



ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY
INSTITUTE OF TECHNOLOGY
DEPARTMENT OF SOFTWARE ENGINEERING

A TEXT FREE MOBILE APP USER INTERFACE DESIGN APPROACH
(THE CASE OF M-PREGNANCY _CARE)

FIKIRTE TIRFE WOLDEHAWARIYATE

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ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY
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DEPARTMENT OF SOFTWARE ENGINEERING

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BY:
FIKIRTE TIRFE WOLDEHAWARIYATE

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Names and Signature of Members of the Examining Board

Chair Person, Examining Board

Signature

Amanuel Zewge

Advisor

Signature

Examiner

Signature

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LIST OF ACRONYM

AAU: Addis Abeba University

ANC: Antenatal Care

ATU: Attitude Towards Usage

GSM: Global System for Mobile Communication

GUI: Graphical User Interface

HCI: Human Computer Interaction

HEW: Health Extension Worker

HP: Hewlett Packard

IDE: Integrated Development Environment

IGUANA: Independent Group of Unix Alkies and Network Activities

M-HEALTH: Mobile Health

PEU: Perceived Ease of Use

PNC: Prenatal Care

PRA: Pragmatic

RIA: Rich Internet Applications

SMS: Short Message Service

TAM: Technology Acceptance Model

LTO: Term Orientation

UI: User Interface

UNESCO: United Nations Educational, Scientific and Culture Organization

USA: United States of America

ABSTRACT

Mobile phones are becoming a booming new technology in the developing world. They have proven to be valuable tools to improve the life quality of the local population. Yet we cannot expect to be able to apply conventional mobile user interfaces design in mobile apps for the local population. Ethiopia has one of the highest levels of illiteracy, and there are many cultural oriented UI design issues. The main focus of this research was to deal with how a mobile app user interface should be designed for semi/illiterate users. This research was conducted as a case study in Ethiopian Merci non-governmental health center. The user-centered design methodology was used to focus on the users as the heart of the design process. This in turn supports results in products that are more likely to provide what the users need and want. To this end, a mobile application was designed to provide pregnancy advice to all women who have diversified cultural background and illiteracy problem. The result is a model that is designed to help mobile app developers with a number of UI guidelines to follow and considerations to be made while designing the mobile app for similar kind of users. It has been evaluated by developing the design of a use case application, and by collecting survey analysis of user satisfaction level. The prototype achieves good performance and meets the objective of the study. Given the existing knowledge gap among pregnant women, availability of smartphone in the market, this work would provide ideas for both health sectors and mobile app developers on how to improve knowledge of pregnant women.

Keywords: text-free interface, Mobile Phone, M-Health, literacy, pregnancy, Model

CHAPTER ONE

INTRODUCTION

1.1 Overview

Mobile phone has become a very important part of our daily lives. It is very difficult to imagine our live without a cell phone as most of our work is done using mobile phones. Considering on how to deliver important service for the users, mobile phone plays a very important role [1]. Among the very important role of mobile technology, delivering health care service to users is one benefit of using mobile phone.

The current rapid expansion of mobile technology infrastructure presents an opportunity to improve health care through new forms of interactive M-Health services that promote personal wellness, preventive care, and gain; access to personalized medical information, anywhere and anytime [2] [3]. Its main application in the health sector is to improve the quality of and access to care because so many different factors in the existing healthcare services can be addressed through m-health intervention [4]. For example, M-Health application can help patients to manage their treatments when attention from health workers is costly, unavailable, or difficult to obtain regularly.

Another aspect of M-Health is educating patients and raising awareness of health issues. This is especially necessary for developing countries. For example the project held by the Clinton Health Access Initiative, in partnership with AAU School of Information Science and in consultation with the Ethiopian Federal Ministry of Health, has developed M-Health application called Enat Messenger [5]. The Enat Messenger System runs text-based confirmation and transmission services via an automated message manager. A system document, user manual, and handbook for health extension workers (HEW) were developed to support implementation. However, such kind of application have limitation for use. This is because; text based message [6] usually has a limit on character count that constrains the content of the message to be exchanged. Illiteracy and language barriers are also topics of unsolved issues [7].

M-Health project [8] was designed and implemented mobile patient follow up system. The system supports long-term outpatient follow-up treatment activities and creates remote reliable communication between health workers and outpatient. The project intended to solve health issues

especially for patient follows up of chronic conditions that may require technology not available in remote area. However, still illiteracy [9] issue has not addressed. The reason behind illiteracy problem are the design of mobile phone are not designed for people who can't read or write, and the interfaces oftentimes require the user to read description or texts in order to understand how to operate the. In addition to this, application design were not following a user-centered approach [10], on the other hand, designing mobile phone user interface for illiterate users let them to get the same benefits from mobile phones as literate users.

The UI is one of the most important elements to consider when designing applications particularly for illiterate users because it connects the user to the service they require [11]. So, for an effective design of M-health UI, efficient human-computer interactions must be considered [12]. According to research literature [13], the UI is a crucial component that influences the efficiency and quality of usage and communication between user and the system. Today, there are a number of M-Health systems, but the role of HCI is left behind any consideration. This influences to appear system usability and usefulness at the end user's sides. Based on the concept of human computer interaction and graphical user interface. This study intended to design text free UI for illiterate and semiliterate users: pregnant women as a case study.

1.2 Motivation

Healthy women are the foundation of a strong community, and healthy newborns are the future. Maternal health [14] is the health of women during pregnancy, childbirth, and the postpartum period. It encompasses the health care dimensions of family planning, preconception, prenatal, and postnatal care in order to reduce maternal morbidity and mortality [15]. In Ethiopia, the levels of maternal mortality and morbidity are among the highest in the world and the current estimate of maternal mortality ratio is 676 per 100,000 live births [16] . The main reason behind this is a little knowledge about danger signs of pregnancy and its associated factors [17] [18] [19]. The knowledge level of pregnant women on danger signs of pregnancy was not adequate and affected by residential area, and educational level. Efforts are needed that focus on availing antenatal care services with appropriate information services to improve the knowledge of pregnant women about danger signs during gestation period [19].

According to the research findings of [20], there are many factors that affect the outcome of pregnancy from the onset of any obstetric complication. The outcome is most adversely affected by delayed treatment. These delays in treatments are described in three phases:

- Delay I: Lack of information and adequate knowledge about danger signals [21] during pregnancy and labor; cultural/ traditional practices that restrict women from seeking health care; lack of money.
- Delay II: Out of reach of health facilities; poor road, communication network, community support mechanisms
- Delay III: Inadequate skilled attendants; poorly motivated staff; inadequate equipment and supplies; weak referral system, procedural guides [22].

As we discuss above the major causes of maternal mortality and obscuring are inadequate knowledge about danger signals, poor health facilities and inadequate attendants. In fact, many projects and researches have been held to reduce maternal health problems through M-Health system. However, usability is the measure issue on the existing projects and researches. To this end, this research intended to develop text free mobile application that meets user needs and requirements.

1.3 Statement of the problem

Mobile health (M-Health) technology has been proposed as a means to improve healthcare in low resource settings, including maternal health [23]. M-Health applications are being used in the developing world to improve health education and awareness, diagnostic treatment and support services, data collection and remote monitoring services, surveillance, emergency medical services and other healthcare services [1].

M-Health Help patients on giving health care service when attention from health workers is costly, unavailable, or difficult to obtain regularly. In relation to reducing maternal mortality and improving maternal health, M-Health applications could allow disseminating of information for the mothers and increase peoples engagement in their own life style management. In addition, well designed electronic forms downloadable to smartphones for ANC care, delivery and PNC, could

assist mothers to easily identify symptoms, danger signs and complications during their pregnancy times.

The realization of the potential of mobile devices to improve healthcare system resulted in many initiatives in mobile health in Ethiopia. To sum up, mobile phones have found broad application in bringing health; however, usability remains a major hurdle for novice and low-literacy population. In Ethiopia, no study has been conducted on designing mobile based text free interfaces for illiterate users especially for pregnant women, this research intended to answer, how we can design mobile phone interfaces in a way that can benefit low literate users.

The biggest problem of M-Health system is the way it delivers the services to the user. For example

1. All of research and project done so far in Ethiopia on the area of M-Health use SMS for information and exchange and giving awareness about the maternal health issues for the health extension workers and the patients. However, use of SMS has its own problems, illiteracy in the developing world such as Ethiopia is another barrier that could reduce the benefit of M-Health tools such as SMS text messaging and still illiteracy issues have not been addressed. It is known that illiterate users have difficulties on interacting with text based interface. As the user interact with the system or any mobile application through the user interface, the UI should be more intractable for the user. And the content which are any M-Health application deliver should be text free feedback for the illiterate users.
2. The other problem of the existence M-Health with reference to maternal health research and projects was Digital divide. Which means there is no way to ensure the mothers get the appropriate information on the appropriate time. The communication made at the community level involves only health and extension workers. However, the limited computer literacy of health workers was a challenge. Some were unable to fix minor problems with the system. In addition, some HEWs lost their mobile phones or did not return them when they left the area (i.e. for further education, transfer). Other HEW failed to visit mothers on time and as a result due to those reasons the mothers can't get the appropriate health care on time [5].
3. The design of mobile phones UI not design with the need of the users and culture restrict the utilization of M-Health applications.

It is a common knowledge that modern technology today is mostly developed in western or modern Asian societies. Most research and projects has not been designed according to the target users. The potential impact of M-Health in health delivery in developing countries is largely untapped, due to technical as well as socio-economic, cultural and regulatory barriers. The design, implementation and adoption of M-Health in developing countries are beset with wide-ranging challenges. For instance, most of the technology applications used in most M-Health interventions are not designed in the developing countries. The users should be interacted on the design process to make the application more usable. However, the existing researches didn't consider user centered methodology to gain access to the users. Moreover, there are currently no techniques, guidelines or well-defined methodologies to help practitioners (developers) to design UI for illiterate people in Ethiopia. Developing a user interface design approach can use developers as a guideline for developing M-Health applications for semi(illiterate)users with the same cultural background.

For the above problem and solving usability issues which has been illustrated above with reference to M-Health application utilization for the pregnant women in particular. This research motivated to develop a mobile phone application user interface design approach(model) based on the knowledge and the interaction of the target users on the design process. The effectiveness and the usability of the approach is evaluated through developing prototype based on the approach.

1.4 Research questions

The research is targeted to find ways to improve the usability of mobile health applications for low-literacy users. However, we need to take into consideration that a substantial amount of the population in Ethiopia has never used a smartphone before. There are also cultural differences that need to be taken into account. The interface should resonate with the target audience, even if a user has never seen such an interface before, and cannot read any form of text. With these items in mind, the research questions of the research are formed as followed:

- What are the dimensions in the design of a user interface, which is specifically targeted for (semi-) illiterate users and what kind of constraints should be taken into account?
- How should a mobile UI be designed for (semi) illiterate Ethiopian users, with pregnant women in particular?

1.5 Objective of the study

1.5.1 General objective

The general objective of this research is to develop mobile app text free UI design approach(model) and to develop a prototype for user evaluation based on the approach(model) for illiterate pregnant women's that will help them to access knowledge about the signs and danger signs that can occur during pregnancy period.

1.5.2 Specific objectives

- To review literature in order to understand concepts, principles and technologies related to human computer interaction
- Analyze the current state of the art in order to propose a better and a working solution.
- To acquire the necessary tacit and explicit information and knowledge from primary and secondary sources using interviews and questionnaires.
- To develop a text free mobile app UI design approach(model).
- To design prototype (M-Pregnancy_Care) for illiterate and novice pregnant women based on the approach(model).
- To test and evaluate user satisfaction rate of the prototype.
- To forward recommendations and suggestions for further work in the application of HCI.

1.6 Methodology

It is crucial to examine what kind of ideas and rules should be applied to making a mobile UI for specific services, especially in the health domain. This research was conducted as a case study on Ethiopia merci non-governmental health Centre, where a mobile application was designed to provide pregnancy advice to all women who have diversified cultural background and literacy problem. We looked ways to improve UI design for M-health app, so that users with a lower literacy will be able to benefit from this technology as well. To this end, the following research and design activities were carried out.

A wide gap in technical abilities, goals, and attitudes often exists between users and developers. A failure to understand the differences will doom a product or system to failure [28]. To improve the

gap between the developer and the user, “use center design” can be effective methodology. User center design is method based on gathering information from end users, and involving them throughout the process, is referred to as user-centered approaches. User-centered design involves focusing on the user’s needs, carrying out an activity/task analysis as well as a general requirements analysis, carrying out early testing and evaluation, and designing iteratively [10]. This means the developers only develop the system based on the idea of the user. On top of this, user involvement in the design phase is based on letting them test prototypes and early versions of the product to observe how it is used, and what areas might need change to be better suited for the actual users and the user know from an early stage what to expect from a product and they feel that their ideas and suggestions have been taken into account during the process.

1.6.1 User centered design process

The User-Centered Design methodology enables interface developers to focus on the users as the heart of the design process. User involvement in the design process results in products that are more likely to provide what the users need and want. Usability engineers and human factors engineers have extensively used this approach, and they emphasize the participation of the end users in the design process. In general involvement of user in the design processes increase the usability of the system.

In order to design the mobile UI for M-Health, the design processes and techniques were considered the characteristics of the users and the socio-cultural environment. The method was adapted to enhance users’ participation in the design process. The design approach was an iterative process with the following activities

- ✓ **User and environment analysis** – a study to identify and understand the potential users, the social and cultural environment;
- ✓ **Tasks analysis** – Analyze the users’ tasks, goals and the system’s functions;
- ✓ **Scenarios design** – design scenarios of users’ activities, information content, interface screens and users’ interactions
- ✓ **Investigate Cultural issues** – analysis of cultural requirements for adaptation of the UI to a culture sensitive user interface;
- ✓ **Prototyping** – develop prototype incrementally and evaluate with the users;
- ✓ **User evaluation** – evaluate the prototype with real users to determine their satisfaction

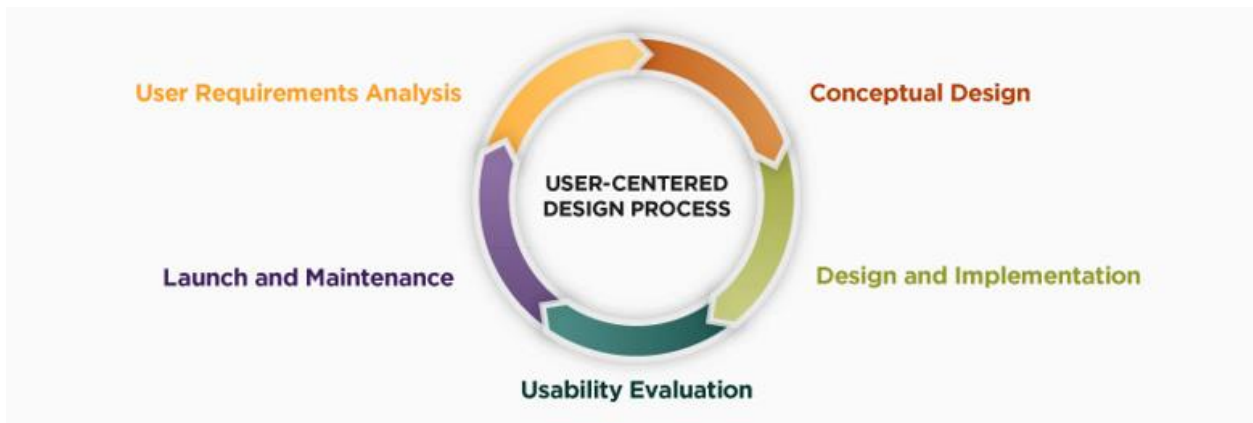


Figure 1-1 user centered design process

1.6.2 Data collection

Knowledge for the research was extracted from primary and secondary source. Primary sources include health expert on maternal health. secondary source used to get the knowledge from: internet resources, booked, and manuals. To acquire relevant knowledge for developing the mobile application, interview was employed. Bothe structures and unstructured interview were conducted to elicit tacit knowledge from domain experts. Interview was carried out with face to face communication, through interactive design and pre and post development surveys, answers were collected to address the research question.

1.7 Scope of th study

The scope of the research work is limited to the following:

- To design prototype mobile text free interface for illiterate pregnant women.
- The intended research only depends on designing an interface for pregnant women's that only gives advice about the signs and danger signs occurring during prenatal stage of pregnancy. It will not include other issues on maternal health.
- The implementation of the text free interface includes only icons and recording voice. It will not include text and speech dialog system.

1.8 Significant of the study

The proposed research provides a text free mobile app UI design approach(model) and design prototype mobile-based text free interface for illiterate pregnant women based on the approach(model). After the implementation, this research will benefit the illiterate mothers by giving them advises through easily and intractable text free interface. Additionally, the intended research will contribute other researchers on designing model based on the model we designed this model help the researchers to design an interface for the target community.

The beneficiaries of the proposed research will be the following:

- The pregnant women:
- Ministry of health:
- other researcher

1.9 Structure of the thesis

The remaining part of this documentation is organized as follows. The next Chapter deals with literature review and related work. The literature review part will try to give a summarized report on the state of art in relation to Human computer interaction and UI design in general. And the related work is about related work that is highly relevant and more related to our study. Chapter 3 will discuss UI dimensions and visual model in order to build mobile phone for illiterate and semiliterate pregnant women in particular; chapter 4 will discuss system implementation based on the guidelines of the visual model we designed. Chapter 5 discusses evaluation of the system and the last Chapter will conclude the research work in general and indicating future works.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

This research undertook in Addis Abeba city specifically on Ethiopian mercy non-governmental health Centre with aim to develop user-interface application for illiterate mother's (women's) to give them advice about the signs which can be occurred during first, second and third trimester. The aims of the literature review in this study are to identify the background and theory behind designing Graphical UI based application and to study about human computer interaction. The information gathered in this review is mainly collected from field study, interview, researches, books and journals. Through these references it's expected to provide a critical understanding in developing a UI application.

2.2 Human computer interaction

Human-Computer Interaction does not have a standard definition, mostly due to its multidisciplinary approach, but the field can be described as a “discipline concerned with the design, evaluation and implementation of interactive computer systems for human use and with the study of major phenomena surrounding them” [29]. Human-Computer Interaction can be interpreted as design to produce a fit between the user, the machine and the required services in order to attain a particular level of performance in the quality and optimality of services [30]. The field derives from several disciplines with particular emphasis on computer science, psychology, sociology and anthropology, and industrial design [31]. [30] State that Human-Computer Interaction was based on the premise that most sophisticated machines are worthless unless humans can use them properly. Consequently, functionality and usability are the core foundations of Human-Computer Interaction.

According to [30] Human-computer interaction (HCI) is the study of how people design, implement, and use interactive computer systems and how computers affect individuals, organizations, and society. The Human Computer Interaction (HCI) program will play a leading role in the creation of tomorrow's exciting new UI software and technology, by supporting the broad spectrum of fundamental research that will ultimately transform the human-computer interaction experience so the computer is no longer a distracting focus of attention but rather an

invisible tool that empowers the individual user and facilitates natural and productive human-human collaboration.

Human-computer interaction is concerned with the joint performance of tasks by humans and machines; the structure of communication between human and machine; human capabilities to use machines (including the learnability of interfaces); algorithms and programming of the interface itself; engineering concerns that arise in designing and building interfaces; the process of specification, design, and implementation of interfaces; and design trade-offs. Human-computer interaction thus has science, engineering, and design aspects [32].

According to [30], Functionality of a system is defined by the set of actions or services that it provides to its users. However, the value of functionality is visible only when it becomes possible to be efficiently utilized by the user [33]. Usability of a system with certain functionality is the range and degree by which the system can be used efficiently and adequately to accomplish certain goals for certain users. The actual effectiveness of a system is achieved when there is a proper balance between the functionality and usability of a system. According [34], knowing the users is critical to successful system design and states that the user's involvement should be direct in the design process from the very beginning of the project, so that the usability need and functionality are ensured. Similarly [35] represent the needs of 'The User' with a diagram represented below, indicating the importance of user needs

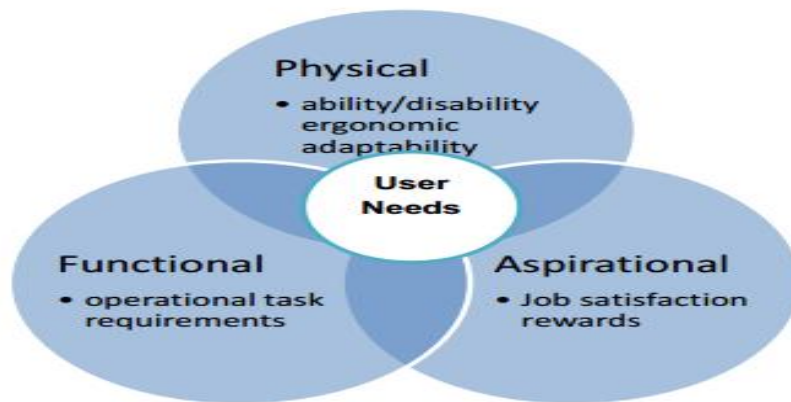


Figure 2-1 user need adopted from [35]

2.2.1 Research contribution types in HCI

According to [36] the research contribution types in HCI is discussed as below:

2.2.1.1 Empirical

Empirical research contribution consists of new findings based on systematically observed data. Empirical contribution may be quantitative or qualitative (or mixed), and usually follow from scientific studies of various kinds (*e.g.*, laboratory, field, ethnographic, *etc.*). In HCI, the purpose of empirical contributions is, by providing new data, to reveal formerly unknown insights about human behavior and its relationship to technology.

2.2.1.2 Artifact

Artifacts in HCI are inventions, including new systems, architectures, tools, techniques, or designs that reveal new opportunities, enable new outcomes, facilitate new insights or explorations, or impel us to consider new possible futures. Artifact contributions are, by definition, dependent upon never-before-seen inventions that are instantiated as prototypes, sketches, mockups, or other portrayals, and are often at least somewhat functional.

2.2.1.3 Methodological

Methodological research contribution adds or refines the methods by which researchers of practitioners carry out their work in HCI. Research methods enable scientists to make new

discoveries, while designers and developers to apply their craft to greater effect. In this case entirely new methods or method variations could be proposed.

2.2.1.4 Theoretical

Theoretical contributions consist of new models, principles, concepts, or frameworks, or important variations on those that already exist. These may be qualitative in nature, but are always structured so as to be useful in the pursuit of future knowledge. Theories are built overtime, and in some fields, after repeated and rigorous validation, may attain the status of “laws”.

2.2.1.5 Dataset

Datasets are infrequent contributions in HCI, but they do occur. A dataset contribution provides a new and useful corpus, often accompanied by an analysis of its characteristics, for the benefit of the research community. Datasets enable evaluations against shared benchmarks by new algorithms or systems. Dataset contributions are common in the pattern matching, and database communities, among others.

2.2.1.6 Survey

Survey contributions are attempts to review and synthesize work done in a research field with the goal of exposing trends, themes, and gaps in the literature. Survey contributions take a step back, organizing the literature of a field and reflecting on what it means. Often, survey contributions are conducted after a field has reached a level of maturity.

2.3 Interaction design

The interaction between the users and the device is through the device’s interface. According to [37] interaction design is designing interactive products to support people in their everyday and working lives. It optimizes the users' interactions with a system, environment or product, so that they match the users' activities that are being supported and extended. Good place to start thinking about how to design usable interactive products is to compare examples of well and poorly designed ones.

In design human–computer interaction and software development, interaction design is about shaping digital things for the use of human being’s people’s use. Alternatively [38] defines

interaction design as the practice of designing interactive digital products, environments', systems, and services. What clearly marks interaction design as a design field as opposed to a science or engineering field is that it is analyzing and imagining things as they might be, more so than focusing on how things are and it is heavily focused on satisfying the needs and desires of the majority of people who will use the product.

Designing usable interactive products thus requires considering who is going to be using them and where they are going to be used. Another key concern understands the kind of activities people are doing when interacting with the products. The appropriateness of different kinds of interfaces and arrangements of input and output devices depends on what kinds of activities need to be supported

For instance, the interaction with the cell phone interface consists of four phases of cognitive activity. The model is derived from the basic model of cognitive activity that has been described by [39]. The block diagram of the model applicable to cell phone interaction for this study can be seen in figure 2-2.

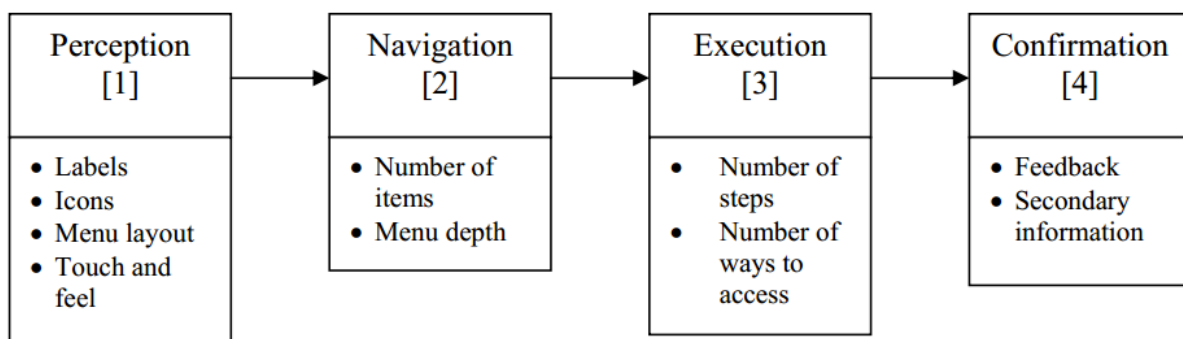


Figure 2-2 Research Model of Cell Phone Interaction with Interface Components [39]

These phases are described as follows:

1. **Perception:** The affordance perception phase when users identify what the system has to offer by viewing the initial presentation on the screen. This is the first phase of the cognitive activity and where the user perceives what affordance the system has to offer, and then goes on to check the applicability of the affordance to the task at hand. The user will first perceive the startup view of the cell phone interface.

2. **Navigation** (Applicability Check): This phase is where the users validate their choice of actions [40]. Culture affects the users' attitude in this phase. In this phase the user will enter the menu structure in order to search for a specific item or a menu, which will lead to the completion of the task goal.
3. **Execution**: This third phase of the activity is where the users enact their action plan [40]. The users have to follow a certain path in order to achieve the ultimate goal. For example, sending an SMS or looking up a number in the phone book.
4. **Confirmation**: The user performs a task with the expectation of confirmation whether the task has been completed or not.

Before discussing on how culture influences interface design, it is important to identify what culture actually means. Traditionally, the term culture has been used to describe a group of people who have certain aspects of life in common. Cultural anthropologists have formulated many definitions of culture. Cultural differences in values and beliefs distinguish societies' behavior and attitude from one another [41].

2.4 Culture in HCI

Before discussing on how culture influences interface design, it is important to identify what culture actually means. Traditionally, the term culture has been used to describe a group of people who have certain aspects of life in common. Cultural anthropologists have formulated many definitions of culture. Culture can be defined as “the fabric of meaning in terms of which human beings interpret their experiences and guide their action” [42]. Cultural differences in values and beliefs distinguish societies' behavior and attitude from one another.

Cross-cultural HCI focuses on how UI designs and principles can be translated from one culture to another, or how interfaces can be designed so as to neutral as possible to cultural differences [43]. Cross culture contains the concept called interface localization and interface internationalization. The internationalization-localization process is the most common means by which culturally determined usability problems are approached in HCI [44]. Generally speaking, internationalization concentrates on separating the ‘cultural elements’ - e.g., character sets - of a product from the rest of it; it is also the process of developing software so that it can be used effectively by users of heterogeneous cultural backgrounds while localization is the process of

adding culture-specific components to the software package to adapt to those “cultural elements “for a specific target culture [45].

2.4.1 Cultural model

As culture influences the way in which people interact in general, culture will also influence the way in which people will interact with computers [43]. Using interactive systems to perform tasks requires communication between the system and the user. People learn patterns of thinking, acting and communicating from living in a specific social environment, normally typified by national culture.

According to [46], every person carries within him or herself patterns of thinking, feeling and acting which are learned throughout his or her lifetime. A person’s childhood and upbringing have significant effects on the development of these patterns. He also suggested the fact that culture is always shared with people who live or lived within the same social environment where it was learned. Hofstede’s long-term dimension concerns orientation and search for underlying concepts: the orientation to practice and search for virtuous behavior on the one hand (long-term) and the orientation to belief and search for truth on the other (short-term).

Hofstede later described differences in national culture with the five cultural dimensions Individualism, Uncertainty Avoidance, Masculinity, Power Distance, and Long Term Orientation [47]. His dimensions are an attempt to comprehend deeply anchored cultural values with the help of a tangible set of variables.

The term power distance refers to the extent to which less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally [48]. Power distance is measured on the basis of inequality in the society. It is defined as the extent to which the less powerful people in society accept and expect that power is unequally distributed [46]. A high power distance culture accepts inequalities of power and status, while lower power distance cultures tend to stress equality in decision-making and opportunity regardless of status. This cultural dimension is often thought of as a continuum from hierarchy (High Power Distance) to equality (Low Power Distance) (context matter)

The cultural dimension referred to as Individualism vs. Collectivism concerns whether leaders see themselves more as individuals or more as group members (context matter). Individualism represents a preference for a loosely-knit social framework where people are expected to look out for their own interests take care of themselves, whereas collectivism indicates an inclination toward a tightly-knit social framework where people expect their companions to look out for their welfare and where personal goals are subordinated to those of the group [46].

Masculinity measures the degree to which a culture separates gender roles. Masculine cultures accept traditional and distinct gender roles, and are mostly male-dominated societies. A feminine culture does not separate traditional gender roles. [46] Focuses on the traditional assignment of assertiveness, competition, and toughness to masculine roles, and feminine roles of orientation to home and children, people, and tenderness, in a masculine culture. However feminine cultures tend to break down these distinctions and overlap gender roles. Masculinity refers to the relative desire of material success and assertive behavior versus quality of life and modest behavior.

Uncertainty avoidance can be defined as the extent to which the members of a culture feel threatened by uncertainty, ambiguity and the unknown, along with the eagerness to avoid these situations [46]. People in a high uncertainty avoidance culture perceive uncertainty as dangerous and show a low tolerance for risk and tend to reject new and unusual ideas [49]. On the other hand, a culture that has low uncertainty avoidance can deal well with vagueness and its members can be characterized as risk-takers. The Uncertainty Avoidance dimension expresses the degree to which the members of a society feel uncomfortable with uncertainty and ambiguity.

Long-term orientation focuses on the degree to which the society embraces, or does not embrace, long-term devotion to traditional or forward- thinking value. High Long-Term Orientation indicates that the country prescribes to the values of long-term commitments and respect for tradition [46]. This dimension was discovered by Michael Bond in the 1980's while he administered a questionnaire called the Chinese Value Survey in 23 countries, and was added to the model and increased the number of dimensions to five [50].

Every society has to maintain some links with its own past while dealing with the challenges of the present and the future. Societies prioritize these two existential goals differently. Societies who score low on this dimension, for example, prefer to maintain time-honored traditions and norms

while viewing societal change with suspicion. Those with a culture which scores high, on the other hand, take a more pragmatic approach: they encourage thrift and efforts in modern education as a way to prepare for the future. In the business context this dimension is related to as "(short term) normative versus (long term) pragmatic" (PRA). In the academic environment the terminology Monumentalize versus Flex humility is sometimes also used.

Table 2-1 cultural dimensions with user interface components [50]

	Culture dimensions			
UI elements	High power distance	Collectivism	Muscularity	UA
Metaphor	Should build with clear hierarchy	Relationship oriented	Sports-oriented; competition-oriented; work-oriented	Familiar, clear references to daily life; representation
Mental model	Reference data with no relevancy ranking	Role oriented	Work/business structures; high-level, "executive views;" goal-oriented	Simple, clear articulation; limited choices; binary logic
Navigation	high restricted access, limited choices, authentication; password	Group-oriented, official choices; changes per role	Limited choices, synchronic	Limited options; simple, limited controls

Interaction	Severe error messages: “Entry Forbidden,” “You are wrong;” wizards or guides lead usage	limited official devices; role driven	Game-oriented; mastery-oriented; individual-oriented	Precise, complete, detailed input and feedback of status constraints
Appearance	Images of leaders, nations; official music, anthems; formal speech	Images of groups, organizations; images of roles; high context; official, static terminology; institution-driven topics, imagery, language; passive verbs	Masculine”; color, shape, sound	Simple, clear, consistent imagery, terminology, sounds;

2.4.2 Culture oriented interface design

“There is no denying that culture influences human-product interaction” [51]. Concrete factors that one can clearly observe are just surface features of an interface. They are tangible, straightforward and easily observable elements [52]. Many guidelines such as the one by [53] have been formulated for interface design elements that are dependent on language, presentation formats, and graphical symbols and so forth. Cultural elements can be deeply embedded in a society and people might not be aware of them

According to [54], there are critical characteristics of design that need attention in a cultural context:

- **Language**, which is a distinctive aspect of different cultures, which when moved to the online domain, presents its own challenges of quality of translation, representation and stylistic elements.
- **Layout** that serves as a communication bridge between the user and the system, it involves placement of banners, menu items, and orientation, amongst others.
- **Symbol:** refer to “metaphors” refer to “metaphors” denoting actions for the user and vary from culture to culture. They may be icons used for currencies, locations, and other navigational elements. Symbols or Pictograph is also called pictogram is an ideogram that conveys its meaning through pictorial resemblance to a physical object. ‘Pictograph does not refer to a word in particular language, but to a physical object in real world brings out the qualities which makes a pictograms more effective, he describes the successful Pictograms as, it is simple and direct, bold and clear, balance if not highly symmetrical, and well integrated with its ground.
- **Content or structure:** referring information or features that the site offers and its organization.
- **Navigation** that is easy to use and facilitates access to information.
- **Multimedia**, including video, animation, images and sound.
- **Color** – where color semiotics varies across cultures and can impact user expectations

There has many researches has been hold on the area of cultural in HCI. For instance, the study of [55] investigates the role of metaphors in interface design. When thinking of designing the interface for system, the concept called “metaphor” comes to mind. A metaphor provides a method by which people can quickly learn to use a system. So the research seeks to provide evidence for the fact understanding of metaphors differs culturally and hopes to provide better insight in to cultural user perception and understanding. The problem in cultural interface design is that the real world changes dramatically from cultural to culture [56]. Localizing interface requires localizing metaphors, which is mostly done by redesigning the objects in a certain metaphor (e.g. the icons in a desktop metaphor) to accommodate for the target culture

The study of [57] provided empirical evidence and offered more insights on how significantly culture could affect HCI and software usability. It demonstrated that culture is sophisticated and constantly changes entity. And the researchers suggested to the researchers on HCI that when

choose cross-cultural software program, it's vital to keep in mind that looking for localized features that seem to symbolize the target culture is not enough and could be misleading. Instead one should look for culturally appropriate features within the specific context. More importantly one should look for appropriate features within the specific context.

This study [57] examined whether using localized interface designs would make a difference in users learning results and their perceptions of the interface design in a classroom-learning environment. The available studies show that culture does have a great impact on the usability of interface design and that globally software accommodates the cultural differences of the target and users. So the studies provide empirical evidence and offered more insights on how significantly culture could affect HCI and software usability. It demonstrated that culture is a sophisticated and constantly changing entity.

The study [39] discuss culture on HCI by determined some attributes of mobile phone services using qualitative methods of in-depth interviews in Korea, Japan, and Finland. Using a qualitative method, this study found 11 critical attributes of mobile data services that showed a clear correlation with characteristics of the user's culture.

To conclude the above concepts; indeed, culture have an impact on the usability of system. As the significance of the intended research is all about designing usable interface for illiterate and semiliterate user based on the theory of human computer interaction it will add some concept of culture.

In a computing icon is a pictogram displayed on a computer screen in order to help the user navigate a computer system or mobile device [58]. When used in modern technology, icons are pictures, often small and linked to a button on some device. On mobile phones and personal computers you see them all the time, telling you were to click to open the phonebook or a word processing application of your choice. Over time you recognize an icon just from its features, be it color, shape or the pictured object, without having to read the text underneath it. But what if you received a new mobile phone with icons you had never seen before, and there was no accompanying text to describe them. Would you then be able to use the phone as you wanted to? This is where the challenge lies when it comes to making text free interfaces: designing icons that

are descriptive enough to let you understand what they are trying to tell you the first time you pick it up.

2.5 Icon and interaction

In a computing icon is a pictogram displayed on a computer screen in order to help the user navigate a computer system or mobile device [58]. When used in modern technology, icons are pictures, often small and linked to a button on some device. On mobile phones and personal computers you see them all the time, telling you where to click to open the phonebook or a word processing application of your choice. Over time you recognize an icon just from its features, be it color, shape or the pictured object, without having to read the text underneath it. But what if you received a new mobile phone with icons you had never seen before, and there was no accompanying text to describe them. Would you then be able to use the phone as you wanted to? This is where the challenge lies when it comes to making text free interfaces: designing icons that are descriptive enough to let you understand what they are trying to tell you the first time you pick it up.

2.6 Related works: UI for low literacy users

We provide a brief overview of existing design guidelines for low literacy users, identifying the gaps in the literature. In particular, few studies perform direct comparisons between different GUI, but instead report on the successes or failures of particular interface features embedded in a larger application. In addition, the majority of the literature addresses low-literacy populations in developing countries, in which culture, infrastructure and education all differ greatly from first world countries and can impact results. To this end, we investigated the related works in terms of research questions, methods and technology used, among others. The detailed discussions these themes are discussed as follows see Table (2-2).

2.6.1 Research question (research focus area)

The focus area of the paper [27] is based on answering the research question on design UI for novice or illiterate users require absolutely no intervention from anyone at all to use. The researchers built two applications using these principles, one for job search for domestic laborers and another for a generic map that could be used for navigating a city. Results show that the text-free designs are strongly preferred over standard text-based interfaces by the communities specially the text free with help instruction is very preferable. However, this research has some limitations such as:

- The subjects due to the complexity of the text free interface they did not understand what they were clicking on.
- The researchers not yet achieving truly assistance less UI for novice, illiterate user.

Table 2-2 Summery of related work by themes

Related work	Technology used	contribution	Research questions
Text free user interface for literate and semiliterate users	computer	Artifact and empirical	How to design text free user interface
Exploring the text free interface for illiterate users Designing an icon-based prototype for mobile phones	Mobile phone	Artifact and empirical	How can an icon based interface be designed
Designing Mobile Interfaces for Novice and Low-Literacy Users	Mobile phone	Artifact	How to design mobile phone UI
igwana: a Text-Free Search Interface	Mobile phone and computer	Artifact	How to design a text free search interface
Using Mnemonic Technique as part of pictorial interface for self-identification of illiterate villagers	Mobile phone	Artifact and empirical	How to design interface using mnemonic technique

Making a Completely Icon-based Menu in Mobile Devices to become True: A User-centered Design Approach for its Development	Mobile phone	Artifact and methodological	How to design icon based interface
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Related to the above research, the same researchers held a research on the idea of designing the UI for illiterates so based on that; the focus area of the research [26] was Designing Mobile Interfaces for novice and Low-Literacy Users which based on answering the research question; designing mobile phone interfaces such that novice and low- literacy users can use more advanced services. The results of the research confirm that textual interfaces are unusable by first-time low-literacy users and error prone for literate but novice users. In the context of mobile banking, they find that task completion is highest with a graphical interface, but those who understand the spoken dialog system can use it more [46] quickly due to their comfort and familiarity with speech. However, these researches have a drawback such as:

- ✚ The subject face difficulty on navigating the interface
- ✚ The subjects face difficulties understanding of spoken dialog system due to language problem.
- ✚ The researchers didn't consider cross culture when developing the interface

Scholar [59] focuses on answering the research question on how to design usable icons for non e-literate users by examining some possible alternative icons and target icons. Also the researchers discuss whether those icons help illiterate and non e-literate users in understanding the functionality of a phone. The purpose of this study was to further analyze some of the problems faced by non e-literate users in using technology and to identify factors that can increase usability of technology. [60] Also develop interface for illiterate users. This research specifically depends on designing text free search interface called “Igwana” to navigate effectively through large sets of content using pictograms in place of text. This interface is designed for illiterate population. The igwana application enables the illiterate users to search and find general and practical content using touch screen devices. [61] Also focus on Using Mnemonic Technique as part of pictorial interface for self-identification of illiterate villagers on developing interfaces using mnemonic techniques. These villagers are unable to use of computer keyboard. In order to answer the

research, question they design a pictorial interface, which will enable the illiterate villagers identifying their pictorial identity (login name) and pictorial signature (password). [62] Also held a research on designing an interface for illiterate users basically focused on filling the gap of illiteracy and interface by answering the research question of how can an icon-based interface for mobile phones be designed to support illiterate people. The other research hold by [63] is on comparing non-literate and semiliterate users based on mobile money transfer UIs. The researchers develop a prototype of a mobile phone with a menu where all text in the menu is replaced by icons. [64] Based on answering the research questions on how to design speech interface driven application and how to deploy the application in the community. The finale related paper which is taking for the intended research is the work of [65] which is also based on designing accessible and usable interface for illiterates by answering the research area of how to develop a prototype spoken language interface and how to test the prototype on the community.

2.6.2 Method used

In this section we investigate on types of HCI research methodology in which each related works used in order to answer the research question. The first paper [27] use User center design. The resulting designs are based on subject trial and ethnographic interview design process. The interface contains graphical icon, voice feedback and minimal use of text. And the researcher's test the two applications with text based interface, text free interface version with help instruction and text free interface. [26] Use participatory design. The researchers explore the usability of mobile interfaces for novice and low-literacy users via three in-depth studies: an ethnographic investigation of 90 subjects in India, Kenya, the Philippines, and South Africa; a quantitative evaluation of text, spoken dialog, and graphical interfaces across 58 first-time low-literacy subjects in southern India; and a quantitative evaluation of electronic forms, SMS, and live operator interfaces across 13 novices but literate users in northern India. [59] Also use participatory design. The interviews were conducted in the two cities of Yogyakarta and Makassar between the two-target community such as cellophane users and non-cellophane users. The researchers participate the users on exploring the icon designed for them. Finally, they conclude their investigation by suggesting that a user-friendly interface can help to overcome the technology gap and minimize the digital divide in modern society. [60] Used participatory design in which they take interview and field study to get the mental model of the user. [64] The villagers base this research on

participating the target community in which the researchers hold experiment for helping the subjects identifying the effectiveness of a visual image mnemonic and other complimenting mnemonic technique for recalling the sequence of picture. Related to the other studies also [65] use participatory design by taking ethnographic study by involving users on the research. The other researcher who took participatory design [66] also participates or involves the target community to provide interactive agricultural information to rural villagers in southern India. [62] Use interaction and user centered design. The researchers use ethnographic and field study types of design process. Drawings were collected from illiterate persons, which are used in the development of a prototype that aims at giving a concrete answer to the research question.

Schroder [64] making a completely Icon-based Menu in Mobile Devices to become true: A User-centered Design Approach for its Development is user-centered design. Their approach towards the problem was to collect drawings from 56 participants who made drawings representing functions used in mobile phones. Icons were later evaluated by a new set of users, by having them match icons with textual functions, and to describe with own words their understanding of a given icon to map peoples understanding of them. The paper [63] use user center design. In this paper, the researchers present two studies that provide preliminary answers to these questions. The researchers first investigated the usability of existing mobile payment services, through an ethnographic study involving 90 subjects in India, Kenya, the Philippines and South Africa. This was followed by a usability study with another 58 subjects in India, in which they compared non-literate and semi-literate subjects on three systems: text-based, spoken dialog (without text), and rich multimedia (also without text). Results confirm that non-text designs are strongly preferred over text-based designs and that while task completion rates are better for the rich multimedia UI, speed is faster and less assistance is required on the spoken dialog system.

2.6.3 Technology used

These sections discuss on the technology that has been used by the researchers to address the target communities and to test the prototype. Through that technology the users can easily interact with the system developed by different researchers. [27] , [61], [66] Use computer technology to deliver the application to the end user. [60] Use both computer and mobile phone. [26] , [59] , [65] [64] [63] Used mobile phone to deliver the application to the user.

2.6.4 Technology types

As we discuss in the literature review section, there are six types of contribution types in HCI [36]. Based on that we evaluate and describe the contribution of the related works. The first research [27] contributes artifact and empirical types of HCI. Also [26] contributes empirical contribution. [59] Contributes both empirical and methodological for the HCI communities and for others. [60] Contributes artifact. [61] Contributes artifact and empirical. [65] Contributes empirical and artifact. [66] Contributes Artifact and empirical. [62] Contributes methodological and empirical. [64] Contributes Artifact and empirical. [63] Contributes empirical.

2.6.5 Summary of research analysis and gaps

In the previous section we have discussed on the related works, which are based on designing UI for illiterate and semi-literate users. However, the above researchers have some drawbacks those are:

- ✚ Researchers didn't consider culture when developing the interface
- ✚ The interfaces are not clear enough and difficult to the users so that the users need human assistance.
- ✚ Many researchers use design an application, which is only deployed on computer for addressing the interface to the users. Rather they should use mobile so that the users can use the system as well as the interface everywhere and anytime.
- ✚ No researches have been held for illiterate pregnant women with reference to text free interface in the case of Ethiopia.

To generalize the concept of illiterate or semiliterate users may require specific, static interfaces, based on simple and repetitive actions. More researches are required to investigate whether or not a pictorial design could provide appropriate cues for the use. So with the goal of answering the research question, this researcher will design prototype mobile-based text free interface for illiterate and semi pregnant women.

CHAPTER THREE

USER INTERFACE DESIGN APPROACH(MODEL)

3.1 Overview

User Interface (UI) is the medium between the user and the system [67]. The intended UI should fit the needs of at least the target users; other non-targeted users might as well find UI attractive to use. Before designing the UI for the target audience, the designer should consider the demographic behavior of the target user such as age, sex, and occupation, level of education, religion, social class and income. Also when the designer thinking of designing UI for the target user they should consider the UI components [68]. Another aspect of designing for a target user is culture. Culture gives awareness of what to expect from the behavior of people in a certain country or region. In [67] Hofstede defines this behavior as the six dimensions of national culture, which helpful to design UI components with cultural dimensions based on this understanding, the study investigated on how to integrate UI components with cultural dimensions. This chapter basically deals about how user interface design approach(model) can be developed for semi(illiterate) pregnant women in particular. The approach(model) is based on the combination of the user interface component's which were designed basically from obtained information from the survey and the field work with the target users. The purpose of the approach(model) is to create a set of guidelines and choices, which define what an interface should contain and what kind of considerations should be made in order to comply as suitable for semi(illiterate)low-literacy users. The validation of the model consisted of building a prototype interface, and the user perception on the prototype is taken as to validate the effectiveness of the approach(model). The overall design of the approach were discusses on the next sections.

3.2 Target community/ context analysis

The development of the approach(model) consists of viewing and understanding the constraints and problem of the target users. And the researcher should consider the demographic characteristics of the target users. We based our research on illiterate and semiliterate pregnant women specially who are on prenatal stage. To gain access in to these communities we worked with a non-governmental health center called Ethiopian mercy health center, which is found in Addis abeba around kechene medhaniyalem. The reason we based our research on this center was the selected health center works primarily with women health especially on pregnancy and also all

staffs and target users was so cooperative. To get explicit knowledge and to gather information on maternal health especially on signs occurred during prenatal stages (first trimester, second trimester and third trimester until delivery) we interviewed the available health workers (Doctors, nurses, midwiferies). As our methodology is user centered or participatory design we also participate our target user on interview part and some tasks, the interview is illustrated on appendix C. To gain access to the problem of our target users, we use demographic variables such as age, sex and levels of education. For this study we select 16 female participants. We select female users because our study concerned specially on female health. During interview we asked them about their age and we analyzed it and showed it on graph below.

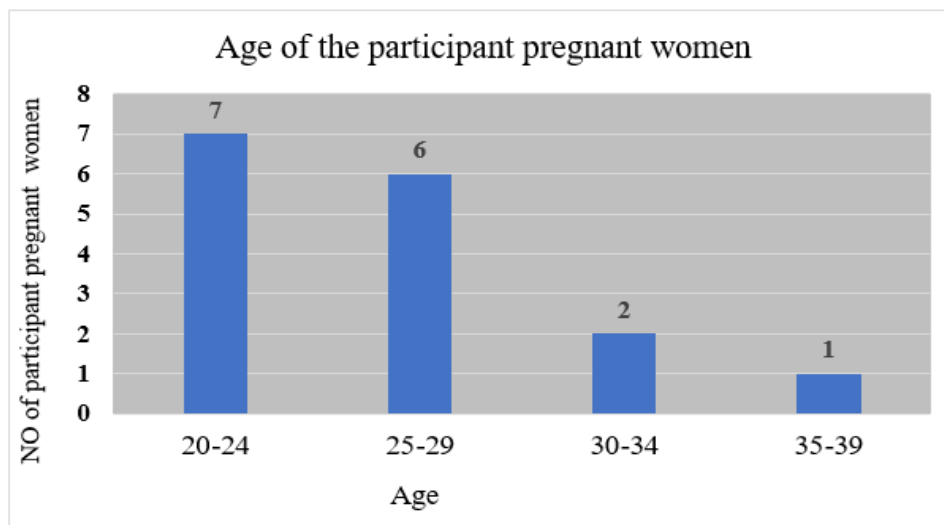


Figure 3-1 Age Distribution of participant target communities

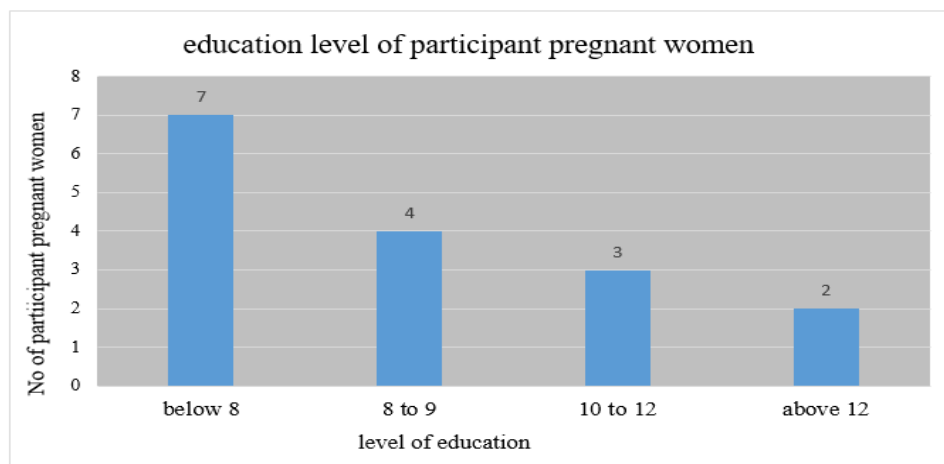


Figure 3-2 Education level of participant pregnant women

The second variable we selected was target user's education level. This survey helps us to consider the literacy level of the target users. As we described on figure 3-2 for this survey we selected 16 pregnant women. Before designing UI, we asked the users about their technology and textual literacy level. 7 of our participants are below 8 grade, 4 of our participant was 8 to 9 grade, 3 of our participants are 10 to 12 grade and 2 of our participants are above 12 grade.

According to their technology literacy level. We investigate the phone access of the women whether the mothers have the facility of phones to be able to use mobile applications and the type of phone that they use. 4 of our participants have smartphone and we observe they do have some applications on their mobile phones like games, social network applications. Other participants don't have smart phone we observe they have smadle and techno mobile phones. We also noticed one of our participants don't have a mobile phone.

On the survey session, after identifying the types of mobile phone the target user's use, we investigated how they use the interface and applications installed on their mobile phones. Some of the users told us that they have difficulties in understanding some icons, on navigating the interface and reading and understanding English and Amharic content. Also some of them told us they need some assistance to use their mobile phones. To better understand our target users, we investigated their textual literacy level. We asked our participants to read paragraphs written in Amharic and English language. 7 of our participants can't read English words and they took too much time to read the texts in Amharic. While reading the Amharic texts they were making some mistakes. 5 of our participants have difficulties of reading and understanding the paragraphs written in English but they can read and understand the Amharic texts. 2 of our participants can read and understand the paragraphs written in both languages; we observed, however, that they had some difficulties to understanding some words. 2 of our participants can read and understand the paragraphs. After identifying the written language literacy of the target users the next work of the researcher was designing metaphors for the approach(model).

3.3 User interface design elements

3.3.1 Metaphors

Metaphors are fundamental concepts that are communicated through different mediums such as words, images, sounds and tactile experiences. This element of the user interface helps users understand how to interact with the system using a known concept in the real world. The concept of a user-interface metaphor is very familiar in the field of human computer interaction, which can provide analogues from the user's real world that can be employed in the virtual world. Thus metaphors can be employed in the interface is to convey to the user instantaneously knowledge on how to interact with the interface.

Icons/images help users to memorize and recognize functions available within an application [69]. To be effective, an icon must fulfill several criteria, such as whether it is visible, legible, and comprehensible. As we discussed on the previous sections the domain area of our study is on pregnancy health especially on signs and danger signs occurred during prenatal stage of pregnancy. The first reason we choose this metaphor for UI design was the illiteracy problem of our target users. It's preferable to convert text-based interface to text free user interface. The second reason was the behavior of the domain area of our study, it is based on the signs which needs certain metaphorical description. For example, there has to be some icon or pictograms that describes signs nausea or vomiting. Unless there is something describe each signs the user can't interact with the interface easily.

3.3.1.1 Identifying design concepts: symptoms and danger signs

Identifying and categorizing design concepts allowed building easier graphical representation of non-literate and semi-literate users. We first extracted knowledge from health experts and the target users about the signs and danger signs, which can occur during prenatal stages. We divide the target users on three parts: women on first, second and third trimester stages. To categorize signs based on the three trimesters stages; we took survey on participating our target users in affinity diagram task. An affinity diagram is a hierarchical representation of the user data that is built from the bottom up see figure 3-5. The reason we participate the target users on the affinity diagram task was to get more information about the signs and to make the participants arrange and categorize the signs based on the three trimester's stages.

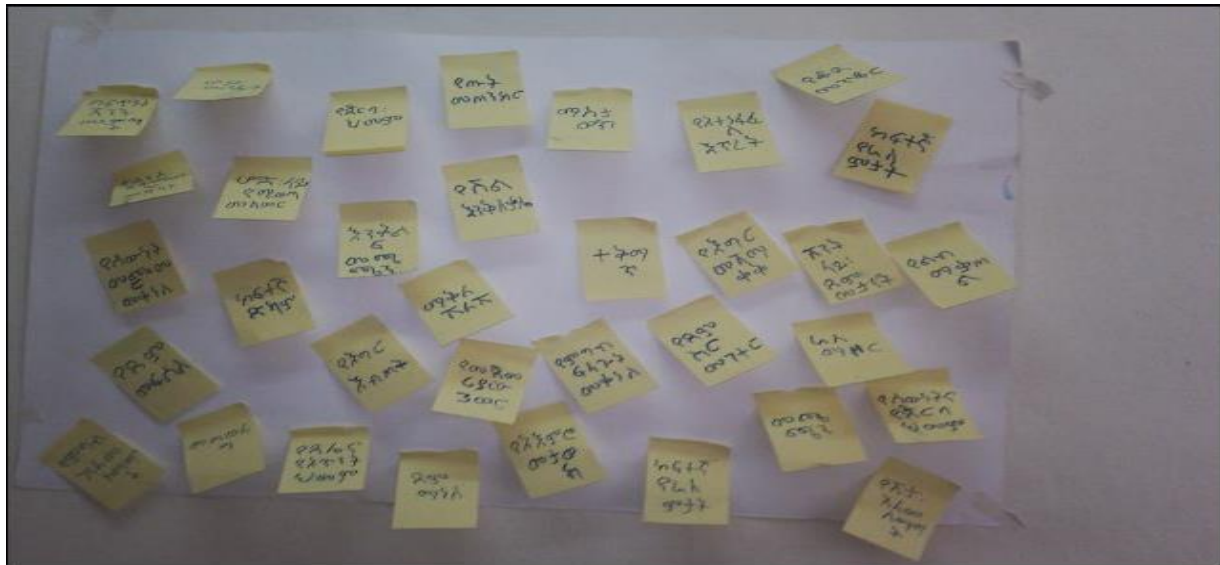


Figure 3-3 affinity diagram: list of signs and dangers signs

As depicted in figure 3-3 we had a list of 34 signs including dangers signs. We guide the users on selecting the signs occurred on them and put it in to the appropriate trimesters stages (first- 1 to 12 weeks, second- 13 to 27, third- 28 to until delivery) of pregnancy see figure 3-4.



Figure 3-4 sample affinity diagram from participants

After finishing the task. All participants categorize signs occurred during their trimesters stages.

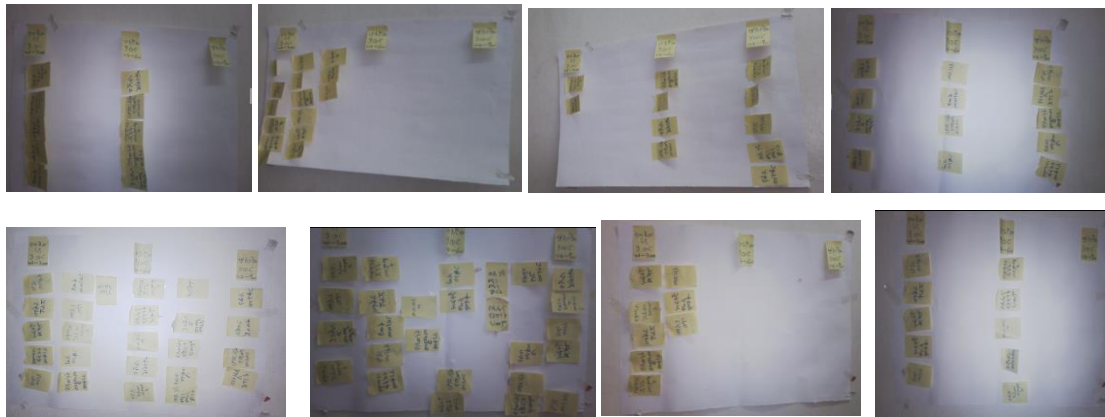


Figure 3-5 sample affinity diagram from participants

3.3.1.2 Designing metaphors (understandable icons)

Once all the necessary danger signs were identified and classified into groups, the next task was mapping signs/terms in to corresponding icons and pictograms. Also, the arrangement of the affinity diagram directly converted in to menus. Although, designing icons or pictograms were sometimes challenging, therefore; we identified and use some of already made icons and pictograms. To investigate the metaphorical choice of our target user, we show them a list of printed icons (home icons, pregnancy icons, next icons, previous icons microphone icon and stop icon and numbers icons) and printed pictograms (which was easily to describe the signs and danger sign). From the list they choose the icons which give them sense). Similarly, they choose a pictogram, which gave them a sense to be used as a menu list in the UI design (see appendix A). We finally map terms/signs in to icons/pictograms in order to investigate user's mental model through design UI.

3.3.2 Mental model

To design the UI or developing application for the target user, mental model is the basic object. If the designing of the interface correctly mirrors the user mental, the interface can easy to use for users. A mental model is the means whereby humans are able to generate descriptions of system purpose and form, as well as how the system functions and predictions of future system interface and functionality [34].

To study the mental model of the target users we participate them on different tasks and roles. As we discussed on the metaphor section, users were asked to arrange the list of signs/terms in to the corresponding trimesters stages using affinity diagram technique. The reason we participate them on affinity diagramming task was to identify their understanding towards the domain area and to investigate how they group/arrange those signs/terms to be used as menu list on UI design.

After identifying the possible already made icons and pictograms based on the signs/terms, which was arranged on the affinity diagram. We participate users on the task of choosing the corresponding icons and pictograms that better describes the signs/terms based on their understanding and needs. For example; there was a number of already made icons which describes next and previous signs/terms, each icons describes the two signs in a different way. Besides, target users level of understanding the icons and there meaning was diverse. Therefore, the user task was needed on choosing icons according to their understanding. Also there was different pictograms which describes the signs “headache” or “nausea” thus, the target users again need to choose better pictograms which describe the signs based on their understanding. Our tasks were analyzing the icons/pictograms, which was repeatedly selected by the target users’.

For better investigation and for further understanding of the target users mental model, we hold paper prototype and mockup see figure 3-6 during the prototype section we examine how the users arranging the icons in appropriate arrangements. This was done through paper prototyping with a list of 43 UI pictograms /icons which were disseminated over a total of 4 pages on the mobile phone which include the first page screen which is the home page of the interface, second screen contains four items; there were 16 icons for the first trimester’s stages, 13 icons for the second trimester’s stages, 15 icons for the third trimester’s stages and 9 icons for the danger signs. And the finale screen which contains the audio content. There were redundant icons on the three trimester’s screens because on the survey, we noticed that some signs occurred in all three trimesters’ so we add those signs on each pages.



Figure 3-6 paper prototype and mockup

3.3.3 Interaction

Mobile phone interaction is nowadays part of everyday human behavior and an activity that involves speaking, listening, touching and performing other tasks, in order to communicate. In addition, iconic interfaces are especially important for novice users who use interactive systems only infrequently [69]. Since metaphors such as graphical, icons or pictograms and sounds are essential elements for illiterate and semiliterate users device interaction, The basic assumption is that visual icons and sounds are capable of transcending language barriers and of presenting, meaning in condensed form [70], [71].

As the domain area of this study is on pregnancy health specially on signs and danger occurred during prenatal stages. There is enough knowledge which can be extracted from the health works: doctors, nurses and midwives. Therefore, no need of extracting /inputting information from the user reference to the domain area. The only thing we do is feeding/outputting information and knowledge for the target users. Therefore; we based our design on one-way interaction. Every signs and danger signs have the same meaning across culture which means the sign “headack” has same meaning on first trimester stage mothers in Ethiopia and first trimester stage mothers in USA.

Therefore, to localize the signs we use the proper icons on behalf which are selected by the users themselves. The only mechanism that the user use for getting the feedback or the knowledge from the system is by interacting the icons which is arranged in menus. The user will interact the icons until she reached to the final interface which contains Amharic audio feedback. At the final interface the user can also interact the icon which contains the knowledge, in our case the user should interact the “microphone” icon for listening the content and whenever she wants she can end the audio feedback by interacting “finger” icons.

3.3.4 Navigation

Proper navigation plays a vital role. Navigation involves movement through the mental models through content and tools. Examples of navigation are menus, dialogue boxes, control panels, icons etc. that enable this movement [29]. After identifying the possible icons and pictograms, we explored two types of navigational structure to make it suitable for the target users. This was done because displaying all items once on a mobile phone screen is not preferable like desktop screen because mobile phone screen space is limited. Therefore, navigation on different screen is needed. Designing navigation require understanding the mental models of the target users. For identifying the needs of our target users we designed prototype for Each navigation type. The prototype allowed the user to select list of pregnancy signs and danger signs. As we discuss on the previous sections, the users were arranged signs/danger signs in two menus which is listed on the affinity diagram see figure 3-4,3-5. The user follows a particular sequence of steps determined by the designer of the application. In linear navigation it is possible to return to the beginning (or main page of the application) from any step in the sequence. At the end of the sequence, the user is automatically taken back to the beginning. The second prototype the users investigate was based on Hierarchical navigation. This type of navigation allows users to go down different paths to finish subtasks from the main page, follow the same steps backwards to get back to a previous screen and then down another path for a different subtask. The prototype contains 4 screens: the first screen contains the home page, the second screen contains three trimester’s signs and danger sign and when the user clicked any button from the list it will navigate the user in to the next screens and the third screen contains the list of signs and danger signs for each trimesters and the fourth screen contains the final content of the interface.

In the linear prototype the user chooses signs, which are categorized on subsequent pages until they reach the target item page. When the user click the button found in the last screen it will navigate back the user in to the home page. In hierarchical prototype interactive icon can push and pop to the next and the previous screen. This navigation also did not need to return the user to the main page. We help the users on exploring the navigation structures. We have made the users to investigates the two navigation structures on computer. We deployed the prototype on our hp 32bit computer.

There were 8 participant women's who was on their first, second and third trimester stage. three of them was on their first trimester, two of them was on second and three of them was on their third trimesters. As the target users are more written language and technology illiterates. Most of them didn't know how to use computer. From eight participants we notice that five of them was delayed and very illiterate to use the computer. Two of them was need less assistance compared to the other. One of them was very illiterate to open and use the computer but still she needs our help on testing the prototype. We analyzed that the linear navigation was easiest task than the hierarchical for illiterates however; as deep the root or the depth of the screen, the user be unable to remember the path. Due to this they made errors than the hierarchical navigation.

Also The semiliterate users support the hierarchical navigation. The drawback of linear navigation as they described for us is, due to absence of next and previous icons on each screen, the user can't choose icon other than the selected one until they navigate back to the home page.

During the survey and evaluation session low-literate and semiliterate users were very interactive and good on trying new things. However, we analyzed that users have better performance in hierarchical than linear navigation. Additionally, as the layout of our design is menu based its preferable to use hierarchical navigation structured on the design.

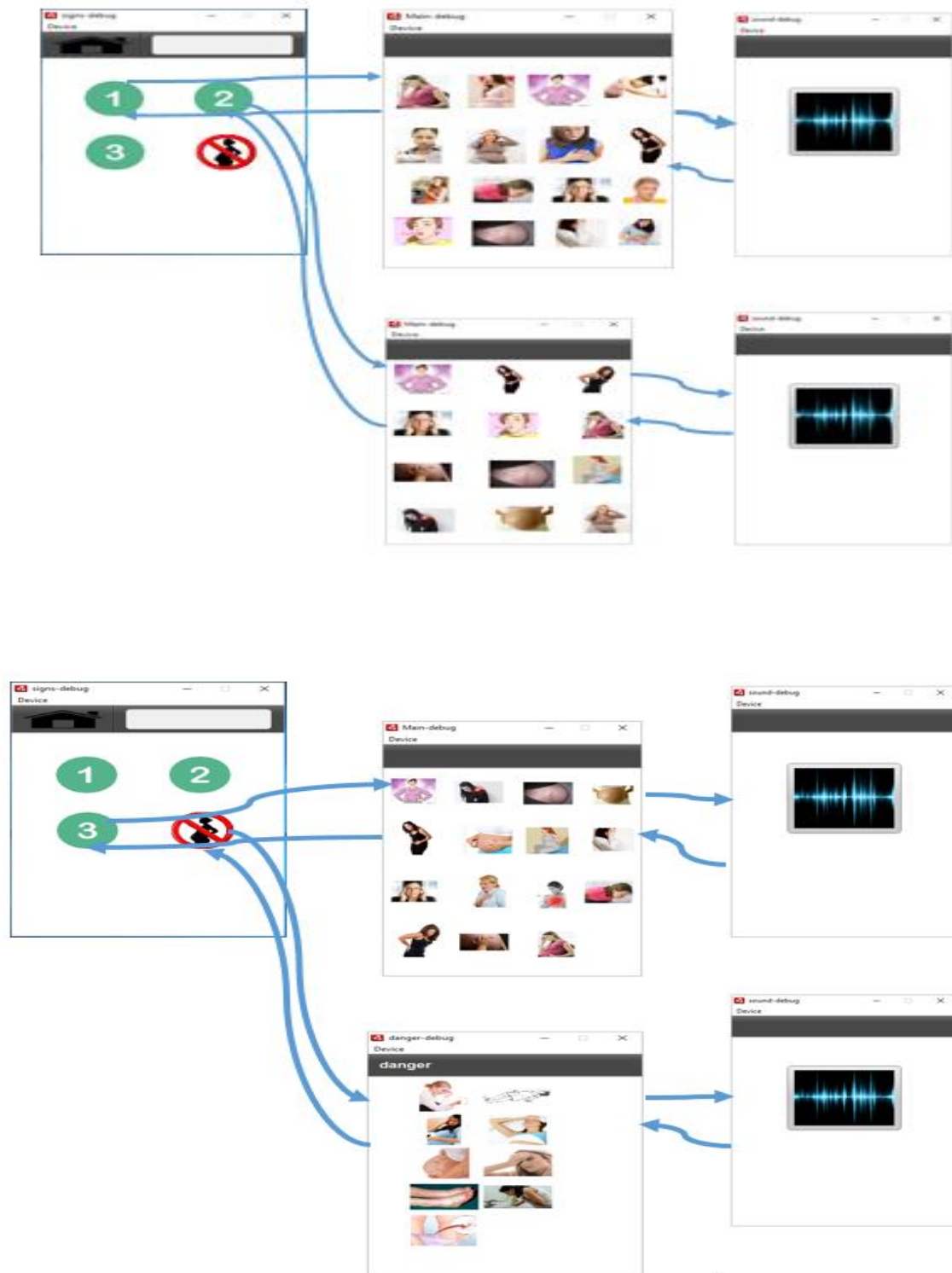


Figure 3-7 screen shots from navigational structure prototypes to select a sign and danger sign

3.3.5 Appearance

As we discuss above in designing UI the color choice should consider the users mental model. And also color is an important part of cultural design. All the attraction of the interface comes from the combination for constructing color theme. To this end to make the UI more user centered we add some aspect of culture. The understandability of Colors varies across culture [72].

We develop the interface using adobe flash builder 4.6. We use default adobe flash theme called spark. For editing the background of the interface we use red and green color. We get the two colors describe the domain area of our research more, for example for the home, second and signs pages we use green color because green color in Ethiopia means fertility. And for the screen which contains the list danger signs we use red color also red color in Ethiopia means danger, blood [73] [72]. Therefore, use of color in interface design may have a greater impact on the user's satisfaction and expectations. The target users have diversified color choice, due to this we can't fulfill their need. However, we add cultural aspect on the appearance.

3.4 Cultural issue towards user interface design

Hofstede's dimensions of culture clearly demonstrate that the existence of culture difference among different country. [46] defined culture with the five cultural dimensions: Power Distance Index, Individualism Vs Collectivism, Masculinity vs Feminine, Uncertainty Avoidance, and Long Term Orientation (LTO). Each of these dimensions is indicated with a score from zero to over 100. According to Hofstede's cultural model Ethiopia, this study adopted it for design UI as shown in figure 3-8.

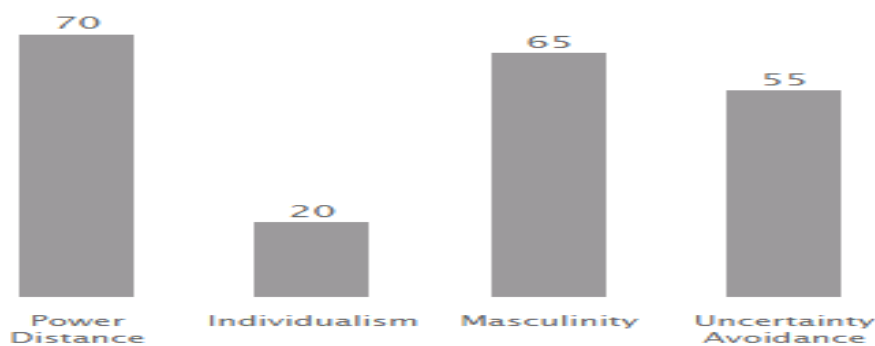


Figure 3-8 Ethiopian subjective Culture, quantitative measurements

As seen in figure 3-8, Ethiopia has a strong hierarchical structure (70), which means that people accept a hierarchical order in which everybody has a place and which needs no further justification. There exists hierarchical structure in both navigation as role of people, symbolism and symmetry. This means the hierarchical life styles relate our design with hierarchical navigation structure.

Ethiopia has highly collectivist (80) than individualism (20), which means there is strong relationship between the societies. With respect to masculine and feminism Ethiopia is a high Masculine society (65). High masculinity cultures place importance on traditional gender, family and age distinctions. Ethiopia received an intermediate score of 55 on this dimension of high uncertainty avoidance, which means high uncertainty avoidance cultures are more emotional, and control changes with rules, laws and regulations. This ambiguity brings with it anxiety and different cultures have learnt to deal with this anxiety in different ways.

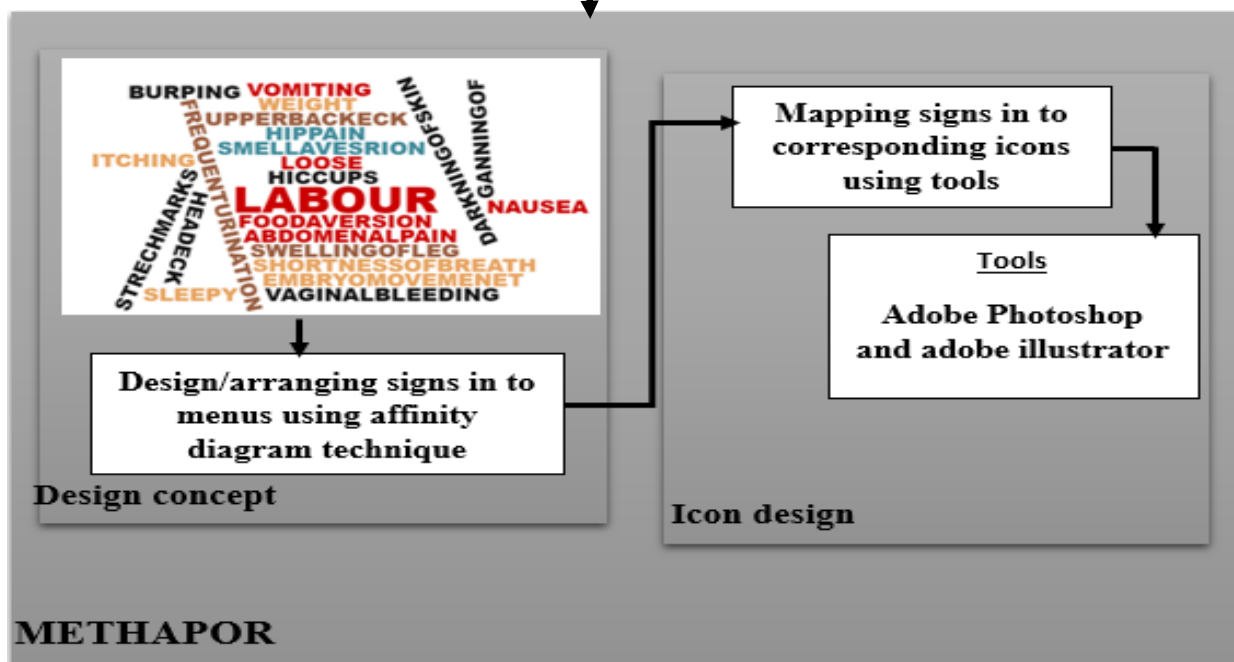
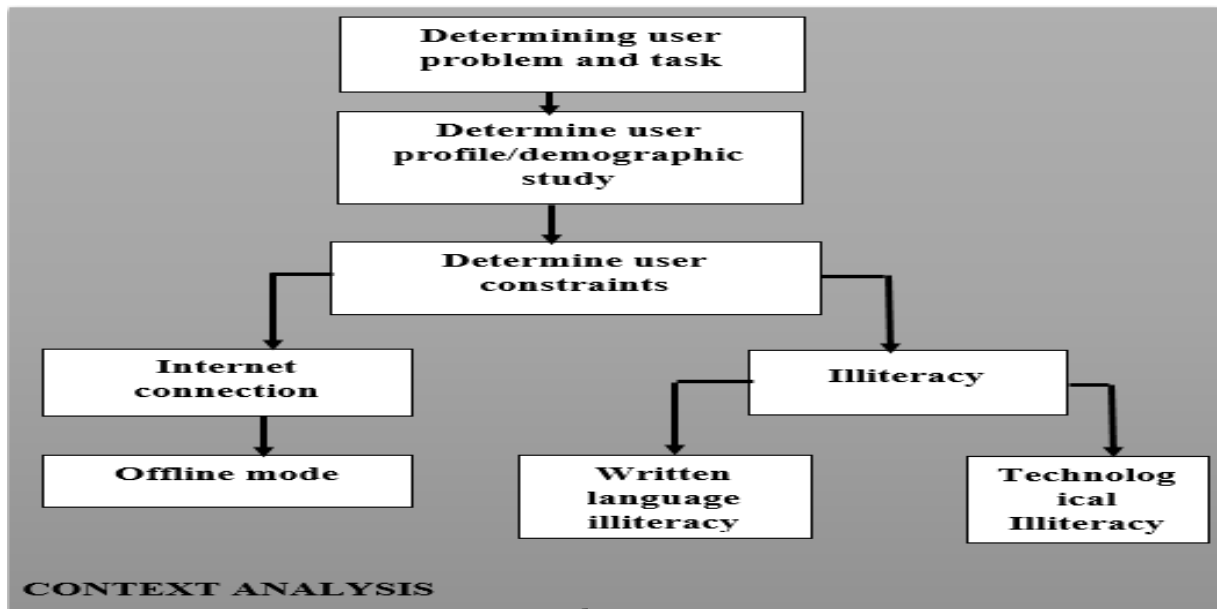
The general score indicates that Ethiopia has high power distance, high masculine, collectivism and high uncertainty avoidance cultures. This result indicates that designing a common user interface for all people in the world is not a usable approach, which in turn demand on ways on how to integrate culture into the design issues. After understanding and knowing the Ethiopian Subjective Cultural score; we perform the recommendations of user interface guidelines which were adapted from [74] incorporating culture in to our UI design process.

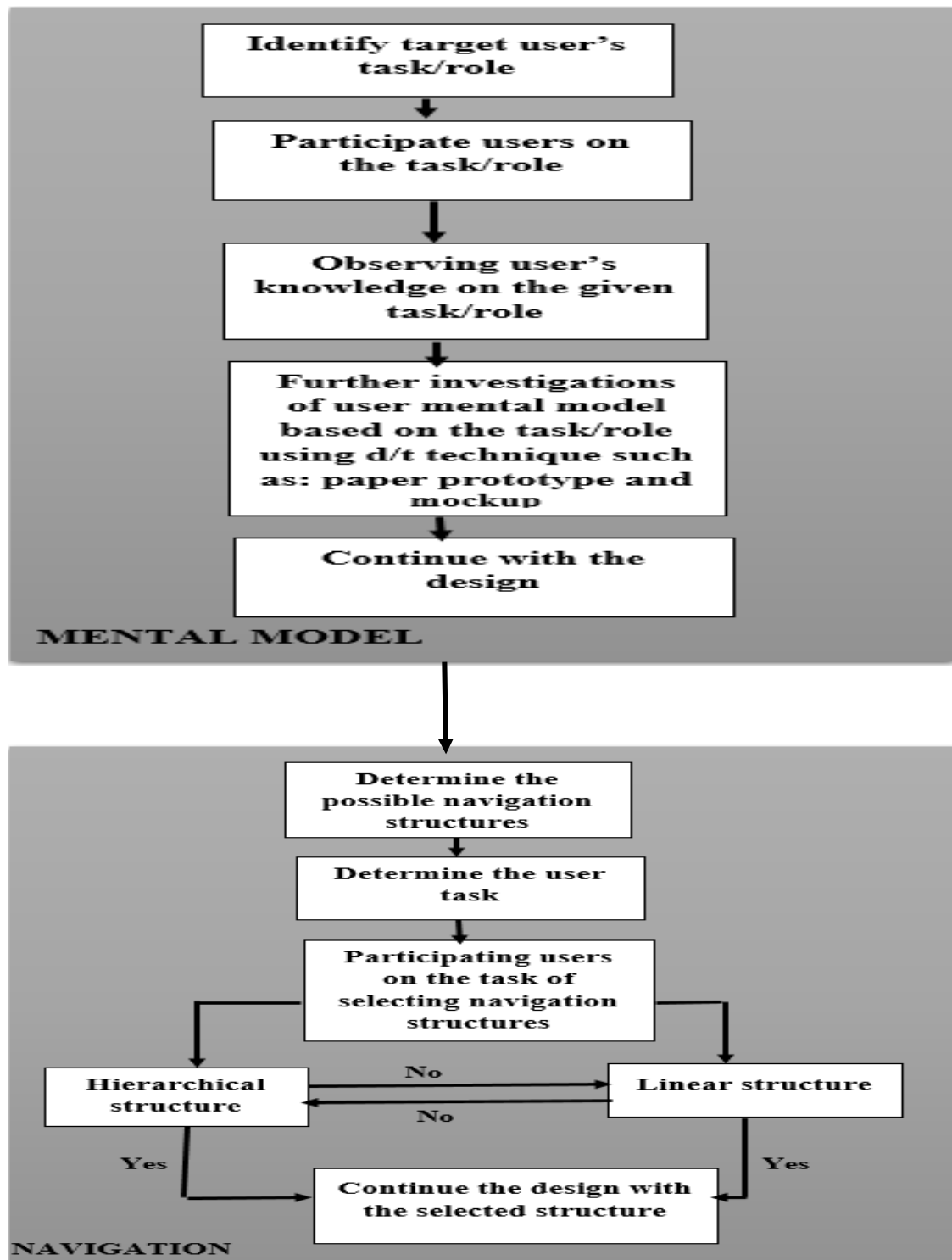
Table 3-1 summer of UI components with their characteristics

Culture and illiteracy features	UI component's				
	Mental model	Metaphor	Interaction	Navigation	Appearance
Clear and tidy	✓				✓
Amharic language			✓		
Menu based layout			✓		
Tile group layout			✓		
Icons		✓			
Amharic audio messages			✓		
Interactive buttons			✓		
Red/green colors					✓
Linear structure				✓	
Clear hierarchy	✓			✓	
Limited choice/option				✓	
Role/task oriented	✓				
Simple and clear articulation	✓				
Limited controls	✓			✓	

Sound		✓			✓
User oriented	✓				
	✓				

Table 3-1 summarize UI components and their characteristics which we use them for designing the interface. We got those characteristics from the target users. As we discussed above Ethiopia scores high power distance, high uncertainty avoidance, masculine, collectivism cultural dimensions. Also [51] describes the designs principles for the Hofstede cultural dimensions. We also adopt designs principles of [51] for designing the UI with cultural concept. Finally, we design a model which can use to design application for illiterate and semiliterate target users based on the needs of the target user and based on culture.





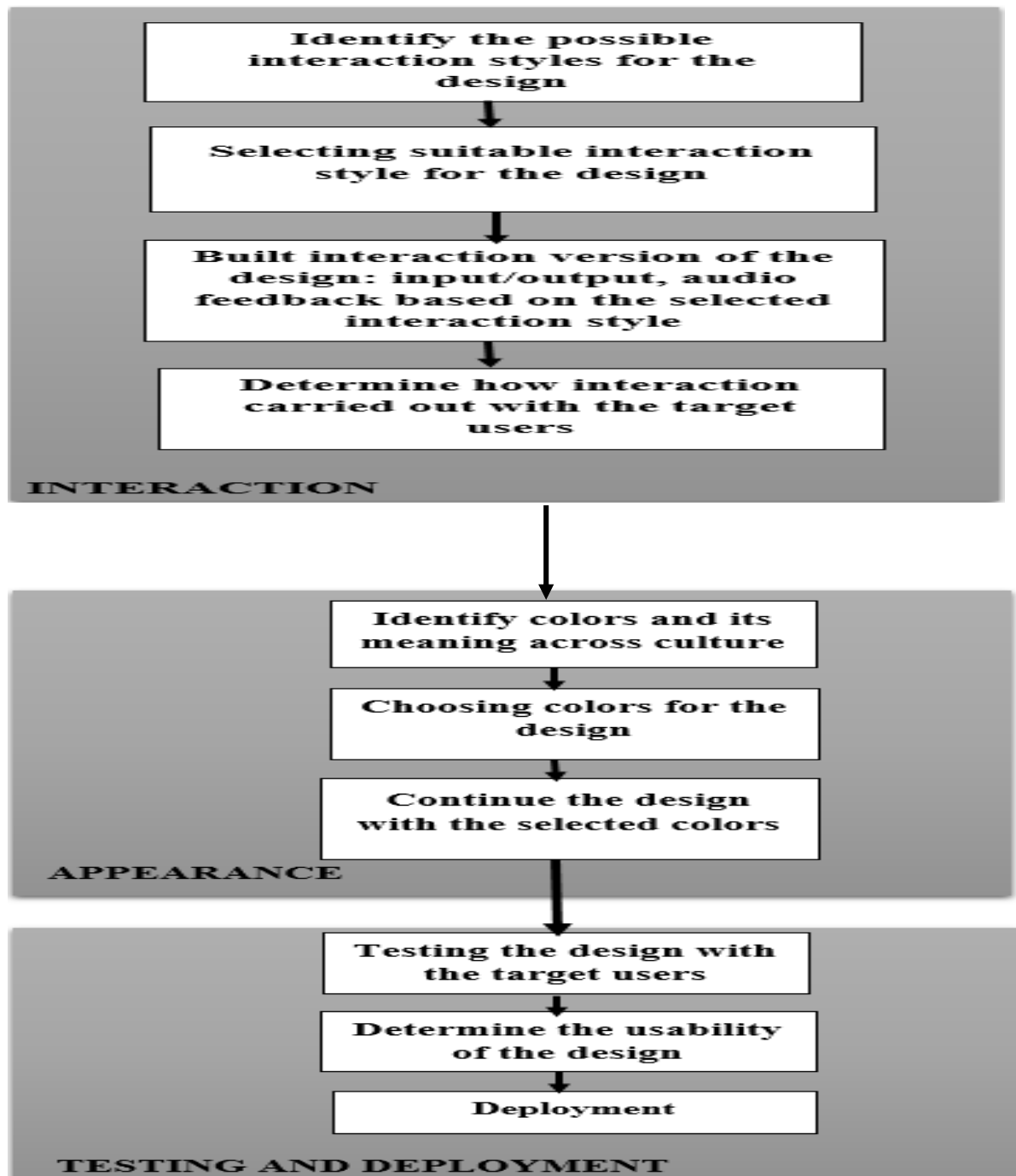


Figure 3-9 Visual model of the design

Figure 3-9 describes the visual model that contains guideline for designing application for illiterate and semiliterate users. Specifically, a model contains a guideline which shows away to design UI component's according to the need of the target users and culture. All components are interrelated to each other. Which means the problem of one component can get a solution with another component. This model guides how each user components 'connected to each other and shows the flow information b/n the user component's through designing the application. The finale process is testing. The target users finally test the prototype, which is developed based on the visual model. As we discussed on the problem statement there is no guideline or an approach that help developers on developing a text free mobile application which feet's a certain target user. The basic indication of the approach is on designing the user centric design. The evaluation will be discussed on chapter 5.

CHAPTER FOUR

PROTOTYPING IMPLEMENTATION

4.1 Overview

This chapter describes the implementation of text free UI for illiterate and semiliterate users based on the model we design. We use the model as guideline for the implementation. As discussed in chapter 3, there are five UI components: mental model, metaphor, interaction, navigation and appearance. We design the model based UI components, which consider the target user and culture. The following sections describe the detail implementation of the mobile app based on the model.

4.2 Tools used for design and implementation

For the implementation part we use adobe flash builder 4.6 which is an integrated development environment (IDE) for building cross-platform, rich Internet applications (RIAs) for the desktop and a wide variety of mobile devices. It also includes testing, debugging, and profiling tools that lead to increased levels of productivity and effectiveness. Flash Builder runs on Microsoft Windows and Apple Mac OS X, and is available in several versions. Installation configuration options let you install Flash Builder as a set of plug-ins in an existing Eclipse workbench installation or create a stand-alone installation that includes the Eclipse workbench.

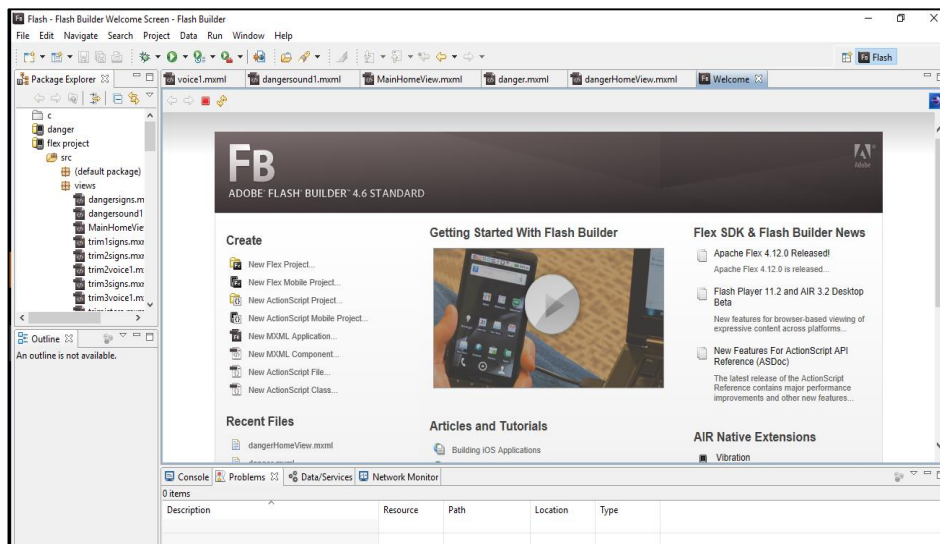


Figure 4-1 snip shoot of implementation tool environment

4.3 Description of interfaces: selected screen shots

The mobile phone prototype is based on a touch screen mobile phone, which is a text free interface. All buttons, images and icons are symbols telling the user what to do. The whole implementation and design of the mobile user interface is based on the perception of the approach(model). As the design of the application is based on user centric process the approach was designed based on the knowledge and the mental model of the target users. The finale content is voice based recorded message or advice, which tell them what to do on the signs and the danger signs. As interface is based on hierarchical navigation there are next and previous buttons which is depicted by finger icons on each screen. This ensures that users can push and pop to the next and previous screens mistake is. The detail description of the interface will be discussed below



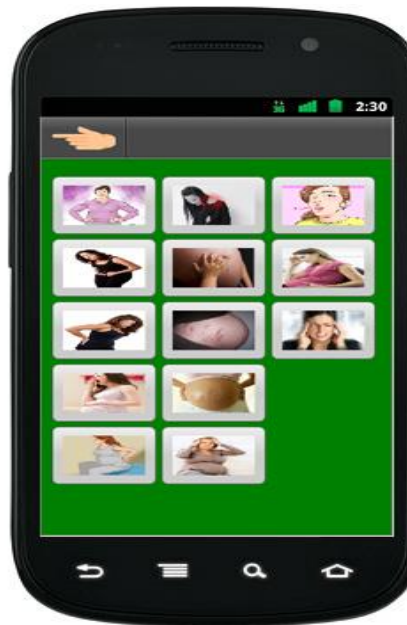
Figure 4-2 interface page 1&2: The well come screen (left) list of trimesters stages and danger signs (right)

Interface page1: the first page allows a user to enter in to the whole page. The finger icon represents the next button it will navigate the user to the next page (trimester's page). When the user presses the next button it will make her navigate to the next page.

Interface page 2: this page consists of four different tasks. Number one, number two and number three icon represent the three trimesters occurred during prenatal pregnancy stages. The fourth icon indicates the danger signs occurred during the three trimester stages. Each icon which we used on the second interface was chooses by the target users. The overall process was illustrated on chapter 3 specifically on designing metaphor section. Whenever the user wants to get the advice about any signs occurred during the three trimesters they can press the three button, the button direct the user in to signs interface. Also when the user press the danger sign icon it will direct her to the next page which contain the list of danger signs occur during the three trimester stages. The finger icon represents the previous button it will direct the user in to the previous page (home page).



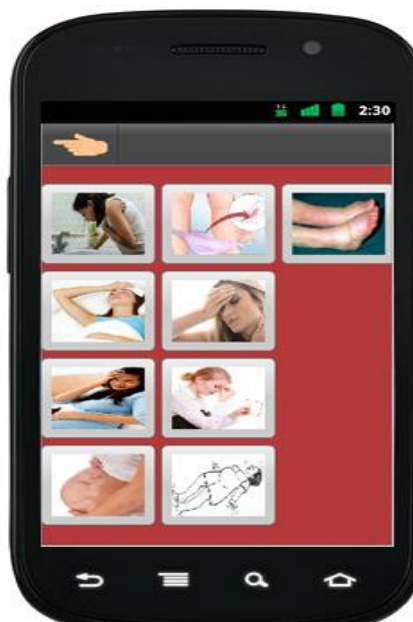
(A) First trimester stage signs



(B) second trimester stage signs



(C) third trimester stage signs



(D) danger signs

Figure 4-3 interface page 3: list of first, second, third trimesters signs and danger signs screens

Interface page 3: this page consists list of first, second, third and danger signs. Those pages appear when the users press the buttons found in the second page. The user can select any signs from the list based on the signs occurred on her. After selecting any of the signs it will direct her to the finale page, which consists the voice content. The user can use the previous icon to navigate back to the previous page.



Figure 4-4 Interface page4: voice content screen for 1, 2, 3 trimesters stage danger signs

Interface page4: this page is the final page of the applications interface. It is consisting the recording audio content. This content contains Amharic audio which is about the treatments that the users should do during the prenatal stage with reference to the signs and danger signs. The voices are recorded by the researcher. The two icons (microphone and finger) represent the play and stop button. The user can press the play button whenever she wants to listen the content. And she can press stop button whenever she wants end the voice. The user can use the previous button to return back to the previous page.

CHAPTER FIVE

EVALUATION AND USER FEEDBACK

5.1 Evaluation procedure overview

After developing text free user interface approach (model) for the target users, the next step was developing prototype which is based on the approach. After the prototype of the text free user interface for (semi)literate prenatal stage women in particular using adobe flash builder 4.6, the prototype is evaluated to ensure it meets the user's requirements and needs. The sections below deal with the description about technology acceptance model and its types. The second section deals with questioner in TAM, respondent selection process and respondents' demographical characteristics is also described. the user satisfaction and discussion is illustrated in this chapter.

5.2 Technology accepted model: TAM

User acceptance broadly refers to an individual's psychological state with regard to his or her voluntary and intended use of a technology [75]. Users' acceptance to information systems had been studied extensively in order to determine the elements that influence the decision to use these systems. Researchers tried to determine the behavioral factors that influence an individual's decision to accept or reject a technology. [76] presented The Technology Acceptance Model (TAM) theory that models how users come to accept and use a technology. The theory states that an individual's behavior intention to use a system is determined by his or her perceived usefulness and perceived ease of use of that system. The goal of TAM is to predict information system acceptance and diagnose design problems before users have experience with a system. The model is shown in figure 5-1

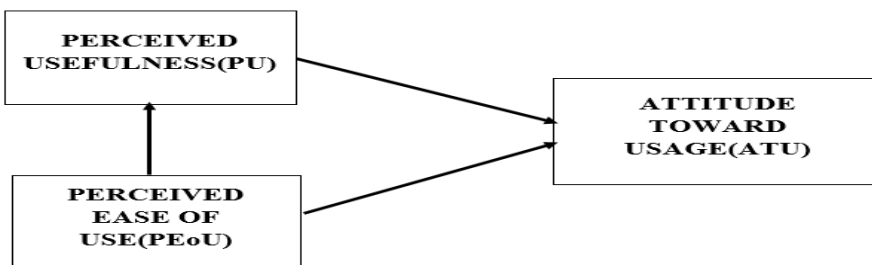


Figure 5-1Technology Acceptance Model-Source: [75]

A. Perceived usefulness (PU)

Davis [76] defines perceived usefulness as the degree to which an individual believes that using a particular technology would enhance his job performance. In TAM, perceived usefulness becomes one of two keys to measure attitude influence to the new technology. PU in the model includes the perceived usefulness of content and value of the mobile system. This measures how users perceived that the information and contents provided by the system are useful and suitable to the task and whether using the system is time and money saving.

B. Perceived ease of use(PEoU)

Davis [76] defines perceived ease of use as "the degree to which a person believes that using a particular system would be free from effort "Perceived ease of use also affects the perceived usefulness see figure 5-1. PEoU has strong influence on intention to technology acceptance. If one technology perceived ease to use, one will make it as new alternative to use. Based on previous research on TAM, PEoU was found has indirect effect on attitude intention but the effect much more on indirect mediation factor from PU.

At first perceived ease of use is based on external factors such as the user's attitude towards technology in general, experiences of using similar services and information from other people. In actual use and sustained use, perceived ease of use is increasingly affected by the user's own experiences of using the system in different contexts of use. Ease of use refers to the user's belief that the technology in question is difficult to use. Specifically, it is the evaluation of the degree to which using the technology is free of effort.

C. Attitude toward using (ATU)

ATU was defined as consumer intention to act in certain way in order to obtain, dispose and use product or service. It is an extent to which people has formulated a plan to do or not to do some attitude in the future. In information system application, TAM has been used successfully by many researchers to predict

5.2.1 Questionnaire used in TAM

To evaluate the M-Health application and get the user perception on the system, we used technology acceptance model questionnaire. TAM is used to investigate the user acceptance of

mobile technology application within healthcare industry. The related constructs for evaluation are: Perceived of Usefulness, Perceived Ease of Use and attitude towards usage. All of these have a number of questions constructed to evaluate the effectiveness of the system. Respondents were asked to rate their opinion using a 4-point scale ranging from 1=disagree, 2=Neutral, 3=agree and 4=strongly agree. The mean Values and the standard deviation were calculated for each of the factors included in the model.

5.2.2 Respondent selection process

The respondents were chosen from Ethiopian mercy non-governmental health center. As the system is for supporting pregnant women's, we randomly select 10 participants who are on first, second and third trimesters stages. Most of the participants were illiterates so we converted the questionnaire into Amharic language. Each of the participants was asked to use the prototype of the mobile system and fill in the questionnaire.

5.2.3 No of respondents' and demographic characteristics

10 respondents from the target communities were selected for the evaluation. All participants were illiterates and semiliterate. For understanding the respondent's demographic characteristics such as: age and level of education were selected. The characteristics are described in figure 5-2, 5-3 below.

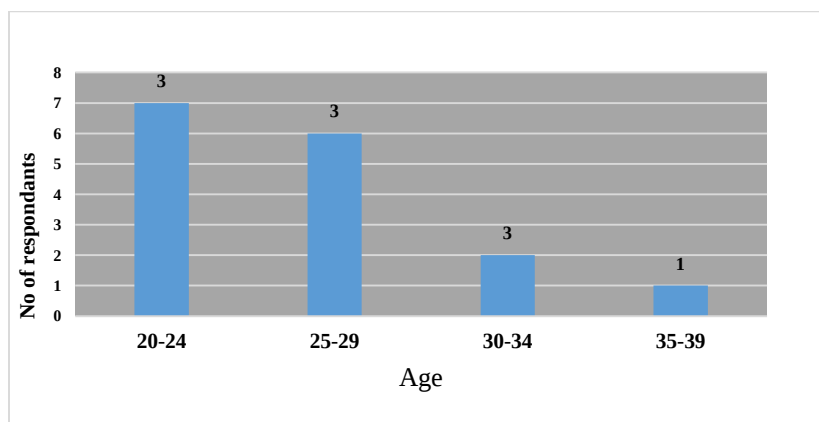


Figure 5-2 Age of the respondents

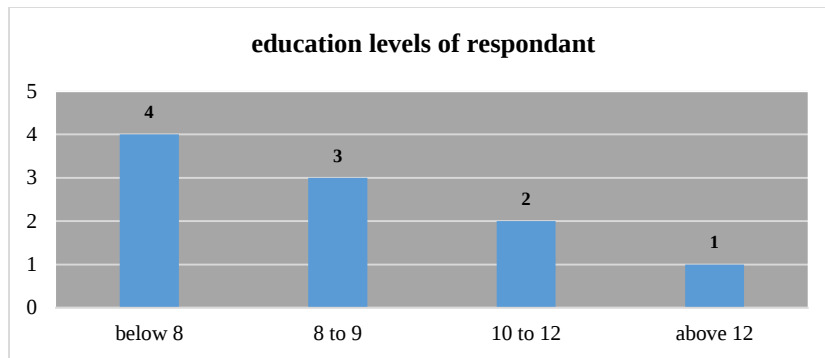


Figure 5-3 Education level of respondents

5.3 User satisfaction

The system should meet the user need and requirements. The aim of taking user perception testing was to make sure how comfortable and acceptable the system for the target users during the consumption of the content and the interaction with the system. furthermore; to investigate how the system is accepted and usable by the user. As mention above 10 mothers who are on prenatal stages were selected to test the application. The users fill the forms based on the questions listed on the questionnaire. Based on their response we measure mean scores of participants' perception of the system. the result confirmed that the users score more on attitude toward usage, which means they are more willing and interested on using the M-Health system. the users score average on perceived ease of use, even thought, illiteracy is constraints for them to use the technology; they consider using the application will give them a benefit of getting the advices about their health. the list score we got from the questioners was the score of perceived ease of use.as the users was more illiterate to use the technology they face difficulties on interacting the application, moreover, we observed they will perform more if they get training on using the system.

Table 5-1 mean score of participant' perception of the system

Mean Scores of Participants' Perception of the System (1=Disagree 2= Neutral 3= Agree 4= Strongly agree)			
Results	Perceived Ease of Use (PEU)	Perceived Usefulness (PU)	Attitude Toward Usage (ATU)
Mean value	2.83	2.6	3.1

SD	2.52	3.70	6.48
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5.4 Discussion

Table 5-2 the overall result of user perception on the system

	1=Disagree	2= Neutral	3= Agree	4= Strongly agree
Perceived Usefulness(PU)				
Using M-Health in my pregnancy time would enable me to better informed more quickly	2	2	3	3
Using M-Health would improve access to health service performance	1	2	5	2
I would find M-Health useful for preparing me for exam	2	3	3	2
<u>total</u>	5	7	11	7
Perceived Ease of Use(PEoU)				
It is easy to use the M-health system with few training	2	2	4	2
I feel that using M-Health system would be easy for me	3	3	3	1
I feel that my interaction with M-Health is clear and understandable	2	2	3	3
I feel that it would be easy to become skillful at using M-Health	2	2	4	2
it would be easy for me to get M-Health to do what I want to get advice	2	2	3	3
<u>total</u>	11	11	17	11
Attitude Toward Usage (ATU)				

I believe it is a good idea to use a M-health system for Health service	0	1	4	5
I like the idea of using a M-Health system	1	2	3	4
I will use a M-Health system in the future	1	2	4	3
Assuming that I have access to an M-Health system I intend to use it	1	1	4	4
<u>total</u>	3	6	15	16
<u>Over all total</u>	19	24	43	34

The overall affective evaluation by an end-user of their experience with a system; generally measured with a Likert scale. Respondents were asked to rate their opinion using a 4-point Likert scale ranging from 1=disagree, 2=Neutral, 3=agree and 4=strongly agree. The values indicate numbers of evaluator who evaluated the system as disagree, neutral, agree and strongly agree with respect to evaluation criteria.

As table 5-2 showed from the perceived usefulness, specifically on **Using M-Health in my pregnancy time would enable me to better informed more quickly(PU2)** 2 evaluators disagree. similarly, 2 numbers of respondents were neutral for it. this is due to the depth/ the root of the system to get the audio content. With respect to the second question, which is **Using M-Health would improve access to health service performance(PU2)**, 1 respondents' disagree,2 respondents 'were neutral,5 respondents 'agreed and 2 respondents' were strongly agree. This shows that more of the respondents believe that using the system would enhance health service performance. The third question is about **how the users would find M-Health useful for preparing me for exam(PU4)** based on that 2 respondents' disagreed, 3 respondents 'were neutral, similarly 3 respondents' agreed and 2 respondents' were strongly agreeing. From their response we can perceive that more number of users are agree in which the system help them on giving advice and giving alarm for them to prepare for further exam.

the second general evaluation criteria are Perceived Ease of Use(PEU): the first question which is contained PEU is **"It is easy to use the M-health system with few training"**, 2 respondents'

disagreed, similarly 2 respondents' were neutral also 4 respondents' agreed and 2 respondents' replied strongly agree. Their response shows more number of users can perform the system with few training. still third response shows that the system has weakness on simplicity. The second question is **"I feel that using M-Health system would be easy for me(PEU1)"** for this 3 respondents' replied disagree, similarly 3 respondents' replied neutral, 3 respondents' replied agree and 1 respondents' replied strongly agree this confirm that more number of users have difficulties on using the system without training. For the third question which says **"I feel that my interaction with M-Health is clear and understandable(PEU2)"** 2 respondents' replied disagree, similarly 2 respondents' answered neutral, 3 respondents' replied agree and also 3respondants replied strongly agree. Their response showed that the respondents' equally adore the system with respect to the interaction. It shows that the system centralizes their need and requirements. Equal number of respondents also disagrees with the system the system intractability. The fourth question is **"I feel that it would be easy to become skillful at using M-Health (PUE3)"** 2 respondents' responded disagree, also 2 respondents' responded neutral, 4 respondents' responded agree and 2 respondents' responded strongly agree. The general indication of their responses is about how the system is more flexible and learnability. We can't fail to recall the 2 respondents'' who disagree the fourth question and the 2 respondents' who responses neutral. Generally, the system need to address all respondents'. The fifth questions are **"it would be easy for me to get M-Health to do what I want to get advice (PEU5)"** for this question 2 respondents' answered disagree, similarly 2 respondents' answered neutral, 3 respondents' answered agree and 3 respondents' answered strongly agree. More of the respondents agree on the system giving advises this due to the localization of the interface and the audio feedback which is based on their local language. The third evaluation criteria are Attitude Toward Usage (ATU): the first question contained in the third criteria is **"I believe it is a good idea to use a M-health system for Health service (ATU1)"** for this no respondents' answered disagree, 1 respondents' answered neutral, 4 respondents' answered agree and 5 respondents' answered strongly agree. The overall analysis of responses showed that the target users desperately need a system which they can get anywhere any time on respect to their health. The second question is **"I like the idea of using a M-Health system(ATU2)"** **"1** respondent' answered disagree,2 respondents answered neutral, 3 respondent's answered agree and 3 respondents' answered strongly agree. The third question is **"I will use a M-Health system in the future (BIU1)"** for this 1 respondents answered disagree, 2 respondents'

answered neutral, 4 respondents answered agree and 3 respondents' answered strongly agree. The fourth question is "**Assuming that I have access to an M-Health system I intend to use it (BIU2)**" 1 respondents answered disagree, similarly 1 respondent answered neutral ,4 respondent answer agree and also 4 respondents' answered strongly agreed.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

In this study, the mobile application user interface approach(model) is developed. And with the use of the approach mobile application is design. Furthermore, this study probes the impact of human computer interaction on M-Health. The domain area of the study is pregnancy health specially providing support for mothers who are on the prenatal stage. Thus the target users were chosen from Ethiopian merci non-governmental health center, which is found in Addis Abeba city. To get access to the target user, user centered methodology was used for the study.

Mobile app was developed with respect to the target users' needs and requirements to make the app more user centered the culture of the target users' were explored. Localization interface for the target users were one part of the study. To this end the study integrates user interface components and Hofstede cultural dimension to design the approach/model.

To evaluate the M-Health application and get the user perception on the system, we used technology acceptance model. The general analysis of the evaluation shows the system is good for users. Some of the users have the difficulties of interacting with the users. It's observed that assistance is needed for the target users on using the system.

6.2 Recommendations

The designed prototype support illiterate and semiliterate pregnant users in particular on giving advices about signs and danger signs occurred during prenatal pregnancy stages. Hence the researcher believes further researches have to be done to improve the mobile application the following recommended for further study.

- To support the illiterate and semiliterate users on using technology voice assistance/help (support) should be added on the approach(model) for further design of interface for the application.
- The system is designed based on one-way interaction. The users only extracting knowledge from the system. They didn't input anything in to the system, for future two-way interaction

such as dialog system; question- answering system should be designed for the pregnant women in particular. Further work is needed on localizing the interface: by designing icons, which directly describe the sign and danger signs that is occurred on pregnant women in particular.

- The mobile phone operating system user interface and some of the mobile applications should have to be (replaced)changed with local icons so as to make them usable for illiterate people.

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APPENDIX A

icons and pictograms with their meaning

Icons and pictograms	Meaning
	Pregnancy icon which indicate the home screen
	The home icon which help the user to navigate back to the home page
	Numbers icon which indicate first, second and third trimesters
	Danger icon which describes danger signs
	Finger icons indicates next and previous buttons
 	finger icon indicates stop button and microphone icon indicates play button
	Pictogram that indicate headache sign
	Pictogram for dizziness
 	Pictograms that indicates Lower and upper abdominal pain sign
	Pictogram that indicates breast pain
	Pictogram that indicates burping sign
	Pictogram that indicates itching
 	Pictograms that indicates smell aversion and food aversion
	Pictogram that indicates heart burn
	Pictogram that indicates blurring of vision sign

	Pictogram for nausea sign
	Pictogram for stretchmark sign
	Pictogram for vomiting
	Pictogram for fever sign
	Pictogram for danger vomiting
	Pictogram for swelling of legs
	Pictogram for danger dizziness
	Pictogram for severe abdominal pain
	Pictogram for bleeding

APPENDIX B

Color and its meaning matrix

No	Terms/concepts/ Meaning	Color	Color Code
1	Danger, blood	Red	#B33A3A
2	Death	Black	#000000
3	Illness	Yellow	#ffff00
4	Fertility	Green	#008000

APPENDIX C

interview document

This document provides instructions for the interview of the master's research. The interview is about gaining an insight on opinions about mobile phone interfaces from the perspective of a person who lives in Ethiopia. Part of the interview is about the design of mobile phone. Part of the interview is about the design for a phone application that will advise illiterate and semiliterate pregnant women in Ethiopia, which has made according to a model that should make the usage of phone interfaces easier for illiterate users. This interview was held on Ethiopia mercy non-governmental health center in Addis abeba. We select 16 target users for the interview, survey session. All participants were female who are on their first, second and third trimesters pregnancy stages. The detail description of the interview question is listed below.

Questions

Introduction questions

1. What is your name?
2. What is your age?
3. What is your level of education (criteria: below 8 grade, grade 8 and 9, grade 10 to 12, above 12 grade)?

Questions about technology literacy

1. Do you have a mobile phone?
2. What kind of mobile phone you use?
3. Do you have application installed on your smartphone (for those who have smartphone only)?
4. How do you use your smartphone application and interface?
5. What are the challenge's you face when you use your mobile phones?

Questions concerning the navigation prototypes

1. How do you get the navigation prototypes?
2. What are the difficulties you face when you use the interface?
3. Which type of navigation structure (from hierarchical and linear) is easier and clear to you?

4. What are the critics you want to add on the two navigation structures?

Questions concerning selecting the icons and images

1. What do you think those list of icons represents?
2. What do you think those list of images represents?
3. Which icon is more clearly represent home?
4. Which icon is more clearly represent next?
5. Which icon is more clearly represent play and stop?
6. How do understand the images?
7. Which images clearly represent signs and danger signs?

APPENDIX D

Sample selected Message in Amharic

ይህ በእርግዝና ላይ ላሉ እናቶች የተዘጋጀ የድምጽ መርጃ አገልግሎት ነው

የመጀመሪያው ሶስት ወር ላይ የሚከሰቱ ምልክቶችና መደረግ ያለባቸው ጥንቃቄዎች

1. ከፍተኛ ድካም

ከፍተኛ ድካም ካጋጠመት እባክዎ ፕሯናታል ቫይታሚን ይውሰዱ፣ጤናማና የተመጣጠነ ምግብ መመገብ ብዙ ፈሳሽ ይውሰድ በተጨማሪም በቂ እረፍት ይውሰዱ።

2. የሰውነት መጨመር

በእርግዝና ጊዜ ያልተመጣጠነ የሰውነት ክብደት በመውለዎ ሰአት ችግር ስለሚፈጥር ክቤደቶን ማመጣጠን ይኖርበታል ይህንንም ለማድረግ የሚከተሉትን ጥንቃቄዎች ማድረግ ይችላሉ

- ቅባት የበዛባቸውን ምግቦች አለመመገብ ለምሳሌ እንደ ቅቤ
- ጣፋጭ ምግቦችን ሠእንደ ኬክ ቀዝቃዛ ክሬም የመሳሰሉትን ይቀንሱ

3. ማቅለሽለሽ

- የማቅለሽለሽ ምልክት ካጋጠመዎት እባክዎ በቂ የሆነ እንቅልፍ ይተኙ
- አዝወትረው ውሃ ይጠጡ
- ቀዝቃዛና ታፋጭ መጠጥ ይቀንሱ
- ምግቦችን በተገቢው ሰአት ይመገቡ

4. በፍጥነት ሽንት መምጣት

በፍጥነት ሽንት መጫጣት አንዱ የእርግዝና ምልክት ሲሆን ይህንን ለመቀነስ የሚከተሉትን ማድረግ ይችላሉ

- መጠጦችን ለምሳሌ ቡና ሻይ አልኮል ማቆሞ
- ማሳሰቢያ ሽንቶን ሲሸኑ የማቃጠል ስሜት ከተሰማዎት በፍጥነት ወደ ጤና ጣቢያ ሄደው ምርመራ ያድርጉ።

5. ራስ ማዘር

በዚሻው የእርግዝና ጊዜዎ ራስዎን የሚያዘረት ከሆነ እባክዎ የሚከተሉትን ጥንቃቄዎች በመውሰድ መከላከል ይችላሉ

- ጊዜውን ጠብቀው በአግባቡ መመገብ
- በቂ እረፍት ማድረግ
- በቂ እንቅልፍ ይተኙ
- ለረጅም ሰአት አለመቆም
- ሲቀመጡም ሆነ ሲነሱ በቀስታ ይሁን
- ለቀቅ ያለ ልብስ ይልበሱ

6. ስርቅታ

ስርቅታ የሚያስችግሮዎ ከሆነ እባክዎ የሚከተሉትን ዘዴዎች ተጠቅመው መከላከል ይችላሉ

- ውሃ መጠጣት
- አተነፋፈስዎን ገታ ማድረግ
- በምላስ ላይ ስኳር መያዝ
- ሎሚ በጥቂቱ መምጠጥ

7. ግሳት

- የተመጣጠነ ምግብ መመገብ
- ሰውነቶ ውስጥ ጋዝሊፈጥሩ የሚችሉ ምግቦችን መቀነስ
- የአልኮል መጠጥ አለመጠጣት
- እርጌዝናዎን በማይጎዳ መልኩ ቀለል ያሉ እንቅስቃሴዎችን ማድረግ

8. ሆድ መንፋት

- ብዙ ፈሳሽ መውሰድ
- እንቅስቃሴ ማድረግ
- የሚመገቡትን ምግብ መፈተሽ
- አነስ ያሉ ምግቦችን በተደጋጋሚ መመገብ

9. ሆድ ላይ የሚወጣ መስመር

እባክዎ የሚከተሉትን መንገድ ተጠቅመው ሆድዎ ላይ የወጣውን መስመር ለማስወገድ ወይም ለመቀነስ የሚከተሉትን ዘዴዎችን ይጠቀሙ

- በሀኪም ተደግፈው የሚሰጡ ቅባቶችን መጠቀም ለምሳሌ
- የሚወጣው መስመር ከሰውነቶ ክብደት ጋር ተያያዥነት ስላለው እባክዎ የሰውነቶ ክብደት ጋር ተያያዥነት ስላለው የሰውነቶን ክብደት ያመጣጥኑ።

10. የአይምሮ መታወክ

- የአይምሮ መታወክ ካጋጠሞት የሚከተሉትን ያድርጉ
- ጽንሱን በማይጎዳ መልኩ ቀለል ያሉ የአካል ቤቃት እንቅስቃሴ ማድረግ
- በቂ እረፍት ማድረግ
- አመጋገብን ማስተካከል ለምሳሌ

የሁለተኛው ሶስት ወር ላይ የሚከሰቱ ምልክቶችና መደረግ ያለባቸው ጥንቃቄዎች

1 የሽል እንቅስቃሴ

የሽል እንቅስቃሴ ከተሰማዎት የሚከተሉትን ጥንቃቄዎች ያድርጉ

- እንቁስቃሴው በተሰማዎት ሰዓት በግራ ጎንዎ ጋደም ቤለው ለጥቂት ሰአታት እረፍት ያድርጉ
- የተለያዩ ጭማቂዎችን ይጠጡ
- ማሳሰቢያ ምንም አይነት የሽል እንቅስቃሴ ከ 16 ሳምንት በሀላ ካልተሰማዎት ክትትል ወደሚያደርጉበት ጤና ጣቢያዎ ሄደው ምርመራ ያድርጉ

2 ሆድ ላይ የሚወጣ መስመር

እባክዎ የሚከተሉትን መንገድ ተጠቅመቀው ሆዱ ላይ የወጣውን መስመር ለማስወገድ ወይም ለመቀነስ የሚከተሉትን ዘዴዎችን ይጠቀሙ

- በሀኪም ተደግፈው የሚሰጡ ቅባቶችን መጠቀም ለምሳሌ
- የሚወጣው መስመር ከሰውነቶ ክብደት ጋር ተያያዥነት ስላለው እባክዎ የሰውነቶ ክብደት ጋር ተያያዥነት ስላለው የሰውነቶን ክብደት ያመጣጥኑ።

3 ወደታች ጫን ማለት

- ምጥ ለደርስ አካባቢ ወደ ታች የ መጫን ስሜት ከተሰማዎት በመቀጠል የተዘረዘሩትን ያድርጉ
- በተሰማዎት ሰዓት ሃይል ሰጪ የሆኑ ፈሳሾችን መውሰድ ለምሳሌ
- ትንፋሽን ሊጨምሩ የሚችሉ የአካል ብቃት እንቅስቃሴ ማድረግ

4 ራስ ማዞር

በዚህ የእርግዝና ጊዜዎ ራስዎን የሚያዞሩት ከሆነ እባክዎ የሚከተሉትን ጥንቃቄዎች በመውሰድ መከላከል ይችላሉ

- ጊዜውን ጠብቀው በአግባቡ መመገብ
- በቂ እረፍት ማድረግ
- በቂ እንቅልፍ ይተኙ
- ለረጅም ሰዓት አለመቆም

- ሲቀመጡም ሆነ ሲነሱ በቀስታ ይሁን
- ለቀቅ ያለ ልብስ ይልበሱ

5 ከፍተኛ ድካም ካጋጠሞት እባክዎ ፕሯፍታል ሽይታሟን ይውሰዱ፣ጤናማና የተመጣጠነ ምግብ መመገብ ብዙ ፈሳሽ ይውሰድ በተጨማሪም በቂ እረፍት ይውሰዱ።