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Developing an Interactive Voice Response System for behavioral change communication in Ethiopia

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DEDICATION

This thesis is dedicated to my mother Samrawit Tesfaye.

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First of all, I would like to thank Almighty God for giving me the patience, wisdom, knowledge and strength I needed to complete this study and for always guiding me in every phase of my life.

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ACRONYMS

BCC-IVR	Behavioral Change Communication Interactive Voice Response
DTMF	Dual Tone Multi-Frequency
ETC	Ethiopia Telecommunication Corporation
FMOH	Federal Ministry of Health
HEP	Health Extension Program
IBCTs	Interactive Behavioral Change Technologies
IVR	Interactive Voice response
MDB	Major Disease Burden
MHB	Major Health Burden
PMTCT	Preventing Mother to Child Transmission
PSTN	Public Switched Telephone Network
SMS	Short Messaging Service
TB	Tuberculosis
UHF	Ultra High Frequency
UML	Unified Modeling Language
VHF	Very High Frequency
VOIP	Voice over IP
WHO	World Health Organization

Executive Summary

Background: Ethiopia is undergoing a heavy health care burden, mainly attributed to communicable diseases and nutritional deficiencies. The Federal Ministry of Health aims to improve health through the Health Extension Program (HEP). On the other hand, the number of mobile phone subscribers in Ethiopia has shown a significant increase. The use of voice message can deliver the kind of universal access, including the portion of population that doesn't know how to read, to support prevention services.

Interactive Voice Response (IVR) is a phone system technology that allows a computer to interact with humans by using pre-recorded or computer generated voice responses via Dual Tone Multi-Frequency (DTMF) signal.

Objective: The main objective of the project is developing and testing the BCC-IVR system to improve health outcomes of selected major health problems in Ethiopia.

Methodology: The requirement collection used guided discussion with 25 participants, 12 residents and 13 health care professionals and document review. After data collection, functional and nonfunctional requirements were identified and analyzed using UML's Use Case diagram, Class diagram, Activity diagram and Sequence diagram.

Implementation: During implementation this project the prototype has shown how to create the services in Asterisk. The flow of BCC-IVR system is implemented in the dial plan and the user interacts by using telephone keypad with the asterisk server. The IVR system has a three-tier architecture model made up of presentation, application/logic, and storage layers.

After implementation, the BCC-IVR system is evaluated by 9 English and Amharic speakers to identify and correct functionality issues and ensure usability.

Result: The result of this project is a Behavioral Change Communication Interactive Voice Response system accessible from any phone under the same network. The resulting BCC-IVR system includes information on Reproductive care, Sanitation and environmental hygiene, Nutrition, Cancer and Periodical Screening and treatment and First-Aid. The information on the health topics is presented in English and Amharic Languages.

Conclusion: Universal access is the important while providing information. People should be able to choose the access method that suits them. Literate people might still be more comfortable with written information, but the need for voice information is also there, mainly for illiterate and visually impaired people. The IVR system is accessible, helpful, inexpensive to implement and easy to learn tool to deliver Behavioral Change Communication Messages.

CHAPTER ONE: INTRODUCTION

1.1. Background

Ethiopia is a Federal Democratic Republic country with 11 regions, 9 regional states and two city administrations, totally containing 805 districts. Ethiopia is also the second largest county among the sub-Saharan Africa. As of now, the record for the total amount of population in the country is more than 90 million [1].

Almost 80% of the Ethiopian residents are living in the rural areas of the country and 51.9 % of the total population does not know how to read and write in ways that are present in books and other educational tools [2]. This means, more than half of typical population of the country have to get their health information elsewhere, not through reading.

Ethiopia currently experiences a heavy health care burden, mainly attributed to avoidable causes like communicable diseases and nutritional deficiencies. The country is also progressively facing the burden of chronic health problems such as cardiovascular diseases, diabetes and cancer. When injuries are added on top of that, the triple burden the country is facing manifests. Shortage and high turnover of health professionals and inadequacy of essential drugs and supplies have also contributed to the problem [3].

Ethiopia has a three-tier health care delivery system to fight these health problems. The system is characterized by a first level of Woreda /district health care delivery system comprising a primary hospital, with population coverage of 60,000 to 100,000 people, health centers serving 15,000 to 25,000 residents, and their satellite health posts covering 3,000 to 5,000 people. A primary hospital and each health center with their five satellite health posts form a Primary Health Care Unit (PHCU). On the second level, the tier is made up of a general hospitals with population coverage of 1.5 million people, and the third tier level specialized hospitals serve a population of 3 to 5.5 million [4].

The Federal Ministry of Health aims to increase the results through the Health Extension Program (HEP). The HEP is designed to deliver health promotion, immunization and other disease prevention measures along with a limited number of high-impact curative interventions [5].

However, primary care physicians and health care delivery systems face substantial challenges to provide preventive services. First, Preventive Care and Counseling is time consuming when done face to face. Second, it is not affordable or feasible to implement a hundred percent face to face approach even in, highly resourceful, developed countries. Therefore, prevention should be supported by activities other than face to face encounter by using information delivery methods, given they are found beneficial and accessible [6].

Today e-Health, the use of ICTs to facilitate heath care and service delivery, presents a unique opportunity for the development of the health sector. In Ethiopia, the Federal Ministry of Health (FMOH) has recognized the benefits of Information and Communication Technology (ICT) as a tool to support the health sector [7].

Within ICTs, portable technology through the use of mobile devices is by far the fastest growing segment in Ethiopia. Currently, the country has more than 40 million mobile subscribers and plans to raise the number up to 64 million in GTP II period [8].

In developing countries, lack of facilities, equipment, and health care professionals mean that many people do not have appropriate access to care providers and medical facilities. This is especially true for those living in remote rural areas. mHealth initiatives are effective in reaching those populations, changing health behaviors and outcomes, and addressing a wide variety of healthcare challenges. Therefore, they are preferable to implement in Ethiopia, a country where almost 80% of the population lives in rural areas.

mHealth projects' implementation can use Text messages, Voice messages and Internet for information exchange and data collection. In a country where more than half of the population don't know how to read and write, voice is the best way to deliver messages.

In the vicinity of voice messages, Interactive voice response (IVR) systems, a rapidly expanding technology for automated acquisition and dispersal of information represent the convergence of computer-automated interviewing with touchtone telephone service. IVR systems are applicable in numerous areas. Its applications for routing telephone calls or accessing banking services are now commonplace. Potential benefits of IVR systems for clinical research and treatment have recently begun to be explored and realized [8].

Secured IVR systems protect confidentiality by unique personal identification numbers and passwords, patients interacting with IVR systems provide information that is used to tailor their current and future interactions. This type of interaction may be most beneficial in treating frequently occurring behaviors that intrude on daily life, such as hygiene, nutrition, substance use, sexual behaviors, obsessive-compulsive behaviors, depression etc. [9].

1.2. Statement of the Problem

Over the last decades, Ethiopia has successfully implemented strategies to expand and rehabilitate primary health care facilities. The country also scaled up investments in human resource development and management. Although good trends are observed, the country is still facing a triple burden of diseases consisting of communicable diseases, non-communicable diseases and injuries [7].

The progress in health status of the Ethiopian population indicates that about 80% of diseases in Ethiopia are attributable to preventable conditions related to infectious diseases, malnutrition; and personal and environmental hygiene. Also, environmental risk factors contribute to 31% of the total disease burden in the country [10]. In line with WHO and FMOH strategic plans, this project focuses on the problem areas explained bellow.

Reproductive care

Reproductive health care in Ethiopia is generally poor, with significant regional disparities in access to services and in health outcomes. In the country gender inequality, sexual coercion, early sexual debut, unwanted/ unplanned adolescence pregnancy, abortion, Sexually Transmitted Infections and HIV/AIDS are the major sexual and reproductive health problems [11].

In Ethiopia, the youth has a disadvantaged access to sexual and reproductive health information and services. There are residents of the country with avoidable yet highly risky behaviors regarding reproductive health. There is high number of unwanted pregnancies, indicating low level of Family planning [12].

HIV/AIDS incidence rate has shown a declining trend in Ethiopia, currently at 0.29%, but the country's large population means there are nearly 1.2 million residents living with HIV/AIDS. The disease is still a major reproductive health burden [13].

Environmental Hygiene and Sanitation

Estimates based on national exposure and WHO country health statistics in 2004 shows 112,100 deaths each year from water, sanitation and hygiene related causes in Ethiopia [10]. This means the promotion of hygiene and sanitation through the health extension program should be strengthened.

Open defecation is also a big problem in the country; promotion is needed to structure open defecation free villages. FMOH plans to implement a national sanitation marketing strategy to generate demand and create access to supplies for construction of improved latrines [7].

Nutrition

Worldwide, malnutrition is an underlying cause in the deaths of more than 3.5 million children under the age of 5 each year. 13 million infants are born each year with low birth weight (LBW), 55 million children are wasted, and of these 19 million are severely wasted. About 178 million children around the world are stunted and 90 percent of these estimated number live in 36 countries, one of which is Ethiopia [14].

First Aid

In Ethiopia, Health Information communication methods include house to house visits, dialogues, discussions, mass-media, and entertaining plays, none of which are easily accessible on and according to demand of the information [15].

Ethiopian Red Cross has an android application, available on the World Wide Web for free, to be used for smart phones, but people who can't read and people without a smart phone don't have a way to access that helpful information.

The problems mentioned above coupled with quite a few others make up what is known as triple burden of health care in Ethiopia. The procedures taken by the government include, increasing government expenditure, providing free care, and searching for other financing sources for

sustainable financial option [7]. But all this effort; though progressive, is not nearly sufficient for getting rid of accessibility, quality and equity problems in the country.

Since, the majority of diseases in Ethiopia are attributable to preventable conditions and information is an important input for preventive interventions. The BCC-IVR system is designed to easily deliver information on selected conditions aiming to decrease the impact with informed decisions. The BCC-IVR system's purpose is to reduce the financial burden associated with computer, internet, or "smart phone" accessibility, literacy and financial restrictions on access to simple health information.

In conclusion, Ethiopia needs to overcome poor health care seeking behavior trend, information unavailability and the destructive ignorance towards avoidable health problems. Easy access to information has a major impact on health promotion and is also an important input for making healthier decisions. Typical residents of Ethiopia get health care information from government providers, but the need is greater than the resources and Health promotion can be a potential remedy to these problems. The project aims to develop an Interactive Voice Response System for delivering behavioral change communication messages.

1.3. Objectives of the Project

1.3.1. General Objectives

The main objective of the project is developing and testing an Interactive Behavioral Change Communication Voice Response system in English and Amharic to ease access to health information in the selected domains.

1.3.2. Specific Objectives

The specific objectives of the system are: -

- Selecting and categorizing dominant health problems to Behavioral Change Communication messages using guidelines and guided discussions as tools.
- Designing easily navigable and Interactive Voice Response Menu tree.

- Implementing and Evaluating the Behavioral Change Communication Interactive Voice Response System prototype.

1.4. Scope and limitation of the System

The BCC-IVR system, to help preventive intervention message delivery, is developed using the local language "Amharic" for the first prototype. The system delivers only important, relevant and brief messages on prevention practices for typical residents. Currently, the system doesn't have dependency on clinic-based care.

The system includes brief BCC messages on the following five major areas: -

- ✓ Preventive sexual and reproductive care recommendations- Including Family Planning options and HIV/AIDS
- ✓ Sanitation and environmental hygiene dos and don'ts
- ✓ Nutritional facts
- ✓ Screening and treatment (Cancer and Periodical)
- ✓ First-Aid

Limitations of the system

- The IVR system is using only one local language, Amharic.
- The BCC-IVR doesn't have a Patient centric follow up.
- The IVR system doesn't include targeted messages from Health Professionals.
- Inadequate funding, because the project was sponsored by the student.

The IVR system can be applied using multiple local languages in the future and also other areas such as, Therapeutic smoking and drinking cessation, Patient centric follow up, Health Extension Workers assistance and others (see future works).

1.5. Significance of the System

The proposed BCC-IVR system improves information accessibility and narrows the gap in health promotion of selected health care issues in line with at least three of Ethiopian development goals.

The benefits of the system are:

- Delivering health promotion and preventive care advices timely 24/7.
- Providing better information for better decision making.
- Improving health care seeking behavior trend by pointing out symptoms and warnings for the uninformed part of the population.
- No transportation cost and time loss to get simple medical advices.
- Knowledge dissemination to decrease impact of particular avoidable health problems.
- Provide low cost implementation choice for preventive care.

1.6. Organization of the Project

This project report is organized as follows: Chapter 1 is an introduction to the problem area and the proposed solution. Chapter 2 discusses general literature and related works parallel to Interactive Voice Response systems (IVRs) and Behavioral Change Communications (BCCs). Chapter 3 includes all the methodologies, tools and techniques used to put together this project. Chapter 4 discusses system analysis and conceptual model of the development. Chapter 5 illustrates all the concerns, goals and remedies regarding system design and Chapter 6 demonstrates the implementation and evaluation of the BCC-IVR prototype system. The final section, Chapter 7 discusses conclusions, and recommendations for future works.

CHAPTER TWO: LITERATURE REVIEW AND RELATED WORK

2.1. Overview

Ethiopia is a poor country with weak health care infrastructures and uneven access to health care services. Ranking 92 out of 95 on the UNDP Human Poverty Index, Ethiopia is one of Africa's poorest states, with 45% of its people living below the poverty line [16]. Three-quarters of the population lack access to clean water, and four persons out of five live without proper sanitation. In addition, Ethiopia hosts sum of 133,000 refugees from neighboring countries [16].

Poor health coverage is of particular concern in rural Ethiopia and access to any type of modern health institution is limited at best. In the last two decades, major crises combining droughts, epidemics, displacements and armed conflicts have repeatedly affected the country. Health systems and roads are underdeveloped, and transportation problems are severe, especially during the rainy season. The diversity of socio-economic environments, climates, and terrains among regions of Ethiopia also has an impact on health conditions and outcomes [17].

In the absence of a strong health care infrastructure, prevention and promotion are the most efficient towards improvement of health outcomes. The health policy of the Federal Democratic republic of Ethiopia has given due emphasis to promote preventive interventions coupled with basic curative services [7]. And, the recent progress shows, almost 80 percent of morbidity in Ethiopia is credited to preventable communicable and nutritional diseases, both associated with low socio-economic development [10].

In Ethiopia, most of the population lives in rural areas and only 49.1% of the residents are literate enough to read. Absence of sufficient budget by is one of both the causes and effects regarding illiteracy [2]. Therefore; any health promotion system of Ethiopia has to be cheap, inclusive towards low literacy groups and easily accessible for different groups in order to be successfully implemented in this country.

Historically, mHealth initiatives were expensive and backed up by inadequate infrastructure to implement in African and even more so in sub-Saharan countries. But; recently the increasing number of phones due to various market reasons makes the means especially appealing for countries like Ethiopia. Figure 1 shows the significant increase in the number of both urban and

rural area mobile subscribers and to demonstrate the opportunity for Ethiopian mHealth initiatives in health care.

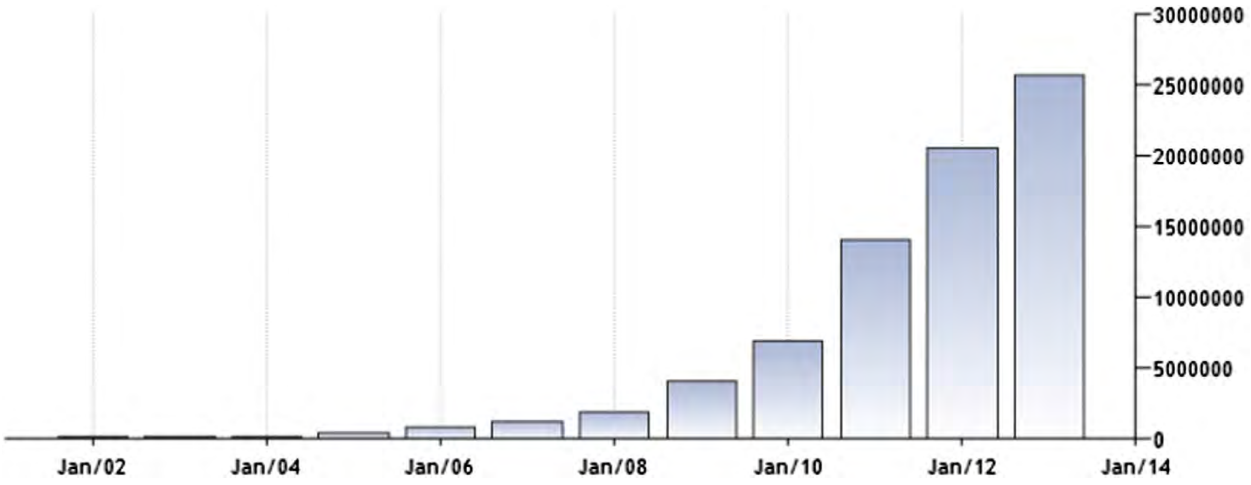

Figure 1: Mobile cellular subscribers in Ethiopia both rural and urban, Source Trading Economics (2014)

The Behavioral Change messages in the BCC-IVR system are delivered through voice calls. The health topics of choice for the project are Reproductive care, Sanitation and Environmental hygiene, Nutrition, Maternal and Child Health, and First-Aid for purposes and limitations discussed in chapter one.

2.2. Health Education, Health Promotion and Behavioral Change Communications

The term Health Education is the oldest of the three, but it is still used. Health education comprises consciously constructed opportunities for learning involving some form of communication designed to improve health literacy [18]. Classic Health Education describes the kind of short talks to groups of people which are included so often in Primary Health Care, about any health topic. Therefore, some people feel it implies only one part of the process, which is the giving of information and motivation. Health education may be used where community mobilization is the best way to go.

Health Promotion is the process of enabling people to increase control over, and improve, their health. It moves beyond a focus on individual behavior towards a wide range of social and

environmental interventions [19]. It is the process of helping people to adopt healthier patterns of behavior. Information, Education and Communication (IEC) are essential for health promotion.

Behavioral Change and Communication (BCC) is defined as an interactive process of any intervention with individuals, communities and/or societies (as integrated with an overall program) to develop communication strategies to promote positive behaviors which are appropriate to specific settings [20].

Behavioral changes cite environmental, personal, and behavioral characteristics as the major factors in behavioral determination. In recent years, there has been increased interest in the application of these theories in the areas of health, education, criminology, energy and international development, with the hope that understanding behavioral change will improve the services offered in these areas [21].

Behavioral health interventions include a range of communication activities designed to encourage risk reducing behavior and increase protective behaviors. The behavior change communication activities include [22]: -

- Discussion groups
- Patient and Professional interactions and Counseling
- Peer education
- Talk-lines
- One-on-one outreach

2.3. Health Promotion in Ethiopia

Ethiopia's Health Extension Program was introduced in 2003 [23]. The health promotion and disease prevention strategic and annual plans as well as monitoring and evaluation activities are carried out by the directorates established. The directorates oversee the development of specific plans for each programme, the Pre-service and In-service trainings for the professionals, Health Extension Workers (HEWs) and the Monitoring and Evaluation of all health programmes using the new Health Management Information System (HMIS) [24].

The health policy of the Federal Democratic Republic of Ethiopia has given due emphasis to promotive and preventive interventions and coupled them with basic curative services. All health

programmes under HPDP-GD are organized within the Agrarian, Pastoralist and Urban Directorates to provide communities with client-oriented services.

The four major health programs that have been integrated within the HPDP-GD are [24]: -

- Maternal and Child Health
- Communicable Disease Prevention and Control
- Hygiene and Sanitation
- Information, Education, Communication (IEC) and Advocacy

2.4. Behavioral Change Communication and Information Communication Methods

Primary care physicians and health care systems face substantial challenges to provide preventive services. Because; preventive care and counseling is time consuming when done face to face, and is not possible to serve each need solo. Therefore; prevention should be supported by activities outside face to face meetings. A variety of IBCTs, including the Internet and mobile phones have been shown to be feasible and potentially valuable adjuncts to clinic based behavioral counseling by increasing effectiveness, extending reach and reducing effort etc.

There are several alternate media that can be used prevention Information delivery [25]: -

- Mass Media (TV, Radio and Newspaper)
- Short Messaging Service (SMS)
- Interactive Voice Response (IVR)
- Telephone with human attendant
- Internet knowledge dissemination(Website, Email and Social Media)
- Word of Mouth. Etc.

Word of mouth lacks the outreach needed for delivering information. Today the use of ICTs to facilitate heath care and service delivery presents a unique opportunity for the development of the health sector. The benefits of the use of Information and Communication Technology (ICT) in the health sector are numerous. The benefits ICT in Health care include [26]:

- Faster information delivery
- Reducing paper work

- Organization of data
- Efficient retrieval of data
- Reliable storage of data
- Maintaining consistent data
- Making useful information for decision making etc.

From the ICT category, web based systems like Email and websites lack the accessibility in developing countries like Ethiopia due to cost of smart phones and computers. The increasing number of phones makes mHealth appealing for Ethiopia. Human attendants need to be skilled to give health care advices, which cost more than automated SMS and IVR systems.

The use of SMS and internet also has several problems including [27]: -

- Most mobile devices do not support SMS service in local languages and require full literacy or at least reading.
- Smart phones, which are internet enabled, are expensive and not affordable by rural area residents with low income.
- The high rates of internet connection fees set by the sole telecommunication provider.
- Ethical and security concerns with permanently saved data at client side like text messages.
- Security risks that come with the World Wide Web connection.
- The frequent shutting down of internet service by ETC.

In conclusion, the rapidly increasing number of both urban and rural area phone customers, due to various market reasons, shows the information delivery medium is appealing for the country, and the superiority in usability and accessibility caused by the reasons above make voice calls the most convenient choice.

2.5. Talk-lines with respect to Ethiopia

Talk-lines, also known as Hotlines, are telephone lines set up to accept incoming calls from people seeking information or answers on one or multiple topics. Since the only requirement to get information from hot line is to have a phone line, they are easily accessible. Talk lines typically need human attendants but the use of IVR reduces that challenge.

Most part of the Ethiopian population live in rural areas, under poverty and only 49.1% of the residents are not literate enough to read [2]. Therefore, any health promotion system has to be cheap, inclusive towards low literacy groups and easily accessible for different groups in order to be implemented in the country. Voice call, implemented as hotlines, is arguably the best information delivery mechanism satisfying those requirements making it reasonable for implementation in Ethiopia.

Talk lines typically need human attendants to answer all calls, but the need for a human operator to handle a high volume of simple repetitive phone calls is a thing of the past. Today, Computer Telephony Integration (CTI) enhances phone systems with automated applications that answer and direct calls and even provide callers with the information they require. Those systems include Interactive Voice Response (IVR) systems.

2.6. Interactive Voice Response (IVR) Systems

Advances in technology have changed the way service providers educate, advertise and interact with their target population. A number of these innovations are largely computer or mobile phone based. The Computer Telephony Integration (CTI) today enhances phone systems with automated applications that answer and direct calls and provide the information without requiring a human assistant available at the other end of the line [28]. Therefore, there is no need for a human attendant to handle large number of repetitive phone calls these days and that reduces the financial burden associated with computer, internet, or “smart phone” access restrictions on use.

Interactive Voice Response (IVR) is a technology that allows a computer to interact with humans and provides pre-recorded or computer generated voice responses using the Dual Tone Multi-Frequency (DTMF) signal via a telephone with a simple standard keypad. A common misconception refers to an automated attendant as an IVR [29].

IVR is not just an auto attendant! An auto attendant is a system that is integrated into an existing phone system or an external server to answer incoming phone calls with a menu of options for navigating the phone system to reach the department or phone number they desire [29]. An auto attendant can be quite simple or it can provide advanced features such as voice recognition and

text-to-speech translation. However; an auto attendant is unable to retrieve information from other systems, limiting its ability to be truly interactive.

On the other hand, IVR provides all the features of an auto attendant plus the ability to use input from callers to interact with separate external systems. The terms IVR and automated attendant are distinct and mean different things to traditional telecommunications professionals. The purpose of an IVR is to take input, process it, and return a result, whereas the job of an automated attendant is to route calls [30].

The Interactive Voice Response (IVR) System also serves as a bridge between people and computer databases. There are several advantages of using Interactive Voice Response Systems, IVR systems provide customers with many services such as [31]: -

- Secure access to confidential information
- Provide general information such as phone numbers and working hours
- Information availability for 24 hours 7 days a week
- An easy way to navigate through a complex phone system
- Decrement of human attendant cost
- Inform callers about products and services when calls are on hold etc.

From a business perspective, IVR adds to customer satisfaction by giving customers the information they want, and options to get it. If the customer is satisfied, the IVR system will pay for itself through increased sales. IVR systems also reduce call center costs by fielding the bulk of routine calls, allowing live agents to handle only the calls that require specialized skills.

Additionally, an IVR system provides detailed information about call center activity and services that customer access making it easy to tailor a call center to the specific needs of the customer and streamline operations to reduce waste. IVR systems not only reduce the number of skilled human attendants needed, but also it can be translated to local languages to increase the outreach. Unfortunately due to time and budget restrictions the BCC-IVR prototype includes partial implementation and system design of the IVR system in need.

With confidentiality protected by unique personal identification numbers and passwords, patients interacting with IVR systems provide information that is used to tailor current and future interactions. This type of interaction may be most beneficial in treating frequently occurring

behaviors that intrude on daily life, such as sanitation and environmental hygiene, nutrition, smoking, drinking, sexual behaviors, obsessive-compulsive behaviors, depression etc.

2.7. Related Works

Wegen AIDS Talk-line

Wegen AIDS Talk-line empowers Ethiopians to know their HIV status and help those HIV negative maintain their status. The 952 hotline currently has eight dedicated lines hooked with to PABX telephone sets serving the public [32]. The Talk-line also promotes healthy life style to HIV infected people and their families. The project provides services in the three major languages: Amharic, Oromifa and Tigrigna. This project serves the community with up-to-date information, counseling and referral service on HIV/AIDS, STI and TB. The Talk-line provides anonymous, confidential and nonjudgmental service allowing callers to speak about sensitive and private issues without embarrassment.

Fitun Warm-line

The 932 line is a toll free call-in center, devoted in answering questions about HIV/AIDS from health care providers. The center's aim is to help health professionals overcome challenges in the rapidly evolving science of HIV medicine. The Warm-line consists of multidisciplinary team of HIV/AIDS experts. These experts provide a line that makes quick, accurate and up-to-dated answers to HIV/AIDS questions just a phone call away.

8028 call in system-- First agricultural hotline in the country

An agricultural hot line designed to provide free agricultural advice to small holder farmers about planting crops using fertilizer and preparing land. The hotline is a result of a collaborative effort between the Ministry of Agriculture, the Ethiopian Institute of Agricultural Research (EIAR), Ethio-Telecom, and the Ethiopian Agricultural Transformation Agency (ATA). The agricultural hotline was launched recently and according to Ethio-Telecom, has more than one million

registered callers averaging 17,500 daily calls into the 8028 system making knowledge is simply a phone call away for Ethiopian farmers [33].

Interactive Voice Response System to Deliver Refresher Training in Senegal

The USAID-funded Capacity-Plus project, led by Intra-Health International, developed, deployed, and assessed an innovative m-Learning system that used a combination of IVR and SMS text messaging to deliver refresher training to family planning providers in Senegal [34].

The system focuses on management of contraceptive side effects and counseling to dismiss misconceptions and is aligned with Senegal's national family planning policies and international guidelines. It was delivered using a distance learning approach called Spaced education in which content is spaced and repeated over time and which has been found to increase retention of clinical knowledge and skills.

2.8. Conceptual Framework

The BCC-IVR platform menu is designed using several criteria. The BCC messages will be categorized using Age, Sex, Pregnancy status and preventive intervention guidelines.

The prevention recommendations include First Aid, Reproductive Care, Nutrition, Sanitation, Screening and Treatment. General screening and treatment recommendations of the system will be subdivided to Drugs, Immunizations and Doctor Visits and tests. Figure 2 shows holistic view of the BCC-IVR system.

The BCC-IVR system uses this framework to build the navigation menu of the system and implement it as an IVR menu tree. The criteria used to group are adopted from prevention guidelines (see chapter 4 for details) and the topics are selected according to the statement of the problem (see section 1.2).

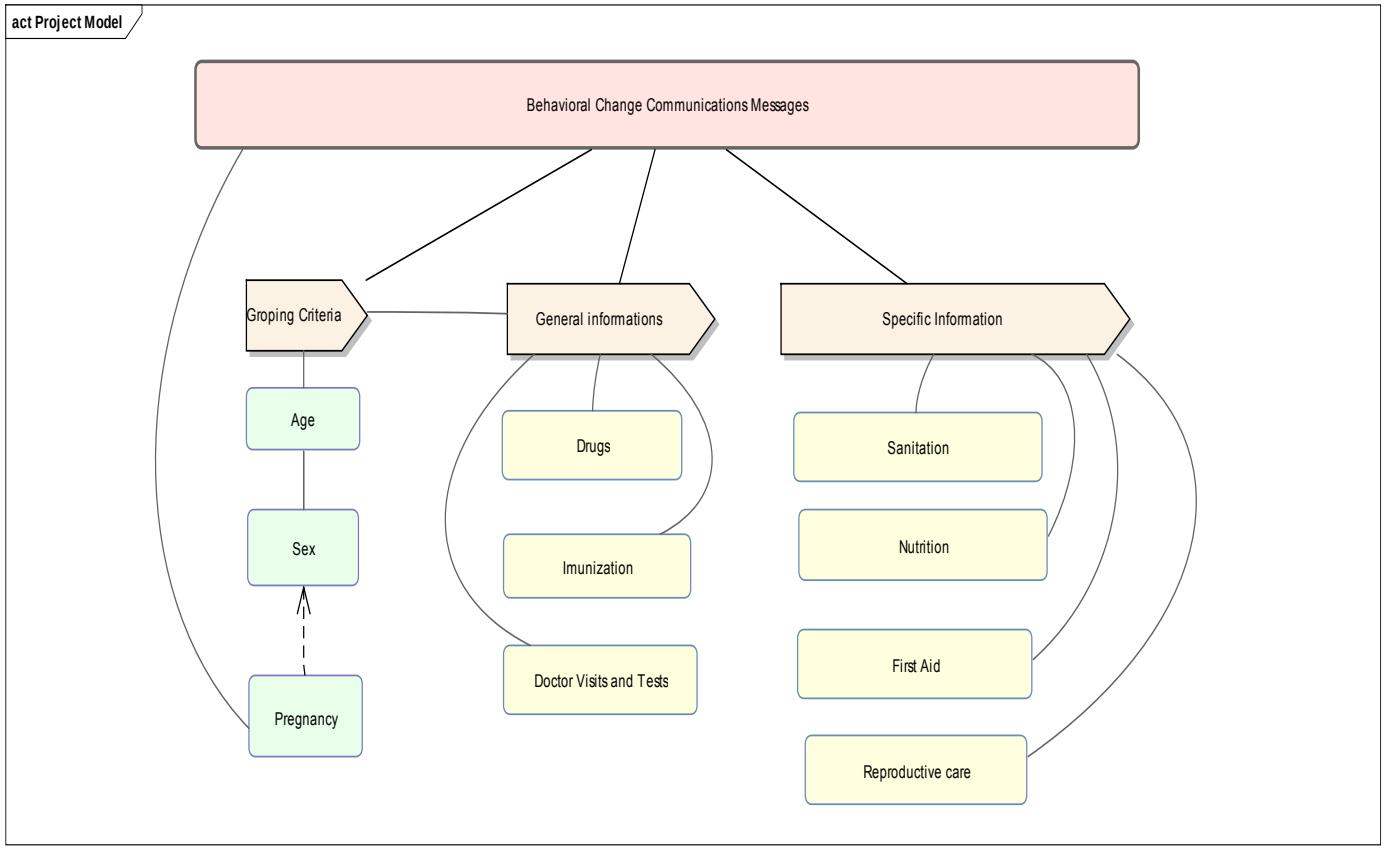

Figure 2: Conceptual framework of the BCC-IVR

CHAPTER THREE: METHODOLOGY

The study used exploratory study design and the participants were selected using purposive sampling technique. The source population included individuals involved in both sides of the Ethiopian healthcare system, i.e. health care providers and health services' consumers.

Guided discussions were used to collect expert judgment from health professionals and functionality requirements from typical residents living in Ethiopia. A questionnaire was used for collecting usability test feedback summary from participants. All the participants were from Addis Ababa and Hawassa.

The development tools that were used to build the system are Asterisk to build an IVR server, PHP as an AGI to write the administrative program and communicate with IVR server and Zoiper as soft phone to implement and test the prototype.

3.1. Study Period and Area

The study was conducted from November 2016 to June 2017 to develop and test an Interactive Voice Response System for Behavioral Change Communication in Ethiopia using English and Amharic. The study is scoped in two regions of Ethiopia, Addis Ababa and Hawassa.

3.2. Study Design

Exploratory study design was used to develop an Interactive Voice Response (IVR) system for Behavioral Change Communication (BCC) in Ethiopia.

3.3. Source and Sample Population

The study population consisted of Ethiopian people who have access and can use a phone and health professionals for group one and three and group two respectively. The participants in both groups were selected using purposive sampling technique from Addis Ababa and Hawassa.

Group one and three: The sample population included convenient and willing residents in the Addis Ababa and Hawassa.

Group two: Health professionals in Addis Ababa and Hawassa.

Inclusion criteria

Group one: The study participant has to know how to use a phone, and can speak Amharic.

Group two: The participant has to be a health professional (Doctor or Nurse).

Group three: The study participant has to know how to use a phone, and can speak Amharic. The usability test purposefully included people who has limited access to health information caused by low-literacy level to test inclusivity of system design.

Exclusion criteria

Group one, two and three: The respondent can't speak Amharic or English.

Group two: The respondent is not a health professional.

3.4. Sample Size

The total number of participants was 34. 25, for requirement study, 12 typical residents and 13 health care professionals and 9 for usability testing.

Test methodology and data saturation determined the number of participants for usability test and requirement collection groups respectively.

3.5. Data Collection Instruments

This study was conducted using discussions, a questionnaire and guidelines.

i. Discussions

Open-ended questions were used in the discussion guides for tailoring of preventive guidelines presented in the system according to the needs of residents and expert judgment of health professionals (see Annex A and B).

ii. Guidelines

Prevention guidelines are used to develop BCC-IVR platform, on each topic included (see Chapter 4 for details).

iii. Questionnaire

Since the main aim of the project includes testing a prototype, usability testing is used to evaluate acceptance and the process included guided face to face discussion.

While evaluating the system 13 usability testing questions about the product were forwarded to the 9 participants. 10 were close-ended and used likert scale to measure response. 3 open-ended questions were included to encourage participants to point out what seemed neglected to them.

3.6. System Development

System development methodology is the framework used to plan and control the process of system implementation. There are several methods developed and evolved over the years, but it is suitable to use RAD for developing this IVR system because of the following reasons

1. Iterative development: - RAD transforms the step-by-step linear development flow of conventional methods into an iterative process. The system development process is allowed to be vibrant and can execute desired changes any time throughout the development life cycle.
2. Prototyping: - An unfinished version of the system is to be produced at the end of the project life cycle.
3. Time saving: - Fast development and Delivery.

Rapid Application Development (RAD) is a people-centered and incremental development approach and an iterative framework with objectives of High Speed, High Quality and Low Cost [35]. The RAD approach includes developing and refining the data models, process models, and prototype in parallel using an iterative process.

3.7. System Evaluation

Usability test is conducted on the Behavioral Change Communication Interactive Voice Response prototype. The system is evaluated using usability lab testing method.

Usability lab testing is a method in which users follow pre-defined scenarios. In this testing method, the session to place in a room divided into two parts by a two-way mirror – moderator

with a participant of the study are in one part of the room while observers are in the second part. Usually during a session respondents' desktops and facial expressions are recorded. This type of typical usability lab testing involves 5-8 participants [36].

Zoiper softphone was the supporting software used to access the IVR application's extensions number running on a personal computer's virtual server under the same network.

The organizer briefed the participants about the BCC-IVR application and assisted the participants while they were evaluating the application and asked the participant if they have any questions.

Participants signed an informed consent acknowledging the participation was voluntary and it was possible to quit at any time. They knew the amount of time taken to complete the test tasks were be measured.

During this evaluation of the BCC-IVR system, 13 usability testing questions about the product were forwarded to the 9 participants from Addis Ababa and Hawassa, and all the participants of the test were Amharic speakers. Orientation about the system is given for 15 to 20 minutes to the participants prior to test.

3.8. Tools and Techniques

There are several tools, in three categories, used for data collection, analysis and development throughout the project. The tools and techniques are described in the table 1.

The categories are System implementation, Data Collection and Usability Testing and the whole development life cycle.

Development phase	Technique or Tool	Description	Purpose
Data collection	Guided Discussion	Contains mostly open-ended questions. In-depth, face to face.	To point out neglected areas by the researcher, set efficiency goals. To get expert judgment. To address and select significant decision affecting points to increase usability and user-friendliness.

Data collection	Guidelines	Guidelines in each topic.	The main source for the BCC messages and categories used to put design the IVR menu. (see chapter four for details)
Development	Analysis and Design	Developing behavioral change IVR platform.	To generate themes, menus and categories from the data collected and documents read.
Development	RAD	Rapid Application Development	For developing and refining data models, process models, and prototype using an iterative process in parallel.
System Design	UML	Unified Modeling Language	Object oriented design modeling tool
Implementation	Audacity	Recording and Editing software.	To edit quality of audio recordings used in the system.
Implementation	Asterisk	Audio/ Voice server	To build an IVR server
Implementation	UBUNTU	Operating System	As an environment to run Asterisk and other utilities and write programming languages. N.B. Currently, Asterisk doesn't have a successful version that runs on Windows operating system [29].
Implementation	PHP	Programming language	To build the administration program of the IVR application
Implementation	AGI	Asterisk Gateway Interface	Used as an interface between asterisk server and IVR Application
Implementation and Evaluation	Zoiper	Simulation of a phone	As a Soft phone to simulate a phone
Evaluation	Usability Lab Testing	A methodology to test usability of a product	A tool to test usability of the BCC-IVR system.
Evaluation	Excel 2013	Statistical analysis tool	Used for presentation of system evaluation results.

Table 1: Summary of Techniques and Tools used in the project

3.9.Operational Definitions

AGI: - An interface system between asterisk IVR server and administrative program

Asterisk: - IVR server of choice for the project

Auto-Attendant: - It is a system that is integrated into an existing phone system or an external server to answer incoming phone calls with a menu of options for navigating the phone system

BCC: - Behavioral change communication is an application of behavior change theories to improve environmental, personal, and behavioral characteristics in several areas.

IVR: - Interactive Voice Response (IVR) is a technology that delivers information using audio by pressing a number key and communicates with any type of phone.

IVR Server: - Interactive Voice Response server is a computer serving as a PBX (Private Branch Exchange).

PSTN: - Public switched telephone network is a means of communication using telephone lines, not IP addresses or Internet.

TCP/IP: - A protocol used for communication between computers.

UBUNTU: - Linux family operating system developed in South Africa

VOIP: - A protocol for transmitting Voice over IP

UML: - Unified Modeling Language, Object oriented design modeling tool

Zoiper: - A software used to simulate a phone. It is a high quality softphone.

3.10. Ethical Consideration

An ethical approval from a research ethics committee of School of Public Health in AAU should be obtained before the study is conducted. Informed consent was be obtained from each participants confirming willingness, disclosure of project purpose and agreement to spend the time required. The data collector is the developer and signed along with the participants declaring confidentiality.

3.11. Result Dissemination

The result of this project will be submitted to Addis Ababa University School of Information Science and School of Public Health. The developer will implement the system after applying improvements based on project feedback.

CHAPTER FOUR: SYSTEM ANALYSIS

This chapter includes an introduction, functional requirements, non-functional requirements, and system model diagrams and tools with their appropriate descriptions.

4.1. Overview

System analysis activities focus on understanding the application domain. The domain includes descriptions of the system and its components as results of the system analysis processes. The system analysis process for the BCC-IVR system, comprises prevention care guide lines about each topic, prioritized with guided discussions with 25 participants (see discussion guides Annex A and B).

System Analysis activities produce [37]: -

- Functional requirements and a Use case diagram, representing business processes.
- A set of non-functional requirements and constraints, setting quality standards.
- An object model and class diagram, describing participating entities.
- Activity diagram/s for major activities, describing flows.
- Sequence diagrams of Use cases, describing interactions between objects.

System analysis processes for the BCC-IVR system include adopting guidelines and conducting discussions: -

Discussions

Guided discussions were users to point out neglected areas by the guidelines selected by researcher, set efficiency goals for the system and get expert judgment from health professionals. The discussion included two groups of participants.

Participants

The requirement collection for the BCC-IVR system was conducted using two discussion guides (see Annex A and B) for two separate groups containing 25 people, from which 13 of the participant were health professionals. The selection was based on convenience sampling technique and willingness of the participants. The response rate was 67.6 %, i.e. 37 individuals were approached and 25 were willing.

Participant	Details			
Group 1: Health Professionals	Profession	Sex		Total
		Male	Female	
	Doctors	2	4	4
	Nurses	4	5	9
	Total	6	7	13
Group 2: Typical Residents		Male	Female	Total
	Resident	6	6	12

Table 2: Summary of participants' in the requirement analysis

Guidelines

- **First Aid** -- Red Cross android application and FMOH, First aid Extension package, A.A, September 2003
- **Reproductive Care** -- Massachusetts Health Quality Partners, Adult Preventive Care Guidelines, 2017 and FMOH, NATIONAL Reproductive Health Strategy, 2005-2015
- **Nutrition** -- FMOH, National nutrition strategy, A.A, Jan 2008 and Food and Nutrition Guidelines for Healthy Children and Young People Aged 2–18 years, FMOH, 2012,
- **Sanitation** -- Wash guidelines and Keep it clean food hygiene guidelines, MAST Icelandic food and veterinary authority, 2015
- **Screening and Treatment** -- Blue cross BlueShield of Illinois, prevention guidelines, 2016-2017 and Bright Futures, American Academy of Pediatrics, Recommendations for Preventive Pediatric Health Care, May 2015

4.2. The Existing System

The health policy of the Federal Democratic Republic of Ethiopia has given due emphasis to promotive and preventive interventions coupled with basic curative services. Ethiopia's Health Extension Program was introduced in 2003 [23]. The health promotion and disease prevention

strategic and annual plans as well as monitoring and evaluation activities are carried out by the directorates established. They oversee the development of strategies and plans [24].

The program deployed more than 38,000 HEWs. The health education and health promotion activities took advantage the existence of the HEP to increase awareness, knowledge, behavior change, community mobilization and participation. The HEWs have become instrumental for the remarkable achievements made in the key health programs [25].

All health programs under HPDP-GD are organized within the Agrarian, Pastoralist and Urban Directorates to provide communities with client-oriented services. There are four major health program areas that have been integrated within the HPDP-GD [24].

1 Maternal and Child Health
2 Communicable Disease Prevention and Control
3 Hygiene and Sanitation
4 Information, Education, Communication (IEC) and Advocacy

There are many local languages spoken in Ethiopia, and this has an impact on health promotion in the country. Ethiopia has recently conducted a reform and restructuring process and to ensure a population centered approach, the department in charge of health promotion and disease prevention is organized into urban, rural and pastoralist health.

Other measures taken by the government include, increasing government expenditure, providing free care, and searching for other financing sources for sustainable financial option. The Ethiopian Federal Ministry of Health also implemented the Wegen AIDS talk-line providing free information, telephone counseling and referral services on HIV/AIDS, STIs, TB and related topics in over 14 local languages [32].

4.2.1. Gaps in the existing system

The main goal of the Ethiopia health system is ensuring that everyone who needs health services is able to get them without undue hardship [7]. Health promotion is one of those services. Therefore; in all the series of HSDPs including the HSTP for the period 2015/16 -2019/20, health

education and health promotion are clearly featured as an integral part in the health sector program planning and implementation. [25]

The HEP implementation manual states that health extension workers lead the planning, implementation, and evaluation of community outreach activities [25]. However, there is high turnover rate of HEWs in some places. Additionally, some health posts need to be rehabilitated. Revisiting the HEP in the coming years is critical to sustain the gains made so far and address the needs of the community. Besides training of HEWs to achieve the next higher level, creating mechanism for retaining them and improving health posts accordingly are among the issues that need to be addressed in the subsequent strategy [23].

The weaknesses of Health promotion and communication in Ethiopia includes [38]: -

- Inadequate number of health education experts and structure at each level
- Inadequate strategic guidance and follow up of health promotion and communication interventions
- Insufficient experts in behavior change communication and failure to place them at appropriate positions
- Absence of staff and structure at zonal and woreda level for the management of health promotion and communication interventions
- Poor knowledge and skill of HEWs, HDAs and primary health care staffs on health promotion and communication
- Low engagement of media in health promotion and diseases prevention interventions
- Limited adaptation and use of technologies for health promotion and communication

These weaknesses and several others exist, because only little attention had been given to build federal and regional capacity to provide and support technical assistance for the development of region-focused, culturally sensitive to the specific needs of the local communities. Due to limited resources, impact assessment of the IEC/BCC activities has not been made possible [25].

Currently, in Ethiopia, there is no health education and promotion structure at regional, zonal, and Woreda levels [25]. Considering the general literacy status especially, in rural areas, poor access to health information leads to low level of health literacy that adversely affects the health of the

population. This indicates that there are still significant gaps in knowledge, attitude, and healthy practices in most health programs.

Gaps in use of technologies

Despite the contribution by the mass media in keeping the general public at large informed on health information, it lacks the capacity to develop evidence based high impact programs. Health education and communication is multidimensional, requiring the use of different channels and technologies like mobile health, satellite-based services, social media, etc., that can create synergetic effect to improve behaviors of the community towards to health.

In conclusion, Health improvements of the country would not be possible without the improved awareness and behavior change among the people as a result of information, communication, social mobilization, and advocacy work [25]. Although technology has already been instrumental in health communication, its use can be strengthened through innovative approaches that keep the general public and targeted audiences well informed about health issues. The BCC-IVR system aims to improve access to information about those issues.

4.3. The Proposed System

According to the World Health Organization, health promotion is the process of enabling people to take greater control of their health and improve it. Health promotion is intended to strengthen the skills and capabilities of individuals to take action and build the capacity of groups or communities to act collectively to exert control over the determinants of health and achieve positive change [39].

Access to information is an important input for preventive interventions. Typical residents of Ethiopia get health care information from government providers, but the need is greater than the resources and Health promotion is a potential remedy to these problems.

Interactive Voice Response (IVR) systems have been a mainstay application for the delivery of automated self-service in the telecommunications industry for nearly three decades [31]. There are several potential benefits IVRs add to hot-lines and some of them are listed below: -

- Accessibility round the clock
- Ability to provide patient-specific information
- Self-treatment and encouragement
- Support of human attendant on request

The BCC-IVR system improves access to knowledge about health issues and narrows the equity and accessibility gap in the selected health care domains. It is the right step to the future of Health care in the country.

4.4. Functional Requirements

Functional requirements define a functions of a system and its component. A function is described as a set of inputs, behaviors, and outputs. Generally, functional requirements are expressed in the form "system must do" [40].

The functional requirements of the BCC-IVR system are: -

- The system should accept DTMF input from the user's keypad while connected to the IVR server
- The system should verify if user's input or choice exists in the IVR menu.
- The system should receive calls, while the server is running, from users under the same network.
- The system should allow the user to select language between Amharic and English.
- The system should allow the user to select behavioral change communication message.
- The system should prompt the user stating the purpose of the IVR service following the welcome message in Amharic.
- The system should be able to show call detail records for the administrator/s.
- The system should allow users to terminate any call at any time.
- The system should allow the user to hold up any call in progress.
- The system should play a hold music when a call is being held up.

4.5. Non-functional Requirements

Non-functional requirement are requirements that specify the criteria that can be used to judge the operations of a system. The non-functional requirements of a system might include features such as security, maintainability and expandability, user friendliness and portability [40].

The following sections consist the list of non-functional requirements expected from the BCC-IVR system with their appropriate descriptions.

4.5.1. User friendliness

Since the system is designed keeping illiterate and semi-literate group in mind and the user interface of the BCC-IVR is a standard telephone keypad. Therefore, it is safe to say the system to be user friendly. For this reason, the voice interfaces and components of the voice interfaces should be designed in a user friendly fashion to help users interact easily with the system. In addition to this, the menu structure was designed by collecting information need and requirement of Ethiopian residents in order to allow them to easily interact with the system.

4.5.2. Accessibility

The IVR system should be available 24/7 and accessible from any location under the same network and any telephone device or appropriate phone simulation software.

4.5.3. Portability

The system should be designed in such a way that the IVR application can be accessed by any mobile device that supports Ethio-Telecom line for communication.

4.5.4. Security

The IVR system of this project is developed using Asterisk, a system that's far more secure than anything PBX that exists today [29]. The system also doesn't save data at client side. The system also uses username and passwords generated, hashed and pre-registered in the system.

4.5.5. Reliability

As much as possible the BCC-IVR system is designed to provide a reliable service. The system is developed on a reliable software. The contents of the system copies trusted guidelines and resources developed by well-known organizations to make BCC messages authentic, useful and trustworthy. (For further detail on the guidelines used see section 4.2 “The proposed system”)

4.5.6. Performance and Speed

An underpowered IVR can cause customers to become impatient, and it may even drop calls because it cannot handle the volume of incoming traffic. It’s important that the IVR system is able to handle the maximum number of incoming lines expected.

4.5.7. Customer satisfaction

The Behavioral Change Communication Messages IVR System should be designed with the customer in mind. The IVR System’s effectiveness should be monitored using call detail records, to see how many calls are dropped, as dropped calls are most of the time an indication of customer frustration with system. Menus should be designed logically and based on users need. The options should be explained to the customer in a way that semi-literate and illiterate residents can understand them. It’s important to keep the number of options to the minimum and the customer should be enabled listen repeatedly the options, because it’s difficult for callers to remember a long list of menu items.

4.6. System Models

System models are ways to document the system being designed. A picture is worth a thousand words and that's why Unified Modeling Language (UML) diagramming was created, to forge a common visual language. The language is a general-purpose, developmental, modeling language in the field of software engineering that is intended to provide a standard way [41].

UML diagrams represent two different views of the system model

Static views: - Also known as structural views, they emphasize static structure of a system using objects, attributes, operations and relationships. Static views include class diagrams and composite structure diagrams.

Dynamic views: - Also known as behavioral views, they emphasize the dynamic behaviors of the system by showing collaborations among objects and changes to the internal states of objects. Dynamic views include sequence diagrams, activity diagrams and state machine diagrams.

A UML System model consists of both static and dynamic views. Typically, it includes Use Case diagram and narration, Class diagram, Activity diagram and Sequence diagrams.

4.6.1. Use Case Diagram

Use cases evolved from object-oriented analysis. They also are referred to as "behavior diagrams", and are widely used system analysis modeling tools for describing set of actions that systems should or can perform in collaboration with one or more users(actors) of the system.

A use case diagram identifies different types of users and represent available user's interactions with the system. It shows the relationships between users and the different use cases in the system in a simple manner. Each use case is a business scenario or event for which the system must provide a defined response [38]. Figure 3 shows the use case diagram of the BCC-IVR system.

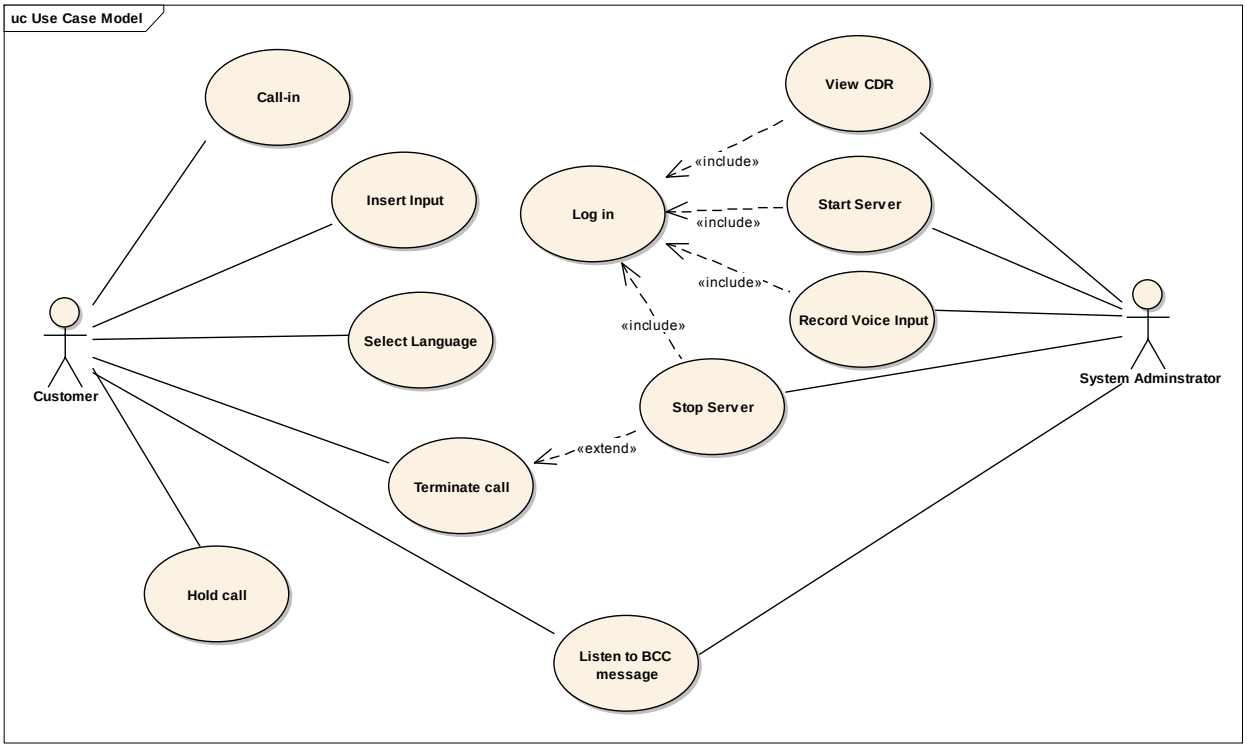

Figure 3: Use Case Diagram for the BCC-IVR system

4.6.2. Actor Definitions

Actors are users of the system. Users of the BCC-IVR system are callers and system administrators.

1. **System Administrator**

Description: Administrator is a person who is responsible to start server, view call detail, stop server and record voice inputs.

2. **Customer/ Caller**

Description: A Customer is a person that uses the functionalities of the system. The Customer can call BCC-IVR extension, insert DTMF input, listen to BC messages in Amharic or English, and hold and terminate call/s.

The term “Customer” is used to describe all users of the system and the term “Caller” is those connected with the IVR extension line. Though; using them interchangeably doesn’t cause much confusion.

4.6.3. Use Case Descriptions

Use case description/narration is a textual representation of the optimistic and alternative flow of events when the system is interacting with the actors/users of the system.

Name	Call-in
Identifier	UC-001
Description	Allows the customer to call to BCC-IVR extension number
Actor	Caller/Customer
Pre-Condition	1. The customer must have access to a mobile phone 2. The customer must know the IVR extension number
Post-Condition	The caller will listen to the welcome prompt and continues to using the system.
Basic Course of Action 1. The customer dials the IVR extension number. 2. The customer will be connected to the BCC-IVR system. 3. The use case ends.	
Alternative Course of Action: None	

Table 3: Description for Call-in

Name	Insert Input
Identifier	UC-002
Description	Allows the caller to navigate the system by using the mobile phone's keypads and associated DTMF tones to acquire desired BCC message.
Actor	Caller/Customer
Pre-Condition	The customer is a connected caller.
Post-Condition	The caller will navigate the IVR system tree.
Basic Course of Action 1. The system prompts the caller BCC menu. 2. The Caller navigates forward and backward by inputting one DTMF tone choice at a time 3. The use case ends.	
Alternative Course of Action [2]: The user wants to select a language 1. The System initiates UC-003. 2. The use case ends.	

Table 4: Description for Insert Input

Name	Select Language
Identifier	UC-003
Description	Allows the user to select language.
Actor	Customer/Caller
Pre-Condition	The Customer is a connected caller.
Post-Condition	The user will select language.
Basic Course of Action 1. The system prompts the caller the welcome message and the language options. 2. The caller selects language by pushing the number of his/her choice from the prompt. 3. The use case ends.	
Alternative Course of Action: None	

Table 5: Description for Select Language

Name	Record Voice Input
Identifier	UC-004
Description	Allows the Administrator to record BCC messages and IVR menus.
Actor	Administrator
Pre-Condition	The user must be logged in.
Post-Condition	The user will convert a text to speech and get the recorded audio.
Basic Course of Action 1. System displays "Administrator" page. 2. User clicks record voice. 3. User enters text. 4. System displays confirmation and output file's folder. 5. The use case ends.	
Alternative Course of Action [4]: There text is empty. 1. System informs the user. 2. The use case ends.	

Table 6: Description for Record Voice Input

Name	Terminate Call
Identifier	UC-005
Description	Allows the Caller to terminate a call.
Actor	Caller/Customer
Pre-Condition	1. The Customer is on a call in progress 2. The Customer wants to end call
Post-Condition	The call will be terminated and CDRs will be saved.
Basic Course of Action 1. The call will be terminated. 2. CDRs will be saved. 3. The use case ends.	
Alternative Course of Action: None	

Table 7: Description for Terminate call

Name	Login
Identifier	UC-006
Description	Allows the Caller/Customer to login to the system
Actor	Administrator
Pre-Condition	The user must be already registered and wants to login.
Post-Condition	The user is logged in.

Basic Course of Action

1. The user starts the system.
2. The system displays login page.
3. The user types username and password.
4. The system checks for password and username to be correct.
5. System displays “Administrator/home” page. (see figure 10)
6. The use case ends.

Alternative Course of Action [4]: User enters wrong password or username

1. The system informs the user “Incorrect username or password”.
2. The use case ends

Table 8: Description for Login

Name	Listen to BCC Message
Identifier	UC-007
Description	Allows the Caller/Customer/Administrator to access Behavioral Change Communication messages in the IVR system.
Actor	Caller/Administrator
Pre-Condition	1. The User is connected to the IVR extension using UC-OO1. 2. The User has selected a language using UC-003. 3. The User has navigated to desired BCC message through the IVR tree
Post-Condition	The system prompts the user with repeat and go-back options.
Basic Course of Action 1. The user chooses the number of the BCC message desires. 2. The system takes the DTMF input and the user gets to listen to a BCC message. 3. The use case ends.	
Alternative Course of Action [2]: The user wants to listen to the BCC message again 1. The user pushes the number 9. 2. The system restarts use case. 3. The use case ends.	

Table 9: Description for Listen to BCC message

Name	Hold Call
Identifier	UC-008
Description	Allows the Caller to hold a call in progress.
Actor	Caller/Customer
Pre-Condition	The Caller is connected to the system using UC-001
Post-Condition	The System will hold the call.
Basic Course of Action 1. The Caller presses hold call key. 2. The System will play on hold music. 3. The use case ends.	
Alternative Course of Action: None	

Table 10: Description for Hold call

Name	View CDR
Identifier	UC-009
Description	Allows the user to view detail records about the calls in the IVR system.
Actor	Administrator
Pre-Condition	1. The Administrator should be logged in. 2. The IVR server must be running.
Post-Condition	The system will display call detail information.
Basic Course of Action 1. Administrator clicks view details of call records button. 2. The system displays all CDRs from master file. 3. Administrator selects CDR to view. 4. System displays the required CDR. 5. The use case ends.	
Alternative Course of Action [3]: The CDR doesn't exist. 1. The System displays the information. 2. The use case ends.	

Table 11: Description for View CDR

Name	Start Server
Identifier	UC-010
Description	Allows the user to start IVR server.
Actor	Administrator
Pre-Condition	1. Administrator must be logged in 2. Administrator should know the server Id
Post-Condition	The IVR server will be started.
Basic Course of Action 1. The Administrator wants to start the server. 2. The Administrator clicks Start IVR server. 3. The system displays the server's terminal. 4. The use case ends.	
Alternative Course of Action [2]: The Server has already started 1. The System asks the user if he/she wants to restart the server 2. If YES the system restarts and the use case ends. 3. If NO the use case ends.	

Table 12: Description for Start server

Name	Stop Server
Identifier	UC-011
Description	Allows the user to stop an IVR server.
Actor	Administrator
Pre-Condition	1. The administrator should be logged in. 2. The administrator must know the server Id.
Post-Condition	The IVR server will stop all services running.
Basic Course of Action 1. The Administrator wants to stop the IVR server. 2. The Administrator clicks Stop IVR server button. 3. The System shuts down the server and displays confirmation. 4. The use case ends.	
Alternative Course of Action [2]: The server hasn't started yet 1. The System displays the information. 2. The use case ends.	

Table 13: Description for Stop Server

4.6.4. Class Diagram

Class diagram of the Unified Modeling Language (UML) is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, their methods, and the relationships among them. The class diagram is the main building block of the object-oriented modeling. It is used both for general conceptual modeling of the systematics of the application. Class diagrams are used for data modeling [42]. The class diagram of the system is shown in Figure 4.

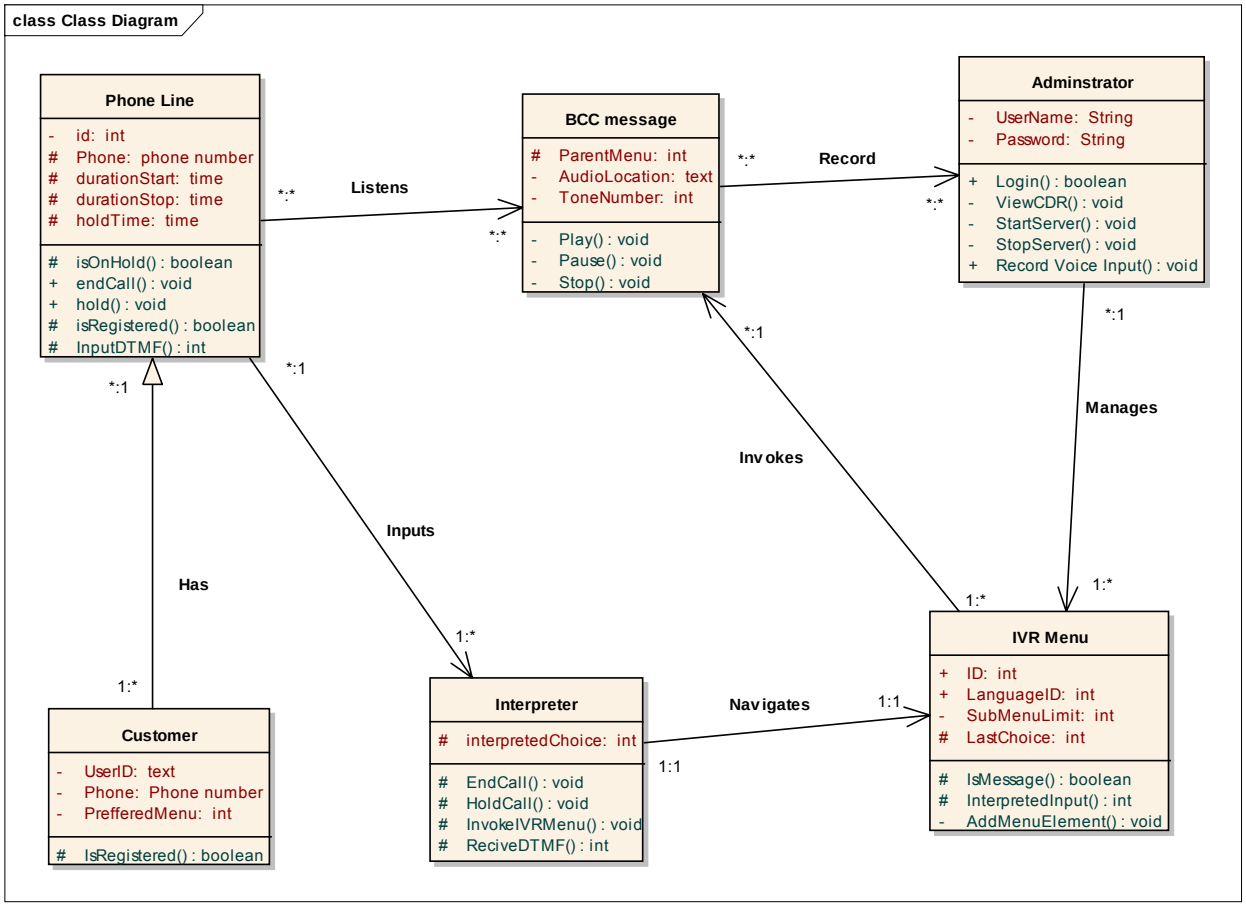

Figure 4: Class Diagram for the BCC-IVR system

4.6.5. Activity Diagrams

Activity diagram is another important diagram in UML used to describe dynamic aspects of the system. An activity diagram visually presents a series of actions or flow of control in a system similar to a flowchart or a data flow diagram. It is basically a flow chart to represent the flow from one activity to another activity [41]. Two major activities of the system, listening to BCC message and Viewing call records are shown in figure 5 and 6 respectively.

Any caller can access recorded BCC messages after the proper navigation through the IVR menu. Figure 5 shows how a caller can listen to a BCC message.

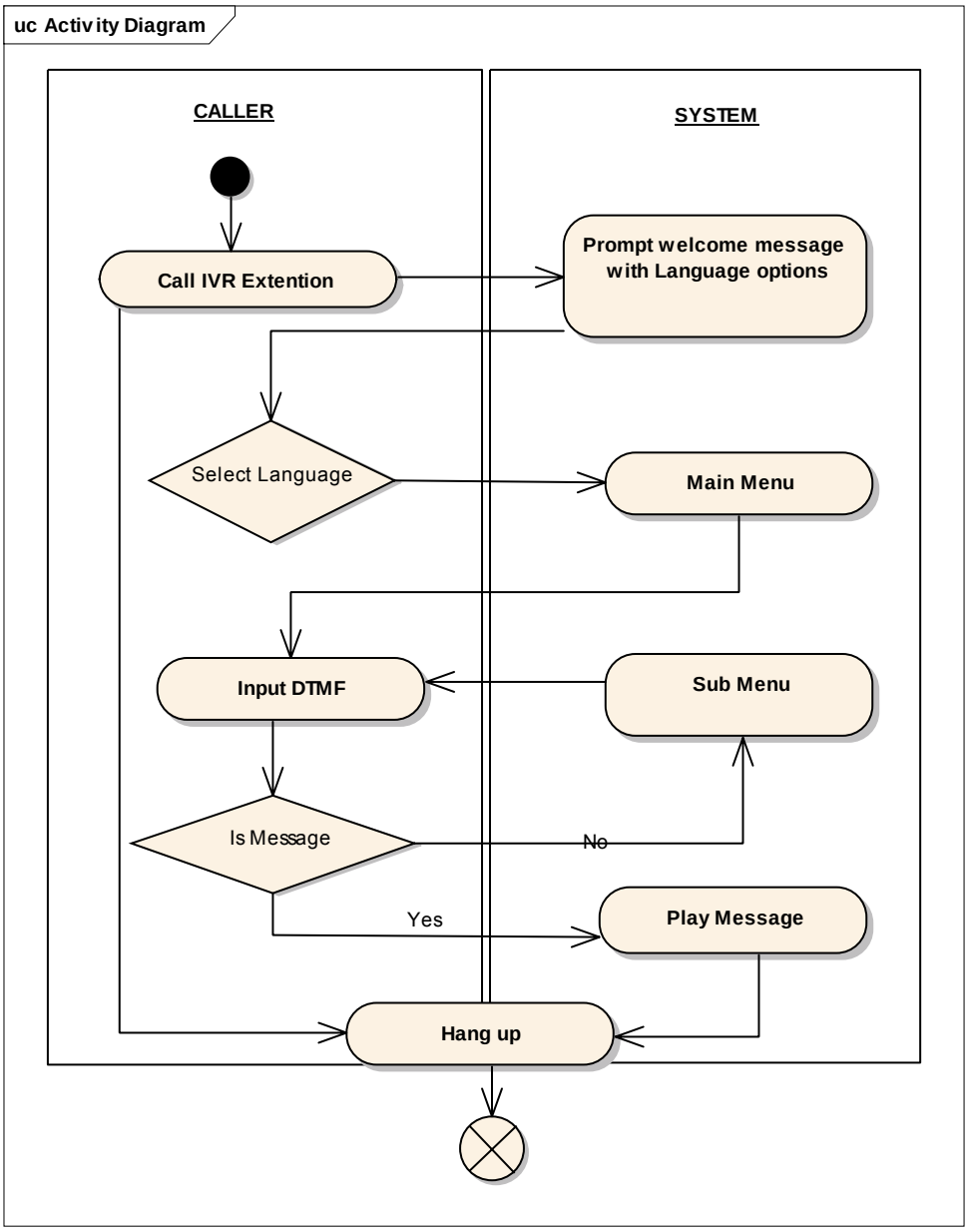

Figure 5: Activity Diagram for Listening BCC message

A user should be a registered administrator to search and access details of call records. Figure 6 shows expected activities.

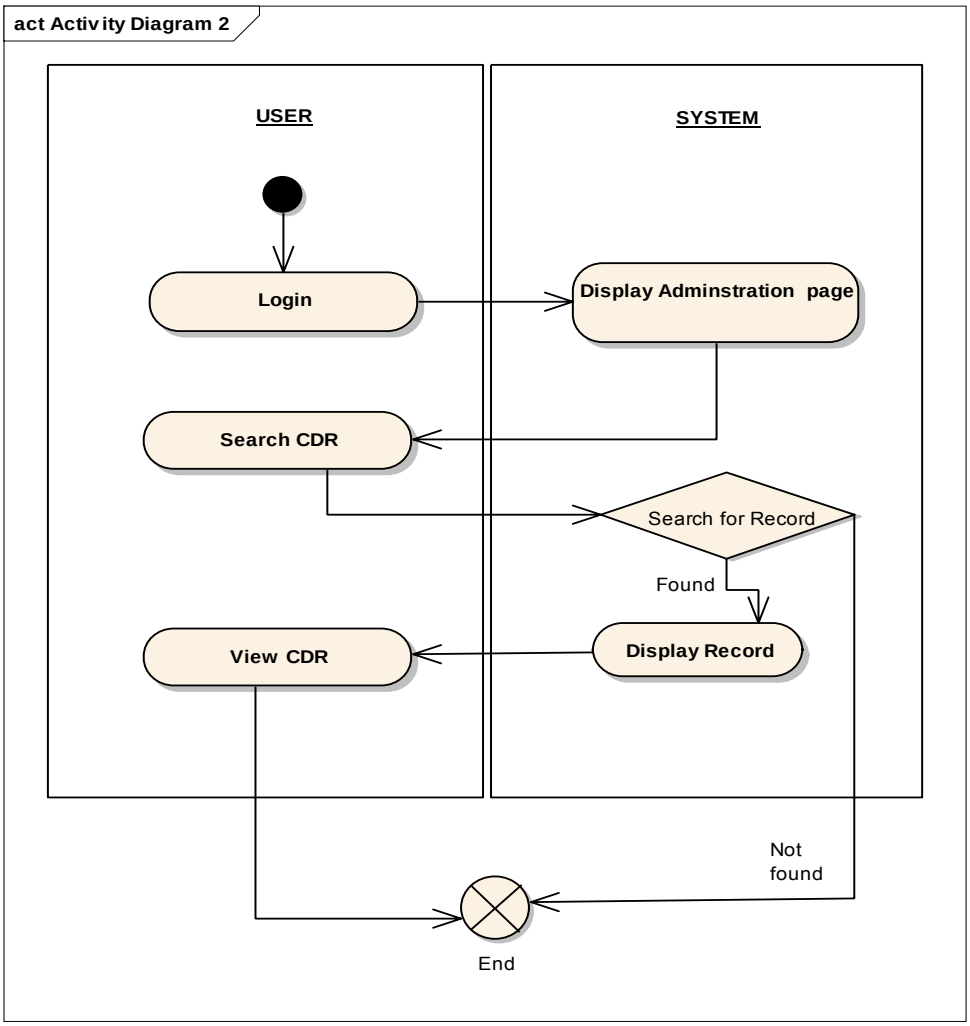

Figure 6: Activity Diagram for View Call Records

4.6.6. Sequence Diagrams

Dynamic modeling focuses on the interactions occurring within the system, and a sequence diagram is an interaction diagram that shows how objects operate with one another and in what order. It is a construct of a message sequence chart. A sequence diagram shows object interactions arranged in time sequence [41].

Sequence Diagrams for Listen to BCC Message, Start Server and View Call Records actions are included Figure 7, 8 and 9 respectively.

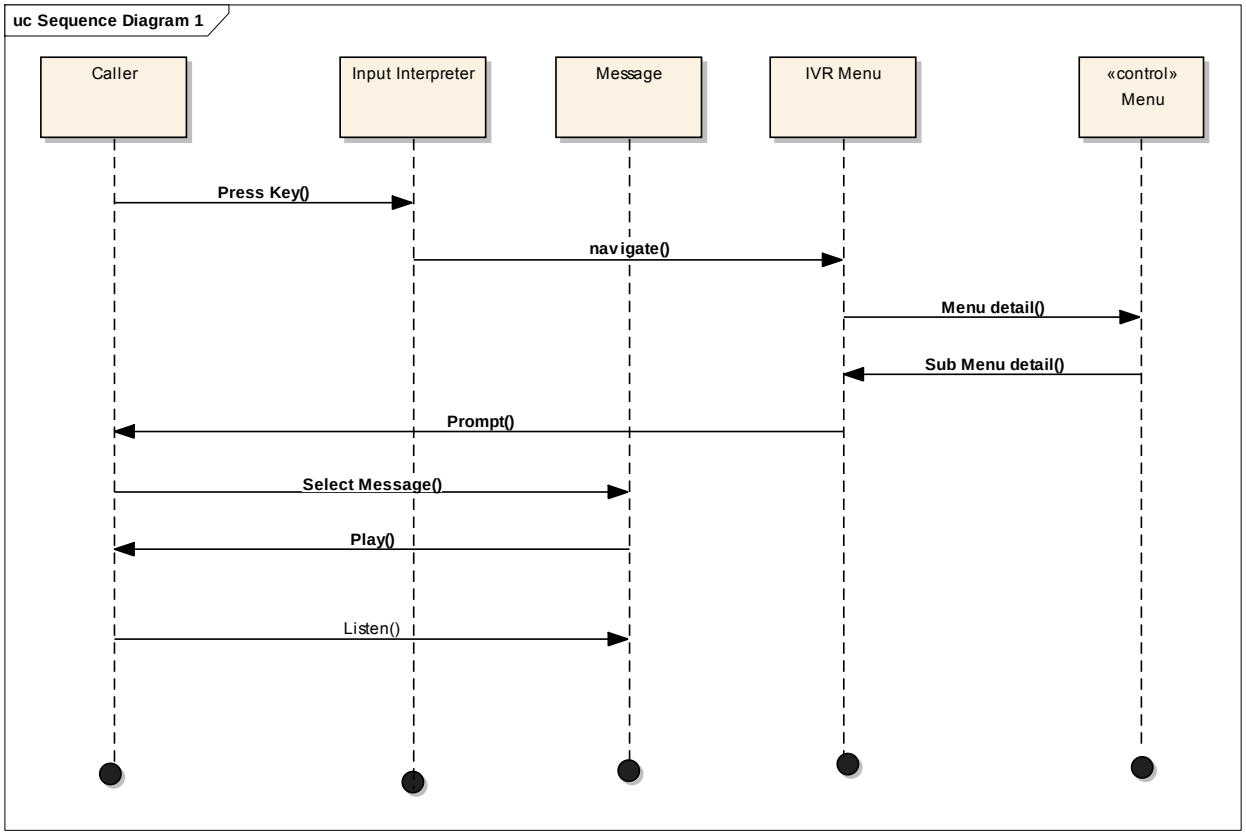

Figure 7: Sequence Diagram for Listen to BCC Message

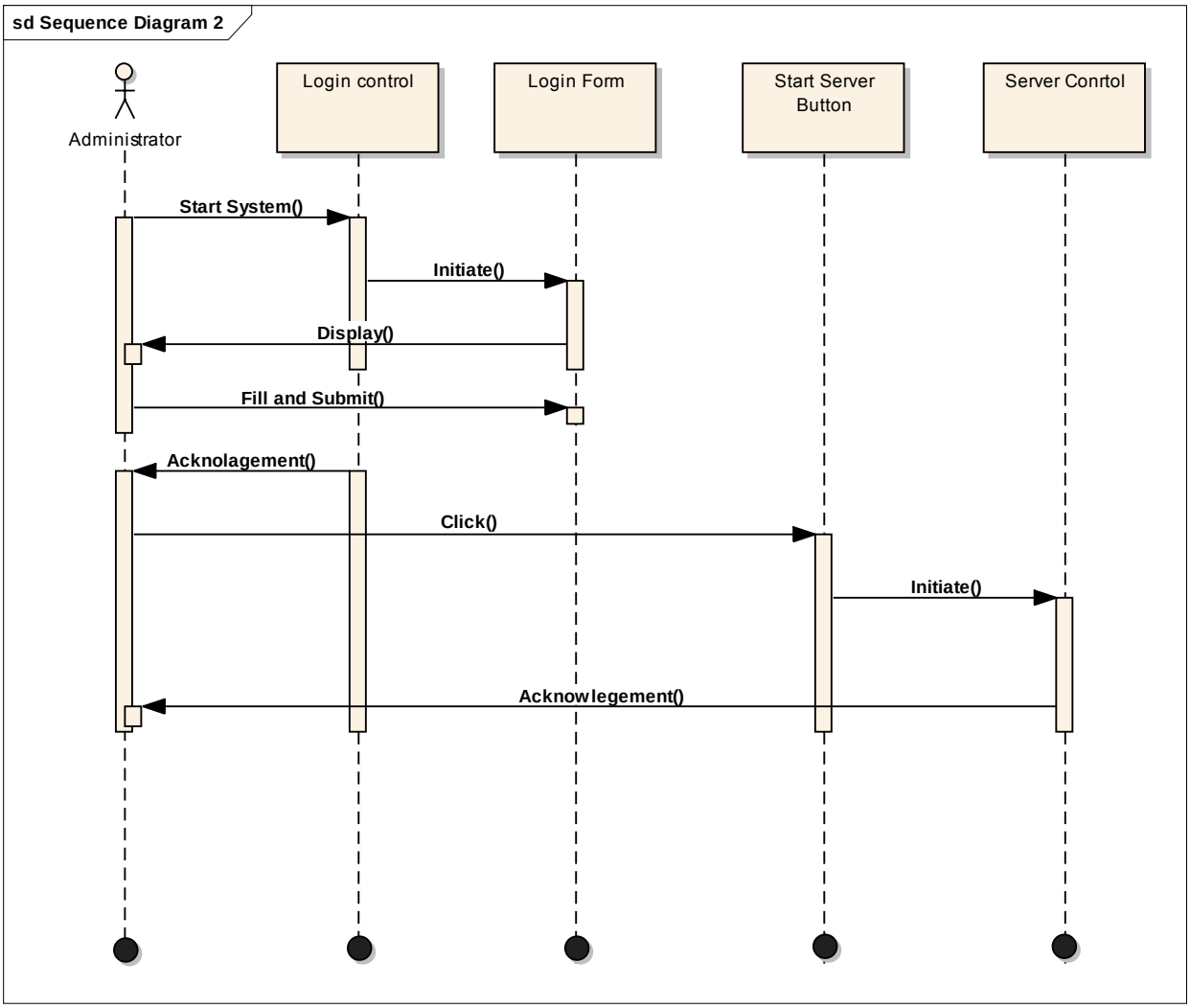

Figure 8: Sequence Diagram for Start Server

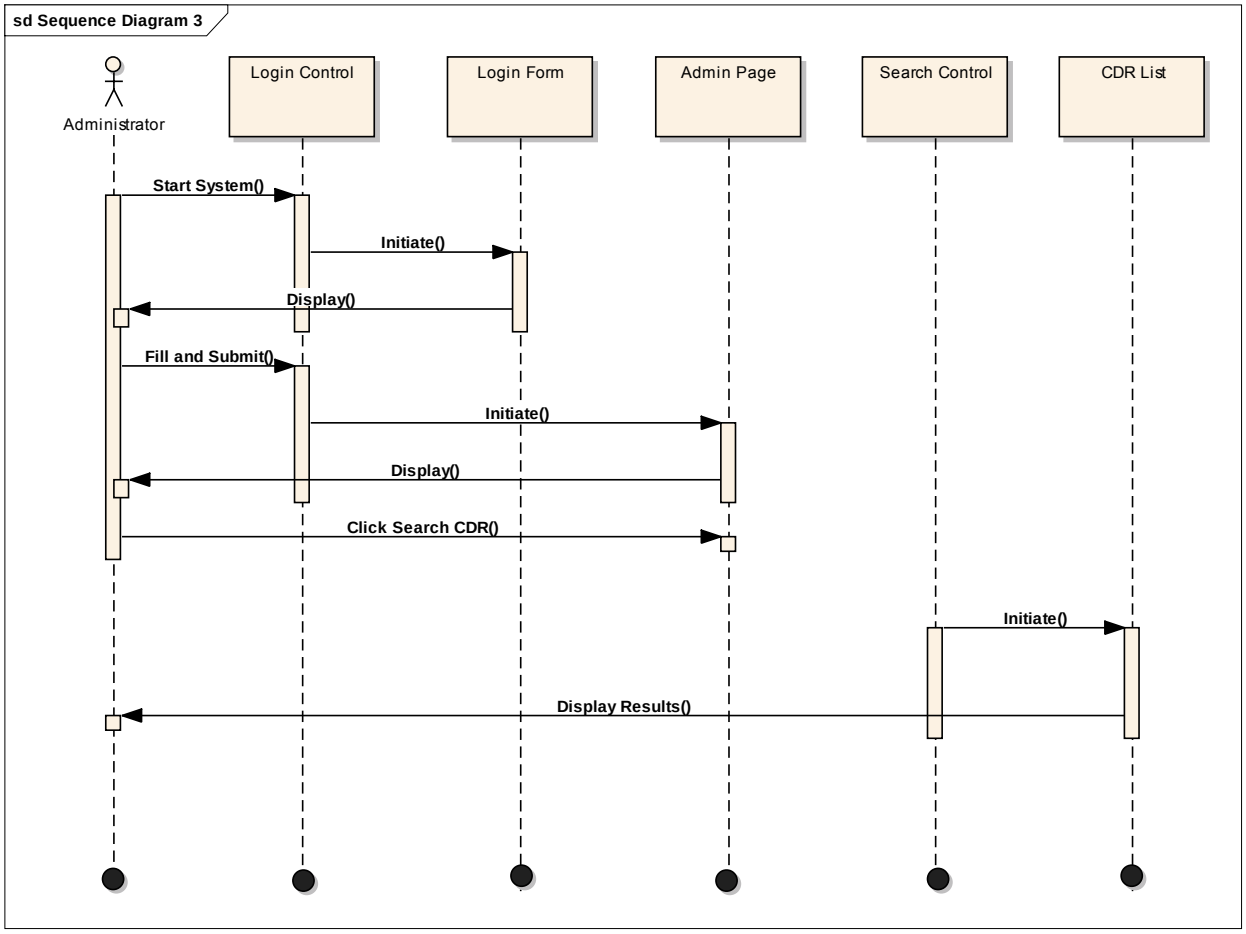

Figure 9: Sequence Diagram for View Call Records

After the system modeling is over, the development continued to design the system. System design will set design goals, manage the balance of requirement tradeoffs and shows hardware and software requirements for the modeled system to be implemented. Chapter five includes detailed description of the system design.

CHAPTER FIVE: SYSTEM DESIGN

System design is the process of defining the architecture, components, modules, interfaces, and data for a system to satisfy specified requirements. Systems design focuses on the solution domain and could be seen as the application of "systems theory" to product development [41].
The following subjects are discussed in this chapter: System design goals with respective criteria, system architecture, sub-system decomposition and Hardware and Software mapping.

5.1. Design Goals

Design goals describe the qualities of the system that developers should optimize. Such goals are normally derived from the non-functional requirements of the system.

Design goals for the project include, Performance, Dependability, Maintainability, Usability and Cost aspects.

5.1.1. Performance

Performance Criteria: Speed and Capability

Speed: - IVR system should deliver BCC messages upon request after the proper navigation through the Menu Tree.

Capability: - The IVR System should able to handle maximum number of incoming lines, because underpowered IVR systems, relative to the volume of incoming calls, frustrate customers and lead to calls getting dropped.

5.1.2. Dependability

Dependability Criteria: Fault tolerance, Reliability, Availability and Security

Fault tolerance: - The system should be able to handle invalid/wrong user inputs.

Reliability: - This system should be trustworthy and reliable towards any personal data the user may give.

Availability: - The system is intended to be on-line 24 hours and 7days.

Security: - The system should authenticate users before giving the user and administrative access to any sensitive information and high emphasis should be given to resisting all types of malicious attacks.

5.1.3. Cost

Cost Criteria: Development cost, Maintenance cost

(See section 5.2 "trade-offs", the management of Development cost Vs. Maintenance cost)

Development cost: - The implementation of the system should keep the cost to a possible minimum.

Maintenance cost: - The system should be built with future changes in mind to make the changes less costly as possible.

5.1.4. Maintainability

Maintainability criteria: Extensibility and Portability

Extensibility: - The system should be easily expandable to add new functionalities and easily modifiable to make changes to the existing ones' in the future.

Portability: - This system should be accessible from any mobile phone/device.

5.1.5. Usability

Usability Criteria: User friendliness, Usefulness

User friendliness: - IVR systems use telephone keypads as an interface, which makes them easy to use than most computer and mobile used systems. But, the system still should be designed with illiterate and semi-literate groups in mind. Therefore, making it easy to learn and use. The number of menu options and menu trees should be kept to a minimum too, if the system is not to be boring or frustrating.

Usefulness: - The BCC messages on the IVR systems should be meaningful, helpful, relevant and important for callers. This leads to callers becoming registered customers.

5.2. Tradeoffs

This section describes all the tradeoffs between requirements of the system.

Usability Vs Utility

The aim of the BCC-IVR system is used to deliver critical and useful information but if the design does not consider offering the users' a pleasant experience it should not be implemented at all. Because when an IVR system irritates a caller once, him/her is never calling back again. Therefore, even if increasing the number of the helpful topics is desirable it had to be under the usability silver line.

Menu Tree Vs Menu Option

The system should be designed keeping unique IVR characteristics in mind. The IVR system should have a simple menu hierarchy with no more than three or four levels deep. Because, as the number of levels increases, so does the number of errors. The system also needs to include repeat, back or the standard “0 option” to speak to a human attendant. This normally increases the number of menu options which results in the caller forgetting the options while the system is going through the long list. In conclusion, while designing an IVR system, the number both Menu depth and Menu branches should considered and traded off properly.

Development cost Vs Maintenance cost

While developing a system everyone is concerned with developing the system with the minimum cost possible. But, neglecting usability of the system, re-usability and portability of features and taking most shortcuts has a cost that comes later after the implementation. Frequent failures are very expensive to maintain. The development of the BCC-IVR system should also consider future costs as much as current time, resource and money constraints.

5.3. System Architecture

The BCC-IVR system has a Client/Server architecture, meaning servers provide services to instances of other subsystems, called clients or callers in this case.

The system is designed using three-tier subsystems organization, which divides the system into three layers (see Figure 10). The layers are: -

Interface layer: including all boundary objects that deal with the user.

Application logic layer: including control and entity objects.

Storage layer: including storage, retrieval, and query of persistent data objects.

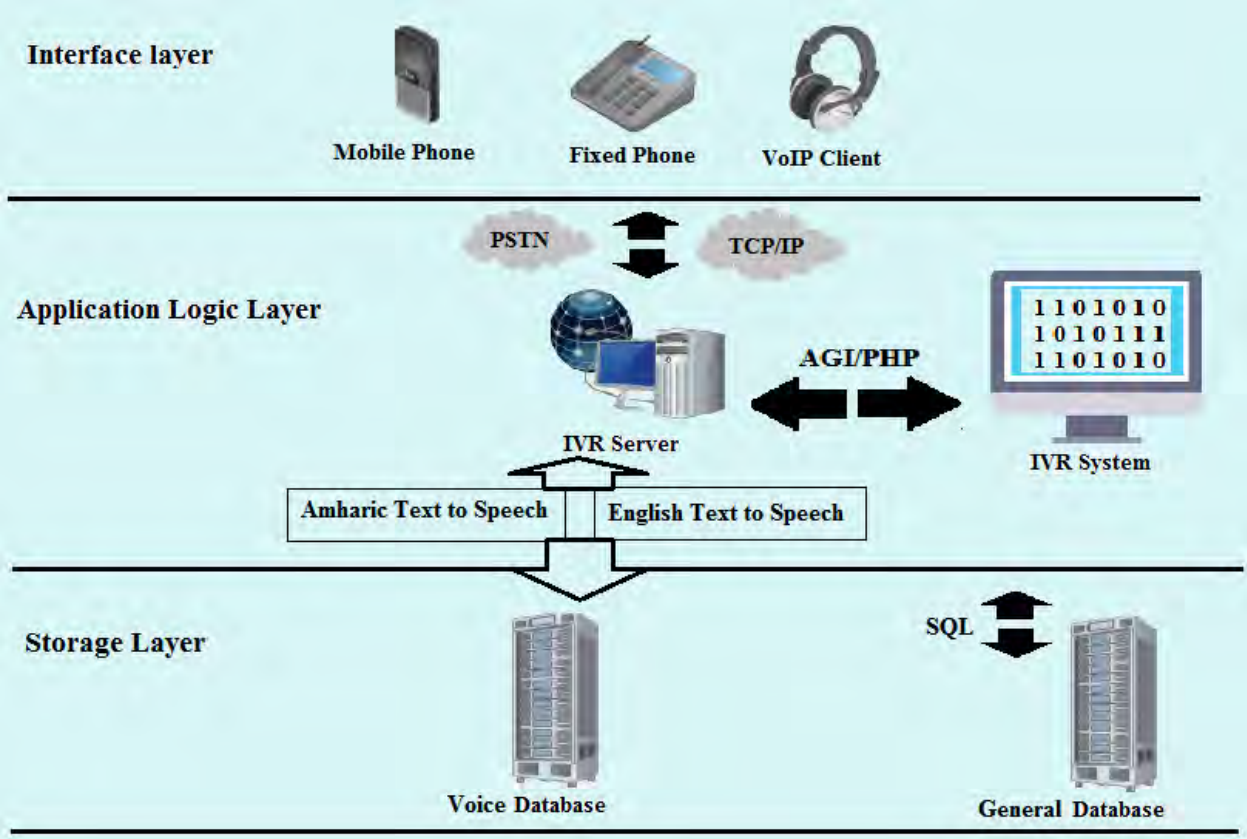

Figure 10: System Architecture

5.4. Sub-System Decomposition

Subsystem decompositions help the system be less complex and more manageable to implement. The subsystems can be considered as packages holding related classes/objects together. The subsystems identified are for the BCC-IVR system are shown in the Figure 11:-

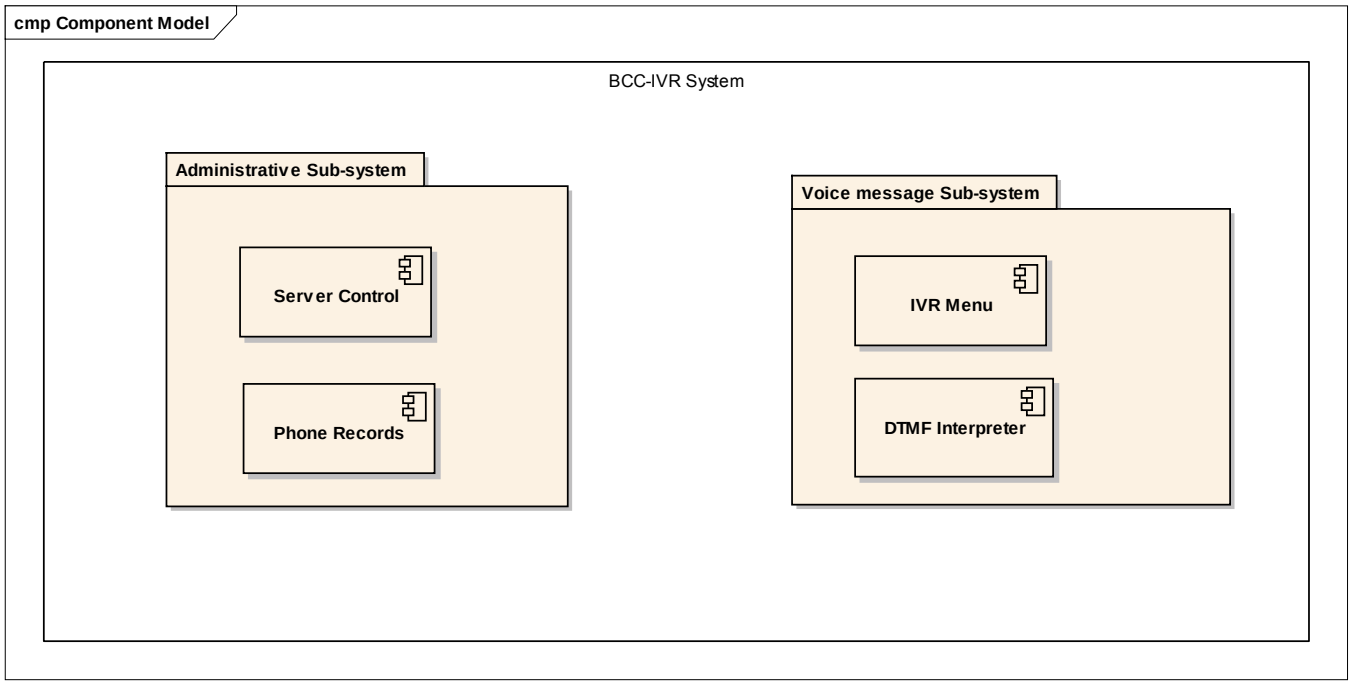

Figure 11: Subsystem Decomposition

5.5. Interface and IVR Menu

5.5.1. Interface

The voice interface input as accepts DTMF digits via telephone keypad from the user over the telephone network. The subsystem detects the frequency and identifies the key. Figure 12 shows the standard frequency the IVR system accepts as an input.

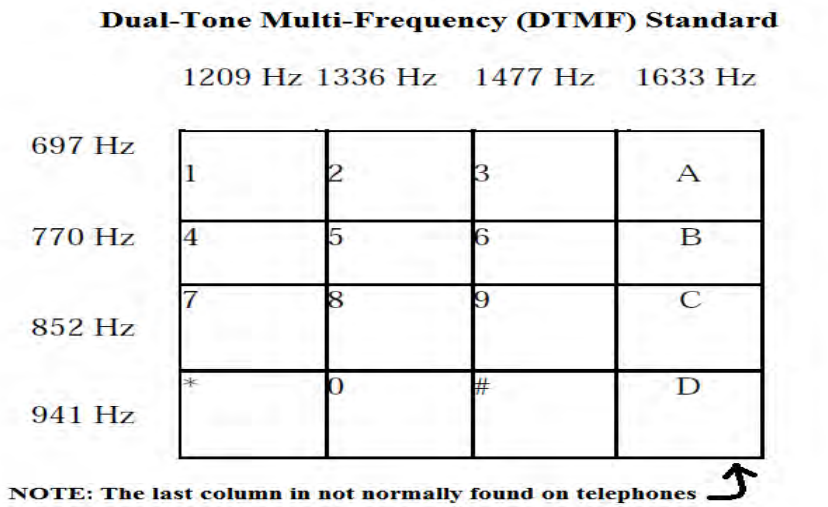

Figure 12: Standard Touch-Tone Dial (Key pad)

Touching a button while connected to the IVR server generates a DTMF tone input to the IVR system from the user's keypad, which is a combination of the two standard frequencies on the upper and lower bands on Figure 12. The first frequency from lower band and second from upper band let the IVR know the callers choice.

5.5.2. IVR Menu

Annex E narrates the BCC-IVR Menu with great details and Figure 13 is the visual representation.

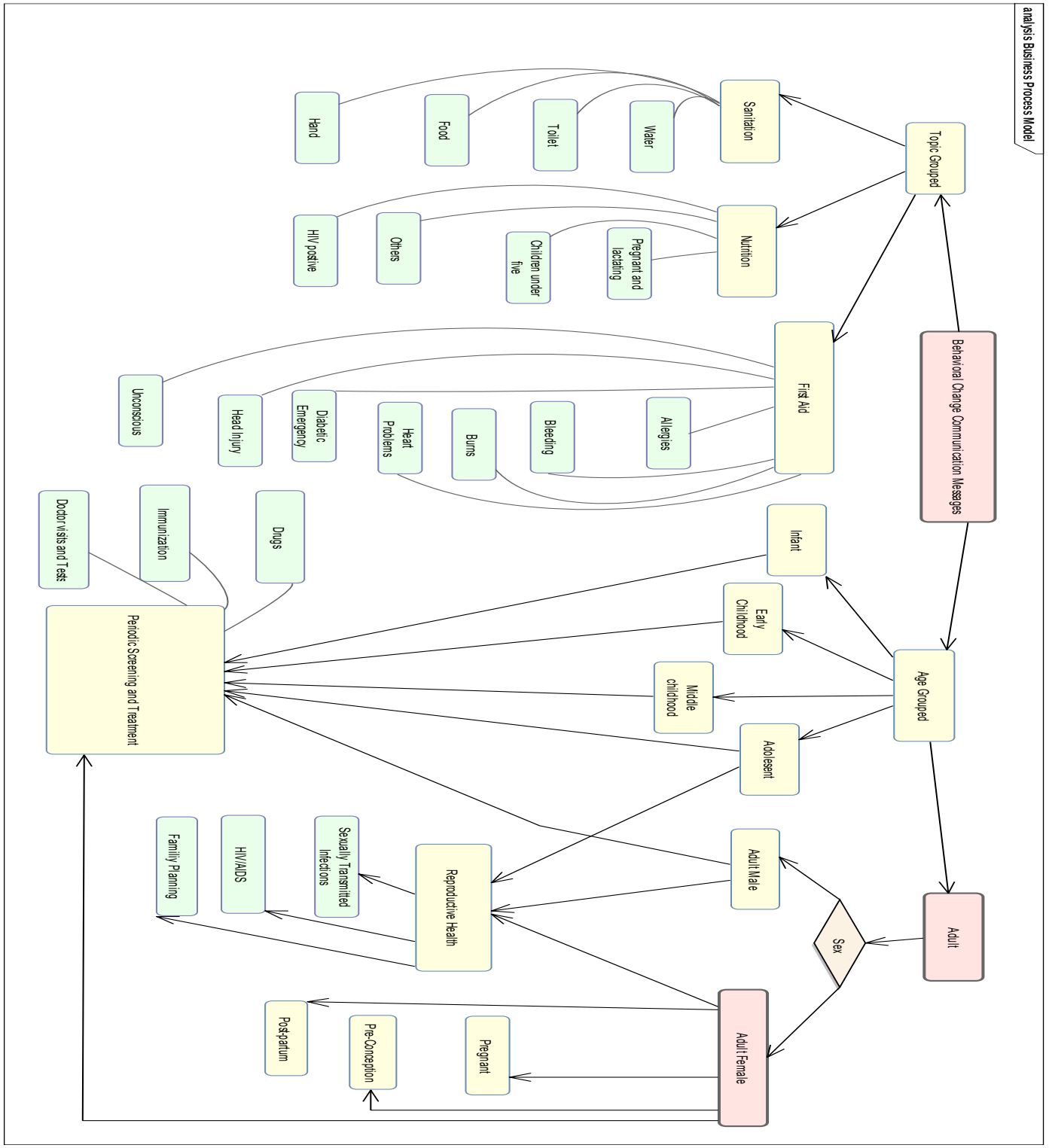

Figure 13: Voice Menu Tree of the BCC-IVR system

5.6. Hardware/Software Mapping

One of the major tasks in system design deals with hardware/software mapping determining components would be part in which hardware and software. This system has a central database server and clients networked with an access to the central server. To make system work as planned we need to uses some hardware and software components, the basic components are IVR server, phone and operating system.

Server: any computer can be used as a server only by installing and configuring one of Linux operating systems and asterisk modules. But, for the sake of performance of the system it is preferable to use computer/s with a good processing speed and memory capacity.

Phone: A Soft phone is needed to call the IVR prototype extension and run the BCC-IVR system.

Operating System: Operating Systems are system software, software which controls other application software and their communication with the hardware. Any computer without an operating system is just a box with no use. This system only runs on Linux based OS, Specifically Ubuntu for the prototype.

Figure 14 shows Hardware/Software mapping of the BCC-IVR system

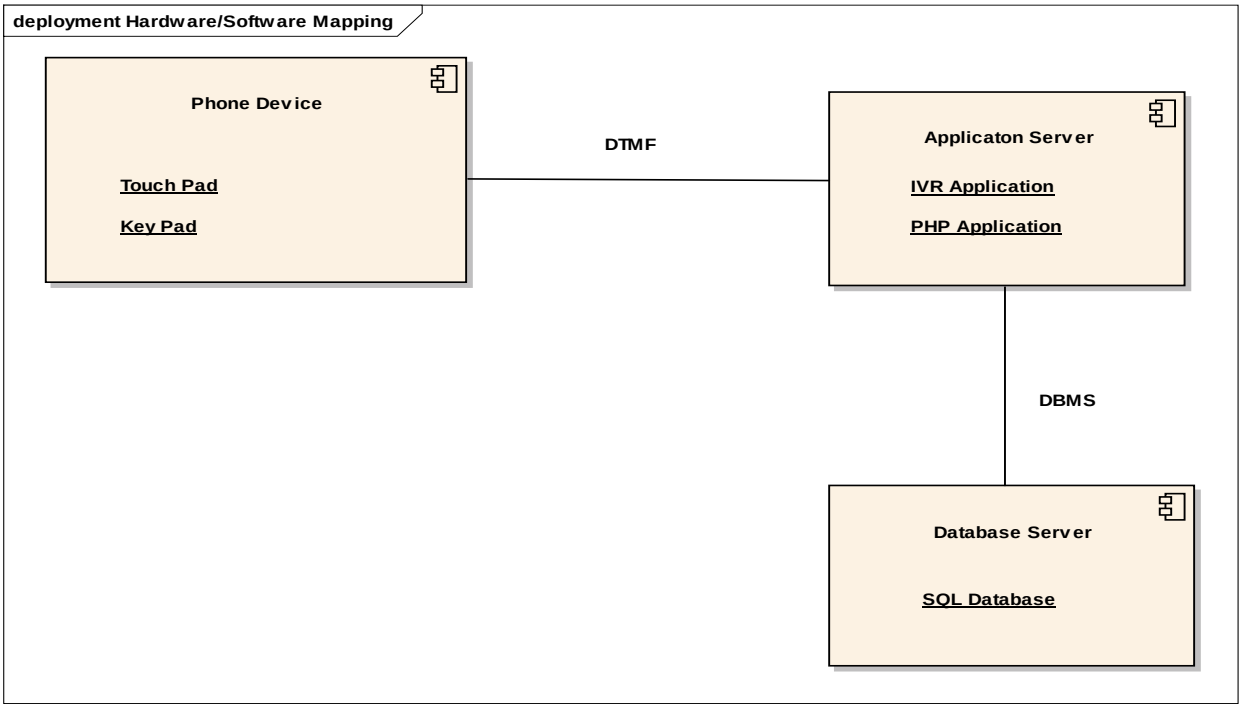

Figure 14: Hardware/Software Mapping

CHAPTER SIX: IMPLEMENTATION AND EVALUATION OF THE SYSTEM

6.1. Implementation of the system

This section discusses about tools and technologies used for developing the BCC-IVR prototype.

6.1.1. System Development Tools

There are several tools and technologies used to implement the BCC-IVR prototype. This section describes all appropriate details of them.

Asterisk

Asterisk is different from other traditional PBXs. Asterisk is an open source, converged telephony platform, which is designed primarily to run on Linux. Asterisk combines more than 100 years of telephony knowledge into a robust suite of tightly integrated telecommunications applications.

During development this system version 2 of Asterisk, a software created by Mark Spencer, was used to turn an ordinary computer into a communications server. The free software has provided a wealth of functions that make it a powerful IVR system, audio playback, digit collection, database integration, and speech synthesis. For the prototype implementation of this project asterisk server is used as replacement of the traditional PBX as software for switching calls, managing routes, enabling features, and connecting callers with outside world over IP, analog lines, and digital connections.

UBUNTU

Asterisk runs on Linux based systems. Ubuntu is a Linux based open source software operating system that can run on personal computers. The BCC-IVR prototype is developed on Ubuntu 15.4 operating system the BCC-IVR prototype.

The Dial plan

In the dial-plan we defined how calls flow into and out of the system. It is a form of scripting language and contains instructions that asterisk follows in response to external triggers. The dial-

plan is the heart of BCC-IVR system. In contrast to traditional phone systems, it is fully customizable form of scripting language, used to define how calls flow in and out of the system.

The Asterisk dial-plan is specified in the configuration file named extensions.conf. The content of "extensions.conf" is organized in four main sections: contexts, extensions, priorities, and applications. This can be either for static setting and definitions, or for executable dial-plan components in which case they are referred to as contexts. The settings sections are general and global and the names of contexts are entirely defined by the system administrator. Every section in "extensions.conf" starts with the name of the section contained within square brackets. In asterisk, an extension is used to define the unique series of steps (each containing an application) through which asterisk takes that call. Within each context, we define as many extensions as required. When dealing a particular extension is triggered by either an incoming call or by digits being dialed on a channel, asterisk follows the steps defined for that extension. It is the extensions that specify what happens to calls as they make their way through dial plan. Each extension can have multiple steps, called priorities.

The priorities are numbered sequentially, starting with 1, and each executes one specific application. Applications are the workhorses of the dial plan. Each application performs a specific action on the current channel, such as playing a sound, accepting touch tone input, looking something up in database, dialing a channel, hanging up call, and so forth. In our operating environment the dial plan is located on directory /etc/asterisk/extensions.conf. The configuration file "extensions.conf" contains the "dial plan" of Asterisk, the master plan of control or execution flow for all of its operations.

Zoiper

Zoiper is a high quality softphone which lets you make secure VoIP, Military grade encrypted, audio and video calls. But, unlike other VOIP applications like Skype or Viber, it is open and can be used with any VoIP provider or PBX. Zoiper has a FREE IAX and SIP applications for VoIP calls. Zoiper also has call center functionalities including Auto-answer, Provisioning, Call recording and CRM integration.

The application runs on a multitude of different platforms like Mac, Linux or Windows. IPhone, Android or a Browser.

Asterisk Gateway Interface

Asterisk gateway interface is used as a media gateway. The Asterisk Gateway Interface (AGI) powerful interface to bridging the legacy PSTN to the expanding world of IP telephony.

Asterisk AGI used for implementing the proposed behavioral change interactive voice response system is the PHP programming language.

PHP

PHP is a programming language used to develop IVR system on AGI script, using the PHP scripting language. This is a major component of the system developed using PHP programming language. The system call flow is implemented based on the design of the multilingual IVR tree structure, shown in appendix A and appendix B. With the introduction of the Asterisk Open Source PBX, it was required to establish a method for third party programs to interact with Asterisk, for our prototype demonstration the AGI interface is used.

6.1.2. Prototype

In this section, how the Behavioral Change Communication system interacts with the users and what the system looks like while running is described. The description of the implementation is from the developer's point of view of the IVR system.

The BCC-IVR system has three major components, VOIP client, asterisk server and IVR application. The administrator has to start the server before the server starts accepting calls. Figure 16 shows the administration page.

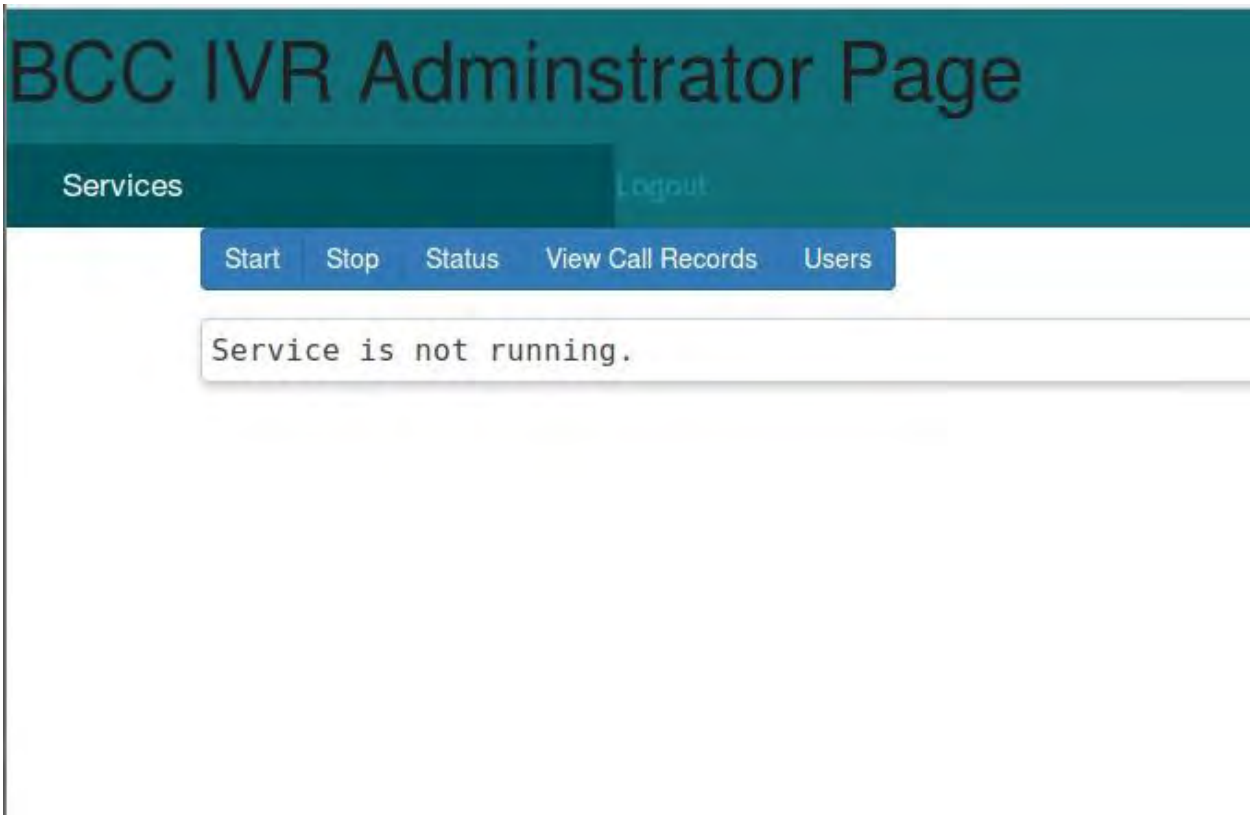

Figure 15: BCC-IVR administration page

After connecting to IVR system, callers interact using telephone keypad with the asterisk server and Zoiper softphone is used to make that call to the IVR extension. Figure 16 shows what the softphone looks like.

Figure 16: Zoiper Soft Phone

When calls are received on this channel to the asterisk server, the call is sent to the BCC-IVR application for processing using the asterisk server have dial plan which is used to define how calls flows in and out of the system (see Annex F for the sample of the dial plan's in "extensions.conf").

Finally, the BCC-IVR interacts with the user on the channel based on predefined IVR process tree on BCC-IVR application. In order to use BCC-IVR system the Administrator must be logging to the system and then it must start service of the asterisk server. When the administrator starts service of the asterisk server, the interface shown in figure 17.

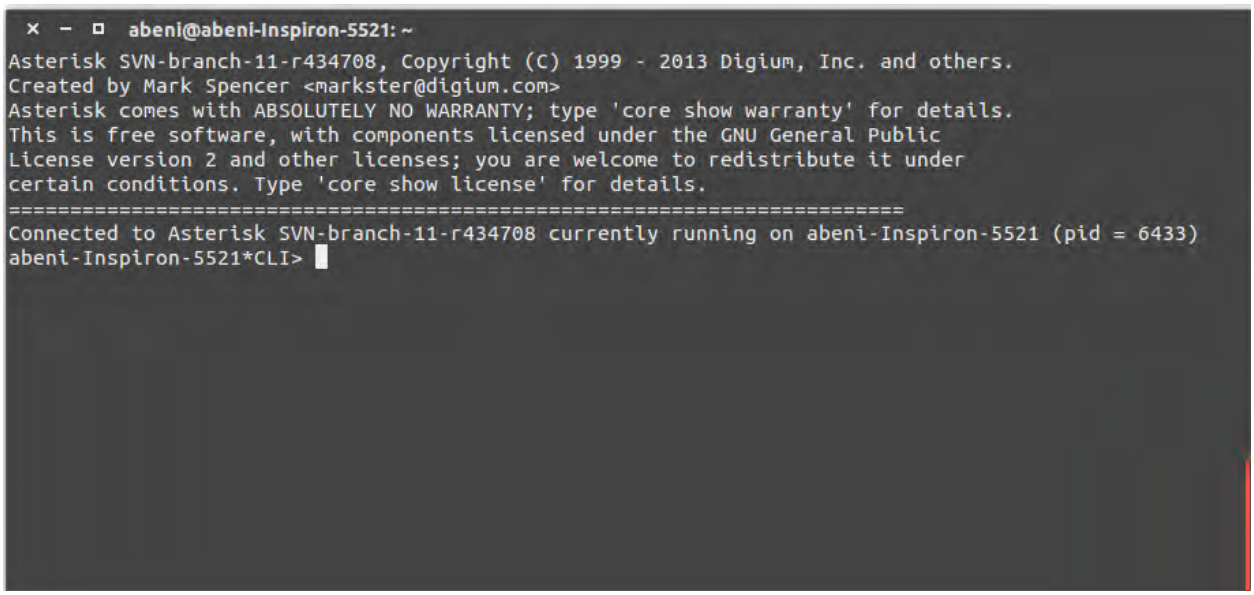

Figure 17: Asterisk Server

After the system has started the server can accept calls to the extension. The system users "Festivox" text to speech engine, the tool is found online free of charge. The audio files are recorded from text to speech engines are edited by audacity to increase quality.

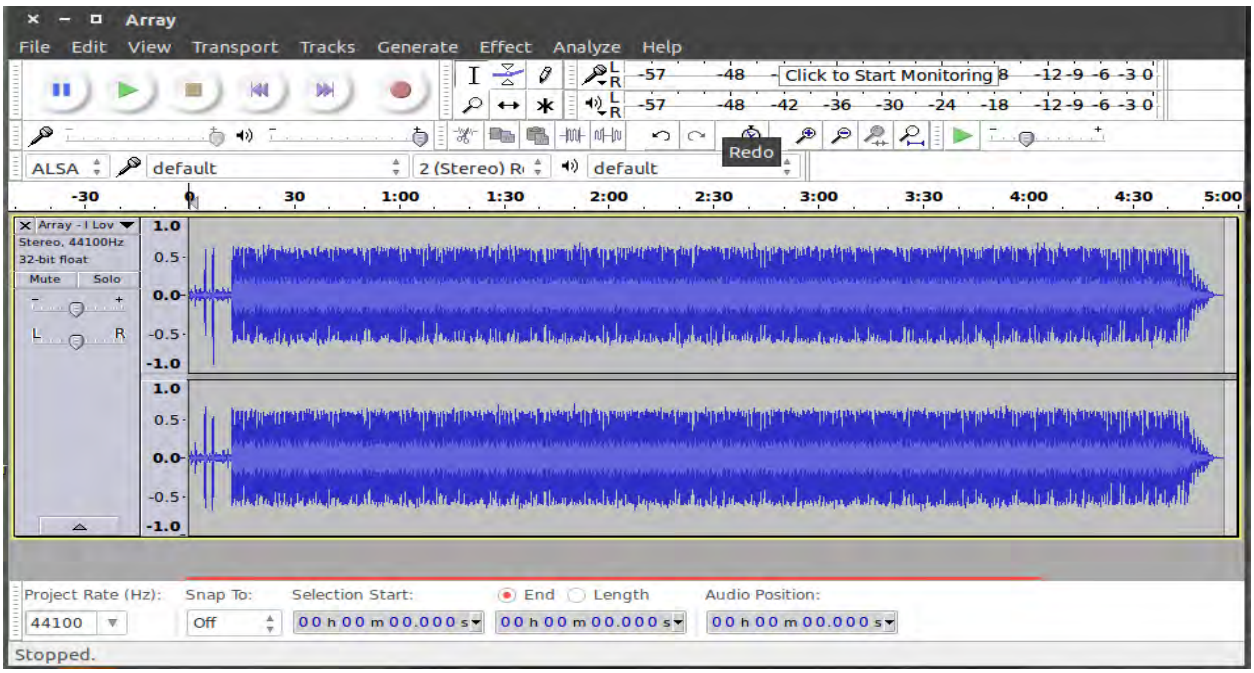

Figure 18: Audacity, audio recording and editing software

Once a call gets through, the running server terminal looks like Figure 18.

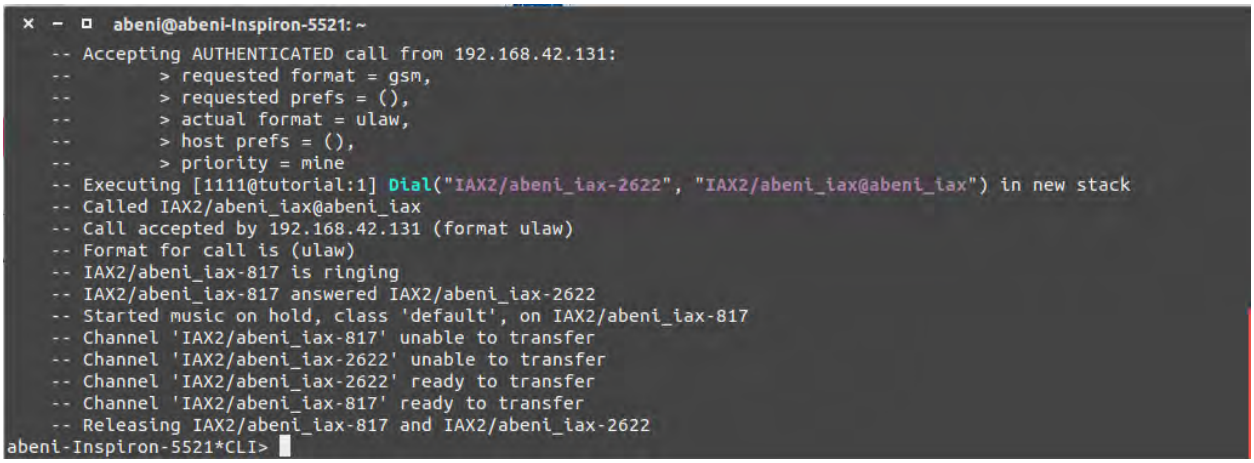

Figure 19: Asterisk Server, Call in progress

The BCC-IVR system is evaluated after implementation (see details under section 6.2).

6.2. System Evaluation

This section discusses the usability testing details for the BCC-IVR system. It covers the following sections; the method used to conduct the test and the questions used for the process and the results of the evaluation.

6.2.1. Overview

User experience testing is getting more and more popular and it is the considered the best way to understand how real users experience an application. A well-designed usability test measures actual performance of a product on mission-critical tasks.

There are several usability testing methods including Card sorting, Paper prototyping, Focus groups, Usability lab testing, AB testing etc. [36]. The BCC-IVR system is evaluated using usability lab testing method. (See section 6.2.2 for details)

During the evaluation of the system, user-centered questions about the system were forwarded to the participants.

6.2.2. Usability Testing Methodology

In usability testing choosing the right method is an important step. The method used to test the BCC-IVR system is Usability lab testing method**.** This choice is made as a result of shared requirements between the BCC-IVR system's values and the testing method's characteristics. The criteria are: -

- The IVR menu have pre-defined scenarios to test.
- Observers need to be apart from the users/callers of the system to determine the real usability challenges and lessons of the prototype.
- The test is meant to discover functional issues.
- The test needs to be followed by discussions to summarize the results.

6.2.3. Usability Test Participants

During the evaluation of the BCC-IVR system there 9 people from Hawassa were included. The response rate for the study was 69%. The people were chosen following convenience and their willingness to test the system. The participants of the test were 9 and all were Amharic speakers.

	Male	6
	Female	3
Total		9

Table 14: Usability test participants

6.2.4. Usability Test Training

The participants of the usability test were given an orientation about the system prior to usability testing for about 15 to 20 minutes.

6.2.5. Usability Test Procedure

Participants take part in the usability test at a silent room located in Hawassa and Addis Ababa, Ethiopia. Zoiper softphone was the supporting software used to access, i.e. call, the IVR application's extensions number running on a personal computer's virtual server under the same

network. The participant's interaction with the IVR application was be monitored and documented by the researcher seated in the same room.

The organizer briefed the participants about the BCC-IVR application and assisted the participants while they were evaluating the application and asked the participant if they have any questions.

Participants signed an informed consent acknowledging the participation was voluntary and it was possible to quit at any time. They knew the amount of time taken to complete the test tasks were be measured. Exploratory behavior outside the task flow did not occur before task completion and time measurement began when the participant started the task.

6.2.6. Usability Test Roles

The roles of the people involved in the usability test are described in this section.

Participants: Attempt to complete a set of representative task scenarios as efficient and timely a manner as possible. After the completion of the tasks, provide guided honest opinions regarding the usability and acceptability of the BCC-IVR system.

Organizer: Give a brief orientation about the system prior to the usability testing for about 15-20 minutes, defined the purpose of usability test to participants and responded to participant's requests for assistance when needed.

Data Logger: Record the usability test, identifying problems, concerns and errors.

6.2.7. Usability Test Goals

A usability questionnaire was prepared to test the system. The usability questions on the questionnaire were developed certain requirements on performance of IVR systems. The overall evaluation aims to test the BCC-IVR system's usability based on the following requirements:-

- Speech naturalness
- Messages' usefulness
- Menu structure simplicity
- Ease of use
- Being specific and to the point

- Prioritization of information
- Completeness of the system

6.2.8. Usability Test Tasks

Tasks for testing IVR systems cannot be specific because completeness of the menu structure is up for questioning as much any other usability requirements. Therefore, the user is allowed to pick applicable areas of desire under the general topic described during orientation prior to the test, which means all tasks are basically the same, the table 15 shows the description.

Task Name	Task Description	Test Requirement	Test Instruction
Listen to a BCC message of choice	This feature allows to navigate the IVR menu and listen to message of choice **Task performance** Five times. **Task Type** Frequent, mistakes can be reversed. **Measurement attributes:** Recovery from wrong inputs Time to complete the task	This test requires: Phone access and familiarity with standard key-pad Knowledge of IVR extension number Speaking Amharic	Call the extension for the IVR system. Navigate through the menu to listen to desired topic. Tip: Disclose the topic of choice to the organizer before starting to test. Tip: Do this five times with five different topics.

Table 15: Usability test task

6.2.9. Test Results and Conclusion

The participants of the usability testing were presented with number of prepared questions to evaluate the system immediately after using the BCC-IVR prototype. The user experience testing questions were presented in the manner of discussion. The evaluation discussion included 13 questions, 10 close ended and 3 open ended. The close ended questions used five scale Likert style and were prepared in English to be translated in to Amharic on the scene. The results were recorded by the data logger.

The usability testing questions, including the open ended ones, are attached in the annex section. The results of the evaluation are presented in the form of a table and a graph and they were analyzed using descriptive statistical analysis tools. The mean tells the average degree of agreement between respondents and the standard deviation shows the deviance of respondents' evaluation from the averages result.

No	Criteria for evaluation	Disagree	Neutral	Agree	Mean	SD
1	The IVR system was easy to use		✓		3.22	0.63
2	It was confusing to choose between menu options	✓			2.11	0.54
3	The operator's voice used was clear		✓		3.11	0.45
4	The operator spoke too slow or too quick		✓		3.22	0.6
5	Understanding how to use the system was easy		✓		3.33	0.46
6	The behavioral change messages of the system were useful			✓	4	0.77
7	I could recover easily from mistakes	✓			2.44	0.47

8	The menu directed me to the questions I wanted answered		✓		3	0.39
9	The system gave me the health information I desired		✓		3.22	0.63
10	I could not remember the list of options provided to choose from	✓			2.11	0.54
	Average				2.8	0.55

Table 16: Usability test interview results, source evaluation survey of the BCC-IVR system 2017

The evaluators found the BCC messages useful and the average usability of the prototype system according to the evaluation results filled by the participants is 56.01%. Other criteria like ease of use, operator voice clarity and understandability implied there is more work to be done by resulting ion neutral responses rather than agreement. Figure 20 shows the graphical representation of the results.

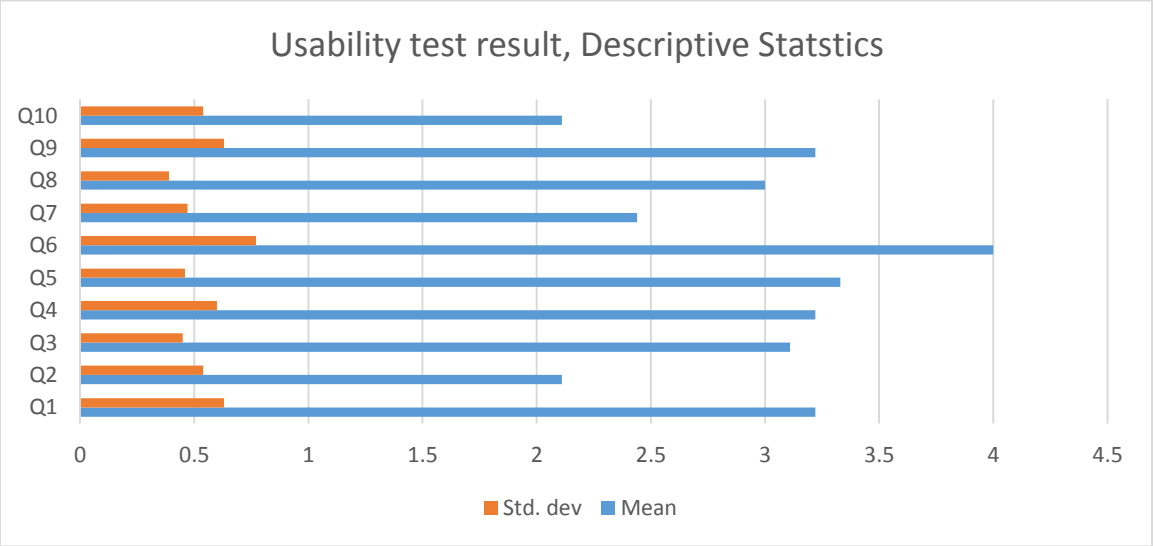

Figure 20: Usability test results, source evaluation survey of the BCC-IVR system 2017

Overall, BCC-IVR system's evaluation results have shown that the system is easy to navigate and is functional in terms of IVR menu structure to satisfy customers/callers and addressing vital issues accordingly per customers desire, at least for the time being with small scale coverage.

It is also seen that the BCC-IVR system disseminates information for all interested parties in understandable presentation and with pertinent interface. This shall be implemented considering coverage for rural areas, applicability of the content and capacity to increase usefulness.

The major functionality issues identified after the evaluation of the BCC-IVR system should be avoided by:-

- Providing a better mistake recovery options
- Keeping the number of menu options to the minimum
- Providing the best quality speech, regarding naturalness
- Improving the completeness of the contents
- Providing the “0” option, speak to a Human attendant

CHAPTER SEVEN: CONCLUSION AND FUTURE WORKS

7.1. Conclusion

Interactive Voice Response Systems are the latest PBX technology. The systems provide the foundation for providing convenient new services for customers with reduced operational costs, improved customer satisfaction, increased return on investment and a stronger market presence for the IVRs services providers. That is why the behavioral change communication system is designed and implemented using interactive voice response to utilize those potential benefits.

To design the BCC-IVR system, the functional and nonfunctional requirements are identified and analyzed using the use case diagram, class diagram and activity diagram. The behavioral change communication interactive voice response system uses three-tier architecture model, which is the fundamental framework for the logical design model, which segments an application's components into three tiers of services namely, the presentation tier, the middle tier, and the data tier. The top layer of the presentation logic is service via the telephone network. The second level of the architecture is middle tiers that accepts inputs from the user and provide required information back to the caller via voice messages. This tier accepts telephone digits from the user over the telephone network.

During implementation this project has shown how easy it is for services to be created in Asterisk. It has also illustrated that these services can be extended so that they are accessible from any interface or device, integrated with text to speech engine and that they can be expanded so that their functionality reaches deep into the system, allowing the users total control over their environment. In addition, it has investigated and documented various open source systems that were used in achieving these goals, and shown that they are mature enough and stable enough to be used in the deployment of a production telephony system.

The flow of BCC-IVR system looks like when the user interact by using telephone keypad with the asterisk server and then the asterisk server has dial plan which is used to define how calls flow into and out of the system. When messages are received on this channel to asterisk server, the message is sent to the BCC-IVR application for processing using Asterisk's. The Asterisk Gateway Interface (AGI) powerful interface to bridging the legacy PSTN to the expanding world of IP

telephony is also used in the implementation. At last, the BCC-IVR interacts with the user on the channel based on predefined IVR process tree on BCC-IVR application.

Evaluation of the BCC-IVR is conducted by involving 9 people who are speakers of English or the local language Amharic.

In conclusion, universal access is the important while providing information. People should be able to choose the access method that suits them. Literate people might still be more comfortable with written information, in booklets or on a web page where they can print the information they are interested in, but the need for voice information is still there, mainly for illiterate and visually impaired people. IVR systems are the future of health promotion in Ethiopia!

7.2. Future Works

In order to increase the speech naturalness of IVR system for the Amharic language using high quality speech synthesis systems is recommended, since using recorded audio has an overhead of playing high compression audio files for several of callers simultaneously. Any further hotline implementation of the BCC-IVR should unquestionably consider including the "0 option" of speaking to a human attendant.

To make the system more complete increasing the amount topics is necessary, but some concerns arise with the quick fix. Because, as important it is to increase the amount of information provided by the system, it is more important to maintain the easy navigation within it. One possibility is to have separate phone numbers for different diseases categories to keep the average time of the phone calls to IVR menu as short as possible with simple and navigable menu tree.

For future researchers

In the case of IVR systems, confidentiality is protected by unique personal identification numbers and passwords and callers interacting with IVR systems provide information that is used to tailor current and future interactions. This type of interaction may be most beneficial in treating chronic diseases and frequently occurring behaviors that intrude on daily life, such as smoking, drinking, sexual behaviors, obsessive-compulsive behaviors, depression etc.

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ANNEX

Annex A: Requirement collection Discussion guide 1

1. Demographic data (Optional)

Name _____ Age _____ Sex __ M __ F

2. Educational background _____

3. Where do you work?

_____

4. Do you have any remarks on how information can positively impact the following areas?

4.1. Healthy behavior adoption

_____

_____

_____

4.2. Risky behavior avoidance

_____

_____

_____

5. Do you have any comments on how to present brief behavioral health intervening advices on the following areas?

5.1. Sanitation & Nutrition

_____

_____

_____

5.2. First Aid

_____

_____

5.3. Periodical and Cancer screening

_____

_____

_____

5.4. Reproductive Care

_____

_____

Annex B: Requirement collection Discussion guide 2, for health professionals

1. Do you own a phone? __ Yes ___ No (If yes skip question number 2)

2. Do you have access to a phone? __ Yes __ No

3. Demographic data

Name _____ Age ____ Sex __ M __ F

4. Educational background _____

5. Where do you get health information from especially preventive advices? (Multiple selection is possible)

___ Health institutions ___ Broadcasts (TV, Radio) ___ Hotlines

Please provide details on the following areas

5.1 Preventive sexual and reproductive care

_____
_____
_____

5.2 Sanitation and environmental hygiene dos and don'ts

_____
_____
_____

5.3 Nutritional facts

_____
_____
_____

6. Do the sources satisfy your health information need? ___ Yes ___ No

7. Are you willing use your phone as alternate health information for minimum or no charge?

__ Yes __ No If no, please disclose why?

_____
_____

_____

Annex C: Usability Test Questionnaire

On the scale from one to five shown below, indicate if you agree or disagree with the nineteen statements on this page.
Participant's Name _____ Age_____ Sex_____
Literacy/Education level_____

I. General Instruction
Please rate each item according to the scale below:
1 = Strongly Disagree
2 = Disagree
3 = Neutral
4 = Agree
5 = Strongly Agree

Scale Questions
1. The IVR system easy to use.....1 2 3 4 5
2. It was confusing to choose between menu options.....1 2 3 4 5
3. The operator's voice used was clear.....1 2 3 4 5
4. The operator spoke too slow or too quick …….....1 2 3 4 5
5. I understood how to use the system.....1 2 3 4 5
6. The behavioral change messages of the system were useful.....1 2 3 4 5
7. I could recover easily when I made mistakes while using.....1 2 3 4 5
8. The menu directed me to the questions I wanted answered.....1 2 3 4 5
9. I wouldn't use the system to get health information I desire.....1 2 3 4 5
10. I could remember the list of options provided to choose from.....1 2 3 4 5

Discussion questions
1. What was the biggest challenge you faced when using the IVR system?
2. What did you like most about the IVR system?
3. Do you have any other comment/s about the IVR system?

Annex D: Informed Consent

All information about you is protected by law and your identity, contact information, or any information about you will not be given to any outside parties.
By answering the interview questions, you will be helping the development of Behavioral Change Communication Interactive Voice Response system prototype, which aims to deliver preventive advices to Ethiopian residents in a local language.

Participant's name _____ (optional)
I know the discussion will take less than an hour. I decided to participate in this project, and know I will be asked to complete a survey. The participation was completely voluntary. I knew I may skip any question I do not want to answer and I will not be affected in any way if I chose not to participate.

Conducted

Date _____ Time _____

Participant's signature _____

Annex E: English IVR Menu

The wav files are recorded BCC messages and the rest is IVR menu!

Welcome to ICARE hot line! Your call is important to us, please choose a language. Press one for English or Press two for Amharic Press three for Introduction to the BCC.IVR system.

1 Please choose a topic. Press one for First Aid. Press two for Reproductive Care. Press three for Nutrition. Press four for Sanitation. Press five for Screening and treatment. Press 0 if you want to listen again press 9 if you want to go back to the previous menu.

1.1 Please choose Emergency Type. Press one for Allergies. Press two for Bleeding. Press three for Burns. Press four for Heart attack. Press five for Diabetic emergency. Press six for Unconsciousness. Press 0 if you want to listen again. Press 9 if you want to go back to the previous menu.

1.1.1 What do you want to know about allergic reactions? Press one for "What should I do if someone is having an allergic reaction?" Press two for "What is anaphylactic shock?" Press three for "What sort of food items can cause an allergic reaction" Press four for "Can I give them an auto-injection or Epi-pen?" Press 0 if you want to listen again press 9 if you want to go back to the previous menu.

1.1.1.1 What should I do if someone is having an allergic reaction? Msg1111E.wav

1.1.1.2 What is anaphylactic shock? Msg1112E.wav

1.1.1.3 What sort of food items can cause an allergic reaction? Msg1113E.wav

1.1.1.4 Can I give them an auto-injection/Epi-pen? Msg1114E.wav

1.1.2 Please choose your question. Press one for "What should I do if someone is bleeding?" Press two for "What can I use put pressure on a bleeding wound?" Press three for "What should I do if someone has a head injury?" Press four for "Should I worry about infection or catching something from their blood?" Press five for "Should I wash the wound?" Press six for "What should I do if there is an embedded object in the wound?" Press 0 if you want to listen again and press 9 if you want to go back to the previous menu.

1.1.2.1 What should I do if someone is bleeding? Msg1121E.wav

1.1.2.2 What can I use put pressure on a bleeding wound? Msg1122E.wav

1.1.2.3 What should I do if someone has a head injury? Msg1123E.wav

1.1.2.4 Should I worry about infection or catching something from their blood? Msg1124E.wav

1.1.2.5 Should I wash the wound? Msg1125E.wav

1.1.2.6 What should I do if there is an embedded object in the wound? Msg1126E.wav

1.1.3 Please choose one question. Press one for "How should I treat burn victims?" Press two for "Should I put butter or cream on a burn?" Press three for "How do I know when to go to hospital?" Press four for "If clothes are stuck to the burn, should I try to remove them?" Press five for "Should I use ice to cool the burn? Press 0 if you want to listen again and press 9 if you want to go back to the previous menu.

1.1.3.1 How should I help burn victims? Msg1131E.wav

1.1.3.2 Should I put butter or cream on a burn? Msg1132E.wav

1.1.3.3 How do I know when to go to hospital? Msg1133E.wav

1.1.3.4 If clothes are stuck to the burn, should I try to remove them? Msg1134E.wav

1.1.3.5 Should I use ice to cool the burn? Msg1135E.wav

1.1.4 Please choose one question. Press one for "What should I do to help someone suffering from a heart attack?" Press two for "How can I tell if someone is having a heart attack?" Press three for "Can I give them aspirin?" Press four for "What is the difference between heart attack and cardiac arrest?" Press five for "What is angina?" Press 0 if you want to listen again and press 9 if you want to go back to the previous menu.

1.1.4.1 What should I do to help someone suffering from a heart attack? Msg1141E.wav

1.1.4.2 How can I tell if someone is having a heart attack? Msg1142E.wav

1.1.4.3 Can I give them aspirin? Msg1143E.wav

1.1.4.4 What is the difference between heart attack and cardiac arrest? Msg1144E.wav

1.1.4.5 What is angina? Msg1145E.wav

1.1.5 Please choose one question. Press one for "What are the symptoms of a diabetic emergency?" Press two for "What is diabetes and how will I know if it is a long term condition?" press three for "Press four for "How should I know when to call an ambulance?" Press five for "What should I do if someone is having a diabetic emergency?" Press 0 if you want to listen again and press 9 if you want to go back to the previous menu.

1.1.5.1 What are the symptoms of a diabetic emergency? Msg1151E.wav

1.1.5.2 What is diabetes and how will I know if it is a long term condition? Msg1152E.wav

1.1.5.3 What happens in diabetic emergency? Msg1153E.wav

1.1.5.4 How should I know when to call an ambulance? Msg1154E.wav

1.1.5.5 What should I do if someone is having a diabetic emergency? Msg1155E.wav

1.1.6 Please choose one question. Press one for "How do I look and feel for breaths?" Press two for "How should I help if someone is unconscious and breathing?" Press three for "How should I help someone who is unconscious and not breathing?" Press 0 if you want to listen again and press 9 if you want to go back to the previous menu.

1.1.6.1 How do I look and feel for breaths? Msg1161E.wav

1.1.6.2 Please choose one question. Press one for "What is a recovery position?" Press two for "How do I help a baby who is unconscious and breathing?" Press three for "What should I do if someone is falling faint?" Press four for "How do I help an adult who is unconscious and breathing?" Press 0 if you want to listen again and press 9 if you want to go back to the previous menu.

1.1.6.2.1 What is a recovery position? Msg11621E.wav

1.1.6.2.2 How do I help a baby who is unconscious and breathing? Msg11622E.wav

1.1.6.2.3 What should I do if someone is falling faint? Msg11623E.wav

1.1.6.2.4 How do I help an adult who is unconscious and breathing? Msg11624E.wav

1.1.6.3 Please choose one question. Press one for "Do I do chest compressions differently on a child or a baby?" Press two for "Will I break their ribs?" Press three for "How do I do mouth to mouth?" Press four for "What is a defibrillator and can I use it?" Press five for "What should I do to help someone who had been in a drowning accident?" Press 0 if you want to listen again and press 9 if you want to go back to the previous menu.

1.1.6.3.1 Do I do chest compressions differently on a child or a baby? Msg11631E.wav

1.1.6.3.2 Will I break their ribs? Msg11632E.wav

1.1.6.3.3 How do I do mouth to mouth? Msg11633E.wav

1.1.6.3.4 What is a defibrillator and can I use it? Msg11634E.wav

1.1.6.3.5 What should I do to help someone who had been in a drowning accident? Msg11635E.wav

1.2 Please choose one topic. Press one for “Sexually Transmitted Infections” Press two for “Male Family Planning options” Press three for “Female Family Planning options” Press four for “HIV/AIDS” Press five for “Womens' Perinatal Care” Press 0 if you want to listen again and press 9 if you want to go back to the previous menu.

1.2.1 Sexually Transmitted Infections Msg121E.wav

1.2.2 Male Family Planning Msg122E.wav

1.2.3 Female Family Planning Msg123E.wav

1.2.4 HIV/AIDS Msg124E.wav

1.2.5 Please choose one question. Press one for “Preconception counseling and interventions” Press two for “Prenatal Care” Press three for “Postpartum testing and counseling” Press 0 if you want to listen again and press 9 if you want to go back to the previous menu.

1.2.5.1 Preconception counseling and interventions Msg1241E.wav

1.2.5.2 Please choose one question. Press one for “First Prenatal Visit” Press two for “Each Subsequent Prenatal Visit” Press three for “Testing recommended for all pregnant women” Press four for “Education and counseling” Press five for “Treatment and Immunization” Press 0 if you want to listen again and press 9 if you want to go back to the previous menu

1.2.5.2.1 First Prenatal Visit Msg12421E.wav

1.2.5.2.2 Each Subsequent Prenatal Visit Msg12422E.wav

1.2.5.2.3 Testing recommended for all pregnant women Msg12423E.wav

1.2.5.2.4 Education and counseling Msg12424E.wav

1.2.5.2.5 Treatment and Immunization Msg12425E.wav

1.2.5.3 Postpartum testing and counseling Msg1253E.wav

1.3 Please choose which one group. Press one for “Pregnant or Lactating” Press two for “Child under five” Press three for “HIV positive” Press four if you don't belong to none of the categories Press five for “What is malnutrition?” Press 0 if you want to listen again and press 9 if you want to go back to the previous menu.

1.3.1 Please choose food category. Press one for “Micro-nutrients” Press two for “Protein” Press 0 if you want to listen again and press 9 if you want to go back to the previous menu

1.3.1.1 Micro-nutrients Msg1311E.wav

1.3.1.2 Protein Msg1312E.wav

1.4 Please choose sanitation and hygiene category. Press one for “Clean Water” Press two for “Food hygiene” Press three for “Toilet hygiene” Press four for “Clean Hands” Press five for “What is personal hygiene?” Press six for “What is environmental hygiene?” Press 0 if you want to listen again and press 9 if you want to go back to the previous menu.

1.4.1 Water Msg141E.wav

1.4.2 Food Msg142E.wav

1.4.3 Toilet Msg143E.wav

1.4.4 Hand Msg144E.wav

1.4.5 Personal Msg145E.wav

1.4.6 Environmental Msg146E.wav

1.5 Please choose one question. Press one for “General Screening and Treatment” Press two for “Cancer Screening and Counseling” Press 0 if you want to listen again and press 9 if you want to go back to the previous menu.

1.5.1 Please choose age group. Press one for “Infant” Press two for “Early childhood” Press three for “Middle childhood” Press four for “Adolescent” Press five for “Adult” Press 0 if you want to listen again and press 9 if you want to go back to the previous menu.

1.5.1.1 Please choose one topic. Press one for “Immunization” Press two for “Periodical Doctor Visits and tests” Press three for “Drugs” Press 0 if you want to listen again and press 9 if you want to go back to the previous menu.

1.5.1.1.1 Immunization Msg15111E.wav

1.5.1.1.2 Periodical Doctor Visits and Tests Msg15112E.wav

1.5.1.1.3 Drugs Msg15113E.wav

1.5.2 Please choose one topic. Press one for “Colorectal Cancer Screening” Press two for “Prostate Cancer Screening male only” Press three for “Breast cancer screening female” Press four for “Cervical Cancer Screening female only” Press 0 if you want to listen again and press 9 if you want to go back to the previous menu

1.5.2.1 Colorectal Cancer Screening Msg1521E.wav

1.5.2.2 Prostate Cancer Screening male only Msg1522E.wav

1.5.2.3 Breast cancer screening female only Msg1523E.wav

1.5.3.4 Cervical Cancer Screening female only Msg1524E.wav

Annex F: Declaration

I, the undersigned, declare that this research project is my original work and has not been presented for degree in any other university, and that all sources of materials used for the project have been acknowledged.

Declared by:
Name: **Abenezer Tsegaye**
Signature: _____
Date: _____

Approved by:
Name: **Dr. Dereje Teferi**
Signature: _____
Date: _____

Name: **Dr. Eshetu Girma**
Signature: _____
Date: _____

Place and time of submission: Addis Ababa University, June 2017.