USE OF MOBILE NETWORK-BASED APPS IN HIV/AIDS TREATMENT AND COUNSELING IN ETHIOPIA

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In

Computer Science

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ACCEPTANCE

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Accepted by the Faculty of Informatics, St. Mary's University, in partial fulfillment of the requirements for the degree of Master of Science in Computer Science

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DECLARATION

I, the undersigned, declare that this thesis work is my original work, has not been presented for a degree in this or any other university, and all source of materials used for the thesis work have been duly acknowledged.

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Table of Contents

ACKNOWLEDGEMENTS i

LIST of Acronyms v

List of Figures vi

List of Tables vii

Abstract viii

CHAPTER ONE:INTRODUCTION 1

1.1 Background 1

1.2 Statement of the Problem 2

1.3 Objectives 3

1.3.1 General Objective 3

1.3.2 Specific Objectives 3

1.4 Contributions and Significance 4

1.5 Organization of the Rest of the Thesis 4

CHAPTER TWOS:REVIEW OF RELATED WORKS 5

2.1. Introduction 5

2.2 Case studies 7

2.2.1. Cell-Life: Cellphones4HIV 7

2.2.2 Project Masiluleke 9

2.2.2.1. Phase one 9

2.2.2.2. Phase two 10

2.2.2.3. Phase three 10

2.2.3. Text to Change (TTC), ... 10

2.2.4. Mobiles in Malawi 11

2.2.6. Phones for Health (PEPFAR) 16

2.2.7. Diagnostics 17

2.2.8. Cellscope 17

2.2.9. Cellophone 18

2.2.10. The Health at Home/Kenya Impact Initiative 18

2.2.11. UNF-VF Partnership 19

2.3. Summery 23

CHAPTER THREE:METHODOLOGY 25

3.1. APPS for HIV Treatment and Adherence 25
3.2. SMS for HIV Treatment and Adherence 26
3.2.1. Sample 26
3.2.2. Interview Structure 27
CHAPTER FOUR:THE PROPOSED SYSTEM 29
4.1. Android Application implementation details 29
4.1.1. Android service components 31
4.1.2. Sequence diagram for the proposed system 33
4.1.3. Activity Diagram for the proposed system 34
4.1.4. Web Based discussion forum navigational implimentation design 34
4.2. Component of Short Messaging Service 37
4.2.1. Process of SMS reminder 38
4.2.2. Use Case Diagram for SMS Reminder 39
4.2.3. Class Diagram for SMS Reminder 40
4.3. Components of USSD Voice Message Service 41
CHAPTER FIVE:SYSTEM TESTING AND EVALUATION 42
5.1. SMS intervention 42
5.1.1. Feasibility of the Intervention 42
5.1.2. SMS Usage 42
5.1.3. Usage Assesment 43
5.2.4. Programmatic Challenges and Suggestions 45
5.2.4.1. Suggestions for Frequency of the Messages 46
5.2.4.2. Communicating with HCPs 46
5.2. Mobile Phone Applications Intervention 46
5.2.1. Populating The App with Data 47
5.2.2. Data collection 47
5.2.3. Age distribution of participants 48
5.2.4. Sex distribution of participants 49
5.2.5. Marital status 50
5.2.6. HIV testing behavior of participants 50
5.2.7. Risk of becoming infected with HIV 51

5.3. Discussions 51
5.4. Voice message for HIV Treatment and Adherence 53
5.4.1. Description of the service 54
5.4.1.1. Benefits of Voice Message 55
5.6. Findings 56
CHAPTER SIX:CONCLUSIONS, RECOMMENDATIONS AND FUTURE WORKS 57
6.1. Conclusions 57
6.2 Recomendations 58
6.3 Future Works 59
Appendices 55
Appendix A: Questionnaire For Target Populations 55
Appendix B: Evaluation Questionnaire 60
References 62

LIST of Acronyms

HIV/AIDS: Human immunodeficiency virus or Acquired immune deficiency syndrome

HCT: HIV Testing and Counseling

PMTCT: Prevention of mother to child transition

ART: Antiretroviral Therapy

VCT: Voluntary Counseling and Testing

STD: Sexually Transmitted Dieses

SMS: Short messaging service

GPRS: General radio packet service

3G: Third generation

USSD: Unstructured Supplementary Service Data

ARV: Antiretroviral

HCP: Healthcare providers

NGO: Non-Governmental Organization

SDK: Software Development Kit

List of Figures

Page

Figure.1. Android Architectural Framework and module development.....30

Figure.2. Service component of an android system.....32

Figure.3. Sequence diagram: provide treatment.....33

Figure.4. The android system activity diagrams.....34

Figure.5. The android discussion forum relational database diagrams.....35

Figure.6. Navigation Diagram for HIV/AIDS Counseling and Treatment Pag.....36

Figure.7. Components of SMS Reminder Process.....38

Figure.8. Use Case Diagram for SMS Reminder Process.....39

Figure.9. Components of USSD service [62] 40

Figure.10. Front line SMS platform sending message.....43

Figure.11. Front line SMS platform sending message.....44

Figure.12. Front line SMS message content.....49

Figure 13. Age distribution of participants. 50

Figure 14. Sex distribution of participants.....50

Figure 15. Marital status.....51

Figure 16. HIV testing behavior of participants.....53

Figure.17. Android application front page screenshots.....53

Figure.18. Android application screenshots.....54

Figure.19. Android forum screenshots of login page.....54

Figure.20. Android forum screenshots of add topic page.....55

Figure.21. Android forum screenshots of reply to answer page.....56

List of Tables

Page

Table 1: Apps for HIV/STD-positive persons.....22

Table 1: Participant characteristic.....24

Table 3: Voice Message Service Tariff.....28

Table.4: Sample SMS reminder 37

Abstract

Studies have been conducted in developing countries using short message service (SMS), mobile Apps and voice mail to communicate with patients to reduce the number of missed appointments and improve retention in treatment; however; very few have been scaled up. One possible reason for this could be that patients are dissatisfied with the method in some way. This research work presents a study on a mobile health intervention in antiretroviral therapy (ART) and tuberculosis (TB) treatment aiming to support retention of patients' and youths vulnerable for the diseases in Ethiopia.

The study was conducted at two healthcare centers in Ethiopia. Automated SMS health promotions and reminders were sent to patients in a randomized control trial (RCT). android based platform which gives information about human immune virus and sexually transmitted diseases in Amharic is developed and uploaded on App store for download. Finally, recorded voice mail reminder was forwarded to patients. A total of 89 patients and youths vulnerable to the diseases were interviewed and quationeered. Respondents rated usefulness, perceived benefits, ease of use, satisfaction, and risks of the systems using a Likert scale questionnaire. A semi-structured interview guide was followed. Interviews were transcribed, and thematic analysis was conducted.

Both patients and youths found the mobile based systems useful and reliable. Most highly rated positive effects were reducing the number of failures to collect medication and avoiding missing appointments. Patients' confidence in the system was high. Most perceived the system to improve communication between health-care provider and patient and assist in education and motivation. A majority would recommend the system to other patients or healthcare centers. Risks also were mentioned, mostly by patients, of unintentional disclosure of health status in cases where patients use shared phones.

The results suggest that mobile based technology for human immune virus (HIV) and TB could be used to transmit reminders for appointments, medications, motivational texts, and health education to increase retention in care. Measures must be taken to reduce risks of privacy intrusion, but these are not the main obstacles for scaling up such a system.

Keywords: *Antiretroviral Therapy, Android Based Platform, Human Immune Virus*

CHAPTER ONE

INTRODUCTION

1.1 Background

Mobile phone health interventions are increasingly being used for the prevention and care of human immunodeficiency virus (HIV) and other sexually transmitted diseases (STDs) [1]. These initiatives have been designed to promote prevention messages, facilitate test result notification [1], improve HIV medication adherence, and increase adherence to clinic appointments [2]. Although phone-based interventions have typically used the voice or text-based Short Message Service (SMS) features of mobile phones, the increasing popularity of smart phones and Smartphone applications (apps) has greatly expanded the possibilities for phone-based HIV/STD interventions [3]. These interventions are critical for reversing the HIV epidemic; 34.2 million people worldwide are living with HIV [4]. Sub-Saharan Africa countries are the most affected region, with 25.6 million people living with HIV in 2016 [4].

Smartphone's have revolutionized mobile communication markets by offering enhanced mobile phones featuring improved Internet access and the capacity to perform more advanced computer functions. Currently in Ethiopia there are approximately 42 million active cell phone users from this 4% of users own Smartphone [5]. Smartphone apps are downloadable programs that run on the Smartphone's operating system, which may include Web-based features. As of March 2016, Apple's iTunes apps had received over 25 billion downloads and the Android Google Play Store exceeded 15 billion app downloads in May 2012 [6] [7].

Sexually transmitted disease (STD) is a term used to describe more than 20 different infections that are transmitted through sexual contacts, blood strains, and by direct contact with the affected body areas of people with these infections. HIV is sexually transmitted disease. It can also be spread by contact with infected blood or from mother to child during pregnancy, childbirth or breast-feeding.

There are different nongovernmental organizations working to disseminate information about HIV treatment in Ethiopia like CARE, CHAD-ET, Christian Aid, Plan, Oxfam, Save the Children, The United Nations Children's Fund (UNICEF) and others. And, the information is disseminated via different ways including print media, radio, television, billboards, newspapers and the Internet. Not all of these media are accessible to everyone all the time. Using mobile-based systems to increase the convenience seems an obvious extension.

This research is, thus, aimed to develop a mobile based HIV/AIDS counseling information and guidance system. The information includes reminding people to take their medication on time, the dangers of having multiple concurrent partners, cause or effects of HIV/AIDS medical prescription, HIV and pregnancy and other VCT information using messaging in story format. The research aims to develop an application in local language that offers treatment recommendations approved by experts for the treatment of adult, adolescent, pediatric, and prenatal HIV infection, as well as the prevention and treatment of HIV-related opportunistic infections in adults, adolescents, and children.

1.2. Statement of the Problem

Mobile based applications have become one of the popular ways for communication and use in many applications like m-health. The emerging cellular infrastructure (mobile penetration and rural network expansion) in developing countries like Ethiopia can open opportunities to utilize it in different applications like m-health. Different communication technologies have been used to disseminate information amongst HIV/AIDS patients. TV is traditionally widely utilized, and it is the most expensive medium compared to other technologies [7]. The cost of production and cost of advertising on local TV channel is higher. Radio is more affordable. However, both technologies cannot deliver timed and urgent information for patient [7]. The cost of using mobile based application is much less than the cost of other communication technologies and can reach substantial population instantly [8]. Content and timing of the information can be used to examine which communication technology is better than the other [9]. Therefore, in this research work the use of mobile technology in HIV treatment are is explored.

So, the following are major problems regarding HIV/AIDS and STDs.

- Patients are unable to get timely antiretroviral therapy (ART) information unless they are going to the nearest ART centers.
- Patients cannot get information regarding side-effects of medicines and what diets they should use and do not use in case of prescription.
- Adults are unable to get adult information at the time they look for it for prevention and care.
- Adults fear to go to ART service provider centers in fear of seen by others.
- Using Android apps, Ussd voice message and SMS to exploit and share relevant information among patients themselves and with health professionals.

1.3 Objectives

1.3.1 General Objective

Using mobile application and mobile technologies (like SMS, Voice USSD and Android application) to provide essential medical information, counseling and advice to people affected by HIV/AIDS in a tailored and timed format and to examine the efficiency, scalability, confidentiality and challenges associated with its applicability.

1.3.2 Specific Objectives

- To develop Android app that will increase users' knowledge about the benefits of Antiretroviral Therapy
- To understand technological issues and content that we have to consider when using mobile technologies for HIV treatment and counseling.
- To support antiretroviral health care for patients at home
- To develop system that deliver accurate and accessible ARV information that is targeted or tailored in preferred language.
- To provide personalized self-management support
- Enable quick and informed response to HIV/AIDS health risks and provide emergency information
- Provide new opportunity for ARV related information for diverse and hard to reach populations.

1.4 Contributions and Significance

The purpose of this research is to evaluate the feasibility and acceptability of SMS messages, Android application and voice-mail among HIV-positive persons and vulnerable youths, to elicit suggestions for the implementation of specific SMS features, and to infer the potential pathways through which the intervention is perceived to work. Further, this study would be beneficial to the users as the technologies will provide the necessary information's in local language specifically Amharic. Furthermore, this study contributes to health care providers as it measures, and asses use of four mobile based systems and evaluate it to come with concurrent outcomes and risks associated with it

1.5 Organization of the Rest of the Thesis

Formal studies and evidence demonstrate that mobile applications have a measurable impact on and a greater ability to influence behavior than radio and television campaigns. According to unite nations report, In the developing world, mobile applications have proven particularly effective in targeting hard-to-reach populations and rural areas, where the absence of clinics, lack of healthcare workers, and limited access to health-related information all too often prevent people from making informed decisions about their health. For future work: "For example, map indicating nearest HTC could be developed and web-based HIV/AIDS educational forum could be established. This interactive model has been deployed in several countries (e.g., India, South Africa, and Uganda) to promote AIDS education and testing and pro-vide information about other transmittable diseases (such as TB), as well as to promote maternal health and educate youth about reproductive health".

Customizing these applied technologies in Ethiopia can upgrade the present communication methods in advance. Therefore, in my belief this concept of work will have remarkable impact and can boost future works for other researchers.

CHAPTER TWO

REVIEW OF RELATED WORKS

2.1. Introduction

Mobile phones are one of the fastest spreading technologies in the world, and they are now being used for more than just making calls. Like SMS, voice messaging, users are adopting the devices and the technology to completely new ends never used when mobile phones first used.

With an estimated 42 million mobile phone users in Ethiopia, mobile phone technology presents a great opportunity and potential to address and positively impact the many health challenges facing resource-poor countries. This is commonly referred to mobile for health (mHealth) or electronic health (eHealth) [10]. The public health community essentially uses the following working definitions:

- EHealth: Using information and communication technology (ICT) - such as computers, mobile phones, and satellite communications - for health services and information [10].
- MHealth: Using mobile communications - such as Personal Digital Assistants (PDAs) and mobile phones - for health services and information [10]."

In 2005 the World Health Organization (WHO) proposed the use of low-cost technology (eHealth) to improve the quality of health care delivery particularly at the primary healthcare (PHC) level, as well as build health worker capacity in resource-poor countries [12].

The mobile phone is accessible in even the most remote areas of the world where access to medical personnel or health facilities do not exist. A tool remarkable in its simplicity has already dramatically changed how societies and communities interact on a personal and professional level and the promise it offers health care is no less remarkable.

Six key applications in HIV have already emerged:

- Supporting adherence
- Sending basic prevention and other health messages
- Hooking people into services, especially VCT
- Supporting health workers to do their jobs, saving time and increasing the operational efficiency of services
- Improving the efficiency of data gathering and analysis for service management purposes
- The adaptation of phones to provide a portable diagnostic device

This article reviews some case studies of service developments that reflect these applications. The case studies present illustrative strength and depth of mobile technology in emerging markets in the developing world. Not only do they demonstrate the potential of eHealth as a powerful and effective tool to combat HIV and TB, but also to help address other global health problems in addition to providing (health-related) assistance.

Mobile phones also offer the advantage of low-cost, providing immediate communication and they can be maintained in areas without electricity, for example with solar power chargers [15].

Mobile technology is a tool that offers the potential for:

- Decreasing the isolation of the healthcare community: making it possible for healthcare workers to provide real-time diagnoses and accurate health information in rural as well as marginalized areas where minimal or no health services exist.
- Improving access to care.
- Remote diagnosis, monitoring and evaluation.
- Improving quality, efficiency and cost-effectiveness of care.

- Tracking of diseases and monitoring of populations at risk.
- Enabling a faster and more co-ordinate response globally and nationally to disease events and natural disasters [16].

2.2 Case studies

2.2.1. Cell-Life: Cellphones4HIV

South Africa has one of the highest rates of HIV in the world with more than 5.6 million people living with HIV or one tenth of the population. The South African government began supplying antiretroviral (ARVs) in 2004. An estimated 30% of those in need are now on ARVs. Successful treatment requires adherence and monitoring. With a weak healthcare infrastructure, lack of trained healthcare workers and a disparate system of rural clinics, consistent and adequate follow-up is a serious challenge.

Access to health care may be limited for most South Africans but over 80% have mobile phones (cell-phones), whereas barely 10% have access to the internet. Cell-Life was created to explore the opportunities this technology offers for HIV prevention and care.

The project is working to determine the impact of mobile phones for mass-messaging for prevention; mass information for positive living; linking patients and clinics; building the capacity of the health system, peer-to-peer support and counseling; building the capacity of HIV-related organizations; and monitoring and evaluation.

Cell-Life, a non-profit organization based in Cape Town, South Africa, began as a community home-based care system, known as 'Aftercare', for the direct management of HIV patients and has since evolved to cover broader aspects of HIV management noted above. The project started as a joint venture between the University of Cape Town and the Cape Peninsula Institute of Technology. The project's objectives included: reduced treatment errors, improved comfort for the patient and increased quality of care, increased and improved quality of patient data [24].

Central to Aftercare, a peer support home-based care model, are the volunteer community-based health workers (CBHW) who are themselves living with HIV. Each CBHW was assigned 15 to 20 people living with HIV. One-to-one sessions were held in

the patient's home where information about medical status, drug adherence and other factors affecting ART was recorded. This information was then relayed via text message to a central Cell-Life database accessed by a care manager through a web-based system. The data are monitored and stored. At the same time the care manager can respond in real-time to the CBHW's questions and provide information that will improve patient care. A monitoring and evaluation system was built into the project [25].

Initial results indicated improvement in quality of care. Success of this project was illustrated by the appropriate use of technology designed to address the end-users needs. Its simplicity, participatory approach and real-time feedback via text message all contributed to the positive outcomes. Familiarity with mobile phones was an important factor for rapid adoption. While the workload for CBHWs was increased, their competency was viewed as enhanced by their patients who cited an improvement in the quality of care received. In addition, their status within their professional community was boosted by their eHealth work [26].

Challenges were identified: long-term, financial sustainability is questionable, and there were difficulties in bringing it to scale. The system could only be used on one mobile-phone network using pre-paid accounts. The software used was written in English and would need to be translated into the 11 official languages of South Africa to effectively bring it to scale. Additional barriers for individual CBHWs were identified too. Personal security and fear of having the mobile-phone stolen was an issue. Some were concerned with the intrusion of their work into their personal lives.

Cell-life has been working to resolve these issues as their brief expands as described above. Funders now include the Vodacom Foundation, the Raith Foundation (an original funder), USAID-PEPFAR and Johns Hopkins Health and Education in South Africa.

Pilot projects include: working with Treatment Action Campaign (TAC) using text messages (SMS) to communicate within the Western Cape, supporting adherence clubs by sending reminders. A survey involving 140 club members was undertaken to determine self-reported ART adherence rates, TB co-infection and socio-economic data. Members were invited to sign up for twice-daily text messages which included a reminder to take ART, treatment literacy information, and positive living advice. Only three club members

declined. Information sent was based upon the expressed interests of the survey respondents. Initial reports indicate the acceptance and popularity of using mobile phones in this way [27]. Formal research studies to measure the impact of mobile communications on prevention and adherence have been started.

2.2.2 Project Masiluleke

Project Masiluleke, another South African NGO, is using a free text message service (Please Call Me - PCM) to encourage HIV testing and counseling. Given that mobile usage is highest in the age groups most likely to be infected and undiagnosed, they hope to make a significant impact on reducing the numbers unaware of their HIV status by encouraging them to be tested, counseled and treated where eligible [28].

The concept was born out of frustration and anger with the recognition that stigma associated with one's HIV status and with having TB contributed to the current situation [29].

iTeach serves as the primary clinical site for Project Masiluleke. ZinhleThabethe together with Krista Dong, M.D. started iTeach, an HIV/TB education, and outreach and service organization based at Edendale hospital, one of the busiest in KwaZulu-Natal, the epicentre of South Africa's HIV epidemic.

Project Masiluleke consists of the following key components:

2.2.2.1 Phase one

First one million text messages a day are being sent for a period of one year (365 million) to encourage people to be tested and treated for HIV and TB [30].

Message content is supplied by iTeach, and MTN has donated space for the messages. The Praekelt Foundation provides the technology and frog design the design elements. Messages are sent in the unused space of 'Please Call Me'- a free text message service widely used in South Africa and across the continent. These free text messages allow individuals without phone credit to request a call back. The messages connect mobile users to existing HIV and TB call centers. Specially trained counselors provide callers with accurate information as well as referrals to local testing clinics. Messages are

written in local languages. Initial beta tests indicated that after three weeks of sending messages, calls to the National AIDS Hotline tripled [31]. A second phase is planned to expand geographic coverage. Careful monitoring and evaluation are integral to the project. Unlike radio and television advertising Please Call Me provides a direct and measurable link between use and end-goal: the number of people who saw the messages, how many called as a result and how many subsequently used the service can all be measured.

Second Text Alert: Keeping Patients Connected to Care [32]: An automated text message reminder service was linked to the existing patient record data system at Thembu Lethu clinic in 2007 to improve clinic attendance for those receiving ARVs. Missed appointments were slightly higher for those not receiving reminders than those who did.

2.2.2.2. Phase two

Virtual HIV-positive call centers: The idea is that call centers will be staffed by teams of highly trained, highly adherent HIV-positive counselors who will field questions remotely from their mobile phones.

2.2.2.3. Phase three

At-home HIV testing with Mobile Support: the project partners are actively exploring the possibility of an at-home HIV testing model with mobile counseling support, using a home testing kit. The concept parallels that of the home pregnancy kit. It is anticipated that such a model would provide a free, private and reliable way for anyone to find out their status. Information would be provided via a mobile device. Such a system raises many questions [33]. Project Masiluleke is heralded as the world's biggest field trial of mHealth [34].

2.2.3. Text to Change (TTC)

In September 2008 Text to Change (TTC), a local NGO that uses text messages to provide HIV education in Uganda, partnered with the AIDS Information Centre (AIC) in Uganda and Celtel, a local mobile network to launch a pilot project in western Uganda to provide information about HIV and encourage subscribers to volunteer for HIV testing.

According to the Uganda Demographic Health Survey (DHS) an estimated 6 million Ugandans own mobile phones with 50% usage in urban areas and 10% usage in rural areas. DHS found that while most Ugandans are aware of HIV, comprehensive knowledge is estimated at approximately 30% for women and 40% for men [35].

The pilot project, launched on Valentine's Day, ran for a six-week period. A list of 15,000 Celtel subscribers were sent an introductory text message and asked whether they would be interested in participating in a free interactive quiz about HIV. Incentives to participate included the offer of handsets and airtime for correct answers. Participation was anonymous.

Each week one question was sent. A correct answer was confirmed with a text message. An incorrect one received a corrected response. Approximately 2500 of the 15,000 responded to questions each week. At the end of the quiz a final text was sent encouraging participants to go for testing and counseling at the local health center. The fee for the test was waived for TTC participants and brought about a 40% increase in the numbers getting tested over the six-week period.

Bas Hoefman, public relations officer at TTC thought that participation could be further increased by presenting the quiz in local languages. The quiz was interactive and focused on two specific areas: knowledge about HIV transmission and the benefits of testing and counseling [36].

2.2.4. Mobiles in Malawi

"St. Gabriel's is certainly not alone in the challenges it faces as a rural healthcare provider. After witnessing the effects of simple ideas and equally uncomplicated technology on medical care, one thing was clear – each day that a clinic goes without tools they want, and need is a day with undue hardship", says Josh Nesbit, a student at Stanford University who has been working with a mission hospital in Malawi to adapt mobile phone technology to the needs of local healthcare workers [37].

An SMS-based communications network was set up for a rural hospital, St. Gabriel's, and its 600 volunteer community health workers (CHWs) in Namitete, Malawi in the summer of 2008 to help overcome the barriers that distance created for patients and healthcare

workers alike. Active within the HIV-positive community, many of the CHWs were recruited through the hospital's ART programme to act as CHWs in their respective villages [38].

St. Gabriel's serves 250,000 Malawians in 700 villages within a 100-mile radius. Access to the hospital for many involves walking or, for the more affluent, riding a bicycle over 100 miles. Access and communication was no less difficult for the CHWs and limited their abilities to help patients.

With a 15% HIV prevalence rate, widespread malnutrition and diarrhoea, multi-drug resistant TB and other opportunistic infections, the doctor ratio of one doctor for every 80,000 patients is typical of many rural areas in Africa.

The programme began with 100 recycled mobile phones and a donated laptop running FrontlineSMS:Medic – a free application that enables analysis of vast amounts of text messages without the need for a central server or internet access. This application acted as a central text-message hub and was placed within the hospital to co-ordinate the network's activities. "FrontlineSMS:Medic merges two pieces of open-source software. FrontlineSMS allows users to connect a SIM modem to a PC to create an SMS hub", the developers say. "Open MRS is an open-source electronic medical records system developed by Partners in Health and the Regenstrief Institute. The platform integrates these tools and will enable two-way communications between clinicians and health workers and text messages with patient data will automatically be entered into a unique medical record for individual patients [39]."

During the pilot study, CHWs were brought to the hospital in groups of 10 to 15 and trained in text messaging. Their locations were mapped, and the phones were distributed throughout the service area.

The SMS network has had a positive impact on patient care and hospital operations.

- The hospital is able to respond to requests for remote patient care. The CHW will test the hospital when immediate care is needed, and the patient will then be visited by the Home-Based Care mobile unit.

- Patients can be tracked. For example, if a TB patient should miss an appointment a CHW in close proximity is sent a text and can follow-up.
- Drug dosage and usage can be checked. CHWs are given basic drug supplies for primary care. When FrontlineSMS:Medic receives a drug name all information relating to dosage and usage is automatically texted back.
- CHWs are able to provide regular patient updates including deaths.
- Co-ordination of Home-Based Care visits is facilitated. The mobile unit texts a CHW who lives close to the patient to be visited to ensure the patient is at home and so avoid wasting precious travel time and fuel.
- CHWs communicate and collaborate with each other.
- HIV testing, and counseling has been improved. Upon testing positive a patient is linked to a CHW with a phone. Support and close links to the hospital and care are maintained.

In a period of six months the SMS network saved the hospital an estimated 1200 hours of staff follow-up time and over $3000 in motorbike fuel. Close to 1400 patient updates have been processed through SMS. Over 100 patients have started TB treatment when their symptoms noticed by CHWs were reported by text message. The network has brought the Home-Based Care unit to the homes of 130 patients who might otherwise not have received care. Additionally, texting has saved ART monitors 900 hours of travel time and eliminated the need to hand-deliver paper reports.

Within two weeks of setting up the operation the day-to-day management of the project was handed over to hospital staff [40].

Josh Nesbit, founder of FrontlineSMS:Medic has compiled a guide on 'Building an SMS Network into a Rural Healthcare system' and in keeping with his philosophy, "This guide provides an inexpensive way to create an SMS communications network to enable healthcare field workers as they serve communities and their patients. The steps are purposefully simple - the system is easy to set up, use and maintain [41]."

Plans to scale-up the project begin next year with a 500,000-patient study in Bangladesh, a co-operative venture with Brac, a development charity, Stanford Medical School and Independent University, Bangladesh. The goal is to roll out the current set-up to 30 sites in 20 countries over the next six months. Funding from the Clinton Global Health Initiative has recently been received for the development of a low-cost HIV test to be integrated into the text messaging system.

Work has also begun on further development of the software through the open source community. The potential for the text messages to overload the current system is real. A common lesson emerging from the various eHealth pilot projects is that no matter where they operate the need is for them to be "as simple and user-friendly as possible, and the hidden back end should use sophisticated software and hardware [42]."

"The dream within two years is that you can be on a website, you can download our software, you can apply to get our hardware and you decide what to do with it. You the patient, you the health worker, you the clinician, who's on the front lines fighting this battle, you decide how it's used.

FrontlineSMS:Medic launched the website: www.hopephones.org – a way for people to donate their old mobile phones for use by a medical clinic.

2.2.5. Uganda Health Information Network (UHIN) AED-Satellife

Access to information is no more available in many parts of Africa and especially rural areas, than clean running water, electricity or the internet. Quality of care is dependent upon the knowledge a nurse or CHW - often working alone - has retained and/or has access to. Personal digital assistants (PDAs) are handheld computers that make it possible to store, access and organize a considerable volume of information. PDAs can exchange data electronically with other devices. When telephone capabilities are included they are referred to as 'smart phones' [43].

For six years AED-Satellife has pioneered the use of PDAs by health professionals working in resource-poor areas enabling them to receive and transmit important data where they are needed, at the point of care, enabling healthcare workers to make better informed treatment decisions. Information includes disease treatment information, treatment

guidelines, newsletters, essential drug lists and databases via a wireless or mobile network. Customized software for data collection enables the health worker to track patients and maintain electronic records.

Initiated four years ago, the Uganda Health Information Network (UHIN) (a collaboration of the Ugandan Chartered HealthNet, Makerere University Medical School and district health authorities) is AED-Satellife's largest project using PDAs in Uganda, and now connects 175 remote health clinics serving an estimated 1.5 million people.

It began as a pilot project in two health districts. Project implementation was carried out by Ugandan workers from local and national health organizations co-ordinate by Makerere University Medical School. Information content was developed using a participatory approach involving local health workers (the end-users). It involved primarily digitization of existing paper-based health data forms, decision support guidelines and educational materials. Training and technical support were provided throughout the initial phase. The two main applications were:

1. The health management information system and
2. The e-learning contents, which included locally developed and WHO guidelines for managing the health-related Millennium Development Goals (MDGs) [44].

Having translated the software and materials into Portuguese the project is now being replicated in 110 health centers in Mozambique and was launched in the spring of 2008 in South Africa. UHIN only gained support from the Ministry of Health once the project proved viable, three years into the project. Realizing the importance of governmental support to ensure sustainability and capacity AED-Satellife chose to engage the Mozambique Ministry of Health as a partner from the outset.

An initial evaluation of UHIN revealed a 24% cost-saving over the traditional paper approach for recording data [45].

Lessons learned over the past six years of working in resource-poor countries using PDAs for delivering and collecting health information have been incorporated into a 'PDA Toolkit' available from AED-Satellife [46]. The toolkit consists of a step-by-step guide on

how to set-up and organize PDAs, including how to assess an organization's readiness for using handhelds [47].

2.2.6. Phones for Health (PEPFAR)

Phones for Health, a global public-private partnership, (composed of the GSM Association's Development Fund, Accenture Development Partnerships, Motorola, MTN, Voxiva and PEPFAR) is designed to use mobile phones for the collection and management of data, to order drugs and obtain treatment information.

Key objectives include:

- The development of an integrated set of standard information solutions that support the scale-up of HIV/AIDS, TB, and malaria services
- Using mobile phones for real-time data capture
- Delivering those solutions to countries in a way that is cost-effective, scalable and sustainable
- Help build the foundation for national Health Management Information Systems (HMIS) [48].

The partnership was piloted in Rwanda in 2006 through a project called TRACnet with a focus on HIV/AIDS. Rwanda is a country of hills and muddy roads in the rainy season where information can take weeks to get from a remote village to a health center. Phones for Health has revolutionized the way that information is received and used, enabling the Rwandan government to better track and manage the epidemic.

"With TRACnet, we have a powerful tool to manage the HIV and AIDS programme and deliver care to Rwanda's patients affected by HIV and AIDS. Healthcare workers use something as simple as a cell phone – even where there is no electricity – to report on the number of patients on treatment, drug stock levels and the other key data we need", said Dr. Agnes Binagwaho, Executive Secretary, Rwanda's National AIDS Control Commission. "Rwanda is the first country in Africa with a national-scale, real-time information system to manage its HIV and AIDS programme. We believe this can be a

model for scaling up HIV and AIDS programmes across Africa and can be extended to TB, malaria and other diseases [49]."

The partnership is currently in the process of expanding to nine other countries in Africa.

Phones for Health is a system designed to enable health workers in the field, by using a standard Motorola handset equipped with a downloadable application, to enter health data. This data is then transferred through a packet-based mobile connection into a central data base. If a mobile connection is not available, the data can be sent via an SMS data channel. The system then maps and analyses the data which is available to health managers at all levels of the system [50].

Timely receipt of accurate health data will enable health ministries to better plan, respond to and act on current and emerging epidemics as well as potential outbreaks in real-time.

2.2.7. Diagnostics

In most resource-poor areas the ability to perform even the simplest medical tests, such as blood counts, necessary to effectively treat diseases like HIV and malaria, is extremely limited. The capability to analyses samples in a simple and cost-effective way that requires minimal training is urgently needed. The mobile phone has been readily adapted for two diagnostic technologies already, *Cellscope* and *Cellophone*, described below. Both inventions won prizes in the Vodafone Foundation's Wireless Innovation Project earlier in 2008.

2.2.8. Cellscope

A project that began as a challenge to Dan Fletcher's undergraduate students at the University of California, Berkeley has turned a mobile phone into a diagnostic tool for malaria. The goal of the project is to bring modern diagnostic testing to remote areas cheaply and effectively via telemicroscopy [51].

The Cellscope is a device that is attached to the digital camera of a mobile phone effectively turning it into a microscope. The Cellscope can show individual white and red blood cells. This means that with the correct stain it can be used to identify the parasite

that causes malaria. This image could then be transmitted directly over the mobile network and so provide assistance with remote diagnosis and monitoring of illnesses.

Malaria was chosen initially since its diagnosis demands a high-quality image, but the invention is potentially applicable to any disease in which microscopy is required, such as TB. The team believes that minimal training would be needed to take and stain blood samples which could then be captured and sent to an expert for diagnosis [52].

2.2.9. Cellophone

The aim of the Cellophone Project led by Dr. AydoganOzcan of UCLA is to provide a revolutionary optical imaging platform to be used specifically to analyze bodily fluids within a mobile phone.

The technology advanced by Dr. Ozcan and his team relies on what is termed as Lensfree Ultra-wide field Cell Monitoring Array platform (LUCAS) and is based on shadow imaging. This technology counters the dominant thinking that has prevailed over the past few decades in the development of microscopes of building more powerful lenses or other advanced imaging apparatus. Shadow imaging of cells and bacteria relies on the detection of their shadow signature – the pattern of diffraction of waves by cells. Each type of cell has a specific electronic signature, or 'shadow', that can be detected.

No bulky attachments or components or lenses are needed, and its developers say "…it can immediately monitor an ultra-large field of view by detecting the holographic shadow of cells or bacteria of interest on a chip. Through advanced signal processing tools that are running at a central computer station, the unique texture of these cell/bacteria holograms will enable highly specific and accurate medical diagnostics to be performed even in resource-poor settings by utilizing the existing wireless networks [53]."

2.2.10. The Health at Home/Kenya Impact Initiative

An important initiative in western Kenya is in the process of moving from concept to proof of concept. 'The Health at Home/Kenya Impact Initiative' plans to provide home-based HIV/AIDS testing and counseling, TB screening and malaria bed-nets for millions who reside in a remote region with limited access to health care. It is a collaborative public-

private partnership that includes members of the Global Business Coalition on HIV/AIDS, TB and Malaria (the Abbott Fund, Accenture, Bristol-Myers Squibb Foundation, CfCStanbic Bank Kenya, The Coca Cola Company, Deutsche Post DHL, Pfizer Inc, Premier Medical Corporation, SAB Miller and Standard Chartered Bank), the Kenyan Government and PEPFAR. The project will build on the successful Kenya-based AMPATH (Academic Model Providing Access to Healthcare Program) door-to-door pilot project where HIV testing teams achieved an 80% uptake of HIV testing among those eligible. A nurse/counselor who enters the home has a PDA and Geographic Positioning System (GPS) device to collect and enter data on family health, record test results and identify the physical location of the household for treatment, education, counselling and data collection follow-up. Data is entered into the AMPATH medical record system, the most complete and comprehensive medical data base in sub-Saharan Africa. Anyone identified as HIV-positive is immediately given an appointment for follow-up clinical care.

Should this initiative prove successful it would serve as a model for replication in other similar areas of Africa. It also represents an example of usually competing groups working together to harness the benefits of mobile technology for a social good [47].

2.2.11. UNF-VF Partnership

The UNF-VF Partnership was formed, to establish a unified global body to promote best practices and commonly agreed standards for eHealth, known as the mHealth Alliance.

An opportunity exists, described by Karl Brown of the Rockefeller Foundation in New York, a founding partner of the UNF-VF Partnership as 'smart globalization' where, as exemplified in the Mekong Basin Disease Surveillance Network, "people with different skills, speaking different languages, and reporting to different hierarchies now enjoy new ways of working together on shared information communication technology platforms" [55]. InSTEDD (Innovative Support to Emergencies, Diseases and Disasters), a not-for-profit based in the US, headed by Eric Rasmussen, exemplifies this approach. They are currently developing open-source communication solutions that can be adapted to local needs. For example, the belief is that for a global surveillance system to be effective it must "provide the people closest to the trouble with the information and authority they

need to act swiftly [56, 57]." They have created an open-source application that pulls together data from different mobile sources combining them with maps and other data sources allowing health workers in the field to act on a warning of a disease outbreak.

The case studies, cited above, while not exhaustive, exhibit basic characteristics that make these pilot projects a success. They demonstrate, albeit on a small scale, improved healthcare delivery as well as increased efficiency of healthcare systems. They present a foundation for future best practices. Common characteristics include:

- A clear programme with well-articulated and realistic goals and objectives reflecting both the needs on the ground and of the intended beneficiaries
- The needs must drive the technology, not the technology drive the needs. Solutions must be appropriate and responsive to local needs. The visible face of mobile technology needs to be simple and user-friendly, while the hidden back-end requires sophisticated hardware and software
- End-users must be involved from concept to completion and beyond; use of mobile technology must be incorporated into daily use and not be viewed as a burden or handicap; incentives in the form of time/cost savings and/or added prestige are important
- Ease and familiarity of use; trainings should be an integral and ongoing activity
- Engaging government at the outset is essential to sustainability

While there is a proliferation of 'mobile technology solutions', many have not moved from the concept stage. One example is the Council on Foreign Relations' 'doc in a box' – first promoted in 2005[58]. It is a standard cargo container set up to serve as a basic mobile rural health clinic and would be linked to medical professionals via mobile phone. One factor that is perhaps delaying its piloting, even though it is creative and does appear to address the issues that beleaguer healthcare workers in remote areas in resource-poor countries is that it was developed in the west and would appear to be a developed world solution for a resource-poor problem.

If the real potential that mobile technology offers to help meet the MDG health targets is to be realized, then key to moving forward is investment in the compilation of solid evidence-based information by way of impact assessments in addition to sharing of knowledge and resources. The mHealth Alliance, an important partnership, aims to foster and meet these objectives.

2.2.12. Voice message for HIV Treatment and Adherence

2.2.12.1. Description of the service

Voice messaging is an instant communication technology in which messages are transmitted via voice media. Voice messaging is an alternative to voice calls or text messages. It stores voice messages in a voice mail, which can be accessed via a smart device or even a landline phone. For businesses, voice messaging can offer considerable lead generation and can be used for appointment reminders, recalls and dissemination of information. It can also be used to reach out to customers or provide them with customized information or to reach a larger segment of peoples.

Voice messaging can be used to communicate either with a group or with just a single contact. It also allows more expressiveness than text messaging but requires a little more effort when composing a message. Voice messaging, however, is more expensive than text messaging. Also, for short messages, the voice messaging is more convenient and has a higher delivery success rate. Voice message service enables to record and send voice messages like a short text message. The receiver can listen to the voice message by dialing the number code received through text message.

2.2.12.2. Benefits of Voice Message

- Voice Message can record and send voice Message in the preferred language.
- It is less time consuming to send a voice message.
- Enable users to express their emotions in the voice message.
- Easy to send voice messages on the move.
- All handset types can support the service
- Listening to new messages is free of charge.
- Can directly listen to the message by dialing the number received with the notification text message.

In Ethiopia the service is activated to all customers; therefore, no need to subscribe to get the service dialing 886 & follow the prompt, insert the recipient's number, record the message, press the hash key, anyone can re-listen, re-record, or delete the message before to send. Also, people can choose to send the message as normal or confidential. To check whether there is a new message call 845 for free.

To listen saved voice messages users, call 887. They can forward, delete, and reply to Voice messages they received from others.

Table 1: Voice Message Service Tariff

No	Service type	Duration of a message	Price
1	Sending VMESSAGE	30 second	0.42birr
2	Retrieve/Listen new VMESSAGE	Free	
3	Re-play/ listen saved message (after two times)	30 second	0.12birr
4	Reply to V MESSAGE	30 second	0.42birr
5	Forwarding a VMESSAGE	0.42	
6	Subscription and rental fee	Free	
7	Notifications from system number	Free	

Maximum duration of one voice message to be sent at once is 180 second.

- When a new message arrives, users will receive a text message notifying this. Dial the number code from the text & you can listen the message twice for free.

If users need to listen more than 2 times, dial 887 & follow the prompt.

- All received messages will be saved automatically if it is not deleted by users.
- Unread VMESSAGE can be saved for a maximum 90 days.
- The maximum voice message users can store in the message box is 10 messages.
- The voice message that users have received as a confidential message cannot be forwarded to other receivers.
- Messages can be stored for maximum of 90 days.

2.3. Summery

The reviewed studies have suggested that SMS, USSD and applications can be used in the HIV community to link people to care, support treatment adherence, and increase community engagement. Localization of the apps can be easy on the listed apps but as the research aims to develop only informational application, it's better to start from scratch beyond this Amharic resources for HIV/AIDS can be found on different NGOs currently working in Ethiopia and the apps found on both stores are suited for specific community that may not include information regarding behavior of audiences found here in Ethiopia. The research also developed a discussion forum using a web-based forum which can be integrated with the android application. Summary of apps found on both iPhone and android store are listed on table 1.

Table 2. summery Apps for HIV/STD-positive persons

Name	Platform	Price (US $)	Features	Language
Birmingham AIDS Outreach[BAIDSO]	iPhone, Android	Free	Connect to resources and support groups	English
HIV and Your Heart[HIV&YH]	iPhone	Free	Track CD4, viral load, weight, smoking, and other heart health measures	English
iStayHealthy[ISH]	iPhone, Android	Free	Track CD4, viral load, medication, adherence, side-effects	English
PatientTreatment Companion[PTC]	iPhone, Android	Free	Track CD4, viral load, medication, appointments, weight	English
PositiveSingles[PS]	iPhone, Android	Free	Connect to other positive persons	English
PozTracker[PZ]	iPhone	3.99	Track CD4, viral load, medication, clinic location	English
Red Ribbon HIV/AIDS Manager[RRHIVM]	iPhone, Android	9.99	Record allergies, medication, CD4	English
Talk Positive [TP]	iPhone	Free	Track side effects, CD, viral load	English

CHAPTER THREE

METHODOLOGY

3.1. Introduction

Now days mobile phones in developed countries become the main source of information and their use for health purposes is widening. This is not true when we come to developing economies like Ethiopia. As the reach of cell phones increases in the country, their use as health intervention and prevention tool is not explored well examined. There are no literatures studying on mobile technologies for HIV counseling and treatment in Ethiopia and only one project in the continent.

3.2. Research Design

The study used a behavioral experimental design with pre and post-test control group design. Participants were found in a convenience sample from a call to volunteer. The call for volunteers specified only people who live or work in ADDIS ABABA. The study used the quantitative approach for data collection. The intervention used in the study is a mobile application (app) promoting HIV prevention, including the benefits of HCT and testing center locations in Addis Ababa, Ethiopia. The mobile application (app) was developed to deliver accurate messages on the benefits of HCT in HIV prevention to mobile devices, including mobile phones and tablets. The app was free to download and there was no inducement to participate in the study.

3.3. Methods

3.3.1. Data Collection

Data collected was analyzed using Predictive Analysis Software (PASW) formerly called Statistical Package for Social Sciences (SPSS) software. The data was coded and cleaned of inconsistencies before analysis. The data were summarized using simple descriptive statistics like mean, percentages, frequencies as well as pie and bar charts. Following the guidance in Leta, Sanjoy, and Fylkenes, (2012), an HIV/AIDS-related knowledge index was built from participants' responses to seven questions on HIV prevention including benefits of HCT and the index is categorized as low score ≤ 4, high score 5 – 6 comprehensive score 7. Three questions addressed modes of transmission, consistent

condom use and the risk of exposure to HIV associated with the incidence of sexually transmitted infections. Further, a line graph was used to show the group means of the pre and post-test control group design studying the effect of the use of the mobile network-based app. The study also used inferential statistics to analyze data. Analysis of covariance (ANCOVA) was used to determine the statistical significance of the difference in the responses of the intervention group participants who used the mobile app and the participants in the control group who did not. Square Test of Association was used to determine the relationship between use of the mobile app and uptake of HIV testing during the 10 weeks of the experiment.

3.3.2. Population

The data of the study were collected as part of the research for developing an SMS based intervention called Reminding patients to Adhere. A subsequent three randomized controlled trial will test the interventions ability to prompt HIV- positive peoples aged above 25 with adherence problems in two clinics in Ethiopia (African mother's foundation and hiwot Ethiopia) to take their medications on time and offer social support via motivational l text messages.

3.3.2.1. Sample

Table 1 provides information about participant characteristics, perceived barriers to treatment and feasibility of the intervention. The average age was 25 years. More than 50% of the study sample reported they could understand instructions provided at clinics and they could attend scheduled appointments on time.

Table2: Participant characteristic

Total number of participants	50
Age	22-40
Take medication as directed	8-10
Understand instruction received at clinic	7-10
Have all information to pursue treatment	6-10
Return for scheduled appointment	8-10
Disclosure about HIV status	0-10
Own cell phone	95%
Share Phone	50%
Knows how to read a text	100%
Intervention anticipated to be helpful in improving adherence	100%

The research has been conducted with 39 HIV-positive peoples who were receiving ART from two clinics, African mother's foundation and hiwot Ethiopia, in Addis Ababa Ethiopia. In each clinic, six focus groups involving females and males aged 25 years and above respectively were interviewed. I conducted focus groups separately by the clinic in order to reflect potentially different clinic environments or different types of patients in care at the two sites. By gender to take into account different types of barriers for women's and due to a smaller number of available patients in both clinics, I conducted focus groups.

3.3.2.1. Discussion

Each focus group involved the participation of 5–9 clients (median = 6) who had adherence problems defined as having missed at least one medication dose per week on average that patients asked and reported.

Focus group participants were randomly selected. First, the research used the clinic's database to determine the age and reported adherence for clients that were expected to visit the clinic during recruitment days (Tuesdays and Wednesdays at AHF). Selected participants were approached during their clinic visit and were asked if they would be interested in participating in a Focus Group. Those who were interested in participating were administered verbally informed about The Procedures by the researcher.

3.3.3. Interview Structure and analysis of data

Before the start of focus groups, I provided participants a short quantitative survey so that I would have a better understanding of focus group participants. This survey consisted of 13 short items that asked participants to answer questions pertaining to the following domains: age; adherence challenges; and feasibility of intervention, the availability of cell phones, familiarity with text messages including being able to read, write and send messages and acceptability of SMS-based interventions to improve adherence among HIV-positive individuals. For adherence challenges, participants had to evaluate how confident they felt that they could access and use HIV care on a scale of 0 to 5 with higher scores indicating more confidence while for feasibility related questions they provided yes/no answers.

An interview guide was developed to structure focus groups. The interview was prepared in order to elicit information about how HIV patients thought SMS based interventions would function to improve their adherence and the best ways of implementing such interventions.

Specifically, participants were requested to reflect upon

1. General reaction to the research program
2. Cell phone related issues

3. Familiarity and comfort with text message s
4. Privacy concerns as well as potential pitfalls to be avoided.

The sample questions that were used to guide focus groups were conducted in the native language of participants, which was typically Amharic. Interviewing was done typically by the researcher while the other collaborator took notes and contributed to the discussion as needed. All focus groups were digitally recorded with permission from participants and then translated into English for data analysis.

Data were analyzed for six focus groups. I began the data analysis procedure by reading the six focus group transcripts. During this process, I realized that respondents discussed three themes these are

- Perceived benefits of the intervention,
- Perceived challenges of intervention and
- Provided suggestions for best implementing the research.
- Respondents discussed pathways through which the intervention was perceived to have an impact.

Suggestions for implementing the research included specific feedback regarding

- The content of messages
- The identity of the sender
- The frequency of messages
- Use of passwords and feasibility of two-way messages.

CHAPTER FOUR

THE PROPOSED SYSTEM

4.1. Android Application implementation details

Android is a Linux-based operating system designed primarily for touch-screen mobile devices such as smart-phones and tablet computers, with its support for multiple device configurations. Android has various versions and varied from device to device. Applications in Android work on the top of OS and are implemented in Java. My android application is built and supported on android version 2.0 and above.

Architecture: The Android operating system software stack consists of four divisions. These divisions are Applications, Application Framework, Libraries and Linux kernel. The Linux kernel acts as an intermediate layer between hardware and the software stack. Android depends on it for system services such as security, memory management, process management, network and drivers.

User Interface: Each UI screen is Activity in Android application. Operations on UI components (like button, check box, text field, radio button, etc.) Is written In Java, whereas UI design is implemented in XML. Android MANIFEST file deals with maintaining association between the Java classes and UI. The XML is designed such that it can support multiple screen sizes and screen pixel densities. My android supports screen sizes ranging from 3" to 7" screen sizes. To implement support screen sizes Relative Layout is used. Also, the application is designed to work completely stand alone and if internet connectivity is made available, user can use it for more features and HIV/AIDS patients can connect to each other. In order to remind user about medical information, system has a facility to deliver related timely notifications. So that user interacts with system to maintain periodicity and consistency. There is provision in Android to have periodic notifications depending on particular events. This can be considered as a kind of alarming service.

Thus, an HIV/AIDS expermental application, based on such technology will be effective to promote awareness. For simplicity of application this android application is divided into four different modules. Each of these modules focuses on different aspects of application. This section signifies their operation and importance with demonstrating diagram.

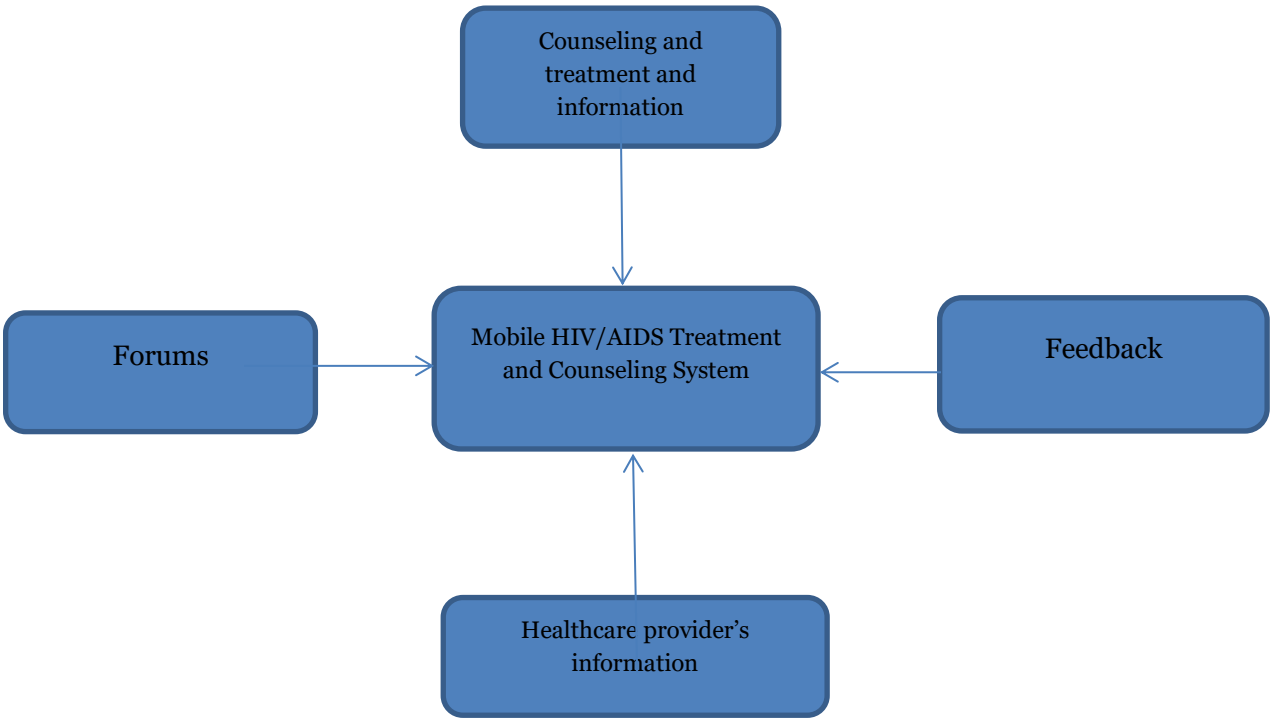

Fig.1. Android Architectural Framework and module development

Module 1: "Counseling and treatment information" This module is about awareness of HIV/AIDS. Instead of presenting data in bulk unmanageable format, it is broken down into smaller pieces. The information's includes Health Topics, HIV Testing, Health Monitoring, Treatment Guidelines, Side Effects, Adherence, Drug Infections, Treatment for Woman, Treatment Interruptions, How Transmit ion Occurs, Sexual Transmit ion, Condoms, Vaccines, Prevention of Mother to Child Transmit ion, Smoking, Alcohol, Sexually Transmitted, TB Vaccines. Each module explains about its role as its name suggests and is intended to give users the complete know-how on AIDS. This aims at clarifying user's doubts, biases and misunderstandings regarding the spread and prevention of the disease.

Module 2: "Forums "offer people around the country to support and connect with others living with HIV/AIDS. Users can share experiences, successes, laughter and pain with others who can really understand what it's like to live with HIV or AIDS. They also can perhaps give diet tips so that they can continue living a healthy life. The sub-modules are reproductive health, safer sex and mental and emotional support. Each module open discussion about its role as its name suggests.

Module 3: “Feedback” Obtaining a customer’s opinion about the app. Feedback can be about the improvement of the app, to know user’s implication about the app, know users need to incorporate in the app, malfunctions, suggestion, feeling, failure, performance, confusion, unawareness and inconvenience with the app. It includes name of the user, email address and message body to get important information from the user.

Module 4: “Contact us” Include a contact form, list physical address, include social media links and photos.

4.1.1. Android service components

A Service is an application component that can perform long-running operations in the background, and it does not provide a user interface. Another application component can start a service, and it continues to run in the background even if the user switches to another application. Additionally, a component can bind to a service to interact with it and even perform inter process communication [59].

Onstartcommand (): The system invokes this method by calling startservice() when another component requests that the service be started. When this method executes, the service is started and can run in the background indefinitely. It can be stopped by calling stopself () or stopservice ().

Onbind (): The system invokes this method by calling bindservice() when another component wants to bind with the service. It must be provided an interface that clients use to communicate with the service by returning an ibinder. This function is always implemented.

Oncreate (): The system invokes this method to perform one-time setup procedures when the service is initially created (before it calls either onstartcommand() or onbind()). If the service is already running, this method is not called.

Ondestroy (): The system invokes this method when the service is no longer used and is being destroyed. The service should implement this to clean up any resources such as threads, registered listeners, or receivers. This is the last call that the service receives.

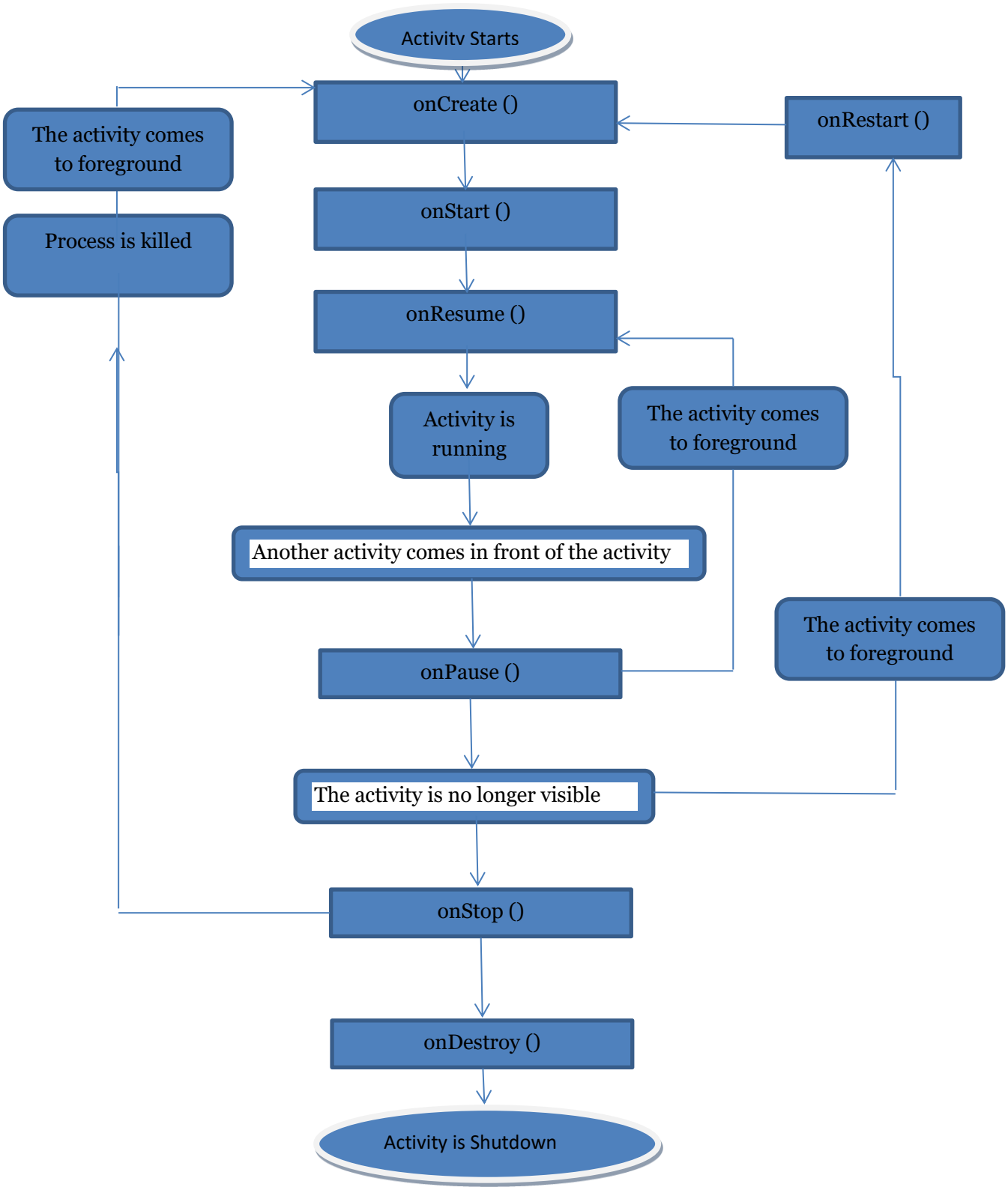

Fig.2. Service component of an android system

4.1.2. Sequence diagram for the proposed system

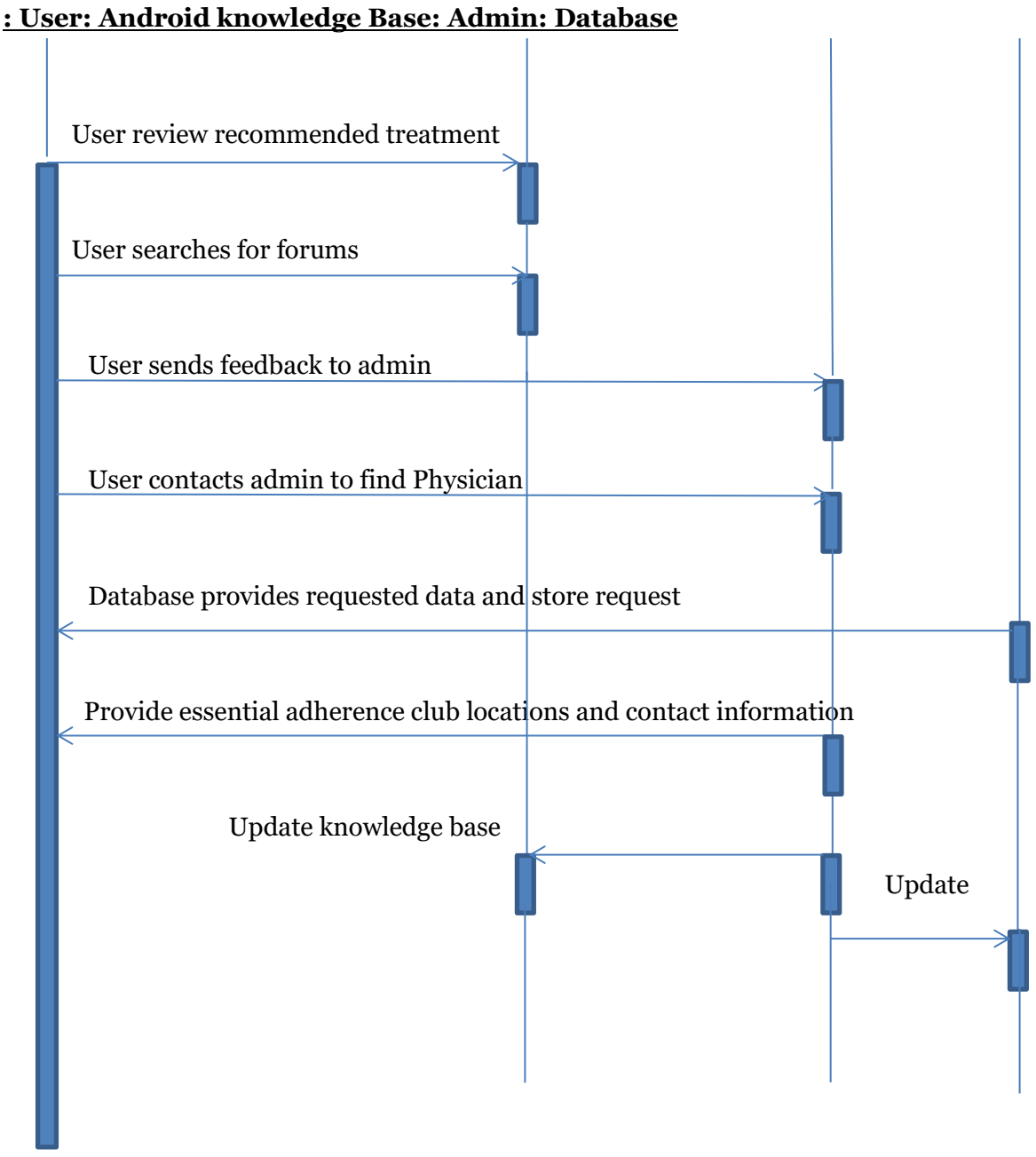

Fig.3. Sequence diagram: provide treatment

4.1.3. Activity Diagram for the proposed system

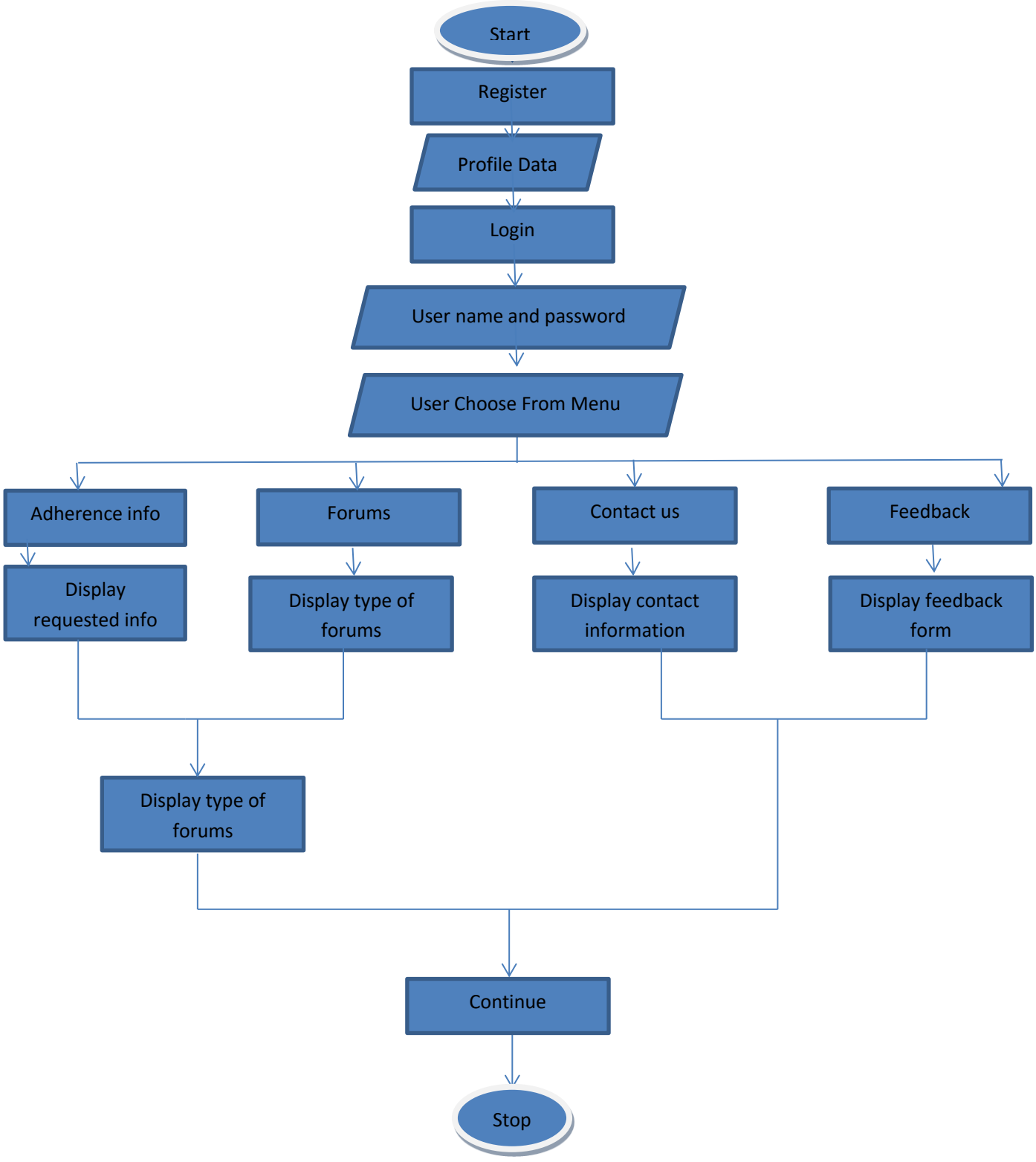

Fig.4. The android system activity diagrams

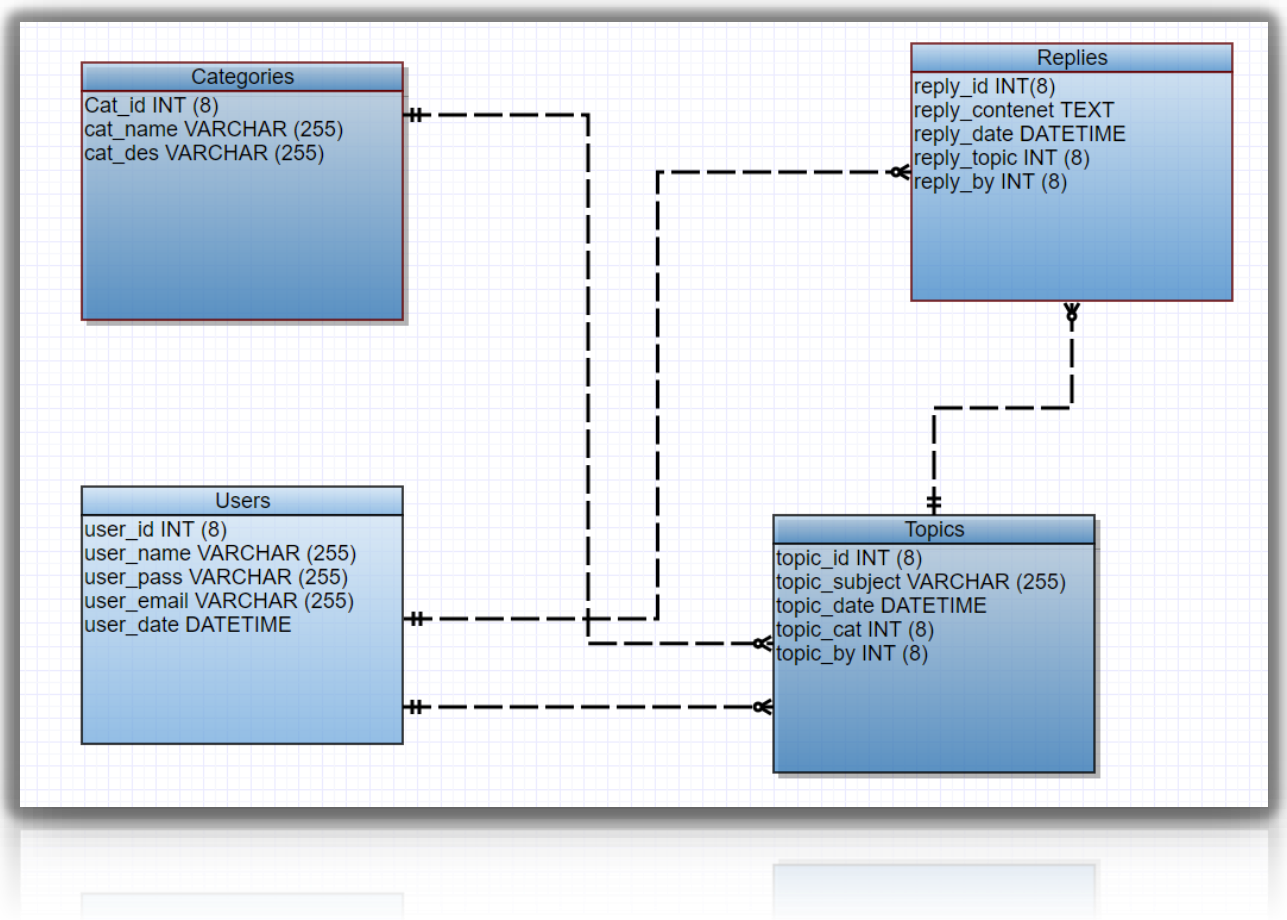

Fig.5. The android discussion forum relational database diagrams

4.1.4. Web-Based Discussion Forum Navigational Implementation Design

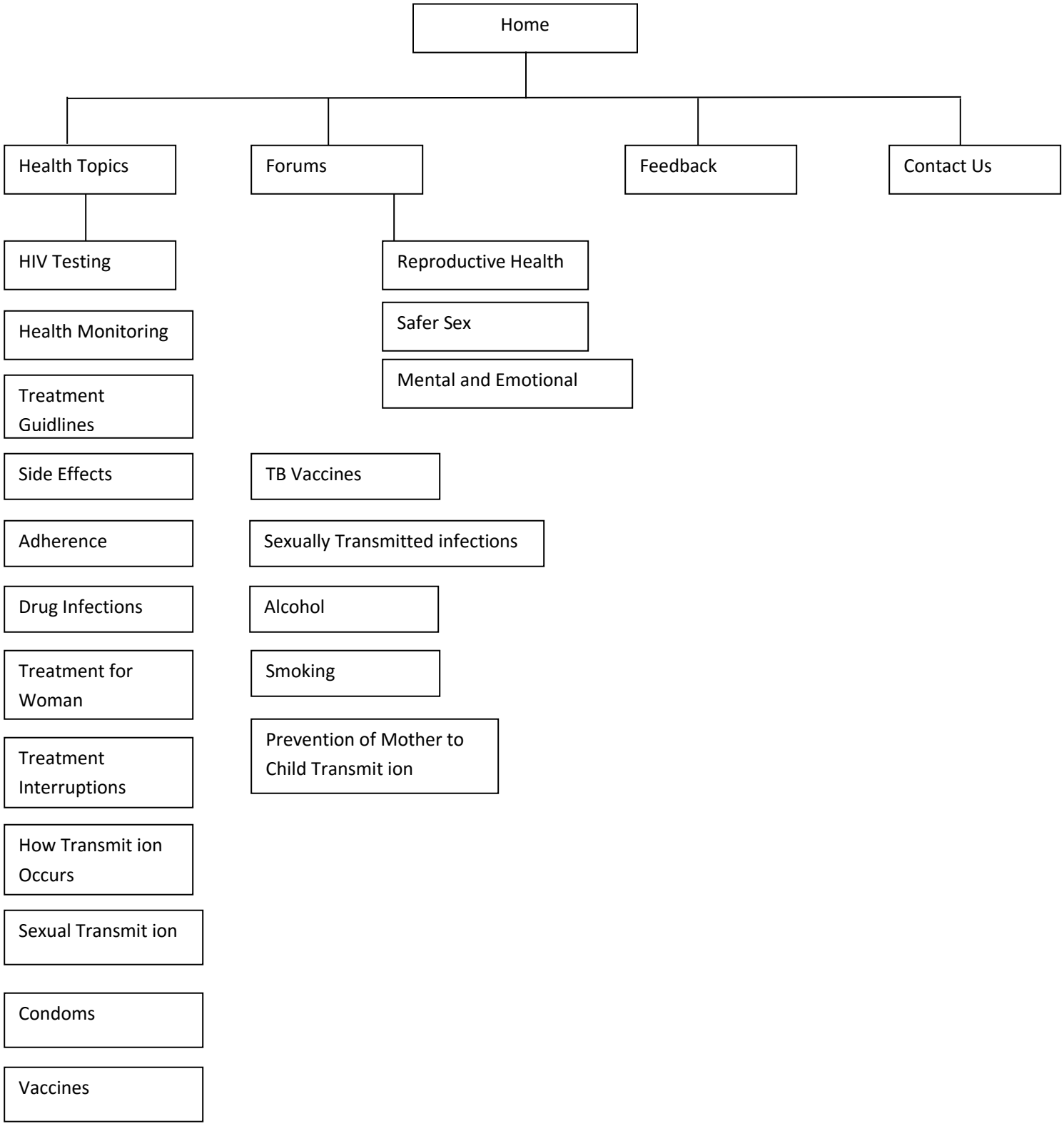

Fig.6. Navigation Diagram for HIV/AIDS Counseling and Treatment Page

4.2. Component of Short Messaging Service

Text messaging programs require specialized software applications to handle message content and delivery scheduling, and message routing services to deliver messages. SMS messaging application software supports scripting, scheduling, replying, and routing to an SMS gateway based on pre-configured algorithms, thus eliminating the need for an individual to send, monitor, and respond to each text. There are different types of message features. In my proposed system, I will use Bulk Messaging which is one-way text messages are sent to a list of recipients because this feature is useful for public health alerts or health education campaigns [60] and requires minimal or no customizability. The following table shows a sample tailored message format to be delivered for users.

Table.4. Sample SMS reminder

Message Type/Outcome	Message Content	Character Count	Date	Time	Tailoring
Reminder: forget to take your arvs on time	Don't forget to take your arvs on time. Adherence means taking your arvs on time, every day. The arvs may not be effective if you miss doses or take them late.	137	4/8	8am	Women ages 35-50

The main issue regarding text messaging in healthcare is the transmission of protected health information. Unfortunately, it is currently not possible to encrypt SMS messages end-to-end when they are sent between different cellular networks. The concern is messages may be visible to those other than the phone's owner, either because the phone is not password protected or because incoming text messages are displayed on a screen preview feature. Study participants can be advised to protect their phone and turn off preview features that allow a preview of the message to be automatically displayed on the screen.

4.2.1. Process of SMS reminder

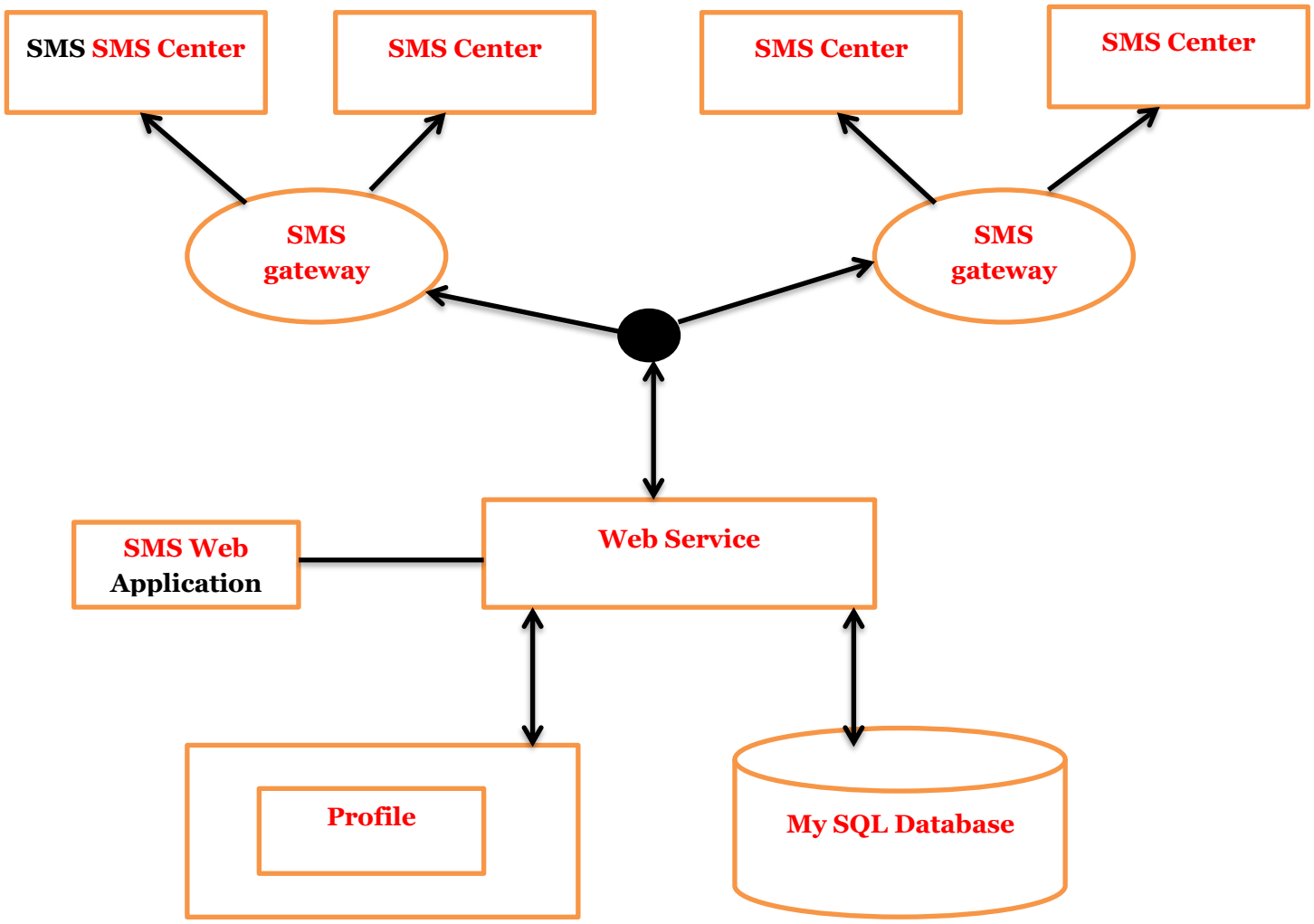

Fig.7. Components of SMS Reminder Process

4.2.2. Use Case Diagram for SMS Reminder

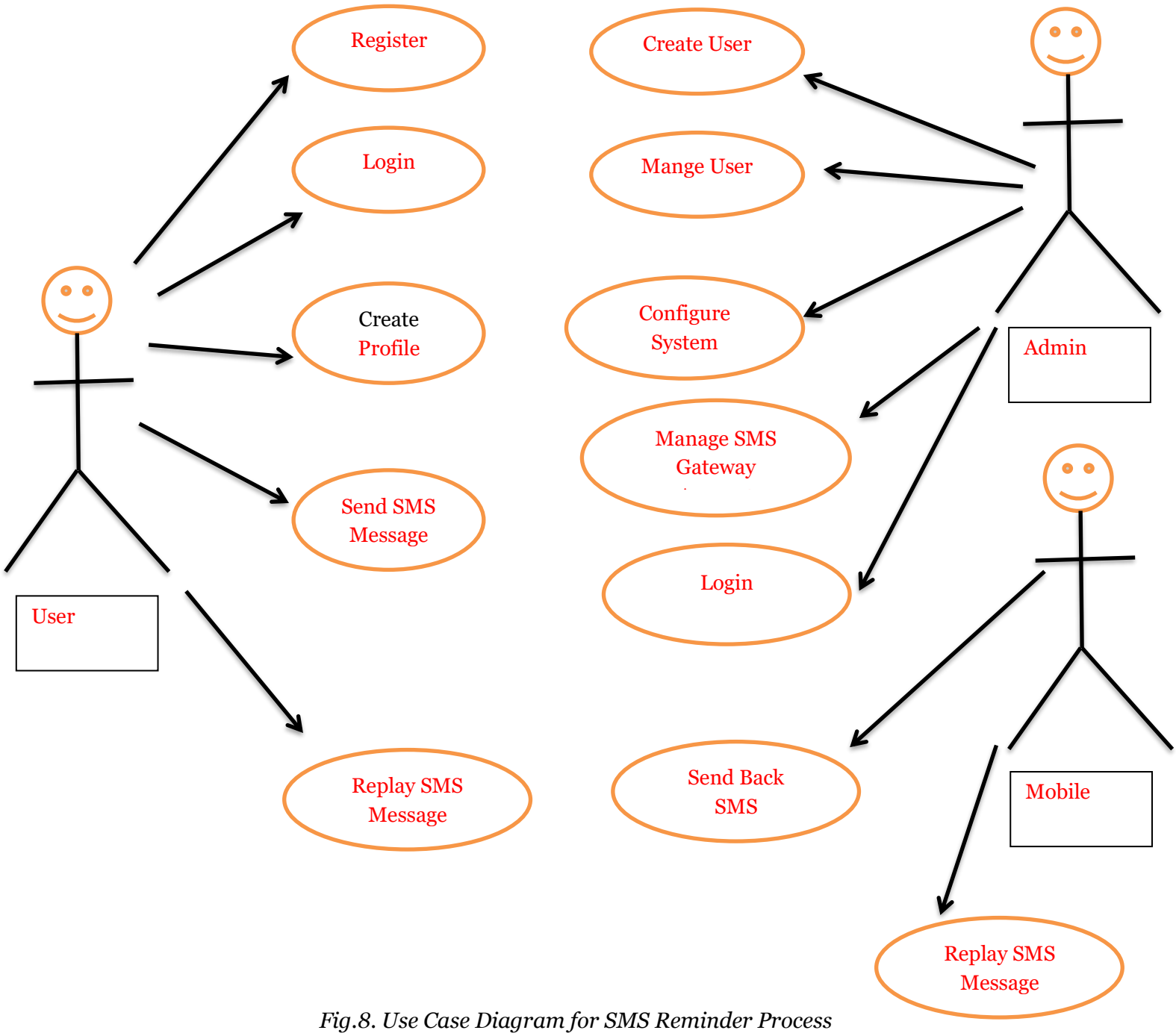

Fig.8. Use Case Diagram for SMS Reminder Process

4.2.3. Class Diagram for SMS Reminder

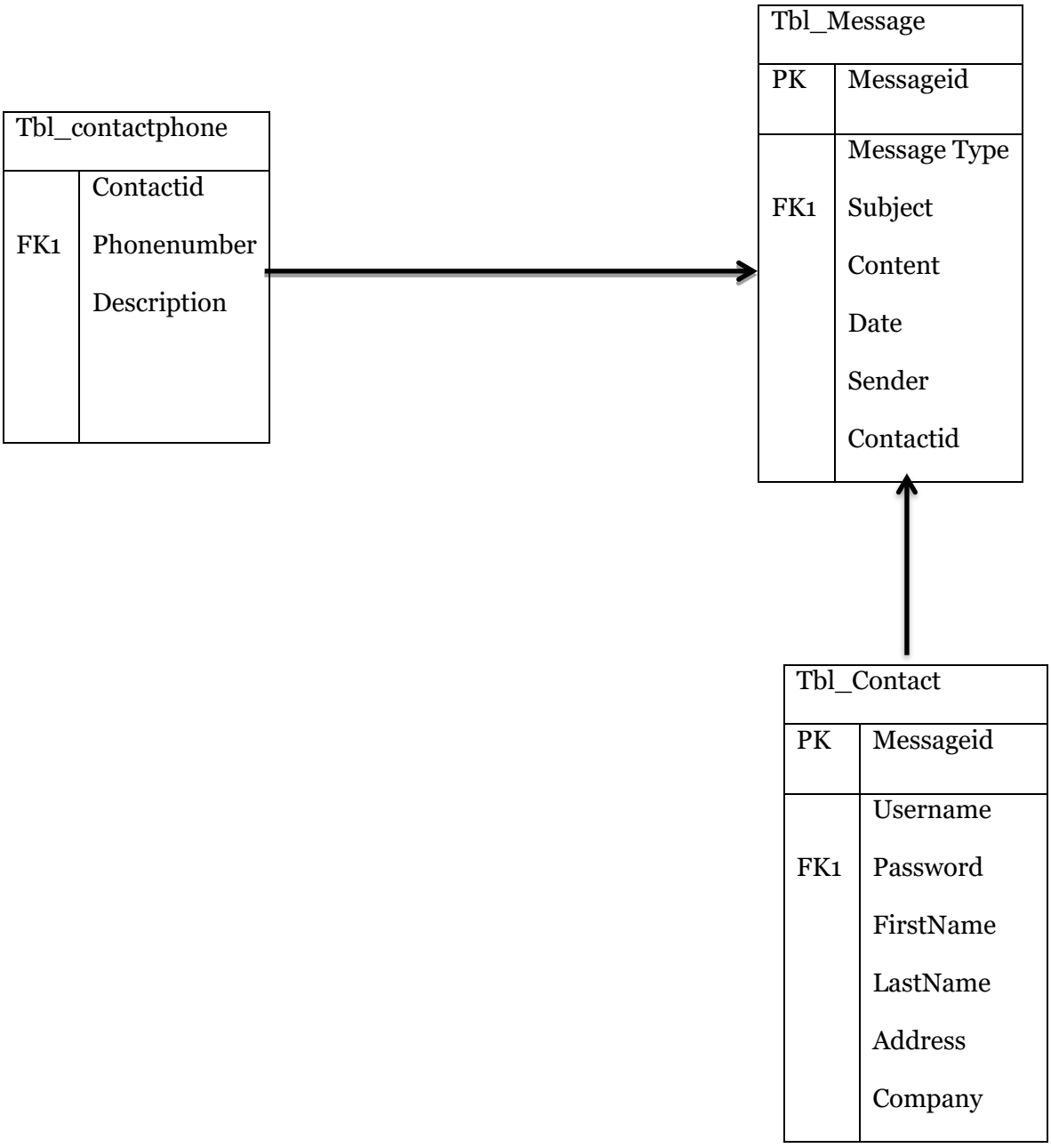

Fig.7. Class Diagram for SMS Reminder Process

4.3. Components of USSD Voice Message Service

Since all handsets are able to use USSD and these services are relatively inexpensive, this technology seems to offer immense potential for content delivery. Although few people know the acronym, many Ethiopians already use USSD to recharge their prepaid airtime. The technology is thus widely available and should be at least vaguely familiarly to users. This service can be used to educate people about the dangers of multiple concurrent partnerships and why alcohol can be dangerous.

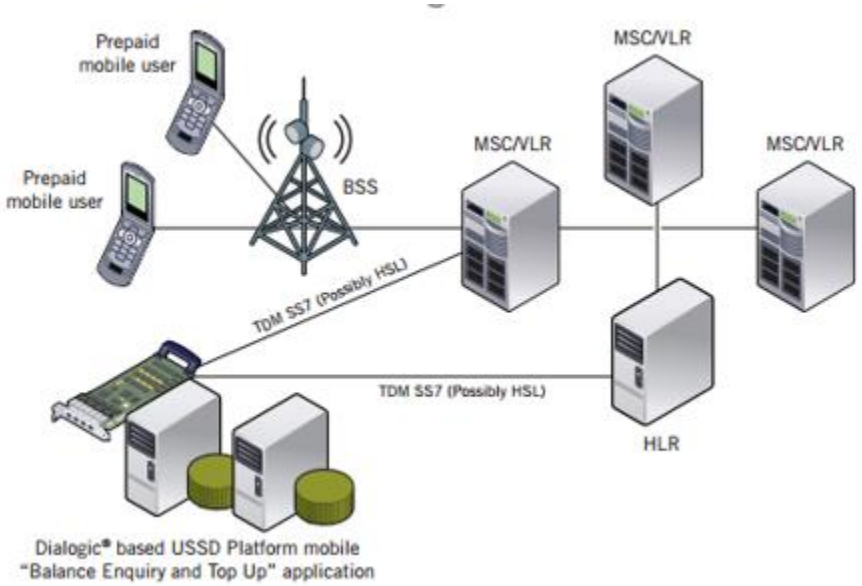

Fig.9. Components of USSD service [62]

CHAPTER FIVE

SYSTEM TESTING AND EVALUATION

5.1. SMS intervention

5.1.1. Feasibility of the Intervention

Ninety-five percent of the sample reported knowing how to write, read and send texts, and allowing a cell phone. Nearly half of sample participant s (50%) reported sharing phones with others. participants were most likely to share phones with family members such as mothers, grandmothers, and older siblings. Few participants of moderate age also reported sharing phones with their partners and friends. In general, almost all participants felt that the research intervention would help them improve their adherence.

5.1.2. SMS Usage

Starting on 1 October 2017, around 50 people have been receiving twice-daily SMSs in Amharic, at the time they should take their ARVs. The SMSs contain both a reminder to take the medication and ARV or HIV related information on topics such as side effects, nutrition, and TB. The information is sent with Amharic language and is transferred from English to Amharic with Google translator for convenience Amharic grammar structure.

Examples of adherence SMSs are

- Don't forget to take your ARVs on time. Adherence means taking your ARVs on time, every day. The ARVs may not be effective if you miss doses or take them late. ARV time again! Remember to take spare pills with you if you go away. And try to keep some extra pills in a safe place for emergencies.
- Good morning, please take your ARVs now. And if you need support or advice you can go to Hiwot Ethiopia council office, you can get free advice.
- It's ARV time! Hope you're feeling well today but remember to keep eating even if you feel sick. Your immune system needs energy to fight off infections.
- Remember your pills. Forgetting can cause tingling in your hands and feet. If untreated this can become very painful. Speak to your doctor.

It is easy to time SMSs relatively precisely (depending on network availability, which is generally good in Addis Ababa Ethiopia), which is important for ARV efficiency patients have a 'window' of around an hour in which to take their medication. If they start to miss the time of their medication or skip it, any regularity, resistance can easily develop, forcing them to move onto second line treatment which is costlier and complicated.

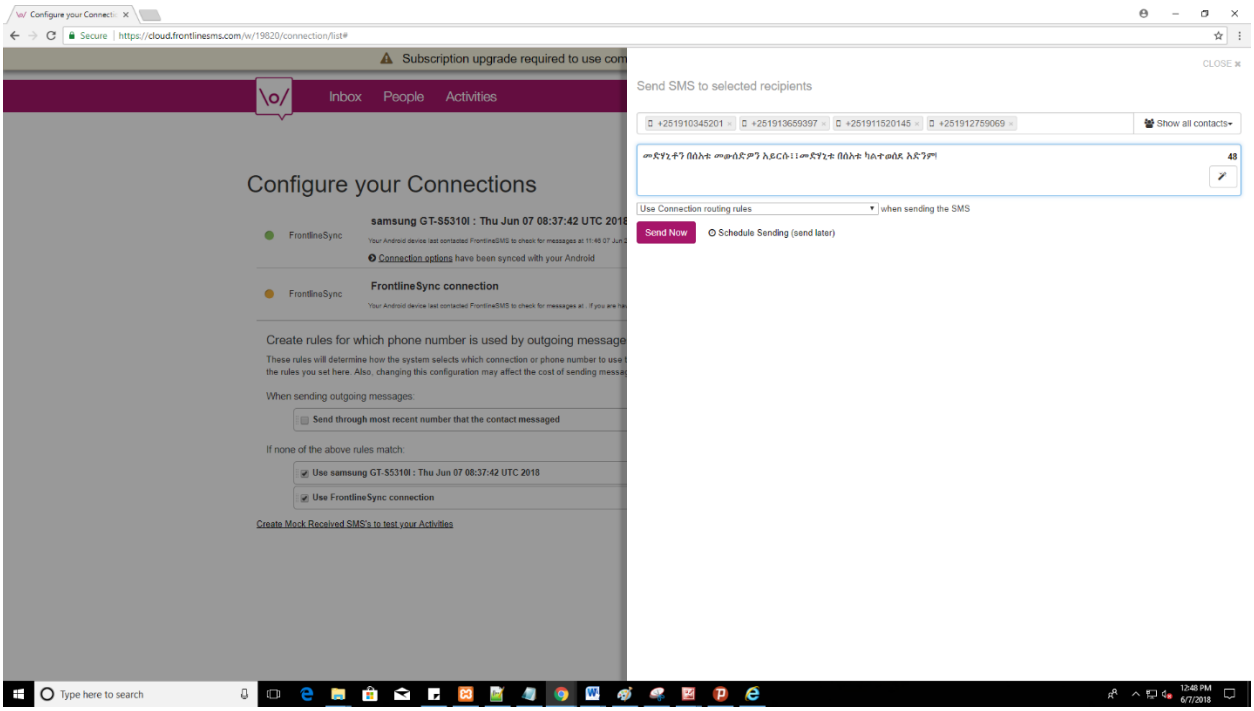

Fig.10. Front line SMS platform sending message

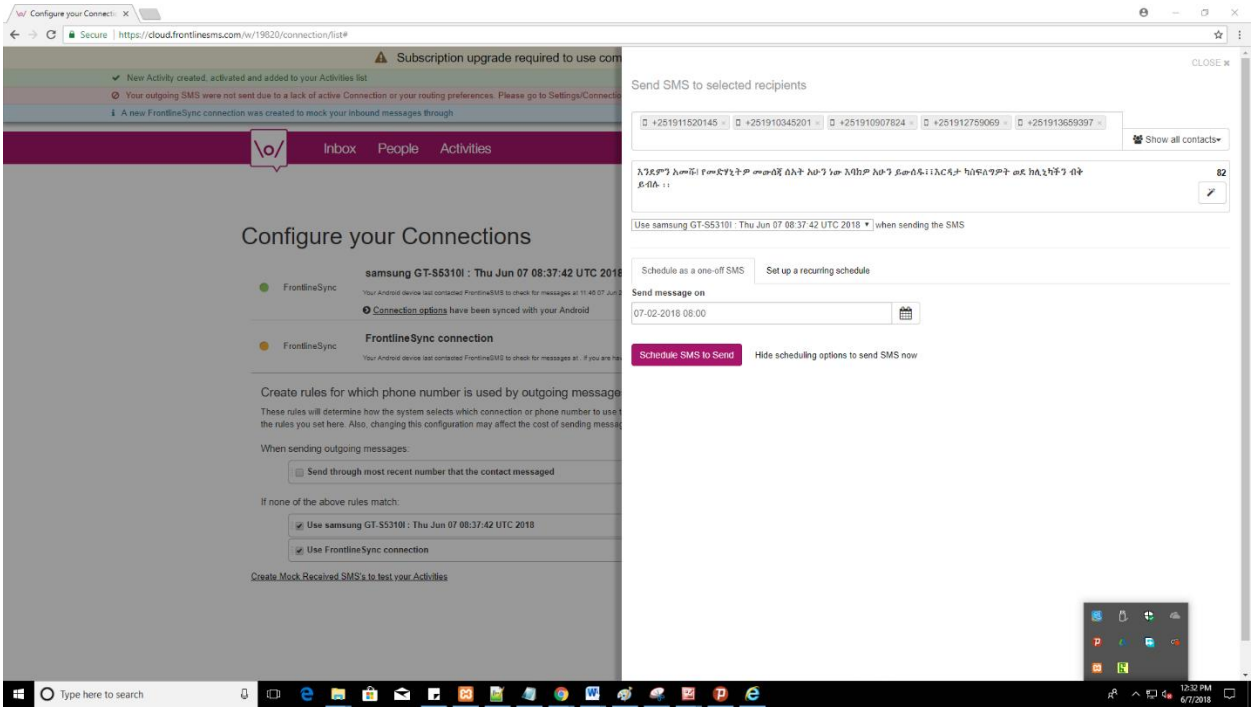

Fig.11. Front line SMS platform sending message

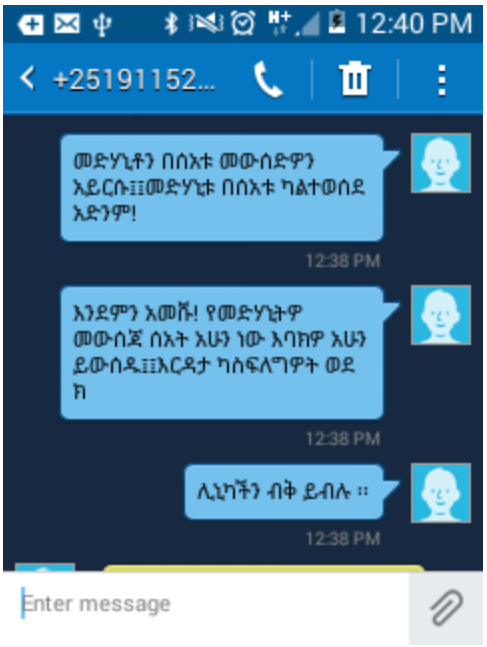

Fig.12. Front line SMS message content

5.1.3. Usage Assessment

At the time of writing, the pilot had only been running for three months. It is thus far too early to be able to make statements on the impact of the SMSs. however, for the completion of the research, the researcher interviewed people receiving the SMSs. The researcher has requested that all 39 sent the SMSs. So far only 5 people have chosen to opt-out of the service. At the first phase of the 15-additional people asked to receive the SMSs. That means the samples become 54.

An issue to be examined in the evaluation of the service is not only whether the content and timing of the SMSs are helpful, but also whether the fact of receiving them makes recipients feel like they belong to something like a group or a particular community.

The findings also shed some light on the hypotheses about the potential pathways through which SMS-based interventions may affect adherence. From the surveys and focus groups administered, I find that the majority of HIV-positive individuals were not confident that they had adequate knowledge about their treatment. Yet program participants were suffering from poor adherence. Hence, information in itself does not seem to be sufficient to induce optimal adherence. Individual-specific cognitive traits may have a moderating effect on motivation and SMS messages may have the potential to positively influence motivation and impact behavioral skills. In focus groups discussions, individuals noted that receiving messages could provide them with a much-needed social support that they believe would function to motivate and encourage them to look after their health. This feature of support is especially critical in the stigmatized environments that most of these

HIV positive persons live in and that prevents them in many cases from disclosing their status to even their family and close friends.

Along with social support, SMS-based interventions can function as reminders to address forgetfulness, either by providing just-in-time information that a pill dose is due (if the messages are sent at high frequency) or more generally of the importance of taking one's drugs when sent less frequently. In programmatic suggestions, the participants therefore voiced that messages would be most effective if they were sent to the time participants were expected to take medications. This finding is in line with similar findings from a review paper that found that a greater treatment effect was observed in studies in which messages were sent at the time of a dosage. Increased salience may come about if participants are reminded of the importance of taking their pills regularly because of the SMS messages. However, some participants seemed to largely favor high-frequency messages to battle forgetfulness. Pop-Eleches et al. (2013) tested weekly-versus daily messages which at least for those on a one-pill-per-day regimen are close to just-in-time information about pill-taking and found weekly messages to be more impactful. This highlights the possibility that forgetfulness may actually mask other barriers to optimal pill-taking, such as stigma or lack of social support that for example could make it likely that a patient is unwilling to think about pill-taking, in particular when in other patients they have not disclosed to [60]. Such more structural forces underlying reported forgetfulness are likely targeted also by less frequent messages that are less likely to suffer from potential fatigue of receiving messages with high frequency. The group's dynamics in the focus groups allowed me to solicit disparate views on the topics of interest. This was also evidenced in the often-lively discussion s that developed among focus group participants and that highlighted the often-differing opinions on the particular topic. However, this study has some limitations that should be considered when interpreting results. This study's findings may not be applicable to HIV-positive persons with sub-optimal adherence.

5.1.4. Programmatic Challenges and Suggestions

Participants identified some main challenges to the implementation of the research. First, sharing phones would be problematic for those patients who have not disclosed their status to those with whom they share phones, patients concerns about accidental disclosure of HIV status because others may knowingly or unknowingly read their messages when their phone is not with them and are worried that the program might make their minds "dormant" and dependent on text messages.

5.1.4.1. Suggestions for Message Content: Participants in five out of the six focus groups argued for messages that would help maintain confidentiality. Overall, there was a general consensus that it would be best if the messages did not contain the words 'drugs' or 'pill s' so as not to compromise participants' HIV status. Participants collectively

suggested keeping the content of the message straightforward. Most focus group participants preferred not disclosing the clinic as the sender of the message primarily because of the stigma that participants feared that they would experience if others in their social circle knew about their HIV-positive status.

5.1.4.2. Suggestions for Frequency of the Messages: There was no consensus as to the number of times messages should be sent in a week. Some focus group participants preferred receiving messages every day as long as the sender is able to send since it would act as a reminder Suggestions for Two Way Messages. Focus group participants liked the option of being able to reply to messages. They felt that this would allow them to keep in touch with their providers especially when they are feeling unwell.

5.1.4.3. Communicating with HCPs: At study end, participants reported that they were satisfied with their ability to contact HCPs. Many participants already felt quite connected to their health care clinic. Participants enjoyed communicating via text with their HCPs and, for some, it made them feel less socially isolated. It was very helpful for them when they sometimes feel really alone, so it made them not feel so alone" as one women participant described. Participants appreciated that they prefer receiving a text messaging than traveling to the clinic to receive information. A few clarified that texting and in-person visits were not comparable and that they liked having the opportunity to communicate except for if the network goes down.

5.2. Mobile Phone Applications Intervention

The mobile network is the combination of mobile communication devices and the Internet, mobile phone applications the typical type and current trend of the mobile network. Four million Ethiopians are currently using smart phones to link to the Internet. Comparing with a computer network, mobile network has more strength. We can make the intervention to penetrate into the user's daily lives and because of the personal privacy of mobile phones; the intervention can be more targeted and individualized. The application should include educational content like information about HIV testing, HIV/STDs diagnose and treatment information, drug, and alcohol abuse risk and safer sex skills.

Usability of the application is the most important feature because the app would not be of value if patients do not use it, which means patients feel useful, safe and trustworthy about the application language and confidentiality. The objectives of the study are to

1. Design and develop an easy to use, user-friendly, non-stigmatized and free app, and deliver app-based HIV prevention intervention to patients.
2. To evaluate the effectiveness of the app at decreasing rate of HIV infection, promoting HIV testing behavior and consistent condom use among individuals,

and cost-effectiveness analysis of the intervention. App-based intervention mechanism will also be explored.

This study comprises 2 phases. In phase 1, a qualitative method is employed for designing and developing the app. Functional modules of the app are designed on the basis of

1. A retrieval of currently exist HIV/STDs prevention and treatment-related apps,
2. Personal interviews with about preferences and function needs of the app. Fifty users will is invited to test the application after completion of application development and modifications will be made according to their user experience and advice. Phase 2 is a randomized controlled trial lasting for3months, to evaluate the effectiveness of the app-based intervention and to explore intervention mechanism. Fifty participants will be recruited and evenly divided into the intervention and control. Participants in the intervention arm will receive app-based HIV prevention intervention.

Participants Inclusion criteria includes.

1. Women aged 25 years or older,
2. Has experience of sexual intercourse,
3. HIV negative and positive
4. Own at least one smart phone, and
5. Willing to report individual HIV/STDs testing result s to the researcher.

Recruit method is Participants are found from Addis Ababa Ethiopia. Participants are included from 2nd-year management students in admass University College (30 students) and from the two clinics African mother foundation and Hiwot Ethiopia.

5.2.1. Populating the App with Data

Preliminary functional modules of the app were presented in design part. They are searched and evaluate currently exist worldwide HIV/STDs prevention and treatment-related applications on Android no domestic application until the writing of this report. Also, simple personal face to face interviews which involves questions about currently confronting behavioral, mental and social problems and barriers of taking HIV test. The app will be developed by the researcher who has little specialized in mobile application development by online learning. After the app development completed, 50 participants were invited to test it and evaluate.

5.2.2. Evaluation

The study was an experimental design employing a quantitative approach for data collection. The eligible participants were adult males and females aged 20 years and older who are based in ADDIS ABABA Metropolis during the study period and who consented to participate in the study specifically students from two colleges (Admas University and Gage Collage). The study participants were recruited into an initial convenience sample through a direct meeting when students are attending class from 1st October to 7th January 2018 and 50 responded willingly to participate in the sample. Convenience sampling is used because of the use of smart phone usage among students.

People selected to participate in the study were briefed on the research to obtain their consent. Following guidance in Christensen et al. (2011) for providing good control for any confounding variables and provide strong evidence about the causal relationships between the variables in the study, 50 participants who gave their consent were randomly assigned to an intervention group that received the app on their mobile devices and a control group that did not receive the app on their mobile devices. Both intervention and control groups were surveyed at pre-test before the intervention group received the app for use on their mobile phones. There were 25 people assigned to each group at pre-test. All participants completed the questionnaire in the experimental group and 24 participants completed it in the control group. Hence there were 49 participants in the experiment. There were no participants lost to follow up at the post-test survey. The two groups were also surveyed after ten weeks using the same questionnaire. The study was conducted between Octobers to January 2018.

5.2.3. Age distribution of participants

Participants' mean age was 29.66 Figure 3 is a histogram summarizing age of participants. The normal curve overlaying the histogram shows the age of participants is skewed towards young people. The median age was 28 years.

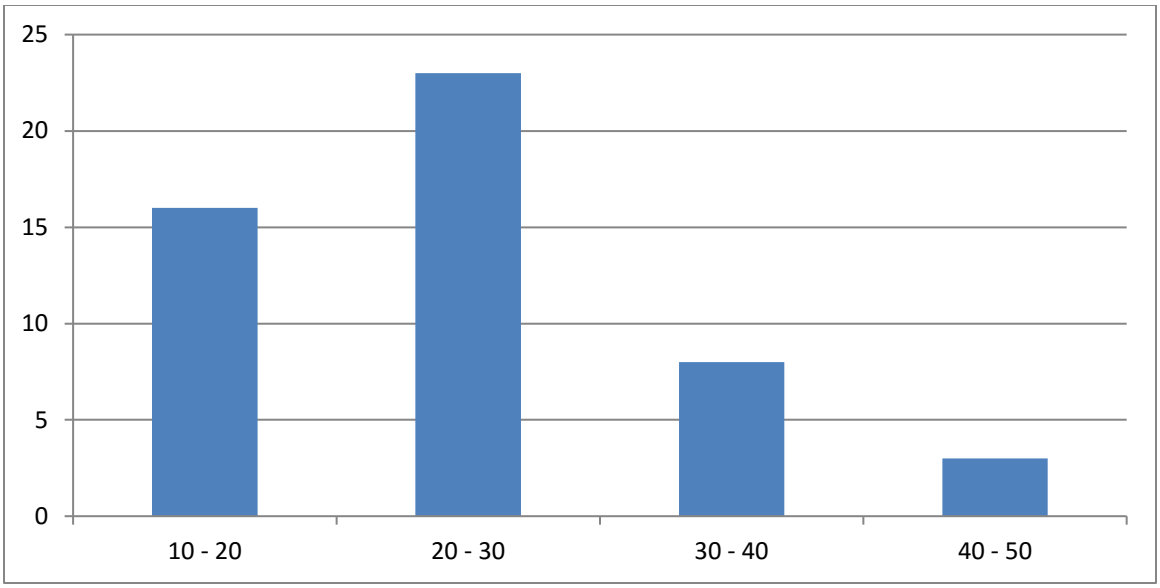

Fig 13. Age distribution of participants

Most of the participants are in the 15-25 (32.6%) and 25- 34 (45.7%) age categories. Hence about one in three participants are young people aged 15 -24, who are a key focus for HIV prevention intervention.

5.2.4. Sex distribution of participants

The sample selected was represented by 65.65% men and 35.35% women

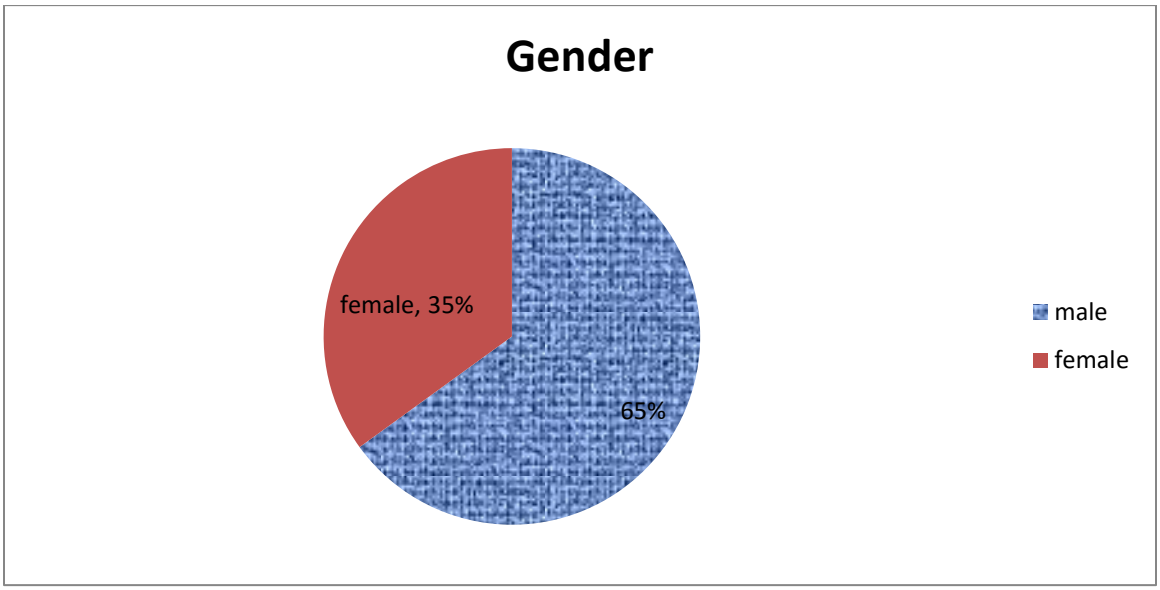

Fig 14: Sex distribution of participants

5.2.5. Marital status

According to marital status of participants 34% are married, 61% have never been married and 5% of participants are either living together, divorced or separated.

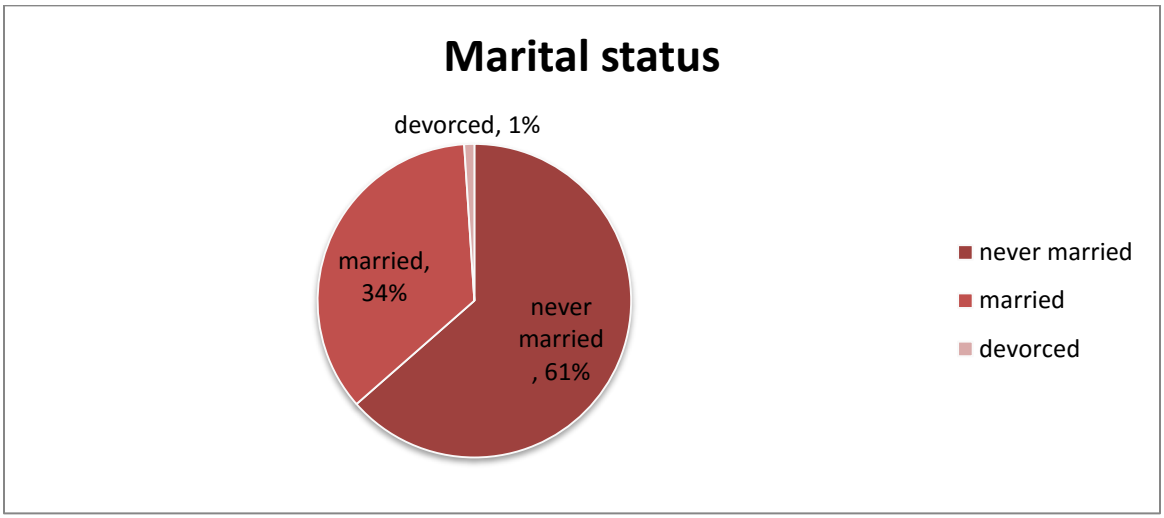

Figure 15. Marital status

5.2.6. HIV testing behavior of participants

Overall, almost 70% of participants had not had an HIV test in the past 12 months; although 8 out of 10 participants indicate they know where to test.

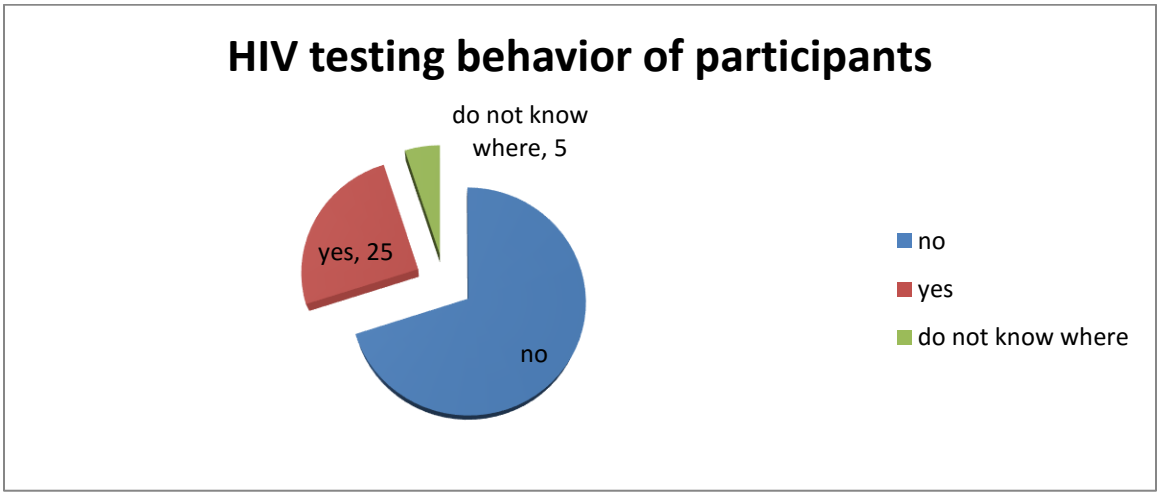

Figure 16.HIV testing behavior of participants

This is comparable with findings from other African countries where various authors note that uptake of HCT is often poor, despite the potential benefits of HCT and the availability of HCT services.

5.2.7. Risk of becoming infected with HIV

Participants were self-assessed on their risk infected with HIV. Almost all (94%) are becoming infected or at risk; only 6% are not at risk of infected with HIV. Another 10% of participants indicated they do not know their risk of becoming infected with HIV. However, a further exploration of the risk of exposure to HIV suggests participants had a low perception of their risk of exposure to HIV.

5.3. Discussions

The study using a mobile application delivering HIV prevention information to mobile devices on people's knowledge benefits of HCT and uptake of HIV testing in Addis ABABA, Ethiopia. The research question was: use of a mobile application promoting HIV prevention knowledge of HCT uptake of HIV intervention participants compared to control participants who do not use the mobile app?

The study met its objective of establishing the effect of a mobile app in promoting HIV prevention and the benefits of HCT on people's knowledge of HCT. The study found a low level of knowledge of benefits of HCT pre-test. There was a marked improvement in knowledge of benefits of HCT by experimental group participants but not the control group after mobile app use by the experimental group. Post-intervention knowledge of benefits of HCT score was statistically significantly greater in the experimental group who used the mobile app than for the control group that did not. The mobile app accounted for 81% of the increase in knowledge.

App use on the uptake of HIV testing during the three months of the intervention. The study found the knowledge gained from using the mobile app translated into the statistically significant uptake of HIV testing. The effect of the mobile app on testing was moderate. Further, the study met its objective to determine the association of the demographic factors, marital status, and gender, with HIV the mobile app. A selection indicates a statistically significant association between marital status and gender with HIV testing after app use. Effective promotion of HIV testing in ADDIS ABABA, Ethiopia. Knowledge of the benefits of HCT as well as greater uptake of HCT. The findings suggest the app significantly improved participants' knowledge of the benefits of HCT and created demand for HIV testing. We recommend that NGO adopts the app as one of the channels for promoting HIV testing in Ethiopia. It has been shown that applications are beneficial to self-management of people with chronic conditions, physical activity promotion among different age groups, and other health-related behaviors. There were systematic reviews pointed out that applications have great potential as tools for HIV prevention among individuals, and there were also studies on an acceptability and preferences of application-based interaction. There are several strengths of the study. The mobile network is the combination of the Internet and mobile devices and has the advantage of higher portability. The "always online" feature made it become a part of one's daily life.

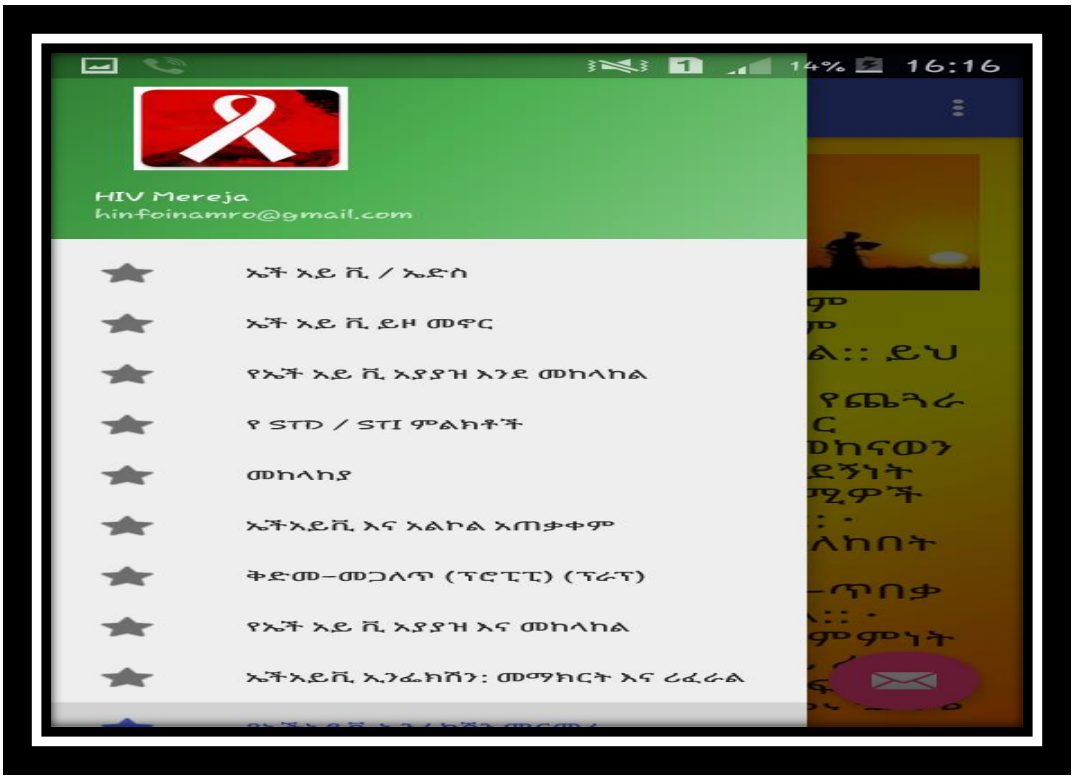

Fig.17. Android application front page screenshots

Fig.18. android application screenshots

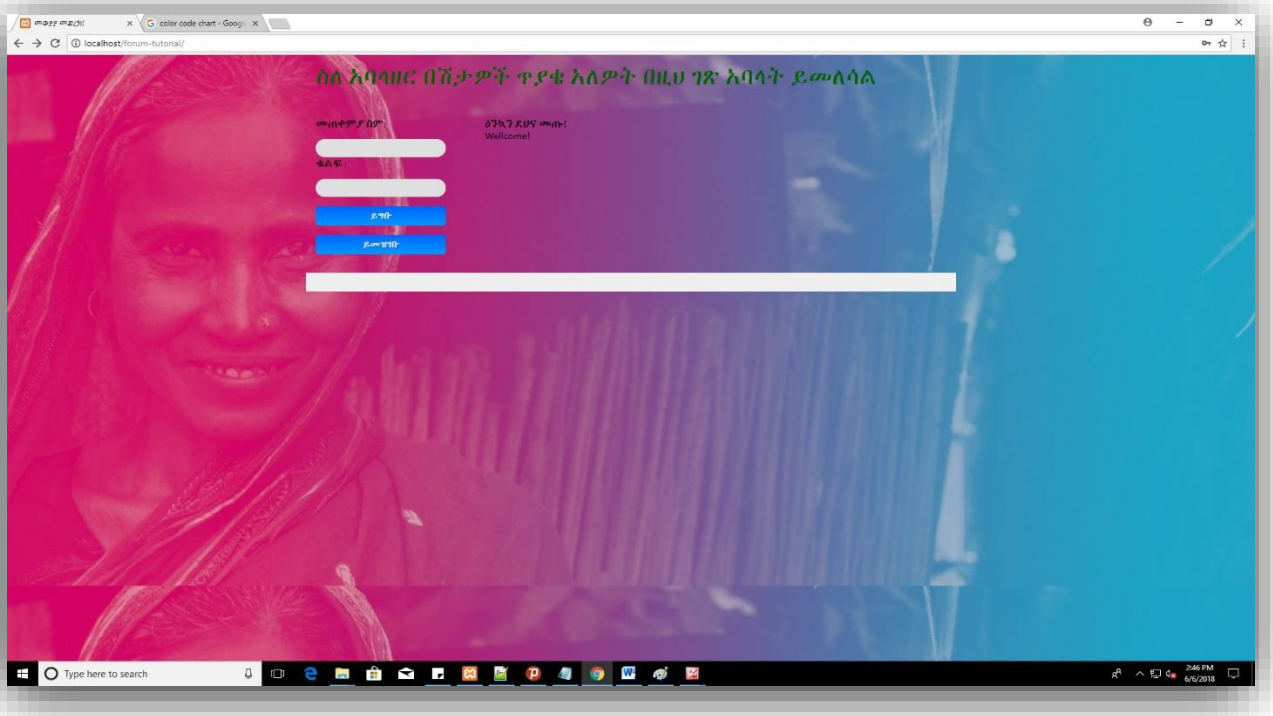

Fig.19. android forum screenshots of login page

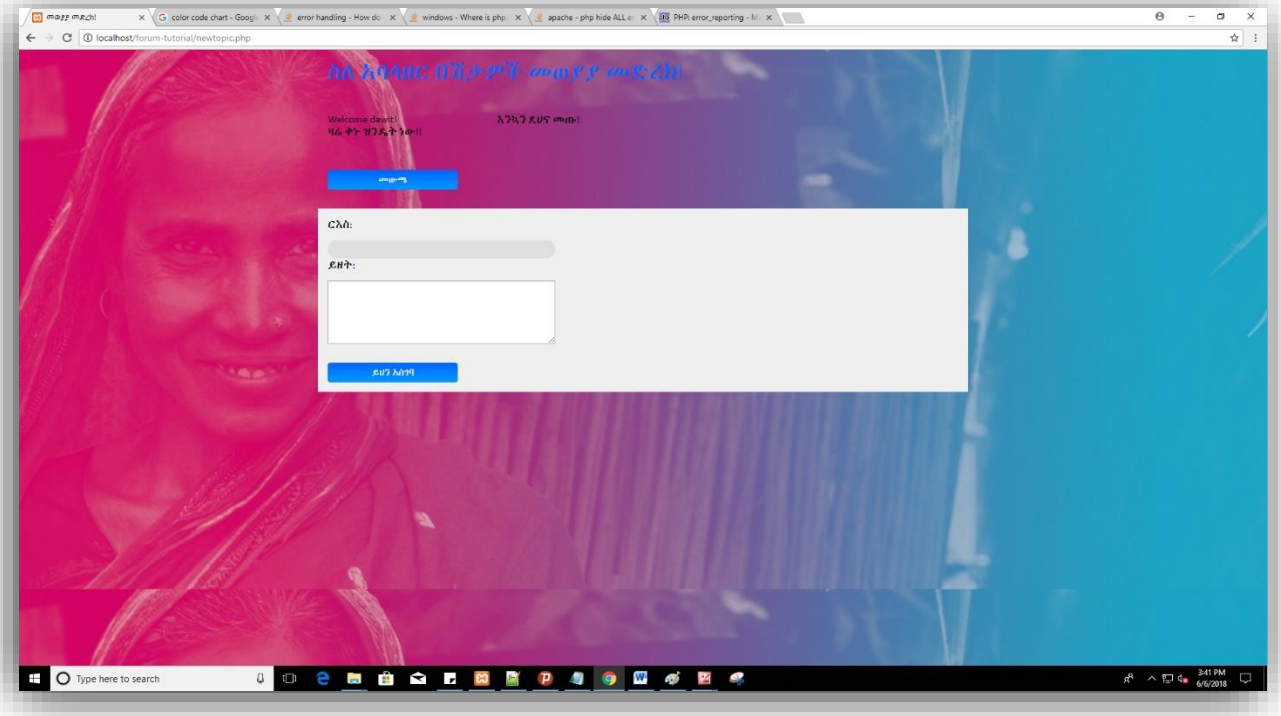

Fig.20. android forum screenshots of add topic page

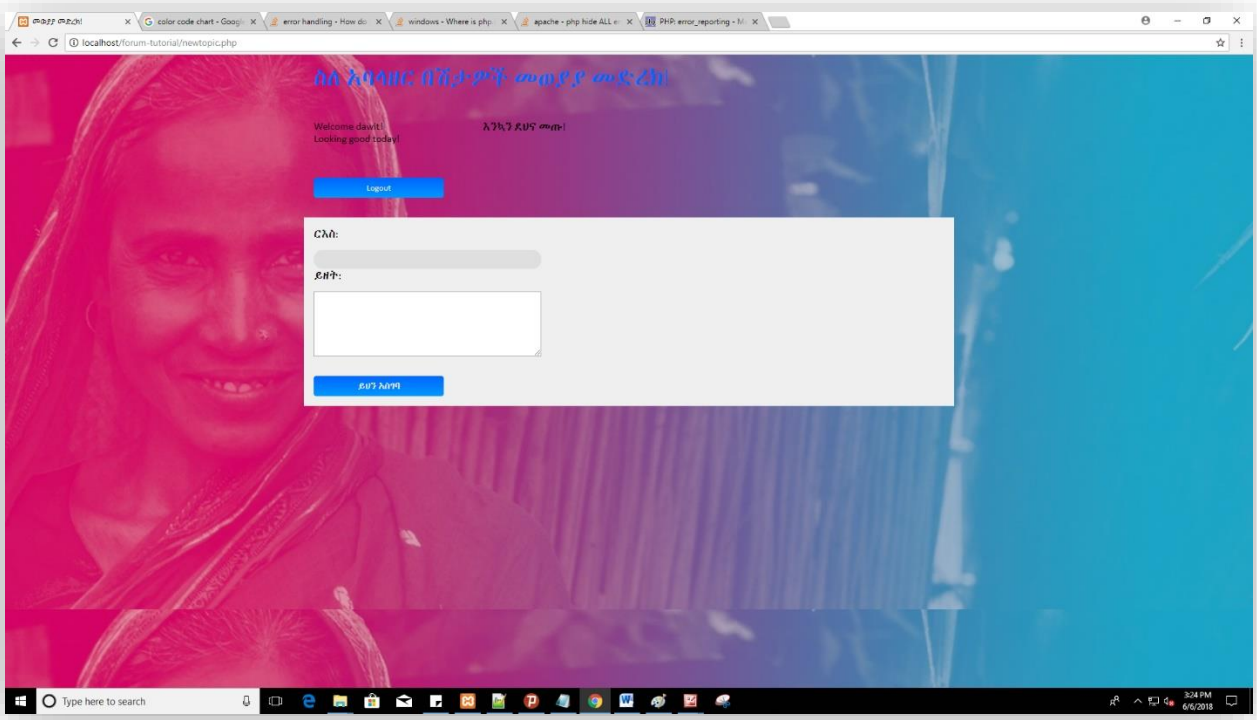

Fig.21. android forum screenshots of reply to answer page

5.4. Voice message Intervention

5.4.1. Voice message for HIV Treatment and Adherence

The intervention comprises the delivery of a standardized, SMS and Voice MESSAGE system to provide real-time adherence support to patients with HIV and TB treatment. The study uses a simple mobile handset to send one message. The process uses USSD message series provided by the telecom provider. The process includes dialing to formal USSD code then follow the procedure to send and receive one message. Voice MESSAGE messages were sent "one-way," which meant that recipients could not respond. In Ethiopia, patients with HIV and TB routinely identify a treatment supporter, usually a family member, to assist with day-to-day treatment support. For this study, patients were given Voice MESSAGE reminders sent at the time when they take their medication. Reminders were sent daily for 6 weeks of ART. Patients. Medication reminders used code words ("Did you take your medication today?") to protect patients' confidentiality.

Data Collection for voice Message Adherence use and acceptability were assessed using mixed methods. Voice Message Adherence use was quantitatively analyzed from study process data, drawn from a six-week Program Characteristics Survey to track implementation. Voice MESSAGE Adherence acceptability was assessed using questions about intervention acceptability that were integrated into six-week follow-up interviews and qualitatively evaluated via in-depth interviews with a purposive, heterogeneous subset of patients, six-week post study initiation African others foundation and Hiwot Ethiopia sites. The use and acceptability of Voice MESSAGE Adherence were vocalized by adherence data, drawn from weekly follow-up interviews with 50 patients at African others foundation and Hiwot Ethiopia sites during the course of TB treatment.

All weekly follow-up interviews were based on standardized questionnaires and administered face-to-face by the researcher. All qualitative interviews were conducted face-to-face by the researcher only and thematically analyzed using a grounded theory approach. Grounded theory involves construction of theory through methodic gathering and analysis of data where the researcher chooses an existing theoretical framework, and only then collects data to show how the theory does or does not apply to our phenomenon.

5.4.2. Findings

Usage over the study course of six weeks, the Voice MESSAGE Adherence successfully delivered 1638 Voice MESSAGE Adherence to 39 individuals who consented to receive study Voice MESSAGE. Of 39 patients who were eligible for Voice MESSAGE Adherence reminders at the two sites, all consented to receive the Voice MESSAGE Adherence intervention, with no difference by gender.

Between October 2017 and December 2017, qualitative interviews were completed with 30 patients, approximately equally distributed across the two sites. Patient participants were on average 38 years old, 43% were women, and 77% had a primary education or no formal education; these socio demographic characteristics are representative of the populations served by participating health facilities.

During six weeks' follow-up interviews, 39 measurement participants in two sites were asked what had made it easier or helped them take their TB medications or ART. 95% stated the messages were a facilitator to adherence in six-week follow-up interview. No measurement participant reported that the messages posed a challenge to adherence in follow up interviews.

Patient participants were appreciative of the Voice message Adherence intervention. They perceived the appointment and medication reminders were complementary cues to adherence, alongside visits from clinics, and appreciated being able to self-select the time and frequency of messages. Most patient participants also understood the Voice message Adherence was a form of private health communication.

Patient participants were very appreciative of the Voice message provided by the study. Voice message empowered them to communicate with their health care providers and treatment supporters in a timely manner, without incurring a personal cost. Patients said Voice message can provide support for medical side effect, advice and a receive clinical support about potential delays to a clinic appointment. Unstable access to electricity and temporary technical difficulties appeared to bar a few patient participants from receiving regular Voice message reminders.

CHAPTER SIX

CONCLUSIONS, RECOMMENDATIONS AND FUTURE WORKS

6.1. Conclusions

The purpose of the research was to evaluate feasibility and acceptability of SMS messages among HIV-positive persons, to elicit suggestions for the implementation of specific SMS features, and to infer the potential pathways through which the intervention is perceived to work. The results show that people living with HIV commonly use and are familiar with SMS. Over 95% of the patients in this study knew how to read, write and send text messages, in addition, 97% of the sample participated would be helpful towards improving their treatment adherence. When viewed in the context of the widespread use of mobile phones, SMS-based interventions have promising potential to address adherence barriers among HIV-positive peoples in a setting such as Ethiopia.

Regarding the implementation of my SMS intervention, the most important recommendation forwarded by patients was to maintain confidentiality about their HIV-positive status and their being in HIV care. Past studies have found that HIV related stigma impact peoples' abilities to adhere to treatment by lowering their social support and ability to cope. This study' s finding is in line with findings from other studies that have noted that participants using text messages are worried about stigma, privacy, and confidentiality since text messages can leave a trail of evidence. Like elsewhere, in Ethiopia privacy is a critical issue since HIV stigma still exists in many communities leading to negative attitudes and maltreatment against people living with HIV/AIDS and their families.

Due to stigma, participants had reservations about the content of text messages and identity of the sender. Participants suggested having simply coded message s without the words 'drug s' or 'pills' that would function to remind patients to take their medications without raising suspiciousness, however, patients who shared phones with other family members feared that others may discard coded messages not realizing they are meant for the patients. Patients also recommended the researcher to personalize the identity of the sender or agreeing to a name for the sender of messages that only group members would know. Participants were not optimistic about the functionality of using passwords because for patients especially in relationships the presence of a password could indicate infidelity in the relationship. Since past studies that incorporated participant feedback to generate message content have had greater effectiveness, future program implementers and policymakers should pay attention to these suggestions.

In summary, this research study demonstrates that SMS-based interventions are likely feasible and have the potential to be acceptable as a means to improve ART adherence among peoples in HIV care if issues related to confidentiality and privacy are

appropriately taken into account in the program design. A key contribution of my study is that it provides insights from patients that can contribute to my understanding of the pathways through which such SMS-based interventions may affect medication adherence. Overall, delivery of the intervention was found to be inexpensive, as one server can provide SMS messages to thousands of patients in a large geographic area with very few human resources needed beyond the initial setup.

A major issue confronting the research project is the scalability of the project. It costs Birr 21 (US$1) per person per month to send the SMSs. This does not include the costs to write, translate and schedule them. Even for 39 people, that would add up to well over Birr 819 (US$30) per month. Given that currently around 1.2 million patients in Ethiopia are on ARVs, integrating SMS reminders into Ethiopians ARV program would cost over Birr 12million per month. Clearly the scaling up of SMS reminders will only be feasible if the cellular networks provide severely discounted or free SMSs for such program, or if the SMSs can be targeted at certain groups (e.g. those who are isolated and/or are identified as experiencing difficulties with adherence).

Study evaluating the use and acceptability of a Voice MESSAGE Adherence to improve early ART initiation and retention and TB treatment success among HIV/TB patients in Ethiopia, the Voice MESSAGE Adherence component of the intervention package was considered beneficial by patients. Intervention delivery process data highlighted very high uptake of the MESSAGE intervention among both male and female patients. The perceived importance of Voice MESSAGE in supporting adherence also arose during patients' weekly follow-up interviews and in-depth qualitative interviews. There are several implications to be drawn from the findings. First, interventions are more likely to be successful if they allow for flexibility in MESSAGE capability, frequency, and timing. Second, the potential challenge of HIV stigma should be recognized and addressed in context-specific ways as HIV non-disclosure, an established proxy for stigma.

6.2 Recommendations

The initiatives that are discussed in this paper aim to change the users' health-related behavior, i.e. they are examples of cell phones used for behavior change communications. There are a few published examples indicating that information delivered via cell phone can be effective in this area. The SEXINFO service in San Francisco has reported that a survey of 214 youth linked knowledge of the program to increased concern about STIs. Their research also indicated that youth were intrigued by the idea of using cellphones to receive this information. These kinds of initiatives can present challenges in measuring impact

- Changing behavior is difficult.
- It takes time, especially for behaviors to change enough to measure impact.

- Data collection can be difficult, for instance, because of sensitive questions on sexual practices, fidelity, etc. (This is especially true of HIV.)

6.3 Future Works

Two channels the research is exploring are WAP and voicemail push. Ethiopia has relatively low desktop internet penetration, while mobile web users stand at around4 million. Interestingly, 70% of that 4million only use their cellphone to access the internet. While those cell phones that can use WAP are mostly in the hands of people who are not poor, this will shift over time. The research is looking at piloting HIV-related chat rooms through WAP offering.

An exciting potential is voicemail- push, where a voicemail message is pushed into the user's voicemail inbox, and they are notified of its arrival by MESSAGE (like for any voicemail). Voicemail push can overcome a number of barriers related to content delivery by cell phone:

- Some cell phone services (e.g. MESSAGE, USSD) are very restricted in terms of the number of characters. Others (e.g. APP, WAP) are constrained by screen size and usability factors. A voice message can allow for a lot of information to be delivered without those restrictions.

- Illiteracy can be overcome as the user just needs to listen.

- Content can easily be delivered in the user's language of choice (and the issue of some local languages being a lot longer than English falls away).

Most significantly "Can content delivery via cell phones impact on HIV - related behavior? Although we are still a long way from answering that question, we have nevertheless learned a number of valuable lessons. Possibly the most significant of these has been the need to test my assumptions before implementing projects. My small - scale pilot testing has raised important points in terms of language of choice, technical ability and project cost.

The research assesses the findings in relation to the objectives set out for the study. The study met all its objectives. The findings suggest that the app could help to promote knowledge of the benefits of HIV for HIV prevention more effectively and encourage uptake of HIV testing in ADDIS ABABA. The study found a low the benefits of HCT for HIV prevention amongst study participants in ADDIS ABABA, ETHIOPIA at pre-test. The level of knowledge increased after the use of the mobile app intervention by the experimental group. The increase in knowledge was statistically significant. Mobile app use was also significantly associated with HIV were significantly associated with HIV the mobile app. The app may also help to improve the efficiency of HCT delivery by providing counseling information within the focusing on HIV testing at provider locations.

An exciting potential is voicemail-push, where a voicemail message is 'pushed' into the user's voicemail inbox, and they are notified of its arrival by SMS (like for any voicemail). Voicemail-push can overcome several barriers related to content delivery by cellphone:

- Some cellphone services (e.g. SMS, USSD) are very restricted in terms of number of characters. Others (e.g. MXit, WAP) are constrained by screen size and usability factors. A voice message can allow for a lot of information to be delivered without those restrictions.
- Illiteracy can be overcome as the user just needs to listen.
- Content can easily be delivered in the user's language of choice (and the issue of some local languages being a lot longer than English falls away).

Appendix A:

Questionnaire for target populations

The following is the final printed survey questionnaire that was distributed to and filled out by 49 members of the target populations. It asks about general demographic information, HIV/AIDS-related knowledge, and practices, along with their ability and willingness to use mobile healthcare applications. English and Thai versions are provided.

English Version

This questionnaire is being distributed by a student from saint merry University in Addis Ababa, Ethiopia who is doing a master's degree research to assess the impact of different types of technology-based approaches to health care, specifically HIV/AIDS prevention, monitoring, and treatment.

I appreciate you taking the time to fill out this questionnaire. I hope to learn basic demographical information, your involvement in community-based programs, and the measures you currently take to prevent or manage HIV. I also hope to learn your opinion on and familiarity with technology-based approaches to health care, such as the use of a mobile application. I hope to find ways to help people living with HIV/AIDS better manage their disease.

This questionnaire will take about 15 minutes to complete and has 68 questions.

Please fill out the following questionnaire as fully and honestly as possible. You do not need to answer questions that you are uncomfortable answering. Please keep in mind that your responses will be kept completely anonymous and confidential. The research will not ask for any identifying information. Thank you for your time.

General information

1. What is your gender?

- ☐ Male
- ☐ Female

2. Age: _____

3. Which community-based organizations do you receive services from?

- ☐ African mother's foundation
- ☐ Hiwot Ethiopia
- ☐ Other (please explain): _____

6. How often do you visit a community-based organization?

- ☐ More than once per month
- ☐ Once per month
- ☐ A few times per year

7. What services do you receive?

- ☐ Mental support
- ☐ HIV services
- ☐ Other (please explain): _____

8. How often do you use condoms?

- ☐ I never use this prevention method
- ☐ I sometimes use this prevention method
- ☐ I always use this prevention method

9. How many times per year do you get tested for HIV?

- ☐ I have never had an HIV test.
- ☐ I have been tested once over many years
- ☐ Once
- ☐ Twice or More than twice

10. How many months ago was your last HIV test?

- ☐ I have never had an HIV test
- ☐ Within 3 months
- ☐ Within 6 months

11. Check any reasons that apply for why you have not had an HIV test.

- ☐ I have never been asked to get tested by a health care professional
- ☐ I trust that my partner will not be HIV+
- ☐ I am afraid to know my status
- ☐ I do not think I am at-risk for HIV
- ☐ I do not know where to get tested.

- ☐ I am afraid to encounter discrimination
- ☐ Other (please explain): _____

12. What is your current HIV status?

- ☐ Positive
- ☐ I do not know my current HIV status
- ☐ Negative
- ☐ I am not comfortable sharing my HIV status.

13. If you were HIV-positive, who would you be comfortable sharing your status with?

- ☐ Personal doctor
- ☐ Family
- ☐ Friends

14. If HIV-positive, do you regularly monitor your disease through CD4 and viral load testing?

- ☐ Yes
- ☐ No

20. Did you know that antiretroviral treatment (ART), the primary method for treating HIV, is free?

- ☐ Yes
- ☐ No

This next section of the survey will be used to gather information about your Internet, phone, and mobile application usage.

21. Do you have access to the Internet?

- ☐ Yes
- ☐ No

22. Please check any methods that you use to access the Internet.

- ☐ Personal computer
- ☐ Tablet or Mobile phone
- ☐ Public computer or Internet cafe
- ☐ I do not access the Internet

23. Do you use Internet services to meet new people?

- ☐ Yes
- ☐ No

24. What kind of mobile phone do you have?

- ☐ Smartphone
- ☐ Feature phone
- ☐ I don't have a mobile phone

25. Do you use mobile applications?

- ☐ Yes
- ☐ No

26. What types of applications do you typically use?

- ☐ Social networking
- ☐ Games
- ☐ Entertainment
- ☐ Information
- ☐ Health care

Evaluation of the application developed and used by participants

Please rate the following attributes of the mobile applications based on how important they are to you, with 1 being not important and 4 being very important.

	Not important	Somewhat important	Important	Very Important
Easy installation				
Frequent update				
Entertaining				
Interesting				
Useful				
Easy to us				
Stable				

27. Which of the application attributes is the most important to you?

- ☐ Easy to install
- ☐ Interesting
- ☐ Useful
- ☐ Easy to use
- ☐ Stable

40. What might cause you to stop using or uninstall an application?

- ☐ It was boring
- ☐ It did not update enough
- ☐ It stopped being useful
- ☐ It took up too much memory on my device
- ☐ It had many errors
- ☐ It ran slowly

41. What is your experience with mobile health care applications?

- ☐ I have used a mobile application to monitor my health
- ☐ I would be willing to use a mobile application to monitor my health
- ☐ I would feel uncomfortable using a mobile application to monitor my health
- ☐ I am not interested in a health care application

Appendix B:

The questionnaire used in the quantitative evaluation of the mobile application participant knowledge of HIV/AIDS ART and knowledge about sexually transmitted diseases

1. Have you ever heard of sexually transmitted infections (STIs)?

- ☐ Yes
- ☐ No

2. What is your source of information?

- ☐ TV/radio Newspaper
- ☐ Public talks
- ☐ Hospital/health workers
- ☐ Friends/relations

1. Most Sexually Transmitted Diseases (STDs) can be cured, but there is no cure for AIDS

- ☐ True
- ☐ False

2. You can get HIV by shaking hands with a person who has HIV or AIDS

- ☐ True
- ☐ False

3. Condoms can protect people from HIV if they are used correctly

- ☐ True
- ☐ False

4. The more sexual partners a person has, the greater their chance of getting HIV

- ☐ True
- ☐ False

5. There is no danger of getting HIV if you eat food prepared by someone with HIV or AIDS

- ☐ True
- ☐ False

6. A person can get HIV by giving (donating) blood

- ☐ True
- ☐ False

7. You can always tell if a person has HIV by the way they look

- ☐ True
- ☐ False

8. Can people reduce their chance of getting HIV by having just one uninfected sex partner who has no other sex partners?

- ☐ Yes
- ☐ No

12. Can HIV be transmitted from a mother to her baby during pregnancy or Breastfeeding?

- ☐ Yes
- ☐ No

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