

ePharm: A Mobile Pharmacy Application for Locating Nearby Pharmacies

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Abstract: *The use of mobile phones and the implementation of mobile applications and services have progressed dramatically in the present society as they have made the lives of people more efficient. Even then, if the prescribed medications are difficult to obtain or unavailable in some pharmacies, patients must visit many different pharmacies to obtain them. This is mainly because there is no proper network between the existing pharmacies. It is hectic task to visit numerous locations merely to find a certain medicine, especially in the current economic crisis in the country with the shortage of medicines and fuel. It would be more efficient and effective, in terms of time and energy, if there was an app that could discover nearby pharmacies where the recommended medications are accessible. A mobile pharmacy application is presented as a solution to the problems that individuals experience daily. The goal of this research is to find the major requirements for implementing the application and designing it by integrating those features. Following a thorough literature analysis, it was able to identify the drawbacks of the existing systems and determine the appropriate technologies for implementing the identified features. Through that Google Maps API and Google Directions API were recognized as adequate for geographical placing and tracking of pharmacies. These technologies would improve the accuracy of the system's ultimate output while also making it more usable for consumers. Further, these outcomes can be used for the future implementation purposes of the mobile pharmacy application.*

Keywords: *Mobile app, System design, Pharmacy application, Geolocation positioning*

1. Introduction

Healthcare is a system that is supported by a variety of disciplines that are critical to its progress. Pharmacy is one of these fields in particular. The root term of Pharmacy is pharma, which refers to the knowledge and technique of drug manufacture and administration (“pharmacy | Britannica,” 2017). To be more exact, pharmacy is a clinical health science that combines medical science and chemistry, and it is responsible for the discovery, manufacture, disposal, safe and effective use, and management of prescriptions and pharmaceuticals. It is one of the most important and accessible health professionals

to the public, as they are available to provide personalized advice about health and medicine on a walk-in basis, without the need for an appointment

As mentioned above, pharmacy plays an important part in the healthcare system. The purpose of pharmacies is to assist and sustain the healthcare system. Clinical services, medication safety and efficacy reviews, and pharmacological information are all part of the package.

According to the international pharmaceutical federation, sixty-nine countries and territories reported a total number of 1,580,575 community pharmacies (including branches supervised by a pharmacist, but excluding mail-order only pharmacies), serving a population of 5,549 million people which is 75% of the world's population. Further there are similar amount of hospital pharmacies and mail-order pharmacies around the world adding the sum of total pharmacies into a larger number.

Similarly, there are a wide number of online stores for the pharmaceutical purposes. But most of these pharmacies are particularly built for a single pharmacy, or for an online platform of an existing physical pharmacy. Even though there are a huge number of pharmacies worldwide as mentioned in the above statistics, there is a lack of network and connection between these pharmacies. Due to that reason, people have faced difficulties in going to several different pharmacies in order to find drugs, especially if they are not available in one particular pharmacy. Further, this is a time-consuming and energy-consuming process where, patients experience significant challenges in locating rare drugs, and they are unable to compare the pricing of the same drug at different pharmacies. This has been a concern for the elderly, who have difficulties in traveling, as well as practically to all persons, especially during this economic situation in the country and the Covid-19 epidemic. This was clearly shown through the results obtained through the survey carried out to identify the research problem, where 71.2% of the people who participated in the survey has faced difficulties in obtaining medicines especially during the pandemic period with quarantine and social distancing regulations.

Hence it is more efficient and useful if there is a proper network between the existing pharmacies, where the patients can search a particular medicine they need and find, locate the nearby pharmacies where the drugs are available. Throughout this study the limitations of the

existing systems are identified, and the proposed system is designed to address those limitation and the user requirements that were identified.

2. Literature Review

In the Sri Lankan context, there are around 5000 pharmacies serving a population of 21 million people (Rannan-Eliya and Sikurajapathy, 2009). Also, there is a number of online platforms developed for the pharmaceutical purpose and the trend of having an online portal for the business purpose has increased vastly (Klaic et al., 2022), especially due to the covid-19 situation. There is a various number of studies and research that were conducted related to this pharmaceutical area as well.

For the review process I identified 08 most common features and functionalities that could be seen in existing applications and reviewed 10 pharmaceutical applications based on those features. Further 07 more applications were reviewed to identify on the tools and technologies to be used for the implementation. Table 1 presents a comprehensive review on existing pharmacy system together with the features and functionalities included in them.

Table 1. Summary on features of the Reviewed existing systems

Application	Upload prescription	Add to cart option	Get delivered	Chat with pharmacists	Provide information about medicines	Channelling doctors or place bookings	Monitor and send alerts for reordering	Manage prescriptions
SwipeRx ("What are the benefits of using SwipeRx?," 2022)					✓			
Healthnet ("Most Trusted Online Pharmacy in Sri Lanka Healthnet.lk," 2022)	✓		✓	✓			✓	✓
Healthguard ("Best Online Pharmacy in Sri Lanka Healthguard," 2022)	✓	✓	✓					

Doc990 ("About Us - Doc990," 2016)	✓			✓				✓
Mymed ("Our Story MyMed.lk," 2022)	✓			✓	✓			
HealthX ("HealthX - Sri Lanka's one stop app for healthcare services," 2022)	✓							✓
Quickmed ("Quickmed.LK," 2022)	✓	✓	✓					
Unique Pharmacy ("Products - Unique Pharmacy," 2020)	✓	✓	✓					
Union Chemist ("Upload your Prescription Now - Union Chemists Pharmacy," 2022)	✓	✓	✓					
PharmEasy ("PharmEasy - Healthcare App - Apps on Google Play," 2022)	✓			✓			✓	✓
Netmed ("Netmeds Sign In / Sign Up," 2022)	✓	✓						
Count	10	5	8	2	1	3	2	2
Percentage (%)	90.9	45.4	72.7	18.1	9	27.2	18.1	18.1

According to the table 1 it can be seen that the above-mentioned pharmacy systems are consisted with many

innovative features but, the limitations of these existing systems are, that these systems are designed for a single pharmacy. Through these applications people can order medicines from the particular pharmacy that it is designed for. But the problem is that there is no network between the existing pharmacies.

When creating a network between the pharmacies, it is more beneficial to the users if the application could find and locate pharmacies where the user required medicines are available (Siuly et al., 2021). Therefore, a study was carried out to identify the suitable tools and technologies for this purpose.

For the purpose, of locating a place on a map there have been several technologies used in the reviewed research of different research areas.

CamPharma (Noutat et al., 2016) is one existing system that is quite similar to our proposed system with the ability to locate the pharmacies close to the patients with including other features such as searching pharmacies with a specific drug; view the price, information of it; receiving alerts.

Through the review of research on map-based geolocation displaying systems, useability and user-friendliness (Bevens et al., 2021) were identified as key factor to be considered (“What are the benefits of using SwipeRx?,” 2022), (Nurwarsito and Savitri, 2018; Pardo et al., 2010; Sholeh et al., 2017).

In (Pardo et al., 2010), a user-friendly graphical interface was used to easily guide the users to the nearest pharmacy by using geographic and temporal information retrieval methods. Ibrahim and Mohsen (IBRAHIM and MOHSEN, 2014) ensure useability and user-friendliness by allowing the users to add, remove or review locations on the map while providing the basic navigation functionalities as well. For this reliable and open-source tools and technologies like Google Maps API, Google Directions API, MySQL, PHP and JSON had been used. Furthermore, the completeness of the system makes the system more usable and easier for the users to use. Based on that, integrates features like searching information and the location of a place on a map. According to this research (“Smart Geographic object: Toward a new understanding of GIS Technology in Ubiquitous Computing,” 2015), languages like PHP, Perl and CGI can be integrated in Google map APIs.

In the mobile application (“What are the benefits of using SwipeRx?,” 2022) to automate the pharmacy activities map features were integrated to search the locations. For this Google Maps API Geolocation Tagging method, which is a JavaScript-enabled library was used. Apart from the Google Map API and Open Street Map API, a geolocation API was introduced for the orange Emerginov platform (Pinandito et al., 2018) which maintains geolocation data on an offline environment while periodically updating it from an online database.

Manav and Anupam (“Smart Geographic object: Toward a new understanding of GIS Technology in Ubiquitous

Computing,” 2015) proposed an implementation of a location-based service using Google web services and Walk Score Transit API. In this, longitude-latitude-altitude coordination system, Global Positioning System (GPS), Assisted GPS were identified as the methods for discovering the position of the mobile or users.

3. Methodology

This application is a platform that enables the users to find and locate any nearby pharmacy that has the required drugs available with them. Through this application, the users can also request navigation support to get to any selected pharmacy that they require. The major feature of this is that the ability to access any pharmacy through a single platform.

The following subsections present the steps that were carried out to identify the requirements that should be integrated into the application and determining the design of the application before development.

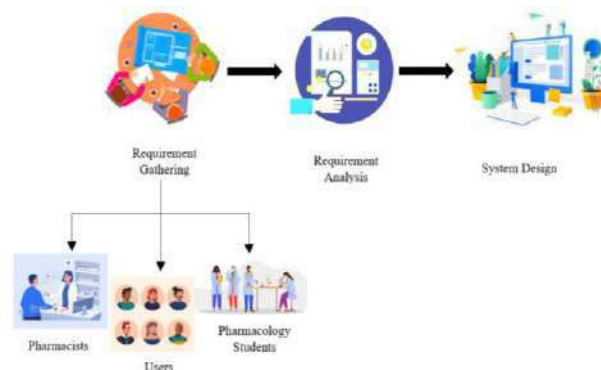


Figure 1. The methodology of the research
Source: Author

A. Requirement Gathering

During the requirement gathering phase, questionnaires were distributed between 52 users representing almost all the age categories, and interviews were carried out with ten pharmacists and then their answers were taken down into a form. These surveys were carried out to gather the requirements that they expect from the application according to their perspective. Another round of requirement gathering was taken place by distributing a survey to 12 pharmacology students to get the requirements and suggestions considering them as individuals who knows the requirements that the system should fulfill for the common users and to the pharmacists in general. Further, during the requirement gathering process the privacy and security ethics were taken into consideration. When dealing with the users’ and pharmacology students’ opinions their anonymity was protected by not collecting their names, email addresses or any other form of personal identification details. Also, sensitive information like their illnesses the medicines they use were not asked in the survey questionnaires.

In these surveys the users were given a set of features like, including a scanner to identify handwritten prescriptions, locate the pharmacies on a map, a communication platform

to connect with the pharmacists, a description about the medicines displayed on the prescription, ability to compare the prices of different pharmacies. The Figure 2 presents the results obtained from the users regarding their preferences to have the above-mentioned features in the application.

The users have further suggested on having features like, the ability to find similar brands of a certain medicine, index the search to find drugs based on the disease and symptoms and the ability to get alternatives for a given medicine. The users also suggested on integrating a feature where a notification would be sent to the pharmacists when a new order is placed by a user.

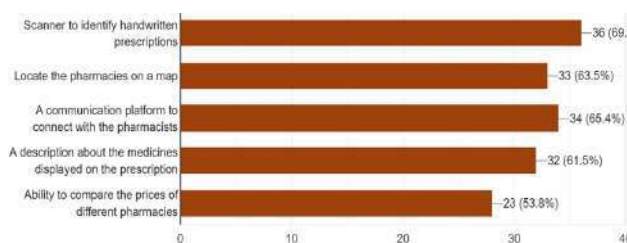


Figure 2. Results of the user preferences on features to integrate in the system
Source: Author

When considering the requirements for the pharmacists' portal in the proposed system, the survey included a set of features and asked for the pharmacists to select the features that they prefer to have in the application. These features are, a chat option to connect with the patients, an option to contact the doctors, ability to add/update details of the pharmacy, send alerts to the system, update stock details, a way to deliver medicines to the patients, ask for prescriptions, symptoms and other details required. Figure 3 presents the results obtained from the interviews conducted with the pharmacists.

Also, the pharmacology students were given the same set of features and asked for their preferences on them about the features and requirements were assessed.

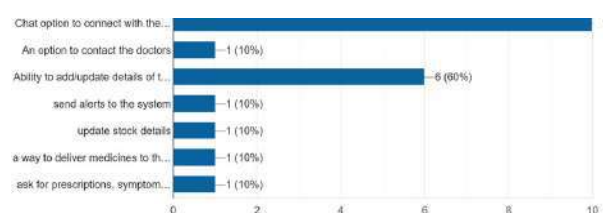


Figure 3. Results of the preferences of the pharmacists on features to integrate in the system
Source: Author

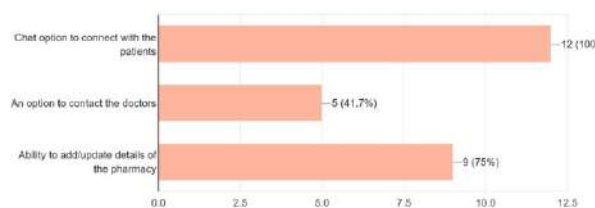


Figure 4. Results of the preferences of the pharmacology students on features to integrate according to the pharmacists' perspectives
Source: Author

B. Requirement Analysis

The requirements that are essential for system development are the functional requirements, on which the developing system, should be focusing on. The requirement analysis process was carried out in order to identify the critical functional requirements based on the responses gathered through the interviews and questionnaires distributed in the requirement gathering phase. In here as the analysis method a deductive approach using a Likert scale and based on the responses the hypothesis testing was carried out. Table 2 presents the number of responses received, the scores and thus the criticality of the functionalities classified accordingly.

Table 2. Summary of the requirement analysis

Requirement	Not at all important (1)	Neutral (2)	Slightly important (3)	Fairly important (4)	Very important (5)	Score	Criticality
Scanner to identify handwritten prescriptions	2	3	3	2	2	35	Not feasible
Locate the pharmacies on a map	0	0	0	3	9	57	Most critical
A communication platform to connect with the pharmacists	0	0	1	3	8	55	Most critical
A description about the medicines displayed on the prescription	0	2	3	7	0	41	critical
Ability to compare the prices of different pharmacies	0	2	6	3	1	39	Nice to have
Ability to search a medicine in a search bar and see the availability	0	0	1	2	9	56	Most critical
Ability to create our own list of required medicines	0	0	4	8	0	44	critical
An option to contact the doctor	5	2	4	1	0	25	Nice to have
Ability to find alternatives for a prescribed medicine	0	7	3	2	0	31	Nice to have
Get navigation support to reach the pharmacy	0	0	1	6	5	52	Most critical

According to the requirement analysis performed and presented in table 2 the critical functional requirements were identified as follows. The users could upload the prescriptions to the system, display locations of the pharmacies that has the drugs available with them, provide navigation support, connect pharmacists and patients through a communication platform, ability to search a medicine in a search bar and see the availability, ability to create our own list of required medicines, a description about the medicines displayed on the prescription.

C. Designing the system

To accommodate the features and functionalities that were identified as critical through the requirement analysis phase the designing phase is carried out. In this phase several

design diagrams are created and planned on how the system should be implemented. The process, features and functionalities of the mobile pharmacy app can be seen through the high-level overview of the system which is presented in Figure 5. Then the use case diagram (Figure 6), sequence diagram (Figure 7) and important UI design diagrams (Figure 8) are presented below.

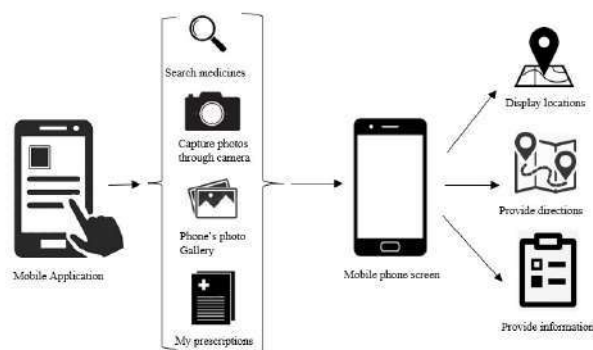


Figure 5. High level overview of the mobile application
Source: Author

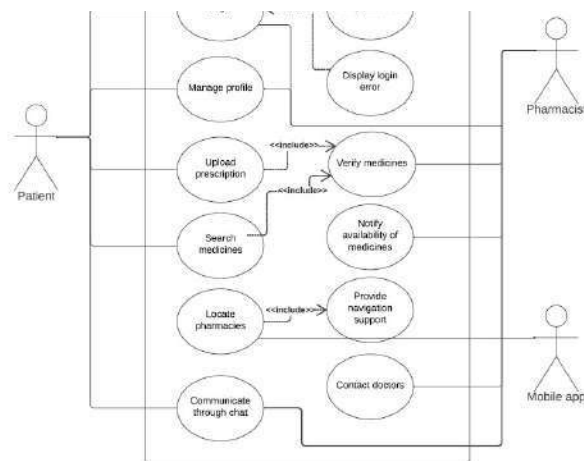


Figure 6. Use case diagram of the mobile application
Source: Author

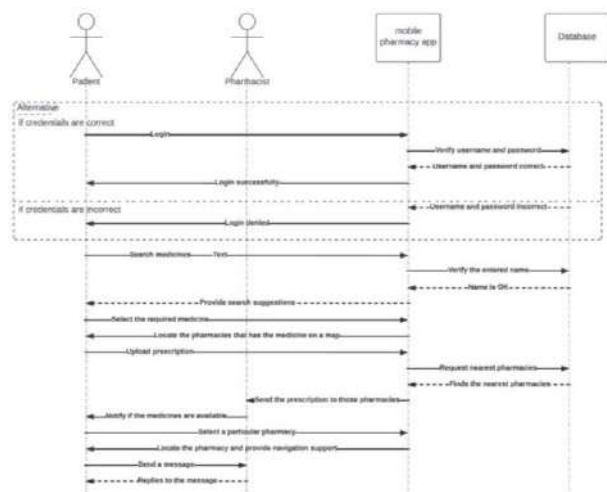


Figure 7. Sequence diagram of the mobile application
Source: Author

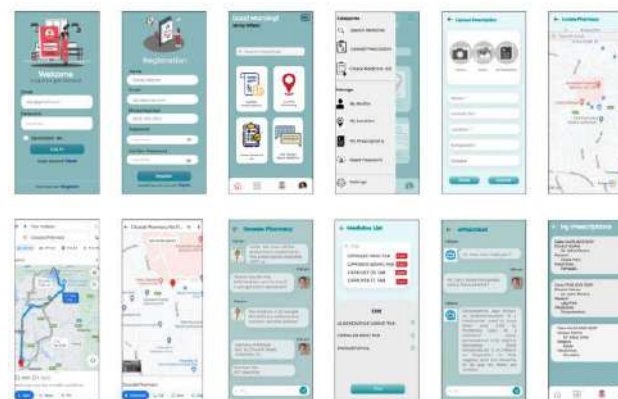


Figure 8. UI design diagrams of the mobile application
Source: Author

4. Discussion

The mobile pharmacy application is a very useful and an effective platform, that provides a network between the pharmacies, and it includes functionalities to locate the pharmacies where the particular drugs are available. Since this application's main objective is to make the process of buying medicines easier by saving the time of the users; the usability of the application should be of major concern. Therefore, several surveys were carried out to identify the user requirements for this proposed application.

Even though 69.2% of users that participated for the survey has preferred having a functionality that could scan the handwritten prescription and identify the medicines available there, due to the inconsistency of the doctors handwriting, implementing this feature is infeasible and would lower the accuracy of medicine identification through handwriting recognition. Identifying the doctors' handwritten letters in prescriptions have become a difficulty to the pharmacists sometimes. Through the interviews conducted with the pharmacists it was made clear. And they mentioned some precautions they take to overcome those situations. Therefore, implementing a handwriting recognition model for the purpose of identifying prescribed medicines in handwritten prescriptions was identified as infeasible in this research.

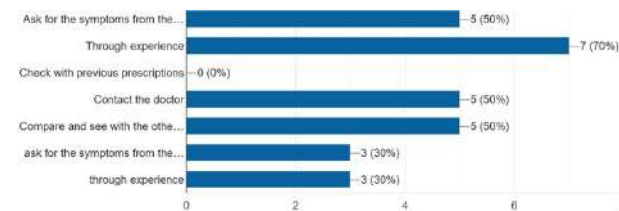


Figure 9. Steps taken by pharmacists to overcome difficulties in identifying medicines in prescriptions
Source: Author

Therefore, as an alternative to that feature, it is proposed to have an option where the patients can directly upload the handwritten prescription to the system, where the system

would identify the nearest pharmacies and forward that prescription to them in order to find availability of prescribed drugs. This prescription uploading feature could be seen in most of the existing pharmacy applications as well, thus it can be stated that it is a more efficient and feasible alternative.

Through the requirement gathering and analysis phase it was able to identify the critical functionalities that the users expect from the system. These include the Ability to upload the prescriptions to the system, display locations of the pharmacies that has the drugs available with them, provide navigation support for the users to get to a particular pharmacy they require, connect pharmacists and patients through a communication platform, ability to search a medicine in a search bar and see the availability, ability to create our own list of required medicines, a description about the medicines displayed on the prescription. These descriptions of medicines are provided to the users through a simple chatbot.

Table 3 illustrates a summary of the analysis regarding the geolocation positioning that was carried out during the literature survey. This was carried out to identify which technologies and tools are suitable for the purpose of locating nearby pharmacies and provide them with navigation and directions support.

Table 3. Analysis performed on tools and technologies for geolocation display and navigation

Application	Google map API	Google Directions API	Custom API	Shortest path algorithm	Swarm intelligence algorithm	GPS
GIRPharma (Pardo et al., 2010)	x	x	√	x	√	x
Online Location based Service (IBRAHIM and MOHSEN, 2014)	√	√	x	x	x	x
Posyandu Administration Services (Nurwarsito and Savitri, 2018)	√	x	x	x	x	x
Web Map based on Scripting Layer for Android (Xing and Lei, 2016)	x	x	x	x	x	√
Geographic Information System (Sholeh et al., 2017)	√	x	x	x	x	x
Location-Based Services in Android ("Smart Geographic object: Toward a new understanding of GIS Technology in Ubiquitous Computing," 2015)	x	x	√	x	x	√
Rapid prototyping (Suddul et al., 2015)	x	x	√	√	x	x
Count	3	1	3	1	1	2
Percentage (%)	42.8	14.2	42.8	14.2	14.2	28.5

According to the reviewed papers, Google Maps API is a vast repository that could be useful to access the Google maps functionalities. Thus, it could be easier and useful for Geolocation display and tracking. Since the system requires real-time results, using a real-time database functionality of Google is much appropriate and easier.

Furthermore, since this application is used by ordinary people the interfaces and its operations should be simple in such a way that it could be used by any person without any special technical knowledge and background. The accuracy and reliability of the results and outputs produced by this application should be high. Also, since the application deals with personal details of the users including their illnesses and the medicines that they are using, the security is a key feature that should be highlighted. The system design is carried out by taking all these factors into consideration. And the designs are presented in the previous section.

5. Conclusion

In conclusion, a Mobile Pharmacy is a good answer for the problem identified and mentioned in Section I of this study, especially in this present situation in Sri Lanka with the shortage of medicines and fuel this is a very useful solution. Which allows the patients to easily find a pharmacy where the drug is available. As a result, the user requirements that should be included and the design of the proposed system together with the tools and technologies that are being used were explored in this paper.

6. Future Work

Based on the outcomes and the design created through this research, a more accurate, user-friendly, and efficient mobile pharmacy application is to be constructed as future work. Anyone interested in this topic can use the technologies and techniques recognized as suitable through this study in the future. Further it is expected that this system would ease the burden of people during these hard times.

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