

Factors that influence m-health implementations in resource constrained areas in the developing world

Stella Ouma ^{1,3}, Marlien Herselman ^{1,2} and Darelle VanGrauen ³

¹ Monash University, South Africa, ² CSIR, Meraka, South Africa, ³ Nelson Mandela Metropolitan University, South Africa

Abstract: This paper looks into an overview of the challenges that are crippling the healthcare domain which provide healthcare services to the resource constrained areas in developing nations. It also looks into how mobile devices can be used to provide service delivery within the healthcare sector by providing different mobile health (m-health) solutions. We also look into various frameworks that have been proposed by other authors in implementing m-health applications. Although these frameworks are helpful, we consider the healthcare context within developing nations to be unique and therefore explore how m-health solutions can effectively be delivered within the resource constrained areas. We propose that these m-health services be deployed from the primary healthcare levels in order to improve the delivery of services within various communities. We further provide the issues that the m-health service providers should take into account when providing m-health solutions to the resource constrained areas.

Keywords: m-health, resource constrained areas, developing world

1. Introduction

There are a variety of challenges that exist in developing nations' healthcare sectors such as within the public hospitals. Most hospitals in the developing world are burdened with patients suffering from various diseases such as Malaria, HIV and Tuberculosis. Additionally, there are few healthcare professionals especially within the rural areas as a result of rural urban migration (WHO 2008).

The use of information and Communication Technology (ICT) can assist in the provision of services within the public healthcare sector to improve service delivery within hospitals. (WHO 2008), states that ICT can be used in health promotion and prevention, human resources for health and the use of ICT for service delivery. The developing world has tried to embrace the use of electronic health (e-health) such as telemedicine, the use of hospital information systems and electronic health records but there have been a lot of challenges which are still being addressed. Of late, a lot of attention has shifted to the use of mobile phones within the healthcare sector in the developing nations and hence the use of m-health. However the m-health technologies still rely on the existing e-health platforms. Many applications which relied previously solely on e-health can now be accessed by use of mobile devices ((Rubio 2007) and WHO 2008)).

According to (Vital Wave Consulting 2009), mobile phones can be used to provide basic healthcare services to the developing world. (WHO 2006), states that 64% of mobile users are located in developing nations. Additionally (Vital Wave Consulting 2009), affirms that by 2012, half of the people living in the remote areas will own and have access to mobile phones. Hence there are a lot of ongoing pilot projects and case studies on the use of mobile phones to provide health services (m-health solutions), especially within the developing world. M-health solutions include the use of mobile phones to provide services on emergency response systems, mobile telemedicine, remote patient monitoring and clinical use, health promotion and community mobilisation, health service monitoring and reporting, health related m-

leaning for the general public and training and continuing professional development for healthcare workers.

The use of m-health services should be availed to communities in order to improve service delivery in marginalised areas because they can improve service delivery.

In this paper we investigate how communities can benefit from m-health applications nationwide. We propose that this can be achieved by deploying m-health services within primary healthcare settings thus empowering local communities through m-health initiatives.

2. Problem

Although many pilot projects have been conducted, these projects have not been extended to provide m-health services nationwide within the developed countries. According to (Drury, 2005), most of the frameworks developed on the use of ICT in healthcare service delivery are based on the context of developed world where the ICT infrastructure is already in place unlike in the developing world. A consequence of this comes with m-health involving diverse sectors and different m-health stakeholders, and a lack of the use of m-health frameworks that are contextually based within the healthcare domain. In this paper, we look into how m-health service delivery can be incorporated to improve services within the healthcare sector at the public hospitals and within reach to various communities.

This paper will apply explorative research methodology as the researchers want to determine and explore the components that can contribute significantly to an m-health framework to be used within resource constrained environments within the developing world.

3. Objective

The main objective of this paper therefore involves:

- i. Identifying the weaknesses of existing m-health frameworks from literature review
- ii. Propose ways in which m-health services can be provided effectively within the resource constrained areas.

4. Theoretical frameworks

A framework is a building block which is provided for the purpose of guiding a process in order to expand a structure into something valuable. (Mifflin 2003) defines a framework as “a set of assumptions, concepts, values and practices that constitute a way of viewing reality”.

There are three frameworks that have been provided to aid in the use of m-health implementations. The Wickramasinge's (2007) m-health framework, the Guah (2007) framework and Micheal (2010), framework.

Wickramasinge's Framework

(Wickramasinge 2007) states that the components of an m-health framework should be composed of the following factors:

- a. Web healthcare players: These are various key stakeholders that contribute greatly to the healthcare sector.
- b. Wireless application process: These are applications that are used by various stakeholders.
- c. Privacy: These mainly contribute to an issue that actually deals with security such as reliability, privacy and security.
- d. Research: (Wickramasinghe 2007) and (Goldberg 2004) propose that research should be carried out on various fields such as e-health, business management and other areas of ICT which can improve the use of m-health applications.

- e. Funding requirements: There should be key players who ought to be known, who invest in the m-health applications. Such actors might include employers, insurance companies, government or the consumers
- f. Healthcare deliverables: These include the benefits that emerge from m-health services such as reduced costs, improved patient safety etc.

Although some of the components mentioned by (Wickramasinge and Goldenberg 2007) framework may be used in implementing m-health solutions in the developing world, such as m-health applications, research, funding and involving m-health stakeholders during m-health implementations, Wickramasinge's (2007) framework is based more on the industrialised countries context when looking keenly at the proposed details of the components. The challenges affecting healthcares sector in the developing nations are unique and some of them have been discussed in the first part of section 5 of this paper. For instance, the framework proposes the use of HIPAA standards when implementing the Wireless application processes. A HIPAA standard does not exist within the African context. This framework also recommends the use of client based architecture when implementing the m-health framework. Certainly, the developing world use different existing frameworks that may not be based on the client based architecture and it may not be wise to change from the existing architectures to the client based architecture. Various e-health solutions are not discussed including matters that deal with quality issues in m-health implementation.

Guah's Framework

The second framework is provided by (Guah 2007). The framework provided by (Guah 2007), does not consider various m-health implementation factors as discussed in section 5 of this document but only outlines the stages that are required for an m-health framework. These stages include:

- **Pre-Adoption stage:** In this stage the technology is assessed on its potential to perform the required task in addition to investigating its worth. The factors that arise from such an investigation then become the drivers for adoption.
- **Adoption stage:** In this stage there is an investigation towards the organisation and the environment to confirm whether there is support of the new technology. Any impediments are discovered in this stage.
- **Implementation stage:** Implementation of the mobile technologies should only occur when there are adoption facilitators which assist in dissemination of the new technology.

Guah's framework seems to specifically identify the stages of e-health implementations and does not dwell on the requirements of the implementation process. However Guah's framework may guide m-health implementers to carry out a readiness assessment before implementing m-health solutions.

Micheal's Framework

(Micheal *et al.* 2010) provides various components that should be included in an m-health framework. These include:

- M-health applications: Include applications that are used by a variety of stakeholders in the healthcare domain using mobile phones
- Tools used: Examples include SMS or the use of video technology.
- Research gaps: There is still a lot of research that has to be done on m-health arena especially on the challenges that exist.
- Policy barriers: A lot of regulations need to be put in place to facilitate and guide the use of m-health applications.

The advantage of (Micheal's 2010) framework is that it has been proposed from a development context. However the framework does not address other key issues such as the way to measure quality of m-health applications, business operations etc. and therefore cannot be solely relied on.

5. Discussions

In this section we review the various weaknesses of the frameworks provided and provide an approach that can be used to provide factors that influence m-health services within primary healthcare centers.

Weaknesses of the previous frameworks

Although these frameworks identified in section 4 of this paper are helpful they may not be adhered to strictly in the developing world context. These are due to the following reasons:

- The frameworks are abstract in nature
- None of the frameworks can solely be relied upon to implement m-health solutions because they are incomplete.
- Some of the ICT technologies provided in these frameworks favours industrialised countries and may not favour the developing world.
- The policies mentioned need to be contextualised.
- The developing world needs to look into solutions that address issues within its context.

Factors that influence m-health implementations at primary care level

Various factors influence the delivery of m-health services within communities. These factors include:

i. Understanding the context of service delivery within the developing nations

According to (ITU 2010:2, 4) the manner in which a telephone is used in Africa depends on the local context. However, these frameworks provided in section 4 of this paper do not take into account how various healthcare services are provided within the healthcare domain. Most of the communities in the developing world receive healthcare services through the public services that are availed to them. The healthcare services are provided through primary healthcare, district hospitals (level 1), secondary hospitals (level 2) and through tertiary hospitals or specialized hospitals (level 3). In this paper, these levels are described as follows:

- **Primary healthcare hospitals:** Comprised of clinics and healthcare centres. Primary healthcare hospitals are mainly described as the key entrance to the public health system. Primary healthcare provides individuals and communities with curative, preventive, promotional and rehabilitation services (Schaay and Sanders 2008).
- **Level 1 hospitals (District Hospitals):** According to (English, Lanata, Ngugi and Smith 2006), the district hospitals have better equipment and trained healthcare specialists than the clinics or the healthcare centers which frequently refers patients to the district hospitals. A district hospital can also be seen as a hospital that provides a filter for patients whose conditions do not require referrals to the tertiary hospitals. (Hensher, Price and Adamakoh 2006), state that apart from the referrals that the district hospitals receive from the lower level hospitals, they also offer outpatient and inpatient services. These hospitals usually have got a range of 30 to 200 beds.

- **Level 2 hospitals (Secondary level hospitals):** These type of hospitals are referred to as either provincial hospitals (Hensher et al. 2006) or tertiary 1 hospitals (Cullen 2006). These type of hospitals accommodates up to 800 beds in a given facility for inpatients (Hensher et al. 2006). These type of hospitals also have got expert healthcare workers who provide sub special services to the referred patients from lower levels (Cullen 2006)
- **Level 3 hospitals (Tertiary hospitals):** Also referred to as National hospitals (Hensher et al. 2006) or tertiary 2 hospitals and consist of very highly specialized healthcare workers and also act as institutions of research (Cullen 2006).

If m-health services are to be provided in developing nations, it would be wise to work with various communities who are mostly affected by poor service delivery. Most of these communities access healthcare systems through the primary care level.

The purpose of having primary healthcare is to provide accessible and affordable services to communities. Primary healthcare services provided to communities entails handling various health conditions; conducting follow ups of patients; providing services to marginalized communities or undeserved groups which otherwise would not have access to the healthcare services and provide co-ordination of services through referrals (DHCP2 2007). However, primary healthcare services are affected by various factors and therefore the service provision varies one country to another. For instance, industrialised countries may provide better services within primary healthcare domain compared to the services offered within the developing nations. A good example is Australia where the workforce that provide primary healthcare consists of medical practitioners, nursing workers, dental workers, therapists, medical imaging workers etc (Commonwealth Australia 2009). However in South Africa though some of these personnel may be accessible in district hospitals, within clinics, workforce that provide primary healthcare services within clinics are mainly nurses although 30% of the clinics receive doctors visitations once a week. It is further estimated that within the clinics only 40% of the nurses are trained healthcare nurses (Facility Survey 2004 as quoted by Cullen 2006). Additionally in some of these clinics basic services such as electricity may not be available within certain areas where the clinics are situated (Cullen 2006), especially within the rural areas. Therefore it will be beneficial if the use of m-health services are deployed within the primary healthcare especially within the clinics and healthcare centres within the developing nations. Figure 1 shows that the need of m-health applications is very important within the lower levels and might decrease on the upper levels of healthcare since most of the upper levels may use e-health solutions.

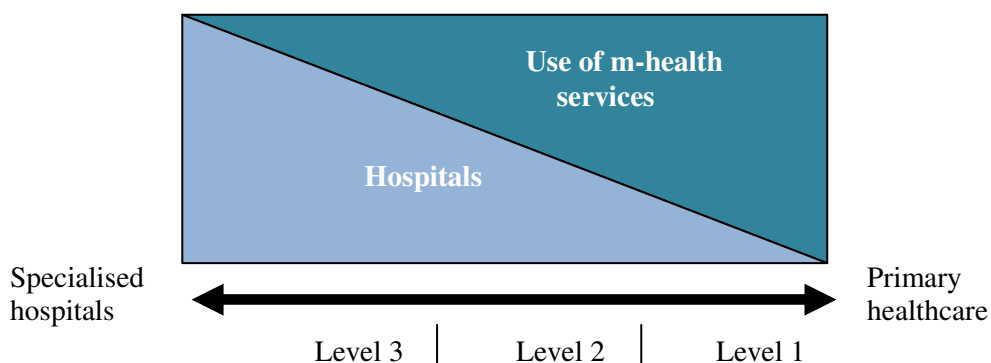


Figure 1: The use of m-health and e-health services within public hospitals

From the figure 1 most of the m-health applications are suited to be used within the lower levels of the healthcare sector. This is because the higher levels of the healthcare sector may already be equipped with computer based applications as they require superior equipment in order to provide various healthcare services.

Therefore the developing nations should direct their efforts towards the use of m-health applications within local communities at the primary healthcare level. By doing so, the government channels their efforts where the majority of the populations exist. This can reduce the number of patients within hospitals especially if the m-health solution focuses on both preventive and curative measures.

ii. Identification and implementation of m-health applications that favour primary healthcare

There are various m-health applications which need to be utilized at primary healthcare level in order to improve service delivery to various communities. These involve applications that can be used in either curative or preventive measure. Some of the m-health services which can be used for primary care include (Vital Wave Consulting 2009):

- **M-health services for training purposes:** These services can be applicable to both the community members and the primary healthcare workers. The communities can access healthcare information on a range of topics such as Malaria, HIV Tuberculosis etc. This ensures that the community is empowered through the access of information on how to manage or prevent diverse ailments. Additionally primary healthcare workers can also learn about various topics within primary healthcare centres.
- **M-telemedicine:** Primary healthcare workers can also use mobile phones to seek advice from other referral centres. This can be done by either calling the various experts or just sending images or textual inquiries.
- **Collection and accessing of healthcare records:** Patients information can be collected and accessed through mobile devices and stored electronically. This ensures that some of the previous medical errors and inconsistencies that used to occur as a result of lost paper based records are avoided. It also promotes reliability of on demand queries of patient's information since they can be accessed at any given time.
- **Public health:** Healthcare information can be sent to individuals within communities issuing them with various alerts or simply updating them on specific healthcare information.

iii. Providing policies to guide content that can be accessed within primary healthcare

The developing nation's government should provide policies that can guide the healthcare content providers on how to present healthcare information and procedures to be undertaken to conduct any healthcare tasks. This creates a standard that all content providers adhere to regardless of whether they are based within the public sector or the private sector. The aim of such policies should be to ensure that the consumers of healthcare information are protected from any harm and that the source of information availed to them is reliable. Policies should also be availed to guide the process of sharing patient's information electronically by healthcare providers. This ensures that patient's information is protected when transmitted from a healthcare to the next. Patients also gain trust on such services if they are aware that such policies exist.

iv. Engaging m-health users within communities

Users of m-health applications are supposed to be consulted and incorporated during m-health implementations process. M-health users in this case are the primary healthcare workers. Primary healthcare workers refer to the healthcare staff stationed within primary healthcare clinics. These include nurses, middle healthcare workers, doctors who access patient's information and also the patients who from time to time use the m-health applications to access their records or general information regarding various diseases. There should therefore be an awareness campaign within the communities on the use of m-health

applications. Primary healthcare providers should be trained on such issues and they can have meetings within communities and share the information. Such awareness can also promote the communities interests in knowing various prevention mechanisms that they can carry out to avoid or manage chronic diseases such as HIV, tuberculosis and diabetes by accessing healthcare information through mobile phones and using that information to benefit them. If such steps are taken and patients are more informed then some of these disease can be avoided through prevention mechanisms which in turn reduces the number of patients visiting the already burdened healthcare system. However if the m-health users are not aware of such benefits then although the benefits may be available they may never profit from them.

Additionally, if such applications are to be used in local communities then the terminology used should be easy to understand and the application should be designed in a manner that is easy to learn. Furthermore, users cultural aspects should be factored in during application development since such supplications are supposed to be used within the constrained environments.

v. Engaging e-health practitioners who work with primary healthcare workers

E-health solutions contribute greatly towards m-health applications. For instance, primary healthcare workers can send m-telemedicine information about a particular patient by sending a picture of a patient’s skin infection. The practitioners who use e-health devices at higher level hospitals will use e-health equipments to view and access the picture and later send feedback to the primary healthcare worker. Therefore there is a relationship between some of the m-health users and e-health users which should be encouraged and taken into account. The relationship that exists between m-health and e-health users is as shown in figure 2.

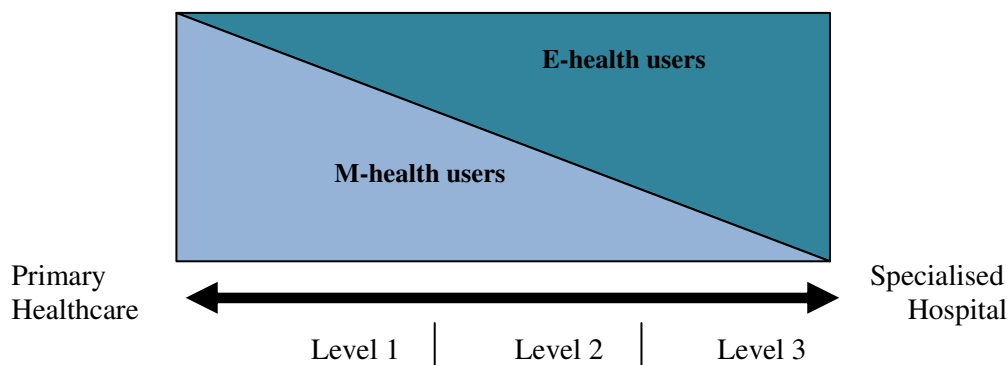


Figure 2: Relationship between m-health and e-health users

E-health users can affect m-health services if no response is received from them. In such situation the reliability of m-health services is compromised and may be deemed to be undependable. It is therefore important that the healthcare practitioners who engage with the primary healthcare workers be also involved as m-health stakeholders.

vi. Using simple and available community technologies

The developed nations should not use technologies that are handed down by the developed nations which are expensive to implement. Instead they should concentrate on technologies that they can afford such as open source technologies which are cheaper to implement compared propriety software. Additionally instead of using complex technology such as Health level 7(HL7) , the developing nations need to work on simple technologies like extensive mark-up language (XML) strategies in order to implement m-health services within the communities.

Developing nations should take advantage of the available technologies such as Living Labs to provide m-health solutions. The Living lab is an approach that “supports community

driven innovation”. Living labs focus on users needs and allows various stakeholders to team up in order to provide solutions that favour various communities (Herselman and Marias et al, 2010).The living lab approach favours the implementation of m-health solutions and should therefore be optimised.

vii. Overcoming interoperability issues

M-health applications should be accessed in all the local communities regardless of the m-health user’s location. In developing nations different hospitals use different platforms for implementing e-health applications. Hence there should be a way to ensure that interoperability issues are addressed in such a way that the m-health solutions can be accessed at all hospitals and hence promote the reliability of such solutions by using simple technologies such as the extensive mark up language(XML).

viii. Address cost issues

It is important to address cost issues in advance putting into consideration that the main use of m-health services within primary healthcare is to improve delivery of services where there are various existing challenges. It is therefore important to ensure that the communities who request for healthcare information or access them are able to afford such services. Hence the ministry of health within the developing nations should come up with ways to address cost issues such as subsidising the m-health costs within the marginal areas.

ix. Carrying out evaluations on the impact of m-health solutions within communities

It is significant to carry out investigations into the effect of m-health solutions within communities in order to improve on the services that are provided. Such evaluations provide a platform for communities to provide perceptions on the use of m-health services. This provides a platform for addressing the m-health user’s needs and addressing any existing challenges that may interfere with the m-health implementations.

6. Future work

It is vital to involve various stakeholders to address the various issues that need further exploration in implanting m-health solutions within primary care. In order to do this it is important to conduct research with various m-health stakeholders and m-health users and find out their experiences with the various m-health applications and their expectations.

7. Conclusion

This study looked into the various m-health applications that are currently used in the developing world. Various frameworks that have previously been proposed were surveyed. The weaknesses of these frameworks were identified in consideration of the developing nation context. The study narrowed down the provision of m-health services to be provided where they may be needed most within the primary healthcare in order to empower communities and improve service delivery. Further research will be done by consulting various m-health stakeholders to find out how these elements affect them and also research on experiences of m-health users or user expectations of m-health applications.

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