Effectiveness of An Intergrated M-Health Platform For Malaria Control.A Case Study Of Bindura, Zimbabwe

[1]Prudence M. Mavhemwa, [2]Pharoah Chaka, [3]Munyaradzi Magomelo,[4]Hilton Chikwiriro
[1]Lecturer, Computer Science Department, Bindura University of Science Education, Zimbabwe
[2]Lecturer, Computer Science Department, Bindura University of Science Education, Zimbabwe
[3]Lecturer, Computer Science Department, Bindura University of Science Education, Zimbabwe
[4]Lecturer, Computer Science Department, Bindura University of Science Education, Zimbabwe

ABSTRACT

Many countries signed to the Millennium Development Goals (MDGs) which need to be achieved by 2015.The MDGs touch on health among other things and it has been noted that developing countries, including Zimbabwe, are lagging behind in their efforts to reach these goals by 2015 with several challenges being noted as undermining efforts to reach the goals. Several countries, in almost all continents are implementing m-health to help complement traditional efforts in many sectors of health delivery. This research was made to assess the effectiveness of an internet enabled mobile phone as a data collection and reporting tool in the fight against malaria. The research was carried out on twenty health workers in and around Bindura , in Mashonaland Central. Health workers collected data on malaria cases and sent them on a password protected website using smart phones which they used to send details on every case that they received and also received messages and could also send messages via the platform. The mobile website was also tested for response time, availability and speed among other factors and together with the users responses it was concluded that a smart phone is a very powerful tool that can be used to improve malaria control in the data collection and monitoring. The author had several recommendations from the lessons learnt during the research which if implemented, will help in the realisation of the full potential of the mobile phone as a reporting tool.

Keywords : m-*health, e-health , mdgs, ICT, data collection, monitoring, evaluation*

INTRODUCTION

Governments of many countries worldwide signed to the fulfilment of the Millennium Development Goals (MDGs) which touch on several aspects that have to do with the well being of the populace (undp, 2010). The MDGs are eradication of extreme poverty and hunger, achieving universal primary education, promote gender equality and empower women, reduce child mortality, improve maternal health, combat HIV/AIDS, malaria and other diseases, ensure environmental sustainability and develop a global partnership for development. Goal Number six which says by 2015 there should be a reverse to the spread of HIV/AIDS and the incidence of malaria and other diseases is the basis for the current research. In developing countries, m-health projects focus on HIV/AIDS, Malaria, and TB using SMS texting (Pujari, 2011). However, while the progress achieved over the years in health sector has remained highly concentrated in the developed countries, many developing and least-developed countries are still seriously lagging behind. This is particularly true in the regions of South Asia and Sub-Saharan Africa where health care coverage and health services remained significantly poor in many countries(sesric, 2011). There have been several challenges that have been noted which are delaying the timely delivery of health services to people in developing countries worldwide. Sub-Sahara Af-

rican nations are lagging behind in working towards the fulfilment of the health related Millennium development goals. (Disease control priorities project, 2007)
As a means to counter that, several countries in Africa and other continents have adopted m-health as a means of facilitating fast reaching the people who are in need of health services and interesting results have been yielded. m-health is a great mechanism to save significant funds in the health sector (Pujari, 2011). (Mujera, 2009) says the availability of information to health professionals is highly regarded as a prerequisite for achieving health for all. He goes further to say information availability enhances the quality of patient care as physicians make better use of evidence and apply appropriate current tools and practices at the point of care. He also says the development of information and communication technologies (ICT) such as internet makes relevant, reliable, current and affordable information can be universally accessed. m-health is a subclass of e-health which is defined by (Eysenbach, 2001)) as cited by (Mujera, 2009) as "the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies". The definition also defines e-health as a state-of-mind, a way of thinking, an attitude and a commitment for networked, global thinking, to improve health care locally.

Background

m-health is an area that has shown potential to complement traditional health delivery and can greatly work towards improving health delivery especially in the rural or distant communities. Researches on m-health have not been fully done in Zimbabwe yet, the country also needs to have successfully met the health targets of the Millennium Development Goals by 2015. This area of m-health has potential to help in the fulfilment of the Millennium Development Goals if properly researched on and implemented and as a country we are not fully taking advantage of this potential. To add to that (Mechael, 2010) says m-health is still at its infancy and runs the risk of not achieving its potential due to small scale implementations and pilot projects with limited reach.The authors go on to say early researches on m-health in developed countries were centred on Personal Digital Assistants (PDAs) but their cost is prohibitive in developing countries so smartphones and mobile phones have gained wide use in developing countries. The mobile phone is the first ICT tool that has reached even remote areas in low- and middle-income countries (LMIC) so it needs to be fully used.

Problem Identification

Zimbabwe, as a country is researching on e-health technology but has not done much in using m-health to reach its population to offer health services. Some researches elsewhere have been done in combating diseases like Sexually transmitted diseases (Blynn, 2009), Measles and other diseases including HIV/AIDS. Since some research projects were implemented successfully in other countries, there is potential for m-health to be tried in Zimbabwe. Where m-health solutions where implemented, either it was a text message based software or a web based solution using the mobile phone so in the Zimbabwean context, this has

not been tried, even the combined solution. Moreover, we are still experiencing cases where outbreaks occur and not reported in time to the extent that when the reports reach responsible authorities, lives will have already been lost. Timely delivery of health solutions is still a problem due to late compilation of reports, late decision making and at times lack of adherence to prescriptions on the side of patients. All this is being caused by a gap that exists in the way health related issues are disseminated from a sick person in a remote area to the health care givers and vice- versa. Therefore since m-health is being tested in other countries, and in Zimbabwe we can benefit from it, as we have the resources and infrastructure, it is viable to test how far it can help improve health service delivery in our local context.

The purpose of the research will be to find the effectiveness of an integrated m-health system that uses both text messages and the web in monitoring, reporting and controlling malaria occurrences.

Objectives of the study

The objectives that have to be met at the end of the research study are:

1. To design and implement an integrated m-health system for use by a group of health workers in controlling diseases, and Malaria in particular.
2. To assess the impact of implementing the system on users, who are health workers.
3. To measure the effectiveness of the system on health delivery.

Research Questions

1) Does implementation of m-health improve health delivery in monitoring, reporting and controlling malaria?
2) Will health workers find the implemented system useful to them?

Hypothesis

The following hypotheses where deduced from research questions:

1. Does implementation of m-health in Zimbabwe improve health delivery in monitoring and controlling diseases?

Null Hypothesis (H_0) : There is no significant difference in monitoring, reporting and controlling malaria by the introduction of an m-health system.

Alternative Hypothesis (H_1): There is a significant difference in monitoring, reporting and controlling malaria by the introduction of an m-health system.

2. Will health workers find the implemented system useful to them?

Null Hypothesis (H_0) : The health workers will not find the implemented m-health system useful to them

Alternative Hypothesis (H_1) : The health workers will find the implanted

m-health system useful to them.

Abbreviations

MDGs	Millennium Development Goals
TB	Tuberculosis
SMS	Short Message Service
ICTs	Information and Communication Technologies
PDA	Personal Digital Assistant
LMIC	Low and Middle Income Countries
ART	Antiretroviral Therapy

LITERATURE REVIEW

Definitions

m health

According to (Vital Wave Consulting, 2008) as cited by (Kallander, 2010) , there is no widely agreed –to definition but the public health community came to these working definitions:

e-Health : Using information and communication technology (ICT) – such as computers, mobile phones, and satellite communications for health services and information.

m-health according to (WHO, 2011) is a medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices.

According to (Vital Wave consulting 2009) as cited by (Vital Wave Consulting, 2011) m-health ranges from simple mobile –phone based applications for the transfer of health information on basic handsets to via short messages to sophisticated diagnostic applications that rely on advanced equipment and back-end data systems. It should also be noted that m-health is not a solution to all the health related problems affecting all countries both developed and developing, but has the potential to greatly improve the efficiency of communication, reduce life threatening delays in the delivery of care and extend the reach of the health system to underserved communities. (Vital Wave Consulting, 2011).

Both m-health and e-health have the same goals of improving health outcomes and at the end fulfilling the health related Millennium Development Goals.

Intervention

According to (Kaplan, 2006) is an intentional activity that comes between persons or events for the specific purpose of modifying some health-related outcome or act and is basically an intentional use of mobile phones to achieve a specific purpose.

The need for electronic intervention

(Sapra, 2011) said in order to achieve the MDG focus should be made on removing the bottlenecks that delay the delivery of health services because the problem is not in the availability of medical resources but getting the resources to the right place at the right time.

(Ticia Gerber, 2010) cites (Garrett L, 2009) as saying e-health is increasingly being employed in combination with tools that build capacity and address the quality of care to improve health systems, use resources efficiently, and plan for the progressive adoption of universal health coverage. The authors also cite (WHO, WHA 58.28 resolution text [Internet], 2005 May [cited 2010 Jan 7].) as saying The World Health Organization has adopted Resolution WHA 58.28, which urges member-states to develop long-term strategic plans for e-health services and to promote international, multisectoral collaboration to improve the compatibility of e-health solutions. Zimbabwe is not an exception and should play a part in using e-health solutions for the improvement of health on the populace. (Mujera, 2009) says provision of equipment to health workers does not complete the information accessibility utilization cycle and health workers must be able to efficiently utilize these resources in order to realize maximum benefit. He goes on to say inexperience with ICT tools is a possible contributing factor to resistance in the use of this new technology amongst the none ICT exposed health professionals. (Mujera, 2009) also says access to ICT equipment matters again in the success of m-health or e-health in general. The author furthers on saying there are no documented surveys in the country on the number of public and private health institutions with computer equipment at their sites (Mischa Willis-Shattuck, 2008) say there is a growing need to strengthen health systems in developing countries to help meet the Millennium Development Goals (MDGs). (WHO, 2008) as cited by (Mischa Willis-Shattuck, 2008) says it is widely accepted that a key constraint to achieving the MDGs is the absence of a properly trained and motivated workforce and improving the retention of health workers is critical for health system performance. It is therefore the view of the author that mobile intervention can play a great role in bridging the missing parts of motivation and training. It is a known fact that Zimbabwe, among other developing countries suffered from brain drain where qualified health personnel migrated to countries like Australia and New Zealand. Health worker loss can greatly compromise health system capacity to deliver adequate care as the more experienced workers migrate because their skills are highly desired in developed nations. Staff shortages increase workloads and stress levels, further de-motivating remaining staff and as a result, poor health services are offered thereby derailing our MDGs. However, the mobile phone can be tested on those that are on the ground to see if they can be motivated and trained whilst at their workplaces.

According to (Sapra, 2011), such data collection can be performed using pen and paper at clinic level with all electronic data entry done centrally, but the approach is difficult and time consuming and provides little or no feedback to the staff doing the collection. (Della, 1999) and (Fraser H, 2001) then said using email or web communications allows staff to check advice from remote physicians. David Aylward, as cited by (Keller, 2011) ,says m-health technology is still in its infancy. He says almost everyone is carrying a cell phone in the US and all over the world, but its impact beyond voice communication is not yet felt and the issue should be to determine the vision, the possibilities and the challenges that are related to m-health technology. According to this author, the developed world operates a centralised system in which consumers travel to facilities. In the developing world, like Zimbabwe, there are a lot of places to go so people who are trying to find high-quality ways of delivering healthcare are looking at the delivery system that wireless represents. Changing from the current paradigm of going to someone for health and instead having distributed health to where you are, the only way to do that is with modern communications.

Why the mobile phone and not other devices?

(Lewis, 2010) cites (Rowling, 2009) and (Mishra, 2008) as saying communication by mobile phone is less expensive than alternative options such as landline telephones or standard Internet. She also quotes the Pew Internet and American Life Project which says the mobile phone use will be the case for the entire world by 2020 because it is currently the primary mode of accessing the internet and the trend is expected to grow. This is also according to (Adler, 2007) and (Rainie, 2009) and supported by (Horrigan, 2009). . The (International Telecommunications Union, 2009*)* saw the need to use the mobile phones as they have the potential to act as catalysts to the fulfilment of the Millennium Development Goals which should be achieved by 2015.

(Tomlinson, 2009) says Low and middle-income countries lack the infrastructure in many research field settings to accommodate adequate fixed line internet access, whereas wireless networks allow access to telecommunications in a region where fixed lines remain limited. The researchers go on to say the use of mobile technology as a research instrument is still in its infancy.

Other advantages of mobile phones are access to accurate information in a timely manner (Angelidis,2008) as cited by (Chib, 2009) ,pre-treatment of primary healthcare problems (Bali and Singh, 2007) cited by (Chib, 2009), improving communication within the complexities of the healthcare system itself (Malkary, 2006) cited by (Chib, 2009) and with the patient community (Harper, 2006) cited by (Chib, 2009), integrating data into a central database for efficient tracking (Anantraman, Mikkelsen, Khilnani, Kumar, Machiraju, Pentland et al 2002, Chetley, 2006) cited by (Chib, 2009) and finally improving the administrative efficiency of healthcare providers (Baker, 2006) cited by (Chib, 2009).

Vital Wave Consulting (2009) as cited by (Caroline Free, 2010) says although m-health intervention programmes are still lagging behind in developing nations, there is huge potential for these interventions and programmes to have positive effects on health outcomes in poor resource settings.

Work done by other researchers

(Laugesen , 2010) researched on a continuance model for a mobile/web based self management system for adolescent diabetes. The researcher focused on controlling Juvenile Diabetes as it is known not to have cure. The researcher also noted that several researches have been made with software solutions made to help patients manage their chronic diseases but the problem was that often the systems suffer from under usage or being completely abandoned. It was also noted that limited research had been done in the issue of continual usage of a solution and then proposed to build and evaluate a mobile/web based system that incorporated rewarding a patient just to increase usage of medication.

(Noordam, 2011) noted that few project actually exist with little evidence available to tell the impact of mobile phones on the quality of maternal health services. It was noted that common researches were simply made to reduce the delay in provision of care and ongoing projects are focusing on empowering women to seek health care. However, this research was mainly centred on scientific and grey literature on improving maternal health in Low and Middle Income countries. Michael (2010) as cited by (Noordam, 2011) saw great potential for m-health, the only problem noted being that there is no much evidence of actual and widespread impact yet. (Barclay, 2009) identified a mobile phone as a tool that can be used to fight tuberculosis. (Kamanga , 2010) did a research on Malaria control in Zambia and realised that effective malaria control depends on timely acquisition of information on new cases, their location and their frequency so as to deploy supplies , plan interventions or focus attention on specific locations appropriately to intervene and prevent an upsurge in transmission in a process called active case detection. The research was carried out in rural Zambia where people where provided with rapid diagnostic tests (RDT) as well as drugs for the diagnosis and treatment of malaria. (Kollmann, 2011) also researched on healthcare delivery specifically looking at the control of Type 1 Diabetes Mellitus. In his research he used a mobile phone–based, patient-centred diabetes management system that was built.

(de Tolly, 2009) researched on the innovative use of cell phone technology for HIV/AIDS behaviour change communications in South Africa with 3 pilot surveys. (Kaplan, 2006) was quoted as having said that there was at that time no literature on using mobile telephones as a healthcare intervention for HIV, TB, Malaria and chronic conditions in developing countries. These sentiments were also echoed by (Pop-Eleches, 2011) who said that there is limited evidence on whether growing mobile phone availability in sub-Saharan Africa can be used to

promote high adherence to antiretroviral therapy (ARV). This concern is however not limited to these diseases only, but apply to a wide range of diseases.

Implementation

Studies by (Lewis, 2010) were required to measure the impact of text messaging interventions by assessing change in health behaviour. Studies utilizing communication technologies other than mobile phone text messaging, such as the Internet, e-mail, phone calls, or video messaging, were included only if text messaging was the primary mode of communication and the other technologies were supplementary. However, this research was mainly based on literature and lacked practical analysis

(Pongthep, 2010) researched on Malaria control in Cambodia and implemented in pilot areas of Sai Yok District, western Kanchanaburi Province, along the Thai-Myanmar border. The disease and treatment monitoring of malaria software module was developed and deployed.

(Lester , 2009) compared the effectiveness of SMS messaging to standard care of adherence, quality of life, retention, and mortality in a group of people receiving antiretroviral therapy in Nairobi, Kenya.

(Kaplan, 2006) evaluated the use of mobile phones to improve adherence if the systems are dynamic and sustainable over time as patients' lives and circumstances change. He also said that for interventions to be effective messages have to be sent in a way that they become an integral part of the recipient's life. It was also concluded that the overall lack of well designed, randomized clinical trials with economic evaluation to confirm or refute clinical and economic benefits with mobile phone/healthcare interventions is an evidence gap that should be addressed in a systematic way.

(Changhong, 2009) developed an SMS based reporting system for use by health workers to report cases of 16 infectious diseases after an earthquake in Sichuan in 2008.

(Noordam CA, 2011) suggested that few projects exist in this field and little evidence is available as yet on the impact of mobile phones on the quality of maternal health services and noted the need for robust evidence on constraints and impacts, especially when financial and human resources will be invested. This research was based on literature but can also be used as a measuring stick on other diseases.

In India (Shet, 2010) designed a Mobile Phone-Based Intervention to Promote Adherence to Antiretroviral Therapy in South India. In this research automated voice reminders were sent to patients reminding them to take their medication. Respondents preferred weekly reminders although the reason was not explained in the research but a possibility was that more frequent calls could be seen as an intrusion. The authors highlighted the need for larger randomized controlled prospective studies assessing the role of the mobile phone influencing adherence and health outcomes among HIV affected populations.

(Lund, 2010) , in his research on the use of mobile phones to improve maternal and neonatal health in Zanzibar raised a question of if we can develop technical solutions that are manageable in developing countries. He also noted that there

is need for documentation and research on the use of these devices in developing countries.

Recommended Architecture

Figure 1 below gives a possible explanation of the current problems as well as the interventions that can be employed.

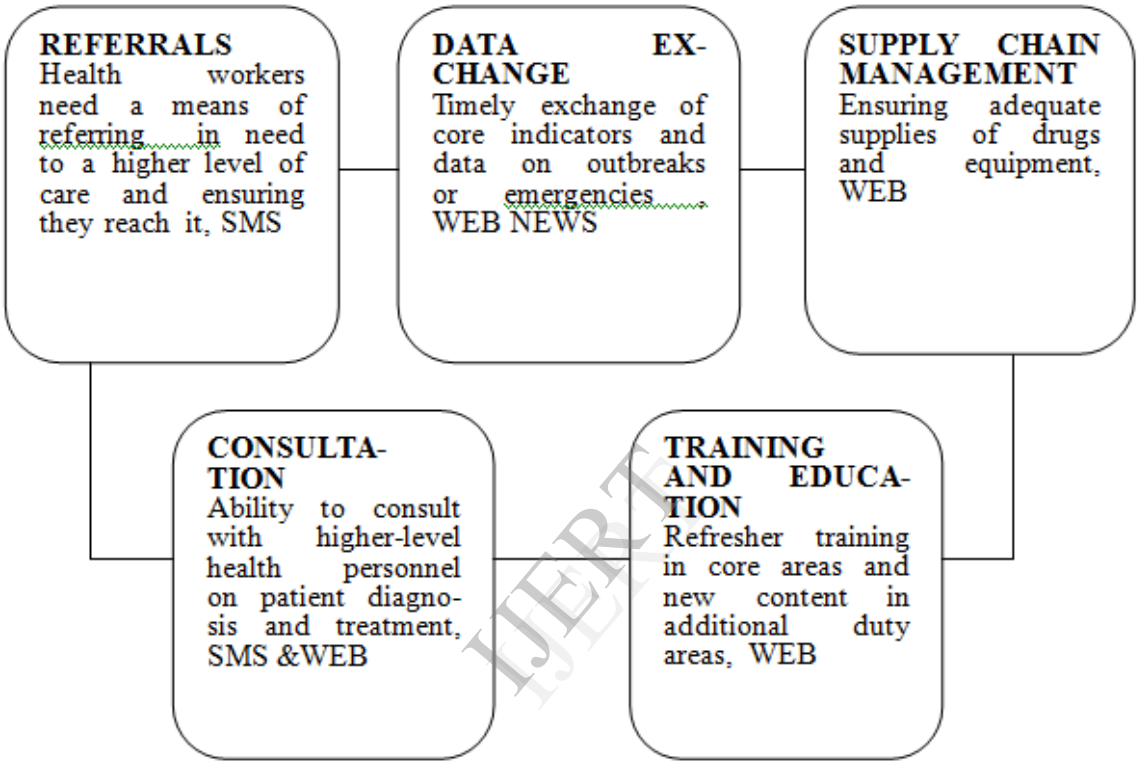

Figure 1 : Possible Layout of m-health interventions in relation to the existing infra-structure: Modified from (Vital Wave Consulting, 2011)

Referrals

Currently higher level facilities are not warned of incoming patients and their needs so they can prepare appropriate staffing and drugs. Complete patient information often does not accompany the referral, impacting continuity of care.

Data Exchange

Currently data collected by health workers is often out of date and of little use by the time it is received at the higher offices. Data transmission typically moves in one direction, with workers rarely receiving access to data to inform the community. Inaccurate data is a problem, in part due to multiple points of manual data entry.

Supply Chain Management

Currently supplies of critical drugs and supplies are often limited in most remote parts of Zimbabwe. Drugs often expire because of inaccurate usage tracking and supply management not inconsistent methods of tracking expiration dates.

Training and Education

Health workers responsibilities are growing requiring them to increase their skills and knowledge. Training that occurs offsite often takes Health workers away from their jobs and away from care delivery, hence the ability to receive training on-site is needed. Turnover increases costs associated with training and education.

Consultation

Health workers are frequently confronted with emergencies where referral is not possible due to lack of transportation or other obstacles. They often lack the training needed to provide help to patients in such cases and there is need to consult. Real-time consultation is currently not being exercised in health centres.

Designing a solution

(Loudon,2009) says in designing a solution it is important to involve all stakeholders, including those who will collect the data, those who will use or analyse it, and those who will manage the process.

Why GPRS and not SMS only

The major reason as cited by (Loudon , 2009) for favouring GPRS are cost and data size. It is known that with SMS, one is limited to 160 characters of data whereas with GPRS there is no realistic limit to the size of the form one submits. Also for the cost of one 160-character SMS, it is possible to send many times that amount of data via GPRS

RESEARCH DESIGN AND METHODOLOGY

Research Design

Group characteristics and population size

The researcher opted for experimental design due to the fact that the test was centred on a platform that had to be used first and then results and conclusions deduced from experiences with the system from users and system evaluators .

Sample and Population Size

The researcher used a population size of twenty (20) health workers drawn from different areas around Bindura. The **control group** was in those who were using the traditional way of collecting data and reporting, i.e. the nurses who were on active duty at the time of the experiment numbered fourteen(14).

The study was be made to examine the time it takes for information on Malaria cases to reach the district centre and time it takes the district hospital to act. This was compared with the normal traditional way where there is use of paper based reports. All the selected health workers were exposed to the integrated system which was accessible using the URL http://www.dariro.org. They recorded cases of malaria as patients came to their centres for treatment. They recorded the data on the tally sheets and observation books just like they do in their everyday work. This was the **control** part of the experiment. Users were assigned Usernames and Password to access the platform with and make their recordings and use the site. The users could log on to the system using internet enabled mobile phone.

Choice of mobile phones

The choice of mobile phone ranged from Samsung E250, SonyErricson Z550i and some Nokia X2 phones some which were owned by the participants and others supplied by the researcher. There was no use of a specific mobile phone as the research did not have funding to purchase new and specific mobile phones for the experiment. A mobile component was installed on the website to allow mobile phones to access the content of the website in a way compatible to the phones.

Participants logged on to the platform and accessed their inbox to see if they had any messages as the administrator could send messages or notifications to users. They in turn could send notifications to each other or to the administrator; they could acquire drugs, enter patients' data and save the details of a case. On clicking the submit button, details would be saved in the database at the server site. At the server side, a component to record statistic was installed so that every visit was recorded for use in the evaluation.

A t-test, cross tabulations and comparisons of means was used to test the effectiveness of m-health as a tool in improving health delivery. The research design would allow us to compare the productivity in terms of performance (reliability and effectiveness) of mobile phones and traditional paper based data collection and reporting methods.

Data transfer method

Once data had been captured on the phone, the completed form was submitted to a central back-end server. This mobile phone data collection system was used and the GSM network for remote data collection, transmitting completed forms and other information was done via both SMS and GPRS. SMS is available on almost all phones while GPRS has the advantage on cost and data size. GPRS has no realistic limit to the size of the form and it is fairly cheaper. At the same time, it is not all communication that will require the web, so SMS was also used when the web was not necessary.

Reporting Tools

The researcher developed a web based disease reporting system using Joomla and a database using WampServer. Ozeki SMS Module was integrated into the system to enable the SMS functionality. and below is the Ozeki structure and requirements.

The figure 2 below shows the context diagram for the proposed architecture.

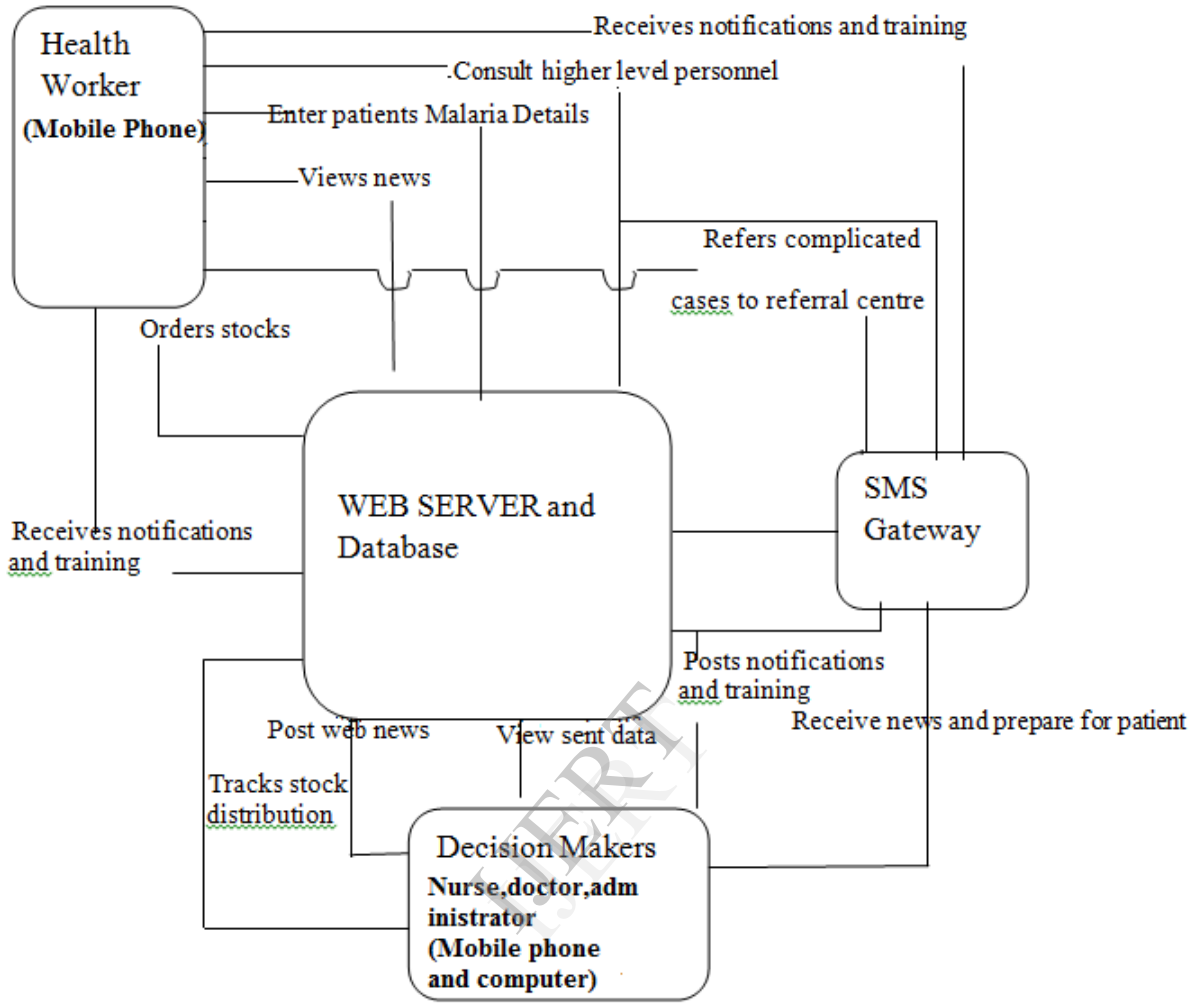

Figure 2 : Context diagram for the proposed architecture

Interface Design

Considering that the main users are mobile users, the web application should have the minimum requirements of a lightweight application. With that in mind, a mobile plug-in was downloaded and plugged in to the website so that the web-site can be viewed from mobile phones. The website had to have minimum graphic, low memory requirement as well as to fit on the small mobile phone screen showing all the important details.

Input Design

Data was to be entered in fields which would be aided by check boxes and radio buttons so that navigating the forms through the mobile phone would be easy as mobile phones do not have keyboards.

Users have to log in to gain entry to the functional parts. See, the menu bar has Home only, where one can get general news that any viewer can see. After successful login, the user is taken to the page that has the complete menu bar. This page is now specific to users. The user is taken to the inbox so that just after

login, they can see if they have any messages.

Data Entry

The figure 3 below shows the main data entry form.

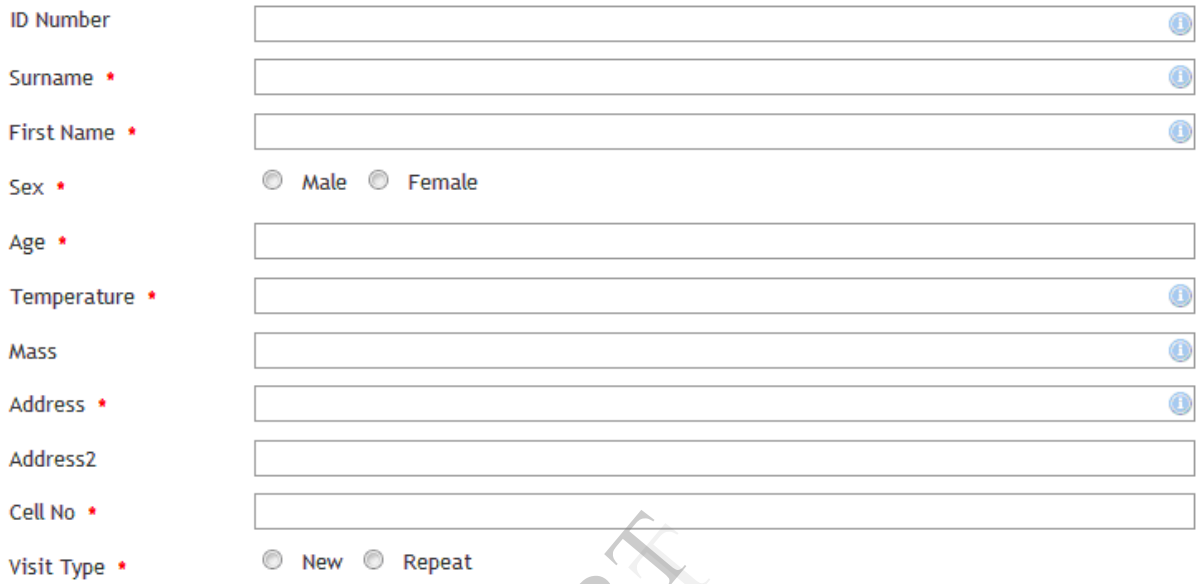

Figure 3 : Data entry form

After completing this form, the field officer submits it and it will be received at the control centre and stored in the database.

Output design

Output was designed for two users, the front-end and the backend user. The front-end user would receive notifications which had to fit on the small mobile phone screen. The backend user would print hardcopies, view on the computer or even use his/her mobile phone for viewing.

Still on time there is another Metric that needed to be measured to find the effectiveness of web based approaches which is :

- Reliability and Uptime

Availability

The availability of a website is measured by the percentage of a year in which the website is publicly accessible and reachable via the internet. :
Total time = 365 days per year * 24 hours per day * 60 minutes per hour = 525,600 minutes per year. To calculate how many minutes of downtime the system may experience per year, we take the uptime guarantee and multiply it by total time in a year.
In this example we'll use 99.99%: (1 - .9999) * 525,600 = allowable minutes down per year.

2) Will health workers find the implemented system useful to them?

Basing on the procedure above, comparisons were made in terms of the general response time of the system on the part the people who will use the system daily, i.e. health workers. Questionnaires were also to be supplied to health workers who would later evaluate the system. A comparison of the time it takes to report a case, get response, get drugs and supply statistics to the district office would be made with the existing systems. Challenges where also to be noted. The table below shows the data collection and analysis techniques for use to answer the question.

Table 1 : Data collection and analysis for health workers

Question	Data Collection	Analysis
Will health workers find the implemented system useful to them?	Pre-implementation views Post-implementation views Latency	t-test comparison of means

Analysis

Data collected was to be used to produce statistics at the control centre for analysis and rapid detection of potential Malaria outbreaks. With this, appropriate action could then be taken without delay. A Graphic User Interface (GUI) was to be developed for the district, provincial or even national responsible staff to view the cases. The figure below illustrates the proposed structure.

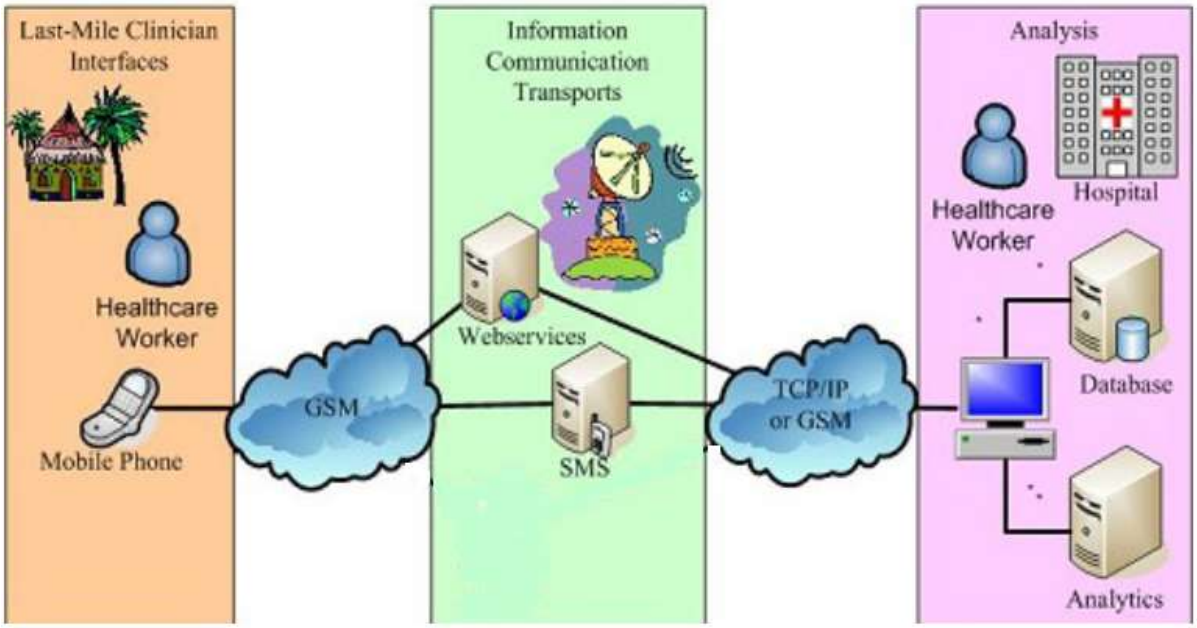

Figure 4 : Proposed design architecture: Adapted and modified from (Waidyanatha)

RESULTS AND FINDINGS

Analysis of Health workers reports.

A sample of 19 Health workers and 20 patients was used in the research for data collection. They were supposed to be 20 but one respondent did not return the questionnaire.

Tables below show the health workers perception towards the current reporting method.

Table 2: Frequency Table of the responses to question "Tally Sheets are efficient"

Paper Tally Sheet Is are efficient

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	9	47.4	47.4	47.4
	Disagree Somewhat	9	47.4	47.4	94.7
	Unsure	1	5.3	5.3	100.0
	Total	19	100.0	100.0	

Table 3 below summarises the means on responses to the question "Where can m-health be implemented". The responses where scaled as 1 = Rural Areas, 2 = Towns, 3 = Countrywide.

Table 3 :Responses on where to implement m-health

Where can m-health be implemented

Sex ...	Mean	N	Std. Deviation
Male	2.71	7	.488
Female	3.00	12	.000
Total	2.89	19	.315

From the scale a 3 means Countrywide, a 2 for Towns and a 1 for Rural Areas. The table shows the majority of females on a 3, males a 2.7 and an average of 2.89 which indicate countrywide acceptance.

Means on responses to traditional reporting by years of experience of health workers

Table 4 below shows analysis of health workers responses towards the traditional data collection and reporting by years of experience.

Table 4 : Analysis by Years of experience

Years of experience	Traditional Way is fast	Less than a day to send a request	Less than day to get response	Need to replace traditional way
< 1 Year Means (N=3)	1.33	1.67	1.67	1.67
2-3 Years Means (N=4)	1.25	1.25	1.00	1.75
3-5 Years Means (N=10)	1.30	1.20	1.20	1.80
>10 Years Means (N=2)	2.00	1.00	1.00	2.00
Total Mean	1.37	1.26	1.21	1.79

The key used for this table was 1 for No and 2 for Yes

The need to replace traditional data collection and reporting is as shown on table 5.

Table 5 : Cross tabulation of need to replace traditional way with years of experience

Count

		NeedToReplaceTrad		
		No	Yes	Total
Years Of Experience at workplace	< 1year	1	2	3
	2-3 years	1	3	4
	3-5 years	2	8	10
	>10years	0	2	2
Total		4	15	19

After an analysis of responses to the traditional data collection and reporting, the researcher looked at responses towards the m-health platform.

Table 6 below shows means on health workers responses to the m-health platform by sex.

Table 6 :Means to responses on m-health platform use by sex

Sex Of Respondent		Easy of Access	EaseOfUse	Navigation AndEntryEasy	DataSending Easy	System is reliable	Phone compatibility with site	Is Network a challenge	Period taken to send a request	What reporting do you prefer	Where can m-health be implemented	Will drug acquisition improve with mhe	Always Available
Male	Mean	4.14	3.71	3.86	4.14	4.00	2.43	3.86	1.57	2.86	2.71	1.86	4.00
	N	7	7	7	7	7	7	7	7	7	7	7	7
	Std. Deviation	.900	.756	.900	.690	1.000	.535	1.345	.787	.378	.488	.378	.577
Female	Mean	4.17	4.08	3.75	4.75	3.67	2.08	3.75	1.08	2.75	3.00	1.92	3.33
	N	12	12	12	12	12	12	12	12	12	12	12	12
	Std. Deviation	.577	.669	.754	.452	.651	.669	.866	.289	.452	.000	.289	.651
Total	Mean	4.16	3.95	3.79	4.53	3.79	2.21	3.79	1.26	2.79	2.89	1.89	3.58
	N	19	19	19	19	19	19	19	19	19	19	19	19
	Std. Deviation	.688	.705	.787	.612	.787	.831	1.032	.562	.419	.315	.315	.692

All the dependant variables with the exception of Phone compatibility, period to send a report preferred reporting, where to implement m-health and improvement in drug acquisition where scaled 1 to 5.

Table 7 below shows means on the responses by health workers based on years of experience.

Table 7 :Means on responses on m-health platform by years of experience

Years Of Experience at workplace		Easy of Access	EaseOfUse	Navigation AndEntryEasy	DataSending Easy	System is reliable	Phone compatibility with site	Is Network a challenge	Period taken to send a request	What reporting do you prefer	Where can m-health be implemented	Will drug acquisition improve with mhe	Always Available
< 1year	Mean	4.00	4.33	4.00	5.00	3.67	2.00	3.67	1.33	2.67	3.00	2.00	3.00
	N	3	3	3	3	3	3	3	3	3	3	3	3
	Std. Deviation	1.000	.577	.000	.000	.577	.000	1.528	.577	.577	.000	.000	1.000
2-3 years	Mean	4.50	4.00	3.50	4.50	4.25	2.25	4.50	1.25	3.00	3.00	2.00	3.75
	N	4	4	4	4	4	4	4	4	4	4	4	4
	Std. Deviation	.577	1.155	.577	.577	.500	.500	.577	.500	.000	.000	.000	.500
3-5 years	Mean	4.10	4.00	3.90	4.40	3.70	2.30	3.60	1.20	2.70	2.80	1.90	3.70
	N	10	10	10	10	10	10	10	10	10	10	10	10
	Std. Deviation	.738	.471	.994	.699	.949	.675	1.075	.632	.483	.422	.316	.675
>10years	Mean	4.00	3.00	3.50	4.50	3.50	2.00	3.50	1.50	3.00	3.00	1.50	3.50
	N	2	2	2	2	2	2	2	2	2	2	2	2
	Std. Deviation	.000	.000	.707	.707	.707	1.414	.707	.707	.000	.000	.707	.707
Total	Mean	4.16	3.95	3.79	4.53	3.79	2.21	3.79	1.26	2.79	2.89	1.89	3.68
	N	19	19	19	19	19	19	19	19	19	19	19	19
	Std. Deviation	.895	.705	.787	.612	.787	.631	1.032	.562	.418	.315	.315	.692

Table 8 below shows health workers responses to the m-health platform by smart phone ownership.

Table 8 : Means of responses on m-health platform by smart phone ownership

Smartphone ownership	Ease of access	Always available	Ease of use	Navigation and data entry easy	Data sending easy	System is reliable	Phone compatibility	Network a challenge	Period to send a request	Preferred reporting	Where to implement m-health	Will drug acquisition improve
No (N=5)	4.20	3.40	4.20	4.20	5.00	3.60	2.20	3.40	1.00	2.40	3.00	2.00
Yes (N=14)	4.14	3.64	3.86	3.64	4.36	3.86	2.21	3.93	1.36	2.93	2.86	1.86
Total Mean	4.16	3.58	3.95	3.79	4.53	3.79	2.21	3.79	1.26	2.79	2.89	1.89

Table 9 below shows means on health workers responses by prior internet knowledge.

Table 9 : Means on response on m-health platform by prior internet knowledge

Ever used internet before	Ease of access	Always available	Ease of use	Navigation and entry easy	Data sending easy	System is reliable	Phone compatibility	Is network a challenge	Period to send a request	Preferred reporting	Where can mhealth be implemented	Will drug acquisition improve
Disagree	4.00	3.00	3.50	3.00	4.50	3.00	1.00	3.50	1.00	3.00	3.00	1.50
Somewhat Agree	4.33	3.67	4.33	4.00	5.00	4.00	2.00	3.00	1.00	2.67	3.00	2.00
somewhat Strongly agree	4.14	3.64	3.93	3.86	4.43	3.86	2.43	4.00	1.36	2.79	2.86	1.93
Total	4.16	3.58	3.95	3.79	4.93	3.79	2.21	3.79	1.26	2.79	2.89	1.89

From the table, those in agreement with the statements constituted 76.5% while those not in agreement contributed 24.5% . The general overview of the responses looking at the total means is that regardless of prior internet knowledge, the health workers saw significance in the mhealth platform and accepted it as a data collection and reporting tool.

Analysis of variables by sex on the experiences with the mhealth platform

Table 10 below shows responses to the need to replace the traditional data collection and reporting by sex.

Table 10 : Need to replace traditional reporting

Count

		NeedToReplaceTrad		
		No	Yes	Total
Sex Of Respondant	Male	2	5	7
	Female	2	10	12
Total		4	15	19

Table 11 below shows a cross tabulation of navigation and data entry easy by sex

Table 11 : Cross tabulation of Navigation and Data Entry Easy by sex

Count

		NavigationAndEntryEasy				
		DisagreeSomewhat	Unsure	AgreeSomewhat	StronglyAgree	Total
Sex Of Respondant	Male	0	3	2	2	7
	Female	1	2	8	1	12
Total		1	5	10	3	19

From table 11 above 13 (68%) are in agreement against 6 (32%) who are against the statement which says "Navigation and Data Entry is Easy". The bar chart below explains the table above.

Table 12 : Cross tabulation of data sending easy by sex

Count

		DataSendingEasy			
		Unsure	AgreeSomewhat	StronglyAgree	Total
Sex Of Respondant	Male	1	4	2	7
	Female	0	3	9	12
Total		1	7	11	19

Those in agreement with the statement are 18 (95%) against 1 (5%)who was unsure. This shows that whether male or female, they concurred on the point that data sending is improved with mhealth.

Table 13 : Period taken to send a request by sex

Count					
		Period taken to send a request			
		<1Day	1-2Days	3-5Days	Total
Sex Of Respondent	Male	4	2	1	7
	Female	11	1	0	12
Total		15	3	1	19

As depicted in the table, the majority (79%) said the period taken to send a report using the m-health platform while (21%) gave a day or more for an answer. This shows that the majority concurred that the m-health platform is fast and therefore useful because health is about timely delivery of information. The table below shows where to implement m-health by sex.

Table 14: Where to implement m-health by sex

Count				
		Where can m-health be implemented		
		Towns	Countrywide	Total
Sex Of Respondant	Male	2	5	7
	Female	0	12	12
Total		2	17	19

As depicted in the table 89% of the respondents said m-health should be implemented countrywide whereas 11% said it should be implemented in towns. These responses show great acceptance of the platform and contradict the null hypothesis that health workers will not find the platform useful to them. If it was unacceptable, they would not recommend its wide usage. Table 15 shows where to implement m-health by job title.

Table 15 : Where to implement m-health by job title

Count				
		Where can m-health be implemented		
		Towns	Countrywide	Total
Job Title of respondent	GRN	2	13	15
	Doctor	0	2	2
	StudentNurse	0	1	1
	NurseAide	0	1	1
Total		2	17	19

As depicted by table 15, 89% of the respondents selected countrywide use of the system and there was a response from all job titles in favor of coutrywide usage which shows acceptance.

Table 16 below shows a cross tabulation of navigation and data sending easy by prior phone internet knowledge.

Table 16 : Navigation and data sending easy by prior phone internet knowledge

Count						
		NavigationAndEntryEasy				
		DisagreeSomewhat	Unsure	AgreeSomewhat	StronglyAgree	Total
Prior Phone Internet Knowledge	No	1	0	1	1	3
	yes	0	5	9	2	16
Total		1	5	10	3	19

As depicted by the table, those with and without prior phone internet knowledge concurred that navigation and data entry is easy with the platform with the highest number coming from those with prior internet knowledge.

Table 17 : Navigation and data sending response by Smart Phone Ownership

Count

		NavigationAndEntryEasy				
		DisagreeSomewhat	Unsure	AgreeSomewhat	StronglyAgree	Total
Smartphone Ownership	No	0	0	4	1	5
	yes	1	5	6	2	14
Total		1	5	10	3	19

The table below is an independent samples t-test for responses based on gender.

Table 18 : Independent samples t-test basing on gender

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					
								95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
NeedToReplaceTrad	Equal variances assumed	1.274	.275	-.587	17	.565	-.119	.203	-.547	.309
	Equal variances not assumed			-.551	10.493	.593	-.119	.216	-.597	.359
Easy of Access	Equal variances assumed	2.856	.109	-.071	17	.944	-.024	.337	-.734	.687
	Equal variances not assumed			-.063	8.947	.951	-.024	.379	-.881	.834
EaseOfUse	Equal variances assumed	.556	.466	-1.108	17	.283	-.369	.333	-1.072	.334
	Equal variances not assumed			-1.070	11.427	.307	-.369	.345	-1.124	.386
NavigationAndEntryEasy	Equal variances assumed	.735	.403	.279	17	.784	.107	.384	-.704	.918
	Equal variances not assumed			.265	10.920	.796	.107	.404	-.782	.997
AlwaysAvailable	Equal variances assumed	2.288	.149	2.238	17	.039	.667	.298	.038	1.295
	Equal variances not assumed			2.314	14.005	.036	.667	.288	.049	1.284
DataSendingEasy	Equal variances assumed	.569	.461	-2.329	17	.032	-.607	.261	-1.157	-.057
	Equal variances not assumed			-2.082	9.073	.067	-.607	.292	-1.266	.052
System is reliable	Equal variances assumed	.004	.950	.885	17	.389	.333	.377	-.461	1.128
	Equal variances not assumed			.790	9.035	.450	.333	.422	-.621	1.288
Phone compatibility with site	Equal variances assumed	.031	.863	1.162	17	.261	.345	.297	-.281	.972
	Equal variances not assumed			1.236	15.092	.235	.345	.279	-.250	.940
Is Network a challenge	Equal variances assumed	.185	.673	.212	17	.834	.107	.504	-.957	1.171
	Equal variances not assumed			.189	8.966	.854	.107	.567	-1.175	1.390
Period taken to send a request	Equal variances assumed	13.776	.002	1.966	17	.066	.488	.248	-.036	1.012
	Equal variances not assumed			1.580	6.956	.158	.488	.309	-.243	1.219
What reporting do you pefer	Equal variances assumed	1.272	.275	.527	17	.605	.107	.203	-.322	.536
	Equal variances not assumed			.554	14.638	.588	.107	.194	-.306	.521
Where can m-health be implemented	Equal variances assumed	47.719	.000	-2.072	17	.054	-.286	.138	-.577	.005
	Equal variances not assumed			-1.549	6.000	.172	-.286	.184	-.737	.166
Will drug acquisition improve with mhe	Equal variances assumed	.594	.451	-.387	17	.703	-.060	.154	-.384	.265
	Equal variances not assumed			-.360	10.138	.726	-.060	.165	-.427	.308

Analysis of this table will be done at the discussion section of this chapter.

Table 19 below shows a t-rest of responses by prior phone internet knowledge.

Table 19 : Independent samples t-test by Phone internet knowledge

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
NeedToReplaceTrad	Equal variances assumed	1.274	.275	-.587	17	.565	-.119	.203	-.547	.309
	Equal variances not assumed			-.551	10.493	.593	-.119	.216	-.597	.359
Easy of Access	Equal variances assumed	2.856	.109	-.071	17	.944	-.024	.337	-.734	.687
	Equal variances not assumed			-.063	8.947	.951	-.024	.379	-.881	.834
EaseOfUse	Equal variances assumed	.556	.466	-1.108	17	.283	-.369	.333	-1.072	.334
	Equal variances not assumed			-1.070	11.427	.307	-.369	.345	-1.124	.386
NavigationAndEntryEasy	Equal variances assumed	.735	.403	.279	17	.784	.107	.384	-.704	.918
	Equal variances not assumed			.265	10.920	.796	.107	.404	-.782	.997
AlwaysAvailable	Equal variances assumed	2.288	.149	2.238	17	.039	.667	.298	.038	1.295
	Equal variances not assumed			2.314	14.005	.036	.667	.288	.049	1.284
DataSendingEasy	Equal variances assumed	.569	.461	-2.329	17	.032	-.607	.261	-1.157	-.057
	Equal variances not assumed			-2.082	9.073	.067	-.607	.292	-1.266	.052
System is reliable	Equal variances assumed	.004	.950	.885	17	.389	.333	.377	-.461	1.128
	Equal variances not assumed			.790	9.035	.450	.333	.422	-.621	1.288
Phone compatibility with site	Equal variances assumed	.031	.863	1.162	17	.261	.345	.297	-.281	.972
	Equal variances not assumed			1.236	15.092	.235	.345	.279	-.250	.940
Is Network a challenge	Equal variances assumed	.185	.673	.212	17	.834	.107	.504	-.957	1.171
	Equal variances not assumed			.189	8.966	.854	.107	.567	-1.175	1.390
Period taken to send a request	Equal variances assumed	13.776	.002	1.966	17	.066	.488	.248	-.036	1.012
	Equal variances not assumed			1.580	6.956	.158	.488	.309	-.243	1.219
What reporting do you pefer	Equal variances assumed	1.272	.275	.527	17	.605	.107	.203	-.322	.536
	Equal variances not assumed			.554	14.638	.588	.107	.194	-.306	.521
Where can m-health be implemented	Equal variances assumed	47.719	.000	-2.072	17	.054	-.286	.138	-.577	.005
	Equal variances not assumed			-1.549	6.000	.172	-.286	.184	-.737	.166
Will drug acquisition improve with mhe	Equal variances assumed	.594	.451	-.387	17	.703	-.060	.154	-.384	.265
	Equal variances not assumed			-.360	10.138	.726	-.060	.165	-.427	.308

Analysis of table 19 will again be done in the discussion section of this chapter.

Statistics of site visits

The following screenshot was extracted from the m-health website and shows some of the statistics on visits of the site

Summary Month — Including summarized data until

Day	Unique visitors	Visitors	Visits average	Page impressions	Referrers	Unique bots/spiders	Bots/Spiders	Unique NIV	NIV	Unique sum	Sum
1											
2											
3											
4											
5											
6	9	17	1.89	87	1	2	8	1 [0]	1 [0]	12	26
7	5	7	1.40	58		4	25			9	32
8	6	8	1.33	37		2	3	4 [0]	5 [0]	12	16
9	3	3	1.00	21		9	14			12	17
10	1	1	1.00	5		4	6			5	7
11				9		6	7	1 [0]	1 [0]	7	8
12	3	3	1.00	20		4	5	1 [0]	1 [0]	8	9
13	8	8	1.00	63	3	6	6	5 [0]	8 [0]	19	22

Figure 5 : Site visits statistics

The visits simply confirm that users, really used the system and their responses where not guesses but a true reflection of their experiences.

Analysis of the performance of the system.

Availability and downtime

Committed hours of availability (A)

This is usually measured in terms of number of hours per month.
Availability = 720 hours per month

Outage hours (B)

This is the number of hours of outage during the committed hours of availability. 10 hours of outage due to hardware failure, 14 hours of outage for maintenance were used for the respective site stoppages.
The amount of availability is:
Achieved availability = ((A-B)/A)*100 percent

Total Hours of outage due to machine hardware problem = 10 hours
Total Hours of outage due to maintenance = 14 hours

- High availability = ((720-10)/720)*100 percent = 98.61 percent availability
- Continuous operations = ((720-14)/720)*100 percent = 98.05 percent availability
- Continuous availability = ((720-24)/720)*100 percent = 96.67 percent availability

High Availability = 98.61%= 7.30 days/year, 14.4 hours /month and 3.36 hours/ week
Availability for continuous operations = 98.05% = 7.30 days/year, 14.4 hours/month, 3.36 hours/week
Continuous Availability = 96.67 % = 10.96 days/year, 21.6 hours / month, 5.04 hours /week

Speed of the website
The following URL http://analyze.websiteoptimization.com/wso was used to test the response time and speed of the website .
http://www.websiteoptimization.com/speed/1/ Monday 19 March 2012 says waiting time is dependant upon several factors, which the researcher is not going to explore in this research, but the general load time should be under **8.6** seconds and load times should be decreased by 0.5 to 1.5 seconds but there is no universally agreed time as the relationship between expectation and user experience is what matters most. After five trials, the response time was averaged to be 0.67 seconds which is in the same range of 5s (DNS lookup and connection time) under the www.webpagetest.org.
The site http://www.webpagetest.org/result/120320_TE_3N5Q9/1/details/ was also used to test the performance of the researcher's website and the produced results gave

www.dariro.org a speed of 1.12 and a score of 79/100 with a total load time of 7.21 seconds. This falls in the range found on http://www.websiteoptimization.com/speed/1/ meaning that the researcher's site is performing optimally.

Discussion

This section is going to discuss the findings in order to come up with a conclusion of whether m-health helps or not. We will look at health workers responses and then the system.

Health workers Responses

Dependent variables will be analysed using data from tables above.

Analysis of Traditional reporting by years of experience

Table 4 shows responses towards the traditional data collection and reporting by years of experiences and show that all years classes excepting the >10 years concurred that traditional data collection and reporting is not efficient with a total mean of 1.37. The opposite responses from the >10 years maybe because they are so used to the traditional way and have trusted it because it is the one they have been exposed to for long. This may be resistance to change. It is the only reporting that they have been exposed to unlike their junior counterparts who are now exposed to a wide range of technologies.

Need to replace traditional system

As depicted by the table 10, 68% of those that agreed to the need to replace the traditional system came from GRNs while 16% were doctors and 16% student nurses. Only four(4) disagreed with the need to replace the traditional way.

M-Health Platform Analysis

m-health by years of experience

Table 7 which shows responses to the m-health platform by years of experience show that the responses based on years of experiences show that the 2-3 years had a higher mean on ease of access and the overall means on the questions show acceptance. But on the preferred reporting they had a difference of 0.33. So we can conclude that the health workers found the platform useful regardless of their years of experience at work. Preferred reporting again showed health workers referred to use both, maybe as a parallel run until the m-health had results seen over some time. This can be attributed to network which was a challenge as well as some compatibility issues. These need to be resolved in future.

.

Response towards m-health platform by sex

Responses from table 6 show that the respondents had words of praise to the m-health platform that they had been exposed to showing that they appreciated it. There were slight variations in the means from either sex attributed to differences in their numbers but the overall mean was in agreement with appreciation

of the m-health platform

m-health by prior internet knowledge

From the table 9 which had responses by prior internet knowledge, those in agreement with the statements or dependent variables constituted 76.5% while those not in agreement contributed 24.5% . The general overview of the responses looking at the total means is that regardless of prior internet knowledge, the health workers saw significance in the m-health platform and accepted it as a data collection and reporting tool. The 24.5% may be attributed to the fact there were some reservations on always available maybe due to the network challenge.

Easy of access by smart phone ownership

From table 18 we can see that respondents without smart phones were five and those with them were fourteen. From the table there was insignificant difference on responses for instance on ease of access ,they had a difference of 0.06. Generally speaking, the responses were not affected by smart phone ownership and both respondents so the significance of m-health platform. We can conclude that factors like smart phone ownership did not have any significant contribution to health workers responses who said the platform had several advantages.

We can then accept the alternative hypotheses that The health workers will find the implanted m-health system useful to them and there is a significant difference in monitoring and controlling diseases by the introduction of an m-health system. There are no significant difference in health workers responses by gender which shows that the acceptance of the platform was independent of gender.

Navigation and Data Entry

From table 17 , 68% of the respondents were in agreement against 32% who are against the statement which says “Navigation and Data Entry is Easy”. As depicted by the table, those with and without prior phone internet knowledge concurred that navigation and data entry is easy with the platform with the highest number coming from those with prior internet knowledge.

As depicted by the table 18 which shows responses by smart phone ownership ,26 % of the respondents had no smart phones but agreed that navigation and data entry was easy.42 % of the respondents had smart phones and agreed that navigation and data entry was easy .26% was unsure with 6% disagreeing. This shows that whether respondents had smart phones or not before, they saw navigation and data entry being easy.

Site Compatibility with mobile phones

On the issue of compatibility 100 % of the males said the site was compatible to their phones while 83 % of the females agreed with compatibility. However ,there were some concerns over compatibility when the site was loaded for the

first time. This might have attributed to the 83% of the females.

Period to send a report

As depicted in table 13, the majority (79%) said the period taken to send a report using the m-health platform was less than a day while (21%) gave a day or more for an answer. This shows that the majority concurred that the m-health platform is fast and therefore useful because health is about timely delivery of information. Those who gave more than a day for an answer may have been due to network which again may have been affected by their locations. There is need to see if health centres locations have a bearing on their responses.

Where to implement m-health

Table 3 basically summarises the means of where to implement m-health. As can be seen, the average is 2.89 which is close to a 3 showing that there is recommendation for countrywide use,showing that they found mhealth useful. If it was not of its usefulness, they would not recommend its countrywide usage. However ,there is need to try it on a larger scale because the numbers may at times not be representative of the country's population but where used in the hope that since health centre enviromnent are basicallly the same and the training they receive is the same,we can trust their suggestions.

As depicted in table 26, 89% of the respondents said m-health should be implemented countrywide whereas 11% said it should be implemented in towns. These responses show great acceptance of the platform and contradict the null hypothesis that health workers will not find the platform useful to them. If it was unacceptable, they would not recommend its wide usage.

As depicted by table 14 and 15 the respondents selected countrywide use of the system and there was a response from all job titles in favor of coutrywide usage which shows acceptance.

As shown by the t-test based on gender in table 18 ,all variables with the exception of availability and data sending easy had two tailed significances greater than 0.05 which aids us in rejecting the null hypothesis, based on gender that health workers will not find the platform useful.with this, we can accept the alternative hypothesis that workers will find the platform useful.

Table 19 is also a t-test by prior phone internet knowledge, all variables with the exception of availability,period to send a request,network challenge and data sending easy had two tailed significances greater than 0.05 which aids us in rejecting the null hypothesis, based on prior phone internet knowledger that health workers will not find the platform useful.with this, we can accept the alternative hypothesis that workers will find the platform useful.

Combining table 18 and 19 as well as other tables above can help us conclude that the platform will be useful to health workers and can help in improving health delivery if properly implemented.We can therefore reject the null hypothesis that health delivery will not be improved and accept the alternative hypothesis. This is in line with the fact that responses are in favour of m-health.

SUMMARY AND CONCLUSION

Summary

The main thrust of the research was to establish whether an internet enabled mobile phone can be used as a data collection and reporting tool for use by health workers. This came from the documented facts that Zimbabwe, like other developing countries is lagging behind in the race to meet the MDGs of 2015. As a result, some countries, still developing, like Zimbabwe started on m-health which was meant to help in timely delivery of health services and the researcher saw, after literature surveys, the potential that mobile phones have as they are just designed wit features almost similar to those on computers.

Objectives were set, research questions formulated and hypotheses defined, which were to guide the researcher throughout the research. A mobile website was designed and developed which was then put online for viewing and use by a group of health workers who where strategically sampled. Malaria cases were recorded through mobile phones and sent to the malaria website for storage and decision making.

Users where then given questionnaires which they completed basing on their experiences with the system. The group was structured in such a way that those practicing nurses would do their normal chores and then report and so worked as a control group again.

The website was also put under several tests to measure response time, availability and speed among other metrics and results where compared with known average values. Analysis of data collected during implementation was then made to come up with a conclusion.

Conclusion

The research was successfully conducted with everything working well and awesome results where produced. Responses from users showed that they were satisfied with the mobile platform and expressed keen in having the system widely used. Users where not affected by any background factor like prior phone internet knowledge or Smart phone ownership. However, they had variation on whether the system was reliable or not and whether drug acquisition would improve with the majority giving a response of unsure. Some users raised concern on the compatibility of the website to their mobile phones. It was just that some graphics where too large for some mobile phones like the SonyErricson and these phones were taking some time before they could load the mobile version.

On loading the website for the second time, it would not show the images but just show the simplified menus and the necessary items. However health workers expressed satisfaction with the speed, efficiency and ease of use of the platform. Analysing their responses we ca reject the null hypothesis that they will not trust the m-health platform as a technology that can be used to help fight malaria. Statistics where also collected to see if the site was actually being used and it was confirmed that users responses where based on their experiences.

The website was finally put under test and availability and downtime where measured first. Using the estimated outage times due to hardware failure and maintenance and also the formula from http://en.wikipedia.org/wiki/Web_hosting_service (Thursday 26/01/2012) the availability for continuous operations was 98.05% corresponding to a downtime of 14.4 hours per month and 3.36 hours per day. These are reasonable figures showing that the website is almost always available considering our network and power outages. Speed was also tested to find the response times and produced acceptable results meaning the site is suitable for normal use. Waiting time was not considered in this research as it is affected by several factors.

In a nutshell, the research was successful, and showed that m-health is helpful and if fully implemented can go a long way in facilitating timely delivery of life saving data or information, can enhance communication, can reduce travel costs and facilitate in-house refresher training among other advantages and therefore should be implemented on a large scale

RECOMMENDATIONS AND FUTURE WORK

Recommendations

With the positive results realised from the implementation of m-health, it can be seen and concluded that m-health can effectively control malaria, looking at the data collection, monitoring and timely delivery of information for decision making purposes. However, the researcher noted some areas that need to be addressed for m-health to fully realise its potential

- The ministry of health and child welfare should play a leading role in these researches as it is the mother body that can facilitate selection of strategic research sites and participants and the researcher noted that he had problems in convincing the participants to participate without the full knowledge of the authorities due to a large number of protocols that needed to be observed.
- The researcher also recommends funding for the research to be implemented at full scale
- The researcher recommends full education on the technology such that it can be implemented in all areas.
- The researcher also recommends that partnerships in such researches should be made so that airtime is subsidised for the sake of these researches.

Future Work

The researcher proposes to advance research using a particular brand of mobile phones if funds are available. The work to be done in the future can also include development of applications to include facilities like chat and other surveillance features that can be used to improve real-time communication between users and administrators. The platform also needs to be implemented on other diseases as it as worked for malaria and this should be done on a larger scale since the numbers used in this research, because of time and funding were small. There is also need to see if health centres geographical locations have a bearing on the effectiveness of an m-health platform. There is also need to analyse the health workers responses by their ages to see if it has an effect on people's responses.

Conclusion

The research was successfully carried out and the mobile phone was seen to be an effective tool in the dissemination of health information in the fight against Malaria. If projects are implemented at large scale, with support from the parent ministry, the mobile phone can go a long way in helping improve health delivery, not on Malaria only but on other diseases as well. On the suggested future work, if it is researched on, the mobile phone has the potential to help us as a country move towards fulfilling the health related Millennium development goals

REFERENCES

Adler, 2007. *Health Care Unplugged:The Evolving Role of Wireless Technology*, Oakland,CA: Carlifonia Healthcare Foundation.

Atun RA, e.-a., 2006. The Role of Mobile Phones in Increasing Accessibility and Efficiency in Healthcare.A review of the characteristics and benefits of SMS in delivering health care. *The Vodafone policy paper*, 4(4), pp. 18-28.

Banks, K., 2008. *Mobile phones and the digital divide*, San Fransisco,CA: PCWorld Communications Inc.

Barclay, E., 2009. Text messages could hasten Tuberculosis drug compliance. *The Lancet*, 373(9657), pp. 15-16.

Blaya, 2010. *Barriers and Gaps affecting m-health in Low and Middle Income Countries: Policy White Paper Release.*, Columbia: The Earth Institute.

Blynn, E., 2009. *Piloting mHealth : A Research Scan*, Cambridge: Knowledge Exchange Management Science for Health.

Capacity Kenya, 2010. *SMS to Reach Remote ealth Workers:*, Nairobi: Capacity Kenya.

Caroline Free, G. P. F. G. P. E., 2010. The effectiveness of m-health for improving health and health services : a systematic review protocol. *BioMedCentral Research Notes.*

Changhong Yang, J. Y. X. L. P. G., 2009. Emergency reporting using mobile phones in China. *Bull World Health Organ*, pp. 619-623.

Chib, A., 2009. *The Aceh Besar Midwives with Mobile Phones Program: Design and Evaluation Perspectives using the Information and Communication Technologies for Healthcare Model Pre-conference workshop at the International Communication Association (ICA),* Chicago,Illinois: s.n.
Compendium of mHealth, p., n.d. s.l.: s.n.
Consulting, V. W., 2011. *m-health in Ethiopia, strategies for a new framework,* s.l.: Vital Wave Consulting.
Cristian Pop-Eleches, H. T. J. P. H. G. J. H. K. J. S. D. N. a. D. T. B., 2011. Mobile phone technologies improve adherence to antiretroviral treatment in a reso.
Curioso W.H, e.-a., 2009. *URBAN COMMUNITY RANDOMIZED TRIAL OF STD PREVENTION.* [Online]
Available at: http://faculty.washington.edu/wcurioso/cellpreven
[Accessed 21 November 2011].
Della, M., 1999. Internet electronic mail : a tool for low-cost medicine. *Journal of Telemedicine and Telecare,* pp. 84-89.
Disease control priorities project, 2007. *Achieving the Millennium Development goals for health : So far progress is mixed - can we reach our targets?,* New York: Disease control priorities project.
Fjedsoe BS, e.-a., 2009. Behavior change intervetions delivered by mobile telephone short-message service. *Am J Prev Med 2009* , pp. 165-173.
Fraser H, B. P. M. C. W. P., 2001. TeleMedMail:free software to facilitate telemedicine in developing countries. *Medinfo,* pp. 815-816.
getyourwebsitehere, n.d. *rttest.* [Online]
Available at: http://getyourwebsitehere.com/jswb/rttest01.html
[Accessed 13 March 2012].
Greenmarsh, 2011. *SMS for life,* Accra: s.n.
Hamish SF Fraser, P. B. D. M. S. C. B. W. M. P. S., 2005. *Implementing electronic medical record systems in developing countries.,* s.l.: s.n.
Health, N. I., 2009 . *Cell phones useful in research targeting Peru's sex workers.,* s.l.: Science for Global Health, Volume 8, Issue 6 ..
Heather-Cole Lewis, T. K., 2010. Text Messaging as a Tool for Behavior Change in Disease Prevention and Management. *Oxford Journal, Epidemiologic Reviews Volume 32, Issue1,* pp. 56-69.
Horrigan, J., 2009. *Wireless Internet use,* Washington DC: Pew Research Center.
International Telecommunications Union, 2009. *Worldwide mobile cellular subscribers to reach 4 billion mark,* Geneva: ITU.
Kallander, K., 2010. *Landscape analysis of m-health which can increase perfomance and retention for community based agents,* Kampala: inSCALE, page 6-43.
Kaplan, W. A., 2006. Can the ubiquitous power of mobile phones be used to improve health outcomes in developing countries?.
Katherine de Tolly, H. A., 2009. *Innovative use of cellphone technology for HIV/AIDS behaviour change communication:3 pilot projects,* s.l.: Cellphones4HIV.
Keller, 2011. Still a Nestling. *For The Record, Volume 23* , p. 20.
Kollmann, A. e.-a., 2011. Feasibility of a Mobile Phone -Based Data Service for Functional Insulin Treatment of Type 1 Diabetes Mellitus Patients. *Journal of medical internet research,* Volume September 15-16.

Laugesen J, H. K., 2010. *A Continuance model for a mobile/web base self management system for adolescent diabetes:The role of loyalty incentives,18th European conference on information systems,* s.l.: s.n.
Lester RT, E. J. M. A. K. P. R. M. C. W. J. J. H. S. K. S. B. R. N. B. E. E. N. T. B. B. L. T., 2009. *The HAART cell phone adherence trial (WelTel Kenya1):a randomised controlled trial protocol.,* s.l.: s.n.
Loudon, M., 2009. *Mobile phones for data collection,* s.l.: s.n.
Lund, S., 2010. *Use of mobile phones to improve martenal and neonatal health in Zanzibar,* Copenhagen: University of Copenhagen.
Mark Tomlinson, W. S. Y. S. T. D. M. C. P. I. A. C. T. a. D. J., 2009. The use of mobile phones as a data collection tool: A report from a household survey in South Africa. *Medical Informatics and Decision Making.*
Mechael P, H. B. K. S. K. G. F. O., 2010. *Barriers and Gaps Affecting mHealth in Low and Middle Income Countries:Policy White Paper.* Columbia University, mHealth Alliance,Centre for global and Econommic Development Earch Institute.
Mishra, S., 2008. *m-health:a developing country perspective.Making the eHealth Connection.Local solutions Conference.* Bellagio,Italy, Bellagio GLobal Partnerships.
Mujera, E., 2009. *E-Health in Zimbabwe :the role and the capacity of the University of Zimbabwe College of Health Library,* Harare: Centre for the Evaluation of Public Health Interventions.
Nokia and Amazonas Health Department, 2008. *Disease and Epidemic Outbreak Surveillance,* Manaus: s.n.
Noordam CA, B. M. K. S. M., 2011. Improvement of martenal health services through the use of mobile phones. *Tropical Medicine and International Health,* Volume 16, pp. 622-626.
Pongthep Meankaew, J. K. A. K. P. K. P. S. ,. S., 2010. Application of mobile-technology for disease and treatment monitoring of malaria in the "Better Border Healthcare Programme". *Malaria Journal 2010,* p. 9:237.
Pujari, S., 2010. *Tobacco control and m-health, A new initiative. ,* s.l.: Tobacco Free Initiative.
Pujari, S., 2011. *Tobacco Control and Mobile Health,A New Initiative,* Geneva: World Health Organisation.
Rainie, L. A., 2009. *The future of the internet III,* Washington DC: Pew Research Center.
Richard T Lester, E. J. M. A. K. P. R. M. C. W. J. J. H. S. K. S. B. R. N. B. E. E. N. T. B. B. L. T. J. K., 2009. *The HAART cell phone adherence trial (WelTel Kenya1): a randomized controlled trial protocol,* s.l.: s.n.
Rowling.M, 2009. *Rising mobile phone use rings change in disasters,* London: Thompson Reuters Foundation.
Sapra, D. S., 2011. *Keeping the promise of achieving MDGs - Reaching the Last Mile,* s.l.: s.n.
Schuster C, C. P. B., 2011. *Cutting costs,boosting quality aand collecting data real-time-Lessons from a Cell Phone -Based Beneficiary Survey to Strnghten Guatemala's Conditional Cash Transfer Program,* Guatemala: World Bank.
sesric, 2011. *OIC Healt Report,* s.l.: sesric publications (http://www.sesric.0rg/publications-detail.php?id=185).
sesric, 2011. *STATISTICAL ECONOMIC AND SOCIAL RESEARCH AND TRAINING CENTR FOR ISLAMIC COUNTRIES.* [Online]

Available at: http://www.sesric.org/publications-detail.php?id=185
[Accessed 21 march 2012].
Shet, A. e.-a., 2010. *Designing a Mobile Phone-Based Intervention to Promote adherence to antiretroviral therapy in India,* s.l.: Springer Science+Business Media, LLC 2010.
speed, W. p., 2011. [Online]
Available at: http://www.websiteoptimization.com/speed/1/
[Accessed 13 March 2012].
The Compendium of ICT Applications on Electronic government, 2007. *Mobile applications for health and learning,* New York: UNPAN.
UNDES, 2007. *Volume 1 : Mobile Applications on Health and Learning. ,* New York:).
UN Department of Economic and Social Affairs..
undp, 2010. *Millenium Development Goals.* [Online]
Available at: http://content.undp.org/go/cms
[Accessed 18 june 2011].
undp, 2010. *Millenium Development Goals.* [Online]
Available at: http://content.undp.org/go/cms
[Accessed 18 June 2011].
Vital Wave Consulting, 2008. *m-health for development : mobile communications for health,* s.l.: s.n.
Vital Wave Consulting, 2010. s.l.: s.n.
Vital Wave Consulting, 2011. *m-health in Ethiopia,Strategies for a new framework,* s.l.: s.n.
Vlasta Vodopivec-Jamsek, e.-a., 2008. Mobile phone messaging for preventive health care. *The Cochrane Collaboration.*
Vodopivec-Jamsek, d. J. T. G.-U. A. R. J., 2008 . *Mobile phone messaging for preventive health care(Protocol),* s.l.: Cochrane Database of Systematic Reviews ..
Voxiva, 2011. s.l.: s.n.
Waidaynatha, N., 2009. *Real-Time Biosurveillance Program in India and Sri Lanka,* s.l.: s.n.
Wave, V., 2008. *m-health for development:mobile communications for health.,* s.l.: s.n.
webpagetest, 2011. [Online]
Available at: http://www.webpagetest.org/result/120320_TE_3N5Q9/1/details/
[Accessed 12 March 2012].
webperformancematters, 2007. *acceptable-response-times.* [Online]
Available at: http://www.webperformancematters.com/journal/2007/7/10/acceptable-response-times.html
[Accessed 13 March 2012].
websitepulse, n.d. [Online]
Available at: http://www.websitepulse.com/help/tools.php
[Accessed 13 March 2012].
WHO, 2011. mhealth,new horizons for health through mobile technologies. *Global observatory for ehealth series - Volume3,* p. 6.
wikipedia, 2010. [Online]
Available at: http://en.wikipedia.org/wik/MilleniumDevelopmentGoals
[Accessed 20 July 2011].