Effectiveness of an integrated m-health platform for disease control

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Abstrac*t*— Many governments the world over ratified the Millennium Development Goals (MDGs) which seek to improve the general wellbeing of people (UNDP, 2010). These MDGs touch on health among other things. The sixth MDG seeks to reverse the spread of HIV/AIDS by year 2015. In tandem with this MDG, our study sought to develop and use an integrated mobile health system to curb malaria disease control. The study also assessed the effectiveness of the integrated mobile health system in combating malaria. The m-health used ubiquitous smart phones which the majority of people owned as a data collection and reporting tool in the fight against malaria. The research was carried out on health workers and patients in a small town called Bindura, in Zimbabwe. 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 cases of malaria and send messages back via the mobile platform. The mobile website was also be used for user to user communication and users information dissemination through administrator. The mobile website was 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.

Keywords-component; m-health; mobile smart phone, malaria, health worker

I. INTRODUCTION

A. Background

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 smart phones 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 of Zimbabwe.

While the progress achieved over the years in health sector has remained highly concentrated in the developed countries, many developing and least-developed countries are still seriously lagging behind. This is particularly true in the regions of South Asia and Sub-Saharan Africa where health care coverage and health services remained significantly poor in many countries. Several challenges are delaying the timely delivery of health services to people in developing countries. In order to address this challenge, many countries including African countries adopted m-health. This m-health facilitates fast accessibility of people in need of health services and interesting results have been seen. M-health is a great mechanism to save significant funds in the health sector[1]. [2], establishes that the availability of information to health professionals is highly regarded as a prerequisite for achieving health for all.

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. Currently, no study has been conducted in Zimbabwe to assess the effectiveness of m-health in controlling malaria. Therefore, this study seeks to help in the fulfilment of the Millennium Development Goals if properly researched on and implemented and as a country. Zimbabwe is not fully taking advantage of this potential. Supporting evidence is presented [3] that 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. Furthermore, 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 [3]. 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) and its penetration rate in Zimbabwe have risen from 13% to 88% in three years. The paper is arranged as follows: the next section illustrates the problem statement, followed by the aims and objectives as well as research questions; a brief literature review is shown then the methodology follows with the results and findings in section IV. The paper winds up with the discussions, conclusion and recommendations.

B. Problem Statement

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. Some researches were done in combating sexually transmitted diseases [2], measles and other diseases including HIV/AIDS. However, some research projects were implemented successfully in other countries, there is potential for m-health to be tried in Zimbabwe although there are some mitigating factors which are different from country to country. 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. Timely delivery of health solutions is still a problem due to late compilation of reports, late decision making and at times lack of adherence to prescriptions on the side of patients. All this is being caused by a gap that exists in the way health related issues are disseminated from a sick person in a remote area to the health care givers and vice- versa.

The aim of this research was to design and implement an integrated m-health platform for use by a group of health workers to monitor report and control malaria and identify the effectiveness of such a system. The research intends to answer the following question: Does implementation of m-health in Zimbabwe improve health delivery in monitoring and controlling malaria diseases?

C. Objectives of the study

The objectives of the research study were:

a. To design and implement an integrated m-health system for use by a group of health workers in controlling diseases, and Malaria in particular.
b. To assess the impact of implementing the system on health workers.
c. To measure the effectiveness of the system in controlling Malaria.

D. Hypothesis

The following hypotheses where formulated:

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

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

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

Alternative Hypothesis (H_1): The health workers will find the implanted m-health system useful to them.

II. LITERATURE REVIEW

A. E-Health vs M-health

According to reference [4], eHealth refers to using information and communication technology (ICT) – such as computers, mobile phones, and satellite communications for health services and information. M-health is defined as using mobile communications such as PDAs and mobile phones for health services and information. From these definitions, it is clear that m-health is a subset of eHealth since it is an application of eHealth only with the use of mobile communication. 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 [4]. On the other hand intervention according to [5] 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.

B. The need for electronic intervention

Reference [6] 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. Furthermore, people often see a cell phone as a talking device but it can also be viewed in many different ways as a substitute for transport, as a personal advisor/ educator, as a digital bridge between those who have fibre optic and other cable based internet connections and those who don't, as key tools that can cut down delays between the times the information is acquired and acted upon [6]. Given these different views of the cellphone, it was necessary to carryout research to establish its potential in Malaria control.

Zimbabwe just like other developing countries should use e-health solutions for the improvement of health on the populace. However, [2] asserts that, 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. Further supporting evidence is provided by [7] that there is a growing need to strengthen health systems in developing countries to help meet the Millennium Development Goals (MDGs). [8] , indicates that 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 our view that mobile intervention can play a great role in bridging the missing parts of motivation and training.

According to [6] 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, hence here we are proposing use of an electronic m-health system. In addition, [9] and [10] establish that using email or web communications allows staff to check advice from remote physicians. Also, [11] 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. Changing from the current paradigm visiting medical practitioners for health and instead having distributed health to where you are, the only way to do that is with modern communications.

C. Why the mobile phone and not other devices?

[12], [13] and [14] highlight that communication by mobile phone is less expensive than alternative options such as landline telephones or standard Internet. Furthermore, [12] 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. Further supporting evidence is presented by [2] that 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.

Previous studies [15]; [16][17] and [18] indicated that 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. In addition,

[1] illustrates mobile phones have a growing potential which make them the tool for the moment and they can reach further into developing countries than other technology and health infrastructures.

D. m-health applications

[12] , asserts that the currently documented m-health programmes include mobile phone text messages for supporting management of hypertension, asthma, and diabetes, eating disorders and HIV treatment. 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[2]; [14]; [18]. In addition to the foregoing, [5] said there is almost no literature on using mobile telephones as a healthcare intervention for HIV, TB, malaria, and chronic conditions in developing countries.

[15] , 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 [13]; [19].

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

[3], noted that few project actually exist with little evidence available to tell the impact of mobile phones on the quality of maternal health services. It was noted that common researches were simply made to reduce the delay in provision of care and ongoing projects are focusing on empowering women to seek health care.

[20], identified a mobile phone as a tool that can be used to fight Tuberculosis. [20], further notes that connection between patients and caregivers using short massage services hold potential to help in improving adherence to taking the medication.

[21] , 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.

[18], researched on the innovative use of cell phone technology for HIV/AIDS behaviour change communications in South Africa with 3 pilot surveys. Similarly, there are researches done in Peru where commercial sex workers were treated using mobile phones. Because visiting clinics for treatment of STIs was 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

[5], 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. Similar work was done by [22] who 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. From this study, 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.

Figure 1 below is an SMS architecture that was used in a research on m-learning in Malaysia. Some concepts can be borrowed for use in m-health.

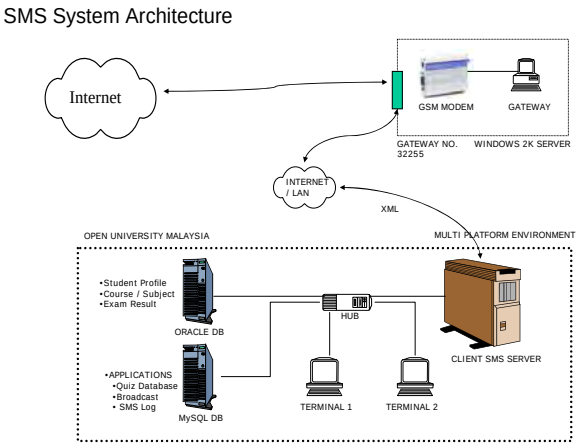

Figure 1. SMS architecture used in a m-learning research in Malaysia (Adapted from [23])

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 SIMPill program was built on proprietary software meaning the code is closed and at times expensive [2].

Projects for health information dissemination like Project Masiluleke and Text-to-Change were successfully held 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.

E. Recommended Architecture

Figure 2 below gives a possible explanation of the current problems as well as the interventions that can be employed.

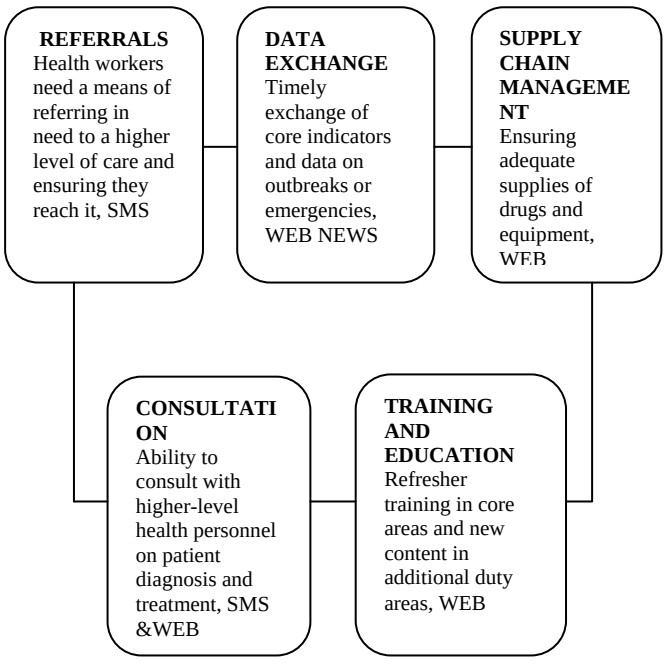

Figure 2. Possible Layout of m-health interventions in relation to the existing infrastructure: Modified from **[11]**

F. Designing a solution

In designing a solution [4] asserts that 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. Further to that, [2] 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. 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: i) Health centric which means that 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, ii) Field-based systems meaning that the system should be non-theoretical and based on field evidence, iii) collaborative and parallel processes implying that the architecture should encourage transparency, local control and open competition and iv) sustainability meaning that the system should be supported by adequate resources to ensure scalability and sustainability.

G. Why GPRS and not SMS only

The major reason as cited by [2] 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.

III. METHODOLOGY

A. Research Design

The study followed an experimental research design. With this design, we developed an integrated m-health system, deployed it and gathered information about its effectiveness. The information about its effectiveness was collected from users, patients and system evaluators. The sample used in the study included twenty (20) health workers drawn from different health areas around Bindura. There was limited number of health workers as the areas were spacey distributed and there were difficulties in accessing most of the health areas. There was also limitation in resources to cover other districts. The control group had ten (10) health workers. The control group comprised of those health workers 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.

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. 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. Users were assigned usernames and passwords to access the platform and record cases of Malaria. The users could log on to the system using internet enabled mobile phone. There was no particular brand of mobile smart phones that was selected for the research due to financial constraints.

Participants logged on to the platform and accessed their inbox. The administrator would 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 any 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 statistics 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 m-health as a tool in improving health delivery.

B. Data collection and Reporting Tools

After an exhaustive analysis of existing SMS based reporting tools, we developed a web based disease reporting system using Joomla and WampServer. Ozeki SMS Module was integrated into the system to enable the SMS functionality and Figure 3 below is the Ozeki structure and requirements. Global Standard for Mobile (GSM) phones was evaluated in terms of paperless Upstream Communication mechanism. The data acquisition software application was based on a menu driven Wireless Access Protocol (WAP) application and SMS facility.

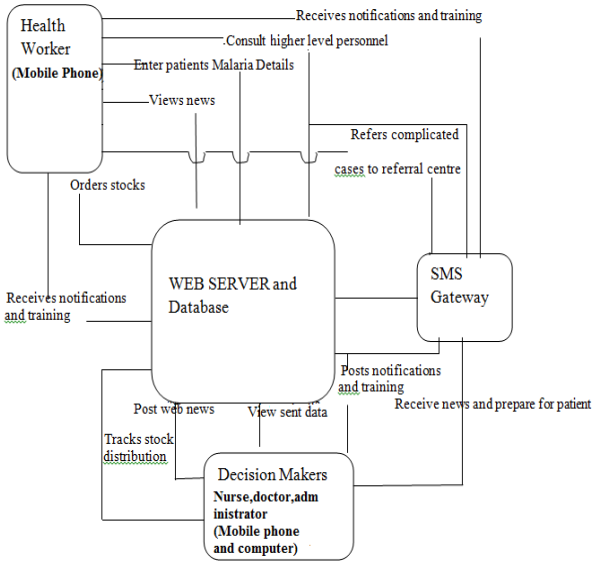

Figure 3. Context diagram for the architecture

Paper based data collection and reporting was used to gather and collect information through:

a. A patient visits a clinic and gives a medical complaint.
b. Health workers record the complaints on the patient's card and also write the diagnosis.
c. He/she then completes an Occurrence Book and a Tally Sheet that will be on the desk recording the disease in its corresponding section.
d. 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.
e. If treatment is there the patient is given.
f. 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 denoted the beginning of a new hospital month. After collection, the tally sheets were then taken to the Provincial Medical Directorate Office in Bindura where they were analysed to give total number of a diseases for that month per district, per centre, etc. The analysis at the PMD offices was the one that was going to give results in conclusions on the prevalence of disease and figures are forwarded to the National Office for action.

As can be seen could 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 was one Information officer who had 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.

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 used to gather data which were supplied to health workers who would later evaluate the system. .A comparison of the time it took to report a case, get response, get drugs and supply statistics to the district office was made with the existing manual systems. Challenges were also to be noted.

IV. RESULTS AND FINDINGS

A. Analysis of Health workers report

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

1) 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.

Table 1 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. The following graph show responses on where to implement m-health

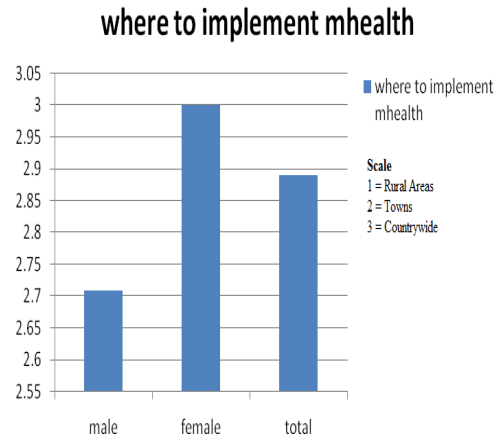

Figure 1 : Graph of where to implement m-health

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.

The need to replace traditional data collection and reporting is as shown on table 2.

Table 2: Cross tabulation of need to replace traditional way with years of experience

Years Of Experience at workplace * NeedToReplaceTrad Crosstabulation

Count

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

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

Table 3 below shows means on health workers responses to the m-health platform by sex.

Table 3: Means to responses on mhealth platform use by sex

Easy of Access EaseOfUse NavigationAndEntryEasy DataSendingEasy System is reliable Phone compatibility with site Is Network a challenge Period taken to send a request What reporting do you prefer Where can m-health be implemented Will drug acquisition improve with mhe AlwaysAvailable * Sex Of Respondant

Sex Of Respondant		Easy of Access	EaseOfUse	Navigation AndEntryEasy	DataSending Easy	System is reliable	Phone compatibility with site	Is Network a challenge	Period taken to send a request	What reporting do you prefer	Where can m-health be implemented	Will drug acquisition improve with mhe	Always Available
Male	Mean	4.14	3.71	3.86	4.14	4.00	2.43	3.86	1.57	2.86	2.71	1.86	4.00
	N	7	7	7	7	7	7	7	7	7	7	7	7
	Std. Deviation	.900	.756	.900	.690	1.000	.535	1.345	.787	.378	.488	.378	.577
Female	Mean	4.17	4.08	3.75	4.75	3.67	3.08	3.75	1.08	2.75	3.00	1.92	3.33
	N	12	12	12	12	12	12	12	12	12	12	12	12
	Std. Deviation	.577	.669	.754	.452	.651	.669	.866	.289	.452	.000	.289	.651
Total	Mean	4.16	3.95	3.79	4.53	3.79	2.21	3.79	1.26	2.79	2.89	1.89	3.58
	N	19	19	19	19	19	19	19	19	19	19	19	19
	Std. Deviation	.688	.705	.787	.612	.797	.631	1.032	.562	.419	.315	.315	.692

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

Table 4 below shows health workers responses to the m-health platform by smartphone ownership.

Table 4: Means of responses on mhealth platform by smartphone ownership

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

Table 5 below shows means on health workers responses by prior internet knowledge.

Table 5: Means on response on mhealth platform by prior internet knowledge

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

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

Table 6 shows means on responses by previous SMS usage

Table 6: Means on responses on mhealth platform by previous SMS usage

Ever used SMS before	Ease of access	Always available	Ease of use	Navigation and data entry easy	Data Sending Easy	System is reliable	Phone compatibility	Is network a challenge	Period to send a request	Preferred reporting	Where can m-health be implemented	Will Drug acquisition improve
Disagree somewhat	3.00	4.00	4.00	5.00	3.00	2.00	2.00	1.00	3.00	3.00	2.00	1.00
Unsure	4.00	3.00	4.00	4.00	5.00	3.00	2.00	4.00	1.00	2.00	3.00	2.00
Strongly agree	4.24	3.59	3.94	3.71	4.59	3.94	2.24	3.94	1.18	2.82	2.94	1.94
Total	4.16	3.58	3.95	3.79	4.53	3.79	2.21	3.79	1.26	2.79	2.89	1.89

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 column 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 in as a tool that can significantly improve data collection and reporting.

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

2) 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.

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

Cross tabulation of health workers responses by Sex

Table 7 below shows responses to the need to replace the traditional data collection and reporting by sex.

Table 7: Need to replace traditional reporting

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

Table 8: Cross tabulation of data sending easy by sex

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

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

Table 9: Phone compatibility with sex

Count		Phone compatibility with site			
		Not Compatible	Compatible	Very Compatible	Total
Sex Of Respondent	Male	0	4	3	7
	Female	2	7	3	12
	Total	2	11	6	19

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.

Table 10: Period taken to send a request by sex

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

As depicted in the table, the majority (79%) said the period taken to send a report using the 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. The bar chart below summarises the responses.

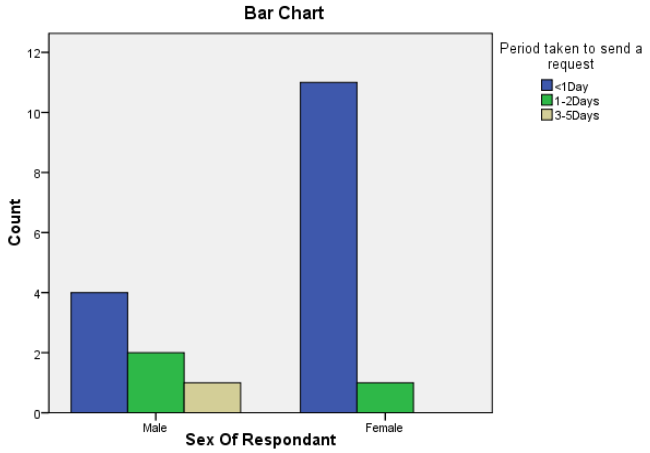

Figure 2 : Period taken to send a request by sex.

Table 1: Where to implement m-health by sex

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

As depicted in the table 89% of the respondents said m-health should be implemented countrywide whereas 11% said it should be implemented in towns. These responses show great acceptance of the platform and contradict the null hypothesis that health workers will not find the platform useful to them.

Table 2 : Ease of use of mhealth platform by job title

Count					
		Ease Of Use			
		Unsure	Agree Somewhat	Strongly Agree	Total
Job Title of respondent	GRN	4	8	3	15
	Doctor	1	1	0	2
	Student Nurse	0	0	1	1
	Nurse Aide	0	1	0	1
Total		5	10	4	19

The figure below depicts that.

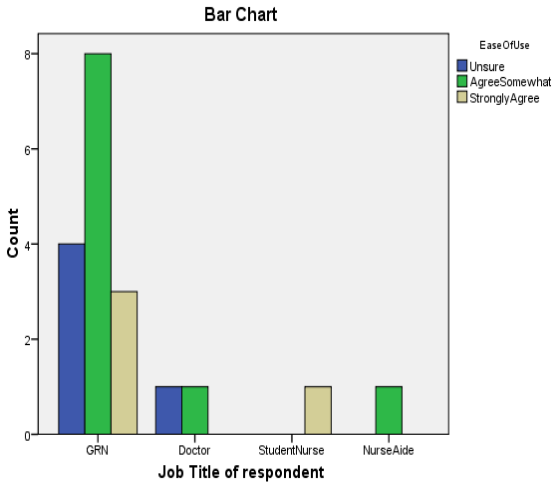

Figure 3 : Bar chart on ease of use

Table 3 : Where to implement m-health by job title

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

As depicted by table 14, 89% of the respondents selected countrywide use of the system and there was a response from all job titles in favor of coutrywide usage which shows acceptance.

Table 4 : Navigation and data sending easy by prior phone internet knowledge

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

As depicted by the table, those with and without prior phone internet knowledge concurred that navigation and data entry is easy with the platform. This is shown in the bar chart .

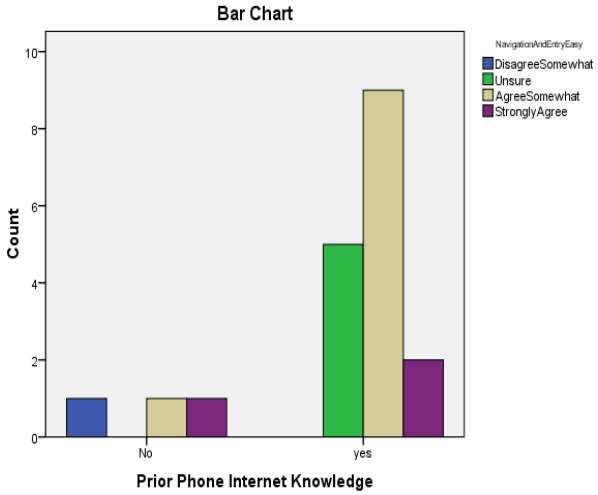

Figure 4 : Navigation and data entry easy by prior phone internet knowledge

Table 5 : Navigation and data sending response by Smartphone Ownership

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

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

Table 6 : Independent samples t-test basing on gender

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
NeedToReplaceTrad	Equal variances assumed	1.274	.275	-.587	17	.565	-.119	.203	-.547	.309
	Equal variances not assumed			-.551	10.493	.593	-.119	.216	-.597	.359
Easy of Access	Equal variances assumed	2.856	.109	-.071	17	.944	-.024	.337	-.734	.687
	Equal variances not assumed			-.063	8.947	.951	-.024	.379	-.881	.834
EaseOfUse	Equal variances assumed	.556	.466	-1.108	17	.283	-.369	.333	-1.072	.334
	Equal variances not assumed			-1.070	11.427	.307	-.369	.345	-1.124	.386
NavigationAndEntryEasy	Equal variances assumed	.735	.403	.279	17	.784	.107	.384	-.704	.918
	Equal variances not assumed			.265	10.920	.796	.107	.404	-.782	.997
AlwaysAvailable	Equal variances assumed	2.288	.149	2.238	17	.039	.667	.298	.038	1.295
	Equal variances not assumed			2.314	14.005	.036	.667	.288	.049	1.284
DataSendingEasy	Equal variances assumed	.569	.461	-2.329	17	.032	-.607	.261	-1.157	-.057
	Equal variances not assumed			-2.082	9.073	.067	-.607	.292	-1.266	.052
System is reliable	Equal variances assumed	.004	.950	.895	17	.389	.333	.377	-.461	1.128
	Equal variances not assumed			.790	9.035	.450	.333	.422	-.621	1.288
Phone compatibility with site	Equal variances assumed	.031	.863	1.162	17	.261	.345	.297	-.281	.972
	Equal variances not assumed			1.236	15.092	.235	.345	.279	-.250	.940
Is Network a challenge	Equal variances assumed	.185	.673	.212	17	.834	.107	.504	-.957	1.171
	Equal variances not assumed			.189	8.966	.854	.107	.567	-1.175	1.390
Period taken to send a request	Equal variances assumed	13.776	.002	1.966	17	.066	.488	.249	-.036	1.012
	Equal variances not assumed			1.580	6.956	.158	.488	.309	-.243	1.219
What reporting do you pefer	Equal variances assumed	1.272	.275	.527	17	.605	.107	.203	-.322	.536
	Equal variances not assumed			.554	14.638	.588	.107	.194	-.306	.521
Where can m-health be implemented	Equal variances assumed	47.719	.000	-2.072	17	.054	-.286	.138	-.577	.005
	Equal variances not assumed			-1.549	6.000	.172	-.286	.184	-.737	.166
Will drug acquisition improve with mhe	Equal variances assumed	.594	.451	-.387	17	.703	-.060	.154	-.384	.265
	Equal variances not assumed			-.360	10.138	.726	-.060	.165	-.427	.308

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

Table 7 : Independent samples t-test by Phone internet knowledge

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
NeedToReplaceTrad	Equal variances assumed	1.274	.275	-.587	17	.565	-.119	.203	-.547	.309
	Equal variances not assumed			-.551	10.493	.593	-.119	.216	-.597	.359
Easy of Access	Equal variances assumed	2.856	.109	-.071	17	.944	-.024	.337	-.734	.687
	Equal variances not assumed			-.063	8.947	.951	-.024	.379	-.881	.834
EaseOfUse	Equal variances assumed	.556	.466	-1.108	17	.283	-.369	.333	-1.072	.334
	Equal variances not assumed			-1.070	11.427	.307	-.369	.345	-1.124	.386
NavigationAndEntryEasy	Equal variances assumed	.735	.403	.279	17	.784	.107	.384	-.704	.918
	Equal variances not assumed			.265	10.920	.796	.107	.404	-.782	.997
AlwaysAvailable	Equal variances assumed	2.288	.149	2.238	17	.039	.667	.298	.038	1.295
	Equal variances not assumed			2.314	14.005	.036	.667	.288	.049	1.284
DataSendingEasy	Equal variances assumed	.569	.461	-2.329	17	.032	-.607	.261	-1.157	-.057
	Equal variances not assumed			-2.082	9.073	.067	-.607	.292	-1.266	.052
System is reliable	Equal variances assumed	.004	.950	.885	17	.389	.333	.377	-.461	1.128
	Equal variances not assumed			.790	9.035	.450	.333	.422	-.621	1.288
Phone compatibility with site	Equal variances assumed	.031	.863	1.162	17	.261	.345	.297	-.281	.972
	Equal variances not assumed			1.236	15.092	.235	.345	.279	-.250	.940
Is Network a challenge	Equal variances assumed	.185	.673	.212	17	.834	.107	.504	-.957	1.171
	Equal variances not assumed			.189	8.966	.854	.107	.567	-1.175	1.390
Period taken to send a request	Equal variances assumed	13.776	.002	1.966	17	.066	.488	.249	-.036	1.012
	Equal variances not assumed			1.580	6.956	.158	.488	.309	-.243	1.219
What reporting do you prefer	Equal variances assumed	1.272	.275	.527	17	.605	.107	.203	-.322	.536
	Equal variances not assumed			.554	14.638	.588	.107	.194	-.306	.521
Where can m-health be implemented	Equal variances assumed	47.719	.000	-2.072	17	.054	-.286	.138	-.577	.005
	Equal variances not assumed			-1.549	6.000	.172	-.286	.184	-.737	.166
Will drug acquisition improve with mhe	Equal variances assumed	.594	.451	-.397	17	.703	-.060	.154	-.384	.265
	Equal variances not assumed			-.360	10.138	.726	-.060	.165	-.427	.308

Analysis of table 18 will again be done in the discussion section of this chapter.

Analysis of the performance of the system.

3) 4.5.2 Speed of the website

The following URL *http://analyze.websiteoptimization.com/wso* was used to test the response time and speed of the website.

http://www.websiteoptimization.com/speed/1/ Monday 19 March 2012 says waiting time is dependent 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 the figure below shows five trials of measuring the website's reaction time and the average.

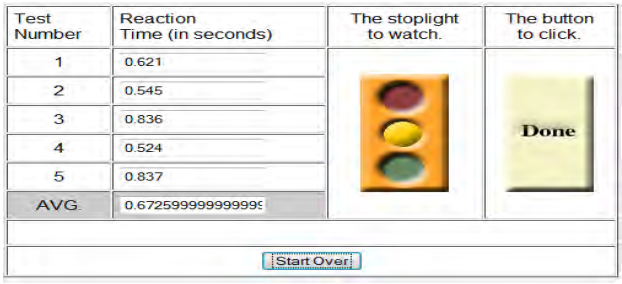

Figure 5 : Website reaction time measurement

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* .

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.

B. Findings and discussions

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

1) Health workers Responses

Dependent variables will be analysed using data from tables 5 above.

a) Need to replace traditional

Table 6 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.

Basing on years of experience as shown in Table 2, about 60% of the less than 1 year agreed to replace with 75% of the 2-3 years again supporting replacing traditional system. 80% of the 3-5 years also supported replacing and 100 % of the greater than 10 years experience supported replacing the traditional system. This shows that regardless of years of experience, health workers do not favour it.

2) M-Health Platform Analysis

a) Response towards m-health platform by sex

Responses from table 3 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.

b) m-health by prior internet knowledge

From the table 5 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.

c) Ease of use

From table 12 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.

d) Navigation and Data Entry

As depicted by the table 15 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.

e) 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.

f) Period to send a report

As depicted in table 10, the majority (92%) of females the period taken to send a report using the mhealth platform was less than a day while (8%) gave 1-2 days to send a report. On males 57% of males said it takes less than a day while about 28% said 1-2 days with the remainder saying 3-5 days. 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 may be 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.

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.

g) Where to implement m-health

Table 1 basically summarises the means of where to implement m-health. As can be seen, the average is 2.89 which is close to a 3 showing that there is recommendation for countrywide use,showing that they found mhealth useful. If it was not of its usefulness, they would not recommend its countrywide usage. However ,there is need to try it on a larger scale because the numbers may at times not be representative of the country's population but where used in the hope that since health centre enviromnent are basicallly the same and the training they receive is the same,we can trust their suggestions. 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.

The website was finally put under test and availability and downtime where measured first.

Using the estimated outage times due to hardware failure and maintenance and also the formula from http://en.wikipedia.org/wiki/Web_hosting_service (Thursday 26/01/2012) the availability for continuous

operations was 98.05% corresponding to a downtime of 14.4 hours per month and 3.36 hours per day. These are reasonable figures showing that the website is almost always available considering our network and power outages in the country. 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. Responses from users showed that they were satisfied with the mobile platform and expressed keen in having the system widely used. Users were 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 and these phones were taking some time before they could load the mobile version. 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.

V. 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

VI. RECOMMENDATIONS AND FUTURE WORK

A. Recommendations

With the positive results realised from the implementation of m-health, it can be seen and concluded that m-health can effectively control malaria, and even other diseases like cholera 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 researchers noted the 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 researchers also recommend funding for the research to be implemented at full scale to many other provinces and districts country-wide.
- The researchers recommend full education on the technology such that it can be implemented country-wide.
- The researchers also recommend that partnerships in such researches should be made with service providers to make subsidy in developing mobile systems.

The researcher proposes to advance research using a particular brand of mobile phones if funds are available. The work to be done in the future can also include development of applications to include facilities like chat and other surveillance features that can be used to improve real-time communication between users and administrators. The platform also needs to be implemented on other diseases as it has worked for malaria and this should be done on a larger scale since the numbers used in this research, because of accessibility and funding were difficult and minimal. 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.

VII. ACKNOWLEDGMENT

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