A Socio-technical Perspective on the Use of Mobile Phones for Remote Data Collection in Home Community Based Care in Developing Countries

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Abstract. The adoption of technology into the health care industry has been criticized as being overtly techno-centric. It is assumed that health information technologies will fit into the environment and be easily adopted by the user. This, however, is a fallacy. Research has shown that a socio-technical approach, optimizing the interaction between the relevant social, environmental and technical sub-systems, is preferred. In this paper, a socio-technical perspective is gained on the adoption of health information technologies in the home community based care context, specifically the use of mobile phones for remote data collection. Based on data gathered through interviews with and observations of caregivers administering care in the community, this paper identifies and discusses the social, environmental and technical factors that affect community health care workers while they are using mobile phones to capture patient data in the home community based care environment in developing countries.

Keywords: socio-technical approach, home community based care, remote data collection, mobile phones, community health care worker.

1 Introduction

Health care systems of developing countries have had to carry an extra burden due to the increase of people living with infectious diseases on their already weakened and poor health care systems. Home community based care (HCBC) has been encouraged as an alternative to lessen the burden on the health care systems of developing countries. Information that is collected by the community health care worker (CHCW) in developing countries is in paper-based format and this information cannot be analysed and used efficiently. There are various technological alternatives that can be used to provide for the shift from paper-based to technology-based data collection, but in developing countries it would have to have the ability to overcome problems such as: poor telecommunications infrastructure, lack of resources, lack of electricity and insufficient political commitment and support [1]. The one information and communication technology (ICT) solution that seems to have the ability to overcome the problems listed above is the mobile phone. The use of mobile phones and other mobile technology in the health sector is known as ‘mobile health’ or ‘m-health’.

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There are six categories of application in m-health namely: education and awareness, remote data collection, remote monitoring, communication and training for health care workers, disease and epidemic outbreak tracking and diagnostic and treatment support [2]. This paper is interested in the use of mobile phones for remote data collection. There has been steady growth of mobile phone subscriptions in developing countries. In 2007, there were 38.5 mobile phone subscriptions per 100 inhabitants and by the year 2010 this had grown to 67.6 mobile phone subscriptions per 100 inhabitants [3]. Botswana has the highest mobile phone subscriptions with 96.12 per 100 inhabitants followed by Tunisia and South Africa with 95.38 and 92.67 respectively [4]. The high number of people who own mobile phones in developing countries gives a clear indication that m-health is a viable technological solution for developing countries and that there is an opportunity to support health care provision through the use of mobile phones. Notably, when introducing a new technology, the user, the technology and the environment where the user will be using the technology must be considered to ensure that all three are in coherence. Socio-technical theory addresses this coherence between the user, environment and the technology.

Socio-technical systems theory was first envisioned by the Tavistock Institute for Human Relations in London in the 1940's [5] and is defined as "a system that involves a complex interaction between humans, machines and the environmental aspects of the work system" [6]. The socio-technical systems theory proposes three interdependent sub-systems namely the social, environmental and technical sub-systems. The social sub-system represents the people that are internal to the organization. In the context of HCBC the people would be the CHCW and other internal people such as supervisors or managers. The environmental sub-system represents the environment that the CHCW and the patients interact in. The technical sub-system defines the technology that is used by the people. This represents the mobile phones that are used by the CHCWs. This paper investigates the use of mobile phones instead of paper-based systems to collect patient data. The paper aims to understand the social, environmental and technical sub-systems in HCBC and identify factors within these sub-systems that affect CHCWs.

2 Research Methodology

The research followed a qualitative approach and was interpretive in nature. This allowed the researcher to understand different aspects in the research: the home community based care environment, the community health care worker as a person, the work that the health care worker does, the factors that affect them while doing this work and how they experience the use of mobile phones to capture data. Emmanuel haven, a non-governmental organization, was investigated as a single case study. A case study was chosen as this type of research strategy allowed the researcher to explore a single phenomenon in its natural setting using to obtain in-depth knowledge about the case study [7]. Semi-structured interviews and observations were used as data collection methods. The structure of the interview questions were divided into three sections that addressed the social, environmental and technical sub-systems. Research ethics were observed during the research process.

3 Case Study Description: Emmanuel Haven

3.1 Background

Motherwell is situated 20km's outside of Port Elizabeth in the Eastern Cape Province of South Africa and is made up of 15 neighbourhood units (NUs); it is home to an estimated 187,680 people [8]. This area is plagued with a high illiteracy level, lack of adequate health service provision such as clinics, high crime rates and poverty. More than 76% of the Motherwell population earn less than R1600 per month with at least 50% of the population being unemployed [9]. Emmanuel haven is a unique community-based project with an integrated marketplace approach that is located in NU 12 of Motherwell Township. The haven currently has approximately 300 volunteer community health care workers who provide a home based care service to patients. The Emmanuel haven has various projects that it runs apart from the home-based care initiative; these include a day care centre, shoe and brick manufacturing, crèche, radio station, computer school, farming and various other initiatives to support its sustainability. The Emmanuel haven was established in 2004 by Dr Mamisa Chabula-Nxiweni with the primary aim of dealing with the growing number of adults and children that are infected or affected by HIV/AIDS [10].

3.2 Data Collection Methods

The interviews were semi-structured to allow for any additional questions to be asked and for the community health care worker (CHCW) to be able to elaborate on their answers. Interviews were conducted with six CHCWs. The interview times ranged from 40 minutes to 105 minutes and were conducted in both isiXhosa and English. The interviews were recorded, translated from isiXhosa to English and transcribed. Three community health care workers were observed in the execution of their daily duties. The observations were recorded on a video recorder and during the observations field notes were made. Each observation lasted approximately 30 minutes. After the observations the video recordings were viewed to validate and supplement the findings from the interviews.

3.3 Interview and Observation Results

Social Sub-system

Gender. The interviewees were all female; this aligns with Simpson's study which shows that most CHCWs are female [11].

Age. The interviewee's ages ranged from 34 to 63. It is important to note that the age is a crucial factor in being a caregiver in developing countries as older people gain the communities respect more easily than younger people.

Language use. The home language of all the interviewees was isiXhosa and they also used the same language to communicate with their patients.

Educational level. None of the interviewees had reached Grade 12 (matric) but one of them was currently in the process of writing examinations to try and complete their Grade 12. The highest grade obtained amongst the community health care workers was Grade 11 and the lowest grade passed being Grade 10.

Community involvement. The CHCWs all lived in Motherwell Township and chose to work in Emmanuel haven as working in the same environment they lived in meant that they would not have to use money for taxi or buses.

Experience in care giving. All the interviewees have had experience in care giving through caring for sick family members from an age as young as 12. This experience of caring for family members has motivated them and built their passion for being caregivers in the community.

Mobile device ownership. All of the interviewees owned a mobile phone. Three of the six interviewees owned basic mobile phones which had limited capabilities. The mobile phone capability usage was evaluated and the most used capabilities were sending SMSes, making calls and using the organizational tools such as calendar and calculator. Taking pictures, videos and listening to music was only used if the phone was capable as was the case with three interviewees. It was noted that the usage of SMS and call capabilities were dependent on airtime and this was sometimes a scarce resource.

Environmental Sub-system

Poverty. The CHCWs stated that because they work in poverty stricken areas, they feel compelled to find means to provide food and clothing to their patients.

Poor road conditions. CHCWs stated that they walk to patients' homes as they do not have enough finances to take taxis or buses. The conditions of the roads in some areas of Motherwell are poor as the roads are not tarred.

Weather conditions. When it rains, the interviewees stated that the road condition deteriorates even further and the roads become slippery, making it even more difficult for them to visit patients.

Remuneration. The CHCWs that were interviewed were all volunteers meaning that they relied on a monthly stipend of R600 to sustain themselves and their families.

Emotional stress. The interviewees reported that working with patients who are sick and living in poverty affects them emotionally. They are unable to provide for the patients as their stipends are barely enough to provide for their own families.

Lack of material. During the interviews, the interviewees reported that sometimes the Emmanuel haven runs out of supplies to refurnish their kits. This includes items such as data collection forms, gloves and aprons which makes it difficult for them to do their work properly.

Discrimination and stigma. The CHCWs stated that some patients face discrimination from their family members and community after they disclose their HIV status. Community health care workers find it hard to work in these environments as seeing the patient being treated badly causes them emotional stress.

Crime. None of the CHCWs reported being directly affected by crime, even though there is a high crime rate and gangsters are known to operate in the area.

Technical Sub-system

The CHCWs were trained to use a mobile phone for remote data collection. The phone that was used during the training was the researcher's Nokia 5130 express music phone. A mobile application was developed using Episurveyor and installed onto this phone. Three CHCWs (labelled A, D and F in the range of CHCWs who were initially interviewed) were followed on one patient visit each and a video recording of the CHCWs using the mobile phone captured. The community health care workers were first required to complete the relevant paper-based forms and were timed, after which they were observed and timed using the mobile device to capture the same data. The recorded times were used as a measure to compare the duration of capturing written data versus capturing data using the mobile device. This cannot be considered as statistically significant though as the sample of CHCWs was very small and except for the training they received, it was the first time they were using the application to capture data. It is to be expected that capturing times using the phone will improve over time.

CHCW A was the oldest of the three CHCWs observed but she had the fastest times overall using the mobile device for data collection. She reported that she struggled to complete the paper-based form more than when using the mobile phone due to the fact that the room that the patients are in is usually dark. She seemed to struggle to enter the letter 'S'. She usually wears glasses and she struggled reading what was on the screen at times due not only to the darkness but also because she did not have her glasses with her. CHCW D found the keypad to be small and ended up using her fingernails instead of fingertips to enter data into the application. Changing to number mode and entering numbers was a problem for this CHCW. She uses a Samsung phone and found that using a Nokia phone was different. She felt that people who are already using a similar phone have an advantage. CHCW F was the youngest and the only CHCW using a Nokia phone therefore she was used to navigating the phone. Even though she was familiar with the phone the entering of numbers was troublesome and time-consuming for her.

This discussion of the social, environmental and technical sub-systems in HCBC leads onto the following discussion of the social, environmental and technical factors that impact the use of mobile devices for remote data collection in the HCBC environment.

4 Socio-technical Factors Affecting the Use of Mobile Phones for Data Collection in the HCBC Environment

The directed content analysis technique was applied to analyse the interview transcripts as there is some pre-existing theory about the phenomenon (although limited). A coding process was used to identify codes. The codes from the interviews along with codes identified from pre-existing literature were used to compile a list of socio-technical factors (Tables 1 – 3) affecting the use of mobile phones for remote data collection in the HCBC environment. The triangulation with literature reported in this section (where available) shows that the findings of this study are valid but also highlights instances where literature differs from the results of the case study.

Table 1. Social factors

Factor	Literature	Case-study
Age	The age of the community health care worker plays a role when determining how effectively they will use mobile phones in the HCBC environment. A study conducted on people (ages 20-35 versus ages 50-64) it was found that older people have a lower navigation performance when compared to younger people [12].	In our case study it was interesting to see that the oldest person was faster when using a mobile phone to capture patient data when compared to her younger counterparts. However, as mentioned, the sample was not statistically significant and although the caregivers had received training, they had only used the application once thereafter.
Language barriers	The use of a common and understood language in a mobile health application is important for the users so they are able to understand it. Language can be a barrier in adoption of technology as user's can sometimes be reluctant to use a technology if it is not in their native language [13].	The paper-based forms used by the community health care workers are in English and therefore using a mobile application that was in English was not a hindrance. During the observations two of the three CHCW's asked what the word "comprehension' meant as it was used in the application. This shows that language remains a factor.
Educational level	A high educational level is required for one to grasp and understand the commonly used language in ICTs i.e. English, as it is the dominant language used in ICTs [14]. The educational level of users must be known so that a mobile application is created with this in mind.	It was gathered from the interview results that most of the CHCWs had achieved a level of education between Grade 10 and 11. Their understanding of the language used in the application can be attributed to the level of education they attained.
Care giving experience	All the CHCWs had vast care giving experience some having started at the tender age of 12. This experience enabled them to better understand the requirements of the mobile health application for data capturing.	
Preference of where to capture data	Four of the six CHCWs use a notebook to write everything that they do at a patient's home. When they get to their homes, they complete the paper forms based on what they wrote in the notebook. The other two CHCWs preferred capturing the patient data during the visit.	
Distance from CHCW to patients	The closer the CHCW lives to the patient, the easier it is for them to travel (regularly) to visit the patient and collect information. Therefore distance between patients and CHCWs has an effect on data collection.	
Mobile device ownership	3.8 out of 5.3 billion mobile phone users in the world belong to developing countries [15]. CHCWs who own mobiles phones find using the phones for data collection to be easier as they already understand it; those who have never used one experience some difficulties [16].	It was gathered from the interviews that all the CHCWs had phones. This made it easier for them to use the mobile application as they were familiar with the use of mobile phones. The CHCW that had a Nokia phone was the most comfortable with the phone.

Table 2. Environmental factors

Factor	Literature	Case-study
Weather conditions and road conditions	Due to poor road conditions patients who live in remote rural areas cannot be reached easily and this becomes worse during rainy seasons as the road condition deteriorates [17]. This literature support shows that the weather conditions and road conditions are interlinked as weather conditions affect the road conditions, which can affect data collection.	The CHCWs considered mobile phones to be able to overcome weather conditions that affect forms. If the forms they use to capture patient data get wet, information is easily lost. The roads that CHCWs use to travel to patients are in a very poor state and during rainy days their condition deteriorates, preventing the CHCW from visiting patients.
Uniformed CHCW	In some countries uniforms make CHCWs approachable as it gives them visibility in the community [18]. However, at times, families deny CHCWs access to their homes, or even insult CHCWs, fearing that their presence would enable the community to identify and stigmatize them [19].	In the Motherwell township there was some stigma attached with a uniformed CHCW being seen entering a patients' home. This can hinder the CHCWs daily work (including data collection) if they are prevented to enter a home due to fear of stigma.
Poverty	The expensive costs and lack of basic commodities make it difficult for CHCWs to replenish their kits; a stable environment is the key for HCBC to be successful [18].	The CHCWs experienced a lack of supplies to replenish their kits. Poverty is a hindrance as CHCWs find it difficult to focus on data collection if a patient is too ill.
Lack of funding	The government, donors, funders and telecommunication operators are all stakeholders that each has a role in ensuring the success of mobile health [20]. Financing structures need to be in place to ensure the use of mobile health.	The CHCWs were affected by a lack of funding as their stipends are occasionally not paid due to a lack of donor funding. The sustainable use of mobile phones for data capturing will depend on the continued availability of funding.
Quality of data collected	During the interviews all the caregivers stated that they write down the detail related to the patient visit at the patient's home. However, during observation of the caregivers, it was noted that none of them captured data at the patients' homes. They indicated that they would do this at their homes. Arguably this could affect the quality of the data that is collected.	
Lack of electricity	Investment into alternative power sources will help to overcome the barrier of not having charged mobile phones [20]. Lack of electricity in developing countries is seen as a constraint [21].	In the Motherwell community, all the houses have access to prepaid electricity but it does sometimes happen that the family cannot afford to buy it.

Table 2. (*continued*)

Factor	Literature	Case-study
Crime	Crime is prevalent in HCBC environments and affects CHCWs in such a way that they have to have paired or escorted patient visitations [22]. When working in crime-ridden areas the CHCWs feel vulnerable to the point that they sometimes end up not carrying the cellphone [16].	In this community none of the CHCWs had been affected by crime directly or in the execution of their duties. However, they did report that some areas that they work in are unsafe.
Transport issues	A lack of transportation does prevent sufficient visitation to a patient as the patient cannot be reached if they live in remote rural areas where transport is scarce [17]. The fewer the visits, the less data collection occurs.	The lack of transport to patients was mentioned by the CHCWs to be a factor in their work as they sometimes have to decrease the number of times they visit a patient due to a lack of transport or a lack of money for transport.

Table 3. Technical factors

Factor	Literature	Case-study
Familiarity	The forms that were created on the mobile phone were based on the paper-based forms that the health care workers used, therefore it was easier for them to understand the application as it was familiar to them.	
Internet connectivity	The lack of telecommunications infrastructure in developing countries can be problematic for the collection of data [21].	Without the existence of an internet connection, data could not be saved onto the server.
Mobile phone support	It was difficult to get a version of Episurveyor that could work on the Nokia 5130 express music phone as not all phones are supported by the Episurveyor application.	
Timing and error rate	The use of mobile phones for data capturing is said to be very efficient and time saving for the CHCW [16].	The time that the CHCWs took to complete the paper forms versus using the mobile phone has been mentioned not to be statistically significant.
Trust in CHCW	It was gathered through the interviews that a certain level of trust in the CHCW is required in order for the patient to be comfortable with the CHCW collecting their private information. If a patient does not trust the CHCW, it will be difficult for the CHCW to collect data.	
Trust in ICT's	Patients find it easier to trust paper-based methods rather than the use of ICTs; even though ICTs can break down certain barriers it does carry some fears along with it [23].	In this case study the CHCW and the patients had not been exposed to the use of ICTs for data collection and therefore this factor was not investigated.

Table 3. (*continued*)

Factor	Literature	Case-study
Portability	CHCWs in developing countries have to work alone in isolated and remote areas with little to no access to information; the use of small portable handheld devices enables CHCWs in remote areas to access up to date information [21].	The CHCWs are required to travel between patients and most CHCWs do not have transportation means. Portability is seen as a technical factor as an ICT solution that is implemented in the HCBC environment must be portable for the CHCW to carry between visits.
Privacy	Although CHCWs assure patients about privacy, they still insist to look at their files to be sure that information such as their HIV status are not recorded; they fear it might be seen by other people[20].	During the interviews the CHCWs stated that a mobile application to capture data would have to be secured through some means. The privacy of the data was well-recognized by the CHCWs.
Mobile phone training	If it is the CHCWs first time using a mobile phone then they will require significant training and education related to this [23].	None of the CHCWs had used a mobile phone for data collection before; therefore training had to be provided.
Airtime dependency	In order for the mobile application to be functional, airtime is a requirement. It was clear that the CHCWs assumed the mobile application would be "for work" and that they assumed airtime would be provided.	
Key size	The size of the keys affected the way that the community health care workers used the mobile phone for data capturing. One CHCW had to use her nails because she felt that the keys were too small.	
Screen size	A small mobile phone screen size can create problems for users as it limits the amount of information that can be put on the screen [24].	One of the CHCWs could only read the screen with her glasses on.
Input mode	The way that information such as numbers was entered during data collection affected the time the CHCWs took to capture patient data.	

5 Conclusion

CHCWs in developing countries still use paper-based systems to collect patient data in the home community based care environment. M-health presents a viable option to introduce a technological solution to replace paper-based data collection. It is being realised that technology is an influencing factor in the health care environment but it cannot stand alone. An approach that is focused purely on technology impacts negatively on its users. The espousal of a socio-technical perspective is more appealing because it encompasses the technology along with understanding the social and environmental factors.

This study has enabled a robust understanding of the social, environmental and technical factors affecting CHCWs when using mobile phones for remote data capturing in HCBC. The factors reflect the sub-systems comprising the context of the study as proposed by socio-technical systems theory. Valid questions still remain on

the overlap of the sub-systems; such as are the community health care workershappy to use mobile phones for data collection? Do the emotional stresses of the job vastly outweigh any issues of technology? Is there a bottleneck issue in any of the sub-systems that should be focused on?

It is recommended that the factors identified in this paper be considered when an m-health application for data collection is introduced in an HCBC environment. However, further research is required to enable a comprehensive understanding of the overlap between the social, environmental and technical sub-systems of HCBC. The aim should be adoption and meaningful use of mobile phones to capture data in this environment, which is represented by the intersection of all three the sub-systems.

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