWs had stopped using paper forms altogether, but others did not use the eCDS at all, and several AMWs did not use the application during client consultation. We report why this was the case and what the consequences of the different ways of use were.

As we expect that the mHealth community could benefit from some of the lessons we learned, we discuss in more depth what practical issues AMWs encountered when using the application. For example, practical information such as that keypad phones did not support Burmese font could be useful, as it implies that SMS might not be an appropriate platform to reach the population in Myanmar. Similarly, cultural information, such as the local use of a lunar calendar that counts 1-14 days prior and post full moon instead of the solar calendar of 1-30 or 31 could be useful information for software developers.

AMWs reacted differently to some of the consequences of using the application. Some AMWs experienced a substantial increase in workload, and whereas some regarded this positively, others did not. Moreover, the transparency provided by the application, which made AMWs' workload and decision-making visible to all users, was welcomed by some AMWs but not by others.

An adaptation of the conceptual framework considering all our findings and emerging themes will figure in our second article that is under development.

Chapter 7: Conclusion

7.1. Concluding reflections

In this section I address some points of reflexivity with regard to this study, as my professional background undoubtedly coloured many of the choices I made and the approaches I used.

I have worked for humanitarian medical organizations since 2000, first with Médecins Sans Frontières and in 2011-2012 as Country Director for Première Urgence Internationale in Thailand. As practitioners we had to apply evidence-based practice, but I experienced that evidence was not always practical and not always existent. Moreover, we ourselves were major generators of data that, with the right tools, could have been transformed into evidence. When I returned to university, my objective in research has therefore been to contribute to practice-based evidence that would directly benefit the field.

This objective is reflected first in the choice of my research topic. As it was the first mHealth project for both the Myanmar mission and PUI in general, findings would directly benefit their operations, as well as contribute to mHealth knowledge in this implementation context.

Second, because of my background I was able to participate in this innovative project from the pre-implementation phase. I investigated implementation science approaches and co-constructed the program logic and rationale, which benefitted the study through a refinement of the interview guide and a better understanding of the project that helped with the data interpretation.

My focus on the practical usefulness of the study is further reflected in my decision to use a directional depiction of technology acceptance theories in my conceptual framework. This could be perceived as an indication that the study would be deductive, whereas this study is qualitative, thus inductive. My aim, however, was to communicate with an audience of practitioners and I felt that this was the most effective visual representation of the technology acceptance theories that I used.

Having completed this study, I realize that its practical usefulness has been limited for the implementing organization. PUI mainly benefitted from the findings I described in the preliminary analysis that I shared immediately after the data collection. The need for rapid information in practice seems incompatible with the much lower pace of conventional evidence production. In the future, for an innovative project such as this, I would rather use an approach that would be more useful for practice, such as the developmental evaluation approach (Patton, 2011) that allows for rapid and creative production of evidence. I do hope, however, that other practitioners will benefit from the findings of this study and am therefore content to have contributed to practice-based evidence.

7.2. Study conclusions

When PUI implemented Myanmar's first point-of-care mHealth project, it wanted to know whether AMWs would accept and use mHealth tools. We found that mHealth tools were generally perceived as easy to use, useful, and important others in the social environment of AMWs were mostly supportive of AMWs using mHealth tools. As technology acceptance theories claim that these factors determine acceptance, this suggests that the acceptance of mHealth tools by AMWs in Dala Township is high. Internet network problems represented the key contextual barrier, but unexpected socioeconomic facilitators in Dala Township positively affected the use of mHealth tools. What our study especially highlights, however, is that acceptance and use of mHealth tools by AMWs in Dala Township were notably determined by their belief in mHealth and their public-spirited professionalism, which were in turn reinforced by political support for mHealth and an ethos of service. Despite the barriers that they encountered, AMWs were determined to embrace mHealth tools, as they believed them to be the future norm, superior to the traditional system, and in the best interest of their communities and health system.

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Annex I: Interview Guide

Could you describe the phone and the application and how you use it in your daily life?

Ease of use

- Is the phone easy to use? Why?
- Is the application easy to use? Why?
- Could you give an example of what is (not) easy?

Usefulness

- What is more useful for you: phone or applications + why?
- Please show me an example of what you find most useful in the application
- Could you give me an example of what you do not find useful in the app? Why?
- How does the application compare to the paper system?
- How could the tool be more useful to you and others?

Social Influence

- How do your friends and family feel about you using mHealth tools for your work?
- How do you like using these tools with your patients?
- How do patients like it that you use this application?
- Do you use the application when you are with patients or afterwards? Why?
- Have you noticed an increase in new patients since you use these tools? Why (not)?
- How do patients perceive the confidentiality of their data?
- How do you use the mHealth tools in your communication with your supervising midwife?
- How do you feel about the transparency provided by the application?
- How does this transparency influence your relationship with your supervising midwife?
- Do you use the mHealth tools in your communication with other AMWs? How?

Contextual barriers and facilitators

- How does network coverage affect you using the call option or the application?
- How do you charge your phone, how long does it take?
- How does (the absence of) electricity affect you using the Smartphone?
- What do you think of training you receive from PUI? Why?
- What do you think of the support (material, technical, financial) you receive from PUI? Why?
- If PUI would stop paying for communication costs (5000 kyat p/m), would you still use the mHealth tools? Why?
- Are there other factors that would facilitate you using the mHealth tools?

Annex II: AMW Characteristics

#	Fictive Name	age (yrs)	age (cat)	village nr	smart phone exp	key pad exp	cell netw	Internet	electricity	power source	yrs wrk exp	work load (del /yr)	work load (anc)	work load (pnc)	total (n del * n anc + pnc)	work load (cat)	meet MW (# p/m)
1	Aye Aye	24	young	1000	yes		yes	bad	no	husband's family	8	2.5	4	6	25	low	4.5
2	Barani	25	medium	610	no	yes	yes	bad	yes	city electricity	8	36	3.5	4.5	288	very high	3
3	Cho Cho	56	old	3300	no	yes	yes	bad	no	village gen	32	36	3	4.5	270	very high	2.5
4	Dwae Hla	28	medium	1052	yes		yes	bad	yes	city electricity	5	48	5	4	432	very high	4.5
5	Ei Ei	26	medium	500	no	yes	yes	bad	yes	city electricity	5	10	7	7	140	medium	4
6	Gant Gaw	24	young	600	yes		bad	bad	no	village gen	2	1	4	4	8	low	2
7	Hla Hla	38	medium	200	yes		yes	bad	no	PU-AMI solar	6	23	4	4	184	high	2
8	Inn Gyin	27	medium	700	yes	yes	yes	no	no	private solar	2	4.5	4	5	40.5	low	2
9	Jue Jue	21	young	110	yes		yes	no pb	yes	city electricity	2	10	8	1	90	medium	3
10	Kathy	33	medium	750	no	yes	yes	bad	no	PU-AMI solar	5	20	3.5	4	150	high	2
11	Lae Lae	33	medium	262	no	yes	yes	bad	no	private solar	2	5.5	3	5.5	46.75	low	2.5
12	Moe Moe	32	medium	700	yes		yes	bad	no	monastry/PU-AMI	6	4	4	5	36	low	9
13	Ni Ni	53	old	1339	no	no	yes	no pb	no	city electricity	35	12	3.5	4	90	medium	3
14	Ohnmar	23	young	700	yes		yes	bad	no	village gen	2	10	4	4	80	medium	2.5
15	Pa Pa	27	medium	1500	yes		yes	bad	no	village gen	8	25	2	9	275	high	30
16	Su Su	22	young	630	yes		yes	bad	no	private solar	2	3	4	4.5	25.5	low	2
17	Thida	28	medium	500	yes		yes	-	no	private solar	8	3	5	8	39	low	2
18	Wut Yi	32	medium	150	yes		yes	bad	no	private solar	2	9	4	6	90	medium	4.5
19	Yadana	23	young	328	yes		yes	no pb	no	village gen	2	3.5	4	3	24.5	low	4.5
20	Zin Mar	36	medium	110	no	no	yes	-	yes	city electricity	5	48	4	5	432	very high	6
					12	6		5 yes, 15 no				16.5	4.4	5.2	145.6		3.5

17-24	6			avg yrs work exp	7.35		# del:	36-48	4 very high
25-39	12			w/o outliers 35, 32	4.4444			20-25	3 high
40-59	2							9 to 12	4 medium
								1-5.5	8 low

Annex III: Thematic Framework

Thematic framework mHealth in Myanmar 2014-2015

constructs		themes		categories		sub-categories	
1	**ease of use**						
	1.A.	Ease of use voice	1.A.1.	Voice is easy to use			
			1.A.2.	Voice is not easy to use			
	1.B.	Ease of use app	1.B.1.	app is easy to use			
			1.B.2.	app is not easy to use	1.B.2.1.	afraid to make mistakes	
					1.B.2.2.	inexperienced	
					1.B.2.3.	technical issues make it difficult to use	
					1.B.2.4.	difficulty manipulating the device	
	1.C.	Use other features	1.C.1.	Use of SMS			
2	**Usefulness**						
	2.A.	usefulness voice	2.A.1.	voice facilitates coms w patients			
			2.A.2.	voice facilitates coms w MW			
			2.A.3.	voice facilitates coms villagers-MW			
			2.A.4.	voice facilitates referral & logistics			
	2.B.	usefulness app	2. B.1.	app is useful	2.B.1.1.	easy access to data & data sharing	
					2.B.1.2.	useful to inform patients	
					2.B.1.3.	useful to memorize (patients, records)	
					2.B.1.4.	it teaches you	
					2.B.1.5.	everything is useful	
					2.B.1.6.	automatic calculation due date	
					2.B.1.7.	automatic generation recs (summary)	
					2.B.1.8.	checklist with danger signs	
					2.B.1.9.	convincing power summary w. patients	
			2.B.2.	app is not useful			
					2.B.2.1.	it is time consuming	
					2.B.2.2.	it is not flexible	
					2.B.2.3.	it is impractical (combi physical exam.)	
			2.B.3.	app more useful if…			
					2.B.3.1.	incl. diagn/tx info PW	
					2.B.3.2.	incl. diagn/tx info general population	
					2.B.3.3.	incl. newborn app	
					2.B.3.4.	incl. under-5 app	
					2.B.3.5.	incl. data collection app	
					2.B.3.6.	incl. health info & family planning	
					2.B.3.7.	it is already useful enough	
			2.B.4.	most useful			

		2.C.	comparison App-paper					
				2.C.1.	app more useful than paper	2.D.1.1.	app easier access + sharing	
						2.D.1.2.	app more comprehensive	
						2.D.1.3.	storage in phone is useful	
						2.D.1.4.	app cheaper than paper (copy & transportation cost)	
				2.C.2.	paper more useful than app			
						2.D.2.1.	familiarity with paper system	
						2.D.2.2.	paper system more reliable	
						2.D.2.3.	history is saved in paper system	
						2.D.2.4.	correction in paper is easier	
						2.D.2.5.	paper allows for skipping parts	
				2.C.3.	app and paper equally useful			
3	**social influence**							
		3.A.	influence friends& family	3.A.1.	positive	3.A.1.1.	they like for AMW to use mH tools	a. they think it this the future
								b. now I don't use my family's phone
				3.A.2.	negative	3.A.2.1.	they don't like AMW using app	
				3.A.3.	neutral	3.A.3.1.	they don't say much	
		3.B.	influence patients					
				3.B.1.	positive	3.B.1.1.	patient endorsment of mH tools	a. patient like that app is used
								b. AMW takes pics of patients/kids
								c. patient perceive improved care
						3.B.1.2.	patient is curious about app	
				3.B.2.	negative			
				3.B.3.	neutral			
		3.C.	influence peers					
				3.C.1.	positve	3.C.1.1.	AMWs discuss app with each other	
						3.C.1.2.	AMWs help each other with app	
						3.C.1.3.	AMWs call each other for advice	
				3.C.2.	negative			
				3.C.3.	neutral			
		3.D.	Influence supervisors (MW)					
				3.D.1.	postive			
				3.D.2.	negative			
				3.D.3.	neutral			
				3.D.4.	Supportive supervision by MW	3.D.4.1.	App used for supportive supervision	a. MW looks at patients AMW in app
								b. MW and AMW discuss about app
			Influence other supervisors			3.D.4.2.	App not used for supportive supervision	
		3.E.		3.E.1.	influence PU-AMI			
				3.E.2.	influence TMO			
4	**Contextual barriers**							

		4.A.	Technical	4.A.1.	app does not work right now			
				4.A.2.	app did not work (at some stage)	4.A.2.1.	app does not work with storage pics, music, video	
						4.A.2.2.	serious techn problems with app	
				4.A.3.	design flaws			
						4.A.3.1.	translation problems (EN-Burmese)	
						4.A.3.2.	English words in Burmese translation	
						4.A.3.3.	solar vs lunar calendar	
						4.A.3.4.	history disappears (42+ days, BP, weight…)	a. AMW finds solution to history issue
						4.A.3.5.	AN not separated from PN (patient names)	
						4.A.3.6.	Lack of spec responsibilities MW-AMW	
				4.A.4.	hardware problem			
						4.A.4.1.	phone heats up	
						4.A.4.2.	problem with the battery	
				4.A.5.	no (major) technical problems			
		4.B.	Environmental					
				4.B.1.	Cellphone cov + Internet network	4.B.1.1.	Good connection -no pb sending data	
						4.B.1.2.	bad Internet network	a. sending data takes a long time
								b. data sent at inconvenient times
								c. problematic w high workload
				4.B.2.	Electricity	4.B.2.1.	good electricity (village electricity)	
						4.B.2.2.	is problem for charging phone	a. pb charging phone (takes long)
								b. when charging I can't bring phone
						4.B.3.2.	Alternative solutions charging	
								a. village generator
								b. private solar system
								c. charging at neighbors/family
								d. charging with PU-AMI solar charger
								e. free charging at monastry
		4.C.	Job-related barrier	4.C.1.	ANC organization not conducive for mH app use			
				4.C.2.	very low workload			
		4.D.	Financial barrier					
				4.D.1.	problematic	4.D.1.1.	patients are poor	
						4.D.1.2.	cost for delivery services	
						4.D.1.3.	communication costs	
				4.D.2.	not problematic			
						4.D.2.1.	village insurance	
						4.D.2.2.	copying more expensive than comm cost	
5	**Contextual facilitators**							
		5.A.	Organizational facilitator	5.A.1.	training	5.A.1.1.	training was sufficient	
						5.A.1.2.	training was not sufficient	a. refresher training is needed
				5.A.2.	material support (solar charger, spare battery)			

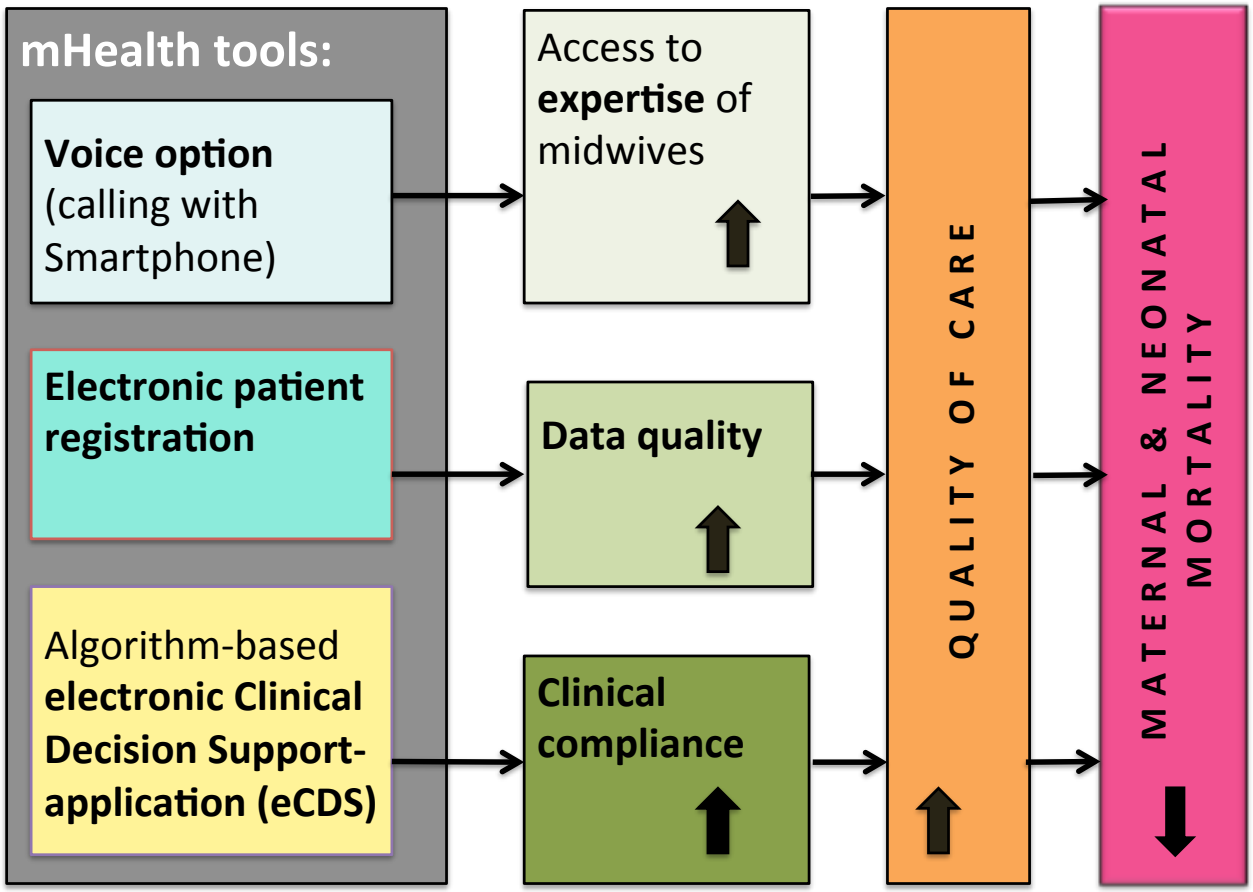
				5.A.3.	technical support	5.A.3.1.	technical support was sufficient	
						5.A.3.2.	technical support was not sufficient	
				5.A.4.	financial support	5.A.4.1.	amount is (in)sufficient	
						5.A.4.2.	top up cards are late	
						5.A.4.3.	ineffective because SIM card doesn't work	
		5.B.	Socioecon: patients/villagers own/use cell phones					
		5.C.	Political: MOH wants mHealth					
6	**Reported use**							
		6.A.	I use voice more	6.A.1.	preference face-to-face interaction			
		6.B.	I use app more					
		6.C.	mH app used during patient cons?					
				6.C.1.	app used during patient consult			
				6.C.2.	app not used during patient consult	6.A.2.1.	app not used during PNC consultation	
		6.D.	informed consent?					
				6.D.1.	app demonstrated to patient			
		6.E.	Does MW use app?					
				6.E.1.	MW uses mH app			
				6.E.2.	MW does not use mH app			
				6.E.3.	MW cannot use mH app			
		6.F.	Reported Consequences					
				6.F.1.	Increased workload for AMWs?	6.F.1.1.	workload increased	a. AMW happy with increased workload
					(because of improved connectivity)			b. AMW not happy w increased workloa
						6.F.1.2.	workload decreased	
						6.F.1.3.	workload did not change since mH tools	
				6.F.2.	Increase in patients?	6.F.2.1.	yes	a. increase because of app
								b. because my skills/efforts improved
								c. increase # patient visits
						6.F.2.2.	no	a. no increase because of app
7	**Beliefs and values**							b. I covered all PW already
		7.A.	Intrinsic motivation	7.A.1.	Motivators to use	7.A.1.1.	concern for community	
						7.A.1.2.	sense of professional duty	
						7.A.1.3.	mH is good for health system	
						7.A.1.4.	electronic registration/reporting is the future	
				7.A.2.	Motivators to not use	7.A.2.1.	disrespecting patient when using app	
		7.B.	patient confidentiality					
				7.B.1.	patient confidentiality no concern			
				7.B.2.	patient conf concern for sensitive info			
				7.B.3.	patient doesn't know app = transparent			
		7.C.	Transparency					
				7.C.1.	Transparency is good	7.C.1.1.	AMWs learn from each other	
						7.C.1.2.	AMWs like to have a look at each other's patients	

						7.C.1.3.	Others can see my workload	
						7.C.1.4.	despite risks, wanting to be transparent	
				7.C.2.	Transparency is not good			
						7.C.2.1.	preference to not see other AMWs patients	
						7.C.2.2.	risks of transparency	
						7.C.2.3.	AMW does not really look at other AMWs patients	
						7.C.2.4.	long list of patients is not practical	
		7.D.	continue using app if no $?	7.D.1.	yes			
				7.D.2.	no			
		7.E.	Personal preferences					
				7.E.1.	preference electronic system	7.E.1.1.	electronic system is the future	
						7.E.1.2.	elestronic system is more efficient	
						7.E.1.3.	compliance with majority	
				7.E.2.	preference paper system			

Annex IV: Central Chart

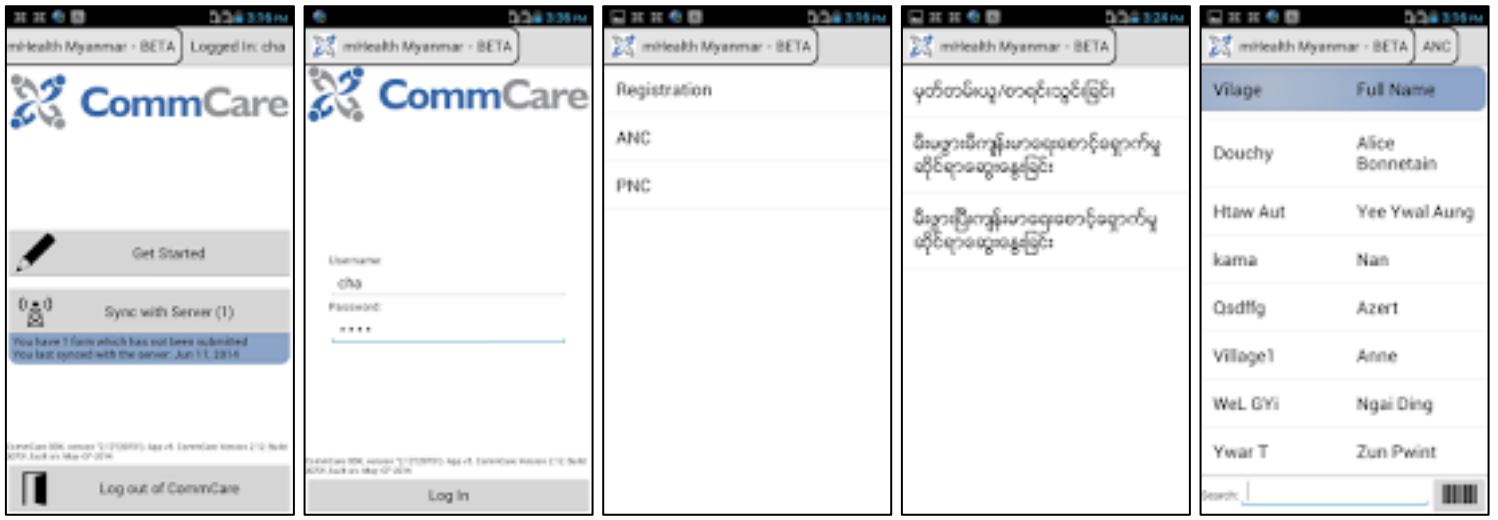
AMW	voice easy	app easy	voice useful	app useful	use SMS	paper/ app?	reaction patients	%villagers own cell phones?	supp super vision	MW use	technical problems	use during ANC	use during PNC
AMW 01	yes	yes	no	yes	yes	app	supportive	40	no	yes	-	no	-
AMW 02	yes	yes	yes	yes	yes	both	enthusiastic	90	yes	yes	-	group	-
AMW 03	no	no	yes	no	no	paper	none	50	no	no	a lot	no	-
AMW 04	yes	yes	yes	yes	-	-	positive	70	yes	yes	rarely	group	-
AMW 05	yes	yes	yes	yes	no	app	positive	50	yes	yes	once	group	-
AMW 06	yes	no	yes	yes	yes	app	positive	50	no	no	a lot	yes	yes
AMW 07	yes	no/ok	yes	yes	not easy	app	positive	70	checks	no	yes	no	no
AMW 08	yes	yes	ok	YES	-	both	positive	70	checks	no	rarely	yes	no
AMW 09								90					
AMW 10	card	no/ok	yes	yes	no	both	neutral	70	checks	yes	yes	yes	-
AMW 11	-	ok/yes	yes	yes	-	both	positive	50	no	no	-	yes	-
AMW 12	yes	yes	yes	yes	-	both	positive	50	checks	no	a lot	yes	-
AMW 13	yes	no/ok	yes	no	-	paper	neutr/supp	40	no	no	yes	no	no
AMW 14	yes	yes	yes	yes	-	app	positive	60	no	no	yes	yes	-
AMW 15	yes	yes	yes	yes	-	only app	positive	90	no	no	yes	yes	no
AMW 16	yes	yes	yes	yes	-	app	-	50	checks	yes	yes	no	-
AMW 17	yes	yes	yes	yes	-	na/paper	-	70	no	-	a lot	-	yes
AMW 18	yes	yes	yes	yes	-	app	neutr/supp	90	yes	yes	no	yes	yes
AMW 19	yes	yes	yes	yes	-	only app	neutral	70	checks	?	no	yes	yes
AMW 20	yes	no	yes	yes	-	paper	positive	90	not sure	not sure	a lot	no	no

Annex V: mHealth program Rationale



Annex VI: Commcare Application

The mHealth application developed by Première Urgence Internationale and Télécom Sans Frontières (2014), based on open source software CommCare. Example of English version.

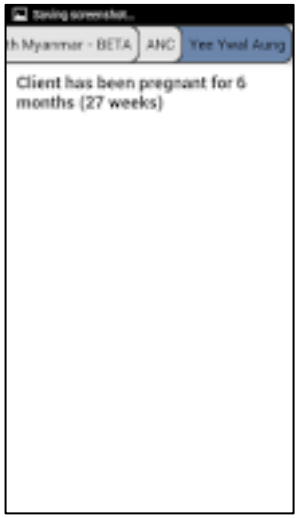


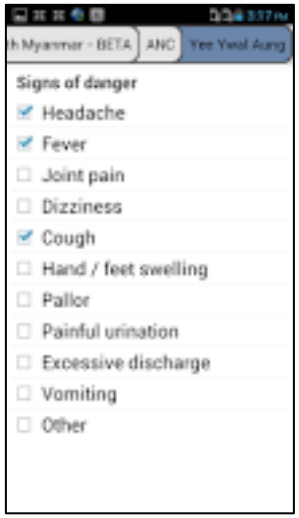

mHealth Myanmar - BETA
ANC
Full Name
Yee Ywal Aung
Age
23
Next Appointment
2014-06-16
Education
university
Occupation
office_work
Date Opened
2014-06-16
Phone Number
09422490798
Select Client

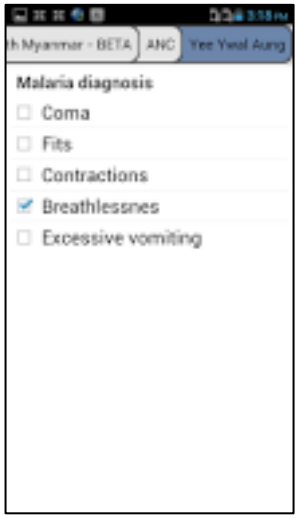

Yee Ywal Aung
Personnal medical history
Hypertension
Diabetes
Heart disease
Poliomyelitis
Limp
Tuberculosis
Blood transfusion
Asthma


Yee Ywal Aung
Gravida
2


Yee Ywal Aung
First day of last menstruation
Nov 08 2012
Dec 09 2013
Jan 10 2014


Yee Ywal Aung
Client has been pregnant for 6 months (27 weeks)


Yee Ywal Aung
Signs of danger
Headache
Fever
Joint pain
Dizziness
Cough
Hand / feet swelling
Pallor
Painful urination
Excessive discharge
Vomiting
Other


Yee Ywal Aung
Malaria diagnosis
Coma
Fits
Contractions
Breathlessnes
Excessive vomiting


Yee Ywal Aung
Summary
High risk pregnancy Refer for follow-up ---- Malaria Refer immediately for malaria management ----