Science real and relevant conference 2010
Proceedings homepage://www.conference.csir.co.za/

Strengthening the decentralised healthcare system in rural South Africa through improved service delivery: testing mobility, information and communication technology intervention options

James Chakwizira, Goodhope Maponya[2], Charles Nhemachena[3], Sipho Dube[4]

[2] CSIR Built Environment, PO Box 395, Pretoria, 0001
[3] CSIR Built Environment, PO Box 395, Pretoria, 0001
[4] CSIR Built Environment, PO Box 395, Pretoria, 0001

*Corresponding author: Sipho Dube: sdube@csir.co.za

Reference: HE19-PO-F

Abstract

A decentralised healthcare system (DHS) is a system developed to address issues of power, management and functions of local spheres of government and to address the healthcare backlogs created by the previous apartheid system. Prior to the system, healthcare delivery was centred on one sphere of government which held most power, and thus invested most healthcare services in the private sector creating inequalities between rural and metropolitan areas. To speed up and equate healthcare delivery for all, healthcare was then decentralised by shifting power from central offices to peripheral offices such as districts and municipalities. One of the strategies used by the government is to encourage healthcare service providers (private and/or public) to employ their own human resources in providing healthcare services that ultimately counteract these inequalities. Presently, what could be considered the last level of decentralised healthcare is mostly represented by home and community-based healthcare organisations. As part of the DHS, these organisations provide healthcare services to communities and patients that are released from or referred by clinics and hospitals to continue with medication and healing at home. Yet poor transport remains a challenge faced by most of these organisations, therefore exacerbating access difficulties. As a result, access to healthcare facilities (such as hospitals and clinics), access to patients when providing services, and access to financial support (due to lack of information) become most difficult. In addition, access to information and communication technologies (ICT) and systems is cross-cutting through all challenges. As part of the overarching framework, this paper seeks to provide a platform on which ICT systems could be understood as viable solutions and used to reduce transport and communication burdens of healthcare workers within the ambit of the DHS system.

Keywords
Health, healthcare, mobility, rural areas, transport, ICT, Africa

1. General introduction

Service delivery such as quality healthcare in rural South Africa is fraught with deep-rooted challenges, many of which are to do with access problems emanating, in part, from the remoteness and spatial dispersion of rural communities (Mashiri et al, 2008). In rural areas, emergency medical services (EMS) are often not available or purchased at a high social and economic cost, thus forcing rural households to seek health from informal sources such as self-cure, traditional healing or home-based care (HBC) services (Mashiri et al, 2007). These rural areas have long been characterised by spatial isolation, which hinders households' access to job opportunities or services (Chakwizira et al, 2008). Settlement patterns are often not agro-ecologically friendly or they lack the socio-economic logic – they are often unrelated to major commercial or public transport routes, thus leading to further misrepresentation in residential patterns and service provision. Communities in rural South Africa continue to be characterised by a class of society living below subsistence level, with poor access to basic needs and socio-economic services (Republic of South Africa, 2000). This in turn constrains the communities from achieving economic growth and development, which is also reflected in many sectors including healthcare. Hospitals and clinics are poorly equipped and understaffed. Furthermore, most populations in rural areas have low life expectancies and high incidences of infectious and chronic diseases (SADOH, 2004). Adherence to treatment of chronic diseases is less than 50% in these areas (Sabate, 2003). Life expectancy in South Africa is 47 and 49 years for males and females respectively, and the estimated prevalence of HIV-infected adults is 18.3% (WHO, 2006; UNAIDS, 2008). Under these circumstances, a strong tradition of HBC (also known as an informal healthcare system) has become increasingly important in rural areas where service delivery challenges exist. Although the tradition of HBC is threatened by implosion as a result of severe pressure (Mashiri et al., 2007), some of these challenges can, in part, be remedied using adequate ICT support.

1.1 The Decentralised Healthcare System (DHS) and its implications for effective healthcare delivery

The development of a DHS was mainly aimed at addressing issues of power, management and functions of local spheres of government and to address the health backlogs created by the apartheid system. Prior to the system, healthcare delivery was centred on one sphere of government which held most power, which then invested most healthcare in the private sector and the metropolitan areas (SADOH, 2004). When the new democratic government in South Africa took over, the Reconstruction and Development Programme (RDP) was set in motion to speed up healthcare delivery for all (ANC, 1994). Healthcare was then decentralised by shifting power from central offices to peripheral offices such as districts and municipalities, giving them some degree of decision-making authority. Within district municipalities, healthcare service providers – private and/or public – were encouraged to employ their own human resources to speed up healthcare delivery. This form of healthcare decentralisation was seen as the most appropriate vehicle to deliver healthcare (SADOH, 2004).

The South African Department of Health defines the District Health System as a self-contained system in which primary health care (PHC) is the core emphasis (SADOH, 2004). It further argues that the population living within the health district has to be defined profoundly in a geographical area, taking into account its healthcare activities whether governmental or otherwise. Basically, the DHS can be understood as a community need-based health system within a specified geographical boundary.

1.2 ICTs as the vehicle to strengthen healthcare systems

Improving the health of the poor and marginalised people in the rural and peri-urban areas has become a major development agenda not only in South Africa but on the entire African continent. Disease detection and prevention are crucial to development and poverty reduction. Yet alternative interventions in the form of ICTs also hold potential impact to strengthen the healthcare system (InfoDev, 2006). ICTs can be viewed or understood as means and technologies that facilitate information flow, sharing and management across space and time. Rural areas still lack improved transport services and thus have limited access to healthcare and information services (Heeks, 2002). Information management and communication processes within the rural healthcare sector are of critical importance and could better be facilitated by ICTs. One of the important observations made by COFISA (2008) is that ICTs enable people to perform functions that may otherwise be beyond their capabilities, by overcoming time and space constraints. Given the spatial and development challenges of many rural areas, it is apparent that the use of ICTs can speed up healthcare delivery and improve access thereto.

However, it should also be noted that the use of ICTs in healthcare provision has its own challenges, especially in developing areas. Many rural areas still lack the required and basic infrastructure to host ICT technologies (InfoDev, 2006). In addition to these challenges, there is a huge gap in knowledge and skills required to operate ICT infrastructure and technologies such as computers, internet, specialised software and other mobile technologies (Heeks, 2002). InfoDev (2006) has identified key important lessons to be noted before implementing an ICT intervention in underdeveloped or rural areas as follows;

- All beneficiaries need to be considered in terms of needs, capacity, location and access within a rural area.
- The beneficiaries need to have the necessary capacity to take on the ICT intervention.
- Participatory approaches should be used to ensure that the interventions being implemented become part of the life-styles of the beneficiaries.

Beneficiaries, as defined by InfoDev (2006), include various stakeholders in key health institutions, and in the society as a whole in developing or rural areas. With the understanding that the DHS has shifted power to districts and local municipalities, and thus encouraged private healthcare service providers in employing their human resources in the provision of health (SADOH, 2001), it becomes clear that the majority of key stakeholders are at the lower part of the health spectrum. These include primary healthcare institutions, informal healthcare service providers such as HBC organisations and communities. Clearly, more emphasis on and investment in ICT interventions are required where the majority of stakeholders are located. This can also be regarded as the bottom-up approach in strengthening the decentralised healthcare system.

1.4 Purpose of the paper

The main aim of this paper is to showcase the potential impact of ICTs in strengthening the decentralised healthcare system in South Africa. The paper uses a case study approach, based on an established and tested ICT intervention in one of the pilot study areas.

1.5 Organisation of the paper

This paper is organised into four sections. *Section one* provides background information on the decentralised healthcare system in South Africa as a policy driver to speed up quality healthcare service delivery. It also looks at the benefits of ICTs within the ambit of healthcare delivery and outlines some of the important notes to be considered in implementing ICTs in developing or rural areas. *Section two* presents the research methodology followed in conducting the study, with particular focus on the case study design. *Section three* presents and discusses major research findings from the case study. *Section four* presents the study conclusions and recommendations.

2. Study Methodology

2.1 Methodology

Besides literature review or secondary data analysis (i.e. government publications, internet sources as well as newspapers and journal articles), in-depth interviews with key informants and thematic discussions with selected key informants from hospitals in the study area were conducted. Secondary data sources were analysed for trends, issues, challenges and opportunities regarding healthcare delivery. To test the rigour and robustness of the research process, the study objectives were matched with the appropriate research questions and instrumentation.

From the information gathered from the key informants, a multi-year project was funded and set in motion. In the first year (2006/07), the project unpacked the relationship between healthcare, transport and mobility. In the second year (2007/08), an audit of the district health transport function was carried out. Flowing from the first two projects, intervention options were crafted and the ICT intervention, being one of the crafted intervention options, was tested in the study area, making it the third project in the third year (2008/09).

The build-up of the “User interface” and the “Communication Platform” of the ICT system were outsourced to Truteq – a service provider of unstructured service supplementary data (USSD) technologies. However, the coordination of the “User Requirements” and Truteq services, central to the research, was done by CSIR Built Environment. To analyse the impact of the ICT system on the operations of the selected HBC organisation, transport and mobility were considered important access factors that affected the success of healthcare institutions and service providers in rural areas. Therefore, to assess the impact of the ICT system on the beneficiaries, movement of caregivers was tracked using GPS tracking devices called track sticks for a given period of time. These findings were compared with findings of initial discussions with the key stakeholders to assess whether the impact had been positive, negative or remained unchanged.

3. Study Findings & Discussion

3.1 The Architecture of the HBC ICT System

The concept and the processes as outlined in the previous section above led to the design of the HBC ICT system, which is essentially a system used by the HBC organisation and the clinics to monitor home-based patients in the problem area of Leroro – a study site in Ehlanzeni district in Mpumalanga province. After a series of consultative workshops with the concerned stakeholders in the Leroro area, a final concept (which was later developed into a reality as depicted by Figure 1) was agreed upon together with CSIR Built Environment.

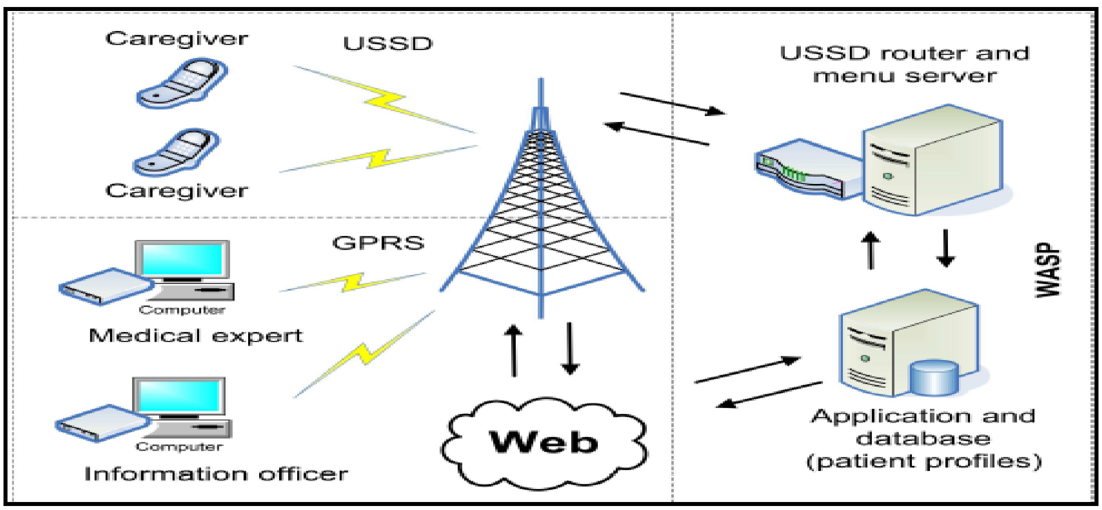

Figure 1: The Architecture/ System Design of the Enhanced Rural Healthcare Delivery Tool

The system is built on simple and yet effective technology called USSD, which is an older protocol than SMS (short messages service) which is applicable on all makes of mobile phones (see http://www.truteq.co.za/tips/ussd/). With USSD, mobile phones can be used to send data from a predefined menu system by dialling a dedicated number that is linked to the menu system and selecting options within the menu. The data on the USSD is then routed via a WASP (i.e. Wireless Access Protocol) and stored onto a remote database that is accessible on the web via an internet connection. Although the USSD system is not two-way (i.e. it cannot respond directly to the sender) it can identify the information and credentials of the sender through the logged data, which normally contains the sender's mobile number, time and date of the sent data.

3.2 System Design & Technical Challenges

- ***USSD Timeout:*** USSD only allows three minutes per session. This means when submitting vital sign data, caregivers only have three minutes per patient. The USSD will logout the caregiver before they submit data if this time is exceeded. However, an advantage is that for every session a caregiver logged in, the initial data entered per vital sign is stored on a remote database and can later be retrieved in the next login of the caregiver; the caregiver can therefore continue to complete the process of entering and submitting the vital signs. However, this process can take a lot of time and therefore more money from the caregivers' airtime.
- ***Menu Structure and User Interface:*** One of the strong features of the ICT system is the structuring of the menu system for entering the vital signs. The USSD allows for a preset menu that can be accessed by any kind or make of mobile phone device. This means that irrespective of the kind of mobile phones caregivers have, the menu structure remains the same. However, a common difference between caregivers' phones is the number of lines of the menu that can be displayed on each of their mobile phones. While a few can see all menu presets on their mobile phone display screens, others can only see a few lines. A common confusion among those who could only see few lines was that they used to think they only had to report on the only visible vital signs or lines displayed on their screens. However, after training and retraining this confusion was cleared and all caregivers were aware of how the menu of the ICT system was structured, irrespective of the displays of their individual mobile phones.
- ***Web-based Database Access Control and Restrictions:*** Patient data flowing on the ICT system can only be accessed by the two clinic sisters. The Information Officer on the other hand has access rights to the patient and caregiver database where s/he manages a pool of patients for both the caregivers and clinic sisters. Access control is by way of unique personal usernames and passwords only known to the users. A common challenge for both the Information Officer and the two clinic sisters is system errors that are caused by poor network coverage on some days. To access the system on the web the users have to connect to the internet using a Vodafone Mobile Connect modem, which uses the mobile phone network. During some days the Information Officer cannot login to the web system due to routine system maintenance.

3.3 ICT System Impact – Caregiver-Patient Movement

3.3.1 Tracking caregivers' daily HBC activity-based movements

For the project it was deemed necessary to assess how the caregivers working on the new HBC ICT system moved to their patients within their respective service areas. An assumption that the new HBC ICT system reduces the amount of daily travel for caregivers was made prior to measuring travel data using GPS track sticks. Previously, caregivers were expected to physically submit patient assessments to both their respective HBC organisations and the clinics. This required a lot of movement between their respective HBC centres and clinics. Since the new HBC ICT system is electronic and timely, we now assess how the movements of caregivers have changed by tracking the caregivers' daily activities using the GPS tracking devices.

Five GPS track stick devices were allocated to caregivers (refer to Table 1). One caregiver in each village received the device before resuming their daily HBC activities. The GPS track sticks tracked the paths taken by the caregivers and recorded the time, speed and locations that the caregivers used in each path taken. It is important to note that the following data show only one day of tracking.

Table 1: Allocation of Tracking Devices per Village per Caregiver

Track Stick No.	Caregiver Name	Code	Village	Approximate start time
TS5	Elizabeth Makhubedu	1002	Moremela	8h45
TS4	Ruth Moropa	3002	Matibidi A	10h10
TS3	Tebogo Molobela	3001	Matibidi A	10h10
TS2	Lizzy Mashego	4002	Matibidi B	10h50
TS1	Lindy Selepe	2004	Leroro	11h25

3.3.2 Single-cluster movements

Movements made by each caregiver are also influenced by the number of patients a caregiver has and the health conditions of the caregiver's patients. The single-clustered movements are movements within one zone where patients may belong to one or two caregivers. For these kinds of movements an experienced caregiver was chosen and assigned a track stick.

The stops made by caregiver 1002 ranged from 15 minutes to 90 minutes in length and can therefore be associated with the time taken at the patient's home while doing HBC duties including submitting vital signs on the HBC ICT system. An important note was that there was no indication of a path that led to either the clinic or the HBC centre where reports previously used to be handed in after a day's activities. We can therefore begin to infer from the above that the new HBC ICT system has reduced the daily movements of caregivers.

3.3.3 Double-cluster movements

Unlike single-clustered movements, double-clustered movements are those that show movements of caregivers between and within two separate zones. This is possible especially when two or more caregivers work in pairs and share the same patients. It is also a common practice for the HBC organisation to pair caregivers so that they assist one another and become efficient in their work. Pairing normally happens between skilled and semi-skilled caregivers to encourage skills transfer.

For clustered movements the tracked movements were discovered to be lined up along the main tarred access road. This tendency is common among most caregivers and can be associated with issues of accessibility. Although all caregivers walk to see their patients, it is often very difficult to walk in areas where there is poor road access. This tendency reduces the chances of access to healthcare services for patients that are located in the outer peripheries of the village where there is poor road access.

Like in the single-clustered movements, the two clusters indicate no tracks leading to either the HBC organisation or the clinic where reports are handed in. Although it can be inferred that there has been a reduction in movements between the caregivers' HBC centres and their respective clinics due to the improved way of reporting, it is also prudent to note that movements within the villages have remained unchanged. For caregivers working in pairs, such as those in the double-cluster scenario, movement is doubled compared to those in single clusters since the paired caregivers both have to see the same patients. If, for example, one caregiver in the pair only visited patients in one cluster and the other caregiver visited patients in the second cluster, movement would be reduced to within a single cluster since there wouldn't be a need to move between the two clusters. Although the pairing of caregivers in the double-cluster situation is done with the assumption that the experienced caregiver in the pair will transfer skills to the inexperienced caregiver, it has been found that with improvements on the new HBC ICT system, caregivers no longer require a lot of experience and training to report on patients, thus pairing is no longer critical to ensure the efficiency of caregivers.

3.3.4 Stopped movements

For every stop that caregivers made, the GPS track stick recorded the locations and the length of the stops. For example, caregiver 1002 in Moremela village at one location had stopped for 27 minutes. Such lengthy stops are normally made at the patients' homes and could be associated with the care duties that the caregivers have to carry out for their patients. Such duties vary from patient to patient due to patients' individual requirements and so does the length of the stops. When a caregiver had to care for more than one patient in a household, a lot of time was spent. However, since the new HBC ICT system has been introduced, caregivers have been impressed with the new electronic equipment which is quick and efficient, thus saving them time at each patient's home.

> I am so happy to work with patients using this new system; it saves me time for handing in reports to the clinic and at the centre. The new BP machine is very quick; it saves me time at the patient's home because it is automatic. When the machine is busy taking the blood pressure I can do other things at the same time; like taking temperature or weight of the patient. The equipment is so accurate that I do not suspect any errors and thus do not have to redo measurements; this saves time.
> ***(Interview transcript of caregiver 1004, Moremela village, 25 March 2010)***

3.3.5 Caregiver tracks and distance travelled

Every caregiver has a list of patients that they look after. Although the lists contain confidential information about the patient, the caregivers know the exact location of their patients. From the information in their patient lists, caregivers can plan and plot a safe and less tiring walking route that shortens their journeys to see patients.

Table 2 contains data on the five caregivers that were allocated track sticks. From the data, the distances, speed and overall trip durations were calculated and inferences done on the basis of secondary data collected prior to this assessment.

Table 2: Number of Patients Visited, Time Taken and Distance Travelled per Caregiver

Track Stick Number	Location	Caregiver Status on HBC ICT System & Code	Total Patients Visited	Average Time Spent with Patients (in mins)	Total Trip Duration (in mins)	Total Distance Travelled (in km)	Average Walking Speed (in kph)
TS1	Leroro	New Id = 2004	2	μ = 27.4 $\tilde{x}$ = 31	t = 65	2.11	3.60
TS2	Matibidi B	Old Id = 4002	3	μ = 9 $\tilde{x}$ = 7	t = 189	4.71	3.23
TS3	Matibidi A	Old Id = 3001	4	μ = 7.75 $\tilde{x}$ = 7.5	t = 55	4.30	3.97
TS4	Matibidi A	Old Id = 3002	4	*Missing Data*	*Missing Data*	*Missing Data*	*Missing Data*
TS5	Moremela	Old Id = 1002	9	μ = 49.5 $\tilde{x}$ = 32	t = 189	10.07	4.31

NB: Mean (μ) is the average and Median ($\tilde{x}$) is the measure of central tendency

Of the five track sticks, four were allocated to the older caregivers. The newer caregivers were the ones who had just been introduced to the new HBC ICT system. It is interesting to note in Table 2 that older caregivers that were allocated track sticks 2 and 5 (i.e. caregivers 4002 and 1002 respectively) both spent a significant amount of time on their visits to their patients; just over three hours. However, caregiver 4002 allocated track stick 2 managed to see only three patients, whereas caregiver 1002 allocated track stick 5 saw more patients (i.e. nine) in almost the same amount of time.

There is no significant relationship between caregiver's average median times spent with each patient. However, both caregivers 4002 and 1002 spent the same amount of time seeing all patients but caregiver 1002 managed to visit more patients. This could be related to the issue of clustering caregivers; caregiver 4002 worked in a double cluster whereas caregiver 1002 worked in a single cluster. In the single cluster, caregiver 1002 was able to allocate more time to patients and less to walking. The average median time spent with patients for caregiver 1002 is 32 minutes, whereas for caregiver 4002 it is only seven minutes. This confirms that caregivers working in double clusters are more concerned about walking to reach other patients than spending time with each patient, whereas caregivers in single clusters have some guarantees about getting patients in the nearby vicinity, and thus dedicate more time to their patients.

Although caregiver 1002 saw more patients than other caregivers, she also moved around a lot more than others (i.e. 10 km). However, to cover the distance, she had to walk faster than the other caregivers with an average walking speed of 4.31kph. This means that to cover the 10 km journey, caregiver 1002 would have required about two hours and 20 minutes of walking (i.e. 10/4.31 = 2.3 hrs = roughly 2 hrs and 20 minutes). This also means that in a seven-hour day, which is normal for all caregivers, caregiver 1002 spends about 33% of the time walking between patient homes, compared to caregiver 4002, who spends about 21%. Perhaps an important lesson to be learnt from the above exercise is that informal healthcare is rather a complex system that requires careful unpacking and understanding. What may seem to be unfair in the eyes of the formal healthcare system could be considered the building block of the informal healthcare system and thus be translated into the concept of "Ubuntu".

Figure 2 below is an example of walking speed fluctuations for a caregiver doing HBC activities in a single day. The x-axis represents the records where the track stick logged in data as the caregiver was walking to patients' homes. It is important to note that household stops, and other stops along the way, were omitted to focus only on the average walking speed.

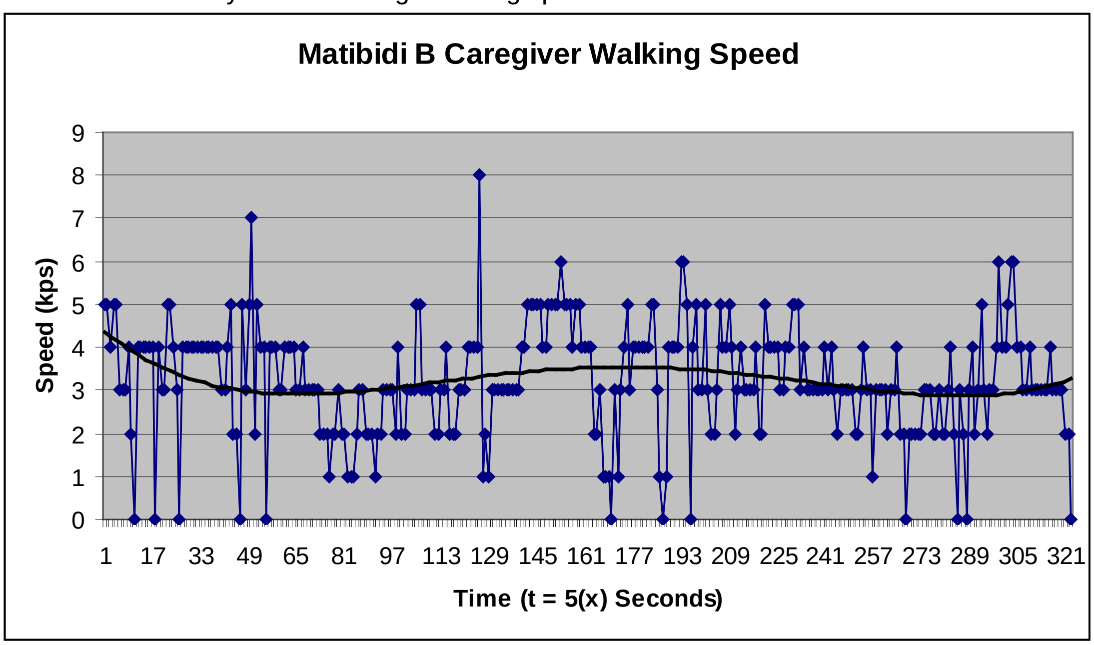

Figure 2: Walking Speed of Matibidi B Caregiver (i.e. Caregiver 4002)

Although the average walking speed of caregiver 4002 is 3.23 kph, she logged a maximum speed of 8 kph and a minimum of 0 kph at some points in her journey. This means that the caregiver was not walking constantly; the speed fluctuated along the way. This could be associated with the terrain of the zone within which the caregiver was walking. Where the speed was declining, it could be said that the terrain was becoming steeper. Although it is commonly expected that speed of any moving object will decrease when the object travels through an inclination, other factors that could decrease speed were considered.

> The equipment that we are using is okay but I think something has to be done about the weighing scale. The scale is too heavy to carry around. I understand that it is important to get the weight of patients but is there not any lighter scale that can replace the one we have?
> ***(Interview transcript of caregiver 3002, Matibidi A village, 25 April 2010)***

Clearly, one of the challenges of the new HBC ICT system for the caregivers is the load of the equipment. In the previous practice, caregivers were not equipped with any sort of medical equipment, thus they walked unburdened. Although caregivers recognise the importance of the equipment, further research is required on alternative means of carrying the equipment, or how heavier equipment can be substituted.

3.4 ICT System Impact – Spatial Analysis and Considerations

In this section, the assumption that the new HBC ICT System has significantly reduced the movement of caregivers is tested by spatial analysis approaches. We embark on the previous analogy that caregivers are no longer required to physically submit their reports to their respective HBC centres and clinics. For this we simply analyse the amount of distance no longer walked to both institutions.

Caregivers from Moremela and Leroro villages report to Bourke's Luck Clinic, which is located outside the village of Moremela and about 1.5 km from Moremela HBC centre. On the other hand, caregivers from Matibidi A and Matibidi B villages report to Elandsfontein Clinic, which is located roughly halfway between the two villages. Until recently, only caregivers in Leroro would use public transport to get to their reporting clinic, while caregivers in other villages would walk to their respective clinics.

A path between Matibidi B HBC centre and Elandsfontein Clinic has been drawn to simulate a walking path previously used by caregivers to submit reports. In Figure 2 we can see that the distance between Matibidi B HBC centre and Elandsfontein Clinic is about 2.83 km one way. This means the distance that has been saved by just introducing the HBC ICT system of reporting is roughly 5.66 km. Caregiver 4002 walked 4.71 km (refer to Table 2) when visiting patients in one zone. The total distance that caregiver 4002 could have travelled in the absence of the HBC ICT system could have been 10.37 km (i.e. 5.66 + 4.71). The new HBC ICT system has saved caregiver 4002 roughly 54.6% of total daily movements.

Movements in Matibidi A village are complex due to the way caregivers work in the double cluster. The two zones are lined up almost in a straight line between the HBC centre and the clinic. It is also possible that caregiver could move from zone 2 directly to the clinic to submit patient reports after a day's work. However, records from the track sticks show that the way caregivers moved was from the HBC centre to zone 2, to zone 1 and then back to the centre. This means that after a day's work, caregivers still regroup at the centre before submitting reports. If this used to be the practice in Matibidi A before the HBC ICT system was introduced, then caregiver 3002 would have had to walk about another 3.26 km from the centre to the clinic after a day's work. A return trip would amount to 6.52 km. Using a similar analogy as in the case of caregiver 4002 in Matibidi B, we can clearly see that the new HBC ICT system has saved caregiver 3002 about 6.52 km of daily walking distance. This means that prior to the new system, caregiver 3002 and their partner used to walk a total of 10.82 km (i.e. 6.52 + 4.3 – refer to Table 2) while visiting patients in a day. The new HBC ICT system has saved caregiver 3002 and their partner about 60.3% of total daily movements.

Although no general inferences can be made about how much the new HBC ICT system reduces movement for all caregiver, it is evident that the system saves considerable and significant amounts of movement for caregivers. For both caregivers 4002 and 3002, the reduction in daily movements have been over and above 50%. These savings could be translated into time saved for caring for more patients in a day. The following is an interview transcript of a new caregiver on the HBC ICT system in Moremela village which corroborated these findings.

> Since I started using this system I am able to see a lot of patients. Today I managed to see 14 patients, which is the highest record for me, and the day has not finished yet. Previously, I used to spare some time for walking to the centre and the clinic to submit the reports but now that I no longer have to physically submit the reports, I can spend the entire day with patients.
> ***(Interview transcript of caregiver 1004, Moremela village, 25 March 2010)***

Each caregiver's responsibilities determine their movement between patients and such movements differ according to villages, patient home locations and patient profiles.

3.2 On-going Observations

3.2.1 Positive Impacts of the ICT system

The ICT system is currently at a very advanced testing phase, with both clinic sisters and caregivers having shown signs of acceptance of the ICT system. Clinic sisters use the ICT system to monitor patients, to monitor caregiver participation and development, and to prevent disasters in health by early diagnosis. Pro-active engagement to find ways in which patient data can be accessed even when the patient is not physically present at the clinics has been made possible by the ICT system. A sense of ownership has been cultivated within clinic sisters' and caregivers' spheres of operation. Caregivers feel that discontinuing the ICT system could be detrimental to the entire HBC healthcare system within their service areas.

The new improvements (e.g. the replacement of the old mechanical blood pressure machine with the electronic blood pressure monitor) on the system have been felt and acknowledged by both the caregivers and clinic sisters. Initially a lot of errors and unreliable data were incurred by the system due to the caregivers' difficulty in mastering the old mechanical blood pressure machine. The new electronic blood pressure monitor is reliable, faster and does not require expertise in the use of medical equipment.

3.5 Summary of key findings

- The introduction of the new HBC ICT system has reduced movement of caregivers between their respective HBC centres and clinics. A saving of over 50% in movements between the caregiver's HBC centres and clinics has been realised.
- The terrain and access road conditions in zones within which caregivers work influence the caregivers' daily patient coverage abilities. The addition of an extra load in the form of medical equipment exacerbates the difficulty in walking within such conditions.
- The new HBC ICT system saves reporting time for caregivers and thus such time could be spent with patients or be allocated to visit more patients in a day.
- Paired caregivers in double-cluster scenarios engage in a lot of movement while visiting patients because they all have to travel the same distances. The new HBC ICT system does not require a lot of experience and training since it is simplified. Thus it is possible to discontinue the pairing technique and still maintain efficiencies within the HBC systems.

4. Recommendations

The following recommendations emanate from the study and project:

- It is crucial to explore and establish funding and sustainability options/models for commercialisation of the HBC ICT technology demonstrator package as herein represented.
- It is also important to understand the context and challenges of implementing an ICT system in typical rural areas. Solutions need to be tailor-made for the local conditions.
- In generating and developing rural technology systems and applications it is very important to include user groups and stakeholders during all stages of technology development, right from problem identification, elaboration, research, tools development, implementation , monitoring and evaluation. This is important for local buy-in, acceptance and future sustainability of technology applications
- It is also essential to explore other potential areas that this ICT system can be extended and adapted for in rural areas e.g. in the water sector
- Above all, it is critical to acknowledge that ICT projects in rural areas need to involve a component of different levels and types of 'on-the-job' capacity building and knowledge transfer for beneficiaries and researchers.

5. Conclusion

Consequent to the major findings, the major conclusions emanating from the successful HBC ICT system and pilot is that the project needs up-scaling. The project has demonstrated that ICT interventions can be used to strengthen the Decentralised Healthcare System and thus ultimately improve the quality and delivery of healthcare services in rural areas. The study has also highlighted the challenges relating to adoption and use of technologies in developing or rural areas. In this regard it is important to note the need to take the HBC ICT demonstrator system through the full innovation cycle so that it can be replicated and extended beyond the initial testing site/area.

6. References

CHAKWIZIRA J, MASHIRI M, NHEMACHENA C.,2008. *Using the integrated rural mobility and access (IRMA) approach in prospering rural South Africa*, 2nd CSIR Biennial Conference, November 2008, Pretoria

COFISA .,2008. *Rural ICT Mapping Exercise in the Eastern Cape and Western Cape: Step 3.3 – Rural development and ICTs.* Cooperation Framework on Innovation Systems between Finland and South Africa (COFISA), Cape Town, South Africa.

DAVIS, F. D.,1993. *User acceptance of information technology: system characteristics, user perceptions and behavioral impacts.* International Journal of Man-Machine Studies, 38, 475-487.

GANAPATHY, K. & RAVINDRA, A.,2008. *mHealth: A Potential Tool for Health Care Delivery in India. Making the eHealth Connection: Global Partnerships*, Local Solutions conference Bellagio, Italy.

GILLWALD, A., ESSELAAR, S., BURTON, P. & STAVROU, A.,2005. *Towards an e-Index for South Africa: Measuring household and individual access and usage of ICT*. LINK Centre, University of the Witwatersrand, Johannesburg, South Africa.

GREENBERG, A.,2005. *ICTs for Poverty Alleviation: Basic Tool and Enabling Sector.* Montreal, Quebec, Sida, ICT for Development Secretariat, Department for Infrastructure and Economic Cooperation.

HEEKS, R.,2002. *Information systems and developing countries: Failure, success, and local improvisations.* Information Society, 18, 101-112.

INFODEV.,2006. *Improving health, connecting people: the role of ICTs in the health sector of developing countries.* IN CHETLEY, A. (Ed.) Washington, The World Bank.

MASHIRI, M., MAPONYA, G., NKUNA, Z., DUBE, S. & CHAKWIZIRA, J.,2007. *PG Report: Rural Accessibility & Development. Unpacking the Relationship between Rural Healthcare, Mobility & Access.* Pretoria, CSIR.

MASHIRI, M., CHAKWIZIRA J, MAPONYA, NHEMACHENA, C & DUBE, S.,2008. *PG Report: Rural Accessibility & Development. Assessment of the Ehlanzeni District Health Transport and logistics Function: Enhancing Rural Healthcare Delivery Systems.* Pretoria, CSIR.

MASHIRI, M., CHAKWIZIRA J, MAPONYA, NHEMACHENA, C & DUBE, S.,2009. *PG Report: Rural Accessibility & Development. Development of a Home Based Technology Demonstrator System.* Pretoria, CSIR.

MASHIRI, M, MAPONYA G, CHAKWIZIRA J & DUBE S.,2009. *Assessment of the Ehlanzeni District Health Transport and logistics Function: Enhancing Rural Healthcare Delivery Systems*, 28th Southern Africa Transport Conference, Pretoria, 6-9 July, 2009, pp 10

OUMA, S. & HERSELMAN, M. E. ,2008. *Digital divide affecting e-health implementations in rural hospitals; Case study of Kenya.* 2nd IFIP International Symposium on Wireless Communications and Information Technology in Developing Countries. Pretoria, South Africa.

REPUBLIC OF SOUTH AFRICA .,2000. *Integrated Sustainable Rural Development Strategy.*

RESEARCH ICT AFRICA.,2008. *ICT Access & Usage in South Africa*. LINK Centre, University of the Witwatersrand, Johannesburg, South Africa.

SABATE, E.,2003. *Adherence to Long-term Therapies: Evidence for Action.* World Health Organization.

SADOH .,2004. *Strategic Priorities for the National Health System 2004-2009.* South African Department of Health.

TRUTEQ .,2009. ***http://www.truteq.com/tips/ussd/.*** TruTeq, Centurion, South Africa.

UNAIDS.,2008. *Country Situation, South Africa*. UNAIDS.

WORLD HEALTH ORGANIZATION.,2006. *Country Health Fact Sheet 2006*, South Africa.

7. Endnote

Contribution to the paper was not equally distributed. James Chakwizira and Goodhope Maponya compiled the paper. Charles Nhemachena & Sipho Dube edited the paper. The authors wish to express gratitude to Debbie Thomson who created the document in template format.