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Addis Ababa University

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College of Natural and Computational Science

School of Information Science

**Enhancing Patient Satisfaction on Hospital Appointment
Scheduling using Mobile Technology**

By

Helina Belete

Advisor

Tibebe Beshah (Ph.D.)

Addis Ababa, Ethiopia

June 2020



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A Research submitted to the School of Information Science in fulfilling the
requirements for the Degree of Masters in Information Systems

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DECLARATION

I declare that this thesis is my original work and has not been presented for any degree in any other university.

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The thesis has been submitted for examination with my approval as university advisor.

Advisor's Signature: _____

Dr. Tibebe Beshah (Ph.D.)

DEDICATION

I dedicate this to my mother Mrs. Ayelech Tibeltaleh, my father Mr. Belete Meaza. Thank you for being patient with me throughout the time of my study.

Above all, to the Almighty God!

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LIST OF ABBREVIATIONS

CATCH	Compressive Assessments for Tracking Community Health
CSS	Cascading style sheets
DSR	Design science research
DSRM	Design science research methodology
DSRP	Design science research process
ECG	Electrocardiogram
E-Health	Electronic health
EMR/EHR	Electronic medical/Health record
ER	Entity relationship
HCI	Health care Industry/Human-computer interaction
HMIS	Health management information systems
HRMIS	Human resource management information systems
HSDP	Health sector development programme
IDE	Integrated development environment
IOS	Internetworking operating system
MDGs	Millennium development goals
MHealth	Mobile health
MPI	Master patient index
MRN	Medical record number
MVC	Model-view-controller
OPD	Outdoor patient department
PHC	Primary health care

PHP	Personal home page
QUIS	Questionnaire for user interaction satisfaction
SDK	Software development kit
UE/UX	User experience
UML	Unified modeling language

ABSTRACT

Implementing the mobile health System is the priority agenda not only in developed countries but also in many developing countries. To make hospital appointments in our country, Ethiopia, a patient needs to directly go to healthcare and wait until doctors are available. This procedure affects the patient's experience. Since there are few studies on patient satisfaction, we need patient satisfaction study and country based (local) application.

The objective of this study is to investigate and design a mobile-based solution that can enhance the patient experience while visiting Healthcare. This app is aimed to reduce the exhaust patients' faces on scheduling appointments.

Design Science Approach is adopted in doing this research, which is a process model, consisting of six activities in a nominal sequence. Data was collected based on a survey collected from participants using semi-structured interviews. Using a narrative approach, we interpreted stories told by participants to determine the requirements of the new system. In translating user requirements into diagrammatic representation, we applied analysis and design models, UML diagrams such as Use Case and Sequence Diagrams and Class Diagram.

The result of this study shows that patients satisfaction increases when factors affecting patient experiences are improved such as patients' expectations, waiting time, consulting time, and arrival time. Additionally, in this work community-based appointment scheduling system for patients is proposed. The User Interface of the prototype is presented using screenshots to show and demonstrate the system.

Smart Doctors Appointment and Prescription System has no functionality for prediction of patient consulting time and community concern like no function of location information and local language-based which are the major challenges for this study. Therefore, we inferred the need for analyzing patient requirements and the development of mobile applications that overcomes the problems and play a vital role to provide healthcare services timely, in an organized way.

Keywords: Patient satisfaction, Health care, Appointment, Doctor, Patient, Mobile

CHAPTER ONE

INTRODUCTION

1.1. Background to the study

The concept of mobile health (mHealth) appeared in the early 21st century with the development of mobile phones and wireless technology (Free, et al., 2010). Since that time research has consistently shown that the deployment of mHealth will benefit patients with chronic disease (Jaglal, et al., 2013), making it easier to implement primary health care (Leventha, Taliaferro, Wong, Hughes, & Mun, 2012) and reduce health care costs (Keh, et al., 2014).

Ethiopia's health system is divided into three: Primary, Secondary, and Tertiary. It is called the three-tire service delivery system. Tertiary level care or specialized hospitals is supposed to serve 3.5 – 5 million people. General (Secondary Level Health Care) Hospital is a medical facility that provides health care to both inpatient and outpatient and treats many types of diseases with professionals. As in Ethiopian status, the general hospital is supposed to serve 1 – 1.5 million people and provide all kinds of clinical services including the surgeon. Primary Levels Health Care (PHC) includes Primary Hospitals, Health Centers, and Health Posts. At the Ethiopian level, PHC focuses on disease prevention and health promotion. It is the type of health delivery system, which is sometimes described as “by the people, of the people and for the people”. This Level is supposed to serve 60,000 – 100,000 people in Primary Hospitals, 15,000 – 25,000 people in Health centers, and 3,000 – 5,000 people in their satellite Health Posts that are connected by referral system (Ministry of Health, 2010).

Since the development of the health policy in 1993 and HSDP I in 1998, the Federal Ministry of Health has formulated and implemented many policies and strategies that afforded an effective framework for improving health in the country including public health emergency management. Ethiopia is at a pivotal moment in its efforts to improve the health status of its people and move the country into a new phase of social and economic development. Even as the country has made progress toward its health-related Millennium Development Goals (MDGs), the government and its partners realize that advances need to be accelerated if targets in maternal and child mortality and infectious diseases are to be achieved (Vital Wave Consulting, 2011).

These days Ethiopia is showing ideal changes in adopting the smartphone market trend. Contrasting to the previous days, people are seen with their smartphones and it is not uncommon now to see people with smartphones. Based on the data in Ethiopia, the annual growth for internet users is 37 % and findings show the majority of Ethiopians access the Internet from a mobile device.

Mobile applications are created to describe a system, solution, or state of the enterprise. As one of the interesting topics mentioned in the 1993 Ethiopia Health Policy was the use of practical technologies that further improve the health status of the population. Owing to this, we are concerned with the patient-to-doctor scenario with three identified main domains of interest: Patient domain, Doctor's domain, and Hospital domain. With the advance of Information Communication Technologies (ICTs) in the last 20 years, different systems are being implemented in healthcare organizations to improve healthcare services with better data management, communication, and decision making (Biruk, Yilma, Andualem, & Tilahun, 2014).

Different models have been proven to successfully decrease patient queuing times and for years paper-based appointment systems have been used to connect doctors and patients with third-party involvement (Donahue, et al., 2017). Since mHealth is in a stage of growth in Ethiopia, many web-based online systems are developed for private and public Hospitals such as Black Lion Hospital, Landmark General Hospital, and Bethzatha Hospital to improve the patient experience.

With the recent rapid advancement of high-functionality smartphones and the growth of mobile phone subscriptions across the globe, there is widespread interest in using mobile health (mHealth) applications for routine collection of health data (Medhanyie, et al., 2015). Mobile technologies continue to evolve and grow in popularity, the healthcare sector has to quickly adapt to meet the demands of the modern day's patient and healthcare professional (Majid, Alam, & Mustafa, 2017). The development of mobile applications accelerated by the advantages of wireless technologies brings many benefits in the area of healthcare. They allow enhanced personalization; give better services to patients and more improved hospital management as well as real-time communication system available for healthcare professionals, patients, and medical health centers.

Researchers give their definition of patients waiting time. They have agreed on patients who waited for so long in the hospital are not satisfied. According to Cayirli & Veral (2003), access time is defined as the time between patients' requests for the appointment and the time he/she is checked

up. They defined waiting time as the time between consultation and scheduled time while neglecting the early arrival of a patient. A well-designed appointment system is likely to improve patients' satisfaction by minimizing cost and less time-consuming health centers where people are busy in their world.

As patient experience is an important metric used for quality assurance, tracking progress, and predicting future trends, a problem-solving artifact is developed for patients without purchasing and using another extra device after collecting a survey from patients who can help to identify the problems people are facing during their visit in Hospitals. There is no payment for this service. This artifact helps the patient and doctor to communicate with each other for an appointment at any time using mobile with internet.

1.2. Statement of the problem

Mobile phones are turned out to be essential devices in our daily life. Lately, people's day-to-day activities are connected to the smallest mobile phones. The development of smartphones plays a big role in making our life easier, as well as the number of existing applications for the operating system. It is not quite new to see people using their mobile phones in transportation, workplaces, schools, etc., which shows the crucial connection to mobile technologies.

The development of technologies has a huge impact on healthcare. Many innovative web-based platforms are designed to manage and facilitate processes related to patient registration and waiting room management. As Fonville, Choe, Oldham, & Kientz (2010) stated, computing technologies in examination rooms become a more pervasive and dominant part of the healthcare experience, those technologies can disrupt the flow of information and empathic communication between a clinician and patient. Effective use of technologies is necessary for successful interaction.

The platform, Web services, and database technology are all gradually maturing so that we can develop a doctor-patient interaction system on different platforms to meet the needs of the patient and provide doctors more efficient and convenient means of communication with patients (Choudhari, Kusurkar, Sonje, Mahajan, & Vaz, 2014). However, in today's world if someone wants to book a Doctor's Appointment we need to call in the clinic or personally go to that place and book the appointment (Prajapati, 2018). This consumes the precious time of the patient. Also if the doctor cancels his/her schedule, the patient does not come to know about it unless he/she

goes to the health center. Normally when we want to make an appointment with the hospital staff, it becomes tedious and time-consuming (Hylton & Sankaranarayanan, 2012).

Mobile apps were originally offered for general productivity and information retrieval, including email, calendar, contacts, stock market, and weather information. However, public demand and the availability of developer tools resulted in rapid expansion into other categories, such as medical apps and GPS services. As Durmaz (2014) stated the market chain of mobile apps causes an imbalance between spoken languages versus app languages since 85% of developers publish in English addressing just 8% of the world population (around 500 million people) who speak English as a primary language.

Various kinds of mHealth-based applications for patients with several functionalities are presently available on the Internet, yet none can maintain a stable and feasible user base to support patient health requirements (Zhang, Zhang, Wang, Yang, & Zhao, 2017). However, not all of these applications are regulated to a particular country (region). They are available in the developer language or the most common language that is English. Accordingly, Durmaz (2014) mentioned the consequence of not having software adapted to local languages in that the software is in many cases restricted to people who know foreign languages. Therefore, they did not give attention to application for children and the local language of the population. Besides, there is no appointment application developed in the Amharic language.

Ministry of Health (MOH) has recognized the benefit of Information and Communication (ICT) as a tool to support the health sector. On this basis of this, Ethiopia has developed Electronic Health Information systems that are being in use. Moreover, this system is a priority to ease of use for healthcare workers and technical parts to give services to patients. However, the patients' side of experience needs to be investigated and addressed.

Many aspects of the patient experience can affect patient satisfaction with the care received. Choudhari, Kusurkar, Sonje, Mahajan, & Vaz (2014) and Hibbert, et al. (2019) show that no satisfaction experiment has been done in understanding different factors affecting patients' hospital experience. Based on Donahue, et al. (2017) with the constant change in the health care industry and the increasing role that patient satisfaction has on reimbursement, it is important that operation management and patient satisfaction with clinics and hospitals are studied to deliver the most efficient and effective patient care.

The ICT remarkable growth in two and a half decades in Ethiopia, delivering Healthcare services is a remaining issue in the country (Weldegebrial, 2016). The major problem in Ethiopia's current healthcare system is patients at the hospital OPDs have to wait for a longer time before they can get treatment or advice from professional health workers. Appointments are still made in old ways that are outdated processes for managing patients. It is observed that in most of the public hospitals, the patient makes an appointment by directly going to the hospital (Yekatit12 Hospital, Menelik II Referral Hospital, Black Lion Hospital). Normally, we see patients coming to the hospital, filling out registration forms and waiting to be called or patients can make a schedule through phone calls in hospitals such as Bethzatha Hospital, Biruk, Bethel Teaching General Hospital and waits for the response for an agreed date.

Even after patients go in person, they wait until their turn to meet him/her Doctor. This is even more of a problem for patients who are in need to meet their Doctors. Patients waste their time when they are stuck in the waiting room of their Doctor's office and waiting to solve the regular medication is carried for both sides.

Theories have shown that patient satisfaction has a subjective concept and includes many influencing factors. The sub-aspect of patient satisfaction includes visiting environment, medical expenses, service attitude, medical technology, medical facilities, and so on. The factors that influence patient satisfaction mainly comes from basic demographic characteristics (age, sex, education), socio-ecological characteristics (employment, income, insurance, and living expenses), and hospital care experience (waiting time, ward environment, medical expenditure) (Shan, et al., 2016). Socio-demographics variables have a positive relationship with patient satisfaction (Naidu, 2009).

Patient satisfaction is a broad concept with the extent to which patients are happy with their healthcare and different aspects of measuring methods, i.e. both inside and outside the doctor's office. Patients' satisfaction has a relation with patient expectations (Berhane & Enquesselassie, 2016). How strongly patient hospital experience could affect patient satisfaction and issues leading to a positive or challenging patient experience define more clearly dimension of patient satisfaction and patient-centered care (Hibbert, et al., 2019). However, most researches pertain to developed countries; they are not generalized to developing countries like Ethiopia, which may be quite different culturally.

Given these problems, many techniques like online patient registration and scheduling appointments have been suggested to improve the workflow and thereby smoothen the waiting time. Systems like “Smart Doctors Appointment and Prescription System” (Majid, Alam, & Mustafa, 2017) has been suggested to reduce the time and hustle of doctors and patients. However, these systems still possess some drawbacks like the patient may need more time than he/she has scheduled therefore it is important to ask the proper questions like “Reason to see a Doctor?” at the time the appointment is made to anticipate the time needed. The other problems rely upon societal concerns like patients have to be informed about the hospital’s location so there might be a need to depict nearby Hospitals on a map. Additionally, the proposed systems concerns only English language users, therefore the development of the application should consider community language.

Possible cause of these problems might be due to the functional impairment experienced by patients, financial, human resource, and the ability to manage resources that results in patients’ dissatisfaction. Therefore, the problem lies in the fact that existing apps do not meet the fundamental health requirements of the patients (Chindalo, Karim, Brahmhatt, & Saha, 2016). Further research is needed on patients' satisfaction and health management to act on related problems like services from different perspectives (Abdosh, 2009).

Taking the weakness in the healthcare systems and by combining different technologies for the healthcare industry, we make an investigation to examine issues, factors, functional and non-functional requirements of patients that can help us to construct an artifact followed by a prototype that can improve the existing service.

Research Questions

In addressing the above-mentioned problems, the following research questions are answered:

1. What are the possible factors that affect patients' hospital experience while visiting the Doctor’s office?
2. How can we best design a mobile-based application to improve the Patient’s hospital experience?

1.3. Objective of the study

1.3.1. General objective

The objective of this research is to design a mobile-based solution that can enhance the appointment scheduling of patients while visiting Healthcare.

1.3.2. Specific objectives

To achieve the general objective of this research, the following specific objectives are dealt with.

- To review and understand the concepts and techniques used for application development.
- To investigate patient's satisfaction on their hospital visit.
- To empirically validate the challenges affecting patient experience while visiting Doctors.
- To design and validate a mobile-based solution that can improve patients' experience in visiting hospitals.

1.4. Significance of the study

The significance of this research is multifold; in this research, we develop a mobile application so that it can be used as a conceptual guide and simplified representation of the real-world problem. The study implies practitioners since the challenges are noted. It is intended that the findings of this research process improve the satisfaction of patients'.

The beneficiaries of this research include patients (users) since it encourages and drawn them to this ease method of interacting with Doctors and to adopt it as it is an effective doctor appointment system that benefits the patient. The app could help patients to better interact with hospitals so that the application can save their money and time. Doctors are also beneficiary since the app can make it easier to interact, manage their time, and create a good environment to communicate easily with their patients. This research also benefits various researchers who are interested in related research areas and who intended to study on mhealth in enhancing patients' hospital experience. Moreover, this research has the potential to reduce the crowd in the hospital so that patients can directly get information from the system. It can also reduce workload and save the time of health workers.

1.5. Scope and limitation of the research

The scope of the study is enclosed to investigate and analyze the current and desired usage and satisfaction level of patients among their experience during Doctors' visits. The respondents

include patients, doctors, and health workers. Due to the sample size, as well as the sample pool, findings focus on patients who use any smart mobile platform. It may vary from user to user.

It is observed primarily that the present study is geographically limited and confined to Ethiopia, Addis Ababa. The study, however, focuses on experiences from patient and doctors side in healthcare found in Addis Ababa. Hospitals selected based on their active status, there are so many in the city and yet have not received research attention in the area of developing applications to improve patient satisfaction.

As a research approach, this study takes in a Design Science Research Approach and data was collect qualitatively through interviews. Nominal data were collected using open-ended interview questions. Data were collected from participants in public sectors: Tikur Anbessa Specialized Hospital (TASH), Yekatit 12 Hospital, and Alem bank Health Center and from the private sectors: Bethezata General Hospital, Dr. Nega clinic, and Christmas International Brain & Spine Hospital, based on the level of the Ethiopian three tire health care system.

1.6. Organization of the thesis

The remaining sections of this paper are structured as follows. In the second chapter, we review conceptual literature and related works to understand the state of the problem (Problem Identification). Then we explicate the design of the design science process model in chapter 3, the methodology section. In Chapter 4, we present the result that shows the finding input and proposed artifact along with the discussion in terms of the objectives of the study. Finally, Chapter 5 of this paper is the last chapter containing a conclusion and recommendation part of the study.

CHAPTER TWO

LITERATURE REVIEW

In this chapter acquiring a comprehensive overview of the subject, a literature review was performed. Obtained information aimed to provide the foundation to elucidate the status of mobile health and patient satisfaction in Ethiopia. Factors affecting patients' satisfaction and works of literature related to mobile applications reviewed in this section. The material generated by the literature review provides the foundation for the thesis' research base, theoretical background, and related works.

The authors of this research thus performed various searches in a wide range of available databases. The databases included Google Scholar, ScienceDirect, SpringerLink, and Sci-hub. The terms used when searching for material are; "mhealth", "ICT", "mobile architecture", "scheduling application", "patient-doctor interaction", "patient satisfaction", "design model" and "design tool". These terms were combined in various ways to narrow the search result. After gathering information regarding the subject, we verify the reliability of the gathered material. The purpose of this step is to ensure that the acquired material originated from a reliable source, and thus qualified to be referenced in this research. For the material to be accepted, it had to originate from a reliable source and include external reliable references.

The categorization of the material is the next step. In this part, we established taxonomy for mhealth, waiting for time, customer and patient satisfaction, existing system, factors associated with patient satisfaction, and application technologies. This categorization was necessary to structure the material precisely. The applied taxonomy is needed to fulfill the requirements for a reliable source, according to the previous step. And the last step is the analysis of the acquired and categorized material. During this step, the authors scrutinized the material for information of relevance to the research and included it in this report. The material generated by the literature review provided the foundation for the thesis' research base, theoretical background, and related work.

2.1. Mobile health

2.1.1. ICT in healthcare

Information and Communication Technologies (ICTs) are additional term for Information Technology (IT) that stresses the role of unified communication and the integration of telecommunication (telephone lines and wireless signals) and computers, as well as necessary enterprise software, middleware, storage, and audiovisual systems, that enable users to access, store, transmit, and manipulate information.

Information and communications technology have increased productivity in many sectors of the economy, and economic growth rests more and more on the contributions of ICT (Ranta, 2010). Benefits include improvements in process efficiency and information dissemination. The use of Information and Communication Technology (ICT) in the Health Care Industry (HCI) has also been on the rise. The Health Care Industry (HCI) has been slow in accepting the use of ICT and for many years relied on paper-based systems, for a task such as patient data management and scheduling appointments.

Today it is clear that information and communications technology have improved efficiency in many industries (Ranta, 2010) and it is an information-intensive sector and could be expected to benefit from advanced information and communication technologies. Health Care Facilities (HCFs) can use ICTs such as Internet-based applications to provide current and potential clients with the information they need when they need it. Some facilities even allow clients to set up appointments to see a doctor using these internet-based applications.

2.1.2. Electronic health in Ethiopia

Electronic Health (E-Health) is the use of Information and communication technology for storing and accessing the data stored electronically, sending the data digitally for clinical, educational, and administrative purposes both locally and externally. The World Health Organization defines E-Health as ‘the use of information and communication technology in support of health and health-related fields (World Health Organization, 2016). In more practical terms, eHealth is the means of ensuring that the right health information is provided to the right person at the right place and time in a secure, electronic form for optimizing the quality and efficiency of health care delivery. EHealth is viewed as both the essential infrastructure underpinning information exchange between

all participants in the Ethiopian health care system and as a key enabler and driver of improved health outcomes for all Ethiopians. Mobile health will advance through creating a country-based strategy that incorporates into the existing system (World Health Organization, 2011).

EHealth is a group name for all electronic systems that are working in the health domain of any country. Some of the major electronic applications that are implemented in Ethiopia and included in this group name are Electronic Medical/Health Record (EMR/EHR), Human Resource Management Information Systems (HRMIS), Mobile Health, and so forth.

Telehealth has been well defined as the use of telecommunication and information technologies for the establishment of healthcare peoples living in different geolocation. Telehealth is ‘a collection of means or methods for enhancing healthcare, public health, and health education delivery and support using telecommunications technologies’. It is important to control costs for countries with large rural populations including Ethiopia. However Ethiopia is one of the poor countries, is an economically growing country in East Africa. Ethiopia is the Federal Republic having ten Regional States & two city administrations; it has 769 districts or woredas (Yilmaz & Venugopal, 2018). Therefore, the health problems, combined with high population growth rates, have increased the demand for health services and for more treatments that are expensive (Weldegebrial, 2016).

2.2. Healthcare work process in Ethiopia

The current patient appointment booking system is managed by the manual method. Currently, there is no automated appointment system for patients’ hospital booking applied in the Health centers. Patients are going directly and served at the hospital using manual paper-based cards. From entry to exit, patients go through multiple processes; which can be tedious and irritating. However, there is a need for a streamlined process for efficiency, time and cost-saving, and most importantly patient satisfaction.

The overall business process description of the hospital booking system in the selected hospitals is presented below. Even though there are other Health Centers in Addis Ababa, the six Hospitals were chosen based on different levels of service delivery.

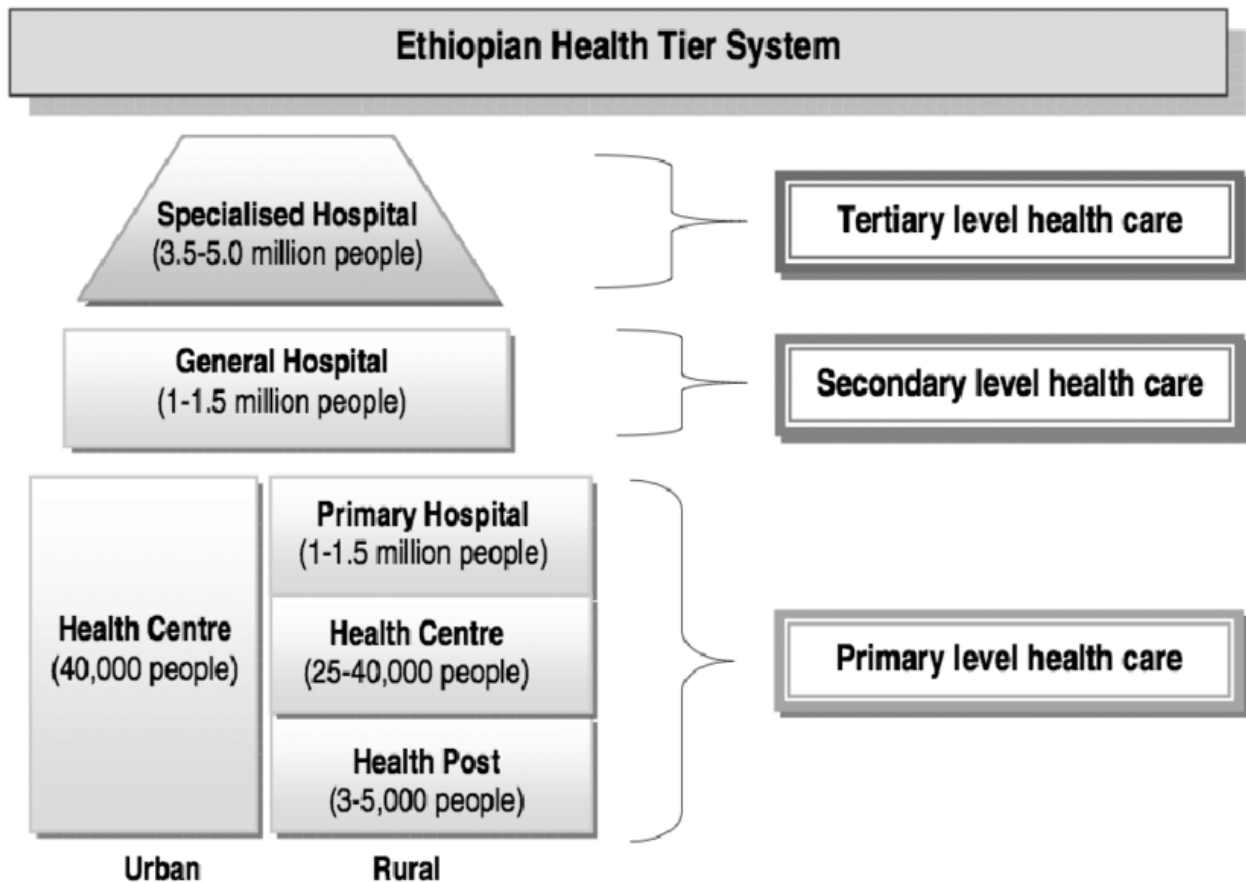


Figure 1: Ethiopian Three Tire System (EFDRE, 2015)

2.3. Customer and patient satisfaction

Whenever either the customer is pleased with the product or the service then it is considered as satisfaction. Satisfaction may be a person's feelings of happiness or disappointment in the result for comparing a product/service perceived performance or outcome with its expectation (Kotler, Keller, Brady, Goodman, & Hansen, 2016). Satisfaction can be derived as happiness achieved from the consumption of goods or services offered by a person or group of people or it may be the state of being happy with the situation. Sometimes it becomes very difficult to satisfy everyone or determine satisfaction among a group of individuals because most people have different perceptions and expectations.

Satisfaction is similar to the other psychological words that are easy to understand but difficult to explain. The idea of satisfaction is similar to themes such as happiness, contentment, and good quality of life. Satisfaction is not the phenomenon waiting to be measured by people but it is a

judgment of people from over a while as they reflect from their experience (Health Boards Executive (HeBE), 2003).

As patients of medical care have changed, the individual doctor-patient relating is being replaced by short-term encounters with numerous disparate specialists and other health workers. Also, according to Korsch, Gozzi, & Francis (1968), there is the daily testimony to the dissatisfaction of the community with the medical care offered. As patients have different attributes, profile, and status, the evidence might differ from person to person.

Consumer satisfaction is playing an increasingly important role in the quality of care reforms and health-care delivery more generally across the United States of America and Europe (Bleich, Özaltin, & Murray, 2009) and in South Africa (Karl & Phaswana-Mafuya, 2012). The relationship between a patient experience (as represented by “responsiveness”) and satisfaction with the healthcare system was explored. They discovered other factors beyond patient experience that might influence people’s satisfaction with the health-care system. Additionally, they discuss challenges on the lack of a universally accepted definition or measure of consumer satisfaction by dividing some focus on patient satisfaction with the quality and type of health-care services received; others focus on people’s satisfaction with the health system more generally.

The increasing importance of patient experience and the sustained interest in comparing people’s satisfaction with the health system across different countries and periods suggests the need to characterize the relationship between them. Patient experience and satisfaction with the health-care system do not overlap, though satisfaction can be explained by patient expectations. The overall satisfaction with the health-care system in 21 European Union countries shows in most of the countries the respondents are satisfied. Their result shows higher satisfaction among individuals with higher income per capita, lower satisfaction among people receiving care from private providers, higher satisfaction among individuals receiving inpatient rather than outpatient care, and lower satisfaction among inhabitants of countries with higher immunization coverage. The responsiveness in eight domains of patient experience, on relevance to all health systems that are: autonomy, choice, communication, confidentiality, dignity, prompt attention, quality of basic amenities, and support (access to family and community support networks). The support domain was not included in the analyses since it was intended only for inpatients (Bleich, Özaltin, & Murray, 2009).

One of the questions raised was related to the general concept that patient satisfaction is closely related to attributes of the patient himself, his background, his education, and so forth then to the experience with a physician. From the sample, there are no significant differences in patients' satisfaction found when different educational levels are compared (Korsch, Gozzi, & Francis, 1968). However, it was not possible to demonstrate a significant relationship between any other attributes of the population measured and degree of satisfaction with patient visits. Therefore 76% of patient visits resulted in satisfaction on the part of patients and 24%, there was dissatisfaction. Several communication barriers were found to contribute significantly to patient dissatisfaction such as a notable lack of warmth and friendliness on the part of the doctor, failure to take into account the patient's concern and expectations from the medical visit, lack of clear cut explanation concerning diagnosis, and causation of illness, and use of medical jargon.

A study was made on two secondary (Zonal) hospitals under the Regional Health Bureau found in the Harari region, which act as major referral hospitals for the whole of the eastern part of Ethiopia. In a survey of outpatients and their classification with their rating level from dissatisfied to satisfy, 518 outpatient health service users interviewed after completing their health care, the majority of patients were in the age group 15-30 (58.9 %) and came from outside of the region (53%). The mean score for the overall satisfaction according to the five points Likert scale was 3.44 with a standard deviation of 0.84. Accordingly, the study shows there is the least degree of satisfaction observed for the general cleanliness of the facility followed by the provider's behavior towards the patient and waiting time between registrations and being seen by the provider. However, the satisfaction level related to consultation time, laboratory and pharmaceutical service is relatively higher. Statistical analysis has shown that the level of satisfaction decreased with an increase in the perceived length of queuing time $p < 0.01$. Even though this research tried to address the satisfaction level of patients more from patients side measurement, it needs to take variables regarding the hospital and other personnel (Abdosh, 2009).

Quality involves the consistent delivery of a product or service according to expected standards (Campbell, 2000). Quality assessment studies usually measure one of the three aspects of quality-structure, process, and outcome. Asking for and understanding users' views and measuring patient expectations are seen as key components of both process and outcome evaluation and the effectiveness of health care to some degree is determined by consumer satisfaction with the

services provided (Sitzia & Wood, 1997). Moreover, patient satisfaction is also directly related to the utilization rate, and hence meeting patient satisfaction improves the utilization of health services (Abdosh, 2009).

For evaluating and making improvements in the quality of health care, it is required to investigate the quality of care in the context of health care. Patient satisfaction is a substantial indicator of health care. For this purpose, the quality of work includes investigation that map outpatient satisfaction with several factors (Johansson, Oleni, & Fridlund, 2002).

Yet from literature, it is stated that the degree of satisfaction varied widely across countries with similar health outcomes (World Health Organization, 2003). The patient expectation needs better measures and variables. More research needs to understand the determinants of satisfaction with the health-care system, particularly the broader societal factors which could not be explored.

2.4. Factors associated with Patients satisfaction

2.4.1. Waiting time

According to Conrad (2013), waiting time was analyzed and factors related to waiting time of service offered at the assessment center Mulago were evaluated. The cross-sectional method was used using the time and motion tool couples structured questionnaire was conducted. The result was based on five key informants and real-time patient data collected from 401 patients. Patients queuing time waiting to receive services is longer at the registration section. The factors for the waiting time are due to high patient load, particular days, and late patient arrivals. The researcher recommended using a system that limits the number of patients reporting to OPD especially those with minor illness to reduce load and improve the quality of outpatient care provided at the outpatient department.

2.4.2. Patient flow

Patient flow characterizes the ability of the healthcare system to serve patients quickly and efficiently as they move through the stages of care. An obstacle in patients' current movement can increase queuing time and throughput time creating a negative effect on the quality of service delivery (Vos, Groothuis, & Merode, 2007). When the patient flow is handled well, it is represented by short wait registration, examination, diagnostic testing, pharmacy, and discharge (Belson, 2010). Therefore, improving patient flow is one way of improving healthcare services.

2.4.3. Operational efficiency of Patient

The awareness of patient flow by healthcare facilities can measure the facility's operation (Zafar, Suri, Nguyen, Petrash, & Fazal, 2016). Thus, to have a better operational efficiency we need a well-organized patient flow (Pandit, Arland, & Rao, 2018). According to Wanyenze, et al. (2010), so many factors can affect efficiency and the emergence of a bottleneck in healthcare operation during examining operational efficiency concerning patient flow. These factors include the volume of patients seen on the daily basis, the type of patient seen in terms of stage care, clinical policies on the frequency of patient visits, the type of provider who they should see, the size and composition of the providers, and the staffing model.

2.4.4. Physical design

The physical environment has a huge impact on the healthcare experience and effort in outpatient settings (Naidu, 2009). In supporting this concept, understanding the journeys patients make through the department. The patient environment can best be studied from the ordinary experience. Studies show that hospital; design coupled with walking distances and common journeys affects access to every department (Wanyenze, et al., 2010), with a direct on the movement of patients, staff, and supplies (Pandit, Arland, & Rao, 2018). Therefore controlling movement in terms of; the number of changes in the direction needed to access different service points from the main entrance, the distances and number of stops (treatment room), would minimize walking to locate service points. Therefore, physical accessibility is an important factor for optimizing patient flow; and to achieve operational efficiency.

2.5. Scheduling system

Computerized scheduling systems are a method of using scheduling algorithms and rules to help multiple people manage appointments and meetings. Computerized scheduling allows users to publicly share free time on their calendars while keeping specific appointments private. They tend to be more efficient than manual scheduling, but a good appointment secretary can more effectively handle some situations.

Hospitals are continuously fighting a scheduling problem that causes either a waste in medical experts' time or a decrease in patient satisfaction and staff morale (Hylton & Sankaranarayanan,

2012). Health organizations need a comprehensive scheduling system that patients can easily interact and make an appointment.

Scheduling systems provide a doctor-patient interaction system based on Android where Doctors can manage appointments from anywhere they are and patients don't have to stand in a long queuing to fix their appointment. The systems help to save the precious time, money of Doctors and patients. It is also helpful to decrease paperwork. Although a well-developed system gives priority to Doctors than patients (Choudhari, Kusrkar, Sonje, Mahajan, & Vaz, 2014).

Even if the Health Care industry is rapidly growing in most countries it needs several improvements in the quality of service and patient waiting times (Hylton & Sankaranarayanan, 2012). Accordingly making an appointment with the hospital staff is becoming tedious. Different systems such as m-commerce, e-commerce, and telemedicine have been developed to improve those problems.

2.6. Related works

Smart Doctors Appointment and Prescription System is an application that provides services to doctors and patients. The Doctor's Appointment and the Prescription system connects between Doctors and patients using web and android apps and patients can search for a Doctor and ask for his/her appointment as well as their prescription using their smartphone. This app is developed to help to introduce Doctors' Appointment and Prescription System for a mobile user, facilitate mass people to connect doctor through mobile to get an appointment, reduce time and hassle of doctors and patients and to record patient information in digital format for future usage (Majid, Alam, & Mustafa, 2017).

Agent-based systems have also been developed for the hospital service, for searching and fixing appointments over mobile phones which gives a direct reply when the appointment is made or the next available date(s) or canceled date. For fixing appointments in respect of health applications, health cares employed a human agent to get the work done at the appropriate health care facility. However, such a job can be done in the mobile environment by employing mobile agents, which would replicate the job of a human being. The system makes appointments with the hospital-based on fuzzy preferences. The agent possesses adequate intelligence to schedule the appointment. It has a future implication to develop the system towards directing the appointment to another health

care organization where the same doctor also works and to provide automatic system calls as a reminder before the appointment time begins and the least scheduling for emergency appointments needs to be taken care of too (Hylton & Sankaranarayanan, 2012).

Oployee Labs, an android application which is developed to find a doctor or a dentist easily and take an appointment with the doctor instantly. In another published a paper with the title “Android Based Health Monitoring System” on the journal of International Journal of Advance Foundation and Research in Computer, they designed a system that is continuously monitoring the heart-rate, temperature, etc (Londhe, Vandre, Narote, Nirmal, & Khandelwal, 2015).

Limited developed “Doctor Apps Pulse” which is a purchasable and subscription-based app, where a doctor can confirm patient appointments, write patients' history and provides prescription and communication can be established through the internet (Dayspring Limited, 2014). Also, a paper “Real-Time Patient Monitoring System Using Lab view” shows the patient’s vital parameters such as ECG, heart rate, pulse rate, and temperature are measured using a patient monitoring system (Gao, Greenspan, Welsh, Juang, & Alm, 2013).

Another appointment system, Book Doctor Appointment System (Pharma and Medical Concepts PvtLtd., 2015), used “Appy Pie” to develop the app and it is available in the Google Play store which is purchasable. Users can manage the online appointment of a listed doctor. There is an easy and quick search option for trusted Doctors across all cities based on their specialty, clinic, or doctor’s name.

Because, the actual system in recent year is consuming the precious time of patient which can affect their satisfaction and experience in the healthcare environment, Prajapati (2018), provide an android system which can offer ease and comfort to patients while taking an appointment from doctors and it also resolves the problems that the patients has to face while making an appointment. Even if the proposed system is efficient and has a friendly user interface, it doesn’t add Doctor and Admin modules in the android application. This has some more future directions for improvements in the patient’s module which includes setting reminders for the appointments and saving the appointment date to the calendar.

Author (Year)	Objective	Key finding
Maryam Tufali (2018)	Provide quality medical care to patients by bringing all medical practitioners of the city into one platform so anyone can easily access them and make an appointment	Proposed a web-based appointment system for online booking and appointment and keep an online medical history.
Birna Abdosh (2006)	Identify areas that need to be improved to make the healthcare service more responsive to the clients.	There is a relationship between patients satisfaction and hospital services. There is a need to address the long waiting time by undertaking further factors.
Conrad Musinguzi (2013)	Quantify the waiting time, identify factors associated with waiting time for services offered at assessment center Mulago.	Most time spent waiting for services is related to long queues due to high patient load, particular days, and late patient arrival.
Tsegaynesh Mogese (2014)	Design and implement a telehealth support system using wireless technology.	Patients and professionals can access the health service from anywhere to get better treatment and guidance using the system.
Esubalew Sebsibe (2015)	Analyze, design, and develop a prototype mobile application for the Public Health Emergency Management system for EPHI	Proposed Mobile application for timely collection, Organizing, and summarizing data for the evidence-based decision-making process.
Abayneh Atewu (2014)	Assess ICT based Pre and Post analytical medical laboratory practices at St. Paul's Hospital.	Found a higher frequency of gap in Pre and Post analytical practices which should be solved for the organization.

Table 1. Related works

2.7. Summary

Patient satisfaction has been discussed concisely in the review. It depends on the patient previous healthcare experience, the purpose of the current visit, a reason to end up in the hospital, arrival time before the appointment, point of delay, and reason for delay. In the meantime, the growth of

mobile phones has not only contributed definitely to people's daily life but also improved the quality of organizing procedures in different sectors.

To the best of the researcher's knowledge and as the researcher checked on different available applications, academic resources, and peer-reviewed articles so far, the area needs to be researched more. There are different solutions developed to overcome the problems in health service, using mhealth for healthcare is still on board. Besides, there are academic studies made on investigating patient experience on visiting health care, there are drawbacks that need to be improved such as lack of country-based solutions and functionalities in the developed systems. Factors affecting patients considering hospitals found in Ethiopia needs more exploration. Therefore this area requires better enhancement considering additional functionalities should be considered.

CHAPTER THREE

METHODOLOGY

3.1. General approach

In this chapter, the methodology applied by the study has been chosen to acquire information about patient's experience on the waiting time in hospitals and deduce conclusions which can lead to developing a problem solving mobile application. The inductive research approach is selected to generate generalization. We follow a qualitative approach to make the inductive meaning of the data that is collected. The data collected is through interviews as the main tool to capture the business system requirement along with interaction with participants. Since the process of surveying aims to attribute meaning from respondents' experience, the study is not limited to the researcher's view or understanding of the situation and we expect to learn new things about participants' experience.

To capture the current state of the field, multiple types of sources should be utilized. This includes, for example, reviews and healthcare sources. Other theories and concepts are often used as a fundamental support to design theories. These theories are referred to as kernel theories and are meant to provide further depth in how the design is conducted (Walls, Widmeyer, & El Sawy, 1992). Accordingly, the design is made based on certain requirements collected from respondents and measured by comparing to the main objectives that are listed in the previous chapter.

3.1.1. Design science research methodology

The Design Science Approach proposed by Peffers, Tuunanen, Rothenberger, & Chatterjee (2007), is adopted in doing this research which is a process model consisting of six (6) activities in a nominal sequence. Hence, Peffers, et al. (2006), provide design science research methodology (DSRM) for IS researchers; research using DS provides a necessary paradigm for conducting applicable, yet rigorous, research, i.e., research that is closer to IS's applied *raison d'être* (reasons for being). Thus, the cyclic process of the DSR suggested by Peffers, Tuunanen, Rothenberger, & Chatterjee (2007) is followed along with Hevner and coworkers' framework guidance (Hevner, March, Park, & Ram, 2004).

Figure 2 below. shows the DSR process which consists of the following processes: problem identification, defining objective of a solution, design and development, demonstration and

evaluation, and communication. DSRM Process for this design study is used to create an artifact to efficiently address important and relevant problems patients have in hospital waiting time, determine the performance objectives for a solution, design and develop an artifact that can be brought to bear in a solution, demonstrate the use of the artifact to solve one or more instances of the problem, observe and measure how the proposed application support solution of the problem and to finally communicate the process to other.

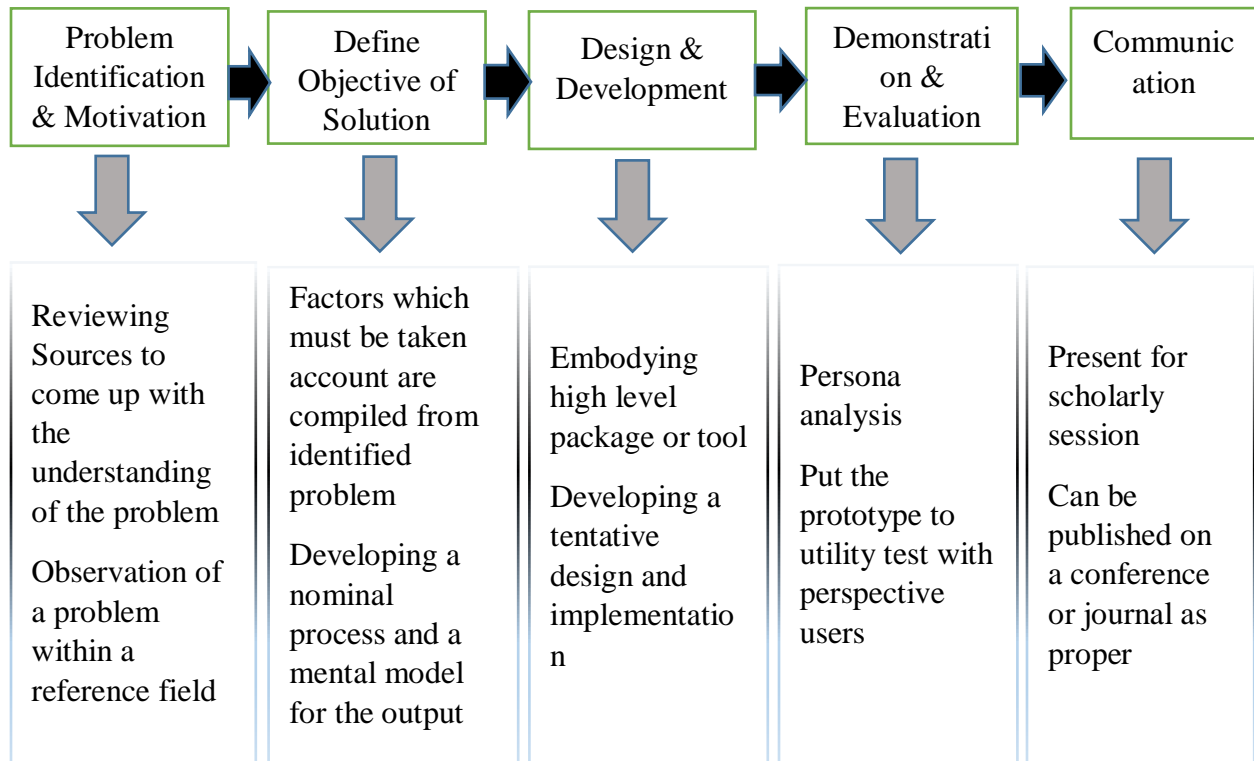


Figure 2: DSR process by adopting Peffer’s DSR Model (Peffer, Tuunanen, Rothenberger, & Chatterjee, 2007)

3.2. Problem identification and motivation

Defining the specific research problem and justifying the value of the solution are the main purposes of this phase. In this stage of design science research, the researchers understand the specific problems and gain a deeper comprehension of the complexity of their nature. This process is done first with understanding the nature of the problems and exploring them, and then by specifying the problems and validating them. We reviewed several sources to come up with the awareness of the problem including identification of a problem within a reference field.

Problems are identified through observation and gaps found in the literature. People have a better experience on mobile phones and applications nowadays. Using mobile health to make appointments with the hospital is not a well-studied area in our country. Drawbacks from previous studies show the lack of functionalities on the patient appointment applications which intend to improve patients' satisfaction and enhance the process of making an appointment with healthcare.

As mentioned earlier in this document, satisfaction is a serious issue for many patients visiting doctors. Not only do hospitals provide easy service but also the available web-based solutions lack functional and non-functional requirements. Web-based solutions are prominent since in some cases patient satisfaction is affected by the distance between their residence and the hospital and therefore, the size of the queue. Besides, a high number of patients in the waiting room results in longer waiting times, and health facilities recommend the patient to another facility, which fits patients' cases.

Since many pieces of research are subjected to community-based there is a need for community-based study in Ethiopia on the patient hospital visit and factors affecting their satisfaction in both private and public hospitals. It is against this development that this study focuses on how healthcare experience can affect patient satisfaction and how can it help to improve patient satisfaction in the selected healthcare organizations (i.e. both public and private).

3.3. Objective of a solution

The objective of a solution artifact is to improve patients' hospital experience based on problem understanding. In the introduction of the paper, we defined our objective to design a mobile-based solution that can enhance the patient experience while visiting Healthcare. The platform can be used by anyone who wants to make a hospital appointment based on their profiles. The information and functionality presented by the mobile application should be displayed in an easily understandable and user-friendly way, considering part of society that might not have previous similar experience on technologies.

The objectives of the solutions are compiled based on problems identified from the previous phase and using a mental model to understand the problem. This involves compiling a detailed list of the factors which need to be taken into account that affect patients satisfaction. Patient satisfaction depends on the patient previous healthcare experience, the purpose of the current visit, a reason to

end up in the hospital, arrival time before the appointment, point of delay, and reason for delay. Therefore, Investigate patient satisfaction, evaluate the challenges affecting patient experience, understand the concepts and techniques used for application development, and design a mobile-based solution that can improve patients' experience should be addressed. To meet these objectives, the system must be designed using different disciplines such as design science and human-computer interaction (HCI).

3.4. Design and development

This phase is a phase where resources are required moving from objective to design and development including knowledge theory that can be brought to bear in a solution (Peppers, Tuunanen, Rothenberger, & Chatterjee, 2007). Therefore, to develop an artifact we convert the problem into parts that help us answer the complexity of the problem.

The design and development of the system are conducted in two steps. First, we collected data through interviews and observations from the selected health organizations, then the data analysis results give in detail, the necessary specifications, features, and operations that will satisfy the functional requirements of the mobile artifact. This is the step where to discuss and determine the specific information need for the scheduling application. Therefore, based on the objectives set above we determine core functionality and futures for the mobile artifact.

The second round is the round where the real design begins. After analyzing the collected data and capturing details about user requirements and functional specification consensus, we use user stories and experiences to incorporate into the design of our application. The selected functions and theories formed the basis for the design of the artifact. In this study, the Object-Oriented System Development life cycle is followed to develop a system that includes the object-oriented and analysis phases.

3.4.1. Study area

The study followed in public and private health facilities, at the outpatient department waiting room located in Addis Ababa, Ethiopia. Public and private facilities are selected based on the level of the Ethiopian three-tire health care system. Accordingly, the selected health care facilities are Public (Tikur Anbessa Specialized Hospital (TASH), Yekatit 12 Hospital, and Alem bank Health Center) and Private (Bethazata General Hospital, Dr. Nega clinic, and Christmas International

Brain & Spine Hospital). From the Tertiary level, health care is Tikur Anbessa Specialized Hospital (TASH) and Christmas Brain and Spine Surgery Specialized Hospital were selected, from secondary level health care: Bethzatha General Hospital and Yekatit 12 Hospital were selected and from the primary level, health care Dr. Nega clinic and Alem bank Health Cente were selected.

3.4.2. Study population

The source population of this research was all the patients seeking care at the Hospitals Assessment center, General outpatient department. Selected health workers who have a common feature in using the electronic health system were also interviewed from each section to identify the causes of patient satisfaction and delay.

3.4.3. Sample size and sampling method

Due to the sample size, there is almost always the need to sample respondents' for any investigation (Cooper & Schindler, 2006). From the routine work and other daily business operations, it is difficult to get all the responsible experts for the interview, therefore a purposive sampling technique was employed to conduct interviews and collect all the necessary information. Purposive sampling of health workers is needed to ensure the respondents have hospital experience on different variables and to ask them about mHealth issues in existing systems and services provided by the health care (Creswell, 1994).

This study is designed to improve patients' experience over their hospital visit using a Qualitative study design where the information about the existing business process was collected using key informants and document review. Interviews were performed in this study with 15 patients and 6 Clinicians from selected 6 Hospitals. Hospitals were selected based on the Ethiopia Health Tire System discussed in the first chapter, which are Primary Level HealthCare, Secondary Level HealthCare, and Tertiary Level HealthCare. The data collection was started through semi-structured interviews involving experienced Doctors, Porters, Receptionists, and Patients. Open-ended questions were asked to find more about the data. The material that was gathered during the Interview of this thesis functioned as a primary foundation for the development process.

The following table depicts the number of participants based on the Ethiopian three-tire health care system.

No	Level	Sample Selected Organizations	Clinicians	Patients
1	Specialized Hospital	Tikur Anbessa Specialized Hospital (TASH)	2	6
		Christmas Brain and Spine Surgery Specialized Hospital		
2	General Hospital	Bethzatha General Hospital	2	5
		Yekatit 12 Hospital		
3	Primary Hospital	Dr. Nega Clinic	2	4
		Alem Bank Health Center		
	Total	6	6	15

Table 2: Sample size

3.4.4. Data collection methods and procedure

In this stage, two forms of data collection and information collection systems are used in the research setting according to Cooper & Schindler (2006). In the road within this research, the Researcher collects data using both primary and secondary data collection techniques, often together with the original data that is collected via instruments such as interview and observation, to produce new knowledge on understanding significant problems for patients and identify the functional and non-functional requirements. They helped to develop patient healthcare satisfaction forms with worthy functionalities like easily capture any kind of data. In addition to primary sources and original instruments, secondary sources used to provide an overview of existing published knowledge on the topic, and possible current debates about the topic are obtained from sources including literature, industry surveys, published electronic and printed sources.

In this thesis, health workers and patients were interviewed about the current paper-based system and related business using an interview guide to identify the core problems that are happening in the existing system. The guide was prepared by reviewing works of literature and most of the functional and non-functional problems of the designed and developed system are identified using an interview guide.

Before the actual data collection, data collection instruments were prepared according to the information needed. Beyond participant interviews, many observation methods exist for collecting information about human behavior and hospital business process. This falls into the development of artifact analysis.

3.4.5. Data analysis methods and procedure

Once research and data collection completed, information, and perspectives gathered from secondary and primary resources are synthesized and analyzed to develop the findings, artifacts, and conclusions contained in the study. The Unified Modeling Language (UML) technique is the primary modeling language we used to analyze, specify, and design the new proposed system. The data collected through interviews were summarized by UML modeling at various phases. The collected data were conducted based on the Federal Ministry of Health, Health Sector Development Program IV.

Data Management

Key informant interviews were captured on audio-tape recorder, labeled with the date and time of interview and section from where the respondents were from for easy identification and analysis. Data were analyzed qualitatively using Narrative analysis. This method is used to analyze content from various sources, in our case from interviews, observation, and document reviews. The experiences and stories that are shared by patients helped us to answer the research questions. Interviews conducted, based on a semi-structured questioner helped to find out what challenges patients are facing in making an appointment with doctors.

Qualitative analysis

Qualitative data analysis is the process in which we move from the raw data that have been collected as part of the research study and use it to provide explanations, understanding, and interpretation of the phenomena that we are studying. As we stated in the previous chapter, interactive interviews have been conducted with twenty-one informants where fifteen of them were patients and six health workers to collect the necessary data regarding patients' hospital experience.

A total of 20 questions were asked to collect respondents' experiences and opinions. The questions are open-ended, held to help researchers obtain the necessary information and response which helps identify the basic needs of patients for the proposed artifact. The survey helps to identify factors that are affecting patients' satisfaction and what kind of system we need in Ethiopia.

All interview questions were checked by the Researchers for comprehensiveness and errors. Contents were transformed from literature and linked among objectives of the study and translation

into content was established. Interview questions were undertaken to target an area of patients and clinical practice that is important to patients (Cheraghi-Sohi, Hole, Mead, & McDonald, 2008).

The need for qualitative interviews to be piloted is not relatively obvious because as the interviews progressed, the quality of the interview guide improved (Harding, 2013). We have used method by Majid, Othman, Mohamad, Lim, & Yusof (2017) to conduct a pilot study i.e; determine interview questions, have the initial interview questions reviewed by experts, selecting the participants piloting the interviews, and report the modification made.

Information from the voice recorder was written down verbatim to Microsoft word in text format. For each section, Code (1): Referral section, Code (2): Registration & triage, Code (3): Clinical Section, more justification on the process in that segment was given, and based on this tenders the researchers picked out the areas to focus the questions. The interview mainly based on four areas i.e.

1. Which sections have the longest waiting time and why? Code(A)
2. What are the major causes of long waiting times? Code(B)
3. What can be done to handle this problem? Code(C)
4. Were you satisfied with the outcome of their service? Code(D)

The opinion of respondents was collected, summarized, analyzed, and presented in a readable product in comparison form related study conducted in a different area. We first browse through all the responses and make note of the first impressions then read through the responses several times line by line and code relative words, phrases, and actions from the collected data. By deciding which codes in the responses are the most significant and create categories from them, and drop the codes that are not significant to the study.

Every answer gathered started on a new paragraph and a unique code assigned at the start of each response depending on the question and section. For example, Which sections have the longest waiting time? A respondent from Clinical. A document was then saved (stored and backed-up). The document was then reopened and sort by paragraphs. The primary document was arranged with similar responses put together in terms of the major question for every segment. The final master document was developed by fine-tuning the primary document. This information was fine-

tuned by cutting out responses that were not related to waiting time and for responses that were similar in context, only one was picked.

3.4.6. Design tools and technique

During designing this system, we used Unified Modeling Language (UML modeling) or modeling the components of the system. UML models are an important part of the software development process. It consists of building an abstraction of reality. We used UML because it allows Object-Oriented implementation to model the system. Such as:

- Sequence Diagram: to show object interaction arranged in time sequence. We used Sequence over activity because it helps to visualize the sequence of calls in a system to perform specific functionality unlike showing the workflow of one activity to another.
- The design class model: is a type of static structure diagram that structure the system by showing classes, their attributes, operations (methods), and the relationship among objects of each class. A clear class diagram is used to show the relationship of objects and methods for the back-end design integrated with firebase.

In designing the artifact, a mobile-based patient scheduling system, Visual paradigm, and Lucid chart were used as a drawing tool with UML support and real-time collaboration capabilities. The design helps in specifying hardware and system requirements and also helps identify overall artifact architecture. Therefore, the functional and non-functional requirements are the basis for artifact development. The application was designed based on the study findings.

We used a mockup tool to depict the lower-level user interface design of the mobile application. A lucid chart is a mockup tool, which is a free UI prototyping tool, which makes it easier to design. It provides very good interfaces and creates a fast mockup for our application. The application was evaluated by polling opinions of system experts. Open-source frameworks are used in developing both the front-end and back-end of the system.

3.4.7. Programming languages

To develop the system, Ionic, Angular JavaScript, HTML5, Bootstrap, and CSS were preferred for client-side development. We chose these as convenient tools to develop a user-friendly interface to any kind of operating system (iOS or Android). It is important to make the application

accessibility for the aiming society. Using Ionic Framework makes it easier to build hybrid mobile apps which are essentially small websites running in a browser shell in an app that has access to a native platform layer. Since Hybrid apps have many benefits over pure apps, mostly in terms of platform support, speed of development, and access to 3rd parties we used Ionic Framework.

Ionic is an HTML5 mobile app development framework. With Ionic, we developed an HTML5 application because it was the 5th and last major version of markup languages which is a WWW Consortium recommendation.

We have used Bootstrap because it belongs to the “Front-end frameworks” category and it is a responsive CSS framework and consistent than the other frameworks such as react.

Node.js was for the back end language because of its tooling and coupling with Firebase and it is much faster for applications than PHP or other back-end technologies.

Client-side Programming

For the development and designing of the app, AngularJS is used to design the front end or interface of the system, and Ionic is used to build a native-feeling application using web technologies like HTML, CSS, and JavaScript. HTML for creating the web pages, CSS for styling and for adding further functionalities JavaScript was used.

➤ HTML

Hypertext markup language (HTML) is used as a markup language for displaying web pages. Originally, HTML was developed with the intent of defining the structure of documents like heading, paragraphs, lists, and so forth to facilitate the sharing of scientific information between researchers. Now, HTML is being widely used to format web pages with the help of different tags available in HTML language.

➤ Ionic

Ionic is a complete open-source UI SDK for hybrid mobile app development. It is used to build high-quality mobile and desktop apps using web technologies (HTML, CSS, and JavaScript). Ionic framework is focused on the front end experience, or UI interaction of an app (controls, interaction, gesture, animations). It's easy to learn, and integrates nicely with other libraries or frameworks, such as Angular, and be standalone without a front-end framework using script include. In developing this system, we integrate the Ionic Framework with Angular.

➤ **Angular JavaScript**

Angular JS is a JavaScript framework written in JavaScript. It is an open-source front-end web framework mainly maintained by Google and by the community of individuals and corporations to address many of the challenges encountered in developing a single-page application. Also, AngularJS, which are built on top of JavaScript is making the life of developers very easy by making application modular and easy to maintain. Its purpose is to help to develop the applications with model-view-controller (MVC) capability to make development, maintaining, and testing easier.

➤ **CSS**

To make HTML pages look attractive, we used CSS. Using CSS developers choose colors, fonts, and different layouts. In short, CSS is used for styling of HTML document. It is designed in such a way that enables the separation of content and presentation so that it makes it easier for any change of content without interfering with a design. It also enables web pages to share a single CSS file for styling to reduce repetition and complexity.

Back End Technology

The back end (server Side) describes the data access layer, server, and other computational logic of the system. The back end of the system was designed with Firebase. NodeJS was chosen to integrate with Firebase to write server code.

➤ **Firebase**

Firebase is Backend-as-a-service (BaaS). Firebase provides web and mobile app developers with a way to link their applications to backend cloud storage through the use of APIs and SDKs. It is built on Google infrastructure and scale automatically, for even the largest apps.

➤ **Node.js**

Node.js is a JavaScript runtime built on Google Chrome JavaScript (V8 Engine). It is an open-source, cross-platform runtime environment for developing server sides and networking applications. We use JavaScript to write code for Node.js applications and run within Node.js runtime on the operating system we want.

Software Tools

The following source tools were chosen to perform various tasks in application development.

➤ **Visual Studio**

As an integrated development environment, we have used Microsoft Visual Studio which is a creative launching pad that we have used to edit, debug, and build code. And then publish an app. It is provided by Microsoft. It is used to develop computer programs, as well as mobile apps, web apps, websites, and web services.

3.5. Demonstration

This phase proves the efficacy of the artifact to solve the problem. We examine the functionality and effectiveness of the artifact and explore potential problems for further improvements. It is done using persona analysis (user-centered). Resources required for the demonstration include effective knowledge of how to use the artifact to solve the problem.

The demonstration of the system is presented through the development of a prototype. Therefore the demonstration is presented through two different scenarios. The first scenario is presenting the mobile application where different parts of the system are presented for users to understand their interaction with the prototype and clarify system readiness for evaluation. Secondly, demonstrate this involves describing how the prototype is meant to function.

3.6. Evaluation

Evaluation in Design Science Research (DSR) is concerned with the evaluation of design science outputs, including theory and artifacts (Pries-Heje, Baskerville, & Venable, 2008). Observing and measuring how well the designed application supports a solution in improving patient satisfaction is done in this phase. Evaluation of design artifact and design theories is a key activity in Design Science Research (DSR) as it provides feedback for further development and (if done correctly) assures the rigor of the research. So during this stage, a full or partial implementation is evaluated according to the functional specification.

Prototype evaluation is done using feedback on the design, usability, and user experience of users. After demonstrating the prototype to a certain group of people we have developed questions and asked patients reflection on the application. These were used to emphasize that the design fulfilled the predefined criteria and functions identified during the development of the artifact. Finally, patients opinion was obtained to evaluate the artifact's usability from an external point of view.

3.7. Communication

In this stage of DSR methodology, the initial description of this study is presented in the thesis work for scholarly sessions. Communicating the problem and its importance, the artifact, its utility, and the rigor of its design are shared. And further, the research can also be published in a conference or journal as proper.

3.8. Ethical consideration

Before data collection, ethical clearance was gain from Addis Ababa University, School of Information Science. Data were collected after getting permission from selected Health Centers. Participants were aware that participation is completely on a volunteer basis and have no influence on their safety. The researcher provided potential participants with information about the purpose and possible outcomes of the study and requested them to respond to the interview. The respondents were assured that all information provided is confidential and used for academic purposes only, no individual names of respondents would be revealed in the reporting. Accordingly, it is the responsibility of the researcher to protect such data by, for example, omitting information that might lead to the identification of individual subjects. The anonymity of respondents is guaranteed by limiting identifying them by their name. Respondents were asked to participate voluntarily in the study without any form of coercion.

CHAPTER FOUR

RESULTS

This chapter is where we present the current system, the business process, the functional and non-functional requirements, new artifact design, and demonstration and evaluation of the study. It is classified as First, we provide the data presentation and analysis of the collected data, then identified factors affecting patient satisfaction are described based on analyzed data followed by triangulation of identified factors. The functional and non-functional requirements of the system are discussed after identifying the major processes in the arrangement of appointments. Application technologies we used in developing the system are depicted along with programming languages. Although the system design phase is presented along with how the system is designed by using different techniques based on data obtained and data analyzed. Finally, The Demonstration and evaluation of the system are shown to complete the process.

4.1. Data presentation and analysis

An inductive approach is used to group the data and look for similarities and differences in the respondents' responses. In addition to that, it helped to discuss issues encountered during making appointments in the extent of the major process carried out in arranging appointments, medical institutions in Ethiopia, clinical departments, physicians, patients waiting time, and their mobile experience. The questions were asked with respective responses during the semi-structured interview and the interview output has been analyzed by conducting open coding as presented below.

4.1.1. Socio-demographic characteristics of respondents

This portion of the survey is concerned with the background of the respondents to understand the respondents who participate in the interview for this research. Respondents were requested to answer their age, sex, residence, employment, education, and marital status. The main characteristics of the respondents are shown in Table 3. A total of 15 patients were surveyed with all of them passing through registration, triage, and clinical examination. they went for checkups and other hospital services.

Seven respondents of the study were females and eight were young adults between 18-49 years. Ten are addressed from within Addis Ababa and five were from regional states. There is a large

number of patients' employment levels for an employed participant that is eight while six of them had attained secondary school and the number of married respondents is eight.

Patient Characteristics	Frequency
Age	
Less than 18	2
18 – 24	5
24 – 49	5
Greater than 50	3
Respondent's Sex	
Male	7
Female	8
Residence	
Within Addis Ababa	10
Outside Addis Ababa	5
Employment	
Unemployed	2
Self-employed	5
Employed	8
Education	
Uneducated	2
Primary	4
Secondary	6
Tertiary	3
Marital Status	
Single	7
Married	8
Divorced/widowed	0

Table 3: Socio-demographic characteristics

4.1.2. Facility related experience of the patient

Patients found to go to other health centers for similar reasons, 10 patients had visited other centers before they get to the right health center. Eight of them visited the health care based on Referrals from other healthcare and most patients (11) reached the intended healthcare using people's recommendations.

In this part of the analysis, respondents were requested to tell a story on their experiences during their visit, and after they visited the health center. Constructs used to investigate patients' pre-visit experience include whether they have previously visited the health care, the purpose of their current visit, and their reason to end up in the health center.

Pre-Visited Characteristics	Frequency
Previously visited the health center	
No	5
Yes	10
Purpose of the current visit	
Review	4
Referred	8
Walk-in	3
Reason to end up in the health center	
Recommendation	11
Media	4

Table 4: Pre-Visit facility characteristics

To examine what the respondents experience after going through the assessment center, we took a record of the arrival time before their appointment, point of delay, the reason for the delay, and whether they were satisfied with the service or not.

Post visited Characteristics	Frequency
Arrival Time before the appointment	
Early	7
On-time	5
Late	3
Point of delay	
Registration	8
Triage	0
Examination	5
Diagnostics	2
Reason for delay	
Many Patients	9
Few Staffs	1
Staff inefficient	5
Satisfied	
Yes	7
No	8

Table 5: Post-Visit characteristics

This table depicts the majority of participants arrived early before their appointment time. Seven participants came early before their appointment time. Eight participants declare they have queued for a registration process which is more than the examination room, i.e. five respondents, and two patients during diagnosis. There is no participant queued in the triage room. Nine patients said the reason for the delay was according to a large number of patients. Moreover, because of the low number of staff were one respondent and five of them responded to healthcare having inefficient staff in doing their job as the reason behind the delay. After doing such an experience/expectation survey, we asked participants if they were satisfied and seven of them were satisfied while eight of them were not satisfied.

4.2. Factors affecting patient Satisfaction

The prior works of literature provide us with factors affecting patient satisfaction in health care. Such problems would help provide a road map for people who want to research on the same area. Regarding different problems affecting patients in hospitals, such solutions would not be the only solution, but they open different good ways to do it.

4.2.1. Waiting time in waiting Room

Overall patients spend an average of four hours and fifteen minutes (04:15:00) waiting to contact a health worker in the waiting room. Which means patients waste their time while waiting for a health worker attending them. The minimum waiting time recorded was zero hours while the maximum was ten hours.

The waiting room has been the bottleneck for patient flow. Patient flow analysis shows that the long waiting time was at the registration (pre visited character). If many patients arrive at the same time then most of the patients would have to wait longer. Patients then queue in the holding room until they enter into examination rooms. The clinician may request for further diagnostic investigation from a laboratory, x-ray, or scans.

From the respondent's socio-demographic characteristics, we captured the relationship between patients demographics and the time they spent in the waiting room. Patients whose age are 50 and above seem to wait a longer time than the others. As for resident, patients who are not resident of Addis Ababa seems to have longer waiting time than patients from Addis Ababa.

4.2.2. Consulting time

The time patients spend in the doctor's office has a range starting from a minimum of ten minutes to a maximum of 26 minutes. This means patients spend an average of fourteen minutes and six seconds (00:14:06) while visiting the doctor.

4.2.3. Arrival time

The majority of people came before their appointment time, arrival time. A study in America shows that 82% of arrived early or on time (Thompson & Fetter, 1966). In this study, result from patients who visit the health organization, arrival time has a range of minimum 30 minutes late arrival to a maximum of 3 hours earlier arrival. The average patient arrival time before their appointment time shows 00:37:30 (thirty-seven minutes and thirty seconds).

4.2.4. Patient expectation

Patient's expectations related to waiting time were analyzed on patients post consulting hospital experience. More than half of patients think the waiting time is not worth comparing to the time they spend for diagnosis (Consulting time). From the overall patient waiting time which is four hours and fifteen minutes (04:15:00), patients spend an average of 17 minutes while receiving a service.

Although Staff politeness is a highly related aspect for patient expectations next to waiting their turn. Patients have to wait longer as the staff member would be busy seeing who were first in the batch and the rest would be waiting. Patients are not effectively attended because there are many staff members presented at the service point but they don't provide the right information to patients in the waiting or they are busy with another work: such as administrative work, preparation, or collecting cards.

Patients Smartphone experience

Nowadays usage of smartphone across people have increased. Respondent patients who have a smartphone use their phones for Social media, service-based applications, calendars, and other applications.

Interviewed respondents 3 but 12 don't have smartphone experience. Some patients use desktop applications, websites, service-based Applications, and Google maps on computers. All the respondents mostly use their mobile phones as one of their day-to-day activities. Even when they are going to the hospitals, they use it for searching Hospitals and hospitals' locations over the Internet and Google map. Most patients ask partners experience in a certain Hospital so that their partners can recommend for hospitals with good service and its location. Despite this, some hospitals receive and make appointments through phone calls, patient's lack of information that they directly go in-person to a certain hospital, and wait for their turn.

Patients' previous application experience makes it easier to apply such kind of system simply. After revising these problems, we considered developing the system with full information providing facility would help users to easily access information and improve time-wasting. Respondents who don't have smartphone experience have shown their readiness to own

smartphones if it is for a hospital appointment system which can ease the current process and function.

4.3. Triangulation of identified factors

To validate data collected from patients we used cross verification for the healthcare side. Information and perspectives were collected from key informants from selected healthcare staff. Their responses on the causes of long waiting times were analyzed by emerging recurrent topics.

According to respondents, patients wait a long time in the waiting room. Most of the health workers also identified the longest waiting time is waiting to get service than in triage or counseling time. The patient appointment system is highly considered in this study modeled in such a way that patients' will have a direct interface with the system. Patients are expected to easily interact with doctors throughout the system. As the result shows now a day's patients' are waiting four hours and fifteen minutes to get services in healthcare. Physicians stated reasons behind this as:

'Because of patients came formerly, appointments are made in order of first come first served. So they have to wait for their turn because porters don't start collecting cards before the expected time and even after that porters sometimes switch cards unconditionally. It turns out to be patients who came first will be served last. Also, we are usually in a hurry to serve all patients in the waiting and give priorities for inpatients'.

'We need a better organization of time for staff and better information should be provided for the patients especially with severe illness. There is less flexibility in staff based on our roles and personal behavior. Patients ask for department and locations all the time therefore we need more functionality of information desk and consultant.'

However health workers believed that developing the scheduling system will improve first come first served bias based on their appointments in an organized way and would offer flexibility to meet better timing. The appointment system is advantageous in many features such as time-saving and reduction of the crowd in the health centers.

4.4. Major processes carried out in arranging appointments

There are major processes where patients go through to make a Hospital appointment with Doctors and there are sub-processes they should do under each process. It is complicated when one wants

to make an appointment. First, he/she goes directly to the Hospital reception then directed to Billing and again return to receptions to make an appointment with the Doctor. In some Clinics, to see a Doctor, a patient first calls to the hospital to make an appointment and he/she speaks to the Receptionist to make the appointment, and even after the standard appointment time, the patient waits longer in the waiting room.

4.4.1. Medical institutions

Still being a developing nation, Ethiopia has seen a tremendous growth of the Health sector in the field of research as well as in the field of development of numerous large and small scale Hospital Institutions. Though, there is a lack of inter-structure in the facilities. Patients' cards and records might be lost many times because lists are not be maintained in either computerized or manual systems.

4.4.2. Clinical departments

- Did you experience (or anticipate) any barriers to an arrangement of place to meet patients?

Clinical Departments are interested to use the Appointment System to improve patient care and to enhance the patient-doctor interaction. Physicians in tertiary level healthcare are overwhelmed with the high influx of referral patients from regional hospitals throughout the country. Furthermore, patients come without referral and/or without their card because of a lack of awareness. Therefore, we observed a keen interest in the use of a mobile system to leverage the service that is provided and the information desk by the Hospital.

4.4.3. Physicians

- Did you experience (or anticipate) any barriers to the arrangement of time to meet patients?

Resident Physicians are among the beneficiaries of the appointment system. Some of them have faced problems regarding lack of time to give information for every patient. In the hospitals providing many kinds of medication and departments, there is a complication.

“In the current system, the content being delivered from the system is elementary where it can only store patients’ history in the database and doesn’t show future appointments. Since there is a problem in the hospitals where patients’ cards disappeared and the patient has to wait for additional waiting time, it is good if such kind of problems would be considered.”

From the content issues the physicians raised, we observed that appointment setting, calendar, and reminder system is needed to avoid patient waiting time and improve physician working condition.

4.4.4. Major business process

The major activities or business processes of the existing system including their purpose, input, process, and output are the following:

Patient registration	
Purpose	the purpose of this function is to register new patients and update existing patients.
Input:	patient personal Information and address are registered.
Process	when a patient arrives or calls for an appointment, the patient registration process commences. It is the responsibility of the front office staff to ask a series of questions, to collect all the pertinent billing and insurance information. The patient then presents in person the registration department with a referral slip to make billing and make an appointment. The data clerk registers the patient's full information including personal information and address and gives a service identification card after the patient pays the service fee. Whereas if the patient is existing, the data clerk searches the patient card by his/her service identification card and updates the patient visit, and sends it to triage.
Output	the patient is registered at the medical record unit.

Table 6: Patient Registration Business Process

Assign patient	
Purpose	it is to assign patients to each medical OPDs and other different caregiving departments.
Input	Vital sine results (blood pressure, pulse, temperature, respiration, height, and weight).
Process	after registration, the patient goes to the triage room. The triage officer screens the patient and assigns it to the corresponding outpatient department.
Output	patients are assigned based on their cases.

Table 7: Assign Patient Business Process

Patient diagnosis	
Purpose	a physician checks the patient history and diagnoses if the patient has a specific disease based on the medical professional prescription.
Input	patient history, physical examination result, and different HMIS registers.
Process	medical tests are done during the diagnosis process.
Output	the physician came up with a medication for the patient.

Table 8: Patient Diagnosis Business Process

Physician set appointment	
Purpose	here the doctor makes another appointment with the patient.
Input	physician set a date.
Process	after patient history is saved patients are recorded on the waiting list for their next appointment.
Output	appointments are set and registered on the system.

Table 9: Physician Set Appointment Business Process

Generate report	
Purpose	physician file a general report about the patient.
Input	patient history, medical records, and necessary information are to be saved.
Process	after assessment with the patient end, every detail has to be saved to be recorded and reported necessarily.
Output	general report.

Table 10: Generate Report Business Process

4.4.5. Software and hardware in the current system

Most Hospitals started using the smart care database which helps them trace patients' medical records by their name or phone number. Even if patients record is stored in the database it seems that patients have to bring service cards to get the id and for authentication purposes. Patients forget or lose their cards sometimes and end up going through the whole process again. They use a manual patient tracing system using MPI to find uniquely identifying MRN of a patient who lost his/her service card by looking at the client's name with his/her MRN.

4.5. System requirements

The point in the scheduling system is to make it easy and convenient for everyone involved in patient care. Fundamental challenges facing the industry today have been discussed and health workers responded over the issues. Since the factor for affecting patient satisfaction has been defined such as waiting time, consulting time, arrival time, and patient expectation, the recurrent solutions have been identified to solve the problems. Below the solutions are listed with the functional and non-functional requirements of this system.

4.5.1. Functional requirement

Functional requirement relates directly to a process the system has to perform or the information it needs to contain. After compiling and reviewing the interview results, we developed a set of requirements. These are examined requirements that are used throughout the study. Therefore, the functional requirements of the proposed system are listed below as follows.

- The application registers a new patient including its address.

Patients wait longer in waiting area crowding to register and take cards which maximize the number of times patients have to wait around in addition to their busy schedules. To make it easy and convenient for everyone involved in patient care, it is better to register using scheduling software. Patient pre-registration capabilities make it possible for the system to collect crucial patient data before the patient even comes into the office.

- The system allows the patient to use his/her username and password for logging in to the app every time he/she uses it.

Logged in user stays logged in the system and once a user logged out he/she has to log in back to the application using the confirmed account username and password.

- The system authenticates the user.

Patients are worried about privacy and their health information therefore Patients' data should be kept authenticated. To satisfy their need to keep their privacy, the system should authenticate the user when they are registered or logged in. Therefore, authentication is assured by username and password.

- The system manages users' information: the system shall have the ability to access and manage, update, and maintain accurate user information.

The system allows patients to identify and edit or annotate information in their medical record that is out of date or incorrect.

- The system allows patients to view different records of their medical information over time.

Patients expressed the need for their healthcare information of all types that would help them understand their health over time and to be more engaged in monitoring their care. Patients are curious about their medical history they think it will be useful for their next hospital visit. Therefore doctors can send patients' histories directly after the patient is checked. The system has the facility to give a unique Id for every patient and stores detail of every patient.

- The system provides alert if patient information is missing, out of date, or requires verification.

Patients described the need for a feature of notification to manage appointment-related processes and other updates required. Since older patients tend to wait a long time due to missing doctors' appointments notifying appointments date and time in advance would improve such a waste of time.

- The system notifies/inform schedules of patient preferences.

Similar to the above requirement, according to busy schedules and workloads, patients happen to forget appointments they made. Therefore, they need to get automatic appointment reminders sent to their email or phone hence they never forget another appointment.

- The system provides the capability to coordinate the appointment scheduling.

Scheduling is the core module of patient scheduling solutions. Patients require to request their appointment through the system and, in combination with physician schedules, they can only book their physician when he/she is available.

- The system provides information resources to help healthcare consumers understand any information within the medical center.

Patients referred to how exhausting the searching process of hospitals is an overwhelming amount of information in understanding services provided under each health care. They described the need for the tools and structure to help them understand and make decisions in which medical center, what kind of medication, what type of procedure, or other treatment decisions.

4.5.2. Non-functional requirement

A non-functional requirement describes the user behavior properties that the user must have and define how the product should work. The ability to access the system using mobile phones would be considered a non-functional requirement. Security, maintainability, error handling, performance, and good user interface are identified as non-functional requirements of patients with a tendency to increase their satisfaction.

Security issue: patients are worried about their information therefore, security issues should be audited. Since this application is going to help to secure confidential personal information, it should be protected from unauthorized users and intruders. An unauthorized user cannot log in to the system without a registered username and the corresponding password. The system has two groups of the user: the back-end and front-end user. The back end user has full privilege to perform on the system whereas the front-end user can only perform limited operations.

Maintainability: there is a need for patients to update and maintain their personal information. The system should be easily maintained by the developer as well as other authorized trained person. It will also be modifiable at any time to enhance features based on the users' needs. As needs change from time to time the original system will be made available to fill the gap between the system and the newly emerging needs. The system could be enhanced by adding new functionalities without necessarily changing the basics.

Error handling: improper validation is one of the causes of user dissatisfaction. The system is expected to handle errors encountered during run time. An error could arise from users and the system. Validations will be added and exception-handling mechanisms will be used to handle errors that occurred from the wrongdoing of users.

Performance: more patients use applications on their phones which shows the good mobile experience and connection patients have with their phone. Systems performance is an important

issue for the system because the user experience depends highly on it. So this system can carry out activities by exchanging viable information in real-time with fast progression.

User interface and User experience (UI/UX): patients have different backgrounds and experiences. UI of this application was developed based on the common need for a good user interface and the ease of operating the application considering the different patient experience.

The UI/UX of a system is mainly concerned with the type of Graphical User Interface (GUI) the system should provide or what level of expertise of the user. Since the system is going to be used by both sides of patients and doctors, it should have a very simple and user-friendly interface for everyone to understand the functionalities easily.

4.6. System architecture

The system architecture is a conceptual model that defines the structure, behavior, and more views of a system. We used the systems architecture diagram to show the interaction between hardware and software used to create the system.

The proposed system aims to follow the two main properties of software architecture: Consistency and Completeness. The components of the appointment system would be consistent internally to avoid any contradiction once they are implemented together. System completeness is a modeling framework based on the information gathered for developing this system. System completeness would provide a practical test from a set of models to examine the balance of internal and external behavior.

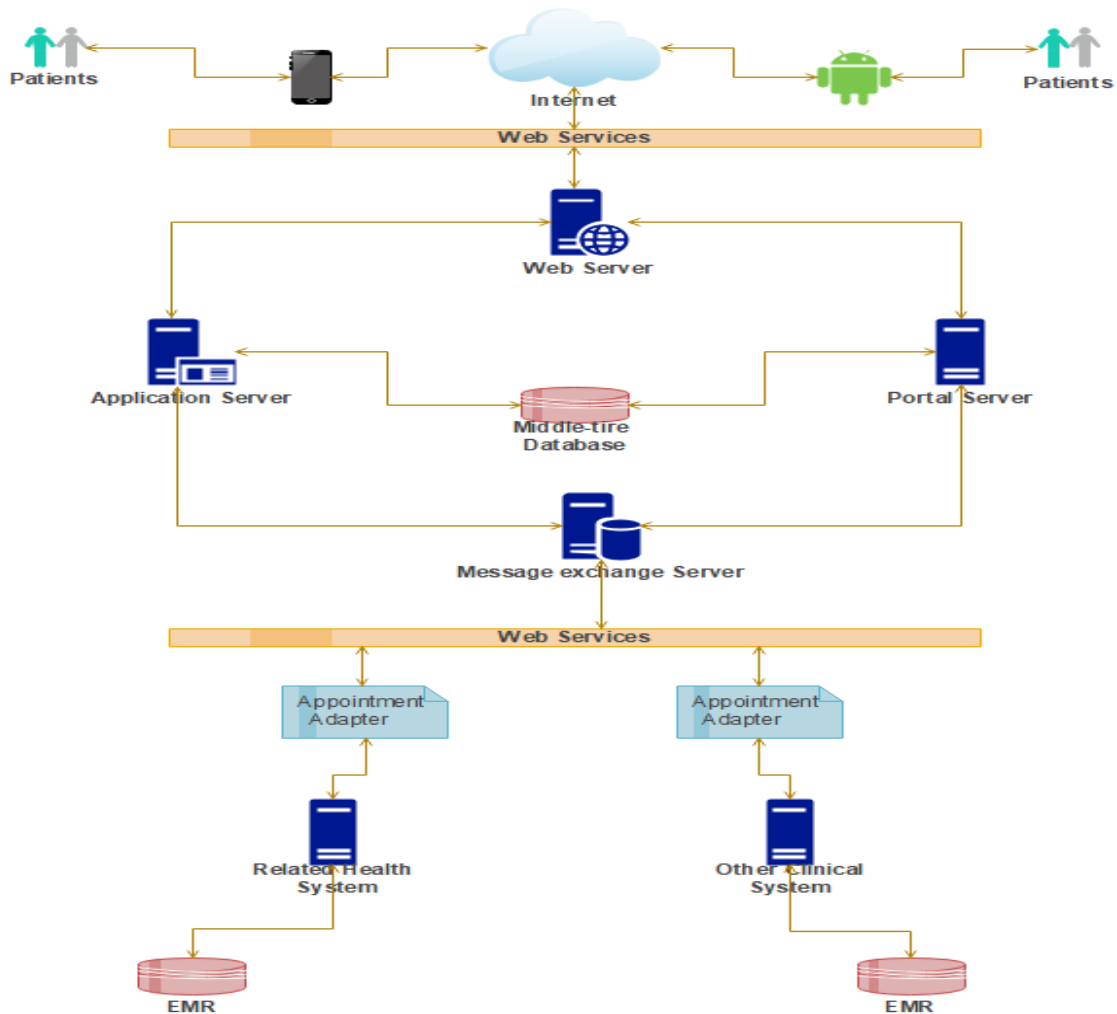


Figure 3: System Architecture

4.7. Application technologies

The purpose of this design is to improve patients' satisfaction with their hospital visit by developing a mobile-based appointment system. The user needs to understand how this application works and the technologies that are used to implement this system.

The front-end design is simple and user-friendly, developed based on users' mobile experience and others on using applications on mobile phones and computers. Once the application is started the patient will register himself and then he will be able to log into the application. The patient can make an appointment by selecting the date and time. The appointments are managed by the admin through a website. The admin also registers a doctor. Admin can view doctors, view patient's records, and view feedback. Firebase, Backend-as-a-service (BaaS) for the back-end development because it is a cloud-hosted NoSQL database that lets us store and sync between patients in

realtime. All the data of registered doctors and patients and the data regarding the appointments are placed on the server. Because firebase provides realtime syncing data is approached and shared by using API so that it eases data access for users from any device.

4.8. System design

Design is the first step in the development phase for any engineered product or system. System design is the creation of the specification for a new system. The system artifact is created in this phase. It deals with the creation of new input, which is the creation of the needed database, the input producer, and the output to meet system objectives.

The patient appointment system consists of three modules:

- Patient
- Physician
- Administration

4.8.1. Identified actors

Actors are usually individuals involved with the system defined according to their roles. Represents a coherent set of roles that are entities to the system that can play in using the system, rather than representing a particular individual. An actor represents a type of user of the system or external systems that the system interacts with. Actors are identified through their roles based on the system's functional and non-functional requirements defined above. The selected actors are listed in the table below with their description.

No	Actors	Description
1	Patient	Refers to the person who books, updates, and cancels an appointment with the doctor.
2	Physician	Refers to the person who views patient appointment records and updates appointment records.
3	Administrator	Refers to a person who will manage the database by creating databases, tables, and make queries. He/she also creates user accounts for users.

Table 11: Identified Actors

4.8.2. Use Case Diagram

A Use case is a methodology used in system analysis to identify, clarify, and organize system requirements. The purpose of the use case diagram in UML is to demonstrate the different ways that a user might interact with a system. It describes the functional roles of different actors (users) of the system. An actor represents a real-world object. The diagram in figure 4 depicts the use case diagram for various users in the system.



Figure 4: System Use Case Diagram

4.8.2.1. System Use Case Description

In this section, use case descriptions are presented based on the role of actors to show the detailed descriptions of activities and functions listed in the above appointment management and other related services.

Use case 1: Use Case Specification for Manage Appointment

Use Case	Manage Appointment
Brief Description	To manage patient Appointments
Actor	Patient, Admin
Pre-condition	Actor logged in to the system
Post-condition	The appointment data is recorded and sent to the next higher level
Process of Main Courses	<ol style="list-style-type: none"> 1. The actor needs to book an appointment. 2. The actor can save the appointment and reschedule. 3. Confirmation will be sent to the user.
Alternative Path	If any Invalid details are entered, a validation message will be displayed.

Table 12: Manage Appointment Use Case Description

Use case 2: Use Case Specification for System Log/ Patient Record

Use Case	Patient Record
Brief Description	Access system log /patient record
Actor	Admin, Patient
Pre-condition	Actor logged in to the system
Post-condition	Access data
Process of Main Courses	<ol style="list-style-type: none"> 1. The actor needs to log on to the system. 2. If the Actor is patient, they are allowed to view their account detail. 3. If the Actor is Admin, he/she is allowed to view all the system logs.
Alternative Path	If any Invalid details are entered, a validation message will be displayed.

Table 13: Patient Record Use Case Description

Use case 3: Use Case Specification for Patient Alerting/Notifying Schedule

Use Case	Patient Notification
Brief Description	Patient Alerting/Notifying Schedule
Actor	Admin
Pre-condition	Actor made appointment
Post-condition	Gets notification
Process of Main Courses	<ol style="list-style-type: none">1. The actor needs to make an appointment.2. If the appointment is made, Admin notifies patient scheduling information.3. The actor gets informed about his/her schedule.
Alternative Path	If any Invalid details are entered, a validation message will be displayed.

Table 14: Patient Notification Use Case Description

Use case 4: Use Case Specification for Patient Information Providing

Use Case	Information Desk
Brief Description	Patient Information Providing
Actor	Patient, Admin
Pre-condition	Actor logged in to the system
Post-condition	Gets Information
Process of Main Courses	<ol style="list-style-type: none">1. The actor needs to log on to the system.2. The actor is allowed to get information.
Alternative Path	If any Invalid details are entered, a validation message will be displayed.

Table 15: Information Desk Use Case Description

4.8.3. Sequence Diagram

A Sequence Diagram is an interaction diagram used to model the interaction between objects in a single use-case. They used to show how the different parts of a system interact with each other to carry out a function, and the order in which the interactions occur when a particular use case is executed.

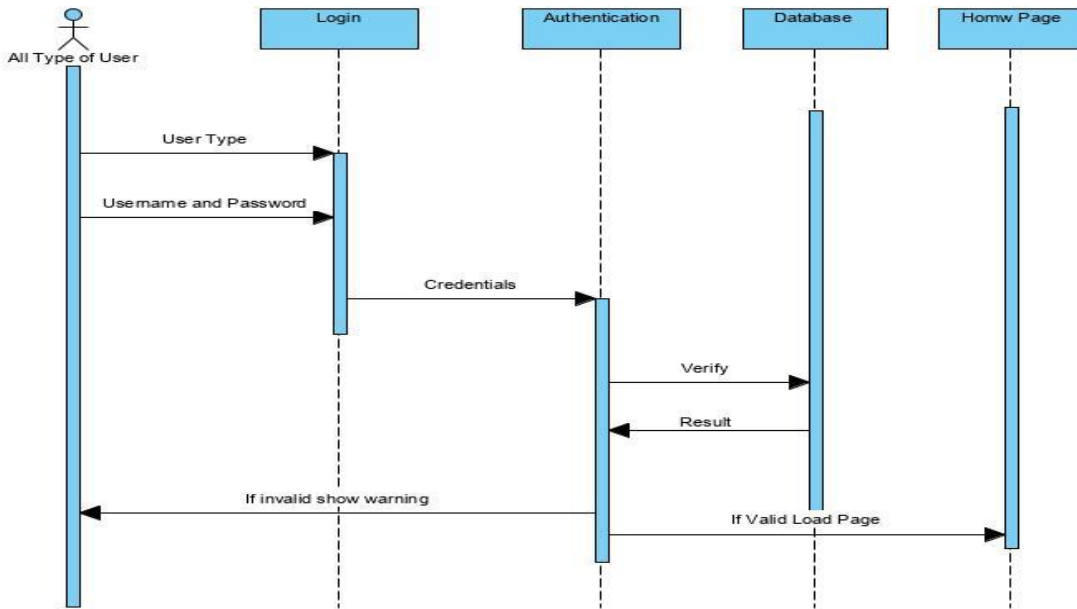


Figure 5: Login Sequence Diagram

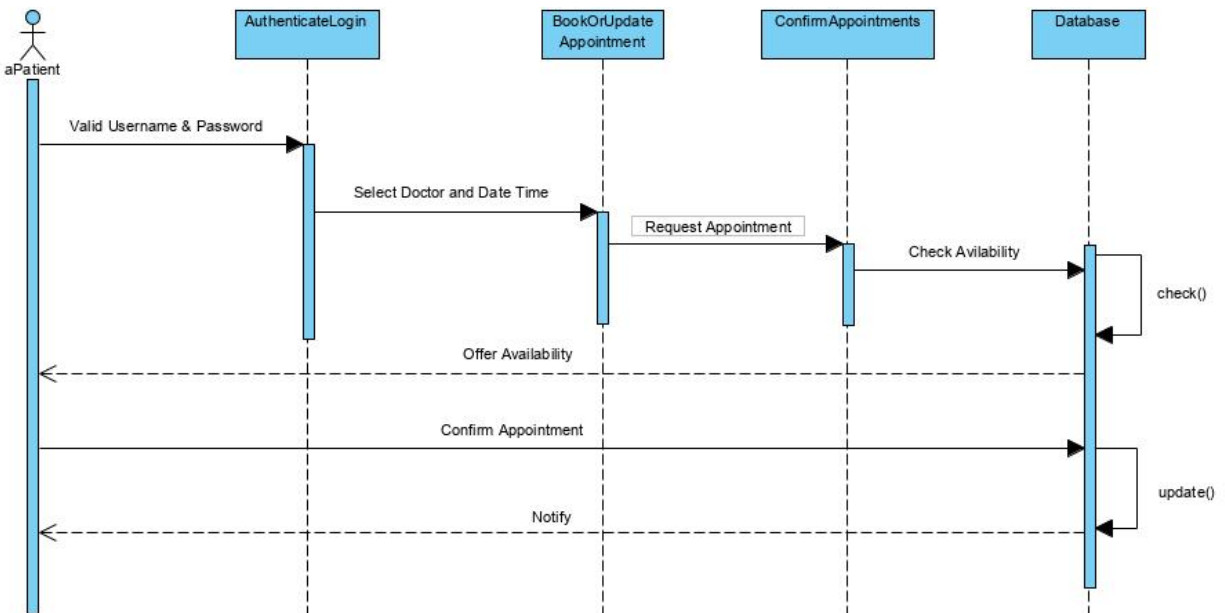


Figure 6: Appointment Sequence Diagram

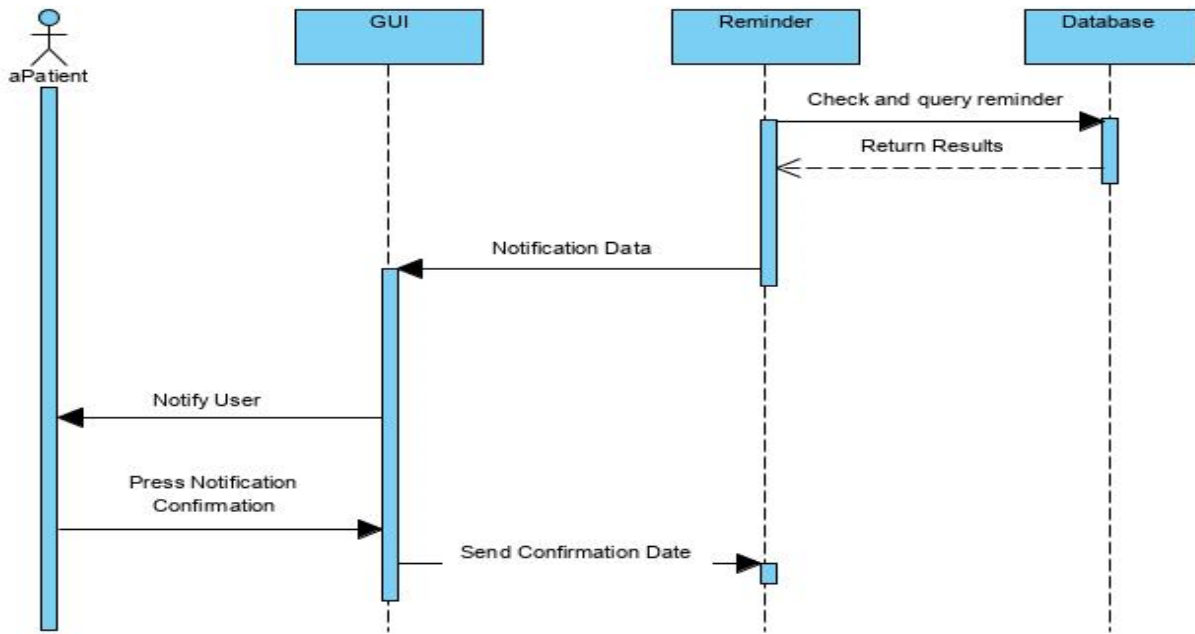


Figure 7: Notification Sequence Diagram

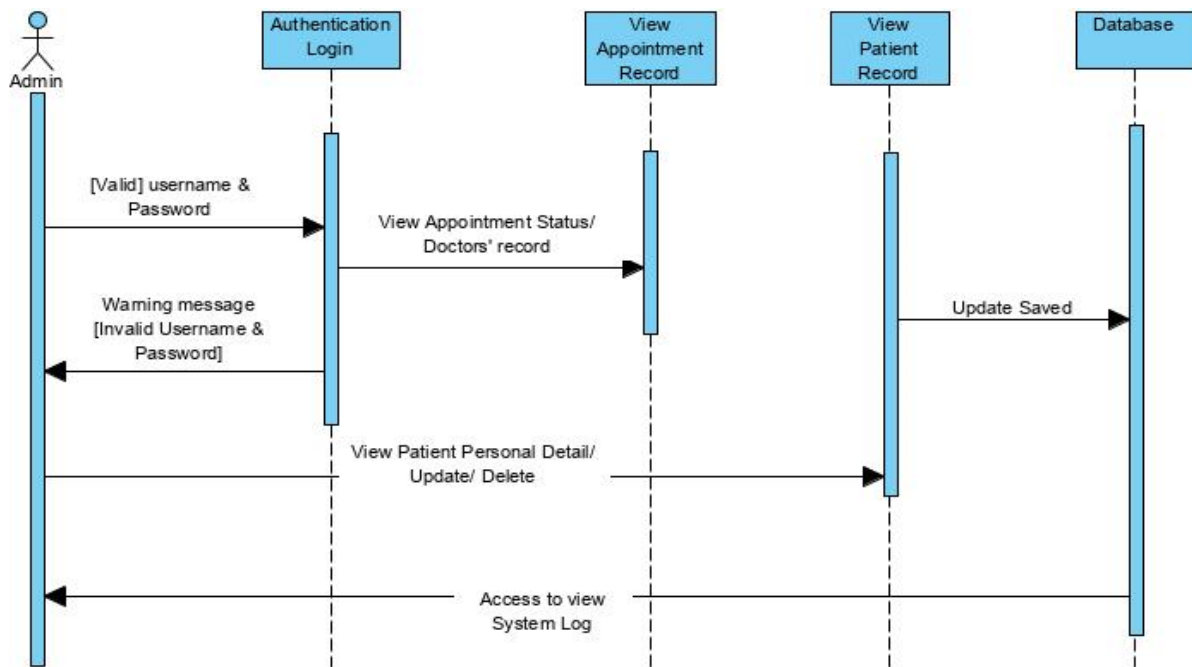


Figure 8: Record Sequence Diagram

4.8.4. Class Diagram

The class diagram shows the diagrammatic specification of the software classes and interfaces in an application to be developed and implemented. It shows the definition of the software classes rather than the reflection of the real-world concepts. Furthermore, it expresses the definition of software classes as software components.

A class diagram describes classes of the system, attributes, and relationships of the classes in a better way. We can say that class diagrams are used to justify the structure or behavior of use cases of the system. Class diagrams best explain the conceptual model of the system in terms of entities and their relationships.

The class patient contains multiple parameters (such as id, name, gender, DOB), which depict the information of all the registered patients.

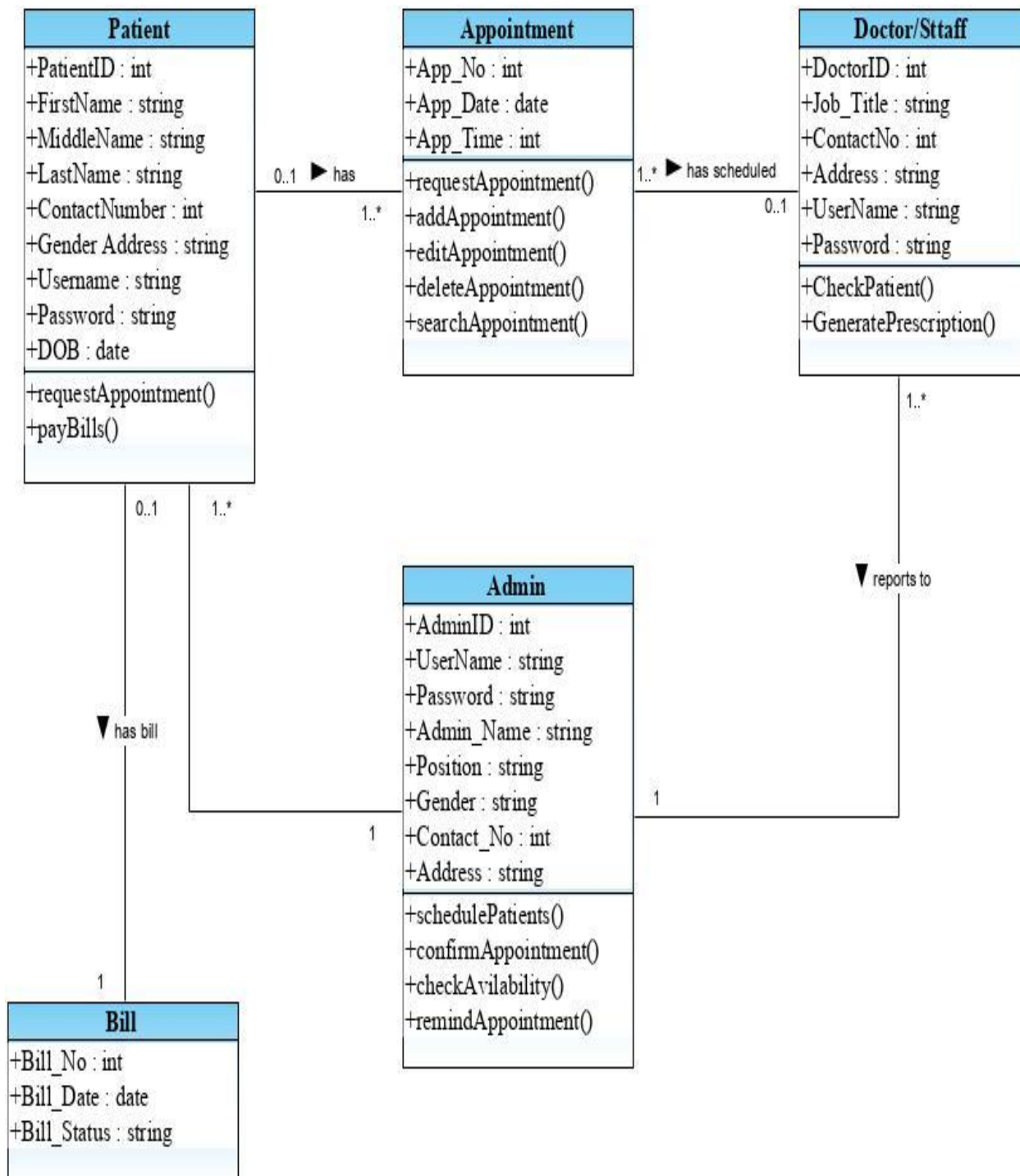


Figure 9: Class Diagram

4.8.5. Authentication Method

Different methods are considered as authentication at the time of registration and login. Login is when a registered person enters the network again. At the time of registration, it is necessary to check that the person trying to register is a valid user.

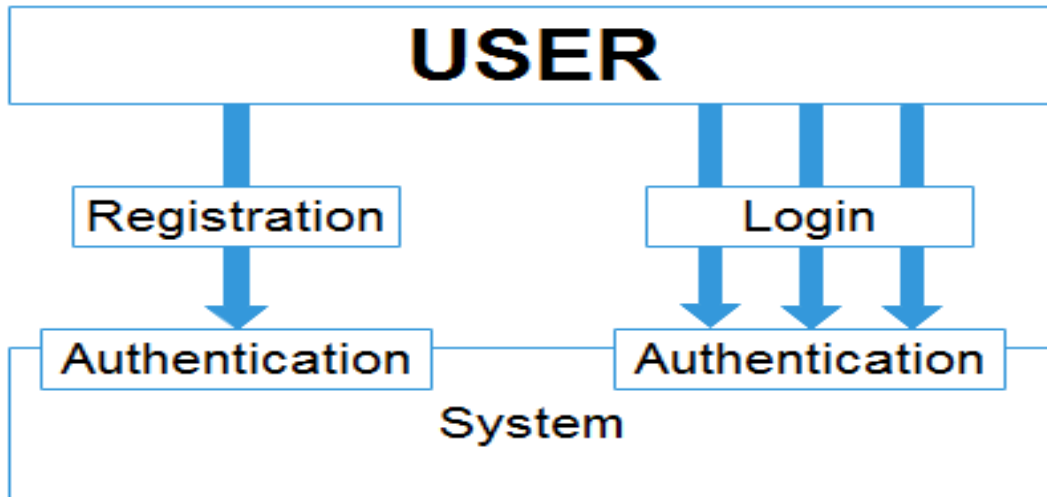


Figure 10: Registration and Login Authentication Process

The user needs to be registered before using making appointments. They are not required to login to view information about their profile, list of Hospitals, and hospital map.

4.8.6. Algorithm form of major functions

In this section, the major functions algorithmic form of the developed system have been presented and discussed. The main implementation of the algorithm of the application is transcribed into pseudocode to make it understandable by even a layman.

The major functions for patient appointments include registering patient information, send an appointment request, view hospital and doctors detail, and notify appointment date and time.

Pseudocode 1: Patient Registration Pseudocode

Input: Username, Email, and password

Output: Registered popup if valid

Load registration form

```

IF first-time entry DO
    Enter a valid User name
    Enter a valid Email
    Enter new password
    Enter the new password again
    //begin matching process
    IF all check results are true THEN
        Generate queries
        Connect to database
        Pass queries to the database
        Display registered successfully message
    ELSE any query fails THEN
        Display error message
    ENDIF
    View Home Page
    See nearby Hospital and Doctor Information
ENDIF

```

Patient registration is one major functionality of the appointment system. Patient registration pseudocode shows the informal description of a computer program on how a patient can register on the mobile application. In this system, the first process is registering on the application. Here a patient enters username, password, and confirms password. After the system checks the validity of users' information, if the validity check is true the user can continue else an error message will be displayed to enter credentials again. Without registering to the application patient can see nearby hospitals and doctor's information.

Pseudocode 2: Authenticate Login Pseudocode

Input: Username and password

Output: Alarm if not valid username or password

Initialize the Login Account

```
Accept Username and Password
IF username and password are valid THEN
    Authentication approval by Admin
    User access to login account successfully
//Proceed for the next factor
ELSE
    Username or Password may be invalid
    Display Try again massaging
ENDIF
```

User authentication is another major function of the system. User information should be kept validated and users have the right to be authenticated. To login to the system, the first process is entering the username and password. The system checks the validity of credentials and if user login is the information is valid authentication approved by the admin and the user is successfully logged in or else popup message send to try entering a valid username and password again.

Pseudocode 3: Schedule Appointment Pseudocode

Input: title, the reason to see a doctor, date and time

Output: notified with start time and end time

Initialize the calendar

```

Input the reason to see a doctor,
Enter date and time
IF event selected THEN
    Return start time and end time
    Function to add an event
        IF validate event THEN
            Pass queries to the database
            Appointment made
            Save the event & send event successful alert
            Confirmation message sent to the user
        ELSE
            Appointment Unavailable message displayed
        ENDIF
    ELSE
        Display required fields shouldn't be empty Event
        message
    ENDIF

```

Scheduling appointments is another major function of the system to show the algorithmic form of how a patient can make a hospital appointment. The main event sources which need to be entered into the application are title, the reason to see a doctor, date, and time. If valid information is entered, queries pass into the database, the system checks the available date and time to make an appointment, and finally, the system returns a confirmation message. The other case is the user entering the wrong information then the system sends an error message to enter valid information.

4.9. Demonstration

The practical usefulness of newly proposed instantiation is examined by demonstrating it. The demonstration was used as a single act bringing the solution to solve the problems patients faced during appointment making. We demonstrate the performance surpasses the appointment system from the analysis and pseudocode above.

The user interface diagram is a diagram used to show the high-level fidelity prototype of the application developed. It is a graphical representation of the actual appearance of the application. The purpose of the prototype is to have a tangible solution to the problems already defined and discussed.

Prototype as a demonstration is presented using screenshots of the system user interface. The following pages are selected to show the necessary process:

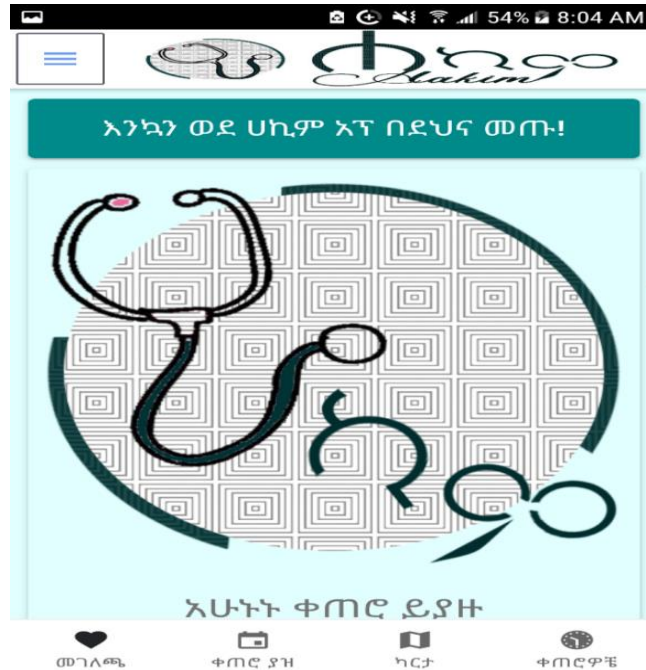


Figure 11: Home Page

Patients have to register on the first use filling registration form despite in figure 12 below; which includes username, password, email, and confirm password. And then the user clicks on the register ('ይመዝገቡ') button to register itself. The information provided by the user is saved on the database located on the server.

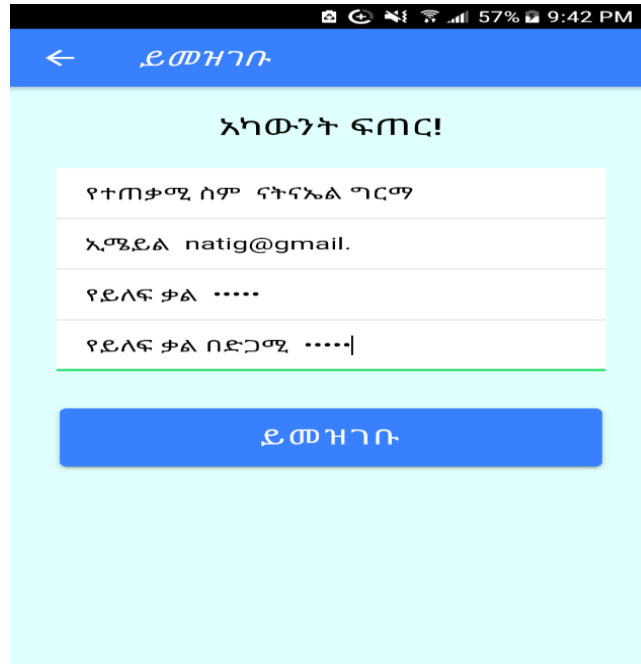


Figure 12: Register User Interface design

If the user is successfully registered Notification message” Successfully registered”, “ተመዘገበዋል” is displayed shown below in figure 13.

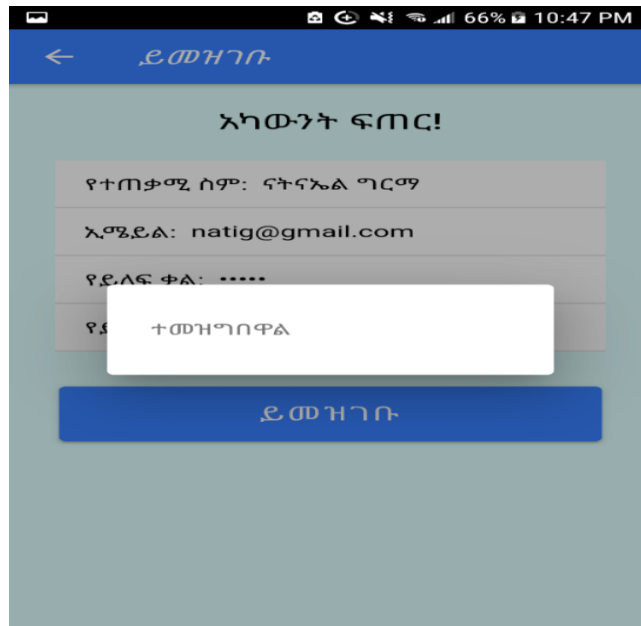


Figure 13: Successfully Registered User Interface design

To make appointments patients have to login first. The patient logged in by clicking on the “login” / “ግባ” button on the menu screen. Then the patient has to fill the login page by filling the required form shown below in figure 14.

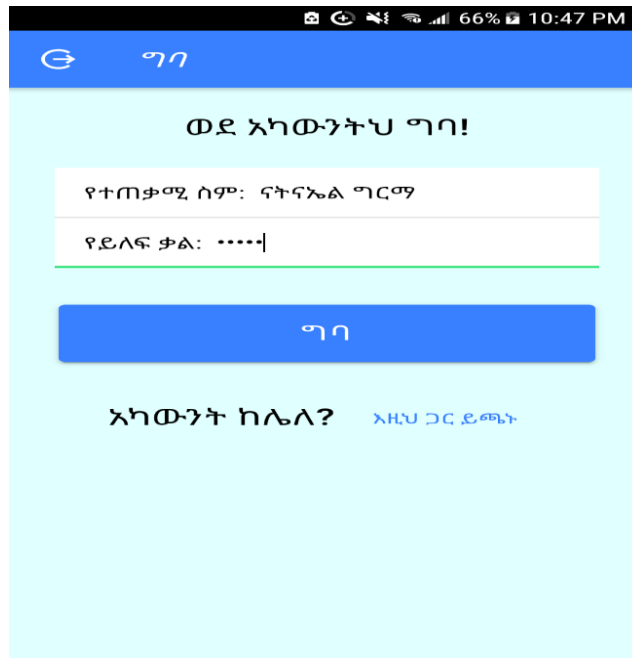


Figure 14: Login User Interface design

By clicking on the “map” / “ካርታ” button under the homepage or pin sign from the hospital list, the location of hospitals is displayed on the screen using Google maps shown below in figure 15.

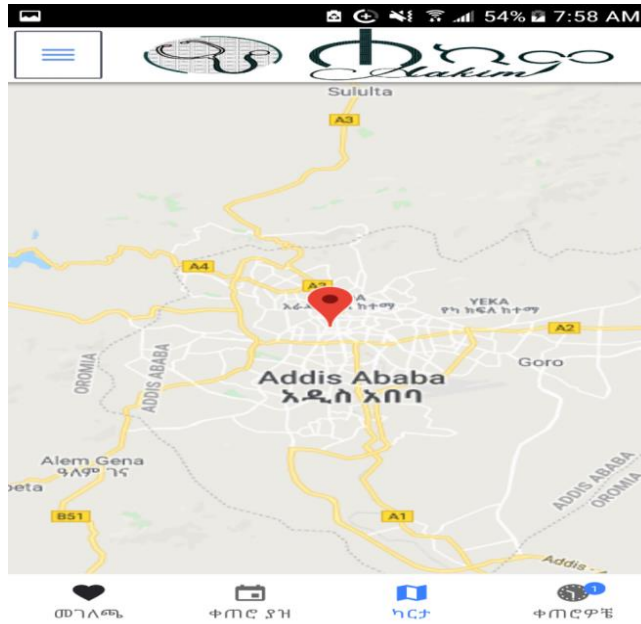


Figure 15: Map Interface Design

Patients can get information about the hospital by clicking “list” / “ዝርዝር” on the left menu shown in figure 16. Patients can view the list of hospitals and get detail by clicking on each hospital.

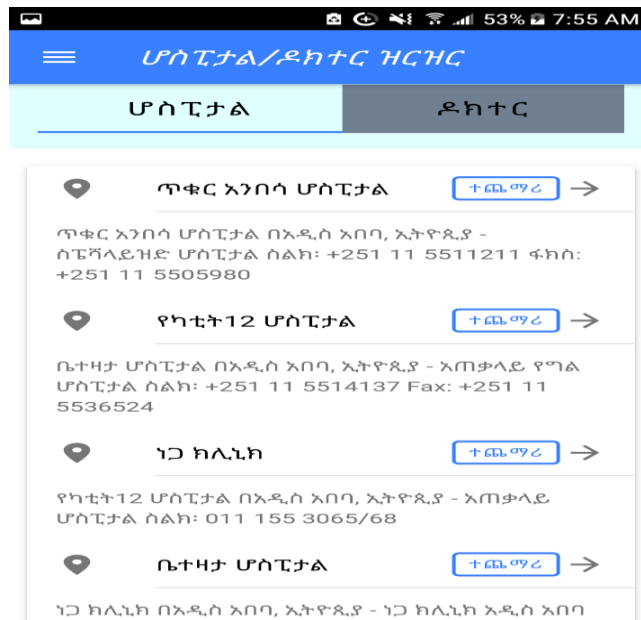


Figure 16: Hospitals List Interface Design

The patient can see the Doctors profile under each hospital by clicking the “View Doctors”/ “ዶክተር ተመልከት” button shown in figure 17. Using that information patients can call or email them if necessary.

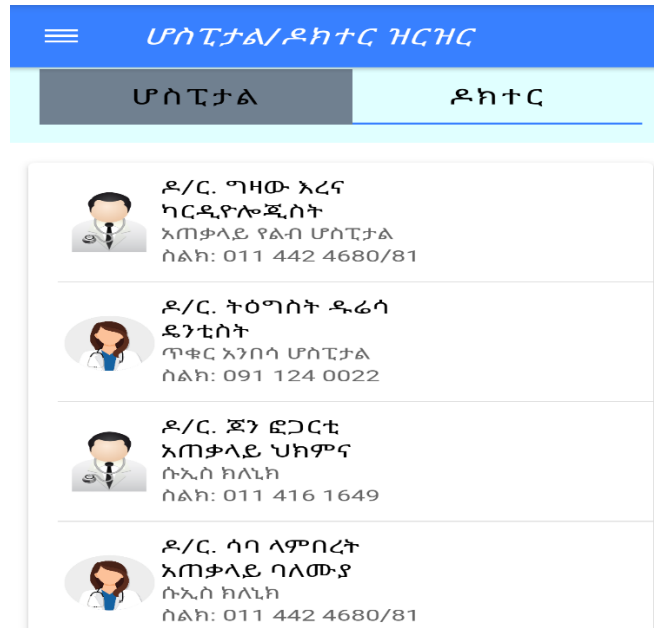


Figure 17: Doctor List Interface Design

The patient can make an appointment by clicking “Make Appointment” / “ቀጠሮ ያዝ” page on the home page (መነሻ) filling the case, description of the case, and time and date of the intended appointment as shown in figure 18. Finally, the patient clicks on “Make Appointment” / “ቀጠሮ ያዝ” button to make an appointment.

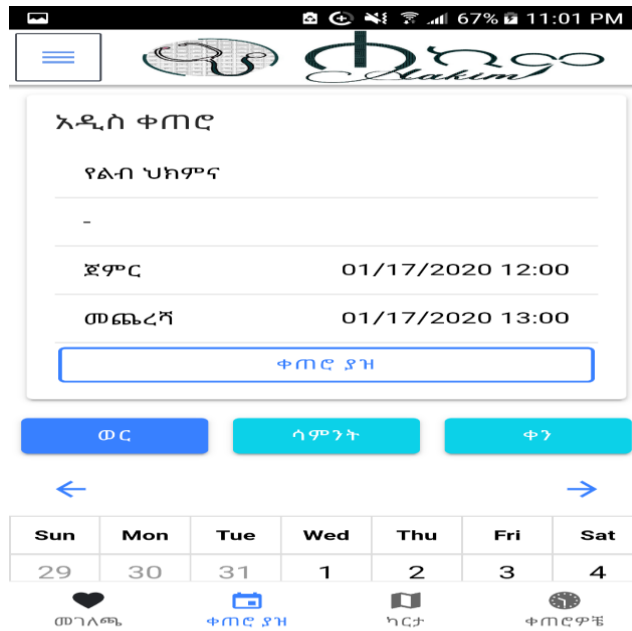


Figure 18: Make Appointment Interface Design

After making an appointment the appointment will be added on the appointments list below the calendar and we can see the detail of our appointment by clicking on the event as shown in figure 19-22. To make sure we have filled the correct information confirmation message will be sent and we click “Ok”/ “እሺ” as shown below in figure 22.



Figure 19: Scheduled Event Date in (a) Month, (b) Week and (c) Days

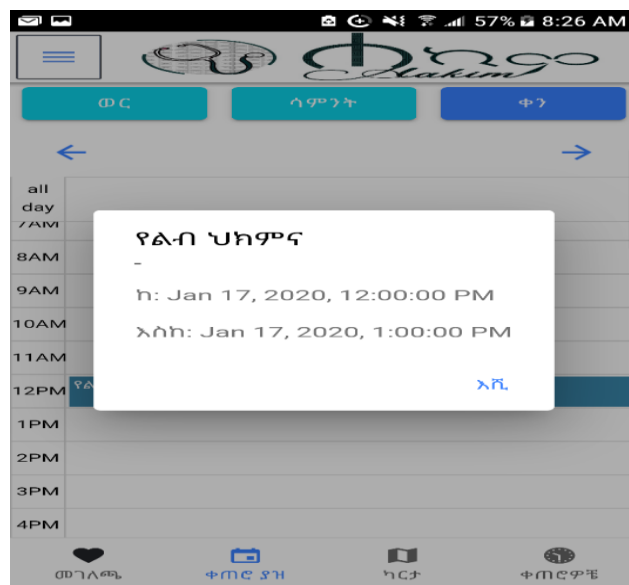


Figure 20: Scheduled Event Date confirmation

The appointments are sent to our appointment list on the last tab of the home page. We click on “My Appointments”/” ቀጠሮዎቼ” to see the events we add previously. Since wrong information might be added we have to make sure by clicking the “Make Sure”/” ለማረጋገጥ” button then a popup will appear. If we are sure we click “Yes”/” አዎ” if we want to cancel the appointment “Cancel Appointment”/” አይ”.



Figure 21: Appointment List, (a) Interface Design and (b) Confirmation

4.10. Evaluation

In this section, we evaluate the artifact, patient scheduling system in terms of objective for the study. Which is, does it improve patient’s experience on their hospital visit? Also to what extent this research enhances patient satisfaction as compared to the factors, which are the current waiting time, consulting time, and arrival time.

Usability is the extent to which users can use a computer system to achieve specified goals effectively and efficiently while promoting a feeling of satisfaction in a given context of use. Usability Evaluation (UE) consists of methodologies for measuring the usability aspect of a system’s User Interface (UI) and identifying specific problems. Heuristic evaluation is one of the most commonly used evaluation methods that are not expensive, easy, and time-saving. It is an inspection method that can prospectively uncover problems with a user interface, indicate the severity of the problems, and make suggestions for fixing the problems (Johnson, et al., 2011).

The proposed patient appointment system improves the patient's experience during their hospital visit. Because we analyzed user pre and post-visit experiences to design the system, it enabled users to easily and effectively make an appointment with doctors and it has a friendly user interface developed based on user requirements. It also creates online interaction between doctors and patients.

The evaluation of the interface for the mobile scheduling appointment system used a method of questionnaires to evaluate the interface for the prototype developed, a mobile-based system to improve patient satisfaction. The research intended to use the developed application to make a huge plan on continued product development efforts.

Pre-Post intervention comparison of factors

The result of a comparison of factors before and after the application was developed is presented using a preliminary appraisal of responses to the open-ended questions included in the patient satisfaction survey. Among patients' responses, pre and post-intervention of factors are compared according to the period.

The waiting time of patients' seen during post-implementation was 00:3:30 mins shorter when compared to the pre-implementation period of patients waiting time in the waiting room. Due to the decrease in waiting time doctors can see many patients calmly therefore most implementation consulting time is 00:10:00 mins larger when compared to the pre-implementation consulting period. Patients' early average arrival time before their appointment which was 00:37:30 (thirty-seven minutes and thirty seconds) is improved by 00:22:00 minutes compared to the post-implementation period.

Functionality and interface evaluation questionnaire

The below-mentioned table was developed to collect the required response from the patients to help in assessing and evaluating system functionalities and user interface for the newly developed system prototype. As shown in the table below the evaluation of the newly designed appointment system was done by 20 participants. Selected participants were patients each from the 6 selected hospitals. Evaluation questions are selected based on Questionnaire for User Interaction Satisfaction (QUIS) with aspects of human-computer interaction.

No	Criteria	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Satisfaction						
1	Do you perceive the Application as satisfactory?	-	-	15%	35%	50%
2	Is the application approachable whenever and wherever you need it?	-	-	30%	30%	40%
3	Is the usage of the system very simple?	-	-	10%	45%	45%
4	Should detail check could be done in the system to minimize operational mistakes and satisfaction?	-	-	20%	25%	55%
System outputs						
5	Is the clarity of the application output information high?	-	-	25%	25%	50%
6	Is the output information of the system consistent?	-	-	10%	45%	45%
7	Is the output information of IS are accurate enough for your purpose?			25%	35%	40%
User interface						
8	Does the app currently have all of the important key features?	-	-	20%	40%	40%
9	Does the application work with your device/s that you choose? (Apple vs. Android)	-	-	-	20%	80%
10	An app cannot use the location services of the device without asking for permission.	-	-	-	10%	90%
11	Push notification can't send personal information.	-	-	-	25%	75%
	Average			14.09%	30.45%	55.45%

Table 16: User Interface Evaluation (based on QUIS)

The result of user interface evaluation was done based on a Likert scale with a value of Strongly Agree = 5, Agree = 4, Neutral = 3, Disagree = 2, strongly Disagree = 1.

Table 16 shows the number of respondents who strongly agreed, agreed, neutral, disagreed, and strongly disagreed. Accordingly, the total response is calculated by the total election of the field.

The respondents strongly agreed on the application tend to be satisfied was 50% and 40% of them were strongly agreed on the approachability of the system while there is the same number of agreed and neutral vote, the highest number of evaluators agreed on the system simplicity and strongly agreed on the proposed system can minimize operational mistakes easily. On the clarity of the application, 45% of evaluators were agreed strongly and the same number of people were agreed and strongly agreed on the clarity of the system.

Accuracy of the system for the intended use has a higher number of agreed as well as meeting user needs. 40% of evaluators were agreed and 40% were strongly agreed on the app currently have all of the important key features. The evaluators also highly agreed on the application working with any operating system we choose to use (Android or iOS), can't restrict users based on location, cannot use the location services of the device without asking for permission and push notification can't send personal information.

Therefore, the final result shows there is a higher number of evaluators who agreed and strongly agreed to evaluate the proposed system's effectiveness and functionality. The average number of agreed users is 30.45% and strongly agreed users are 55.45%.

Additional users' feedbacks were collected to identify areas for improvement and to ensure system effectiveness. Some of the comments collected from the participants are:

“The application provides easy access to resources. For example, if we want to get the location of the hospital or information about doctors' availability, the application will make it available to us immediately.”

“Additional features such as if the appointment scheduling can be integrated with calendars and payment options would be available online.”

“Integration with Google calendar would be helpful, it can help to organize daily schedule.”

Additionally, the participants mention the ability to connect patients and health workers including doctors, and provide them with communication services (Information).

“This app must have the facility to create informative profiles of doctors and patients. Besides effective search filters would help to book an appointment with the desired doctor as per our need.”

“I believe patients' profiles would guide the doctor in the course of treatment.”

Related to development and deployment, the participants raised security issues such as:

“security and full authentication of personal Information are the main factors that I am worried about.”

“Issues like security are big problems with this kind of application.”

“Medical information should be kept private and I want my medical information to myself. So I suggest two-factor authentication to add a layer of security to the authentication process and make it harder for attackers to gain access to our devices or accounts.”

4.11. Discussion and Limitations

In this section, a description of the main contribution and viewpoint of this thesis work is presented. Here we discuss the main results and limitations of this study. The authors present how designing this mobile application help to make huge improvements in the area of healthcare with the method used to make a hospital appointment. This phase presents a discussion of how doctors' appointment systems help to improve patient experience on their hospital visits.

4.11.1. Discussion

For fixing appointments in terms of health applications, we normally use human agents (health workers) to get the work done at the appropriate health care facility. Presenting this thesis, we show that there is an easier way to do that job using handy mobile phones. After we justify the habit of cellphones across people a day to day activities, as shown on patients' smartphone experience analysis above we have developed a mobile-based doctor appointment artifact that can replace the job of a human being. With this in mind, we have now developed a mobile-based application that makes an appointment with the hospital to improve patients' experience while visiting doctors.

Patient need, expectations, and how to obtain maximum patient satisfaction was described. However, researchers' considered the relationship between patients' experience, satisfaction, and waiting time is not well defined (Sitzia & Wood, 1997). Recently, it has also been linked to better treatment compliance and outcomes as well as to lower rates of malpractice suits. While the hospital environment is important to the patient's experience, good communication is critical.

The first pre-visit facility characteristics and post-visit facility characteristics study aimed to assess the relationship between patients' expectations and their satisfaction in the visit of patients at the health centers across 6 hospitals in Ethiopia. The majority reason for their hospital visit was either to get checked up for their health condition or prescription refill or medical procedure. The result of the study pointed there was a difference among the participants having experience/expectation and participants who don't.

We found that patients were not more satisfied where they had queued a lot to get a diagnosis. The result shows patients wait longer in registration and examination room waiting for their turn than the time to get diagnosed. This is in contrast with a prior study that showed longer wait times didn't seem to impact patients' satisfaction overall satisfaction with the care received (Donahue, et al., 2017). Our result shows previous hospital experience have a huge influence on their satisfaction. In line with the previous research, Berhane & Enquesselassie (2016) stated previous experience in healthcare service was the factor that negatively influenced patient satisfaction.

The DSRM is used as a methodology for this research. Recently, however, researchers (Peffer, et al., 2006) stated the outcomes from DS research are expected to differ from those of theory testing or interpretation. In our study, we provide an evident artifact which solves problems on patient expectation and improve patient satisfaction. In designing and developing the system software development tools were used accordingly.

Open-source software was used in the development process and it's designed primarily for touchscreen mobile devices such as smartphones and tablets which mainly helps registration, communication, and patient-doctor interaction. Applications like What's Up Doc (Prajapati, 2018) and Smart Doctors appointment and prescription System (Majid, Alam, & Mustafa, 2017) which helps improve and enhance the healthcare systems, are designed for a specific device, i.e. either Android or IOS. In contrast to these studies, our finding shows the need for the development of

the system for all devices. The developed system, therefore, the developed appointment scheduling system is compatible with any preferred device.

To design the new system we have assessed the major drawbacks which are not yet addressed. In Smart Doctor's appointment and prescription System (Majid, Alam, & Mustafa, 2017) there is no functionality to predict appointment time since the patient reason to make the appointment wasn't considered. We have functionality that asks patients why they make the appointment so it is helpful to anticipate the time for each patient when the appointment is made.

This study also revealed that there is a high interest in making both local (Amharic) and international (English) language beneficiaries of the system. We found it essential to develop the system in both languages. Application developers for the international language (English) consistent with this result, Durmaz (2014) have reported that the market chain of mobile apps causes an imbalance between spoken languages versus app languages since 85% of developers publish in English addressing just 8% of the world population (around 500 million people) who speak English as a primary language.

This study confirmed that the majority of patients agreed with the development of a mobile-based appointment scheduling system, Hylton & Sankaranarayanan (2012) revealed that using a mobile-based appointment scheduling system could increase patients satisfaction and decrease waiting time. Therefore the implementation of a mobile-based appointment system is needed.

Consistent with our finding, some studies showed that factors including short waiting time is effective on patient satisfaction. Conrad (2013) found the overall patient waiting time was 346 minutes approximately 5.7 hours. This study plus other studies found that the causes for waiting time mainly due to operational inefficiency in the process of service delivery (Wanyenze, et al., 2010) and high patient load (Conrad, 2013).

Among pre-visit characteristics, the result shows that the queue to the registration room is the longest and slowest before consulting. As in previous studies, one of the greatest complaint of the Chinese public is the number of times it takes to queue for outpatient registration in china (Cao, et al., 2011). Participants waited in line all night (13.5 hours) to ensure registration with a certain physician.

This study demonstrates that using a mobile application scheduling system could decrease registration time and increase patients' satisfaction with the outpatient department. Similar to this study, few studies are using WAS (web-based appointment system) reported a higher level of satisfaction with the registration method.

The result of our research has been shown as screenshots. The system can help users in health care and patients from different places in registering, processing, and displaying patient data and information. The result of this study help understand challenges affecting patients' experience and problems associated with patients waiting time while issues on the registration area are addressed. Also, the system generates a report and sends a notification message as a reminder of the patient's appointment.

The major activities that were done are studying patients' satisfaction on their hospital visit, empirically evaluate the challenges affecting patient experience while visiting Doctors, review and understand concepts and techniques used for the application development, and design and validate a mobile-based platform which can improve patients experience on visiting hospitals.

4.11.2. Limitations

The findings of this study must be interpreted with attention to the following limitations.

Activity category

Our study was narrowed to 21 informants where 15 participants were patients and 6 were health workers. If we had more participants in the interview, the result would have made different perspectives and there would have been additional features. A small sample size can make problems in interpretations of results. When conducting a research study, the data is used to estimate the true effect using the observed estimate.

The main limitation is the lack of resources. The development of the system has not been completed because of limited time for the development process to make final testing and ensure it meets users' standards.

Health processes

This study mainly focused on hospital appointment processes of health care and did not include the structural aspect and outcome of health care. Departments like inpatient and emergency were

not captured and the study mainly focused on the outpatient department because patients from the inpatient department and emergency department are identified as very sick. We were not given a chance to interview them.

There are limitations associated with health workers' satisfaction and experience. When examining factors affecting patient experience, it is often necessary to analyze the experiences of health workers on patient satisfaction. So that it can be a rational way of studying not only patients' but also health workers'.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

This chapter is where we summarize answers to the questions posed in the problem formulation and the final section involves how we lunch the results of our thesis work and conclusions into the future. Here we conclude the paper and potential implication of the study. The chapter is structured as follows: First, Section. 5.1 provides the conclusions and brief analysis of the research questions proposed in the introduction of this work Finally, Section. 5.2 presents the outlook and the future work for the doctors' appointment system.

5.1. Conclusions

The mobile technologies and applications are growing at a rapid rate and it will continue to impact and shape the business world. People are already using mobile technologies in their daily activities as well as it has become common to use them in private and public sectors. The health sector is one of the sector technology is helping doctors solve problems faster with less stress, permit to record patient history, access the latest drug information, and help make a better decision. Patient appointments are managed manually through human beings in recently in Ethiopia.

Making hospital appointments has become a basic issue in the country, hospitals, clinics, and other health centers. In this paper, we sought to develop a mobile-based application that would make a huge difference accordingly. The functional and non-functional requirements were determined to create the artefactual solution. Furthermore, we wanted the artifact to improve patient satisfaction. By enhancing patient satisfaction, we can improve patient compliance, productivity, increase patient referrals, better staff morale, and lower rates of malpractice suits.

Our study contributes by investigating important factors to improve the patient experience while visiting doctors. Beside data/requirement collection, prior researches used in this study to identify characters and issues to improve patient expectations. Patient satisfaction was the driving force in all patient encounters. It depends on the patient previous healthcare experience, the purpose of the current visit, the reason to end up in the hospital, arrival time before the appointment, point of delay, and reason for delay.

Another contribution is how designing the mobile-based application can improve patients' experience. There is a growing interest in the potential of mobile technologies and related opportunities would pave the way for developing scheduling hospital appointments to improve patients' experience on physician visits.

There were some challenges in focusing on developing a prototype from an understanding of the desired system requirements. Since collecting health workers' data was expensive and needed a lot of effort and time, this study mainly focused on the patients' module. Patients' roles in the application have given priority. Another challenge was the complication due to integrating the three tier health care system due to healthcare industry policy and payment system as well as an increasingly complex healthcare regulatory environment that is difficult and resource intensive for hospital or physician group to navigate.

5.2. Recommendation

This study was made to design and develop a mobile-based information system to improve patients' satisfaction with their hospital visit. We hope that many researchers will try to use this system, thereby testing its usability. While the system is friendly and can work with any operating systems including Android and IOS, there are some limitations collected from patients' suggestions which would be critical for improving the system.

For future work, the researcher recommends adding the Doctors' module and the Admin module into the study. Therefore Doctors should be allowed to register themselves and process different kinds of tasks on the application. The admin should perform tasks on the application rather than using the website.

Additional variables on patients' experience study should be considered. Since this research is limited to particular patients from selected hospitals in Addis Ababa, there is a need to explore more health care, including staff levels, a higher level of clinician involvement, or forms of decision support. Therefore more research is needed to identify effective ways of improving appointment methods using mhealth services, particularly for patients with limited options at present such as for patients with disorders.

The researcher also suggests developing a system that can direct appointments to another hospital and refer patients automatically. And adding functionalities such as Review and Rating

functionality on the application, for doctors and hospitals would make a complete system. Reviews use both patient sides and health care where patients can evaluate on the app and find the preferred hospital and/or physician for their case. Health workers evaluated through the application so they can work competitively and help improve the service. Additionally, billing may be performed to identify the right user or patient since people might register on the application for fun.

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APPENDIX

Interview Questions

The interview questions are made for Patients, physicians, and health management information system focal people about the hospital service.

Appendix A: Patient semi-structured interview questions

A: General

- Gender?
- Age (18-50, 51-60, 61-70, 71-80 or 81-105yrs)?
- Max education level (Primary school, Year 10, Year 12, bachelor degree, postgraduate degree)?

B: Related to Factors

- Can you tell me a little about how you ended up in the hospital?
- How long have you been in the hospital?
 - What was the reason for your waiting? Is the waiting worth it?
- Do you arrive here on time?
- Were you satisfied with the outcome of their service?
 - If not, Why?
- How helpful were the staffs for you?
 - Did you receive clear information from them?

C: Related to Solutions

- Share an experience in which you scheduled and confirmed appointments and consultations.
- Do you use smartphones/s? if Yes, how often do you use applications on your phone?
- Does the language of applications have ever affected you?
- Was the hospital easy to locate?
- How do you suggest the new application should help?
- Have you ever made an appointment and forget? Do you want the system to notify you?

Appendix B: Clinician semi-structured interview questions

A: General

- Gender
- Your (Profession) professional level at this Hospital

B: Related to Factors

- Did you experience (or anticipate) any barriers to the arrangement of time to meet patients?
- Did you experience (or anticipate) any barriers to the arrangement of place to meet patients?
- Tell me how you organize, plan, and prioritize your work.
- Share an experience when you applied new technology or information in your job.
 - How did it help your company?
- Provide an experience in which you effectively maintained appointments with a patient?
- What do you understand by the term ‘appointment system’?
- Have you had previous experience with appointment systems in the past:
 - Communicating with clinicians? Examples, please
 - Communicating with patients? Examples, please

C: Related to Solutions

- Do you think using appointment systems facilitates the use of the mobile application to communicate about patient care with other clinicians?
 - Why/why not?
- Do you think using appointment systems facilitates the use of the mobile application to use the mobile application to communicate about patient care with patients themselves?
 - Why/why not?
- What are your views about developing an application to improve patients waiting time in hospital?
- Do you think there are advantages to using this kind of application? If so, what are they?
- Do you see benefits for the patient in using this process? If so, what are they?
- Have you used/tried to use a system similar to this in the past? If so, what were your experiences?