Abstract

Many countries signed to the Millennium Development Goals (MDGs) which need to be achieved by 2015. These 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. The m-health used ubiquitous smartphones which the majority of people owned. This research accessed 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 health workers and patients in and around Bindura, in Mashonaland Central. Health workers collected data on malaria cases and sent them on a password protected website using internet enabled mobile 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 could also be used for user to user communication and users could receive news or learning material from the administrator. The administrator could also send SMSs to the users mobile phones. The mobile website was also tested for response time, availability and speed among other factors. The health workers and patients responses together with the metrics that were measured on the website led to a conclusion that a mobile 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.
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CHAPTER 1: INTRODUCTION

1.0 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). As for today, people are healthier, wealthier and live longer than 30 years ago (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. South Asia and Sub-Saharan Africa where health care coverage and health services remained significantly poor in many countries are still lagging behind in health delivery (SESRIC, 2011). Several challenges are known to be delaying the timely delivery of health services to people in developing countries worldwide. Sub-Saharan African nations are lagging behind in working towards the fulfilment of the health related Millennium development goals (PROJECT, Disease control priorities, 2007).

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. Mobile phone text messaging programmes have shown to be effective in the short and long term and successful projects have been conducted in USA, UK and New Zealand (PUJARI, 2011). M-health is a great mechanism to save significant funds in the health sector (MUJERA ET, Simbini T, 2009) says the availability of information to health professionals is highly regarded as a prerequisite for achieving health for all. He goes 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 further 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 ET, Simbini T, 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.

**M-health**

M-health according to (WORLD HEALTH ORGANIZATION, 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. M-health according to Royal Tropical Institute (2009) stands for the provision of health-related services using mobile communication technology.

**1.0.1 Background to the study**

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 P, Kaonga N,Batavia H, 2010) say 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. (MECHAEL P, Kaonga N,Batavia H, 2010) 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. Modern information and communication technologies (ICTs), such as the internet, are not yet commonly available in resource-poor settings. The mobile phone is a notable exception as it is the first ICT tool that has reached even remote areas in low- and middle-income countries (LMIC). Because other countries in the world, as poor as Zimbabwe, some with poor network infrastructure than Zimbabwe’s have tried and successfully implemented m-health in helping health services reach remote communities, there is much need for Zimbabwe as a country to see if it can or cannot implement an improved m-health service to our people in order for Zimbabwe to move with technology which is now being applied in health delivery.
1.0.2 Problem Identification
Zimbabwe, as a country is using e-health technology but has not done much in using m-health to reach its population to offer health services save for the McKesson Foundation which in 2010 started a research on sms based per second billing m-health. m-health projects as mentioned earlier have been done regionally in countries like South Africa, Mozambique, Rwanda, Uganda, Kenya, and Tanzania and also in Asia, Europe as well as America (BLYNN, E, 2009). Some researches have been done in combating diseases like Malaria, (KALLANDER, 2010) Sexually transmitted diseases (BLYNN, E, 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. In some health centres, a few nurses have been selected for training to use SMS for data transmission but the project is still at its infancy and there has not been much success. 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 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.

1.0.3 Statement of the problem
There is potential to bridge the gap that exists in the way health issues are disseminated from a sick person in a remote area to the health care givers and vice- versa. The purpose of the research is to determine the effectiveness of an integrated m-health system that uses both text messages and the web in monitoring, reporting and controlling malaria occurrences. Effectiveness will be measured in terms of whether m-health solutions will be available as and when required, ease of use by the users who are health workers and acceptance by intended beneficiaries who happen to be patients.

1.0.4 Aim
The aim of this research is to determine the effectiveness of m-health.
1.0.5 Objectives of the study
The objectives that have to be met at the end of the research study were:

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 assess the impact of implementing the system on a group of patients.

4. To measure the effectiveness of the system on health delivery.

1.0.6 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?

3) Will patients trust the m-health system as technology that can be used to help them in fighting whatever ailments that will be afflicting them?

1.0.7 Justification
The research on the effectiveness of m-health in malaria monitoring, reporting and control is worth carrying out due to several reasons. Some countries like Kenya, Burkina Faso and Zambia have tried some episurveyor software to use on mobile phones and it helped control Measles (BLYNN, E, 2009). Rwanda (Compendium of mhealth projects) implemented TRAC net in monitoring and controlling HIV/AIDS. In South Africa, Dokoza (MISHRA S AND SINGH IP, 2008), Cell-Life (Compendium of mhealth projects) was tried to monitor and control HIV/AIDS and it was successful. These are just a few examples of successful implementation of m-health but there is a vast array of areas where it has been successfully implemented. However, in all these software products that were used, it was either sms based only or web based only and where specific for the projects they were designed for but nothing concrete on a combined sms and web based platform (BLYNN, E, 2009). (Compendium of mhealth projects) also says nothing concrete has been done on a combined solution has been done so the author sees it is worth researching on the combined software in the Zimbabwean context. It is therefore worth researching on the effectiveness of m-health so that at the end of the day we may improve the health delivery in the monitoring and control of diseases so that by 2015 we will have made strides in meeting the Millennium Development Goals. Many people who travel long distances to seek medical care will have no need
to travel to get help especially in the valleys like Zambezi and Dande which can be affected by flooding in summer and other remote areas which have poor transport network. Therefore there is need to research on this because timely delivery of service is an important factor in health delivery.

1.0.8 Hypothesis
The following hypotheses were deduced from research questions:

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

   Null Hypothesis (H₀) : There is no significant difference in monitoring, reporting and controlling malaria by the introduction of an m-health system.

   Alternative Hypothesis (H₁) : 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 (H₀) : The health workers will not find the implemented m-health system useful to them.

   Alternative Hypothesis (H₁) : The health workers will find the implanted m-health system useful to them.

3. **Will patients trust the m-health system as technology that can be used to help them in fighting whatever ailments that will be afflicting them?**

   Null Hypothesis (H₀) : Patients will not trust the m-health system as a technology that can help them fight whatever ailments that will be afflicting them.

   Alternative Hypothesis (H₁) : Patients will trust the m-health system as a technology that can help them fight whatever ailments that will be afflicting them.

1.0.9 Scope of study
The research is going to be based on one disease, which is Malaria on a group of twenty (20) health workers and twenty (20) patients, and if it is successful, then it can be applied to other diseases because the approach to tackling a disease is more or less the same.
1.0.10 Definition of terms
Mobile Health according to (WORLD HEALTH ORGANIZATION, 2011) is an area of electronic health and it is the provision of health services and information via mobile technologies such as mobile phones and Personal Digital Assistants (PDAs).

1.0.11 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

1.0.12 Summary
This chapter is basically an introductory chapter, which spelt out the problem that brought about the need to research. The objectives of the research were laid out in this chapter and the main aim was to establish the effectiveness of m-health in malaria control. The remainder of this dissertation is organized as follows: Chapter 2 presents the Literature Review. Chapter 3 outlines the methodology used in the research. Chapter 4 presents results of this research and discusses the findings. Chapter 5 presents the summary, conclusions and recommendations.
CHAPTER 2: LITERATURE REVIEW

2.0 Introduction
This chapter is going to look at a wide range of literature from various authors who have researched in m-health. It is the author’s anticipation that through the analysis of the literature, there will be a clear justification of why this research is necessary. This part will look at four main areas of m-health and then major on the most relevant areas to this research.

2.1 Definitions

2.1.1 m health
According to (VW, Consulting, 2008) as cited by (KALLANDER, 2010), there is no widely agreed-to definition but the public health community came up with these working definitions:

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

- m-health: Using mobile communications such as PDAs and mobile phones for health services and information.

Closely analysing these definitions we can see that m-health is a subset of eHealth since it is an application of eHealth only with the use of mobile communication. This is further supported by (CONSULTING, Vital Wave, 2009) as cited by (CONSULTING, VW, 2011)) on m-health report for Ethiopia. Also according to the report, 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. The field of m-health is relatively young but has great potential and has had promising results and lessons from the pilot programs that have been conducted in a variety of geographic and health system settings. 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 (CONSULTING, VW, 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.
2.1.2 Intervention
According to (KAPLAN, W.A, 2006) intervention 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.

2.2 The need for electronic intervention
(SAPRA, Dr, 2011) in his paper titled “Keeping the Promise of Achieving MDGs– Reaching the Last Mile” 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.

(SAPRA, Dr, 2011) also said people often see a cell phone as a talking device but he sees it in many different ways as mentioned below –

1. As a substitute for transport – many things can be done over the phone that earlier required the use of transport e.g. cash transfers
2. As a personal advisor/ educator – with appropriate services, a cell phone can become a tool where people can get advice, information and guidance in total privacy and on demand.
3. As a digital bridge between those who have fibre optic and other cable based internet connections and those who don’t – so there wont be need to wait for the cables to reach before people have access to information and who know maybe the technology will advance in a way that no cables would be needed in the future in many of our African countries;
4. As key tools that can cut down delays between the times the information is acquired and acted upon. Significant investments have been made by countries in designing management information systems. Often they are data heavy and replicate the sequential process of moving data as was done with paper from one level to the next. As a result breakdowns are common and the system is only as strong as the weakest link. With cell phones the 4 or 5 bits of actionable and critical information can be sent to the server from where all the processing is done and feedback and aggregated data for action sent via SMS or USSD to all levels almost instantly. Drug stock outs, teacher and student absenteeism are some examples. Birth registration, registration of vulnerable children and households and direct cash transfers are some of the examples that illustrate the point.
5. The power of the cell phones in accountability, transparency and citizenship. An SMS can be sent to hundreds and thousands of pre-enrolled subscribers asking if the water point in their village is working or not, or if the teacher is there in the classroom or not, or if the health centre has a particular marker drug or not and getting instant feedback
that gives the picture of the whole country in a very short time and at a very low cost. By doing this you are making the community aware of their entitlement, engaging them in monitoring their entitlements and giving them feedback as to what action can they take to address the problem. The aggregated information can also be shared with local leadership at various levels and a national public discourse can be undertaken to act on the problem.

Ticia Gerber (2010) cites (GARRETT L, Chowdhury MR, Pablos-Mendez A, 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. These tools are being employed to reduce health disparities and improve patient care. The authors also cite (WHO, 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 ET, Simbini T, 2009) say 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 inexperienced 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. He also says that currently every district and provincial hospital in the country has a computer in the health information office mostly for health information reporting purposes. The author goes on to say there are no documented surveys in the country on the number of public and private health institutions with computer equipment at their sites. (MISHRA S AND SINGH IP, 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, Posy Bidwell, Steve Thomas, Laura Wyness, Duane Blaauw and Prudence Ditlopo, 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 is suffering from brain drain where qualified health personnel are migrating 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, Dr, 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 as supported by (DELLA, M.V, 1999). (FRASER HS, JAZAYERI D, BANNACH L, SZOLOVITS P AND MCGRATH D, 2001) then said using email or web communications allows staff to check advice from remote physicians. The same sentiments were also echoed by (HAMISH SF FRASER, PAUL BIONDIC, DESHEN MOOLEY, SHARON CHOI, BURKE W MAMLIN, PETER SZLOLOVITS, 2005) who quoted (FRASER HS, JAZAYERI D, BANNACH L, SZOLOVITS P AND MCGRATH D, 2001) on an article on implementing electronic medical record systems in developing countries. According to David Aylward, as cited by (KELLER. M, 2011), 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. To some extent m-health takes medical professionals out of the equation.

The problem noted by Aylward is that a lot of people are writing about medical applications, yet what should be written is about connecting the devices to a health system so that doctors can track and share information over time. So what is important is a health record system that is connected to the user and medical staff at control centres.

2.3 Why the mobile phone and not other devices?

(HEATHER COLE-LEWIS AND TRACE KERSHAW, 2010) cites (ROWLING.M, 2009) and (MISHRA S AND SINGH IP, 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 according to (ADLER.R, 2007) and (RAINIE.L, ANDERSON.J, 2009) and supported by (HORRIGAN.J, 2009). The (INTERNATIONAL TELECOMMUNICATION 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 have been achieved by 2015.

(MARK TOMLISON, WESLEY SOLOMON, YAGES SIGH, TANYA DOHERTY, MICKEY CHOPRA, PETRIDA IJUMBA, ALEXANDER C TSAI, DEBRA JACKSON, 2009) say 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. The authors quote several authors who say studies conducted in developed country settings have investigated the use of cell phones on the patient end to generate feedback for improved chronic illness care and monitoring, increased medication compliance and smoking cessation, or reduced missed clinic visits. The researchers also say, few studies have investigated the use of mobile phones as a data collection tool in low income countries and that, there are numerous anecdotal reports but few published studies exist quoting (Kinkade S, Verclas K:2008). With the rapid expansion of mobile technology all over the world, including in developing countries like ours, the issue of reduced costs in setting the network and maintaining it, speed and simplicity in resource constrained environments and also the low cost of short messages in most countries really makes the mobile phone most ideal to use in m-health (BLYNN, E, 2009).

The graph below adapted from (PUJARI, 2010), illustrates the growing potential of mobile phones which make them the tool for the moment.
As can be seen from the graph, Mobile phones have a high figure compared to computers and hospital beds and this shows that mobile phones’ availability can be used to bridge the health gaps that exist. (PUJARI, 2011) further says Mobile phones reach further into developing countries than other technology and health infrastructures. (MADHAVAN S, Sanders AE, Chou WS, Shuster A, Boone K, Dente MA, Shad AT Hesse BW, 2011) say while research to evaluate mobile interventions has been growing, there are relatively few studies of the use of mobile technology itself as a research instrument in developing countries. They also argue saying mobile data collection projects to capture outcomes are abundant, but there are far fewer large-scale and complex surveys using mobile phones. This shows the need to fully exploit mobile phones in support of what other researchers have postulated.

However, according to these researchers, the Guatemalan government in its research in 2008 faced challenges in effective management of its monitoring and evaluation system, including monitoring of conditional ties in health and education.
(LEWIS LC, KERSHAW T, 2010) also say m-health innovations have been developed that address an array of issues such as improving the convenience, speed, and accuracy of diagnostic tests; monitoring chronic conditions, medication adherence, appointment keeping, and medical test result delivery; and improving patient-provider communication, health information communication, remote diagnosis, data collection, disease and emergency tracking, and access to health records citing (ADLER.R, 2007) and (CONSULTING, VW, 2011). Examples include Project Masiluleke in South Africa that uses text messages to increase rates of testing for tuberculosis and HIV as well as to provide counselling. Another one is the CelloPhone Project that creates an optical imaging platform that allows body fluids to be analysed with a mobile phone.

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

In this work an application provider developed a Java applet for mobile phones together with a database for managing the health information. Health advisors, health workers and doctors as well as partners such as UNICEF and UNFPA were also able to access the system via an internet interface to monitor and predict birth complications situations and tracking health statistics in the populations served. The mobile use in this research aimed to facilitate access to time-sensitive information by midwives, improving information accessibility to midwives by connecting with senior staff, and facilitating sharing of information as well as tracking of data and health related information. This was limited to birth related health but was successfully implemented. It is therefore in the context of poor research infrastructure and of increasing demand for large scale health surveys, the affordability and availability of mobile phones and wireless networks that make them a viable alternative to traditional paper and pencil methods and even PDAs (TOMLISON M, SOLOMON W, SIGH Y, DOHERTY T, CHOPRA M, IJUMBA P, TSAI AC, JACKSON D, 2009).

### 2.4 History of m-health applications

improving health and health services: a systematic review protocol”, so far the currently documented m-health programmes include mobile phone text messages for supporting management of hypertension, asthma, diabetes, eating disorders and HIV treatment as quoted from (LEWIS LC, KERSHAW T, 2010), (FJEDSOE BS, MARSHALL AL, MILLER YD, 2009), aids to quitting smoking, body weight loss, reducing alcohol intake, STIs prevention and testing, PDAs for data collection in healthcare and to support health education and nursing practice. However, most of these programmes have been implemented in developed countries and the application of mobile technology in low income countries is still at its infancy as said by (BLAYA J, 2010) and (MECHAEL P, Kaonga N, Batavia H, 2010); (LOUDON, Melissa, 2009).

(CONSULTING, Vital Wave, 2009) as cited by (FREE C, GEMMA P, LOUISE W, LEANDRO G, LAMBERT F, PHIL E, VIKRAM P, ANDY H, 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. Mobile technologies have several advantages over other information and communication technologies which range from wireless communication capability which enables continuous communication from anywhere including the internet, small sizes for portability, rechargeable batteries to sufficient computing power to support multimedia applications and software (FREE C, GEMMA P, LOUISE W, LEANDRO G, LAMBERT F, PHIL E, VIKRAM P, ANDY H, 2010). The other advantage according to (BANKS, 2008) as cited by (LEWIS LC, KERSHAW T, 2010) is that even if the phone is turned off, messages will be delivered when the phone is turned on. The other advantage according to (FJEDSOE BS, MARSHALL AL, MILLER YD, 2009), (BANKS, 2008) and (ATUN RA, SITTAMPALAM SR, 2006) as cited by (LEWIS LC, KERSHAW T, 2010) is that text messaging is an m-health innovation for which utility remains even in resource-poor settings in which people may not have access to expensive technology.

According to (CONSULTING, Vital Wave, 2009) there are four main areas where m-health is being applied which are:

1. Health administration
2. Healthcare Delivery Systems
3. Health Information
4. Patient Care

(KALLANDER, 2010) in the inSCALE report identifies seven areas of m-health which are
1. Education or awareness
   These are basically one-way communication programs sent to mobile subscribers via SMS messaging in support of public health, behaviour change campaigns.

2. Data / health record access
   These are applications designed to use mobile phones, PDAs or even laptop computers to enter and view patient data. In some researches patients could also have access to their own records.

3. Monitoring / medication compliance / appointment
   These are one way or two way communication to the patient to monitor health conditions, maintain care giver appointments or just to ensure adherence to treatment. Some applications in this section can be used to admitted patients or to outpatients at their homes to monitor such things as sugar level or blood pressure.

4. Disease / emergency tracking / warning systems
   These involve applications using mobile devices to send and receive data of disease incidence, outbreaks and are often associated with GPS systems and backend applications for viewing.

5. Health administration systems
   These are applications that allow access by and or integration with m-health application and can even link regional or even global centres. They are mainly for administrative purposes.

6. Analysis, diagnosis, and consultation
   Applications are developed to provide support for diagnostic and treatment activities of remote care givers through internet access to medical information databases or to medical staff.

7. Other mApplications
   These are applications developed for mobile phones that can help health workers to perform better without necessarily requiring connectivity. E.g. applications to make a diagnosis or to aid in decision making.

Mobile health initiatives according to (WHO, 2011) are

1. Health call centres
2. Toll-free emergency
3. Emergencies
4. Mobile telemedicine
5. Appointment reminders
6. Community mobilisation
7. Treatment compliance
8. Patient records
According to this report, except for the African region, the use of mobile phones in emergencies was relatively high and there was need for more comparative research to better understand the most effective methods for data collection using mobile devices and the health benefits they generate. Comparing Kallander’s, World Health Organization and The Compendium of ICT Applications on Electronic Government classification, we see that the last two classifications fit into the first class and in this research, the researcher will consider the former classification as it summarises the later. This is in agreement with (FREE C, GEMMA P, LOUISE W, LEANDRO G, LAMBERT F, PHIL E, VIKRAM P, ANDY H, 2010) and also (Car, 2008) as cited by (VODOPIVEC-JAMSEK, DE JONGH T, GUROL-URGANCİ, ATUN R, CAR J, 2008).

2.5 Types of studies
This part briefly explains how some researches have been conducted. Most researches have used a control design to evaluate an implementation. There are randomised and non randomised treatment groups. Some have highlighted difficulties in assessing the impact of interventions that have been combined. Interventions can be delivered to a treatment group and a control group receives no intervention. Multi interventions are where a treatment group receives one or more interventions delivered through multiple ways, but no interventions through other modes and the control group receives no interventions. Mixed and non mixed interventions are where the treatment and control group both receive all non mobile components of the intervention and the mobile intervention is delivered only to the treatment group, for example SMS plus group counselling for quitting smoking in the treatment group and the control group receives group counselling only. (FREE C, GEMMA P, LOUISE W, LEANDRO G, LAMBERT F, PHIL E, VIKRAM P, ANDY H, 2010).

2.5.1 Health Administration
According to (GOVERNMENT, Compendium of ICT Applications on electronic, 2007) several researches were conducted and software products where developed and deployed but they are
mainly used by administrators mainly for billing purposes. This means that these researches just shade some light but are not really relevant to what we want to investigate.

### 2.5.2 Healthcare Delivery Systems

Several researches were conducted resulting in the development and deployment of software products. Today, health care has improved in several countries because of researches in healthcare delivery.

### 2.5.3 Patient Care

Also in this category several researches were conducted resulting in the development and deployment of software products. Today, health care has improved in several countries because of researches in healthcare delivery.

### 2.5.4 Health Information

Health information is also an important area in health that helps in decision making. Several researches have been made in this area resulting in widespread application both in the developed and developing countries.

### 2.5.5 Combined Health Information, Healthcare Delivery and Patient Care

The researcher sees it befitting to combine the functions of the three systems such that if one system is created with characteristics of the three, it can work well.

### 2.6 Work done by other researchers

(ŁAUGESEN, J., HASSANEIN, 2010) researched on a continuance model for a mobile/web based self management system for adolescent diabetes. This was based on loyalties. The researcher focused on controlling Juvenile Diabetes as it is known not to have cure. The researcher also noted that several researches have been done 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. This was developed combining the IS Model by Bhattacherjee (2001) with DeLone and McLean (2003)’s IS success model.

(NOORDAM, A. C., KUEPPER, B. M., STEKELENBURG, J. AND MILEN, A., 2011) noted that few projects actually exist with little evidence available to tell on 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. (MECHAIL P, Kaonga N, Batavia H, 2010) as cited by (NOORDAM, A. C., KUEPPER, B. M., STEKELENBURG, J. AND MILEN, A., 2011) saw great potential for m-health, the only problem noted being that there is no much evidence of actual and widespread impact yet. He also went on to say that most documentation referred to pilot studies that often lacked baseline data, a control group and clear outcome indicators. The research findings however were mainly based on grey literature which is sometimes unreliable. With the potential that was seen in the mobile phone the researcher recommended further researches in how mobile phones can benefit maternal health services taking into consideration privacy and confidentiality.

(BARCLAY, Eliza, 2009) as reported in the Lancet identified a mobile phone as a tool that can be used to fight tuberculosis. She noted the lengthy period of taking medication as well as the pain and agony involved as the reasons that people drop the medication mid way through or when they begin to feel better. She said connection between patients and caregivers using short massage services (sms) hold potential to help in improving adherence to taking the medication. Mario Raviglone, director of WHO’s Stop TB Department(2009) was quoted in the Lancet as having encouraged the use of anything, including smss to prevent patients from defaulting which poses a high chance of disease relapse.

Other groups are using SMS messaging in combination with economic incentives to improve treatment adherence. X out TB is an SMS-based system invented by a group of scientists and entrepreneurs with the Innovations for International Health project at the Massachusetts Institute of Technology, Cambridge, MA, USA.

(KAMANGA A, MOONO P, STRESMAN G, MHARAKURWA S, SHIF C, 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. Twelve rural health centres in the Choma and Namwala districts were recruited to send weekly information of rapid malaria tests and number of positive
diagnoses to the Malaria Institute at Macha using SMSs and data were entered in excel, expressed
as number of cases per rural health centre and distributed weekly to interested parties. Data from
each of the health centres were mapped using geographical positioning system coordinates to plot
the patterns of malaria case detection in the vicinity of each location. The seasonal patterns of
malaria transmission associated with local ecological conditions were seen in the distribution of
cases diagnosed. Adequate supplies of RDT were made available and malaria was controlled.

(KOLLMANN A,REIDEL M,KASTNER P,SCHREIER G,LUDVIK B, 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 using
Internet technology and comprised the following:

1. Patient terminal: At this terminal a mobile phone was used to record patient data, who
would have made self-measurements and then trigger data transmission to the control
centre, The control centre could then give feedback using text messages.
2. Monitoring centre: This was a 24-hour server which received, stored and processed data
sent to it. Security was considered in it to ensure security, integrity, and traceability of data.
The system had user control which means that only authorized users were able to view, edit,
or enter data.
3. Graphical data representations and reminder: This was an automated process that analysed
all incoming data in order to generate statistics, trends, and graphical representations of the
data. In response to the incoming data, reminder messages were generated and sent to
patients’ mobile phones using text messaging.
4. Web portal: Data were accessible by patients and health care professionals using a standard
Web browser.
The patients were given Nokia 7650 mobile phones loaded with Diab-Memory software application
pre-installed as well as a user manual. Using this mobile phone, the patients tracked their daily
blood glucose measurements and registered their recordings. In the events of patients taking less
than three successful data transmissions per day, an automatic reminder message was sent to the
patient’s phone via SMS. During the study, a help desk was established at the monitoring centre
and skilled personnel handled questions from users and were responsible for training. The study
period was three months and at its end, the patients were reviewed in the diabetes clinic and some
tests were made. Questionnaires were used to check patients’ satisfaction. The results from the pilot
study paved way for the need to improve the diabetes management system in relation to data
acquisition, automatic feedback and alerts and communication between patient and health care professional.

(DE TOLLY K, Alexander H, 2009) researched on the innovative use of cell phone technology for HIV/AIDS behaviour change communications in South Africa with 3 pilot surveys. (KAPLAN, W.A, 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 (CRISTIAN POP-ELECHES, HARSHA THIRUMURTHY, JAMES P. HABYARIMANA, JOSHUA G. ZIVIN, JESSICA HABERER, SYLVESTER KIMAIVO, JOHN SIDLE, DUNCAN NGARE AND DAVID T. BANGSBERG, 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.

Cell-Life initiated a research project titled “Cellphones4HIV” whose aim was to look at how mobile technology can be used in the prevention, treatment and care of HIV and AIDS, and to support the HIV sector in general. It uses SMS to send reminders and HIV related information such as side effects of some drugs and the importance of adherence. According to (CONSULTING, Vital Wave, 2009) cited by (DE TOLLY K, Alexander H, 2009), studies have shown that reminding people to take their medication can increase their adherence and that people with higher levels of health literacy adhere better to medication according to Kalichman et al (2008) as quoted by (DE TOLLY K, Alexander H, 2009). What was examined in the evaluation was whether the content and timing of the SMSs is helpful and also whether receiving them makes recipients feel like they belong to something.

(W, Curioso, 2009) says in Peru commercial sex workers were treated using mobile phones. Because visiting clinics for treatment of STIs is shameful, sex workers were visited and offered treatment which had several side effects ranging from headaches to abdominal pains. Collecting the side effects at first was paper based, then moved to computers which were prone to theft and then settled for mobile phones. They then became popular as a data collection tool and data was sent to a server, with no names collected to maintain confidentiality. If the database detected an adverse event, a text message and e-mail were generated and sent to a team leader who would then contact the field worker on the ground to help the patient. Health workers liked the technology because of
its user friendliness and ease of use. On the other hand, sex workers also liked it citing confidentiality of the process and sensitive treatment of their personal information.

(KAPLAN, W.A, 2006) said there is almost no literature on using mobile telephones as a healthcare intervention for HIV, TB, malaria, and chronic conditions in developing countries.

2.6.1 Implementation

Studies by (LEWIS LC, KERSHAW T, 2010) were on measuring the impact of text messaging interventions by assessing change in health behaviour, health outcomes and/or clinical outcomes using pre-/ post tests. 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.

(M, 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. The mobile phone based follow-up rates by malaria staff improved. Patients’ symptoms were captured onto the mobile phone during each follow-up visit, either during the home visit or at the Malaria clinic. The three main functions of the DTMM were case detection/registry, new case investigation, and case follow-up. The case detection/registry and investigation functions of the DTMM were adapted from the standard paper-based data collection of the infected patients. In the case-investigation form, details of case characteristics, type of malaria, and treatment, were collected. After a patient received medication, a follow-up schedule was generated and updated each time follow-up was performed. Once the data were entered into the module, each individual case, or list of registered or followed-up patients in the system, who had visited the Malaria clinic/who had been visited, could be examined by the responsible staff. The use of the DTMM allowed remote data transfer technology in both textual and geographic format. On a weekly basis, the system would generate short message service (SMS) with a summary of malaria cases, and automatically feed them to predetermined MC/VBDU personnel. A map of each scheduled visit was displayed by clicking on the visit schedule table and this helped to locate cases in the area, and was especially useful for identifying foreign cases in remote border areas. Maps of all cases covered by the health service areas could be seen at the MC, and also at the upper supervisory level. Summary statistics were generated to help malaria authorities make informed decisions and act accordingly. A substantial challenge was to expand and maintain the system nationwide and the system design needed adjustments to be more
modular and easily adapted for use outside Thailand. This points out that most systems are context specific and are not transferable, hence the need to develop a home–grown solution.

(LESTER RT, et-al, 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. A Random sample was collected at three clinics to receive either a structure weekly SMS slogan or received the current standard care support mechanisms as the control group. He cited Karanja (2008) who feels that structured mobile phones communication can substantially improve clinical management of HIV patients in resource- limited settings because, despite other economic factors that may hinder human development, cellular phones are in high use.

According to this author no previous Randomised Clinical Trials of cell phones for ART adherence have been made hence there is no systematic review available. The author proposed using the intention to treat analysis (ITT) to broadly assess the effect of the intervention on patient outcomes and sensitivity and subgroup analysis to assess the intervention effect more specifically. A random sample was selected to receive SMS and another to receive standard care without SMS. In a randomised trial in the United States, a structured telephone counselling intervention improved adherence to treatment according to Reynolds et al (2008) as cited by (LESTER RT, et-al, 2009) Vidrine et al(2006) as cited again by (LESTER RT, et-al, 2009). (KAMANGA A, MOONO P, STRESMAN G, MHarakurwa S, SHIF C, 2010) say a piloted SMS text reminder to improve adherence to ART among Los Angeles youths was accepted and showed early benefit on adherence and another one to help HIV patients to quit smoking in Texas was successful. However, the studies related to HIV control had several items to be measured including quality of life, social factors, and economic indicators other than just improving health, so the researches were broad and did not end up covering the primary goal to improve health.

2.6.2 Evaluation

(KAPLAN, W.A, 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.
Sample Test messages used in Turkey to help smokers quit

Examples of SMS Turkey Text Messages

Table 1 shows examples of SMS text messages. The actual messages are in Turkish and conform to the 160-character SMS limit.

Table 1: Sample Text Messages used in Turkey to help smokers quit

<table>
<thead>
<tr>
<th>Text Message type</th>
<th>Text Message examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-quit day</td>
<td>SMS TURKEY: Congratulations!! The hardest part – deciding to quit – is already behind you. Write down all of the reasons why you want to quit.</td>
</tr>
<tr>
<td></td>
<td>SMS TURKEY: People who quit smoking use coping strategies - things to do instead of smoke. Look 4 cues or triggers 4 your smoking. For each one, write down something U can do instead. e.g. if you're angry, try deep breathing.</td>
</tr>
<tr>
<td>Quit day + 1</td>
<td>SMS TURKEY: Congratulations - today is your special day!!! It is your first day without cigarettes. Your goal today is to keep yourself busy and without a cigarette. Think NOPE… Not One Puff Ever!</td>
</tr>
<tr>
<td></td>
<td>SMS TURKEY Treat every day like your quit day. Pretend like it is the first day without cigarettes and be prepared for temptation.</td>
</tr>
<tr>
<td>Early quit (4 days) intervention</td>
<td>SMS TURKEY: Remember… former smokers live longer than people who keep smoking. Fight the urge to smoke today for better health tomorrow.</td>
</tr>
<tr>
<td></td>
<td>SMS TURKEY: Keep taking your nicotine replacement therapy or smoking cessation medication unless you are having problems. This will help you to stay quit!</td>
</tr>
<tr>
<td></td>
<td>SMS TURKEY: Think about how much money you've saved since you quit. Put it toward a new hobby or activity.</td>
</tr>
<tr>
<td>Late quit (21 days, after completion of Early quit)</td>
<td>SMS TURKEY: Now that you don't smoke, you can go places you couldn't because of smoking restrictions. Try something new as a non-smoker.</td>
</tr>
</tbody>
</table>
|                                          | SMS TURKEY: Whether you smoke or not, life sometimes gets stressful. People who work on the problem instead of hide the problem (by smoking) feel better. What can you do to
Relapse (4 days for those not quit)

SMS TURKEY: A slip is a warning or a learning experience. Warning = you still need to protect yourself in your danger zones (i.e., when you’re most tempted to smoke).

SMS TURKEY: How did you feel just before you smoked? Recommit to complete quitting - cutting down isn't good enough for you!

SMS TURKEY: Smokers live an average of 7 -12 years less than non-smokers. Consider quitting again!

Encouragement for those no longer wanting to quit (3 days)

SMS TURKEY: Whatever you decide about smoking, believe in yourself. You CAN quit smoking if you put your mind to it and have a plan for success.

Source: National Institutes of health(2010)

(CHANGHONG YANG, JUN YANG, XIANGSHU LUO, PENG GONG, 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. Entered into the system included the name of patient, age, diagnosis, time and location. Except for names of patients, all data were input as numerical codes. Information on each case was then sent as an encrypted text message to the national database. It took approximately 2–3 minutes for a trained person to report a case. The reported data were analysed by China CDC and displayed on digital maps in real time. It was recommended that it will be more effective to incorporate the system as part of a regular emergency preparation programme as it helps especially if infrastructure like telephone lines is destroyed by natural or other forms of disaster. It was learned that some restrictions have to be applied to the use of phones. The calling function of the mobile phones had to be shut off after one month because some agencies were using the phones for other activities. Those agencies ran out of prepaid minutes, and disturbed the process as the airtime budget had been prepared basing on the estimated upper limit of the number of cases that would be reported. It was also noted that, whenever possible, mobile phones with global positioning system (GPS) capacity should be used as the reporting system can be programmed to attach coordinate data to each text message automatically.

(NOORDAM, A. C., KUEPPER, B. M., STEKELENBURG, J. AND MILEN, A., 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 A, Arumugam K, Rodrigues R, Rajagopalan N, Shubha K, Raj T, D’souza G, De Costa A, 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.

Despite some potential of m-health noted by some researchers, others think the use of mobile phones SMSs cannot replace face to face health monitoring. (BARCLAY, Eliza, 2009) in her work on use of mobile phones to fight tuberculosis cited Partners in Health (PIH), of Boston, USA as having developed one of the most effective programmes for tuberculosis treatment using community health workers. Every day, the workers visited patients in their homes to supervise treatment. PIH also developed Directly Observed Treatment Short Course (DOTS) Plus, a type of treatment for treating multidrug-resistant tuberculosis, where patients received daily nutritional support as a supplement and incentive for treatment.

(LUND S, 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. The research was conducted using mobile phone to link pregnant women and their newborns to the health system, using text reminders for healthcare appointments and education as well as person to person communication between clients and health care providers. Below is a structure of the communication model used in the research.

2.5.3 Intervention

Intervention has been defined earlier and Figure 2 below illustrates the intervention used by Lund and was mainly based on text messages.
Figure 2: Intervention used in Zanzibar on a research project to improve maternal health

Adapted from Use of mobile phones to improve maternal and neonatal health in Zanzibar, (LUND S, 2010)

Figure 3 below is an SMS architecture that was used in a research on mlearning in Malaysia. Some concepts can be borrowed for use in m-health.

**SMS System Architecture**

![SMS System Architecture Diagram]

**Figure 3**: SMS architecture used in a mlearning research in Malaysia
Adapted from Nurhizam Safie (2004)

SIMPill was implemented in South Africa in 2008 to remind TB patients to take their medication which had a SIM card on the bottle top that sent an SMS every time the bottle was opened. If the report was not sent at the expected time, a message would be sent to you, your friend or your caregiver. If the bottle was opened at odd time a warning message would be sent again reminding a person when to correctly take the drugs. Its problem was that it was associated with TB and HIV/AIDS and hence stigmatised people. The other problem was of it being web-based meaning that the computer storing adherence information needed to be on the internet which is unreliable, expensive or absent altogether in developing nations. The SIMPill program was built on proprietary software meaning the code is closed and at times expensive. The cards needed importation (BLYNN, E, 2009).

2.6.4 Information dissemination

Projects for health information dissemination like Project Masiluleke and Text-to-Change were successfully conducted in South Africa with the main factor behind the success as the simplicity of the project. It was noted that it took advantage of the already widespread use of messages instead of introducing new technology to the local community. With this project, calls to South Africa’s National AIDS helpline quadrupled in five months. (BLYNN, E, 2009).

Diagnostic treatment is not to be looked as it is beyond the scope of the research.

In group discussion, it was mentioned that the South African pilot occurred in an urban area that was not a particularly low-resource setting. Phones were provided to a concentrated group of nurses to better influence their practice. Some of the pilot limitations were the minimal amount of phones and participants in the study. (CHANGHONG YANG, JUN YANG, XIANGSHU LUO, PENG GONG, 2009)

2.5.5 Recommended Architecture

Figure 4 below gives a possible explanation of the current problems as well as the interventions that can be employed.
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.

2.6.6 Designing a solution
(LOUDON, Melissa, 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. She also says the points to consider include:

- Knowledge of the data to be collected
- How the solution will best fit with the work flow of data capturers
- How the data will be analysed
- How the data collection process will be managed

(LOUDON, Melissa, 2009) also identifies three components that should be considered in the design and how they are expected to relate. These are the data collection client interface, the data transfer method and the server-side components to receive and store the data. Figure 5 below illustrates the data collection process and players involved.
Figure 5: Data collection process and players involved

Source: (LOUDON, Melissa, 2009)

Some guidelines also in designing m-health interventions as agreed at the Green tree conference in 2010, commonly known as the Green tree Principles are:

Health centric: The design should be people-oriented, meaning that the technology is designed to meet the health needs of people, rather than making health needs fit the technology.

Field-based systems: The system should be non-theoretical and based on field evidence.

Collaborative and parallel processes: The architecture should encourage transparency, local control and open competition.

Sustainability: The system should be supported by adequate resources to ensure scalability and sustainability.

2.6.6.1 Why GPRS and not SMS only
The major reasons as cited by (LOUDON, Melissa, 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. As a result it is important that we explore the GPRS as we want detailed information to be captured and relayed at a lower cost.
2.7 Chapter Summary

This chapter looked at the definitions of the most commonly used terms in the research and also the need for electronic intervention. The history of m-health applications was also explored together with work done by other researchers. All these studies opened up the research gap that this researcher wishes to fill in the Zimbabwean context.

Basing on the literature read, the researcher now develops a system bridging the gaps identified in the literature of not having a combined web based and SMS platform.
CHAPTER 3 : RESEARCH DESIGN AND METHODOLOGY

3.0 Introduction
In this chapter we will give a detailed description of how this research was carried out. It is meant to discuss the research design and the various approaches that were employed in this research study. This chapter will also explain how the data collection was done in order to meet the overall objectives of the research study. We are going to explain the sampling techniques used, the types of data and the sample size. The research involves experiments meant to provide answer the research questions and also to fulfil the aim and objectives of the research.

3.1 Research Design
3.1.1 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, intended beneficiaries, i.e. patients and system evaluators. Therefore, the test was scientific and it is a fact that science is all about performing real experiments rather than basing on literature. The researcher combined some quantitative and qualitative components in the experiment, each covering a section that the other could not. Experimental design was considered advantageous because the researcher is a scientist and has results from almost similar experiments that were performed in other parts of the globe and hence sees a greater chance of success if implemented in the Zimbabwean context with the problem at hand.

3.1.1.1 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 of size twenty(20) although it could be larger but it was just that some of the participants where student nurses from Bindura University while some where stationed at their centres in Bindura, Shamva and Mt Darwin. The selection of these groups was based on the researcher’s familiarity with the places and personnel in charge of the centres as the proper process of going via the Provincial Medical Directorate required a lot of paperwork and clearance which consumed a lot of time that the researcher did not have. The control group 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 examined 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. The researcher learnt that some health workers had gone for training to use SMS as a reporting tool but this was not being fully used so the researcher concentrated on the traditional tally sheets. Users were assigned usernames and password to access the platform and use the site. The users could log on to the system using internet enabled mobile phone.

### 3.1.1.2 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. The researcher supplied nine Samsung E250 phones, five had Nokia X2 phones, three had SonyErricson Z550i and three had Nokia C2 phones. 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 and comparisons of means was used to test the effectiveness of mhealth 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. The control group gave us light on whether using mobile phones can contribute in the improvement health delivery.

The research process had to answer the following, among other questions:

1. What data is to be collected?
There had to be analysis of the current data collection and reporting to see if redundant data was being collected or if there was any important information missing. A paper based form was created representing the new data sets and circulated among stakeholders for correction and adoption into the mobile application.

2. How will the system fit best with the work flow of data capturers?
For speedy work, safety of the mobile device, at times unavailability of network and convenience for care seeking patients, the health workers had to capture the data on a card first so that they didn’t delay serving patients. After attending a patient, health workers then completed the web based forms and sent them for analysis. This also reduced pressure on the health worker which may result in errors if data capturing is hurriedly done. In-order not to disturb their normal flow of work, the implemented system was used concurrently with the traditional way by fourteen participants while other six where students on study leave.

3. How will the data be analysed?
Since the system administrator is the one who may be so knowledgeable with statistical packages while other decision makers at the central coordinating office were assumed not to be so much into statistics, the data had to be exported to Microsoft Excel, which almost everyone is familiar with. After analysis, if there is any action needed, the responsible persons could promptly respond so that the health workers on the ground may have faith in the system.

4. How will the data collection process be managed?
There had to be close monitoring and management of all processes for this research to be a success. Training, provision of mobile phones and airtime was managed by the researcher to see to it that things go according to plan. The main thrust of the research was on time savings and speed of transmission, accuracy of data, and convenience of health workers in matters relating to training and communication.

3.1.1.3 Data transfer method
Once data was 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.

3.2 Reporting Tools

3.2.1 Programming Language

After an exhaustive analysis of existing SMS based reporting tools, 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 Figure 6 shows the Ozeki structure and requirements.

![Figure 6: Requirements for using Ozeki NG SMS software](image)

**Why Ozeki?**

Combining a website with Ozeki NG SMS Gateway brought about the ability to gain information in time. It offers the ability to forward important calendar entries, urgent reminders or even received e-mail messages as an SMS message. This can save time and money as one will always be up-to-date, prepared and well-informed. It is also possible to send one message to more than one mobile phone and to e-mail addresses at the very same time removing the need to send a message twice or more if there are many recipients. With this solution one will always be available. Figure 7 below shows the context diagram for the proposed architecture.
Figure 7: Context diagram for the proposed architecture

3.2.2 Design Structure

Figure 8 below illustrates the flow of data at the front-end and the backend

User (Front end)

- Access the website via mobile phone
- View notifications and news
- Login to access forms for data entry, write/read messages and order stocks
- Use sms facility on the phone for referrals and other functions

Administrator (Back end)

- Access the website on the computer
- Login and get to the administrator platform
- Analyses sent data, posts news notifications and training material, take appropriate action as when required.
The development of the website is in line with Lyndon Cerejo’s suggestions on his work titled a User-centred approach for web design for mobile devices on the Smashing Magazine of May 2\textsuperscript{nd}, 2011 which is shown as in Figure 9 below.

**Figure 8 : Design structure of front end(user side) and backend(administrator side)**

**Figure 9: User-centred approach for web design for mobile devices :source Cerejo (2011).**

**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 installed on the website so that the website 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.

The Main page where everyone who logs on to the site first sees is shown in Figure 10 below. As you can see, users have to log in to gain entry to the functional parts. The menu bar has Home only, where one can get general news that any viewer can see.

The screen shot below shows what happens when one tries to go to any menu other than the home without logging in.

![Home menu bar](image)

**Figure 10: Research website homepage**

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. Messages get to them through the SMS gateway as we will see in Figure 11 below.
Figure 11: Inbox and the whole menu displayed

Data Entry

The screen shot below shows the main data entry form.

![Data Entry Form](image)

**Figure 12: 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 either print hardcopies, view on the computer or even use his/her mobile phone for viewing.

**Database Design**

The database to be used was MySQL which was working with PHP in Wampserver. The database was to be viewed by the administrator and anyone who has the administrative rights. The users would not be able to view sent data for security purposes. Extraction of data involved queries which could either by Example or by Form.

**3.2.3 Research Tools**

Global Standard for Mobile (GSM) phones was evaluated in terms of paperless Upstream Communication mechanism. The data acquisition software applications was based on a menu driven Wireless Access Protocol (WAP) application and SMS facility.

**3.3 Research Questions**

The research design was in such a way that it has to address the following questions which are on Chapter 1. Without answering the following questions, the research would be meaningless.

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

   The research question scrutinised the application of mhealth technology on the changes in data collection, speed of processing data, decision time and feedback to health workers from the responsible higher offices to determine whether there was an advantage or disadvantage to Malaria patients when compared to a scenario where traditional reporting is made. The traditional system was to be observed and followed for some time prior to the implementation. Below is a summary of activities involved in the paper based data collection and reporting.

   1. A patient visits a clinic and gives a medical complaint.
   2. Health workers record the complaints on the patient’s card and also write the diagnosis.
   3. He/she then completes an Occurrence Book and a Tally Sheet that will be on the desk recording the disease in its corresponding section.
   4. The patient is then offered treatment if it is available and if it is unavailable or the situation is serious, the patient is referred to the district hospital and it is written on that card.
   5. If medicines are available, treatment is administered to a patient.
6. At the end of the month, (the health month ends on the 26th of every month) the Information Officer based at the district hospital visits all health centres in the district to collect information recorded on the Tally sheets and Occurrence books. The 27th of every month denotes the beginning of a new hospital month. After collection, the tally sheets are then taken to the Provincial Medical Directorate Office in Bindura where they are analysed to give total numbers of a disease, say Malaria cases per that month per district, per centre. The analysis at the PMD offices is the one that is going to result in conclusions on the prevalence of disease and figures are forwarded to the National Office for action. As can be seen, it can take more than a month for information to reach the provincial office and takes about a week for the district office to know that a clinic needs some drugs. This is because there is one Information officer who has to visit all clinics in the district to collect data and at that time, if there is an outbreak, lives can be lost before action is taken.

A comparison of variables like time was to be made on the district office staff and administrators to see if there was a significant change in the flow of information with the introduction of mhealth technology. Frequency of reporting was also to be used although it has its disadvantages. Incidences of error will also be recorded and analysed to test on convenience or inconvenience brought about by mhealth.

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%: $(1 - .9999) \times 525,600 = \text{allowable minutes down per year.}$

**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 supplied to health workers who later evaluated the system. 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 were also noted. Table 2 below shows the data collection and analysis techniques used to answer the question.

**Table 2 : Data collection and analysis for health workers**

<table>
<thead>
<tr>
<th>Question</th>
<th>Data Collection</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Will health workers find the implemented system useful to them?</td>
<td>Pre-implementation views</td>
<td>t-test</td>
</tr>
<tr>
<td></td>
<td>Post-implementation views</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Latency</td>
<td></td>
</tr>
</tbody>
</table>

3) **Will patients trust the m-health system as technology that can be used to help them in fighting whatever ailments that will be afflicting them?**

The intended beneficiaries of the research are patients, since our aim is to improve health delivery and work towards achieving the millennium development goals of 2015. They would filled in questionnaires that were later be analysed for results. A comparison was also be done on the patients’ views relating the intervention in terms of convenience to them. A table below shows the data collection and analysis.

**Table 3 : Data collection and analysis for patients**

<table>
<thead>
<tr>
<th>Question</th>
<th>Data Collection</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Will patients trust the m-health system as technology that can be used to help them in fighting whatever ailments that will be afflicting them?</td>
<td>Pre-implementation views</td>
<td>t-test</td>
</tr>
<tr>
<td></td>
<td>Post-implementation views</td>
<td></td>
</tr>
</tbody>
</table>

**3.4 Analysis**

Data collected was 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. Figure 12 below illustrates the proposed structure.
3.5 Chapter Summary

The research was successfully undertaken and everything went according to plan with both groups of respondents playing their part. Data was collected which will be analysed in the next chapter. The successful design and then implementation made it possible for results to be collected which are in the next chapter.
CHAPTER 4 : RESULTS AND FINDINGS

4.0 Introduction
After successfully implementing the system and collecting data there is need to analyse the data collected in order to derive meaningful conclusion. This chapter is going to examine the results obtained from the research and try to present them in a more meaning way. Various forms of data presentation will be done in this chapter.

4.1 Analysis of Health workers and patients reports.
A sample of 19 Health workers and 20 patients was used in the research for data collection. This group also had the control group mainly because it was not possible to have a group that would leave its day to day activity to be dedicated to the research. Health workers were supposed to be 20 but one respondent did not return the questionnaire.

The reliability of the tool with the set of five dependent variables making up the questionnaire was measured using Cronobach’s alpha at 0.820 and showed that four variables had Alpha closer to or greater than 0.5 showing that most of the variables were reliable. These are depicted in the table below.

Table 4 : Reliability Analysis of Health Workers Questionnaire

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Reliability Analysis Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior Internet and SMS Knowledge</td>
<td>0.346</td>
</tr>
<tr>
<td>Responses towards traditional data collection and reporting</td>
<td>0.725</td>
</tr>
<tr>
<td>Responses after experiences with m-health platform</td>
<td>0.571</td>
</tr>
<tr>
<td>Advantages and recommendations</td>
<td>0.506</td>
</tr>
<tr>
<td>Challenges of m-health</td>
<td>0.597</td>
</tr>
</tbody>
</table>

Patients questionnaire’s reliability was also tested and questions were grouped into variables as shown in table 5.

Table 5 : Reliability analysis of Patients Questionnaire

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Reliability Analysis Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient history of treatment at health centres</td>
<td>0.563</td>
</tr>
<tr>
<td>Patients relatives treatment history</td>
<td>0.677</td>
</tr>
</tbody>
</table>
As can be seen from Table 5, the lowest response was 0.563 with the highest 0.677 which shows that the questionnaire was reliable as the values are greater than 0.5.

The research tried to answer the following research questions using the following hypotheses:

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

Null Hypothesis (H0): There is no significant difference in monitoring and controlling diseases by the introduction of an m-health system.

Alternative Hypothesis (H1): There is a significant difference in monitoring and controlling diseases by the introduction of an m-health system.

Tables below show the health workers perception towards the current reporting method.
Table 6: Frequency Table of the responses to question “Tally Sheets are efficient”

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Disagree</td>
<td>9</td>
<td>47.4</td>
</tr>
<tr>
<td>Somewhat Disagree</td>
<td>9</td>
<td>47.4</td>
</tr>
<tr>
<td>Unsure</td>
<td>1</td>
<td>5.3</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 7 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 7: Responses on where to implement m-health

<table>
<thead>
<tr>
<th>Sex</th>
<th>Mean</th>
<th>N</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>2.71</td>
<td>7</td>
<td>.488</td>
</tr>
<tr>
<td>Female</td>
<td>3.00</td>
<td>12</td>
<td>.000</td>
</tr>
<tr>
<td>Total</td>
<td>2.69</td>
<td>18</td>
<td>.315</td>
</tr>
</tbody>
</table>

The following graph shows responses on where to implement m-health.

Figure 14: Graph of where to implement m-health
From the axes of the graph, a 3 means Countrywide, a 2 for Towns and a 1 for Rural Areas. The graph shows the majority of females on a 3, males a 2.7 and an average of 2.89 which indicate countrywide acceptance.

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

Table 8 below shows analysis of health workers means of responses towards the traditional data collection and reporting by years of experience.
Table 8 : Analysis by Years of experience

<table>
<thead>
<tr>
<th>Years Of Experience</th>
<th>Traditional Reporting Fast</th>
<th>Less than a day to send a traditional report</th>
<th>Less than a day to get traditional response</th>
<th>Need to replace traditional reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;2-3Years&quot; Mean</td>
<td>1.33</td>
<td>1.33</td>
<td>1.50</td>
<td>2.00</td>
</tr>
<tr>
<td>N</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>.516</td>
<td>.516</td>
<td>.548</td>
<td>.000</td>
</tr>
<tr>
<td>&quot;4-5Years&quot; Mean</td>
<td>1.22</td>
<td>1.33</td>
<td>1.33</td>
<td>1.89</td>
</tr>
<tr>
<td>N</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>.441</td>
<td>.500</td>
<td>.500</td>
<td>.333</td>
</tr>
<tr>
<td>&quot;5-10Years&quot; Mean</td>
<td>2.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.67</td>
</tr>
<tr>
<td>N</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.577</td>
</tr>
<tr>
<td>}&gt;10Years Mean</td>
<td>2.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>N</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.577</td>
</tr>
<tr>
<td>Total</td>
<td>Mean</td>
<td>1.42</td>
<td>1.26</td>
<td>1.32</td>
</tr>
<tr>
<td>N</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>.507</td>
<td>.452</td>
<td>.478</td>
<td>.375</td>
</tr>
</tbody>
</table>

Table 8 uses the Likert scale which is as follows:

1 = Strongly Disagree
2 = Disagree Somewhat
3 = Unsure
4 = Agree somewhat
5 = Strongly agree

The need to replace traditional way uses the 1 = No and 2 = Yes scale.
From the table, responses came from almost all years groups. The means on all responses ranged from 1 to 2 which shows a disagreement with the statements that traditional reporting is fast, it takes less than a day to send a request and it takes less than a day to get response. On the need to replace traditional way the means of responses were closer to 2 which is a yes. This is shown on tables below:

Table 9 : Cross tabulation of Years of experience with Traditional way is fast

<table>
<thead>
<tr>
<th>Years OfExperience</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Somewhat</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;2-3Years&quot;</td>
<td>4</td>
<td>2</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>&quot;4-5Years&quot;</td>
<td>7</td>
<td>2</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>&quot;5-10Years&quot;</td>
<td>0</td>
<td>3</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>&quot;&gt;10Years&quot;</td>
<td>0</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>8</td>
<td></td>
<td>19</td>
</tr>
</tbody>
</table>

On period of reporting, the exception was the < 1 Year group but the overall mean was 1.26 which is a No. This is as shown below.

Table 10 : Cross tabulation of years of experience with less than a day to send a report

<table>
<thead>
<tr>
<th>Years OfExperience</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Somewhat</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;2-3Years&quot;</td>
<td>4</td>
<td>2</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>&quot;4-5Years&quot;</td>
<td>6</td>
<td>3</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>&quot;5-10Years&quot;</td>
<td>3</td>
<td>0</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>&quot;&gt;10Years&quot;</td>
<td>1</td>
<td>0</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>14</td>
<td>5</td>
<td></td>
<td>19</td>
</tr>
</tbody>
</table>

The need to replace traditional data collection and reporting is as shown on table 11.
Table 11: Cross tabulation of need to replace traditional way with years of experience

<table>
<thead>
<tr>
<th>Years Of Experience</th>
<th>No</th>
<th>Yes</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;2-3Years&quot;</td>
<td>0</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>&quot;4-5Years&quot;</td>
<td>1</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>&quot;5-10Years&quot;</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>&quot;&gt;10Years&quot;</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>16</td>
<td>19</td>
</tr>
</tbody>
</table>

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

Table 12 shows means on health workers responses to the m-health platform by sex.

Table 12: Means to responses on mhealth platform use by sex

<table>
<thead>
<tr>
<th>Sex Of Respondent</th>
<th>Non-Exper</th>
<th>Experience</th>
<th>Malignant</th>
<th>Malnutrition</th>
<th>DataGathering</th>
<th>Study in progress</th>
<th>Phone compatibility</th>
<th>In-Hospital changes</th>
<th>Period taken to send in</th>
<th>What reporting do you prefer</th>
<th>Where can m-health be implemented</th>
<th>Who you think will improve in drug acquisition</th>
<th>Always available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>4.14</td>
<td>3.71</td>
<td>3.88</td>
<td>4.18</td>
<td>4.00</td>
<td>2.49</td>
<td>2.84</td>
<td>1.67</td>
<td>2.96</td>
<td>2.71</td>
<td>1.88</td>
<td>3.00</td>
<td>3.00</td>
</tr>
<tr>
<td>N</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Female</td>
<td>3.70</td>
<td>4.96</td>
<td>3.75</td>
<td>4.76</td>
<td>3.67</td>
<td>2.95</td>
<td>3.77</td>
<td>2.06</td>
<td>2.75</td>
<td>2.60</td>
<td>1.62</td>
<td>2.07</td>
<td>2.07</td>
</tr>
<tr>
<td>N</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>4.46</td>
<td>3.95</td>
<td>3.75</td>
<td>4.53</td>
<td>3.79</td>
<td>2.95</td>
<td>3.77</td>
<td>2.06</td>
<td>2.75</td>
<td>2.60</td>
<td>1.62</td>
<td>2.07</td>
<td>2.07</td>
</tr>
<tr>
<td>N</td>
<td>19</td>
<td>19</td>
<td>18</td>
<td>19</td>
<td>19</td>
<td>18</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>All weeks</td>
<td>4.68</td>
<td>3.95</td>
<td>3.75</td>
<td>4.53</td>
<td>3.79</td>
<td>2.95</td>
<td>3.77</td>
<td>2.06</td>
<td>2.75</td>
<td>2.60</td>
<td>1.62</td>
<td>2.07</td>
<td>2.07</td>
</tr>
<tr>
<td>N</td>
<td>19</td>
<td>19</td>
<td>18</td>
<td>19</td>
<td>19</td>
<td>18</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>19</td>
</tr>
</tbody>
</table>

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 on the Likert Scale.

Table 13 shows means on the responses by health workers based on years of experience.
Table 13: Means on responses on mhealth platform by years of experience

<table>
<thead>
<tr>
<th>Years of Experience</th>
<th>Platform is easy to use</th>
<th>Ease of use</th>
<th>Navigation and data entry easy</th>
<th>Data sending easy</th>
<th>System is reliable</th>
<th>Phone compatibility</th>
<th>Network is a challenge</th>
<th>Period to send a request</th>
<th>Preferred reporting</th>
<th>Where can mhealth be implemented</th>
<th>Will drug acquisition improve</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥5 (N=38)</td>
<td>5.17</td>
<td>4.02</td>
<td>4.17</td>
<td>4.12</td>
<td>3.55</td>
<td>2.56</td>
<td>3.79</td>
<td>3.79</td>
<td>3.79</td>
<td>3.79</td>
<td>2.79</td>
</tr>
<tr>
<td>&lt;5 (N=52)</td>
<td>4.17</td>
<td>4.02</td>
<td>4.17</td>
<td>4.12</td>
<td>3.55</td>
<td>2.56</td>
<td>3.79</td>
<td>3.79</td>
<td>3.79</td>
<td>3.79</td>
<td>2.79</td>
</tr>
</tbody>
</table>

Table 14 below shows health workers responses to the m-health platform by smartphone ownership.

Table 14: Means of responses on mhealth platform by smartphone ownership

<table>
<thead>
<tr>
<th>Smartphone ownership</th>
<th>Ease of access</th>
<th>Always available</th>
<th>Ease of use</th>
<th>Navigation and data entry easy</th>
<th>Data sending easy</th>
<th>System is reliable</th>
<th>Phone compatibility</th>
<th>Network is a challenge</th>
<th>Period to send a request</th>
<th>Preferred reporting</th>
<th>Where to implement m-health</th>
<th>Will drug acquisition improve</th>
</tr>
</thead>
<tbody>
<tr>
<td>No (N=5)</td>
<td>4.20</td>
<td>3.40</td>
<td>4.20</td>
<td>4.20</td>
<td>5.00</td>
<td>3.60</td>
<td>2.20</td>
<td>3.40</td>
<td>3.00</td>
<td>2.40</td>
<td>3.00</td>
<td>2.00</td>
</tr>
<tr>
<td>Yes (N=5)</td>
<td>4.14</td>
<td>3.64</td>
<td>3.88</td>
<td>3.64</td>
<td>4.36</td>
<td>3.85</td>
<td>2.21</td>
<td>3.93</td>
<td>3.56</td>
<td>2.93</td>
<td>2.86</td>
<td>1.89</td>
</tr>
<tr>
<td>Mean</td>
<td>4.16</td>
<td>3.58</td>
<td>3.95</td>
<td>3.79</td>
<td>4.53</td>
<td>3.79</td>
<td>2.21</td>
<td>3.79</td>
<td>2.26</td>
<td>2.79</td>
<td>2.89</td>
<td>1.89</td>
</tr>
</tbody>
</table>

The table above gives means of responses by those who had smartphones and those who did not have smartphones. Some who previously owned smartphones used the ones supplied by the researcher for the data collection whilst others used their own.

Table 15 below shows means on health workers responses by prior internet knowledge.

Table 15: Means on response on mhealth platform by prior internet knowledge

<table>
<thead>
<tr>
<th>Ever used internet before</th>
<th>Ease of access</th>
<th>Always available</th>
<th>Ease of use</th>
<th>Navigation and data entry easy</th>
<th>Data sending easy</th>
<th>System is reliable</th>
<th>Phone compatibility</th>
<th>Is network a challenge</th>
<th>Period to send a request</th>
<th>Preferred reporting</th>
<th>Where can mhealth be implemented</th>
<th>Will drug acquisition improve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disagree</td>
<td>4.00</td>
<td>3.00</td>
<td>3.50</td>
<td>3.00</td>
<td>4.50</td>
<td>3.00</td>
<td>3.50</td>
<td>1.00</td>
<td>3.00</td>
<td>2.67</td>
<td>3.00</td>
<td>1.50</td>
</tr>
<tr>
<td>Somewhat agree</td>
<td>4.33</td>
<td>3.67</td>
<td>4.33</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>2.21</td>
<td>1.36</td>
<td>2.79</td>
<td>2.86</td>
<td>1.93</td>
<td></td>
</tr>
<tr>
<td>Strongly agree</td>
<td>4.14</td>
<td>3.64</td>
<td>3.93</td>
<td>3.88</td>
<td>4.43</td>
<td>3.80</td>
<td>2.43</td>
<td>1.36</td>
<td>2.79</td>
<td>2.86</td>
<td>1.93</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4.16</td>
<td>3.58</td>
<td>3.95</td>
<td>3.79</td>
<td>4.93</td>
<td>3.79</td>
<td>2.21</td>
<td>1.26</td>
<td>2.79</td>
<td>2.89</td>
<td>1.89</td>
<td></td>
</tr>
</tbody>
</table>

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.

Table 16 shows means on responses by previous SMS usage

**Table 16: Means on responses on mhealth platform by previous SMS usage**

<table>
<thead>
<tr>
<th></th>
<th>Degree Observe</th>
<th>Always Available</th>
<th>Ease of Use</th>
<th>Navigation &amp; Data Entry Easy</th>
<th>Data Sending Easy</th>
<th>System is Reliable</th>
<th>Phone Compatibility</th>
<th>Is Network a Challenge</th>
<th>Period to Send a Request</th>
<th>Preferred Reporting</th>
<th>Where can m-health be implemented</th>
<th>Will Drug Acquisition Improve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree</td>
<td>3.00</td>
<td>4.00</td>
<td>4.00</td>
<td>5.00</td>
<td>3.00</td>
<td>3.00</td>
<td>2.00</td>
<td>2.00</td>
<td>1.00</td>
<td>3.00</td>
<td>3.00</td>
<td>2.00</td>
</tr>
<tr>
<td>Usable</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>3.00</td>
<td>3.00</td>
<td>2.00</td>
<td>4.00</td>
<td>1.00</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
</tr>
<tr>
<td>Strongly</td>
<td>4.24</td>
<td>3.50</td>
<td>3.04</td>
<td>3.71</td>
<td>4.50</td>
<td>3.94</td>
<td>3.04</td>
<td>1.18</td>
<td>2.82</td>
<td>2.04</td>
<td>1.94</td>
<td>1.89</td>
</tr>
<tr>
<td>Mean</td>
<td>4.16</td>
<td>3.58</td>
<td>3.95</td>
<td>3.79</td>
<td>4.53</td>
<td>3.79</td>
<td>2.21</td>
<td>2.79</td>
<td>2.89</td>
<td>2.89</td>
<td>1.89</td>
<td></td>
</tr>
</tbody>
</table>

Looking at the independent variables which are previous SMS usage, prior internet knowledge, smartphone ownership, phone internet knowledge, years of experience and job title the total means under each variable are generally the same which shows that the responses are independent of any of the variables. This shows that health workers found the implemented m-health platform helpful as a tool that can significantly improve data collection and reporting.

**4.1.1.2 Patients cross tabulation by sex**

Table 17 below shows patients views towards the m-health platform by sex.

**Table 17: Patients responses based on sex**

<table>
<thead>
<tr>
<th>sex of respondents</th>
<th>Count</th>
<th>Strongly Agree</th>
<th>Disagree</th>
<th>Somewhat</th>
<th>Unsure</th>
<th>Agree</th>
<th>Somewhat</th>
<th>Strongly Agree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>male</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>female</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>total</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

Table 18 shows an independent samples t-test on the sex of respondents.
Table 18: Independent samples t-test on sex of patients.

<table>
<thead>
<tr>
<th>Sex of Respondent</th>
<th>Equal Variance Assumed</th>
<th>t</th>
<th>df</th>
<th>Mean Difference</th>
<th>Std. Error Difference</th>
<th>95% Confidence Interval of the Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equal variance assumed</td>
<td>4.17</td>
<td>4.51</td>
<td>-5.87</td>
<td>12</td>
<td>5.85</td>
<td>-16.7</td>
</tr>
<tr>
<td>Equal variance not assumed</td>
<td>-5.21</td>
<td>4.21</td>
<td>3.22</td>
<td>-14.7</td>
<td>3.15</td>
<td>-18.4</td>
</tr>
</tbody>
</table>

Results of this table are shown in the discussion section later in the chapter.

4.2 Analysis of Health Workers report

The research answered the following research questions using the following hypotheses:

4.2.1 Will health workers find the implemented system useful to them?

The following hypotheses were defined:

Null Hypothesis (H0): The health workers will not find the implemented m-health system useful to them.

Alternative Hypothesis (H1): The health workers will find the implemented m-health system useful to them.

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

Table 19 shows a cross tabulation of network being a challenge with prior internet knowledge of health workers.

Table 19: Cross tabulation of prior phone internet knowledge with network being a challenge

Cross tabulation of health workers responses by Sex

Table 20 below shows responses to the need to replace the traditional data collection and reporting by sex.

Table 20: Need to replace traditional reporting
The bar chart below illustrates table 20 data.

The table below illustrates the data:

<table>
<thead>
<tr>
<th>Sex Of Respondent</th>
<th>NeedToReplaceTrad</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Yes</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>Yes</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>19</td>
</tr>
</tbody>
</table>

Figure 15: Need to replace traditional reporting by sex
Table 21: Cross tabulation of Navigation and Data Entry Easy by sex

<table>
<thead>
<tr>
<th>Sex Of Respondant</th>
<th>DisagreeSomewhat</th>
<th>Unsure</th>
<th>AgreeSomewhat</th>
<th>StronglyAgree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Female</td>
<td>1</td>
<td>2</td>
<td>8</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
<td>5</td>
<td>10</td>
<td>3</td>
<td>19</td>
</tr>
</tbody>
</table>

From table 21 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.

Figure 16: Bar chart for navigation and data entry easy by sex.

Table 22: Cross tabulation of data sending easy by sex

<table>
<thead>
<tr>
<th>Sex Of Respondant</th>
<th>Unsure</th>
<th>AgreeSomewhat</th>
<th>StronglyAgree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Female</td>
<td>0</td>
<td>3</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
<td>7</td>
<td>11</td>
<td>19</td>
</tr>
</tbody>
</table>
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 23: cross tabulation of system reliability with sex

<table>
<thead>
<tr>
<th>Sex Of Respondent</th>
<th>System is reliable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Disagree</td>
</tr>
<tr>
<td>Male</td>
<td>1</td>
</tr>
<tr>
<td>Female</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
</tr>
</tbody>
</table>

Out of the 19 respondents, 13 (68%) concurred that the system is reliable against 6 (32%) who were either unsure or disagreed. This shows that the majority said mhealth has a significance in data collection and reporting.

Table 24 below shows phone compatibility with sex.

Table 24: Phone compatibility with sex

<table>
<thead>
<tr>
<th>Sex Of Respondent</th>
<th>Phone compatibility with site</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not Compatible</td>
</tr>
<tr>
<td>Male</td>
<td>0</td>
</tr>
<tr>
<td>Female</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>2</td>
</tr>
</tbody>
</table>

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. Table 25 below shows responses on period to send a request by sex.

Table 25: Period taken to send a request by sex
As depicted in the table, the majority (79%) said the period taken to send a report using the mhealth platform while (21%) gave a day or more for an answer. This shows that the majority concurred that the mhealth platform is fast and therefore useful because health is about timely delivery of information.

On where to implement m-health by sex 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. If it was unacceptable, they would not recommend its wide usage. Figure 17 below illustrates the results.

Figure 17: Bar graph on where to implement m-health
Analysis of the health workers responses to the need to replace the traditional system was also done basing on job title. This was meant to ascertain if the responses had any relationship with job title. This is summarised in table 26 below.

**Table 26 : Cross Tabulation of Health workers responses By Job Title on need to replace traditional system.**

<table>
<thead>
<tr>
<th>Job Title of respondent</th>
<th>NeedToReplaceTrad</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>GRN</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>Doctor</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>StudentNurse</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>NurseAide</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>15</td>
</tr>
</tbody>
</table>

Health workers were asked for their views pertaining the ease of use of the mhealth platform and analysis was done by job title as shown in table 27 below.

**Table 27 : Ease of use of mhealth platform by job title**

<table>
<thead>
<tr>
<th>Job Title of respondent</th>
<th>EaseOfUse</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unsure</td>
</tr>
<tr>
<td>GRN</td>
<td>4</td>
</tr>
<tr>
<td>Doctor</td>
<td>1</td>
</tr>
<tr>
<td>StudentNurse</td>
<td>0</td>
</tr>
<tr>
<td>NurseAide</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
</tr>
</tbody>
</table>

Another variable that was tested from health workers was the time it took for a request to be sent using the mhealth platform and this was done by job title and shown in table 28 below

**Table 28 : Period to send a request by job title**
A variable “where to implement mhealth” was also tested by job title to see how many, of a certain title were for or against a test criteria. This is shown in table 29.

Table 29: Where to implement m-health by job title

<table>
<thead>
<tr>
<th>Count</th>
<th>Where can m-health be implemented</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Towns</td>
<td>Countrywide</td>
<td>Total</td>
</tr>
<tr>
<td>Job Title of respondent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRN</td>
<td>2</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>Doctor</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>StudentNurse</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>NurseAide</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>2</td>
<td>17</td>
<td>19</td>
</tr>
</tbody>
</table>

As depicted by table 29, 89% of the respondents selected countrywide use of the system and there was a response from all job titles in favor of countrywide usage which shows acceptance.

Table 30 below shows responses on the ease of use of the mhealth platform by years of experience.

Table 30: Ease of use by Years of experience

<table>
<thead>
<tr>
<th>Count</th>
<th>Ease of use</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unsere</td>
<td>Agree</td>
<td>Somewhat</td>
</tr>
<tr>
<td>Years Of Experience</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>=&quot;2-3Years&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>=&quot;4-5Years&quot;</td>
<td>1</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>=&quot;6-10Years&quot;</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>=&quot;&gt;10Years&quot;</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
<td>10</td>
<td>4</td>
</tr>
</tbody>
</table>
As can be seen, 74% of the respondents agreed that the platform was easy to use whilst 26% were unsure. The percentages again confirm acceptance of the platform.

A cross-tabulation was run on experience at workplace with data sending easy on the mhealth platform and results are as shown in table 31.

**Table 31: Data sending easy by years of experience**

<table>
<thead>
<tr>
<th>Years Of Experience</th>
<th>Data Sending is fast</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agree</td>
</tr>
<tr>
<td>&quot;2-3 Years&quot;</td>
<td>1</td>
</tr>
<tr>
<td>&quot;4-5 Years&quot;</td>
<td>3</td>
</tr>
<tr>
<td>&quot;5-10 Years&quot;</td>
<td>1</td>
</tr>
<tr>
<td>&quot;&gt;10 Years&quot;</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 32 below shows the responses to the statement that there is need to replace traditional reporting by prior phone internet knowledge. This was to ensure that bias was eliminated based on prior phone internet knowledge.

**Table 32: Need to replace traditional reporting by Prior Phone Internet Knowledge**

<table>
<thead>
<tr>
<th>Prior Phone Internet Knowledge</th>
<th>Need To Replace Trad</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Yes</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>19</td>
</tr>
</tbody>
</table>

As depicted in table 32, all those without phone internet knowledge agreed to the need to replace traditional reporting. Of those with phone internet knowledge, 75% agreed to the need to replace traditional data collection and reporting.
Table 33 shows responses to navigation and data sending easy by prior phone internet knowledge.

**Table 33 : Navigation and data sending easy by prior phone internet knowledge**

<table>
<thead>
<tr>
<th>Prior Phone Internet Knowledge</th>
<th>Disagree Somewhat</th>
<th>Unsure</th>
<th>Agree Somewhat</th>
<th>Strongly Agree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Yes</td>
<td>0</td>
<td>5</td>
<td>9</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
<td>5</td>
<td>10</td>
<td>3</td>
<td>19</td>
</tr>
</tbody>
</table>

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 34 : Navigation and data sending response by Smartphone Ownership**

<table>
<thead>
<tr>
<th>Smartphone Ownership</th>
<th>Disagree Somewhat</th>
<th>Unsure</th>
<th>Agree Somewhat</th>
<th>Strongly Agree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Yes</td>
<td>1</td>
<td>5</td>
<td>6</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
<td>5</td>
<td>10</td>
<td>3</td>
<td>19</td>
</tr>
</tbody>
</table>

From the table it can be seen that smartphone ownership had little significance on the ease of navigation of the mhealth platform.

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

This table shows relationships between all the variables that were being tested in the research.

**Table 35 : Independent samples t-test basing on gender**
Analysis of this table will be done at the discussion section of this chapter.

Again, an independent samples t-test was conducted by phone internet knowledge to ascertain the relation between the responses and prior phone internet knowledge. This is shown in table 37.

Table 36 : Independent samples t-test by Phone internet knowledge
Analysis of table 37 will again be done in the discussion section of this chapter.

4.3 Analysis of patients report

4.3.1 Will patients trust the m-health system as technology that can be used to help them in fighting whatever ailments that will be afflicting them?

Null Hypothesis (H0): Patients will not trust the m-health system as a technology that can help them fight whatever ailments that will be afflicting them.

Alternative Hypothesis (H1): Patients will trust the m-health system as a technology that can help them fight whatever ailments that will be afflicting them.

The table 38 below shows the means of patients’ perception of the currently used method of data collection and reporting. Table 38 shows some means on patients responses.

As can be seen from table 38, both males and females were once treated of Malaria and showed to be unsure if drugs were always available. The respondents agreed that m-health helps and also...
strongly agree that it should be implemented locally. On the preparedness of the referral hospitals.

There was a mean of 2.35 which is a disagree. This shows some challenges with the current reporting which may have prompted their displeasure with the current data collection and reporting.

Table 37: Means of Patients responses

<table>
<thead>
<tr>
<th>sex of respondents</th>
<th>Tested at</th>
<th>Drugs readily</th>
<th>You are</th>
<th>Current</th>
<th>Mhealth helps</th>
<th>Implement</th>
<th>Prepared</th>
<th>referrals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>load once</td>
<td>available</td>
<td>satisfied</td>
<td>reporting satisfied</td>
<td>mhealth helps</td>
<td>mhealth locally</td>
<td>-</td>
<td>prepared for a patient</td>
</tr>
<tr>
<td>male</td>
<td>Mean</td>
<td>4.60</td>
<td>2.60</td>
<td>2.50</td>
<td>4.70</td>
<td>4.30</td>
<td>3.40</td>
<td>2.69</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Std Deviation</td>
<td>1.265</td>
<td>1.863</td>
<td>1.815</td>
<td>1.080</td>
<td>875</td>
<td>916</td>
<td>956</td>
</tr>
<tr>
<td>female</td>
<td>Mean</td>
<td>3.70</td>
<td>3.70</td>
<td>2.90</td>
<td>4.40</td>
<td>4.70</td>
<td>3.10</td>
<td>2.19</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Std Deviation</td>
<td>1.638</td>
<td>1.058</td>
<td>1.317</td>
<td>1.370</td>
<td>.843</td>
<td>.675</td>
<td>.653</td>
</tr>
<tr>
<td>Total</td>
<td>Mean</td>
<td>4.05</td>
<td>3.30</td>
<td>2.70</td>
<td>4.65</td>
<td>4.80</td>
<td>3.25</td>
<td>2.55</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Std Deviation</td>
<td>1.469</td>
<td>1.418</td>
<td>1.451</td>
<td>1.218</td>
<td>2.69</td>
<td>.623</td>
<td>1.197</td>
</tr>
</tbody>
</table>

Table 38 shows the statistics of patients responses to the statement that says mhealth helps. From the table, 85% of the respondents agreed that mhealth helps which shows confidence in the platform from patients.

Table 38: Mhealth helps statistics

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid Unsure</td>
<td>3</td>
<td>15.0</td>
<td>15.0</td>
<td>15.0</td>
</tr>
<tr>
<td>Agree</td>
<td>3</td>
<td>15.0</td>
<td>15.0</td>
<td>30.0</td>
</tr>
<tr>
<td>Somewhat</td>
<td>14</td>
<td>70.0</td>
<td>70.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Strongly Agree</td>
<td>20</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

From the table, 95% of the patients concurred with the fact that mhealth should be implemented locally.

Table 39: Implement mhealth locally statistics
Table 40 shows current reporting satisfying by gender analysis. From table 41, 50% of the males said the current method is not satisfying while 40% of the females saw the current method not satisfying.

**Table 40 : Current reporting satisfying by gender**

Table 41 show responses to the statement mhealth helps. It shows a total of 9 out of the 10 males agreeing with the statement and 8 out of 10 females agreeing with the statement.

**Table 41 : mhealth helps by sex**

Table 42 shows responses to the statement that says implement mhealth locally. From the table 10 out of the 10 males agreed with the statement while 9 out of the 10 females agreed with the
statement. This shows concurrence by both males and females that mhealth should be implemented locally.

**Table 42: Implement mhealth by sex**

<table>
<thead>
<tr>
<th>Count</th>
<th>unsure</th>
<th>agree somewhat</th>
<th>strongly agree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>sex of respondents</td>
<td>male</td>
<td>0</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>female</td>
<td>1</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1</td>
<td>2</td>
<td>17</td>
</tr>
</tbody>
</table>

Table 43 shows an independent samples t-test by sex of patients to try to ascertain if gender has anything to do with their responses.

**Table 43: Independent samples t-test**
Table 43 will be analysed in the discussion section of this chapter.

**Analysis of variables on gender**

The following table shows summaries of patients responses to the following questions by gender:

1) You were treated of malaria at least once
2) m-health helps
3) Implement m-health locally

**Table 44: Response on m-health on patients by gender.**

<table>
<thead>
<tr>
<th>sex of respondents</th>
<th>Tested at least once</th>
<th>Mhealth helps</th>
<th>Implement mhealth locally</th>
</tr>
</thead>
<tbody>
<tr>
<td>male</td>
<td>Mean 4.40</td>
<td>Mean 4.70</td>
<td>Mean 4.50</td>
</tr>
<tr>
<td></td>
<td>N 10</td>
<td>N 10</td>
<td>N 10</td>
</tr>
<tr>
<td></td>
<td>Std. Deviation 1.265</td>
<td>Std. Deviation 0.675</td>
<td>Std. Deviation 0.316</td>
</tr>
<tr>
<td>female</td>
<td>Mean 3.56</td>
<td>Mean 4.40</td>
<td>Mean 4.70</td>
</tr>
<tr>
<td></td>
<td>N 9</td>
<td>N 10</td>
<td>N 10</td>
</tr>
<tr>
<td></td>
<td>Std. Deviation 1.667</td>
<td>Std. Deviation 0.843</td>
<td>Std. Deviation 0.575</td>
</tr>
<tr>
<td>Total</td>
<td>Mean 4.00</td>
<td>Mean 4.55</td>
<td>Mean 4.80</td>
</tr>
<tr>
<td></td>
<td>N 19</td>
<td>N 20</td>
<td>N 20</td>
</tr>
<tr>
<td></td>
<td>Std. Deviation 1.491</td>
<td>Std. Deviation 0.759</td>
<td>Std. Deviation 0.523</td>
</tr>
</tbody>
</table>

Figure 18 below shows the results from table 44 above.
4.4 Statistics of site visits

Figure 19 was extracted from the m-health website and shows some of the statistics on visits of the site.

The visits simply confirm that users, really used the system and their responses were not guesses but a true reflection of their experiences. The table shows the days, visitors, visits averages, page impressions and sum showing when the site was really visited.

4.5 Analysis of the performance of the system.

4.5.1 Availability and downtime

Committed hours of availability (A)

This is usually measured in terms of number of hours per month
24 hours a day, 7 days a week = 24 hours per day x 7 days x 4.33 weeks per month (average) = approximately 720 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

Using the table shown on appendix it can be deduced that downtime for

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

**4.5.2 Speed of the website**
The following URL [http://analyze.websiteoptimization.com/wso](http://analyze.websiteoptimization.com/wso) was used to test the response time and speed of the website and obtained the results as shown on appendix D.

[http://www.websiteoptimization.com/speed/1/](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. (http://www.webperformancematters.com/journal/2007/7/10/acceptable-response-times.html)

The website http://getyourwebsitehere.com/jswb/rttest01.html was used to measure reaction time of the researcher’s website and figure 20 below shows five trials of measuring the website’s reaction time and the average.

<table>
<thead>
<tr>
<th>Test Number</th>
<th>Reaction Time (in seconds)</th>
<th>The stoplight to watch.</th>
<th>The button to click.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.621</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.545</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.836</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.524</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0.837</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVG.</td>
<td>0.672</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 20: Website reaction time measurement

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 shown in Appendix A.

The site http://www.websitepulse.com/help/tools.php was also used and produced the results.

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.

4.6 Discussion
This section is going to discuss the findings inorder to come up with a conclusion of whether mhealth is effective or not. We will look at health workers responses first followed by the patients responses and then the system.

Health workers Responses

Dependent variables will be analysed using data from tables above.

Paper tally sheets are efficient
Table 6 which shows responses to the statement that paper tally sheets are efficient shows that eighteen (18) out of the nineteen (19) respondents disagreed with the statement suggesting that they had problems with it. This might have prompted them to accept the mobile intervention. This is supported by table 20 which has a cross tabulation of need to replace traditional reporting by sex. From the table 71% of the males agreed to replacing the traditional data collection and reporting while 83% of the females agreed. This shows that both males and females saw the need to replace the traditional system.

Analysis of Traditional reporting by years of experience

Table 8 shows responses towards the traditional data collection and reporting by years of experiences and show that all years classes excepting the 5-10 years and >10 years concurred that traditional data collection and reporting is not efficient. The opposite responses from the 5-10 years and >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

As depicted by the table 11, 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. This is also depicted in table 26.

Basing on prior internet knowledge as depicted in table 32, all those without phone internet knowledge agreed to the need to replace traditional reporting. Of those with phone internet knowledge, 75% agreed to the need to replace traditional data collection and reporting. This shows that with or without prior internet knowledge, respondents are in agreement with the need to replace the traditional way thereby preferring an alternative solution.

M-Health Platform Analysis

m-health by years of experience

Table 13 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 12 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 15 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 smartphone ownership

From table 14 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 smartphone ownership and both respondents so the significance of m-health platform. We can conclude that factors like smartphone ownership did not have any significant contribution to health workers responses who said the platform had several advantages.

Availability of m-health platform

From table 35 all responses, with the exception of “Always Available” which has 0.039 have two tailed means of greater than 0.05 which can help us reject the null hypotheses that the health workers will not find the implemented m-health system useful to them and that there is no significant difference in monitoring and controlling diseases by the introduction of an m-health system. 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.

Ease of use
From table 27 which has analysis by job title, 58% of the respondents that said the platform is easy to use were GRNs who also form a majority of the respondents followed by Doctors who constituted almost 5%, together with student nurses and nurse aides. The remaining 27% were not sure of whether the platform was easy to use or not.
Table 30 shows responses by years of experience. 74% of the respondents said the platform was easy to use with the majority being in the 3 to 5 years experience. The percentages again confirm acceptance of the platform.

Navigation and Data Entry
From table 21, 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 34 which shows responses by smartphone ownership, 26% of the respondents had no smartphones but agreed that navigation and data entry was easy. 42% of the respondents had smartphones and agreed that navigation and data entry was easy. 26% was unsure with 6% disagreeing. This shows that whether respondents had smartphones or not before, they saw navigation and data entry being easy.

Data Sending
In table 22 those in agreement with the statement that data sending is easy were 95% against 5% who were unsure. This shows that whether male or female, they concurred on the point that data sending is improved with mhealth. However, the reasons for the 5% maybe because of prior smartphone ownership or other factors.
In table 31 which shows responses to data sending by years of experience, 95% of the respondents confirmed that data sending is easy with the majority again being in the 3 to 5 years experience group. This can be attributed to the fact that they form a majority or that they have had a feel of the current system and on making a comparison, they have found this system as a faster alternative.
Platform Reliability

Table 23 shows that 68% of the respondents concurred that the system is reliable against 32% who where either unsure or disagreed. This shows that the majority said mhealth has a significance in data collection and reporting.

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.

Network a challenge by prior internet knowledge

From the table 19 which shows cross tabulation of prior internet knowledge with network being a challenge, 74% of the respondents, whether with knowledge or not agree that network was a challenge in the data collection and reporting. This means that for successful running of this project, the issue of availability of network should be fully addressed. This is because there were instances of delayed data sending because of unavailability of network.

Period to send a report

As depicted in table 25, the majority (79%) said the period taken to send a report using the mhealth platform was less than a day while (21%) gave a day or more for an answer. This shows that the majority concurred that the mhealth platform is fast and therefore useful because health is about timely delivery of information. Those who gave more than a day for an answer maybe 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.

As depicted by table 28, 79% of the respondents concurred that it takes less than a day to send a request while 16% said it takes 1-2 days with the remainder saying 3 to 5 days. This can be attributed to the network challenge that was highlighted by some of the respondents.

Table 10 shows responses to the statement that it takes Less than one day to send a report by years of experience. The figure show that with the exception of the <1 Year all other groups disagree
with the statement as shown by a mean of 1.21 which is close to 1. The groups’ responses can be attributed to the fact that they have sent more time at health centres and have real facts of what is on the ground. However, the less than 1 year groups’ response cannot be neglected. This may be because of their ages which need to be analysed in the future to see if they were not youngsters who have blended experiences than their old counterparts. On the need to replace the traditional way all members agreed that there is need to replace the traditional way with an average of 1.79. This may again be attributed to the fact that they have had experiences with the current way as in table 6.

Where to implement m-health

Table 7 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 basically the same and the training they receive is the same, we can trust their suggestions.

As depicted in table 29, 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.

However, those who selected implementation in towns may have some doubts over the current implementation because of challenges noted which include network.

As depicted by table 29, 89% of the respondents selected countrywide use of the system and there was a response from all job titles in favor of countrywide usage which shows acceptance.

Patients responses

Patients responses current method satisfying

From table 17 which showed patients responses by sex 50% of the males disagreed with the statement that the current method is satisfying with 30% being unsure, maybe because of limited visits to health institutions. 40% of the females said the current method of data collection and reporting is not satisfying while 20% was unsure with 40% in agreement. Overall 45% of the
respondents disagreed while 25% where unsure with 30 % in agreement. This shows that the majority were not satisfied with the current data collection and reporting.

T –distribution of patients
On the t-test by patients sex in table 18 Sig > 0.05 means there is no significant difference in the patients responses. This shows that there were no significant differences in their responses by sex. This can help reject null hypothesis that patients will not find the mhealth platform as a tool that can be useful for data collection and reporting and accept the alternative that patients will find mhealth as a technology that can be useful in data collection and reporting and thereby improve service delivery.

m-health helps
From the table 41, 85% of the respondents agreed that mHealth helps which shows confidence in the platform from patients.

Implement m-health locally
From the table 39, 95% of the patients concurred with the fact that mhealth should be implemented locally.

Current method not satisfying
From table 40, 50 % of the males said the current method is not satisfying while 40% of the females saw the current method not satisfying.

Mhealth helps
As depicted by the table 38, 90% of the females said mhealth helps while 80% of the males responded saying that mhealth helps. This shows that 85 % of the respondents accepted mhealth as a technology that helps.

Complexity of the system:
The system is not so complicated and restarting does not take time. The server is housed at WebDev which is fast.

Magnitude of the problem:
The major problem encountered was incompatibility of some components on different mobile phones as was noted by users.

**Availability of support personnel:**

The challenge on support personnel was compounded by the fact that the administrator stays a long distance away from server and at time network was a challenge in implementing remote administration especially on the administrator side.

However, despite the praises and rejection of the null hypotheses in support of the alternative hypothesis, the research also has its weaknesses which might have played a role in affecting the outcome. The sample size is not ideally representative of the population and was taken from one province. It might have been appropriate if the sample was taken from very geographically spaced samples. The choice of mobile phones again is a factor to be considered. The research was financially constrained but it would have been ideal if all respondents had used one type of smart phone like a Nokia X3. The choice of the network provider may have been a challenge again because at times the favourite network may at times be congested. According to the Cronbach’s alpha test, some of the questions on the questionnaire were labelled difficult. But generally speaking, the results that were obtained were positive.

**4.7 Conclusion**

This chapter presented the results that were found during the research from both the participants and the system testing. The results were discussed and used to derive conclusions that the m-health platform is helpful and useful in the delivery of health and control of malaria.
CHAPTER 5 : SUMMARY AND CONCLUSION

5.0 Introduction
After successfully collecting and analysing results as has been shown in the previous chapter, this chapter will now summarise and give a conclusion to the research.

5.1 Summary
The main thrust of the research was to establish whether mhealth using an internet enabled mobile phone is effective 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 with features almost similar to those on computers.

Objectives which were To design and implement an integrated mhealth system for use by a group of health workers in controlling diseases, to assess the impact of implementing the system on users, to assess the impact of implementing the system on patients and to measure effectiveness of the system on health delivery were set. Research questions were formulated and hypotheses were 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 were 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 shown on Appendix B 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.

Intended beneficiaries who are Malaria patients who were also given questionnaires to complete and express how they felt with the proposed system as well as the traditional data collection and reporting.

The website was also put under several tests to measure response time, availability and speed among other metrics and results were compared with known average values. Analysis of data collected during implementation was then made to come up with a conclusion.
5.2 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 SonyEricsson 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 can 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.
Patients also completed questionnaires (Appendix C) and indicated that they were greatly dissatisfied with the way operations of health centres and thereby accepted the new system although they did not have a physical experience of how it works. Analysing their responses again led to the rejection of the null hypothesis which said they would not accept the new system thereby accepting the alternative hypothesis which said they would accept the platform as a technology that can help them fight ailments that may affect them (Malaria in this case)

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 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
It can be concluded that an integrated mhealth platform is an effective tool in malaria control as has been seen from the responses and their analyses in the previous chapter.
CHAPTER 6 : RECOMMENDATIONS AND FUTURE WORK

6.0 Recommendations

Based on the research findings 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 by the ministry of health and child welfare on mobile technology such that it can be implemented in all areas.
- The researcher also recommends that partnerships in such researches should be made with service providers such as ECONET so that airtime is subsidised for the sake of these researches.

6.1 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 since it has 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.

6.2 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
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APPENDIX A

Web Page Performance Test for www.dario.org

From: Dulles, VA 12B - BSL
Tuesday, March 20, 2012 8:40:16 AM

Waterfall View

Connection View
Showing 10 of the 20 request headers

Request Headers

Request 1:

URL: http://www.dariro.org/
Host: www.dariro.org
IP: 196.44.177.99
Location: Harare, Zimbabwe*
Error/Status Code: 200
Start Offset: 0.533 s
DNS Lookup: 194 ms
Initial Connection: 339 ms
Time to First Byte: 2703 ms
Content Download: 15 ms
Bytes In (downloaded): 2.4 KB
Bytes Out (uploaded): 0.4 KB

Request Headers:

GET / HTTP/1.1
Accept: image/jpeg, application/x-ms-application, image/gif, application/xaml+xml, image/pjpeg, application/x-ms-xbap, */*
Accept-Language: en-US
User-Agent: Mozilla/4.0 (compatible; MSIE 8.0; Windows NT 6.1; Trident/4.0; SLCC2; .NET CLR 2.0.50727; .NET CLR 3.5.30729; .NET CLR 3.0.30729; Media Center PC 6.0; .NET4.0C; PTST 2.314)
Accept-Encoding: gzip, deflate
Host: www.dariro.org
Connection: Keep-Alive
Response Headers:

HTTP/1.1 200 OK
Date: Tue, 20 Mar 2012 07:39:53 GMT
Server: Apache/2
X-Powered-By: PHP/5.3.3-7+squeeze8
P3P: CP="NOI ADM DEV PSAi COM NAV OUR OTRo STP IND DEM"
Expires: Mon, 1 Jan 2001 00:00:00 GMT
Cache-Control: post-check=0, pre-check=0
Pragma: no-cache
Set-Cookie: 6b174af7d99bc2f188089788ecb896b0=kjp6n76nortjpe831v6th1hr2; path=/
Last-Modified: Tue, 20 Mar 2012 07:39:55 GMT
Vary: Accept-Encoding
Content-Encoding: gzip
Content-Length: 1875
Keep-Alive: timeout=15, max=100
Connection: Keep-Alive
Content-Type: text/html; charset=utf-8

Request 2:

URL: http://www.dariro.org/media/system/js/mootools.js
Host: www.dariro.org
IP: 196.44.177.99
Location: Harare, Zimbabwe*
Error/Status Code: 200
Start Offset: 3.592 s
Initial Connection: 340 ms
Time to First Byte: 398 ms
Content Download: 1033 ms
Bytes In (downloaded): 20.2 KB
Bytes Out (uploaded): 0.4 KB

Request Headers:

GET /media/system/js/mootools.js HTTP/1.1
Accept: */*
Referer: http://www.dariro.org/
Accept-Language: en-US
User-Agent: Mozilla/4.0 (compatible; MSIE 8.0; Windows NT 6.1; Trident/4.0; SLCC2; .NET CLR 2.0.50727; .NET CLR 3.5.30729; .NET CLR 3.0.30729; Media Center PC 6.0; .NET4.0C; PTST 2.314)
Accept-Encoding: gzip, deflate
Host: www.dariro.org
Connection: Keep-Alive
Cookie: 6b174af7d99bc2f188089788ecb896b0=kjp6n76nortjpe831v6th1hr2
Response Headers:

HTTP/1.1 200 OK
Date: Tue, 20 Mar 2012 07:39:56 GMT
Server: Apache/2
Last-Modified: Wed, 29 Feb 2012 08:25:16 GMT
ETag: "2e0808-122c2-4ba1615491300"
Accept-Ranges: bytes
Vary: Accept-Encoding
Content-Encoding: gzip
Content-Length: 20347
Keep-Alive: timeout=15, max=100
Connection: Keep-Alive
Content-Type: application/javascript

Request 3:

URL: http://www.dario.org/templates/system/css/system.css
Host: www.dario.org
IP: 196.44.177.99
Location: Harare, Zimbabwe*
Error/Status Code: 200
Start Offset: 3.596 s
Initial Connection: 343 ms
Time to First Byte: 396 ms
Bytes In (downloaded): 0.8 KB
Bytes Out (uploaded): 0.4 KB

Request Headers:

GET /templates/system/css/system.css HTTP/1.1
Accept: */*
Referer: http://www.dario.org/
Accept-Language: en-US
User-Agent: Mozilla/4.0 (compatible; MSIE 8.0; Windows NT 6.1; Trident/4.0; SLCC2; .NET CLR 2.0.50727; .NET CLR 3.5.30729; .NET CLR 3.0.30729; Media Center PC 6.0; .NET4.0C; PTST 2.314)
Accept-Encoding: gzip, deflate
Host: www.dario.org
Connection: Keep-Alive
Cookie: 6b174af7d99bc2f188089788ecb896b0=kjp6n76nortjpqe831v6th1hr2

Response Headers:

HTTP/1.1 200 OK
Date: Tue, 20 Mar 2012 07:39:56 GMT
Server: Apache/2
Last-Modified: Wed, 29 Feb 2012 08:24:50 GMT
ETag: "264f54-569-4ba1613be5880"
Accept-Ranges: bytes
Vary: Accept-Encoding
Content-Encoding: gzip
Content-Length: 518
Keep-Alive: timeout=15, max=100
Connection: Keep-Alive
Content-Type: text/css

Request 4:

URL: http://www.dariro.org/templates/themza_j15_39/css/template.css
Host: www.dariro.org
IP: 196.44.177.99
Location: Harare, Zimbabwe*
Error/Status Code: 200
Start Offset: 3.598 s
Initial Connection: 344 ms
Time to First Byte: 421 ms
Content Download: 1 ms
Bytes In (downloaded): 2.6 KB
Bytes Out (uploaded): 0.5 KB

Request Headers:

GET /templates/themza_j15_39/css/template.css HTTP/1.1
Accept: */*
Referer: http://www.dariro.org/
Accept-Language: en-US
User-Agent: Mozilla/4.0 (compatible; MSIE 8.0; Windows NT 6.1; Trident/4.0; SLCC2; .NET CLR 2.0.50727; .NET CLR 3.5.30729; .NET CLR 3.0.30729; Media Center PC 6.0; .NET4.0C; PTST 2.314)
Accept-Encoding: gzip, deflate
Host: www.dariro.org
Connection: Keep-Alive
Cookie: 6b174af7d99be2f188089788ecb896b0=kjp6n76nortjpqe831v6th1hr2

Response Headers:

HTTP/1.1 200 OK
Date: Tue, 20 Mar 2012 07:39:56 GMT
Server: Apache/2
Last-Modified: Thu, 01 Mar 2012 14:28:16 GMT
ETag: "2a6fe6-247f-4ba2f4550e000"
Accept-Ranges: bytes
Vary: Accept-Encoding
Content-Encoding: gzip
Content-Length: 2346
Keep-Alive: timeout=15, max=100
Connection: Keep-Alive
Content-Type: text/css

Request 5:

URL: http://www.dariro.org/templates/themza_j15_39/js/mootools.js
Host: www.dariro.org
IP: 196.44.177.99
Location: Harare, Zimbabwe*
Error/Status Code: 200
Start Offset: 3.596 s
Initial Connection: 342 ms
Time to First Byte: 454 ms
Content Download: 1037 ms
Bytes In (downloaded): 20.2 KB
Bytes Out (uploaded): 0.4 KB

Request Headers:

GET /templates/themza_j15_39/js/mootools.js HTTP/1.1
Accept: */*
Referer: http://www.dariro.org/
Accept-Language: en-US
User-Agent: Mozilla/4.0 (compatible; MSIE 8.0; Windows NT 6.1; Trident/4.0; SLCC2; .NET CLR 2.0.50727; .NET CLR 3.5.30729; .NET CLR 3.0.30729; Media Center PC 6.0; .NET4.0C; PTST 2.314)
Accept-Encoding: gzip, deflate
Host: www.dariro.org
Connection: Keep-Alive
Cookie: 6b174af7d99bc2f188089788ecb896b0=kjp6n76nortjpqe831v6th1hr2

Response Headers:

HTTP/1.1 200 OK
Date: Tue, 20 Mar 2012 07:39:56 GMT
Server: Apache/2
Last-Modified: Thu, 01 Mar 2012 14:28:16 GMT
ETag: "2ec884-12307-4ba2f4550e000"
Accept-Ranges: bytes
Vary: Accept-Encoding
Content-Encoding: gzip
Content-Length: 20349
Keep-Alive: timeout=15, max=100
Connection: Keep-Alive
Content-Type: application/javascript
Request 6:

URL: [http://www.dariro.org/media/system/js/caption.js](http://www.dariro.org/media/system/js/caption.js)
Host: www.dariro.org
IP: 196.44.177.99
Location: Harare, Zimbabwe*
Error/Status Code: 200
Start Offset: 3.596 s
Initial Connection: 342 ms
Time to First Byte: 382 ms
Content Download: 1 ms
Bytes In (downloaded): 1.2 KB
Bytes Out (uploaded): 0.4 KB

Request Headers:

GET /media/system/js/caption.js HTTP/1.1
Accept: */*
Referer: http://www.dariro.org/
Accept-Language: en-US
User-Agent: Mozilla/4.0 (compatible; MSIE 8.0; Windows NT 6.1; Trident/4.0; SLCC2; .NET CLR 2.0.50727; .NET CLR 3.5.30729; .NET CLR 3.0.30729; Media Center PC 6.0; .NET4.0C; PTST 2.314)
Accept-Encoding: gzip, deflate
Host: www.dariro.org
Connection: Keep-Alive
Cookie: 6b174af7d99bc2f188089788ecb896b0=kjp6n76nortjpqe831v6th1hr2

Response Headers:

HTTP/1.1 200 OK
Date: Tue, 20 Mar 2012 07:39:56 GMT
Server: Apache/2
Last-Modified: Wed, 29 Feb 2012 08:25:16 GMT
ETag: "2e0803-7ab-4ba1615491300"
Accept-Ranges: bytes
Vary: Accept-Encoding
Content-Encoding: gzip
Content-Length: 921
Keep-Alive: timeout=15, max=100
Connection: Keep-Alive
Content-Type: application/javascript

Request 7:

Host: www.dariro.org
IP: 196.44.177.99
Location: Harare, Zimbabwe*
Error/Status Code: 200
Start Offset: 3.267 s
Time to First Byte: 353 ms
Content Download: 6 ms
Bytes In (downloaded): 1.1 KB
Bytes Out (uploaded): 0.4 KB

Request Headers:

GET /templates/system/css/general.css HTTP/1.1
Accept: */*
Referer: http://www.dariro.org/
Accept-Language: en-US
User-Agent: Mozilla/4.0 (compatible; MSIE 8.0; Windows NT 6.1; Trident/4.0; SLCC2; .NET CLR 2.0.50727; .NET CLR 3.3.30729; .NET CLR 3.5.30729; Media Center PC 6.0; .NET4.0C; PTST 2.314)
Accept-Encoding: gzip, deflate
Host: www.dariro.org
Connection: Keep-Alive
Cookie: 6b174af7d99bc2f188089788ecb896b0=kjp6n76nortjpqe831v6th1hr2

Response Headers:

HTTP/1.1 200 OK
Date: Tue, 20 Mar 2012 07:39:56 GMT
Server: Apache/2
Last-Modified: Wed, 29 Feb 2012 08:24:50 GMT
ETag: "264ee3-ad9-4ba1613bc5880"
Accept-Ranges: bytes
Vary: Accept-Encoding
Content-Encoding: gzip
Content-Length: 762
Keep-Alive: timeout=15, max=99
Connection: Keep-Alive
Content-Type: text/css

Request 8:

URL: http://www.dariro.org/templates/themza_j15_39/css/blue.css
Host: www.dariro.org
IP: 196.44.177.99
Location: Harare, Zimbabwe*
Error/Status Code: 200
Start Offset: 3.627 s
Time to First Byte: 388 ms
Content Download: 2 ms
Bytes In (downloaded): 1.0 KB
Bytes Out (uploaded): 0.4 KB

Request Headers:
GET /templates/themza_j15_39/css/blue.css HTTP/1.1
Accept: */*
Referer: http://www.dariro.org/
Accept-Language: en-US
User-Agent: Mozilla/4.0 (compatible; MSIE 8.0; Windows NT 6.1; Trident/4.0; SLCC2; .NET CLR 2.0.50727; .NET CLR 3.5.30729; .NET CLR 3.0.30729; Media Center PC 6.0; .NET4.0C; PTST 2.314)
Accept-Encoding: gzip, deflate
Host: www.dariro.org
Connection: Keep-Alive
Cookie: 6b174af7d99bc2f188089788ecb896b0=kjp6n76nortjpqe831v6th1hr2

Response Headers:
HTTP/1.1 200 OK
Date: Tue, 20 Mar 2012 07:39:56 GMT
Server: Apache/2
Last-Modified: Thu, 01 Mar 2012 14:28:16 GMT
ETag: "2a6fe8-895-4ba2f4550e000"
Accept-Ranges: bytes
Vary: Accept-Encoding
Content-Encoding: gzip
Content-Length: 729
Keep-Alive: timeout=15, max=98
Connection: Keep-Alive
Content-Type: text/css

Request 9:
URL: http://www.dariro.org/templates/themza_j15_39/js/moomenu.js
Host: www.dariro.org
IP: 196.44.177.99
Location: Harare, Zimbabwe*
Error/Status Code: 200
Start Offset: 3.981 s
Time to First Byte: 375 ms
Content Download: 1 ms
Bytes In (downloaded): 1.7 KB
Bytes Out (uploaded): 0.4 KB

Request Headers:
GET /templates/themza_j15_39/js/moomenu.js HTTP/1.1
Accept: */*
Referer: http://www.dariro.org/
Accept-Language: en-US
User-Agent: Mozilla/4.0 (compatible; MSIE 8.0; Windows NT 6.1; Trident/4.0; SLCC2; .NET CLR 2.0.50727; .NET CLR 3.5.30729; .NET CLR 3.0.30729; Media Center PC 6.0; .NET4.0C; PTST 2.314)
Accept-Encoding: gzip, deflate
Host: www.dariro.org
Connection: Keep-Alive
Cookie: 6b174af7d99bc2f188089788ecb896b0=kjp6n76nortjpqe831v6th1hr2

Response Headers:

HTTP/1.1 200 OK
Date: Tue, 20 Mar 2012 07:39:56 GMT
Server: Apache/2
Last-Modified: Thu, 01 Mar 2012 14:28:16 GMT
ETag: "2ec883-1326-4ba2f4550e000"
Accept-Ranges: bytes
Vary: Accept-Encoding
Content-Encoding: gzip
Content-Length: 1354
Keep-Alive: timeout=15, max=99
Connection: Keep-Alive
Content-Type: application/javascript

Request 10:

URL: http://www.dariro.org/templates/themza_j15_39/images/blue/top.png
Host: www.dariro.org
IP: 196.44.177.99
Location: Harare, Zimbabwe*
Error/Status Code: 200
Start Offset: 5.135 s
Time to First Byte: 357 ms
Content Download: 1 ms
Bytes In (downloaded): 0.7 KB
Bytes Out (uploaded): 0.5 KB

Request Headers:

GET /templates/themza_j15_39/images/blue/top.png HTTP/1.1
Accept: */*
Referer: http://www.dariro.org/
Accept-Language: en-US
User-Agent: Mozilla/4.0 (compatible; MSIE 8.0; Windows NT 6.1; Trident/4.0; SLCC2; .NET CLR 2.0.50727; .NET CLR 3.5.30729; .NET CLR 3.0.30729; Media Center PC 6.0; .NET4.0C; PTST 2.314)
Accept-Encoding: gzip, deflate
Host: www.dariro.org
Connection: Keep-Alive
Cookie: 6b174af7d99bc2f188089788ecb896b0=kjp6n76nortjpqe831v6th1hr2

Response Headers:

HTTP/1.1 200 OK
Date: Tue, 20 Mar 2012 07:39:58 GMT
Server: Apache/2
Last-Modified: Thu, 01 Mar 2012 14:28:16 GMT
ETag: "2ec899-19e-4ba2f4550e000"
Accept-Ranges: bytes
Content-Length: 414
Keep-Alive: timeout=15, max=99
Connection: Keep-Alive
Content-Type: image/png
APPENDIX B

Health Workers Questionnaire

Effectiveness of an integrated m-health platform in disease control

User Questionnaire

The intention of this questionnaire is to gather information from you in concerning a MSc Computer Science research which tries to evaluate the effectiveness of the mobile phone as a data collection and reporting tool in health, especially in the fight against Malaria. The broad aim of this questionnaire is to inquire from participants on their feeling judgement or perception of the m-health on their use of the mobile phone as a data collection, reporting and general communication tool. It is my assumption that all participants have had experience of logging on to www.darin.org to use the mhealth platform hence it is time for you to evaluate it. The researcher therefore kindly asks for your help and contribution by completing this questionnaire. Your honest assessments is required and the Likert scale will guide you in making choices.

(5) – Strongly Agree
(4) – Agree somewhat
(3) – Unsure
(2) – Disagree somewhat
(1) – Strongly Disagree

SECTION A

Tick where appropriate

1. Gender: Male □ Female □

2. Designation: GRN □ Doctor □ Student Nurse □ Nurse Aide □

3. Years of experience □

4. I have prior experience with an internet enabled phone (Tick) YES □ NO □

5. I own an internet enabled phone YES □ NO □

SECTION B

6. I have used the internet before □ □ □ □ □

7. I have used SMS before □ □ □ □ □

8. I have expert knowledge in the use of internet □ □ □ □ □

9. I have expert knowledge in using SMS □ □ □ □ □

SECTION C

10. The traditional data collection and reporting is fast □ □ □ □ □

11. The use of paper tally sheets is efficient □ □ □ □ □
12. Using the traditional method takes less than a day to make a request to a higher office

13. Response from higher office comes in less than a day

14. Is there need for replacement of traditional way

**SECTION C**

**CELLPHONE DATA COLLECTION AND REPORTING**

After your experiences with the given m-health site, what are your responses to the following questions?

15. The mobile platform was easy to access

16. What was the availability of the system each time you tried to log in

17. The m-health platform is easy to use

18. The data entry process and navigation was easy

19. The process of sending data is very fast

20. The system is reliable

21. What is the compatibility of your mobile phone with the website?

22. Network is a challenge in our reporting.

23. Period taken to send a request

24. What reporting would you prefer? Traditional □ Mobile □ Both □

25. Where do you think m-health should be implemented? Rural □ Towns □ Countrywide □

26. Do you think drug acquisition will improve with m-health? YES □ NO □ MAYBE □

27. What, in your own assessment, are the advantages that can be brought about by m-health?

28. What, in your own assessment, are the disadvantages that can be brought about by m-health?
29. Which other areas do you feel should be improved in order to improve mobile health?

30. What do you recommend to the Ministry of Health and Child Welfare in relation to ways which can help meet the millennium development goals?

31. In what ways has the experiment helped you organise yourself to improve data collection, reporting and general communication?
APPENDIX C

PATIENTS QUESTIONNAIRE

The intention of this questionnaire is to gather information from you in concerning a MSc Computer Science research which tries to evaluate the effectiveness of the mobile phone as a data collection and reporting tool in health, especially in the fight against Malaria. The broad aim of this questionnaire is to inquire from patients who are the intended beneficiaries of the developed system on their experiences in as far as treatment is concerned. A site www.dariro.org was developed for use by health workers and we the researcher would like to hear about your experiences and what you think about the proposed platform and what changes you think it may bring to health delivery if implemented. The researcher therefore kindly asks for your help and contribution by completing this questionnaire. Your honest assessment is required and theLikert scale will guide you in making choices.

1. Strongly Agree
2. Agree somewhat
3. Unsure
4. Disagree somewhat
5. Strongly Disagree

PATIENTS’ PERCEPTION

(TICK WHERE APPROPRIATE)

<table>
<thead>
<tr>
<th></th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
</table>
1. I have been treated of Malaria at least once.   |
2. Every time I visited the clinic drugs were always available.  |
3. I am satisfied with availability of drugs.   |
4. I’m satisfied with the current method of reporting.   |
5. I lost a relative due to poor road infrastructure.   |
6. I lost a relative due to nurses in capabilities.   |
7. I’ve been referred to a big hospital at least once.   |
8. At the referral hospitals nurses know that a patient is coming.   |
9. m-health can improve health delivery to us.   |
10. m-health should be implemented in my area.   |

Thank You: P.M Mavhémwa (R0019161)
APPENDIX D

Website optimisation report

TOTAL HTML – The total number of HTML files is 1 which most browsers can multithread.

TOTAL OBJECTS : The total number of objects on this page is 39 which cause web page delay. Above 20 objects per page, the overhead from dealing with the objects accounts for more than 80% of whole page latency.

TOTAL IMAGES – The total number of images is 29 and needs to be reduced.

TOTAL CSS - The total number of external CSS files on this page is 5, consider reducing this to a more reasonable number.

TOTAL SIZE - The total size of this page is 139987 bytes, which will load in over 20 seconds on a 56Kbps modem - or 35.70 seconds on a 56Kbps modem. Consider reducing total page size to less than 100K to achieve sub 20 second response times on 56K connections.

TOTAL SCRIPT - The total number of external script files on this page is 4, consider reducing this to one or two.

HTML SIZE - The total size of this HTML file is 1871 bytes, which less than 50K which is good

IMAGES SIZE - The total size of all your images is 90551 bytes, which exceeds 50K. Consider optimizing and creatively cropping your images, and combining them where appropriate.

SCRIPT SIZE - The total size of external your scripts is 42971 bytes, which is over 20K. Consider optimizing your JavaScript for size, combining them, and using HTTP compression where appropriate for any scripts placed in the HEAD of your documents.

CSS SIZE - The total size of your external CSS is 4594 bytes, which is less than 8K.

MULTIM SIZE - The total size of all your external multimedia files is 0 bytes, which is less.