Multi-Lingual Mobile Application to Improve the Pharmaceutical Care of Patients in Ethiopia

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Abstract- **Delivering essential information for patients concerning medication they're taking is vital and improves healthcare services. Due to heavy burdens in every pharmacy, patients in Ethiopia do not get proper advice about the medicinal drugs they're taking from the pharmacist. Moreover, it is far tough to recognize and interpret the various written instruction on remedy labels or package deal leaflet while not heaving the domain knowledge. As Ethiopia is an importer of many medicinal drugs from abroad, very often the package leaflets are not written in the local language. Therefore, due to language barrier, most of the patients cannot comprehend the information on medication labels and on package leaflet. In this regards most patients purchase the medication without a proper understanding of how to use the medication. This necessitates a technological based solution which serves patients in their language when they want an advice. This study demonstrates the design and implementation of a mobile-based solution to minimize such challenges and improve patient access to the medicinal drugs information. The requirements of the proposed system gathered using interview from pharmacist, doctors, technical expert, and client. Finally, a mobile application prototype is developed and evaluated for its effectiveness.**

Keywords- Mobile application; Medication; pharmaceutical care; Advisory System; patients; Ethiopia

I. INTRODUCTION

Medication administration error is one of the common cases of medical errors. Medication error in the out-patients caused by under or overdose, drug-drug or drug-food interactions, the absence of in-take enforcement and monitoring mechanisms [1]. Most of these medication administration errors were made when patients are taking medication at home without little or no guidance [1].

Delivering proper guidance or essential information about medication patients are taking or intend to take can help the patients and improves the safety and effectiveness of medicines and significantly avoids medication errors. It is one of the key pharmaceutical services.

Pharmaceutical service is a central aspect of quality of healthcare as the patients often need medication to cure. Hence, improving Pharmaceutical service is required to deliver the quality of health service and sustain health care services. For the well functioning of the pharmaceutical services availability of medicine and the well-trained pharmacist is the central aspect. But the pharmacy services in Ethiopia are highly constrained by a shortage of pharmacist [2].

As there is a heavy burden of clients to be served in each pharmacy, patients in Ethiopia not get appropriate advice about the medication they are taking from the pharmacists. Even, if the patients obtained the appropriate advice, it is difficult for some of them to comprehend the advice and recall later easily and quickly. So, up to the patients to get more information about medication they are taking from package leaflet, it is a document which provides information about the medication, and written directions on drug labels. But, it is difficult to comprehend and interpret many of the written directions on medication labels and on package leaflet without having the training or extensive knowledge of medications.

On the other hand, as Ethiopia is an importer of many medications from abroad, very often the package leaflets are not written in the local language. Therefore, most of the patients cannot comprehend the information on medication labels and on package leaflet because of the language barrier. As the majority of Ethiopian population cannot comprehend foreign language, physicians or pharmacists are the only options to get information about medication they are taking. Because of these reasons, most patients purchase the medication without a proper understanding of how to use the medication.

Moreover, patients can't get different kinds of information which are obtained by using the medical calculator from an expert. In this respect, it is required to automate the medical calculation and provide the result obtained and associated information for clients.

To solve the expert accessibility problem of patients it is advisable to lie down the platform from which they will get this kind of information any time they want. The technology-based solution seems to right solution to address many patients at a time. Therefore, it is required to consider an alternative technology-based solution, which addresses many patients at a time, to combat these challenges.

The high penetration of the smart mobile phone in the country coupled with the need of young generation, to access medication information easily and quickly in digital form, let us to consider mobile based application as an alternative solution in this research.

This paper introduces, design and develop a mobile application, which is called as MD-pharma, to help patients in getting proper advice about the medication they are taking and to automate medical calculation. To achieve this objective: first existing challenges in pharmaceutical services were explored; requirements for the proposed system were identified; the system was designed; finally the prototype was developed and evaluated for its effectiveness.

MD-pharma has many benefits in improving healthcare condition of the patients: 1) let the patients get accurate and thorough information being anywhere at any time through their mobile, 2) Empowering patients to know about medication they are taking, as a result, improve prescription adherence, 3) patients can take medication rationally and obscure from medication error.

The remainder of this paper is organized as follows. Next section elaborates about the methods conducted in this study. Section 3 describes MD-pharma application specifications. Section 4 presents related works with a discussion. Brief conclusion and future works forwarded in the last section.

II. RESEARCH METHODOLOGY

The research approaches, development environment and data collection and analysis method used to develop the proposed application is discussed in this section

A. *Research Approaches*

This study is motivated to improve healthcare service in Ethiopia by introducing new IT artifacts. The design science research approach is well suited for a research that needs to creates and evaluates practical IT artifacts such as construct, model, method, or an instantiation [3]. Hence, design science research approach was used as a method to solve the identified problem in this study.

Hevener et al. [3] design science research Framework are adapted to the context of the problem of this study as shown in Figure 1. The framework describes the whole research processes of the study as three closely related cycles of activities

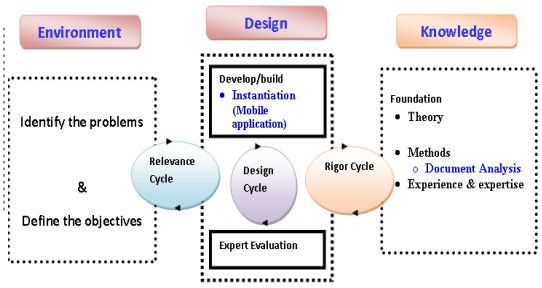

Figure 1: Methodology adapted from (Hevner et al., 2004)

(relevance, design, and rigor) [4]. The adapted framework describes the whole research processes of this study.

The problems of this study identified in actual application environment and it also very important to be addressed to ensure the quality of health services. The proposed system is grounding on existing theory and involves an experience of domain expertise. Selection and application of the already proven appropriate theories and methods for constructing and evaluating the artifact confirm the rigor of this research. The design cycle of the proposed system is going to built and evaluated by the domain expert iteratively.

B. *Data collection and analysis method*

Data collection can be performed using various methods. These include:

- Analysis of records and reports: recently published standards on textbooks consulted to identify the requirements
- In-depth interview or focus group discussion with a domain expert
- Undertaking review meetings with relevant stakeholders (Clients, IT-expert, physician, and pharmacist)

Data collected in these methods analyzed qualitatively to identify the requirement of the proposed system. After the mobile-based advisory system is designed, the prototype is developed for android platform. Final the proposed advisory system was tested by domain expert and clients for its efficiency and effectiveness.

C. *Development Environment*

Android Mobile Operating System, Android studio as an integrated development environment, Java Programming Language, MySQLi Database server, PHP as a server-side scripting language and XML as a middleware between MySQLi database and mobile application was used to develop the proposed system.

III. SYSTEM OVERVIEW

A. *Requirements*

MD-pharma provides the following functions: 1) medication specific information (indications and usage, contraindications, adverse reaction, dosage form, over-dosage, frequency and administration, drug abuse and dependency and Storage condition and shelf life), patient-related warnings and precautions and drug-drug interaction. 2) Calculate body mass index 3) calculate expected delivery date of mothers and 4) vaccine schedule reminders and predict child growth. With this information, a patient can take appropriate precautions and follow their health condition properly.

The functional requirements of MD-Pharma were shown using UML use case diagram in figure 2. The proposed system works as an interactive system that delivers essential information to patients based on a query received from the end user. Hence, it has to be highly reliable and provide a response within small response time.

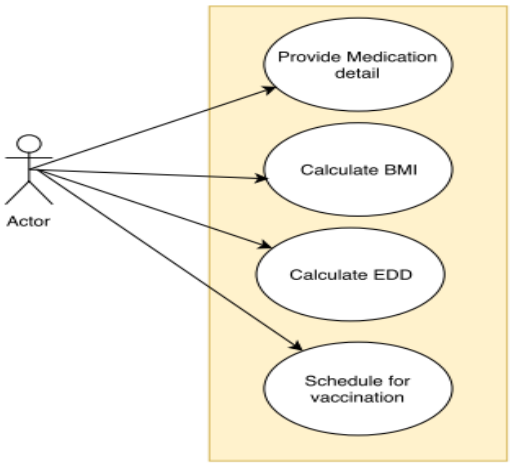

Figure 2: Use case diagram of MD-Pharma

B. System Architecture

MD-pharma system architecture was developed using a 3-tier architecture style as clients, server and persistent data shown in figure 3. Mobile phone with MD-pharma communicates with Apache web server using the wireless network to download the medication detail from the remote database server. The sixth edition list of "Key essential drugs" to treat common health problems in Ethiopia [1] was considered as drug table of the database. The list consists of international nonproprietary (generic) names of drugs that can be imported or locally produced.

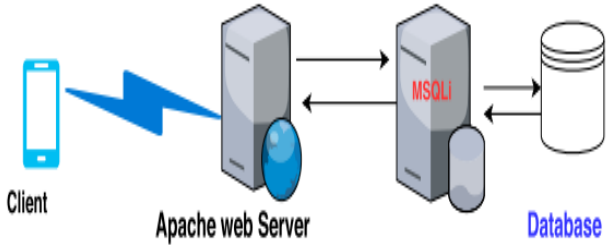

Figure 3: MD-Pharma system 3-tier architecture

C. Implementation

The users interact with user interfaces of MD-pharma to get different services. The details of these user interfaces are described as services provided by the application for the user in figure 4 -9.

The home screen of the application shows a list of services provided by the application as shown in figure 4. MD-Pharma also caches recently accessed drug from the database.

The medication detail and drug-drug interaction information are displayed from remote database server each time clients interact with the module. BMI calculation and Vaccine scheduling ruing and store in each client mobile phone application. The client-side application also store previously accessed medication information to be accessed later on offline.

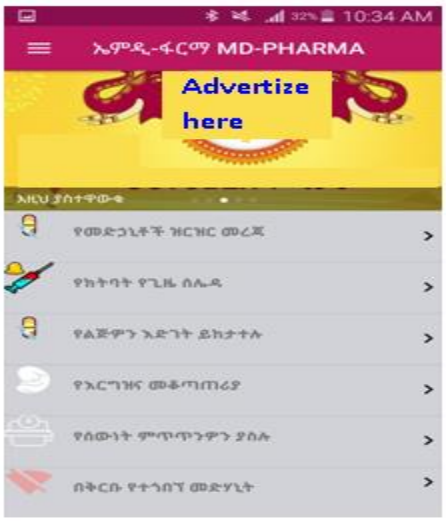

Figure 4: Home screen for MD-Pharma

The navigation button in the left corner of the home page can also let an individual select their language preference as shown in figure 5. At the time of installation, users can also set their language of preferences.

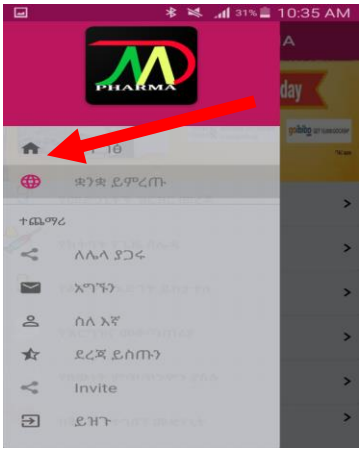

Figure 5: Screen shoot to set language preferences

The MD-pharma in figure 6 let the Client enter the birth date of the child and automatically schedule the vaccine data for the child. Vaccination reminder gives an alert message based on the date of birth provided by mother. Hence it can improve mothers' awareness and adherence. Moreover, this module calculates the expected growth of the child and let the mothers follow their child grows.

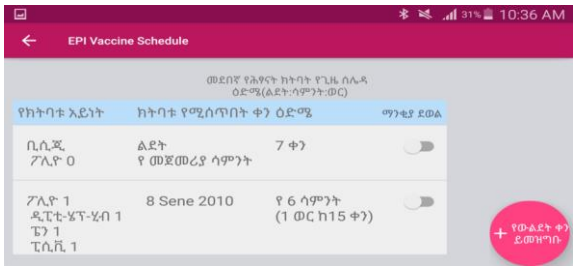

Figure 6: Screen shoot to schedule vaccination

MD-Pharma advice pregnant mothers on the progress of their pregnancy as shown figure 7. The application let the mother to select last menstrual period date from Ethiopian calendar and it calculate stage of pregnancy, expected delivery date (EDD) of the pregnant mother, and left days for pregnancy.

Figure 7: Screen to calculate EDD

Medication detail profile menu provides a list of drugs alphabetically and lets the user search for a specific drug as shown in figure 8.

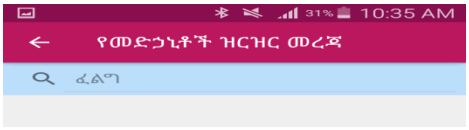

Figure 8: Screenshot to display medication details

Body mass index (BMI) user interface lets the client enter the weight and height of the user in the text box to calculate BMI. Along with BMI, the application displays normal range of weight for the user. If the user is not in normal rage, let the user to know associated risk and required therapy figure 9.

Figure 9: Screenshots for BMI calculation

D. Evaluation of proposed system

Herein we report findings from a pilot study of our pharmacy mHealth app. Testing was performed by giving demo version of the application with detail explanation of how and what the application work.

A total of 28 participants were asked brief questions as per the questionnaire in the annex. The participants were 15 clients, 5 IT-experts, 5 pharmacists and 3 physicians.

The majority of respondents confirmed that the proposed mobile is easy to use (92.85% of 28 participants) and useful in improving quality of health care by avoiding medication administration errors (82.14% of 28 participants). The overall satisfaction of the respondents also showed that they were very satisfied (7.14% of 2 participants), satisfied (53.57 % of 28 participants), neither satisfied nor dissatisfied (17.85% of 28 participants), dissatisfied (14.28% of 28 participants), and very dissatisfied (7.14 % of 28 participants) with the proposed application. Majority of the respondent also recommend that proposed application is not exhaustive in handling all necessary information that a patient required from a pharmacist (64.28 % of 28 participants). So, they recommend the enhancement of proposed work.

Although the testing was carried out with few participants, the feedback obtained from these participants was quite encouraging in achieving its intended task. As per their feedback, the proposed system provides initial information about medications and it has a user-friendly interface and it is easy to use. For proper testing of the proposed application, a large-scale survey is yet to be carried out.

IV. RELATED WORK

In the past few years, tremendous surges in mobile applications development have been observed in different sectors. A mobile healthcare application or mHealth technology is one such a sector. In mHealth technology, users can find essential health or medical related services through their mobile devices. Mobile applications are getting acceptance by the healthcare organizations and patients due to its user-friendly, reliable, low cost, time efficient, mobility etc. [6].

Various mHealth application proposed so far for: staying healthy or prevention [7], diagnosis [8]–[11], management of disease [12], health education [13], improving medication [1], [14], advice dietary [15]–[17], compute medical calculation [18] and so on.

Among pharmacy mobile application, Table 1 describes the most widely used mobile applications that were available in the application store such as Google Play and Apple App stores. But none of them was developed for local context specifically in local languages. This study takes an experience in these systems and proposed MD-pharma for the local context.

V. CONCLUSION AND FUTURE WORK

We have developed MD-pharma to solve lack of information or guidance about medicinal drugs patients are taking or intend to take due to shortage pharmacist. The proposed MD-pharma can increase medicinal drugs information access for the patients.

As a result of this it can maximizes therapeutic effect (improve medication outcomes), minimizes risk, and reduces cost. MD-pharma was demonstrated to different stakeholders to validate its applicability and it was found to be effective in achieving its intended task. Moreover the interview result showed that it is easy to use.

The future work aims to enhance the proposed mobile application to operate in Afaan Oromo, which is most extensively spoken language in Ethiopia. The proposed mobile application can provides medical calculation like BMI. This features need to be enhance in such a way that includes essential medical calculations like medicinal drug dosage calculation and son on. MD-pharma also needs to be improved in the future by adding the functionality which play important role in supporting visually impaired people.

Table 1: pharmacy applications on smart phones

Mobile app	**purpose**	**Targeted users**	**medical calculation**	**Pricing**	**Developer URL**
Epocrate	provide drug information and interactions	Doctors and Health professional	BMI and others	partial free	www.epocrates.com
Medscape	drug information & check the disease references	Health professional	yes	Free	https://www.medicaljoyworks.com
Pocket Pharmacist	contains complete drug profile, check drug-drug interaction, precautions, and adverse reaction	non-medical individuals and health professionals	yes	free	https://www.pocketpharmacist.net
LEXICOMP	comprehensive drug information for both pediatric and adult patients	Health professional	yes	not free	https://www.wolterskluwercdi.com
ipharmacy	provides information on drug interactions and side effects, and helps consumers keep track of the medications they take	consumers & pharmacist	no	free	www.ipharmacylinonia.com
Skyscrape Medical Library	It includes general and specific drug information, calculators to determine dosages, clinical information, algorithms, flowcharts, and 850 medical topics	for pharmacy technicians	yes	free	www.skyscape.com
Micromedex Drug information	Provide detail drug information, drug news, and pregnancy and breastfeeding information, as well as a database of thousands of drugs and medical conditions.	Health professional	yes	free	www.micromedex.com/
MPR	provide detailed drug information, check drug-drug interactions	Health professional	yes	free	https://www.empr.com
RXmindMe	Medicine reminder and pill Tracker	Patient	not	free	http://myhealthapps.net

ACKNOWLEDGMENT

We would also like to thank all stakeholders who participated in the group discussion, review meeting and evaluation of the proposed prototype. We are grateful to Dr.Mihiret Deyessa for her constructive comments and intensive participation from inception of the research to validation of the proposed solution. The authors also gratefully acknowledge the anonymous reviewers and editor for their valuable insightful critique, comments and suggestions they will provide us.

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ANNEX

RQ1: How user-friendly is MD-Pharma application?
RQ2: Do you think MD-Pharma has all necessary information that a patient required from a pharmacist?
RQ3: Do you think MD-Pharma will resolve medication administration errors occurred due to lack of guidance?
RQ4: What is your overall satisfaction with MD-pharma (Satisfied, dissatisfied, neither satisfied nor dissatisfied)?
RQ5: What would you recommend to add to our application?