



# Tiryaq | ترياق

IT 497: Graduation Project Report  
Product Release-2

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# Tiryaq | ترياق

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Recently, the science of medicine and pharmacology has developed, and there has been a significant increase in medications, as well as an increase in the number of pharmacies, therefore it became difficult to find out the availability of the medications in a short time and less effort. In addition to that, consumption of medications became concentrated on certain pharmacies that led to medication stacking problems in other pharmacies. For this reason, our goal is to develop a system with a location-based mobile application that locates the nearest pharmacies with the desired medications. Agile approach is used to develop this project in incremental iterations, starting from the main application for two different users to the admin dashboard. By evaluating the project in real life with actual users, the useability and high need of the project was proved. At last, this project will help people find their medications in a reasonable time and effort, and will solve medications stacking and expiring problems while enabling pharmacies to reach out to a larger segment of customers.

مؤخراً تطور علم الطب والصيدلة وحدثت زيادة كبيرة في العلاجات والأدوية وأيضاً زيادة في عدد الصيدليات، لذلك أصبح من الصعب معرفة مكان توفر الأدوية في وقت قصير وجهد أقل. إضافةً إلى ذلك، استهلاك الأدوية أصبح مرتكز على صيدليات معينة مما أدى إلى مشاكل في تكدس الأدوية في الصيدليات الأخرى. لهذا السبب، هدفنا هو تطوير نظام يحتوي على تطبيق يمكن من تحديد أقرب الصيدليات التي توفر الأدوية المطلوبة. تم استخدام نهج (اجايل) لتطوير هذا المشروع على مراحل، بدءاً من تطوير التطبيق لنوعين مختلفين من المستخدمين إلى تطوير لوحة تحكم للمدير. من خلال اختبار المشروع في الحياة الواقعية مع المستخدمين الغربيين، تم إثبات قابلية الاستخدام وال حاجة العالمية للمشروع. أخيراً، سيساعد هذا المشروع الأشخاص في العثور على أدويتهم في وقت وجهد معقول، وسيحل مشاكل تكدس الأدوية وانتهاء صلاحيتها مع تمكين الصيدليات من الوصول إلى شريحة أكبر من العملاء.

**Keywords:** Pharmacy; Pharmacist; Medication; Prescription; Location.

## 1 Introduction

In recent years, the science of medicine and pharmacology has developed, and there has been a significant increase in treatments and medications, as well as an increase in the number of pharmacies. Because of this increase, there is a need for a system that serves this category, hence the idea of developing the “Tiryaq” system.

In the academic or professional world, pharmacy is defined as the branch of science that deals with the preparation, doses, and dispensing [1]. From a normal point of view, we can say that the pharmacy is a place for selling medications and daily needs. But today's pharmacies have grown into stores that sell a variety of products, including prescription medications, over-the-counter medications, medical supplies, cosmetics, and other products. It is visited by people with chronic or acute diseases and sometimes healthy people on a regular basis. This has led to an increase in the number of pharmacies which makes it challenging and difficult for people to find out the availability of their medications in pharmacies in their neighborhood. Furthermore, it is time and effort consuming to contact or visit each pharmacy. In addition, most pharmacies don't have an online platform for people to get their medications easily, this leads us to the need of having a system that connect pharmacies and customers and provides the customers with the nearest pharmacies that covers their required medications in an efficient way.

The main purpose of the application is to provide the customers with an effective way to reach their goal, which is to find the right medication for them from the nearest point of sale to their location. In addition, pharmacies will be able to join the application and serve customers' orders by providing them with their needs which leads to save customers' time and effort, and making the work of pharmacies more productive, which contributes to improving and facilitating life.

## 1.1 The Problem

People face a difficulty to find their medications due to the large number of pharmacies in their neighborhood, so they waste a lot of time and effort in visiting different pharmacies to search for their medications. In addition, contacting every pharmacy would not be an easy and feasible solution, and most of the pharmacies do not have an online platform to reach their customers. Also, some pharmacies face problem in reaching their customers because the majority of customers go to large pharmacies even if they are far, assuming they will find their medications, which causes stock problems and expirations of the medications without consumption. Therefore, an online unified platform is needed and required to provide a connection between customers and the pharmacies to inform them about the availability of specific medications in the pharmacies in their neighborhood.

## 1.2 Objectives

- **Product (customer focus-value):**

The project aims to develop Tiryaq which is a location-based system that provides a convenient way to find and pickup medications from the nearest pharmacy. The system will be composed of a mobile application and an admin dashboard. The mobile application has two main users: the customer who wants to order a specific medication from a nearest pharmacy to his/her location and the pharmacy that participates to fulfil the customers' orders. To accomplish that, the following are the product features:

1. Customer can create and update account.
2. Customer can search and filter medications.
3. Customer can view cart, add, and delete medications from cart.
4. Customers can find out the nearest pharmacy that has a specific medication.
5. Customer can make an order to pick up a medication from specific pharmacy.
6. Customer can track his/her order to know when it is ready to collect.

7. Pharmacist can receive an order to pick up medication/s from customers and accept/decline this order based on availability.
8. Pharmacist can check the status of orders and update it once needed.
9. Admin can browse and manage customers, pharmacies, medications, and orders through a dashboard.

- **Project (solution focus-plan):**

To complete the project, we will do the following:

1. Understand the domain and user needs using questionnaire and interviews.
2. Design and develop the database.
3. Design and develop a mobile application for customers and pharmacies.
4. Design and develop the admin dashboard.

- **Learning (student focus):**

To accomplish this project, we need to learn the following:

1. Mobile application development.
2. Using Android Studio and Visual Studio as development environments.
3. Using Flutter tool and Dart programming language for development.
4. Developing location-based services.

### 1.3 Scope

Tiryaq system is composed of an android application and an admin dashboard in Saudi Arabia that supports English language to find the nearest pharmacy that contains the required medication.

The dashboard will be built for the administrator to manage medication, customers, orders, and pharmacies with the ability to accept or decline their join request.

The android mobile application will be developed for customers and pharmacies. Through it, customers will be able to add medication to their carts, specify their location, add prescription, and then submit the order. the application will send the customer's order to all the pharmacies in the system, and then displays to the customer a list of pharmacies that either accepted or declined the order, ordered by closeness to the customer's location. Following that, the customer can select one of the pharmacies that accepted the order. When the pharmacy receives the order, it will be able to confirm that the requested medication is in stock or not and write a note to the customer. They will then be able to decide whether to accept or decline the order.

A sample of medication's data provided by the Food and Drug Authority will be utilized to display the medications in the system so the customer can view, search, filter and order these medications. Flutter, dart language and location-based service will be used for creating the application. Html, JavaScript languages will be used for creating the dashboard.

## 1.4 Product Vision

**For** a people **Who** needs to buy medications, **the** Tiryaq is a location-based mobile application **that** enable customers to order and pick up their medications from the nearest pharmacies. **Unlike** other Apps that sell medications. **Our product** is an online unified platform that enable customers to search their medication and communicate with different nearby pharmacies in a convenient way.

## 1.5 Approach

Before the implementation of Tiryaq system, we studied the competitors and conducted a questionnaire with customers and interviews with pharmacists in order to elicit the system requirements. Moreover, we collected Tiryaq's data from Saudi food and drug authority (SFDA), cleaned the data and selected a sample to make it useful for Tiryaq system. After collecting users' needs and preprocessing the data we became able to design Tiryaq system and build it by following agile approach which is incrementally implement the product backlog and evaluate it using user acceptance testing at the end of each sprint and it developed using flutter framework. Finally, to ensure that the system functions as intended and complies with user requirements, we conducted user acceptance and NFR testing for the entire system after the last integration of the sprints.

## 1.6 The Solution

This project will develop Tiryaq system that composed of admin dashboard and location-based mobile application that builds a connection between customers and pharmacies to provide people with the nearest pharmacies which contains a list of medications according to their needs. The application enables the customer to browse, search for medications, create orders, attach the prescription, track the status of the order, or cancel it. In addition, the application detects the customer location and once the location information is acquired, it is sent to the database for data processing and storing along with other parameters relevant to the information. Next, the database is queried to retrieve the data and implement some calculations to calculate the distance between the entered location and the nearest pharmacies. Once the distance is calculated, Tiryaq application will display the nearest pharmacies that contains the requested medications to the customer according to the entered location and then the customer can choose among them.

Using Tiryaq application, the customer can get the order in a convenient and efficient way without the need to visit different pharmacies to search for medications, wait in long lines, hunt through aisles or waste time looking for parking and moreover, there will be no accumulation in the stock and expirations of medications in some pharmacies, as customers will reach pharmacies that do not have online selling platforms, which leads to a balanced consumption of medications.

## 1.7 Report structure

This document outlines the necessary activities to develop Tiryaq system, starting from Introduction chapter that includes the problem we're trying to solve, the solution we've come up with, our system vision, objectives and the scope of the system, hardware and software tools, skill set requirements and learning plan, then the Background chapter that describes the necessary knowledge about the pharmacy and location-based service, and the Literature review chapter that contains the competitors analysis and the System requirements chapter in terms of users, requirements elicitation, user interactions, roadmap and product backlog. Additionally, this document contains the System design chapter that has the architecture, class diagrams, component level design and data design which shows us the configuration of the system and its components and their interaction with each other and the data configuration, in addition there is a System

implementation chapter which includes the methods and some of the necessary functions to develop Tiryaq, and System testing chapter which includes system evaluation and questionnaire to testers, and Conclusions and Future work chapter. Finally, it includes the References chapter and Appendix chapter.

## 2 Background

This chapter provides the necessary background information and concepts about Pharmacy and Location-based service which are the fields that are related to the problem and solution domain and this information has been gathered to understand and guide the development of Tiryaq system.

### 2.1 Pharmacy

The role of the pharmacy in healthcare is critical since it's the place that prepares and sells medications for patients based on the license it obtained from the Saudi Food & Drug Authority (SFDA) to market medications. Therefore, The Saudi Food & Drug Authority (SFDA) issue licenses for drug marketing and aims to ensure safety, effectiveness and quality of medications, medical plants, health, and herbal products, conduct quality checks on medications in the market, monitor medications after marketing, and providing drug information from reliable sources for those who need it from the public or health workers [2]. After the pharmacies obtain the license, they will be able to contract with medications suppliers and import the medications according to the guides and then they will start selling it.

### 2.2 Location-based service

Location-based services (LBS) refers to services that are based on the location of a mobile user as determined by the device's geographical location. LBS applications provide services and information depending on the location of the user [3].

Currently, people can easily find the locations of restaurants or fitness clubs and other places using location-based service applications.

In addition, the location-based application leverages GPS technology embedded in smartphones as it will be useful in Tiryaq system to detect the nearest pharmacies based on customer location [4].

### 2.2.1 LBS Categories

Location-based services can be broken into the following distinct categories [5]:

#### 1. Pull

The application uses the location-based service processes. One example of a query-based location-based service is a user checking a mobile map. Some location-based services also enable users to check in to restaurants, concerts or sporting events using apps such as Foursquare, Yelp or Google Maps. In addition, Tiryaq application is considered as pull-based application as the location will be detected when the customer order from the application.

#### 2. Push

The application initiates the location process based on a trigger or at regular intervals. The application then presents the user or device with relevant information based on their geographic location. Proximity-based marketing is a push-based location-based service example. A user is sent an advertisement or coupon after the application proactively identifies that person as being near a specific retail outlet.

### 2.2.2 LBS Components

To make LBS work, several key components are necessary: a mobile device, positioning capabilities, a communication network, and a service and content provider.

The following figure (2.1) introduce each of these components [6]:

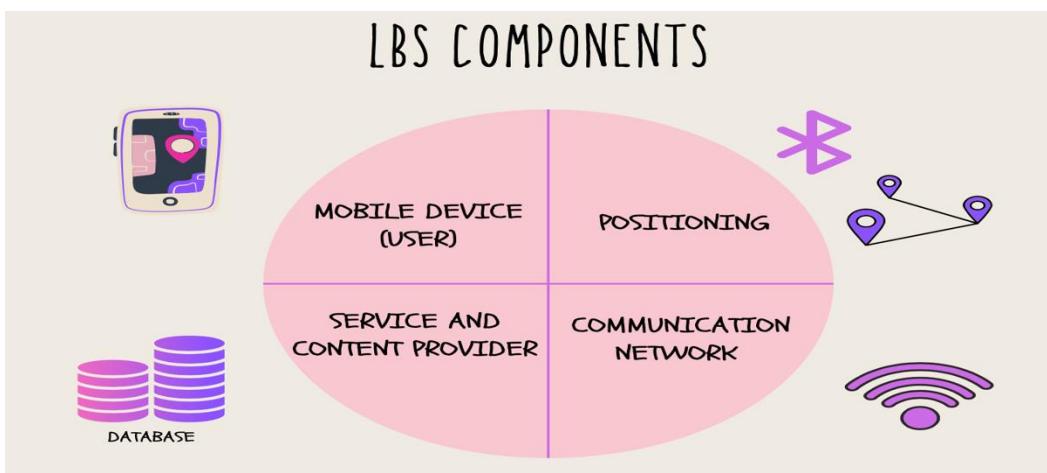


Figure 2.1 LBS components

- **Mobile device:** A client for the user to request and receive the needed information according to his/her location in mobile environments. The results can be given in various forms, such as graphical (e.g., mobile maps, augmented reality, and 3D), verbal (e.g., verbal instructions), haptic (e.g., vibration), and hybrid.
- **Positioning:** The positioning component determines the current location of the user. Many technologies are available, such as GPS, WiFi, Bluetooth, and radio-frequency identification (RFID).
- **Communication network:** The communication network (for example cellular network or WiFi network) transfers the data and service request of the user from his/her mobile device to the service and content provider (Database) and sends the requested information back to the user's device.
- **Service and content provider:** The provider of service and content processes the user's requests and returns the needed information. It might not store and maintain all the information, and very often needs to access and integrate other data sources (e.g., geographic boundaries, road network data, points of interest (POI) data, and event data) for service request processing.

## 2.3 SFDA

Saudi Food & Drug Authority (SFDA) is the source of Tiryaq system dataset. It established under the Council of Ministers resolution no (1) dated 07/01/1424 H.

The main purpose of the SFDA establishment is to regulate, oversee, and monitor food, drug, medical devices, as well as to set mandatory standard specifications thereof, whether they are imported or locally manufactured. The authority responsible for monitoring and/or testing activities in the SFDA or other agency's laboratories. Moreover, the SFDA is in charge of consumer's awareness on all matters related to food, drug and medical devices and all other products and supplies in order to achieve the following [7]:

- The safety and effectiveness of food and medicine for humans and animals.
- The safety of complementary biological and chemical substances, cosmetics, and pesticides.

- Launch clear policies and procedures for food and drug, and plan to achieve and implement these policies. Moreover, setting a scientific base that can be used for education, advisory services, and programs in the fields of food and medicine.
- Conduct research and applied studies to identify health problems, their causes, determine its impact and effects on public, with the consideration of methods for research/studies evaluation. The authority shall establish scientific bases for awareness and consulting services and executive programs in the fields of food and drug.
- Control, monitor and supervise licenses procedures for food, drugs, and medical devices factories.
- Information exchange and dissemination with local and international scientific and legal agencies and setting up a database for food and drug.

## 2.4 Terminology

- **Pharmacy:**

“A pharmacy is the art, practice, or profession of preparing, preserving, compounding, and dispensing medical drugs” [8]. Also, it is known as a store or a part of a store that prepares and sells medications [9].

- **Pharmacist:**

“A person who is trained to prepare and give out medicines in a hospital or shop” [10].

- **Medicine:**

“A substance, especially in the form of a liquid or a pill, that is a treatment for illness or injury” [11].

- **Medication:**

“A medicine, or a set of medicines or drugs, used to improve a particular condition or illness” [12].

- **Drug:**

“Any natural or artificially made chemical that is used as a medicine” [13].

- **Over-the-counter medicines (OTC):**

Over the counter is also known as OTC or nonprescription medicines are defined as a group of medicines that can be purchased without a doctor's prescription [14].

- **Prescription:**

“a piece of paper on which a doctor writes the details of the medicine or drugs that someone needs” [15].

- **Dose:**

“A measured amount of something such as medicine” [16].

### 3 Literature Review

This chapter describes the literature review which includes research for competitive applications that are similar and related to the proposed application to compare them to Tiryaq application. So, we will benefit from this research to determine the requirements.

#### 3.1 Competitive Product Analysis

The market has been researched for current applications that offer medications similar to those Tiryaq application is meant to provide, and it was discovered both their strengths and weaknesses. These applications vary from one another in terms of their internal services and the variety of their medications with some focusing on selling medications while others sell medications as part of their services.

The competitive applications will be displayed one at a time, and the features that differentiate each one apart will be described:

- **Dr. Alhabib pharmacy**

Dr. Sulaiman Al Habib Pharmacy is an online mobile application that offers a pharmaceutical care service [17]. There is a substantial number of medications of diverse types available through the pharmacy including medications that require prescription. Prescription medications are only deliverable to users who have an online prescription from Dr. Alhabib hospital as shown in figure (3.2). As the pharmacy only provide a delivery service, users can track their orders in addition they can get informed about the availability of a particular medicine of any type in the pharmacy branches regardless of whether they have a prescription or not if they wish to visit the branch as shown in figure (3.2).



Figure 3.1 Dr. Alhabib  
pharmacy logo

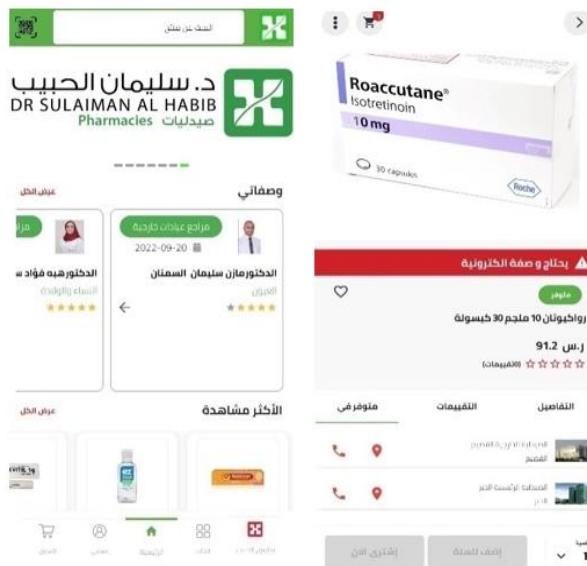


Figure 3.2 Dr. Alhabib pharmacy app

### • HungerStation

Hungerstation delivery mobile application, allows users to browse and order from the largest selection of restaurants, supermarkets, pharmacies, and flower shops, as well as opt to pay online or cash on delivery [18]. The pharmacies that the application offer is displayed and filtered according to the users' location as it only shows pharmacies within specified range as shown in figure (3.4). Regarding to medications, the application is extremely restricted as it only allows users to browse and order limited number of OTC medications and other non-prescription supplements as shown in figure (3.4). Once the order is placed the users are allowed to track its status, however the order can be cancelled only before its being confirmed by the other entity.

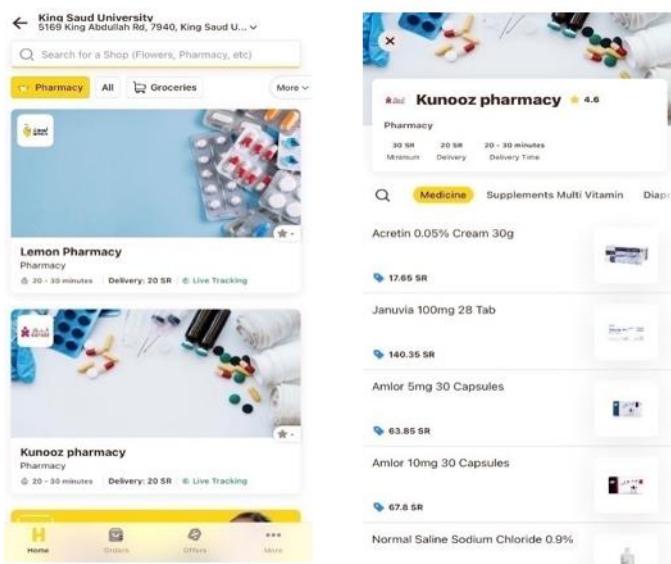

 Figure 3.3  
HungerStation app  
logo


Figure 3.4 HungerStation app

### • Shgardi

Shgardi is an online mobile application that offers a delivery ordering experience. The application allows users to order from a variety of restaurants, supermarkets, pharmacies, and choose to pay online or cash on delivery [19]. The application provides an extremely limited selection of OTC medications without their prices as it lets users specify their preferred pricing range as shown in figure (3.6). Also, it requests the users' location in order to find the closest driver to serve the order from the nearest pharmacies as shown in figure (3.6); the driver is expected to visit several pharmacies in order to complete the order within the price range. Also, users can track the driver through the application.



Figure 3.5 Shgardi app logo

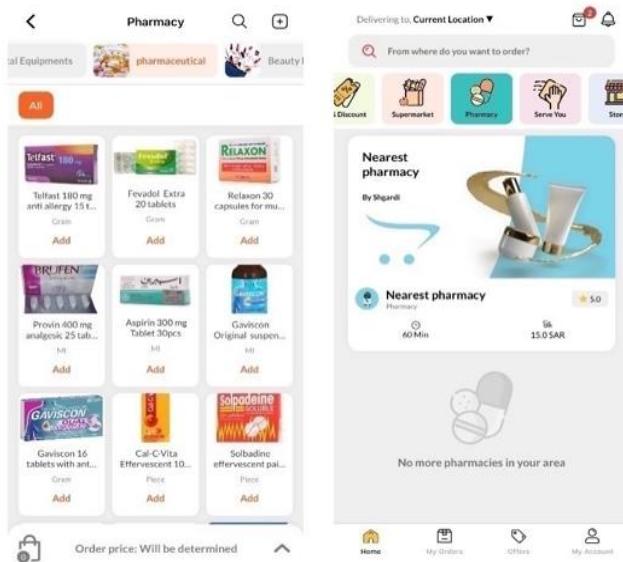


Figure 3.6 Shgardi app

- **Alnahdi:**

Alnahdi is an online mobile application that provides basic daily needs, users can find the location and the contact information of their closest pharmacy, order any preferred type of medications either OTC and prescription and can upload a picture of their prescription and get it delivered or collect it from the nearest Alnahdi branch and can pay online or cash when collected or delivered as shown in figure (3.8) [20]. In addition, services such as order status tracking and an instant chat with a pharmacist at any time are offered. The application offers two options to place an order; either by uploading a copy of the prescription then the application will automatically place an order, or the user place an order manually by adding medications and supplements to the cart, as it is not possible to place an order that includes both an attached prescription and self-selected medications.



Figure 3.7 Alnahdi pharmacy logo

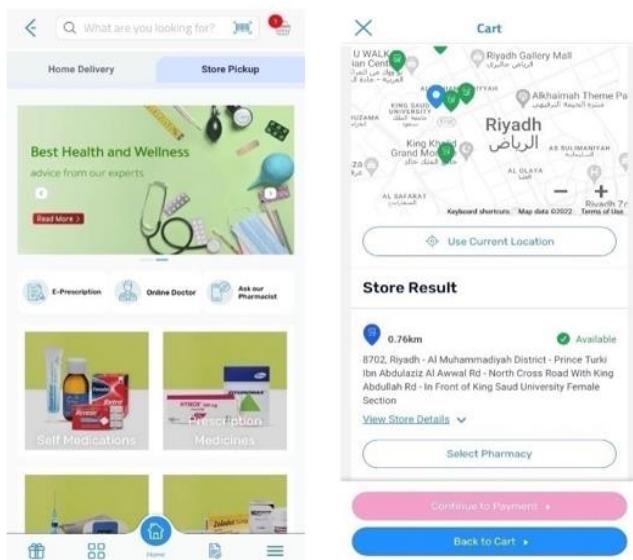


Figure 3.8 Alnahdi pharmacy app

- **Boots:**

Boots is an online mobile application helps users to access health and beauty needs. The application has a section to get inspired through browsing inspiration and advice articles [21]. Orders through the application requires online payment and can be placed for delivery or for pickup. However, pickup orders are ready to be collected after 5 to 7 days from the payment date. Besides that, the online pharmacy only provides a limited number of OTC medicines and other supplements as shown in figure (3.10). The application displays their branches as a list or on a map with the distance between each branch and the user's location that is detected through background location tracking as shown in figure (3.10).



Figure 3.9 Boots  
pharmacy logo

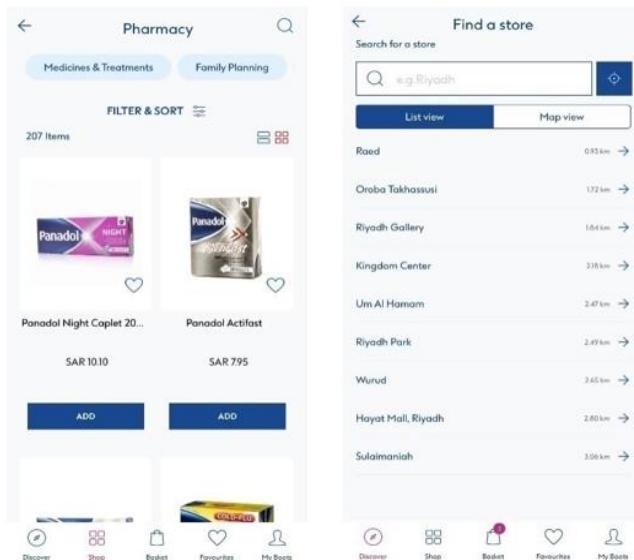


Figure 3.10 Boots pharmacy app

Table 3.1 Competitive applications analysis

Feature/application	Dr. alhabib	Hungerstation	Shgardi	Alnahdi	Boots	Tiryaq
Locate the nearest pharmacy with list of medication				✓		✓
Offer various pharmacy firms		✓	✓			✓
Pickup service				✓	✓	✓
Delivery service	✓	✓	✓	✓	✓	
Pay online	✓	✓	✓	✓	✓	
Track order	✓	✓	✓	✓	✓	✓
Order cancelation						✓
Instant chat with pharmacist				✓		
Provide OTC medications	✓	✓	✓	✓	✓	✓
Provide prescription medications	✓			✓		✓
Attach prescription				✓		✓
Supported Languages	Arabic/English	Arabic/English	Arabic/English	Arabic/English	Arabic/English	English

As shown in the table (3.1) we identified the key features that distinguish each competitor. We can notice that only one of the competitors' applications – Alnahdi – has a feature that displays a list of the nearest Alnahdi pharmacy branches that contain a list of medication entered by the user. Furthermore, competitors that offer various pharmacy firms are delivery-based applications, whereas others provide pickup services only for their pharmacy branches. In addition, Boots pharmacy application pickup service takes 5 to 7 days to get the orders ready while Alnahdi pharmacy takes 3 to 5 hours. Most applications provide OTC medications, while only a few provide prescription medications; however, only Alnahdi allows to attach a prescription. In conclusion, the point that distinguishes Tiryaq and will entice users to use it is that it integrates several features and services into a single application. These features can be defined as locating the nearest pharmacy – among various firms – that provides a list of medications for pickup service as soon as possible. Tiryaq allows the customer to attach a prescription if the medications require it to speed up the purchase process for both the customers and pharmacy, also it gives the customer the ability to cancel the order.

## 4 System Design and Development

### 4.1 Methodology

Due to our desire to produce a high-quality functioning system, we used the agile approach when developing Tiryaq system. As a result, we were able to break down the project into smaller, more manageable units, allowing us to concentrate on the design, implementation, and testing of one unit at a time before integrating the units and testing them as a whole to create a completed, functioning system.

We used the scrum framework as an agile practice to direct the development of Tiryaq system. The initial step was to establish the scrum team, which included the product owner who was in charge of supervising the thorough implementation of the system as well as assessing the user stories and acceptance criteria. The scrum master was in charge of ensuring that the team was following the scrum framework correctly and resolving any obstacles they encountered. Finally, developers were in charge of carrying out the work, making the necessary adjustments, writing and breaking down user stories, and producing the final product.

Following the team formation, the project was divided into sprints. Each sprint consisted of five events, beginning with planning, where we decided what would be worked on during the sprint as well as what would be delivered at the end of each sprint. Next, we reviewed the daily workflow during the daily scrum. After that, the community evaluated the project's progress during the sprint review. Finally, the sprint concluded with a retrospective, where we assessed our own performance.

As for the scrum artifacts, we first established the product backlog, where we wrote all the features as user stories and prioritized them based on importance. Then, we selected a group of features for each sprint based on the type of feature and dependencies. Finally, at the conclusion of each sprint, we integrated the features with one another and then with the remaining user stories that had been completed during the previous sprints. That's what was accomplished in the Product Increment.

A successful step for our project was the adoption of agile approach. Through it, we were able to attain a very significant objective, which was to involve users in the development of Tiryaq system in which we were able to hear their feedback and adjust the application accordingly.

Since agile approach focus on the important functions before diving into the details, as well as the requirement that all team members commit to attend the scrum master's meetings, weekly meetings with the product owner, and daily meetings to monitor workflow, we were also able to deliver a system that functions in a short period of time.

The team members themselves determined how the work would be divided, thus the trust of the product owner provided them the freedom to do so in accordance with their capabilities and skills. As a result, the work was completed in the proper manner. Finally, the team concerned about enhancing its talents and production through self-accounting and work reviews.

GitHub and Jira are two of the most significant tools and websites that supported us during the development of Tiryaq. We were able to manage and build the system more easily because of their utilization. With regard to Jira<sup>1</sup>, it allowed us to create user stories, allocate them into sprints, and write reports about our weekly meetings with the product owner. With regard to GitHub<sup>2</sup>, we were able to assign a branch to each team member so they could upload their work there. This allowed us to merge the work so that the codes did not overlap, also the work remained orderly, and it was kept safe from loss.

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<sup>1</sup> <https://id.atlassian.com/invite/p/jira-software?id=j4an5yz5TweMckPli0z8pQ>  
<https://id.atlassian.com/invite/p/confluence?id=LDA417Y8Q3OGX94zb9h9vQ>

<sup>2</sup> <https://github.com/R2eem/2022-GP1-19.git>

## 4.2 System Requirements

### 4.2.1 System Users

Tiryaq system have 3 types of users which are customers, pharmacist, and administrator. **Customers** are general users of the application who wants to find medications, they need to have experience using basic market applications and online ordering. Customers must understand basic English regardless of their educational level. **Pharmacists** are the users that interact with the customers through the application, they must have at least a pharmacy technician certificate from a health institute or bachelor's degree in pharmacology. Pharmacist should have experience using basic market applications and online ordering. Additionally, there is a dashboard managed by the **administrator of Tiryaq**, to manage the application the admin should have the ability to control and manage customers, pharmacies, medications, and orders. Finally, the admin should have abilities to communicate effectively in both technical and non-technical terms.

### 4.2.2 Requirements Elicitation and Analysis

To elicit the requirements, it has been used several methods such as interviews with pharmacists and publishing a survey to the general public who are considered customers of pharmacies.

- Survey analysis

In order to create solutions that satisfy the user's objectives and improve user behavior, it is crucial to understand user needs and behaviors. The survey technique is an efficient, adaptable, and quick way to compile user needs and requirements. With the help of Google Forms, we created a survey that asks people who speak Arabic and English about their interest in buying medications; how frequently they do so; any difficulties they face; and whether they would be interested in ordering medications online for pickup etc. The survey consists of 15 questions (see Appendix A) and was distributed through social media channels, with 100 responses received. 79% of the participants were between the ages of 18 and 30, 17% were between the ages of 31 and 45, 3 participants were between the ages of 46 and 60, and one participant was over the age of 60. The majority of the participants with 82% were women, and their educational backgrounds ranged from secondary to master's degree and above studies.

Where 6 participants from the secondary level, 73 from the bachelor's stage, 20 from the master's degree and above stage, and 1 from the lower secondary stage took part.

In order to acquire a general idea of the participants' health situation, we asked them if they had chronic diseases or if they had an elderly person who did, both groups required regular medication purchases. We discovered that 16% of participants have elderly relatives who have chronic diseases, and 11% of participants themselves have chronic diseases. The following figure (4.1) showed how difficult it is for the majority of people with chronic diseases to find medications. It becomes clear from the question about the type of disease they have that the three most prevalent conditions for which regular medication purchases are necessary are diabetes, blood pressure, and asthma. There were cases involving heart patients, allergy sufferers, and stroke. The most prevalent disease for which patients have trouble getting medications is blood pressure, as shown in figure (4.2).

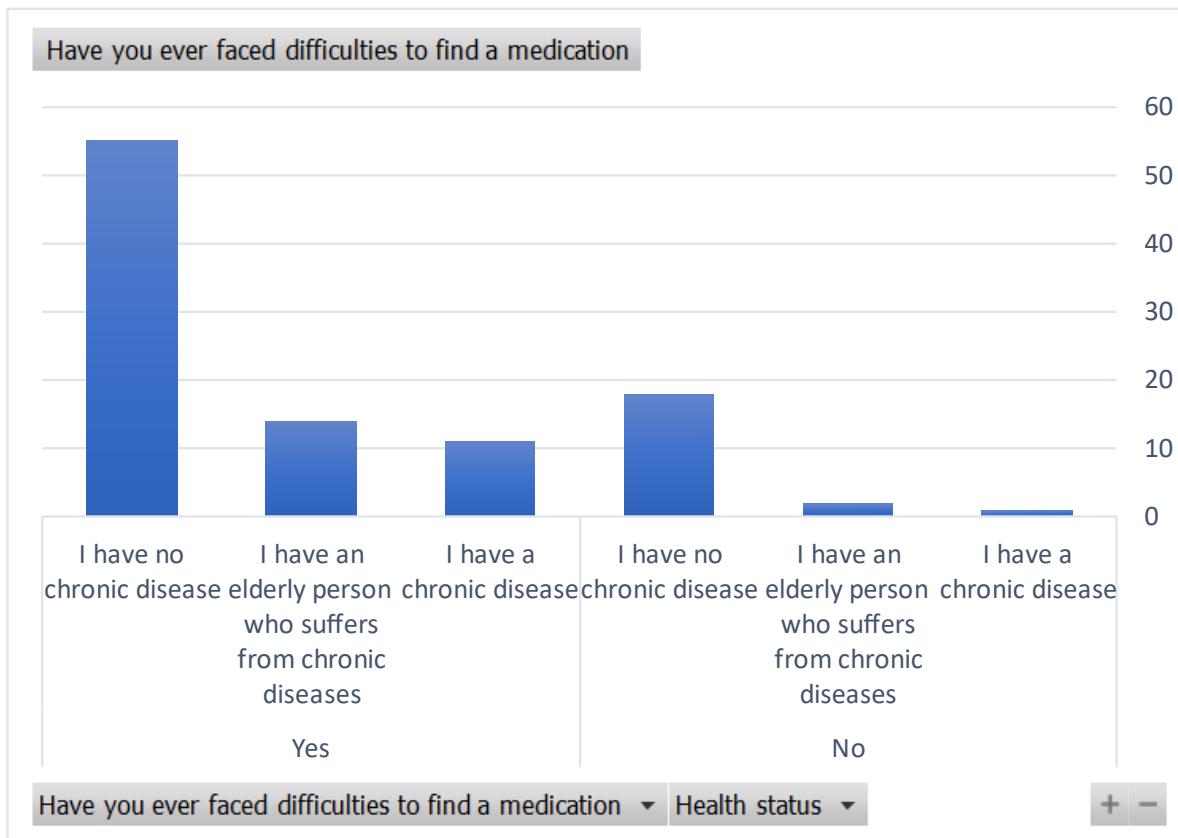


Figure 4.1 Difficulties of majority -Survey analysis

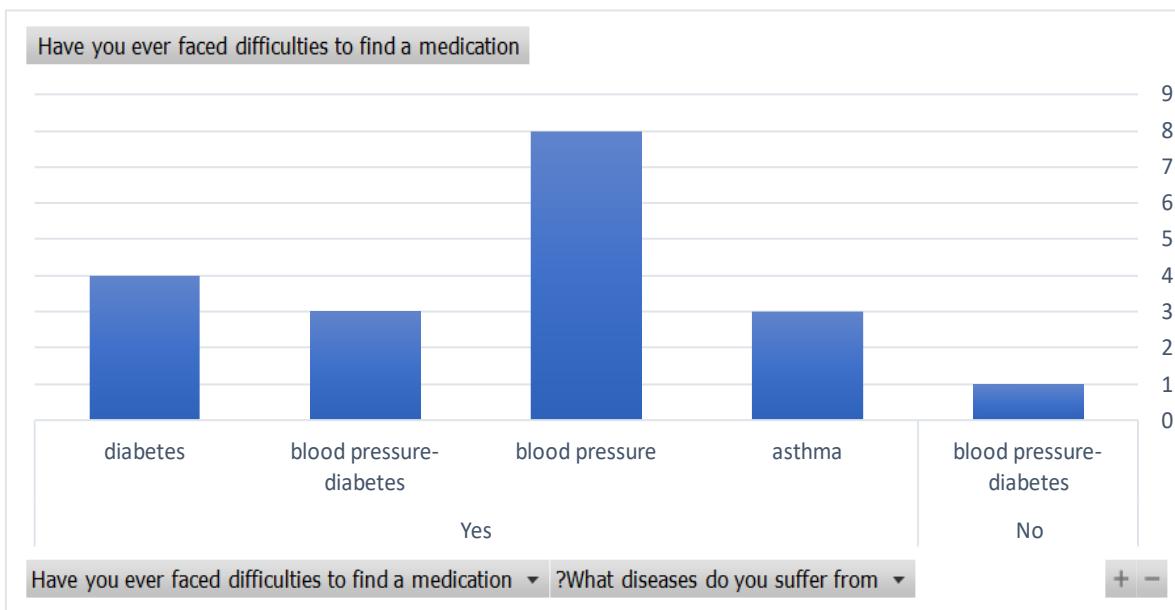


Figure 4.2 Prevalent disease-Survey analysis

To understand the behavior of users in buying medications from pharmacies and their previous experiences, questions were asked about how often they buy medications, the most important factor they take into consideration when searching for a pharmacy to buy medicine, and the method they follow when they want to know whether the medicine is available in the pharmacy or not. It turns out that the vast majority of 34% buy medications once a month, 30% once every three months, 21% don't buy medications, and finally 15% buy them once a year. From this, we concluded that medications purchases are often made monthly for most users, based on the sample. Also, 50% of the participants indicated that the most important factor affecting the purchase of medications from pharmacies is the location of the pharmacy, followed by the customer's previous experience, and a small percentage indicated the pharmacy name and reviews. In addition, most customers visit the nearest pharmacy to verify the availability of the medications by 58%, as it became clear to us that the proximity of the pharmacy that provides the medications is an important factor in the customer's experience, followed by their verification of its presence on the pharmacy's website and then visiting a particular pharmacy.

Moreover, 80% of people face difficulties when buying medications. To investigate these difficulties as shown in figure (4.3), a question was asked about the difficulties people face in general, and it was found that 67% of people indicated that visiting more than one pharmacy to find the required medications is the biggest challenge they face, followed by that they find

medications in a pharmacy because it is very far from them. In addition, they cannot contact the pharmacies to check the availability of their medications before going to them. A small percentage indicated the difficulty of finding parking spaces at pharmacies and the difficulty of finding a way to communicate with pharmacies to verify the availability of medications. The location of the pharmacy that provides the customer's medications needs is important to them.

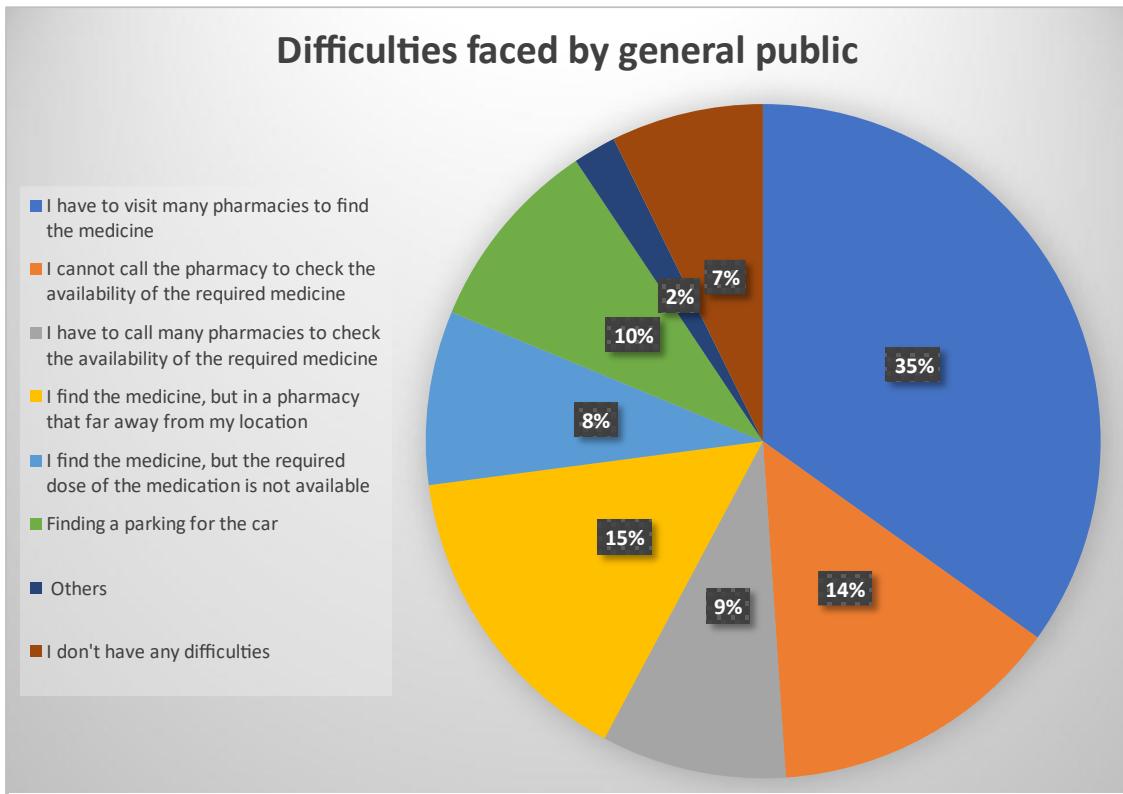


Figure 4.3 General public difficulties-Survey analysis

Questions were also asked to investigate people's experiences in terms of ordering medications via the Internet, such as the number of times they buy medications online, and whether they prefer having the advantage of pick up the order or not, and the time period during which the order is supposed to be processed, and we found that most people do not buy medications online, with 35% of those who do this, but rarely and we found that 20% of them do this sometimes, and 71% of them indicated that they prefer to have the feature pick up the order after being prepared. This option has the highest percentage, which is 60% of the participants, followed by two hours, and we find that three hours is the maximum expected period to pick up the order.

In order to develop a solution with functionality that helps the users in real life, we asked them some questions that help in designing the application in line with the needs of customers, such as

investigating the best way to search for medications through online applications and whether customers are satisfied with attaching the prescription on the application. We found that searching using the medications name is the most appropriate way for many people followed by scanning the medications' picture and uploading it, and finally searching for the medications in the categories, and 76% of them indicated that they do not mind uploading the prescription on the application when the medications need a prescription. We can draw the conclusion that users who need to find their medications have various difficulties trying to do so. It becomes necessary to offer a solution to aid in solving these challenges.

- Interview analysis

The interview is the greatest method to check that the interviewee understood the question and provided a detailed answer. Also, it allows the interviewer to get a deeper answer. We conducted many interviews to understand the pharmaceutical field and the way it works and to get a general idea about medications, how they are supplied and storage. We also asked some questions to understand the difficulties and problems pharmacists face when dealing with customers and the methods used to solve them, as well as some of the details that may contribute to creating an application that serves this field. The interview consists of several questions (see Appendix B).

At the beginning, we interviewed the pharmacist, Hussein, from Al-Nahdi Pharmacy directly in the pharmacy on the 27th of September 2022. We asked him about his experience in the field and the biggest difficulties and problems he faced. Hussein worked in the field for 10 years inside and outside Saudi Arabia, and he mentioned that many customers have a misconception about alternative medications, thinking that it is a completely different medication, so when the pharmacists give the alternative medications to the customers, they ask for his approval so that it does not cause a problem. They are now attempting to correct this misconception.

We also asked about the method of supplying medications to the pharmacy and whether there are problems in storing medications such as the expiring without use and the way to solve the problem, and his answer was that for him as a pharmacist, he does not know the mechanism of supplying medications because there is a specialized department that handles this process and there are no problems with storing medications because they are not allowed to keep expired medications in the pharmacy. As soon as the expiration date approaches, the medications are returned to warehouses. because keeping it in the pharmacy is considered a violation. In addition, questions

were asked about the way customers check the availability of medications and the policy followed in case there is a high demand for a particular medication. Pharmacist Hussain mentioned that customers call customers service to check and ensure the availability of medications, and when there is a continuous demand for a particular medication, the system automatically requests larger quantities without requiring any action from the pharmacist.

Moreover, the pharmacist was asked about the percentage of customers coming without a prescription and the policy used to deal with this case. He mentioned that it is not considered a large percentage because people now realize the importance of the prescription, especially in the past five years, antibiotics and psychiatric medications became available only by prescription, so many customers bring the prescription with them, and if they order through the app, they must attach the prescription. As for the handling policy, we do not sell prescription medications if the customer does not have a correct prescription.

In addition, many questions were asked to investigate the appropriate way to design a solution that serves the pharmacist in a currency. As a pharmacist, he was asked whether he thought it was good to receive orders through an application and prepare them for receipt? What was the best way to deal with the ordered medications that needed a prescription medically, and why? He answered yes, this would make my work easier and more efficient, instead of allowing the customer to wait for several minutes for their order to be prepared, and then taking time to tell them the instructions, it is faster to prepare the order before the customer comes, as he indicated that it is important to attach the prescription when ordering for verification which helps the customer not to wait a long time in the pharmacy. Finally, he was asked about the most appropriate way for him to inform the customer that his order is ready for pick up, and his answer was that he would send a text message to the customer to inform him of the readiness of his order or contact customer service in the event of a cancellation for some reason.

An interview was also conducted with the pharmacist, Aseel Faisal trainee at Whites Pharmacy, via the Internet on the 28th of September 2022. She mentioned that one of the problems they face is the bad behavior of customers and their lack of understanding, as they face many problems with addicts. She also mentioned that often customers come to request a specific medication and do not find it, and their way to solve the problem is to direct them to another pharmacy or offer them an alternative medication from another company. As for the prescription, addicts usually come

without a prescription and insist on taking the medications, but the general public comes with a prescription and if they are not, the pharmacists tell them that the medications are only taken with a prescription, and they respond to that. She also mentioned that it is good to obtain orders through an application, which leads to saving time and effort for customers, and it is not good to attach the prescription because she sees that it is possible for a person to use the prescription more than once in more than one place, so she made a suggestion that there be cooperation with hospitals by having an expiration date for the prescription, for example, a barcode that scans once.

- Findings

According to the results of the survey and the interviews, we summarize that, from the point of view of customers, most people face difficulties in finding medications or verifying their availability as they have to visit more than one pharmacy to verify, especially people who suffer from chronic diseases such as blood pressure, diabetes, and asthma. Also, the majority buy medications once a month, and they are interested in the pharmacy location when purchasing, and most prefer to have the service of pickup the order upon request through applications by searching for the name of the medications and obtaining the possibility of uploading the prescription, as they expect that the processing of the request will not take more than an hour. From the point of view of pharmacists, they see that it is good to obtain customer orders through the Internet to be prepared, which saves time and effort and contributes to solving the problem of the difficulty of verifying the availability of the medications with the importance of attaching the prescription.

After defining our goals and vision for the project and ensuring its feasibility and analyzing the interviews with the pharmacists and the survey that was distributed through social media channels. From the foregoing, we will propose a mobile application that enable the customers to find out the nearest pharmacy that has a nearest medication and make an order to pick up medications from specific pharmacy and track their order to know when it is ready to collect. In addition, the Pharmacist will receive orders to pick up medications from customers and accept/decline these orders based on availability. Also, they can check the status of orders and update it once needed, and our application needs an Admin that can manage customers, pharmacies, medications, and orders through a dashboard.

#### 4.2.3 User Interactions

The Figure (4.4) shows the possible sequences of interactions between Tiryaq system and its external actors, related to particular goal.

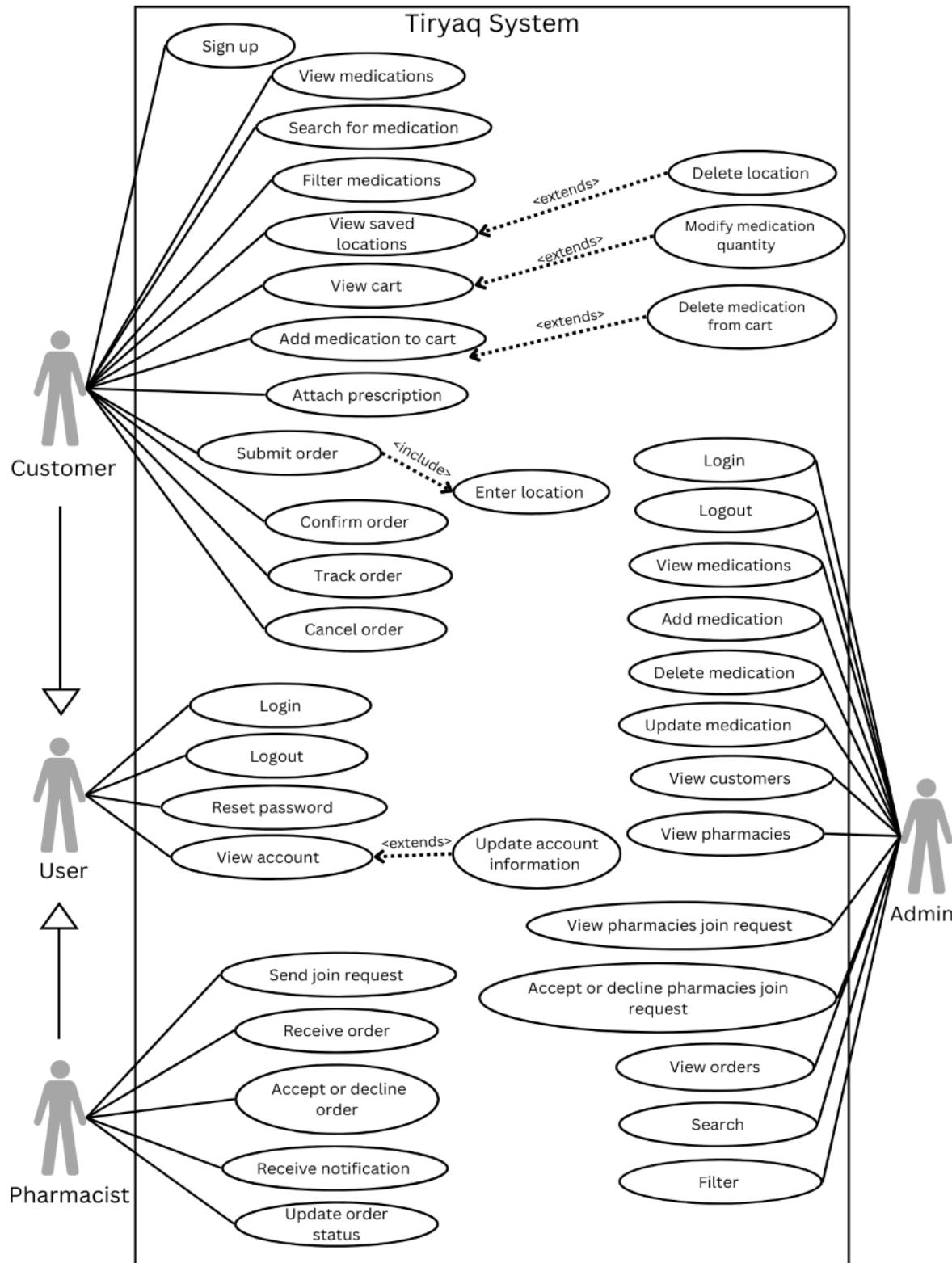


Figure 4.4 Use case diagram

#### 4.2.4 Roadmap and Product Backlog

This chapter presents the product roadmap and backlog.

- Product Roadmap

This section outlines our project's road map as shown in table (4.1) and figure (4.5), which includes sprints, task distribution during the sprints, and deliver dates.

Table 4.1 Roadmap

Sprint#	Release date	Goal	Features
<b>Sprint 0</b>	29th September	The goal of sprint 0 is to study the background of the domain, search the literature review, study the system users, elicit the requirements, design the system architecture, and create the product backlog.	
<b>Sprint 1 (Product 1<sup>st</sup> release)</b>	7th November	The goal of sprint 1 is to design the database, design customer interface, and develop customer tasks.	Customer can create and update account.  Customer can search and filter medications.  Customer can view cart, add, and delete medications from cart.

<b>Sprint 2</b>	22th December	<p>The goal of sprint 2 is to continue to develop customer tasks, design pharmacy interface and develop pharmacy tasks.</p>	<p>Customer can make a request to pick up a medication from specific pharmacy.</p> <p>Customer can track his/her request to know when it is ready to collect.</p> <p>Pharmacist can receive a request to pick up medication/s from customers and accept/decline this request based on availability.</p> <p>Pharmacist can check the status of requests and update it once needed.</p>
<b>Sprint 3</b>	11 <sup>th</sup> January	<p>The goal of sprint 3 is to integrate customers and pharmacist tasks and implement the location-based service.</p>	<p>Customers can find out the nearest pharmacy that has a specific medication.</p>
<b>Sprint 4</b>	19 <sup>th</sup> February	<p>The goal of sprint 4 is to design admin</p>	<p>Admin can manage customers, pharmacies,</p>

		interface and develop admin tasks.	medications, and requests through a dashboard.
<b>Sprint 5 (Product 2<sup>nd</sup> release)</b>	14 <sup>th</sup> May	The goal of sprint 5 is to test the system and finalize the project documentation.	Admin, customer, and Pharmacist can do all their functions.

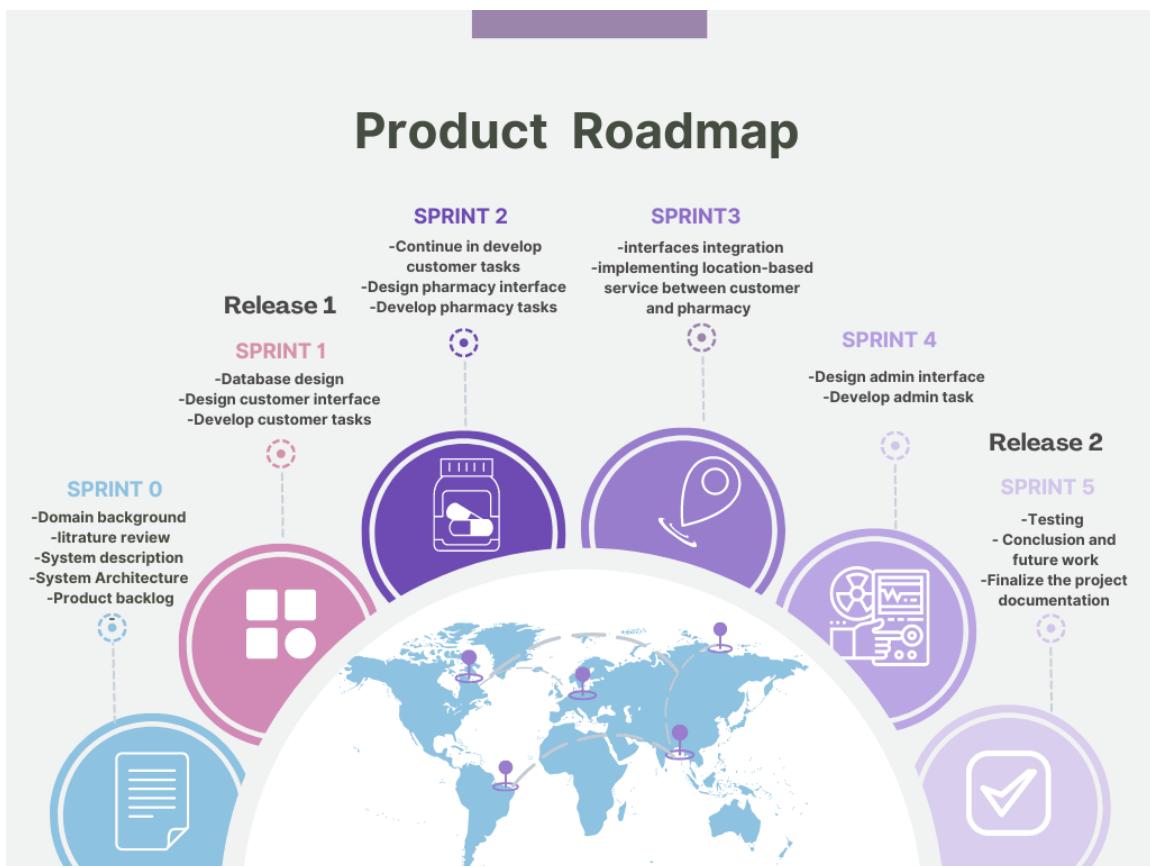


Figure 4.5 Product roadmap

- Product backlog

This section includes the functional and non-functional requirements and their size, type, and acceptance criteria that is written by Tiryaq team.

The table (4.2) includes the user stories of Tiryaq system.

Table 4.2 Product backlog

ID	PBIs (User Stories)	Size	Type (Feature, defect, technical work, knowledge acquisition)	Status (To do, in progress, or done)	Acceptance Criteria (The conditions of satisfaction that must be met for that item to be accepted.)
1	As a customer, I want to be able to sign up to the application, so that I can register and gain access to the application.	3	Feature	Done	<p>As a customer, if I accessed the application for the first time, then I should sign up by entering the required information (First name, Last name, Phone number, email, and password) and click sign up option.</p> <p>As a customer, if I enter valid information and strong password (At least 8 characters, it must include one uppercase, one lowercase letters and one special character) in the sign-up page and click sign up option, then a</p>

					<p>verification message will be sent to my email to complete the registration process.</p> <p>As a customer, if I verified my email, then I am successfully registered and able to log in with my chosen credentials.</p> <p>As a customer, if I enter valid information but weak password and click sign up option, then an error message should appear to indicate that the password is weak.</p> <p>As a customer, if I enter invalid information in the sign-up page and click sign up option, then an error message should appear to indicate that the information is invalid.</p>
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					<p>As a customer, if I leave an empty field in the sign-up page and click sign up option, then an error message should appear to indicate that there is an empty field.</p>
2	As a customer, I want to be able to log in to the application, so that I can have the ability to use the application and no one can access my information.	3	Feature	Done	<p>As a customer, if I am a registered user and go to the log in page and enter correct email and password and click on log in option, then the data associated to the account should be accessible.</p> <p>As a customer, if I am a registered user and go to the log in page and enter incorrect email or password and click on log in, then log in fails with an error message that indicate that the email or password is wrong.</p> <p>As a customer, if I am a registered user but I didn't verify my email and go to</p>

					the log in page and enter email and password and click on log in, then log in fails with an error message that indicate that the email not verified.
3	As a customer, I want to be able to reset my password, so that I can access my account in case I forgot my password.	3	Feature	Done	<p>As a customer, if I am a registered user and forgot or want to change my password and click on forgot password and entered my email, then I should receive an email to enter the new password.</p> <p>As a customer, if I enter a strong password (At least 8 characters, it must include one uppercase, one lowercase letters and one special character) in the forgot password email and click reset option, then my password should have been reset.</p> <p>As a customer, if I enter weak password and click reset option, then an error</p>

					message should appear to indicate that the password is weak.
4	As a customer, I want to be able to log out from my account, so that I can prevent any unauthorized access to my account.	1	Feature	Done	<p>As a customer, if I finish my work on the application and I want to terminate any access, then I should have a logout option.</p> <p>As a customer, if I clicked on log out, then a message should appear to confirm log out process.</p> <p>As a customer, if I clicked on log out, then I should be transferred to the main page.</p>
5	As a customer I want to be able to view medications, so that I can reduce the search space of medication and save my time.	3	Feature	Done	<p>As a customer, if I am in the home page, then I should view medications by categories.</p> <p>As a customer, if I clicked on Prescription category, then I should be transferred to the</p>

					<p>prescription medications page.</p> <p>As a customer, if I clicked on Non-Prescription category, then I should be transferred to the Non-Prescription medications page.</p>
6	As a customer I want to be able to search about medications by scientific name and trade name, so that I can find my medication or alternatives for it.	4	Feature	Done	<p>As a customer, if I start typing in the search bar, then the medications list should be displayed according to the entered word.</p> <p>As a customer, if I search for a medication and it doesn't exist, a message should appear to indicate that this medication doesn't exist.</p>
7	As a customer I want to be able to filter the medication by Pharmaceutical Form, so that I can reduce the medication list to my specifications.	3	Feature	Done	As a customer, if I choose one filter, then the displayed medications list should match the chosen filter.

8	As a customer, I want to be able to view my account information, so that I can know my information that I registered with.	2	Feature	Done	<p>As a customer, if I go to settings page and click on my account, then my account information should be displayed.</p>
9	As a customer I want to be able to update my account information, so I can keep my information up to date.	4	Feature	Done	<p>As a customer, if I go to settings page and click on my account, then I should have an update option.</p> <p>As a customer, if I change my information and click on save changes option, then a message should appear to confirm the update process.</p> <p>As a customer, if I click on save changes option, then my information should be updated.</p>
10	As a customer, I want to be able to view my saved locations, so that I can manage my locations.	4	Feature	Done	<p>As a customer, if I go to settings page and click on my locations, then my saved locations should be displayed.</p>

11	As a customer, I want to be able to delete a location from my saved locations, so that I can keep my locations up to date.	3	Feature	Done	<p>As a customer, if I have locations that I want to remove from my saved locations, then I should have delete location option.</p> <p>As a customer, If I swipe to delete a location, then a confirmation message should appear to confirm the deletion.</p> <p>As a customer, If I swipe to delete a location, then the location should be deleted from my saved locations.</p>
12	As a customer I want to be able to view my shopping cart, so that I can review my order list.	3	Feature	Done	As a customer, if I viewed my shopping cart, then I should have modify quantity option.
13	As a customer, I want to be able to add medications to my shopping cart, so that I can have a list of medications to pick up.	2	Feature	Done	As a customer, if I want to add medication to my shopping cart, then I should click on add medication option.

					<p>As a customer, If I click on add medication option, then it should be added to my shopping cart.</p>
14	As a customer, I want to be able to delete medications from my shopping cart, so that I can update my order list with my current needs.	2	Feature	Done	<p>As a customer, if I don't want a medication in my shopping cart, then I should have a delete medication option.</p> <p>As a customer, If I swipe to delete a medication, then a confirmation message should appear to confirm deletion.</p> <p>As a customer, If I swipe to delete a medication, then it should be deleted from my shopping cart.</p>
15	As a customer, I want to be able to attach prescription, so that the pharmacist can check it and provide me with the prescribed medications.	2	Feature	Done	<p>As a customer, if there is a prescribed medication in my shopping cart, then I should have a field to attach the prescription.</p> <p>As a customer, if I attached the prescription,</p>

					then it should be attached with the order list.
16	As a customer, I want to be able to enter my location, so that I can know the nearest pharmacies to my location.	6	Feature	Done	<p>As a customer if want to enter my location, then I should have an option to enter my current location.</p> <p>As a customer if want to enter my location from the saved locations, then I should have an option to enter from saved locations.</p> <p>As a customer, if I entered my location, then it should be saved with the order list.</p>
17	As a customer, I want to be able to submit an order, so that I can know the nearest pharmacies that have my required medications.	4	Feature	Done	As a customer, if I submit my order and it includes prescription medications, but I didn't attach the prescription, then an error message should appear to indicate that the prescription should be attached.

					<p>As a customer, if I attached an invalid form prescription, then an error message should appear to indicate that it's invalid form and it should be png, jpeg or jpg.</p> <p>As a customer, if I submit my order and I didn't enter my location, then an error message should appear to indicate that the location should be entered.</p> <p>As a customer, If I did the required procedures of submitting the order and click submit option, then my order should be submitted.</p> <p>As a customer, If I submit the order, a message should appear to indicate that the order is submitted.</p>
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18	As a customer, I want to be able to cancel my order, so that I don't reserve medications that I don't need.	2	Feature	Done	<p>As a customer, if I am in orders page and clicked on the order that I want to cancel and click cancel option, then a confirmation message should appear to confirm the cancelation.</p> <p>As a customer, if I am in orders page and clicked on the order that I want to cancel and click cancel option, then the order should be canceled.</p>
19	As a customer, I want to be able to choose one pharmacy from list of pharmacies that have my medications, so that the order is confirmed, and the pharmacist start to prepare the order.	5	Feature	Done	<p>As a customer, if I chose a pharmacy from pharmacies list, then a notification should be sent to the pharmacist to prepare my order.</p> <p>As a customer, if the list of pharmacies displayed, then it should appear with time of preparing my order.</p>
20	As a customer, I want to be able to track my order,	4	Feature	Done	As a customer, if I am in orders page and clicked

	so that I can know if my order is ready for pick up.				on the order that I want to track, then the order status should be displayed to indicate whether the order is (under processing, under preparation, ready for pick up ).
21	As a pharmacist, I want to be able to sign up to the application, so that I can send join request for my pharmacy to the application.	3	Feature	Done	<p>As a pharmacist, if I want to sign up and have an account for the pharmacy, then I should sign up by entering the required information (pharmacy name, commercial register, pharmacy location, email, phone number, and password) and click sign up option.</p> <p>As a pharmacist, if I enter valid information and strong password (At least 8 characters, it must include one uppercase, one lowercase letters and one special character) in the sign-up page and click sign up option, then my join request is successfully sent.</p>

					<p>As a pharmacist, if I enter valid information but weak password and click sign up option, then an error message should appear to indicate that the password is weak.</p> <p>As a pharmacist, if I enter invalid information in the sign-up page and click sign up option, then an error message should appear to indicate that the information is invalid.</p> <p>As a pharmacist, if I leave an empty field in the sign-up page and click sign up option, then an error message should appear to indicate that there is an empty field.</p>
22	As a pharmacist, I want to be able to log in to the application, so that I can manage orders of customers.	3	Feature	Done	As a pharmacist, if my pharmacy join request is under processing and I go to the log in page and enter email and password

				<p>and click on log in option, then a message should appear to indicate that my join request is under processing.</p> <p>As a pharmacist, if my pharmacy join request is declined and I go to the log in page and enter email and password and click on log in option, then a message should appear to indicate that my join request is declined.</p> <p>As a pharmacist, if my pharmacy join request is accepted and I go to the log in page and enter email and password and click on log in option, then the data associated to the account should be accessible.</p> <p>As a pharmacist, if my pharmacy join request is accepted and I go to the</p>
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					<p>log in page and enter invalid email or password and click on log in, then log in fails with an error message that indicate that the email or password is invalid.</p>
23	As a pharmacist, I want to be able to reset my password, so that I can access my account in case I forgot my password.	3	Feature	Done	<p>As a pharmacist, if I am a registered user and forgot or want to change my password and click on forgot password and entered my email, then I should receive an email to enter the new password.</p> <p>As a pharmacist, if I enter a strong password (At least 8 characters, it must include one uppercase, one lowercase letters and one special character) in the forgot password email and click reset option, then my password should have been reset.</p> <p>As a pharmacist, if I enter weak password and click</p>

					reset option, then an error message should appear to indicate that the password is weak.
24	As a pharmacist, I want to be able to log out from my account, so that I can prevent any unauthorized access to my account.	1	Feature	Done	<p>As a pharmacist, if I finish my work on the application and I want to close my work and terminate any access, then I should have a logout option.</p> <p>As a pharmacist, if I clicked on log out, then a message should appear to confirm log out process.</p> <p>As a pharmacist, if I clicked on log out, then I should be transferred to the main page.</p>
25	As a pharmacist, I want to be able to view my account information, so that I can know my information that I registered with.	2	Feature	Done	As a pharmacist, if I go to settings page and click on my account, then my account information should be displayed.
26	As a pharmacist I want to be able to update my	4	Feature	Done	As a pharmacist, if I go to settings page and click on

	account information, so I can keep my information up to date.				my account, then I should have an update option.  As a pharmacist, if I change my information and click on save changes option, then a message should appear to confirm the update process.  As a pharmacist, if I click on save changes option, then my information should be updated.
27	As a pharmacist, I want to be able to receive medications orders from customers, so that I can check the availability of the medications in the pharmacy.	3	Feature	Done	As a pharmacist, if I received medications order, then the quantity for each medication must be specified.  As a pharmacist, if I received medications order that includes prescribed medication, then the prescription must be attached.
28	As a pharmacist, I want to be able to accept or	3	Feature	Done	As a pharmacist, if I checked that the ordered

	<p>decline customers pick up orders, so that I can inform the customer about the medication's availability in the pharmacy.</p>			<p>medications are available, then I want to have an accept option to accept the order.</p> <p>As a pharmacist, if not all the medications are available in my pharmacy, but I want to accept the order and inform the customer, then there should be a field to write a note for the customer.</p> <p>As a pharmacist, if preparing the order takes some time, then there should be a field to specify the time of preparing the order.</p> <p>As a pharmacist, if I clicked the accept option, then the order status in the customer order page should be changed to accepted.</p>
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					<p>As a pharmacist, if I checked that the ordered medications are not available or the prescription is invalid, then I want to have a decline option to reject the order.</p> <p>As a pharmacist, if I declined the order, then the order status in the customer order page should be changed to declined.</p>
29	As a pharmacist, I want to be notified if the customer confirmed the medications order, so that I can prepare the order for the customer to pick up.	3	Feature	Done	As a pharmacist, if the customer confirmed the order, I want to receive a notification.
30	As a pharmacist I want to be able to update the status of the customer order, so that I can inform the customer that the medications are ready for pick up.	3	Feature	Done	As a pharmacist, if the medications are ready for pick up, then I want to have an option to change the order status in the customer order page to ready for pick up.

					<p>As a pharmacist, if I changed the order status to ready, then the order status in the customer order page should be changed to ready for pick up.</p>
31	As an admin, I want to be able to log in to the admin dashboard, so that I can manage the system.	2	Feature	Done	<p>As an admin, if I am a registered admin and go to the log in page and enter my email and password and click on log in option, then the data associated to the account should be accessible.</p> <p>As an admin, if I am a registered admin and go to the log in page and enter incorrect email or password and click on log in, then log in fails with an error message that indicate that the email or password is wrong.</p>
32	As an admin, I want to be able to log out from my account, so that I can	1	Feature	Done	<p>As an admin, if I finish my work on the and I want to close my work and terminate any access,</p>

	prevent any unauthorized access to my account.				<p>then I should have a logout option.</p> <p>As an admin, if I clicked on log out, then a message should appear to confirm log out process.</p> <p>As an admin, if I clicked on log out, then I should be transferred to the login page.</p>
33	As an admin, I want to be able to view medications, so that I can see the list of medications and manage them.	2	Feature	Done	<p>As an admin, if I am at the home page, then I should have view medications option.</p> <p>As an admin, if I am at the medication page, then I should be able to manage the medications (delete, update, view details).</p>
34	As an admin, I want to be able to add medications, so that I can have up to date medications.	2	Feature	Done	<p>As an admin, if I have a new medication I want to add to the list of medication, then I should have add medication option.</p>

					<p>As an admin, if I clicked on add medication option, then a form should be displayed to add medication information.</p> <p>As an admin, If I enter invalid information and clicked on add medication option, then a message should appear to indicate that information is invalid.</p> <p>As an admin, If I enter valid information of the medication and clicked on add medication option, then the medication should be added to the medications list.</p>
35	As an admin, I want to be able to delete medications, so that I can up to date medications.	2	Feature	Done	As an admin, if I have medications that I want to remove from the list of medications, then I should have delete medication option.

					<p>As an admin, If I clicked on delete medication option, then a confirmation message should appear to confirm the deletion.</p> <p>As an admin, If I clicked on delete medication option, then the medication should be deleted from the medications list.</p>
36	As an admin, I want to be able to update medications, so that I can modify any incorrect information about the medications.	2	Feature	Done	<p>As an admin, if the medication information need modification, then I should have an update option.</p> <p>As an admin, If I enter invalid information and clicked on update medication option, then a message should appear to indicate that information is invalid.</p>

					<p>As an admin If I enter valid information of the medication and clicked on update medication option, then a confirmation message should appear to confirm the update.</p> <p>As an admin, if I enter valid information and clicked on update medication option, then the medications information should be updated.</p>
37	As an admin, I want to be able to view registered customers, so that I can see list of customers and manage them.	2	Feature	Done	As an admin, if I am at the home page, then I should have view customers option.
38	As an admin, I want to be able to view pharmacies join requests, so that I can check if the pharmacy is authorized.	2	Feature	Done	As an admin, if I need to accept new pharmacies, then I should view pharmacies join requests information.
39	As an admin, I want to be able to accept or decline pharmacies join requests, so that I can have only	2	Feature	Done	As an admin, if I viewed pharmacy join requests and they are authorized,

	<p>authorized pharmacies that serves customers' orders.</p>			<p>then I should have accept pharmacy option.</p> <p>As an admin, If I clicked on accept pharmacy option, then a confirmation message should appear to confirm the accept.</p> <p>As an admin, If I clicked on accept pharmacy option, then the pharmacy should be added to the pharmacies list.</p> <p>As an admin, if I viewed pharmacy join requests and they are not authorized, then I should have decline pharmacy option.</p> <p>As an admin, If I clicked on decline pharmacy option, then a confirmation message</p>
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					should appear to confirm the decline.  As an admin, If I clicked on decline pharmacy option, then the pharmacy should not be added to the pharmacies category.
40	As an admin, I want to be able to search about medications, customers, or pharmacies, so that I can finish my work easily and faster.	3	Feature	Done	<p>As an admin, if I start typing in the search bar, then the medications, customers, or pharmacies list should be displayed according to the entered word.</p> <p>As an admin, if I search for a medication, customer, or pharmacy and it doesn't exist, a message should appear to indicate that doesn't exist.</p>
41	As an admin, I want to be able to filter the medications, orders, and pharmacies, so that I can reduce the lists to my specifications.	3	Feature	Done	As an admin, if I choose one filter from medications, orders or pharmacies pages, then the displayed list should match the chosen filter.

42	As an admin, I want to be able to view registered pharmacies, so that I can manage them.	2	Feature	Done	As an admin, if I am at the home page, then I should have view pharmacies option.
43	As an admin, I want to be able to view customer orders, so that I can know the extent of customers' demand from pharmacies.	2	Feature	Done	As an admin, if I want to view the orders rate in the application, then I should have view customers' orders option.
<b>Non-functional</b>					
44	(Performance)  As a user, I want the application pages to display within at most 10 seconds, so that I can use the application as quickly as possible.				As a user, If I'm in any page of the application pages, then the page items should be displayed within 10 seconds.
45	(Availability)  As a user, I want the application to be available 99% of the time and not blocked, so that I can access to it any time when I need it.				As a user, If I'm using the application, then the system should not block me and prevent me while using it.
46	(Security)  As a user, I want my account to be secure, so				As a user, If I logged out from my account, then the system should secure my account by authenticating credentials in the log in.

	that no one can spy on me and steal my information.				
47	<p>(Security)</p> <p>As a user, I want the application to accept only strong password when I register in the app.</p>			<p>As a user, If I entered a password that have length less than 8 characters, then the system should display an error message and ask me to enter a longer password.</p> <p>As a user, If I entered a password without at least one uppercase letter, one lowercase letter and one special character, then the system should display an error message and ask me to enter a password with at least one uppercase one lowercase letter and one special characters.</p>	
48	<p>(Usability)</p> <p>As a user, I want the application to be easy to use and familiar, so that I don't waste my time in learning to use it.</p>			<p>As a user, if I'm using the application, then the options should be clear and it turns out that it can be clicked.</p>	

According to the feedback form release 1 and the consultations that we had, we decided to delete the block/unblock user stories.

## 4.3 System Design

### 4.3.1 Architectural Diagram

Since Tiryaq system depends on servers and databases to store information and serve its clients (customers, pharmacists, and administrator) by responding to their requests., hence we decided to choose a client-server architecture pattern that consist of three parts (server, clients, network). Clients will interact with the server by requesting services through the network, and the server will respond. Using the client-server architecture will provide centralized management because all the information will be in one place and with full control by the administrator, thus it will be easier to modify data. Also, the access to the file's records will be simple since they are all kept in a single server. Furthermore, we have many non-functional requirements of the system that must be met. Such as performance and availability, so the client-server is the best option, one of its main advantages is that it is dispersed over the network and accessible to all clients. the internet is also crucial to run the system. The following figure (4.6) shows the client-server architecture pattern that have been chosen for Tiryaq system, and it clarify examples of the functions provided by Tiryaq that users may wish to request.

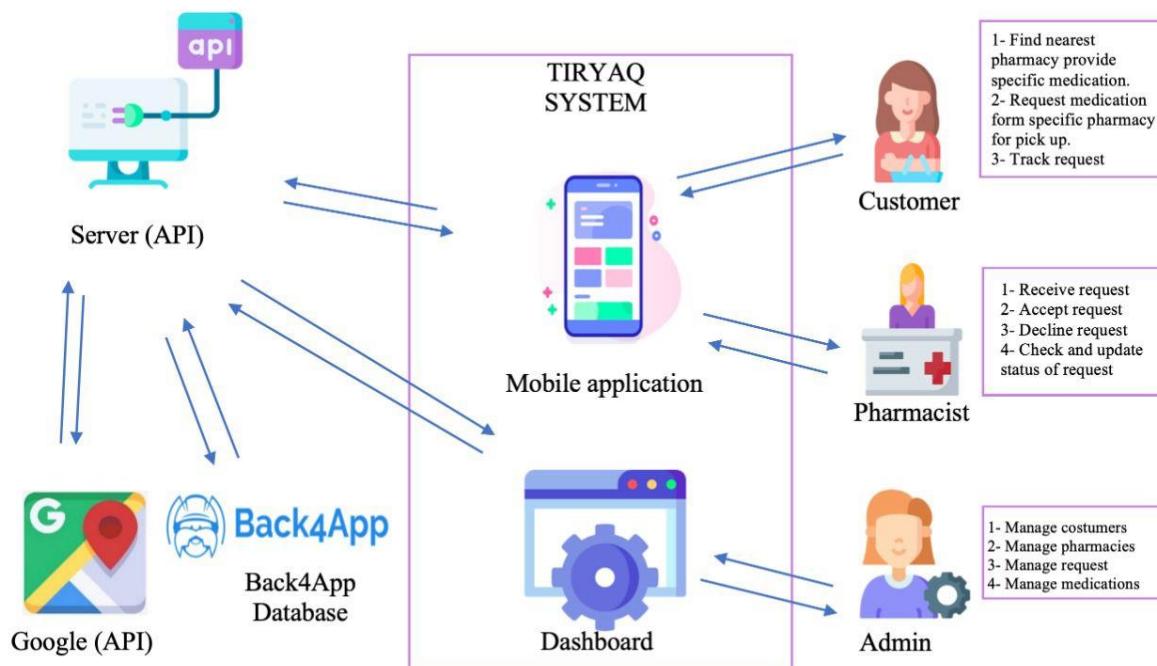


Figure 4.6 Architectural diagram

### 4.3.2 Class Diagram /DFD

The figure (4.7) shows the functionality of Tiryaq system, and how it decomposed and illustrates the working parts.

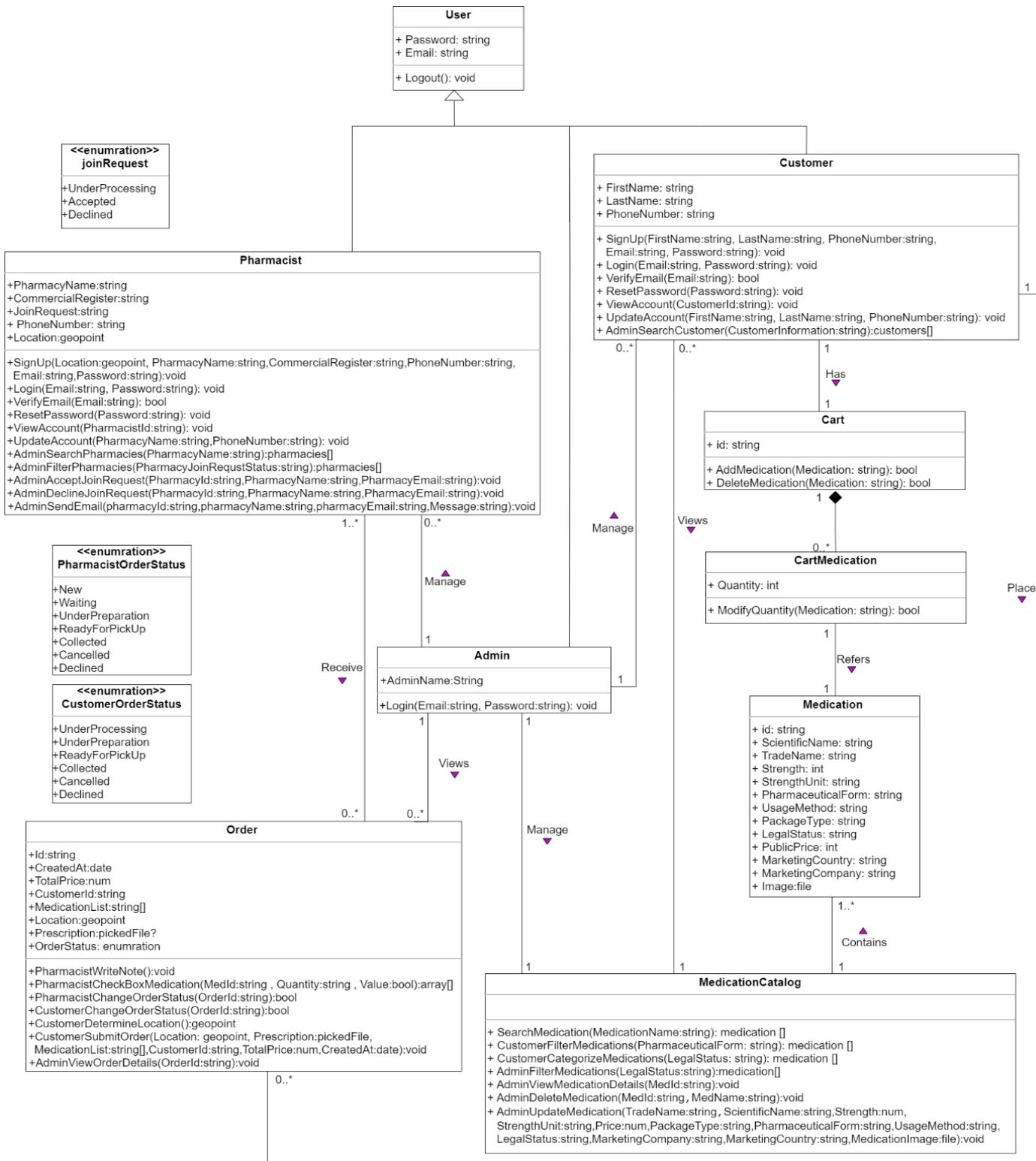


Figure 4.7 Class diagram

#### 4.3.3 Component Level Design

This section includes the design as flowcharts and pseudocode of major system functionalities: Sign up, log in, search and filter medication, order process and distance calculation function. For the user stories task and estimated implementation time (see Appendix C).

The two figures below (4.8 and 4.9) show the flowchart of the order process for both customer and pharmacy side. Since the application is used by two different parties the order process and tracking are different for each side, therefore separating the order process to two different flowcharts explains the system better.

### Order process flowchart “Customer side” in figure (4.8):

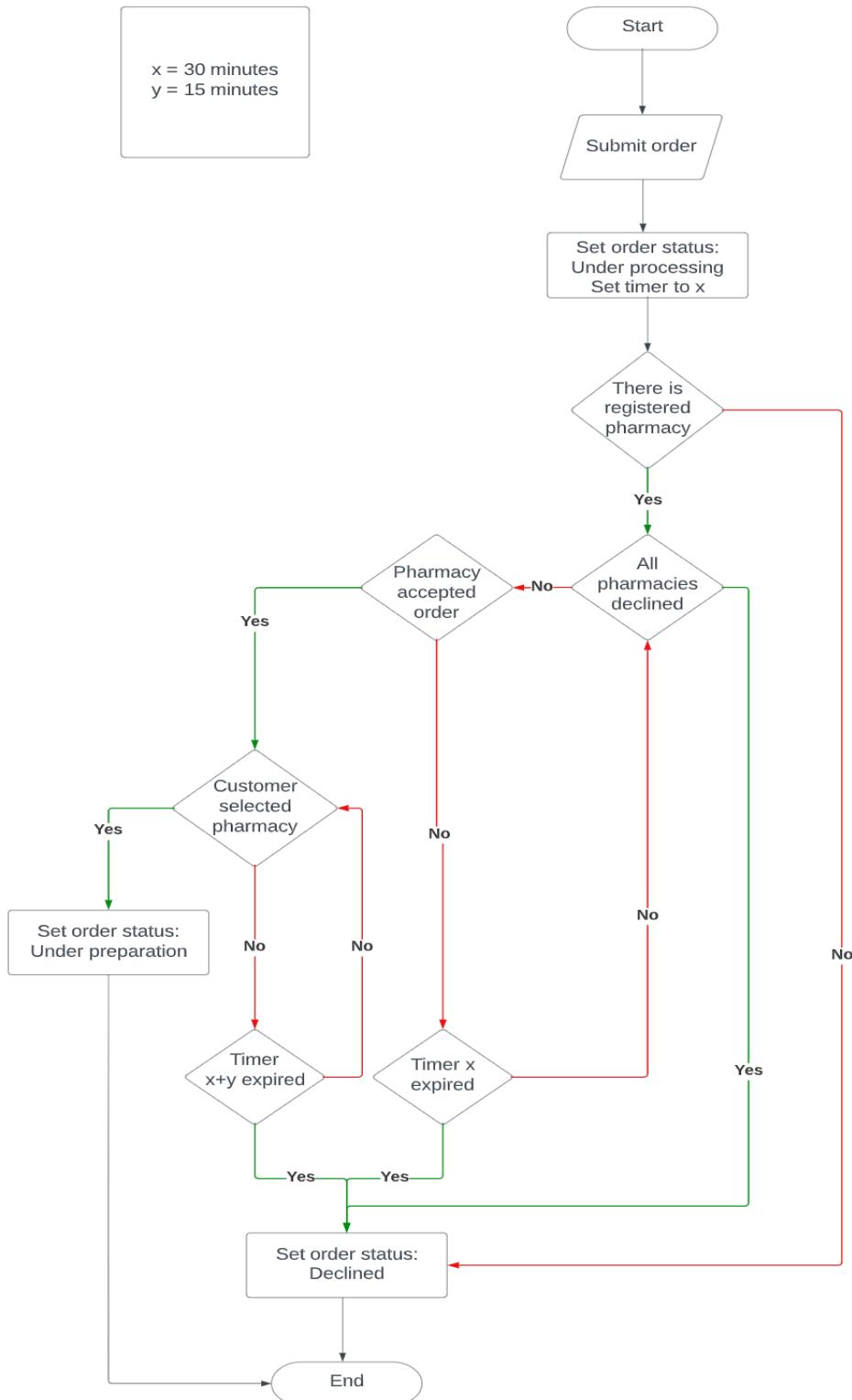


Figure 4.8 Customer order process flowchart

### Order process flowchart “Pharmacy side” in figure (4.9):

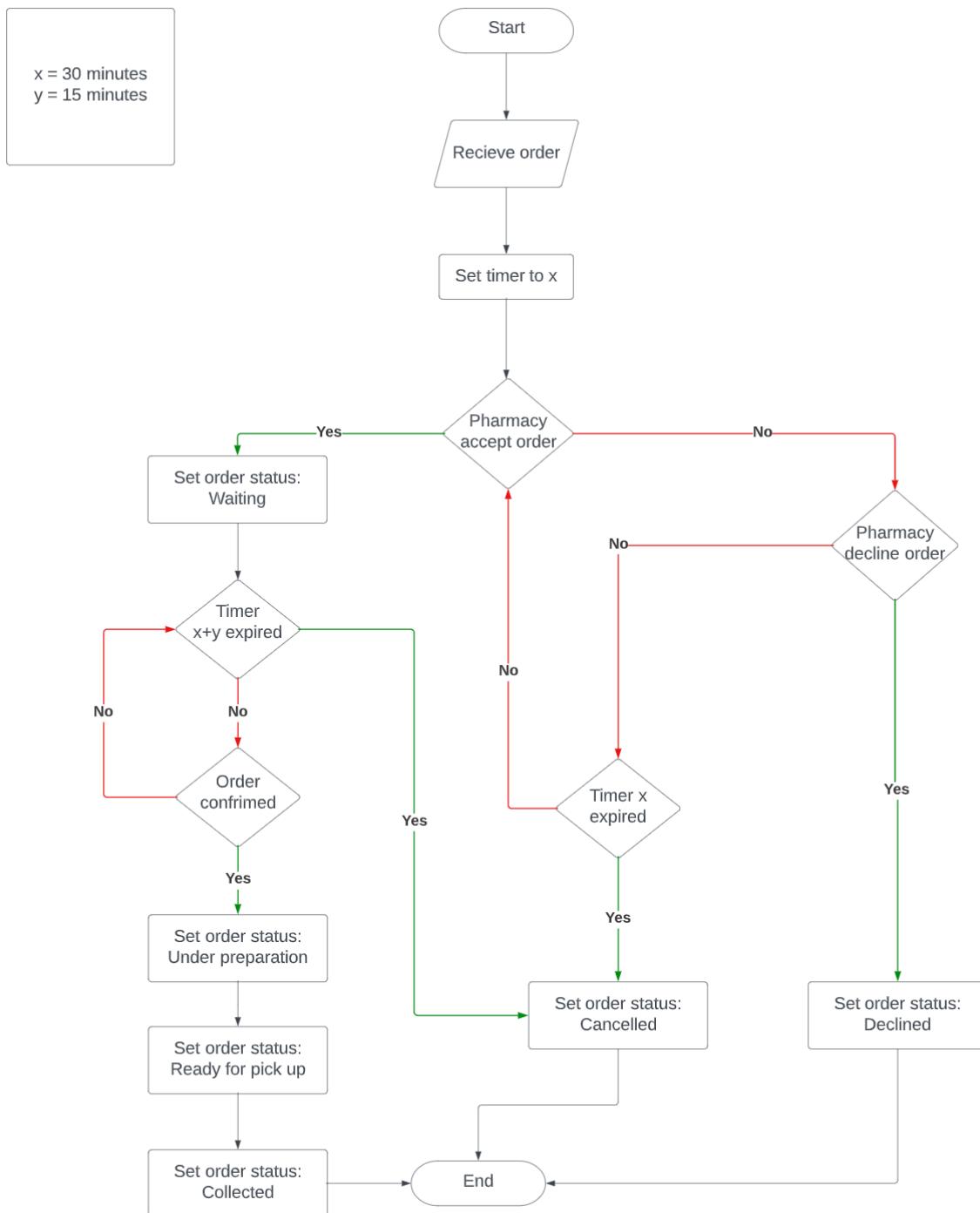


Figure 4.9 Pharmacy order process flowchart

**Sign up and log in flow chart in figure (4.10):**

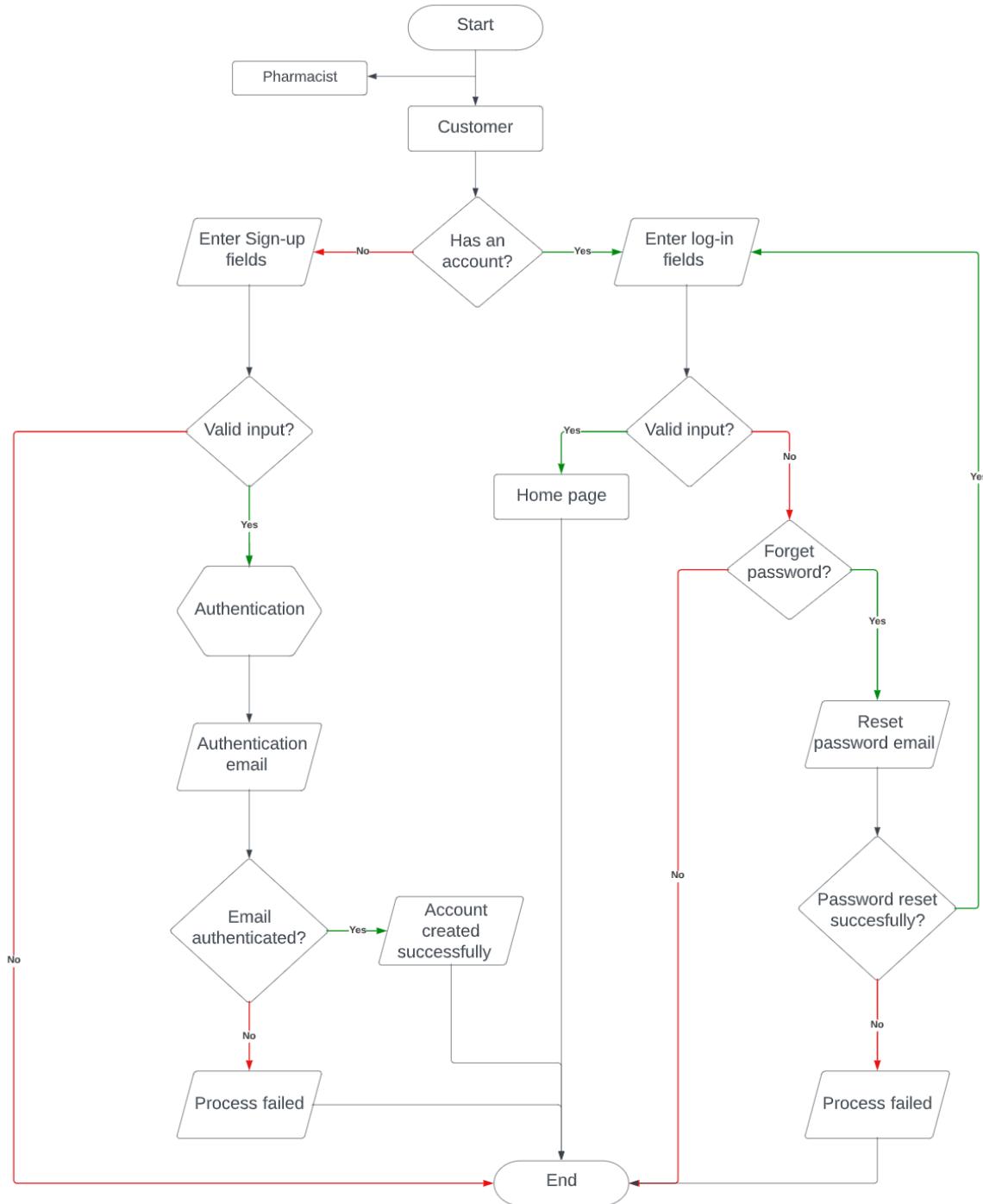


Figure 4.10 Customer registration flowchart

### **Auto suggest Search, and filter medication Pseudocode:**

1. **BEGIN**
2. **SET** categoryString as LegalStatus where LegalStatus can be null or OTC or Prescription
3. **WHILE** category not selected
4.     **DISPLAY** Search bar
5.     **SET** searchString as Search bar value
6.     **GET** Medication list where medication's Legal Status contains categoryString and medication's name starts with searchString from getMedication function
7.         **FOR** i = 0 to Medication list length **DO**
8.             **DISPLAY** Medication[i]
9.         **END FOR**
10.   **END WHILE**
11.   **WHILE** category selected
12.     **DISPLAY** Search bar
13.     **DISPLAY** Filter
14.     **SET** searchString as Search bar value
15.     **SET** filterString as Filter value where value can be All or another Pharmaceutical Form
16.     **GET** Medication list where medication's Legal Status contains categoryString and where medication's name starts with searchString and medication's Pharmaceutical Form contains filterString from getMedication function
17.         **FOR** i = 0 to Medication list length **DO**
18.             **DISPLAY** Medication[i]
19.         **END FOR**
20.   **END WHILE**
21. **END**

### Calculate distance between Customer order location and pharmacy location Pseudocode:

1. **FUNCTION** calculateDistance(location1\_lat1, location1\_lon1, location2\_lat2, location2\_lon2)
2.     **IMPORT**latlong.dart  
       //Create object of class Distance
3.     **SET** distance **TO NEW** Distance  
       //Calculate distance using “LengthUnit.Meter” internal method of latlong.dart package
4.     **SET** distanceMeter as distance.as(LengthUnit.Meter, new LatLng(location1\_lat1, location1\_lon1), new LatLng(location2\_lat2, location2\_lon2))
5.     **SET** distanceKM as distanceMeter/1000
6.     **RETURN** distanceKM
7. **END FUNCTION**

## 4.4 Data Design

This section describes the data structure and contents of Tiryaq.

### 4.4.1 Data Models

- ER diagram

Figure (4.11) illustrates how entities of Tiryaq system are related to each other.

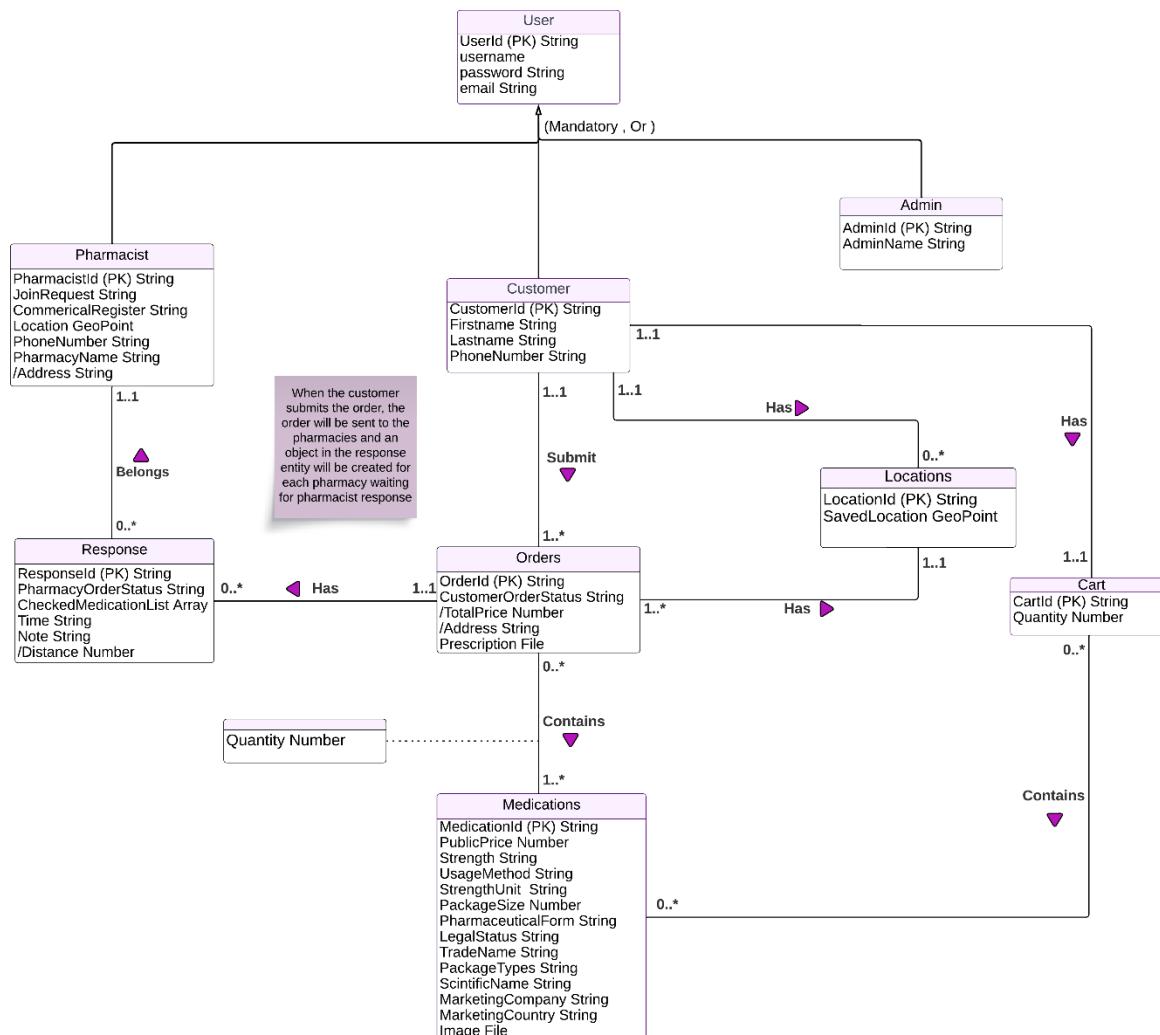


Figure 4.11 ER diagram

In the User class, the Username is a default attribute from back4app. As recommended by Back4app “Ask your users to enter their email but fill it in the username property — ParseUser will work as normal.” [22]. To follow that in Tiryaq, the users will be asked to enter their email

address once, and it will be filled in the Username column (for signup and login process by the back4app) and in the email column (for email verification).

- Relational schema

**Customer** (CustomerId, email, username, Firstname, Lastname, PhoneNumber, password)

Primary key: CustomerId

**Admin** (AdminId, email, username, password, AdminName)

Primary key: AdminId

**Pharmacist** (PharmacistId, email, username, password, PharmacyName, CommerricalRegister, PhoneNumber, JoinRequest, Location, Address)

Primary key: PharmacistId

**Cart** (CartId, Quantity, customerId, medicationId)

Primary key: CartId

Foreign key: customerId references Customer (CustomerId)

Foreign key: medicationId references Medications (MedicationId)

**Medications** (MedicationId, StrengthUnit, PharmaceuticalForm, LegalStatus, TradeName, MarketingCountry, PackageTypes, PackageSize, ScientificName, MarketingCompany, Publicprice, Strength, UsageMethod, Image)

Primary key: MedicationId

**Locations** (LocationId, savedLocation, customerId)

Primary key: LocationId

Foreign key: customerId references Customer (CustomerId)

**Orders** (OrderId, CustomerOrderStatus, TotalPrice, Address, Prescription, customer\_id, Location)

Primary key: OrderId

Foreign key: customer\_id references Customer (CustomerId)

Foreign key: Location references Locations (LocationId)

**Response** (ResponseId, PharmacyOrderStatus, CheckedMedicationList, Time, Note, Distance, OrderId, PharmacistId)

Primary key: ResponseId

Foreign key: OrderId references Orders (OrderId)

Foreign key: PharmacistId references Pharmacist (PharmacistId)

**MedicationsList** (OrderId, MedicationId, Quantity)

Foreign key: OrderId references Orders (OrderId)

Foreign key: MedicationId references Medications (MedicationId)

- Data dictionary

Table (4.3) illustrates the data dictionary of all entities, while table (4.4) illustrates data dictionary of entity relationships and table (4.5) illustrates data dictionary for all attributes.

Table 4.3 Data dictionary entities

Entity name	Description	Occurrence
<b>Customer</b>	Is a person who use the app to view, and order medication.	The customer has one cart.
<b>Cart</b>	It is a cart used by customers to collect a list of medications to order and adjust their quantities.	One cart belongs to one customer and may contains one or more medication.
<b>Medication</b>	A selected list of medication approved by the Food and Drug Authority and their properties, presented to the customer to order.	The medication can be added to one or more carts.
<b>Admin</b>	Is a person who use the website to manages customers, pharmacies, and medications.	-----
<b>Pharmacist</b>	Is a person who use the app to receives customer orders.	The Pharmacist have many responses.

<b>Locations</b>	Locations previously specified by the customer.	Each location belongs to a customer.
<b>Orders</b>	An order created by the customer and sent to the pharmacy.	Each customer has many orders. Each order has many responses.
<b>Response</b>	Pharmacy response for the order.	Each response belongs to one pharmacist.

Table 4.4 Data dictionary for relationships

Entity name	Multiplicity	Relationship	Entity name	Multiplicity
Customer	1..1	Has	Cart	1..1
Customer	1..1	Has	Locations	0.. *
Customer	1..1	Submit	Order	1.. *
Cart	0.. *	Contains	Medication	0.. *
Order	1.. *	Has	Locations	1..1
Order	1..1	Has	Response	1.. *
Response	0.. *	Belongs	Pharmacist	1..1

Table 4.5 Data dictionary for attributes

Entity name	Attribute	Description	Data type	Length	Default value	PK	FK
Customer	CusromerId	Uniquely identifies a customer.	String	10	-	Yes	Yes
	password	Secret number, words, symbols, and phrase.	String	256	-	-	-

	email	Customer's unique email	String	50	-	-	-
	username	Customer's unique email.	String	50	-	-	-
	Firstname	Customer's first name.	String	50	-	-	-
	Lastname	Customer's last name.	String	50	-	-	-
	PhoneNumber	Customers phone number.	String	10	-	-	-
Cart	CartId	Uniquely identifies a cart.	String	10	-	Yes	-
	Quantity	The amount of each medication added to the cart.	Number	-	-	-	-
Mediation	MedicationId	Uniquely identifies a medication.	String	10	-	Yes	Yes
	StrengthUnit	The unit of the drug strength.	String	50	-	-	-
	PharmaceuticalForm	Pharmaceutical Form and shape of the drug, for example: solution or capsule.	String	50	-	-	-
	LegalStatus	Whether the drug need a prescription, or it is OTC medicine.	String	50	-	-	-
	TradeName	The trade name of the drug.	String	50	-	-	-

	MarketingCountry	The country name of drug marketing company.	String	50	-	-	-
	PackageTypes	The type of drug package, for example: bottle or dropper container.	String	50	-	-	-
	PackageSize	The size of drug package	Number	45	-	-	-
	ScientificName	The scientific name of the drug.	String	50	-	-	-
	MarketingCompany	The marketing company name of the drug.	String	100	-	-	-
	Publicprice	The price of the drug.	Number	45.5	-	-	-
	Strength	A number describing the strength of the drug.	String	1000	-	-	-
	UsageMethod	The method of using the drug, for example: parental use or oral use.	String	50	-	-	-
	Image	The medication image	File	400KB	TiryaqLogo	-	-
Admin	AdminId	Uniquely identifies a admin.	String	10	-	Yes	-
	password	Secret number, words, symbols, and phrase.	String	256	-	-	-
	email	Admin's unique email	String	50	-	-	-

	username	Admin's unique username.	String	50	-	-	-
	AdminName	Admin full name.	String	50	-	-	-
Locations	LocationId	Uniquely identifies a location.	String	10	-	Yes	
	SavedLocation	Customer location	GeoPoint	-	-	-	-
Orders	OrderId	Uniquely identifies an order.	String	10	-	Yes	Yes
	CustomerOrderStatus	The status of the order	String	-	Under processing	-	-
	TotalPrice	The total price of the customer order	Number	100000	-	-	-
	Address	Customer address for order	String	-	-	-	-
	Prescription	The accompanying prescription for the medication	File	-	-	-	-
Pharmacist	PharmacistId	Uniquely identifies a pharmacist.	String	10	-	Yes	Yes
	PharmacyName	The name of the pharmacy.	String	50	-	-	-
	CommericalRegister	The commercial register of the pharmacy	String	10	-	-	-
	PhoneNumber	Pharmacy phone number.	String	10	-	-	-
	JoinRequest	Join request status.	String	-	Under processing	-	-
	Location	Pharmacy location	GeoPoint	-	-	-	-
	Address	Pharmacist address	String	-	-	-	-

Response	Response	Uniquely identifies each order call	String	10	-	Yes	-
	PharmacyOrderStatus	The status of the order for particular pharmacy	String	-	New	-	-
	CheckedMedicationList	List of the checked medication.	Array	-	-	-	-
	Time	The time specified for the order to pickup	String	-	-	-	-
	Note	A note attached by the pharmacist when accepting or rejecting the order	String	-	-	-	-
	Distance	The distance between the customer's location and the pharmacy's location	Number	-	-	-	-
	MedicationsList	Quantity	The amount of each ordered medication.	Number	-	-	-

#### 4.4.2 Data Collection and Preparation

Ordering the appropriate medication can be confusing for some people because they may not be aware of the medication's scientific name, necessary strength, or even how to use it. As a result, the Tiryaq application aims to display medication to customers with enough details to make the process of choosing the right medication for order as simple as possible. The list of medication provided by the Saudi Food and Drug Authority's (SFDA) was used in the development of Tiryaq system.

The Saudi Food and Drug Authority (SFDA) dataset includes information on the medication distributed in hospitals and sold in pharmacies and other selling locations. It contains details on the medication in the form of several attributes, such as its scientific name, trade name, strength, pharmaceutical form, administration route, and legal status, as well as other attributes that are explained in detail (see Appendix C) and given that Saudi Food and Drug Authority data does not contain images, images were obtained manually.

In the upcoming part we used the RStudio and Microsoft Excel tool, which aid in the processes of data analysis and cleaning, to examine, comprehend, and extract the key information connected to Tiryaq application.

The table (4.6) presents the SFDA dataset that used in Tiryaq application.

Table 4.6 Data source

<b>Data source</b>	<a href="https://www.sfda.gov.sa/ar/drugs-list">https://www.sfda.gov.sa/ar/drugs-list</a>
<b>Date format</b>	CSV
The dataset has been taken from Saudi food and drug authority website	

- **Data Preprocessing Steps**

**First:** Importing the data into the RStudio tool.

**Second:** using the methods provided by the RStudio tool, we reviewed the number of columns, rows, and the structure of the data and determined that it contained 25 attributes of character data type, 3 attributes of numeric data type, and 1 attribute of integer data type. The total number of columns is 29, and the total number of rows is 7618.

**Third:** The Unique method was utilized to identify the distinct values for each attribute so they will be used later in other data preprocessing steps.

**Fourth:** Began the preprocessing process by counting the number of blank cells as part of data cleaning. We discovered that there were 970 empty cells, therefore, to mitigate their negative impact on the dataset, we encoded them with the symbol (NA), which denotes that they are null.

**Fifth:** To concentrate on the medications distributed in pharmacies, we excluded all the medications distributed in hospitals. We also focused on uncontrolled medications, which are free to be sold without the risk of abuse or harm, while leaving out all the medications under government control.

**Sixth:** The customer's process of selecting the right medication will not be facilitated by all the attributes, thus we selected 11 attributes as the most important ones to be displayed to the customer and excluded the rest.

**Seventh:** Eliminate duplicate rows, rows without scientific names, and rows without trade names.

**Eighth:** The attributes with null cells (NA) were identified, and the entire row was eliminated as a part of the procedures employed to clean the dataset.

**Finally:** Update the name of the attribute (AdministrationRoute) to (UsageMethod) which was more appropriate for the data being displayed. Additionally, we switched the data type of the Strength attribute from character to numeric.

- **Sample selection**

In order to reduce the system overload for the first two releases we selected a data sample.

The first step in selecting the sample was decreasing the number of marketing country using the RStudio tool. To accomplish this, we looked at how frequently each country featured in the dataset, checked its frequency, and then selected the top 8 countries.

After all steps done in the RStudio tool were finished, there were 3902 total rows and 11 total columns. We have finally transferred the dataset from the RStudio tool into a Microsoft Excel sheet in order to continue choosing a sample of the dataset that would be suitable to be shown in the Tiryaq application.

In order to get a representative sample of data, 25 rows from each medication marketing country were selected. Respecting the unique values of the *pharmaceuticalForm*, *UsageMethod*, and *PackageType* attributes, as well as we simplified the scientific name and the trade name for some medication. Therefore, 200 rows and 11 columns made up the final number of rows and columns (see Appendix D).

Table (4.7) shows the unique values of the *PharmaceuticalForm* attribute, which will be utilized to filter the medication list.

Table 4.7 Pharmaceutical form values

Unique values
Solution, Tablet, Capsule, Powder, Lozenge, Drops, Cream, Syrup, Spray, Granules, Caplet, Ointment, Gel, Liquid

## 4.5 Interface Design

This chapter includes the navigation diagrams of Tiryaq and UX guidelines that are incorporated in Tiryaq system interfaces.

The below figure (4.12) shows the customer navigation diagram.

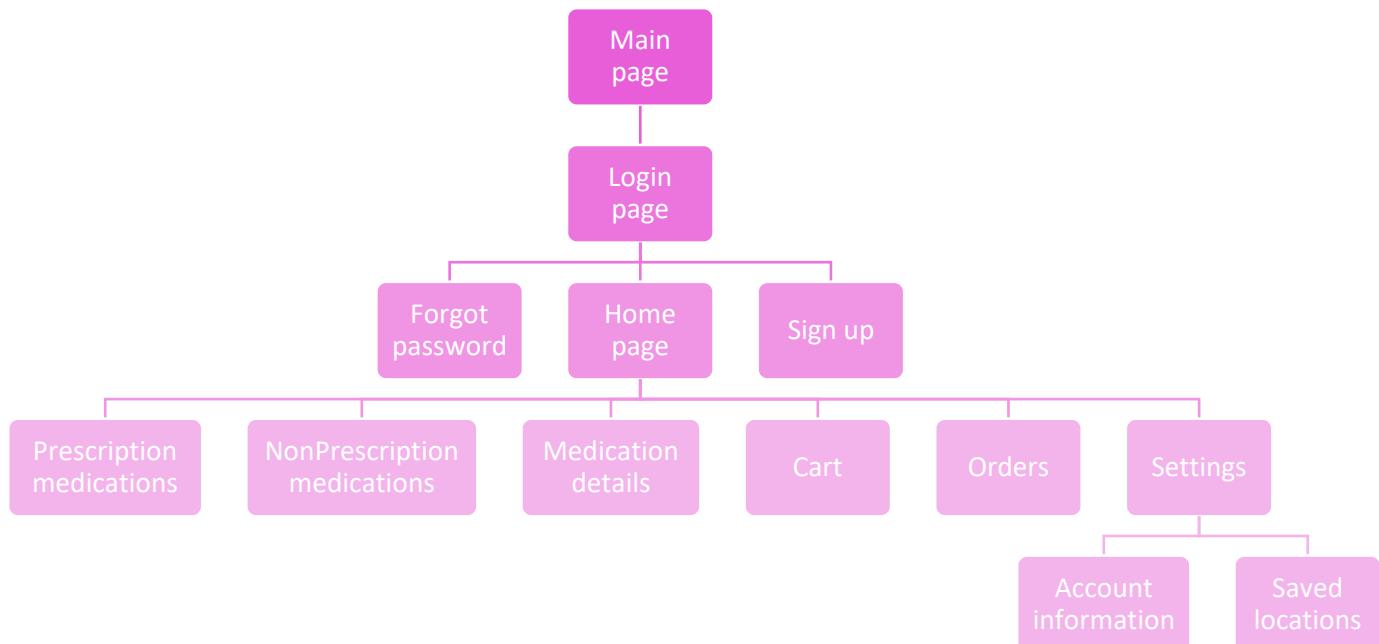


Figure 4.12 Customer navigation diagram

The below figure (4.13) shows the pharmacy navigation diagram.



Figure 4.13 Pharmacy navigation diagram

The below figure (4.14) shows the admin navigation diagram.

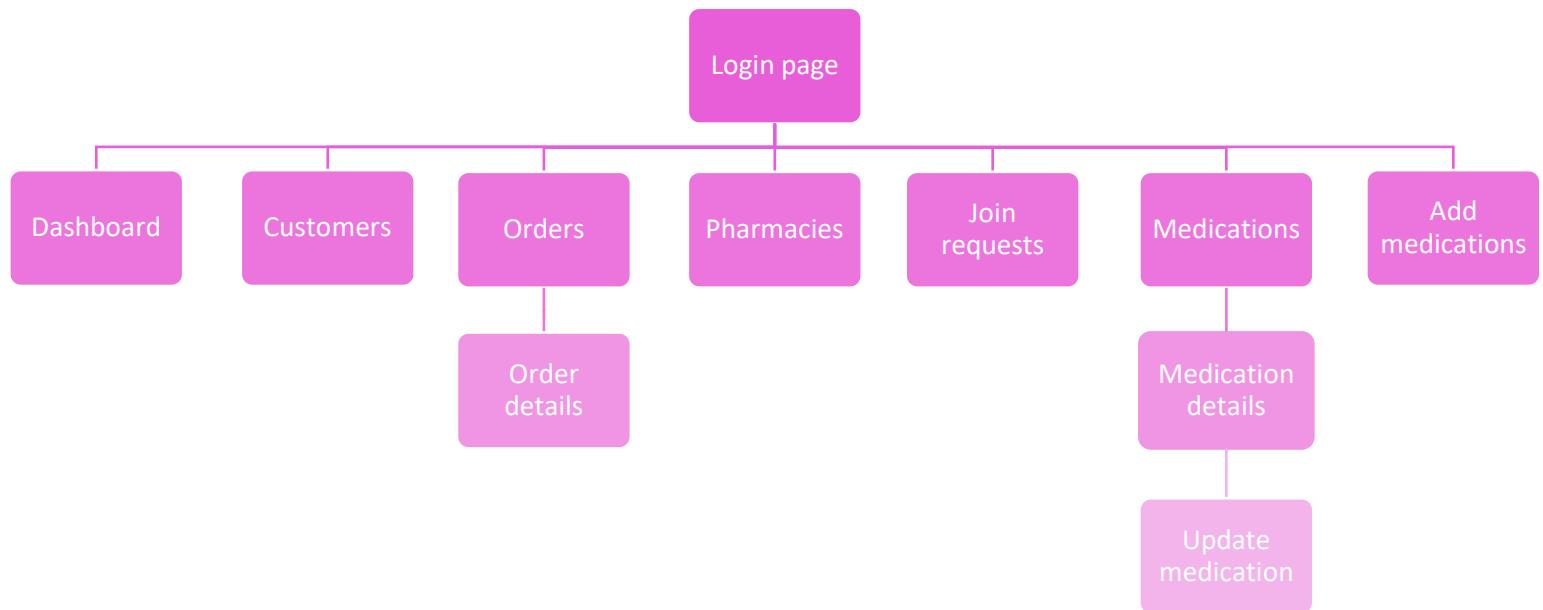


Figure 4.14 Admin navigation diagram

Tiryaq application User interfaces are built based on design rules, as these rules aid in the design of a user-friendly application and increase its usability.

**Familiarity:** the measure of the correlation between the user's prior knowledge and the knowledge required for using the new system [23].

The icons in the bottom navigation bar shown in figure (4.15) support the use of metaphors since they make it easier for users to learn how to use the application without having to go through a detailed tutorial. For instance, most shopping applications utilize a shopping cart as an icon



Figure 4.15 Familiarity

**Predictability:** about determining the impact of future actions based on previous interaction history [24].

As we can see in figure (4.16) that shows Tiryaq's interfaces, the button icon and button text indicate exactly what each button does, and the future action associated to it.

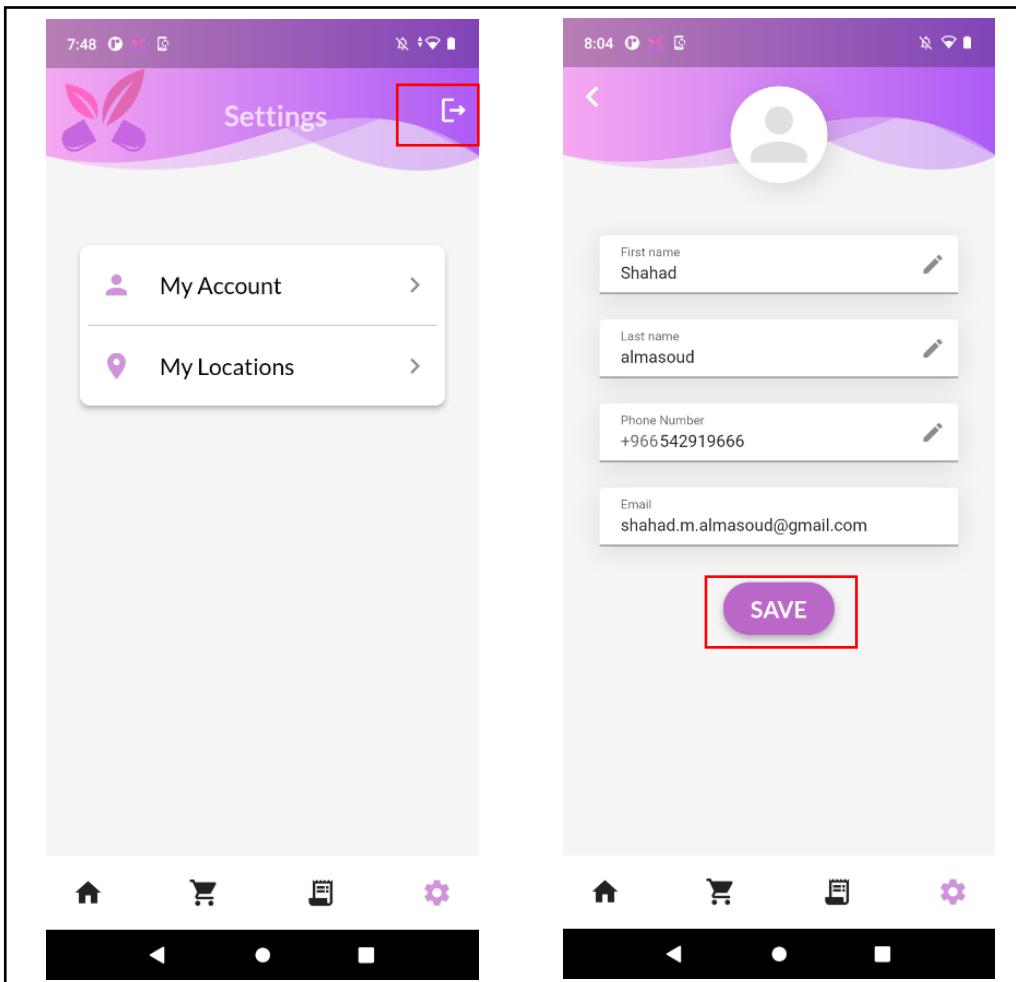


Figure 4.16 Predictability

**Consistency:** refers to the similarity in input-output behavior caused by from similar situations or similar task objectives [24].

Consistency in screens and buttons layout in Tiryaq application as shown in figure (4.17):

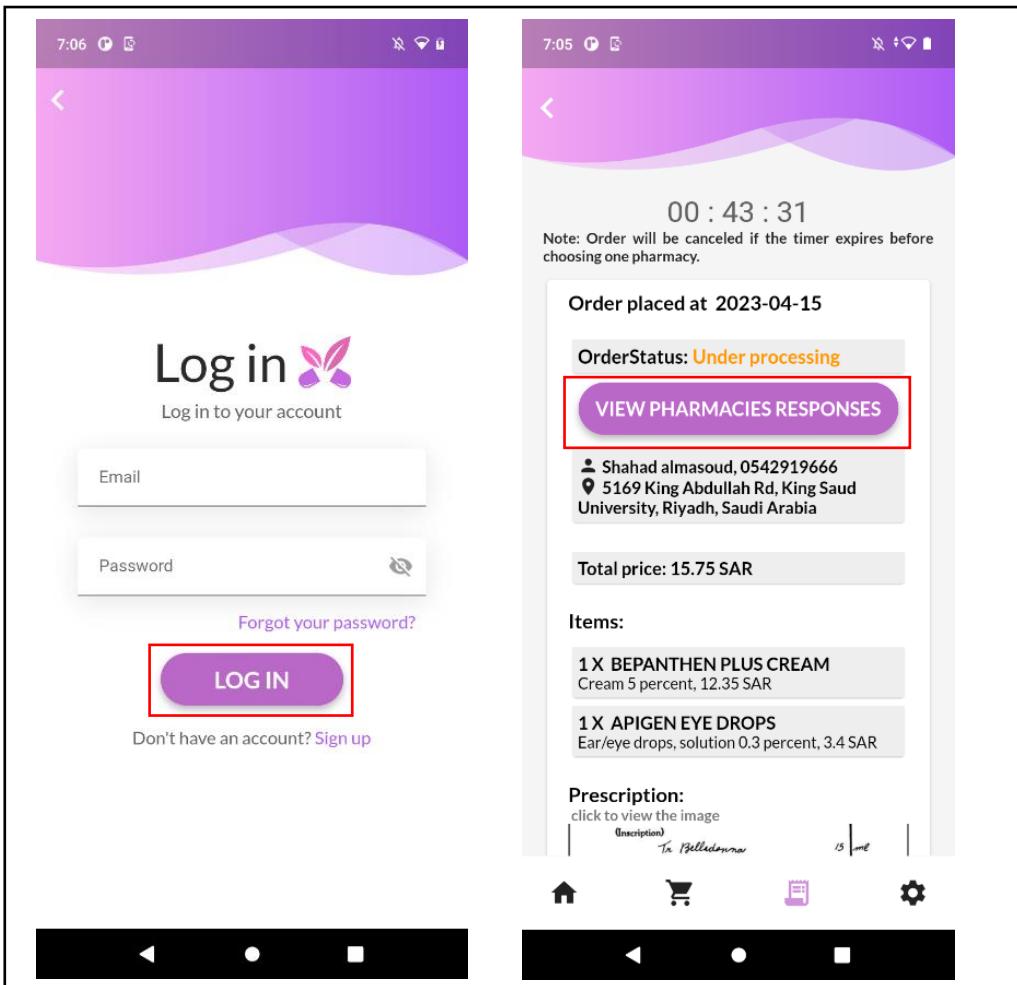


Figure 4.17 Consistency

**Operation visibility:** refers to how the user is shown the availability of operations that can be performed next [25].

The search bar in Tiryaq's interface shown in figure (4.18) clearly states what the user should type in supporting the operation's visibility.



Figure 4.18 Operation visibility

**Recoverability:** refers to the ability to reach a desired goal after recognition of some error in a previous interaction [24].

Tiryaq application displays a confirmation message to verify the order acceptance by the pharmacist as shown in figure (4.19) in order to ensure recoverability since it is a critical action in the order process.

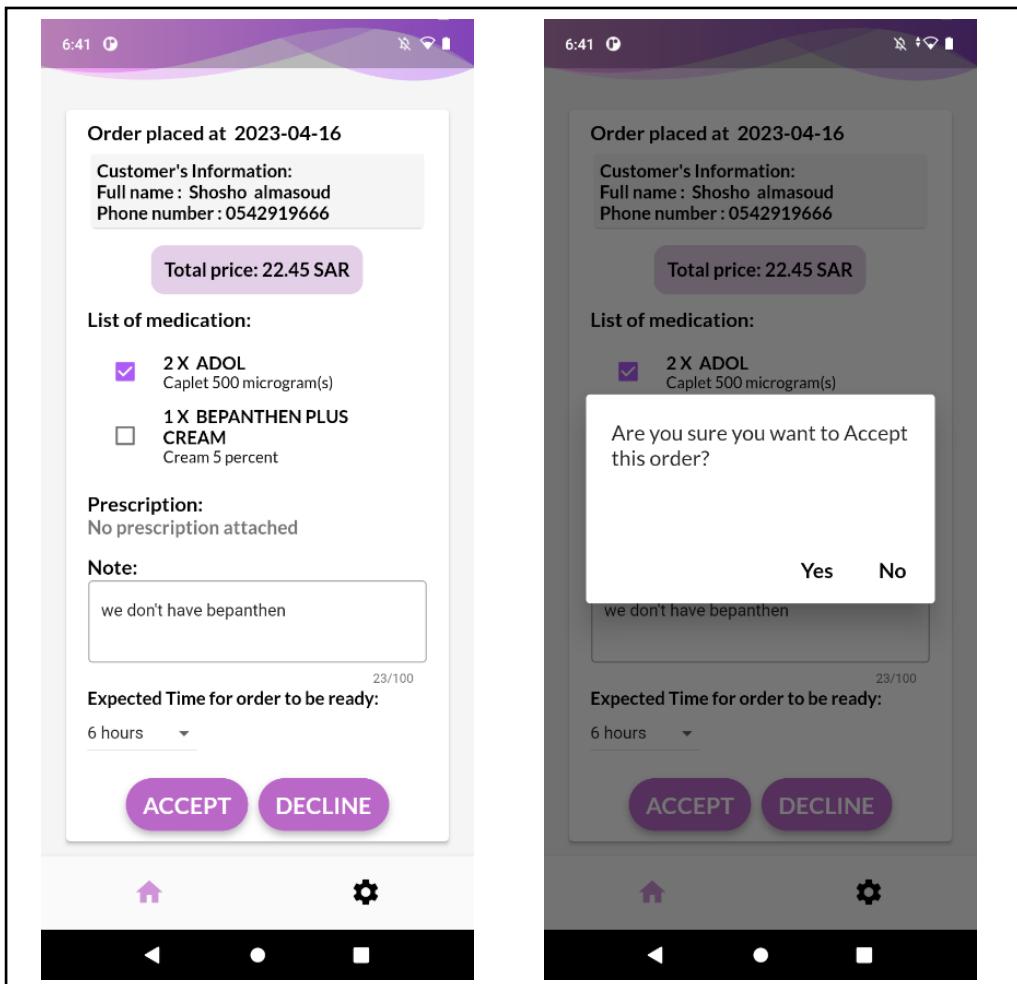


Figure 4.19 Recoverability

**Generalizability:** is about extending specific interaction knowledge to new situations.[24]

Due to the recent popularity of swapping to delete an item in applications, we employed the swapping procedure in the Tiryaq cart interface to remove a medication from the cart as shown in figure (4.20).

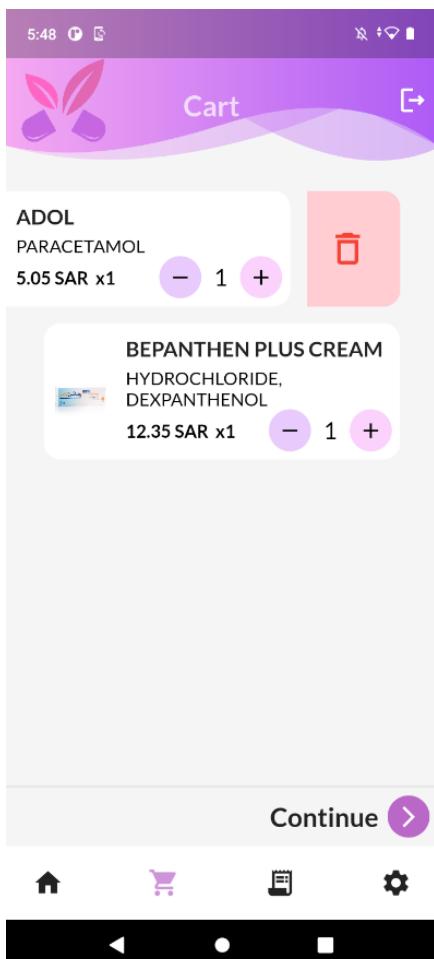


Figure 4.20 Generalizability

## 4.6 Implementation

This chapter represents the implementation and integration of Tiryaq system. Started by describing software tools used in Tiryaq, followed by database connection, then system implementation then system integration then the challenges that we faced during Tiryaq implementation.

### 4.6.1 Software tools

Table (13 – 6.1) shows the software tools used to implement Tiryaq.

Table 4.8 Software tools

Software Type	Version
Flutter	3.3.1
Dart	2.18.0
DevTools	2.15.0
Android Studio	2021.2.1
Back4app	4.5.0
GitHub	2.38.1
Visual studio code	1.75.1

### 4.6.2 Database connection

In this section, we describe the process of database connection.

We used Back4app platform as the system's database.

- Back4app

A database component is a vital component in most systems since they store system data which sometimes is the backbone of the system. In Tiryaq, we used Back4app platform for the features and facilitation it provides. Back4app is an online database server that holds the data of our project. And in this section, we will be explaining how we connected our Flutter project to Back4app and why we need Back4app for Tiryaq.

To begin, we downloaded Android Studio then added Flutter and Dart as plugins. Since Tiryaq is a health application, it means that we will have many users and each user will have his own data. The correctness and consistency of the displayed information is very important, we have used Back4app as a SQL platform to store all their information and to help with Authentication when a user logs in and logs out.

To connect our app with Back4app, we created an account on Back4app website to save and synchronize our project's database and then we built a new app. We connected our flutter project to our Back4app by completing the following steps:

1. Installing Flutter plugin for Parse Server by adding it in the “dependencies” in our project and run it to make sure it is installed.
2. Set up Parse SDK by initializing our Parse app, and to do that we have provided the credentials of our database, which are “keyApplicationId” and “keyClientKey” to make sure the connection between our application and back4app server is secure.
3. Evaluate the connection by running the code, then checking the dashboard in our account on Back4app website to see the results.

The identification and authentication of a user are done by using Back4app authentication service. Once an app is created on Back4app, it provides a table that contains the important attributes to verify the validity of the information, such as the email, password, and username and it automatically encrypts the password.

#### 4.6.3 Google API connection

This section describes the processes of connecting Google API with Tiryaq application to implement location-based service. In order to do so we followed the following steps:

1. Creating an account in Google cloud and generated an API key
2. Enabling the required API services (Geocoding API, Maps SDK for android, Places API) and restricting the key to only calling these API services
3. Adding the API key and location permissions to AndroidManifest.xml file in flutter project.

After following these steps, we were able to connect to google API and implement the location-based service of Tiryaq.

#### 4.6.4 Functions implementation

This section describes the processes of implementing Tiryaq system along with the components and code-fragments of the major functions.

We used android studio with dart to design and develop the code of Tiryaq application. We set up the emulator and real devices to run the application. We could install them in both macOS and Windows and start work on them easily. After that, we used Visual Studio Code to implement the admin dashboard. The following code-segments are for the major functions such as customer registration (table 4.9), view medications (table 4.10), add/delete a medication to/from cart (table 4.11 and 4.12), update customer account information (table 4.13), get customer current location (table 4.14), and convert coordinates into address (table 4.15).

Table 4.9 Customer registration function

<b>Function</b>	Customer registration
<b>Description</b>	This function enables the user to register in the application by entering the required information.
<b>Functions' Flow</b>	The function <i>doUserRegistration</i> will store the values entered in the sign-up fields in final variables, then it will check that the phone number does not exist in customer table, if it doesn't exist it will create new customer account.
<b>Code</b>	
<pre>Future&lt;void&gt; doUserRegistration() async {     final email = controllerEmail.text.trim();     final password = controllerPassword.text.trim();     final firstname = controllerFirstname.text.trim();     final lastname = controllerLasttname.text.trim();     var phonenumber = controllerPhoneNumber.text.trim();     final user = ParseUser.createUser(email, password, email);      //Check unique phone number in Customer table     QueryBuilder&lt;ParseObject&gt; queyPhonenumber =     QueryBuilder&lt;ParseObject&gt;(ParseObject('Customer'));     queyPhonenumber.whereEqualTo('Phonenumber', '0\$phonenumber');     var apiResponse = await queyPhonenumber.query();     if (apiResponse.success) {</pre>	

```
        if(apiResponse.count == 0){//If no same phone number exist create
user account
            var response = await user.signUp();
            if (response.success) {
                final createCustomer = ParseObject('Customer')
                    ..set('Firstname', firstname)
                    ..set('Lastname', lastname)
                    ..set('Phonenumber', '0$phonenumber')
                    ..set('user', user);
                await createCustomer.save();
                showSuccess();
            } else {
                showError(response.error!.message);
            }
        } else(showError('phonenumber'));
    }
}
```

Table 4.10 Update customer account function

<b>Function</b>	Update customer account information
<b>Description</b>	This function enables the customer to update the personal information in the account, first name, last name, and phone number.
<b>Functions' Flow</b>	The function <i>updateInfo()</i> will receive the customer's id and the new information as parameters, it will get the customer corresponding to the id, and then update the information in the database. It will show a message indicating whether the process has completed successfully or not.
<b>Code</b>	
<pre>Future&lt;void&gt; updateInfo(userID, CustomerId, editFirstname, editLastname, editPhonenumber) async {     var object;     //Query the user from Customer table using CustomerId     final QueryBuilder&lt;ParseObject&gt; parseQuery = QueryBuilder&lt;ParseObject&gt;(ParseObject('Customer'));     parseQuery.whereEqualTo('objectId', CustomerId);      //Get as a single object     final apiResponse = await parseQuery.query();     if (apiResponse.success &amp;&amp; apiResponse.results != null) {         for (var o in apiResponse.results!) {</pre>	

```

    object = o as ParseObject;
}
}
//Update the information in Customer table
var todo = object
..set('Firstname', editFirstname)
..set('Lastname', editLastname)
..set('Phonenumber', '0$editPhonenumber')
//userId should be pointer since its a foreign key
..set('user', (ParseObject('_User'))..objectId = userId)
.toPointer());
final ParseResponse parseResponse = await todo.save();

if (parseResponse.success) {
  //If the update succeed call showSuccess function
  showSuccess();
} else {
  //If update fails cal showError function
  showError(parseResponse.error!.message);
}
}
}
  
```

Table 4.11 Add to cart function

Function	Add to cart
Description	This function works to add the medication that the customer chooses to the cart.
Functions' Flow	The function <code>addToCart()</code> will receive the customer and medication id, then it will get the data from customer cart table. If the medication exists in the cart, it will increment the quantity of the medication, if it doesn't exist it will add the medication to the cart and set the quantity to 1.
Code	
<pre> Future&lt;bool&gt; addToCartobjectId, customerId) async {   bool exist = false;   var medInCart;   var quantity = 0;    //Search for medications in customer cart   final apiResponse = await ParseObject('Cart').getAll();   if (apiResponse.success &amp;&amp; apiResponse.results != null) {     for (var o in apiResponse.results!) {       medInCart = o as ParseObject;       if (customerId == medInCart.get('customer').objectId) {         exist = true;         quantity = medInCart.get('quantity');         medInCart.put('quantity', quantity + 1);         medInCart.update();       }     }   } }   </pre>	

```

    if (objectId == medInCart.get('medication').objectId) {
        //If medication exist in customer cart
        exist = true;
        quantity = medInCart.get<num>('Quantity');
        break;
    }
}
//If medication doesn't exist then add
if (!exist) {
    final addToCart = ParseObject('Cart')
        ..set('customer',
            (ParseObject('Customer')..objectId = customerId).toPointer())
        ..set('medication',
            (ParseObject('Medications')..objectId = objectId).toPointer())
        ..set('Quantity', 1);
    await addToCart.save();
    return true;
}
//If medication exist then increment quantity
else {
    var incrementQuantity = medInCart..set('Quantity', ++quantity);
    await incrementQuantity.save();
    return true;
}
}
  
```

Table 4.12 Delete from cart function

Function	Delete from cart
Description	This function removes medication from the cart.
Functions' Flow	The function <i>deleteCartMed()</i> will receive the medication id and its quantity, it will get the data from customer cart table, then it will delete the medication that has the received id. Finally, it will show a message indicating whether the process has completed successfully or not.
Code	
<pre> Future&lt;bool&gt; deleteCartMed(medId, Quantity, Publicprice, legalStatus) async {     //Query the medication from customers' cart     final QueryBuilder&lt;ParseObject&gt; parseQuery =         QueryBuilder&lt;ParseObject&gt;(ParseObject('Cart'));     parseQuery.whereEqualTo('customer',         (ParseObject('Customer')..objectId =             widget.customerId).toPointer());   </pre>	

```

parseQuery.whereEqualTo('medication', medId.toPointer());
final apiResponse1 = await parseQuery.query();

if (apiResponse1.success && apiResponse1.results != null) {
  for (var o in apiResponse1.results!) {
    final object = o as ParseObject;
    TotalPrice = num.parse((TotalPrice -
(Publicprice*Quantity)).toStringAsFixed(2));
    if(legalStatus.compareTo('Prescription')==0) {
      if(numOfPres==1){
        presRequired = false;
      }
      else{
        numOfPres--;
      }
    }
    //Delete medication
    object.delete();
    //Decrement number of medications in customer table
    cartItemNum = cartItemNum - 1;
    return true;
  }
}
return false;
}
  
```

Table 4.13 Get medication function

Function	Get Prescription Medication
Description	This function brings medication that do need a prescription from the database to be displayed, whether it is in viewing, searching, or filtering processes.
Functions' Flow	The function <i>getPresMedication()</i> will create a query to retrieve the prescription medication from database, it will display them based on the selected <i>PharmaceuticalForm</i> filter in an ascending order based on <i>TradeName</i> .
Code	
<pre> Future&lt;List&lt;ParseObject&gt;&gt; getPresMedication(searchString) async {   QueryBuilder&lt;ParseObject&gt; queryPresMedication =   QueryBuilder&lt;ParseObject&gt;(ParseObject('Medications'));   queryPresMedication.whereContains('LegalStatus', 'Prescription');   queryPresMedication.setLimit(200);   queryPresMedication.whereEqualTo('Deleted', false); }   </pre>	

```

queryPresMedication.orderByAscending('TradeName');
queryPresMedication.whereStartsWith('TradeName', searchString);
queryPresMedication.whereStartsWith('PharmaceuticalForm', packageType);
final ParseResponse apiResponse = await queryPresMedication.query();
if (apiResponse.success && apiResponse.results != null) {
  return apiResponse.results as List<ParseObject>;
} else {
  return [];
}
}
  
```

Table 4.14 Current location function

<b>Function</b>	Get customer current location
<b>Description</b>	This function gets the customer current location.
<b>Functions' Flow</b>	The function <i>determinePosition()</i> checks the location permission, if it's already allowed it will return the current position, otherwise it will ask permission from the user, if the permission is allowed it will return the current position.
<b>Code</b>	
<pre> Future&lt;Position&gt; _determinePosition() async {   bool serviceEnabled;   LocationPermission permission;    serviceEnabled = await Geolocator.isLocationServiceEnabled();    if (!serviceEnabled) {     return Future.error('Location services are disabled');   }    permission = await Geolocator.checkPermission();    if (permission == LocationPermission.denied) {     permission = await Geolocator.requestPermission();      if (permission == LocationPermission.denied) {       return Future.error("Location permission denied");     }   }    if (permission == LocationPermission.deniedForever) {     return Future.error('Location permissions are permanently denied');   } }   </pre>	

```

Position position = await Geolocator.getCurrentPosition();

return position;
}
  
```

Table 4.15 Coordinates to address conversion function

<b>Function</b>	Convert coordinates into address conversion
<b>Description</b>	This function converts the coordinates of the location into a readable address.
<b>Functions' Flow</b>	The function <i>getUserLocation()</i> will receive the location, it will call <i>placemarkFromCocoordinates()</i> to convert the location into readable address and return it.
<b>Code</b>	
<pre> Future&lt;Placemark&gt; getUserLocation(currentPostion) async {     List&lt;Placemark&gt; placemarks = await placemarkFromCoordinates(         currentPostion['latitude'], currentPostion['longitude']);     Placemark place = placemarks[0];     return place; }   </pre>	

#### 4.6.5 System integration

In this section, we describe the process of integrating the software components to ensure that the integrated components work after the integration as they are designed for, and to deliver the overall functionality and completed system.

GitHub was used as a collaboration hosting platform to upload the code and commit latest changes and resolve any conflicts.

A repository was created for the Tiryaq system on GitHub platform, it was linked to Jira and included all members and supervisors. GitHub was linked to Android Studio and the project was pushed to the repository. After that a branch was created for each team member in addition to the main branch for the project, so that the members could merge, push and pull the codes from the different branches periodically. Therefore, the tasks were integrated and tested in an incremental process and ensured their functionality

#### 4.6.6 Challenges

While developing Tiryaq system, the team faced several challenges. After choosing Back4App as a database to develop the system, the team had difficulty linking the data to the application, Due to the lack of available sources on Back4App, in addition to the fact that dealing with pointers in the database was a new matter that required knowledge of the queries and its commands. In addition, the integration of the codes and pages between the team members was challenging and had issues sometimes, some methods, tasks or pages work perfect separately but when integrating them with other pages some errors occur and a new methods had to be coded and rewritten, we could solve the issue by using GitHub more frequently so that issues can be solved in an earlier process which makes it easier and faster to notice and solve. Some issues were also observed during operation because Android Studio required strong processors and reliable internet to function, which resulted in device exhaustion, delayed operation, also facing problems in the debug which solved through the null Safety Code.

The team also faced a problem in naming the application, as a project was created on Android Studio with the name “Untitled” and after starting to write the codes and delving into it, this project was approved as a file for the application and the name of the project was changed to “Tiryaq” and pushed to the GitHub repository. After that the team Discovered that the application still holds the name “Untitled” on the user interface and after researching the problem, it became clear that the internal files of the project are called “Untitled”, as the name was changed externally only and after continuous search for solutions, the problem was solved through APK, where the team was able to change Project name to “Tiryaq” on the user interface.

#### 4.6.7 GitHub repository

The following link <https://github.com/R2eem/2022-GP1-19.git> refers to the GitHub repository of Tiryaq system, in which the codes of the application and the admin dashboard are stored.

## 5 System Evaluation

This chapter includes the entire user acceptance testing process of Tiryaq system.

### 5.1 User Acceptance Testing

In this section, user acceptance testing is performed and documented, the testing evaluates the tasks shown in table (5.1) of second release of Tiryaq system to check if it satisfies the requirements. A total of 20 end users participated, 13 as customers, 3 as pharmacists and 4 as admins who meet the project users' criteria. A questionnaire that consists of 10 questions that covers the system's interface, functionality and easiness was created to be answered by the participants at the end of the testing phase. The participants completed the testing by performing the listed tasks in table (5.1), and responding to the questionnaire to evaluate the system, for questionnaire (see Appendix E).

Table 5.1 UAT testing tasks

Task number	Task
<b>For Customers</b>	
1	Registration
2	Reset password
3	View medications
4	Search medication
5	Filter medication
6	View and Update account
7	View and delete saved locations
8	View and modify cart
9	Submit order
10	Confirm order
11	View orders and details
12	Cancel order

For Pharmacist	
1	Registration
2	Reset password
3	View and Update account
4	View orders
5	Accept/Decline orders
6	Update order status
For Admin	
1	Registration
2	View and manage medications
3	View and manage pharmacies join request
4	View customers
5	View orders

### 5.1.1 Demographics of Participants

The table (5.2) describes the end users who tested the second release of Tiryaq system.

Table 5.2 Demographics of participants

Participants	Gender	Age	Customer/Pharmacist/Admin	Basic market application experience	Basic English	Bachelor's degree in pharmacology or Technician certificate	Communicate in technical and non-technical terms
1	Female	21	Customer	Yes	Yes	-	-
2	Female	15	Customer	Yes	Yes	-	-
3	Male	15	Customer	Yes	Yes	-	-
4	Female	42	Customer	Yes	Yes	-	-

5	Male	19	Customer	Yes	Yes	-	-
6	Female	22	Customer	Yes	Yes	-	-
7	Male	30	Customer	Yes	Yes	-	-
8	Female	24	Customer	Yes	Yes	-	-
9	Female	32	Customer	Yes	Yes	-	-
10	Female	30	Customer	Yes	Yes	-	-
11	Female	22	Customer	Yes	Yes	-	-
12	Female	22	Customer	Yes	Yes	-	-
13	Female	27	Customer	Yes	Yes	-	-
14	Male	32	Pharmacy	Yes	Yes	Yes	-
15	Male	35	Pharmacy	Yes	Yes	Yes	-
16	Female	30	Pharmacy	Yes	Yes	Yes	-
17	Female	22	Admin	-	Yes	-	Yes
18	Female	21	Admin	-	Yes	-	Yes
19	Male	50	Admin	-	Yes	-	Yes
20	Female	27	Admin	-	Yes	-	Yes

### 5.1.2 Questionnaire Results

After the testing, each participant answered the questionnaire that consist of 10 questions to evaluate the system. The responses of the questions are a range from Strongly agree to Strongly disagree. The table (5.3) summarize the results of the questionnaire, and for questionnaire charts (see Appendix E).

Table 5.3 UAT questionnaire

Question number	Question	Summary of Results
1	I think that I would like to use this system frequently.	Strongly agree 70% Agree 30% Neutral 0% Disagree 0% Strongly disagree 0%
2	I found the system unnecessarily complex.	Strongly agree 0% Agree 0% Neutral 0% Disagree 35% Strongly disagree 65%
3	I thought the system was easy to use.	Strongly agree 75% Agree 25% Neutral 0% Disagree 0% Strongly disagree 0%
4	I think that I would need the support of a technical person to be able to use this system.	Strongly agree 0% Agree 0% Neutral 0%

		Disagree 20%  Strongly disagree 80%
5	I found the various functions in this system were well integrated.	Strongly agree 70%  Agree 30%  Neutral 0%  Disagree 0%  Strongly disagree 0%
6	I thought there was too much inconsistency in this system.	Strongly agree 0%  Agree 0%  Neutral 0%  Disagree 45%  Strongly disagree 55%
7	I would imagine that most people would learn to use this system very quickly.	Strongly agree 60%  Agree 40%  Neutral 0%  Disagree 0%  Strongly disagree 0%
8	I found the system very cumbersome to use.	Strongly agree 0%  Agree 0%  Neutral 0%  Disagree 15%  Strongly disagree 85%
9	I felt very confident using the system.	Strongly agree 65%  Agree 35%

		Neutral 5%  Disagree 0%  Strongly disagree 0%
10	I needed to learn a lot of things before I could get going with this system.	Strongly agree 0%  Agree 0%  Neutral 5%  Disagree 25%  Strongly disagree 75%
<b>Dashboard Feedbacks</b>		
1- Change the color of the log in fields to darker color.  2- The log in button doesn't show if it's clicked or not when I entered wrong credentials several times.  3- My experience was very good but I think you need to change the update button to save button.		
<b>Application Feedbacks</b>		
1- The app is good but I think you should change the color of add to cart button on home page to color that more match the other colors, maybe to light color.  2- Add Arabic language, Medicine name overflows in details and cart, add customer support.  3- When I wrote my email with a capital letter it said invalid email or password, however, the email worldwide has no differences between capital and small letters.  4- The location selecting and saved location button are not clear.  5- No feedback everything is good.  6- Kindly add service for delivery.  7- Very good. As a customer I will use it again.  8- Good luck.  9- This very good idea.		

- 10- Inside the settings there should be a back arrow.
- 11- The system is good, but selecting the current location is not clear there should be a notification that the location is selected.

After collecting the end users' questionnaire responses, we can state the following, all users agreed that they would frequently use the system without a need to learn anything or a technical support. Most of the feedbacks that we received was positive, while some suggested few changes within the interface to increase the usability of the system. They also agreed that it's easy to use and not complex, from which we may infer that the system can be deployed to the target users without worries. Users who tested the system felt confident while testing, didn't feel overwhelmed and mostly had positive feedback, so in order to understand why and enhance the users experience we looked into some of the questions responses and we came to the conclusion that it's all due to the well-integrated functions, consistency, easiness and clearness in the system. Additionally, we used the System Usability Scale (SUS) approach to assess the system's usability. The average System Usability Scale score is 68 while our system obtained a score of 92.5, which is greater than the average and reflects a high score to the system's user experience and usability performance in the means of effectiveness, efficiency, and general ease of use.

## 5.2 Quality Attributes (NFR testing)

While testing the system we took into consideration the non-functional requirements. We tested each requirement based on its measurement as shown below in table (5.4). The surrounding environment such as the internet connection and the device used for testing were taken into account as they had some effect on the results which are likely to occur in real life.

Table 5.4 NFR testing

User story	Quality Attribute	Measure	Results
As a user, I want the application pages to display within at most 10 seconds, so that I can use the application as quickly as possible.	(Performance)  How responsive is the system and its components?	Compute the response time for displaying application pages.  Pages need at most 10 seconds to be fully displayed.	<ul style="list-style-type: none"> <li>First, we connected DevTools to our IDE</li> <li>Run the application on Android phone</li> <li>Recorded the time the pages take to be displayed</li> <li>The minimum time was (6ms), maximum time was (10s), and the average time was (6s)</li> </ul>
As a user, I want the application to accept only strong password when I register in the app.	(Security)  What are the requirements of the password when registering in the app?	Check the requirement of the password when creating an account in the app.  The password must be strong (at least 8 characters, one upper, one lower case, and one special character).	<ul style="list-style-type: none"> <li>First, let users create an account at the beginning of the test</li> <li>Validate the password requirements when users choose one</li> <li>Make sure that none is able to create account without satisfying the requirements</li> </ul>

<p>As a user, I want my account to be secure, so that no one can spy on me and steal my information.</p>	<p>(Security)</p> <p>How secure are the credentials and the accounts?</p>	<p>Check the password complexity and storage.</p> <p>Check the error message of failed log in attempts.</p> <p>The password must be strong and stored hashed.</p> <p>The error message of failed log in attempts must not provide specific information.</p>	<ul style="list-style-type: none"> <li>• First, let users create an account at the beginning of the test</li> <li>• Validate the password requirements when users choose one and check the type of the password stored in the database</li> <li>• Second, let the users log in with wrong credentials and check the error message informativeness</li> </ul>
<p>As a user, I want the application to be available 99% of the time and not blocked, so that I can access to it any time when I need it.</p>	<p>(Availability)</p> <p>What is the percentage of time that the app is up and running without any downtime or errors.</p>	<p>Track the uptime (the amount of time the app is accessible and functioning as intended) of the app.</p> <p>App needs to be available 99% of the time.</p>	<ul style="list-style-type: none"> <li>• During testing the application with the users, we tracked the uptime of the application.</li> <li>• Application was available 99% of the time.</li> </ul>
<p>As a user, I want the application to be easy to use and familiar, so that I don't waste my time in learning to use it.</p>	<p>(Usability)</p> <p>How much time a user takes to perform main tasks (ordering process) once they see the interface?</p>	<p>Compute the time the users spend performing the order process task (Task completion time).</p> <p>The task completion time shouldn't</p>	<ul style="list-style-type: none"> <li>• First, set a timer</li> <li>• Run the application on Android phone</li> <li>• Start the timer once the users start to test and stop when the users submit the order</li> <li>• First testing: minimum time was (25s), maximum time was (1</li> </ul>

		<p>exceed 1 minute and 30 seconds</p> <ul style="list-style-type: none"> <li>Second testing “After modifying the interface based on the feedbacks”: minimum time was (18s), maximum time was (57s), and the average time was (32s)</li> </ul>	<p>minute and 35s), and the average time was (54s)</p>
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### 5.3 Discussion

This section provides an interpretation of the results obtained from the system evaluation and the users feedback and responses. From the user acceptance testing and the questionnaire, we can say that Tiryaq’s design and interface are clear and easy to interpret by users without having a need of support or learning a lot of things. The main functions for both the application and dashboard such as registration process, medication browsing, ordering process and the managing process are well integrated, consistent and the navigation between these functions and their different interfaces are all properly implemented and represented.

According to some of the dashboard testers feedback, they noticed that the log in button is not visibly clickable and was hard to figure out if it was clicked or not in addition to the text in the log in fields was not clear due to device changes. Moreover, according to the testers knowledge in technical matters and using dashboards frequently in their work, they thought that changing the update button to save button in update medication page is more interpretable and suitable. So, after receiving these feedbacks it was more professional to change the colors and style in the log in fields to make it usable for different devices and to change the update to save button.

As for the application feedbacks, one of the testers faced a problem to view the medication name in the cart and order details page when the medication name was really long and another tester faced an error when they tried to log in with lowercase letters while they signed up with uppercase letters. We immediately started to solve these two problems, and then we tested the application. Two of the testers agreed that the location selecting when ordering was not clear and they needed

some time to understand the process and both suggested to add a notification or other informative text to solve the problem, we also recognized from the first NFR usability testing that the order process completion time was higher than the expected or required time, so we searched for similar applications and found out that displaying the location in readable form as soon as its selected would solve the issue and reduce the time it takes to understand and complete the process.

Others mentioned their own preferences such as adding navigation arrows in the settings page or changing the add to cart button color and some suggested additional features that we will make sure to add in the future such as delivery service, Arabic language and live customer support.

At the end, the overall results obtained from the system evaluation are good based on the feedbacks and responses as we can say most of the modifications was not due to a lack of skills, debugging or bad user experience but was a chance to improve the usability of the system. All testers praised the system and mentioned that they would use it if it will be published someday because it solves a problem they face in real life.

## 6 Conclusions and Future Work

In summary, as the significant increase in treatments and medications, as well as an increase in the number of pharmacies, people faced a difficulty to find their medications in a fast and efficient manner. Therefore, we developed Tiryaq system which is location-based application and admin dashboard that focus on the field of pharmaceutical industry in order to provide the customers with an effective way to reach their goal, which is to find the right medication for them from the nearest pharmacy to their location, in addition to save customers' time and effort, and making the work of pharmacies more productive.

This section concludes the Tiryaq system development process. Starting with the introduction chapter, that outline the core concept of the Tiryaq system and present the problem, solution and product. Next is the second chapter, an explanation of location- based services (LBS), a definition of a pharmacy, and a brief introduction to the dataset's source are all included in the background chapter to help the reader understand Tiryaq's details. To build an application that fits the market's requirements and to define Tiryaq's features, it was necessary to research and analyze the competing applications and comparing them with Tiryaq to clarify the features that distinguish Tiryaq, and all this was done in the third chapter which is the literature review. Continuing with the fourth chapter, the system design and development includes the methodology, the users and their interactions, system requirements, product backlog and roadmap, additionally to the system design diagrams, interface design and implementation details and challenges. The fifth chapter refers to the system evaluation and testing.

### 6.1 Local and Global impact

#### 6.1.1 Local Impact

The Tiryaq system will have a variety of local effects, starting with establishing a connection between the pharmacies and their customers especially for small pharmacies that don't have the funds to develop their own mobile applications to reach their customers, Tiryaq will offer them an opportunity to draw in customers. Tiryaq will also help with the stock and expiration problems for the medication by distributing customers evenly among pharmacies rather than putting pressure

on one pharmacy. Additionally, it will save customers' time and effort while looking for a specific medication in pharmacies.

#### 6.1.2 Global Impact

The global impact of Tiryaq system includes enhancing the mechanism of dispensing and purchasing medication in the Kingdom of Saudi Arabia, and enhancing the ease of access to medications everywhere, which leads to enhancing public health. Also, it will improve the concept of unified mobile application in the IT fields.

### 6.2 Limitation of The System

At the present, only English is available in the Tiryaq system, and only Android users are supported.

### 6.3 The main contribution of the project

The main contribution of the Tiryaq system is the development of a new way to sell medications and link between customers and pharmacies, therefore it enabled pharmacies to reach new customers and enabled customers to reach the nearest pharmacies easily and with minimal effort.

The first release of the Tiryaq system was focused on the customer side to allow the customer to create an account in the application, view, search and filter medications, as well as add or delete medication to the cart and modify the quantity of medication. The second release of Tiryaq system which is the final release continued with customer to allow him/her to complete the order process by entering the current location, submitting the order, confirming the order and finally track the order. Also, release two continued to allow the pharmacy to request a join to the application and receive, accept, and decline orders from customers. Finally, to make Tiryaq system a better it took another curve with the admin dashboard by allow the admin to manage all the processes in the application starting from view, add, update, and delete medications and view, accept, and decline pharmacies join requests. Also, the admin able to view customers and customer orders with features of search and filter.

## 6.4 Problems and challenges encountered during the software development

We encountered challenges when preprocessing the dataset that we obtained from the Saudi Food and Drug Authority (SFDA), because the data were large and had many null cells, preprocessing the dataset and selecting the sample to be displayed in the Tiryaq application took a lot of time. Additionally, since the lack of resources available for flutter with back4app database, the implementation phase was where we encountered the most of our problems. We also encountered some problems in applying the location-based service, determining the location, storing it, and displaying the nearest pharmacies to the customer's location with the distance, in addition to some complications that we encountered in programming the customer's order process. In order to tackle the problems, we ran into while building Tiryaq, we had to take the time to learn how to utilize the dart programming language as well as how to connect the application to the database and manage the database, which was time-consuming, but we overcame it through time management.

## 6.5 Future work

The Tiryaq system team will continue to expand and keep working to make the system better, starting with adding support for iOS operating system and other languages. Also, Tiryaq will expand to include all pharmacy products, not just medications, and it will support the online payment service and delivery service to make the user experience easier and faster. In addition, the customer's favorite list, where he/she can add his/her preferred products in it. Also, the admin will be able to display comprehensive statistics of the application's work and monitor it through these statistics and will be able to adjust the order timer for the customer. In the end, Tiryaq users will be able to use various and different filters to filter the results.

## 7 Acknowledgements

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## 9 Appendices

### Appendix A: Requirements elicitation and analysis survey

This appendix provides the charts of the survey that is conducted during the requirements elicitation and analysis section.

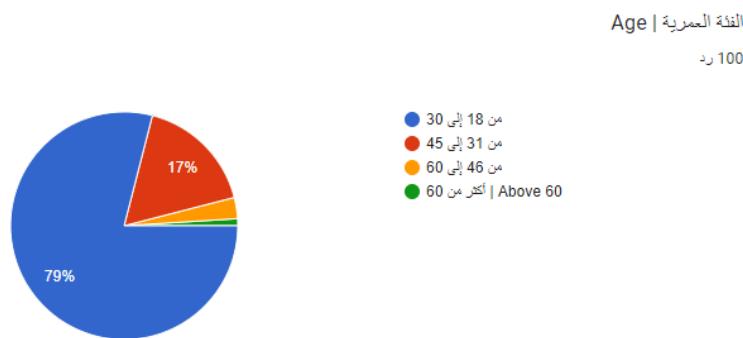


Figure 9.1 Age-Survey analysis

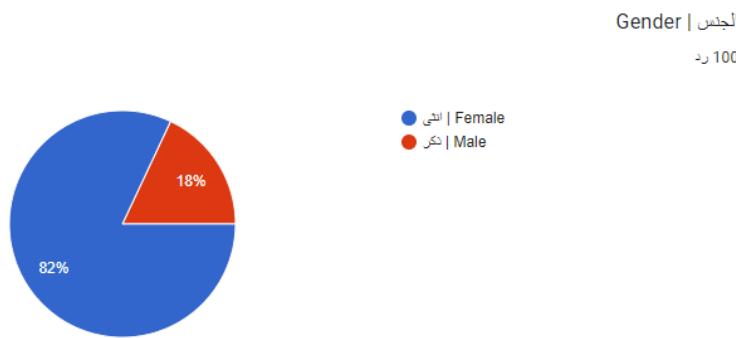


Figure 9.2 Gender-Survey analysis

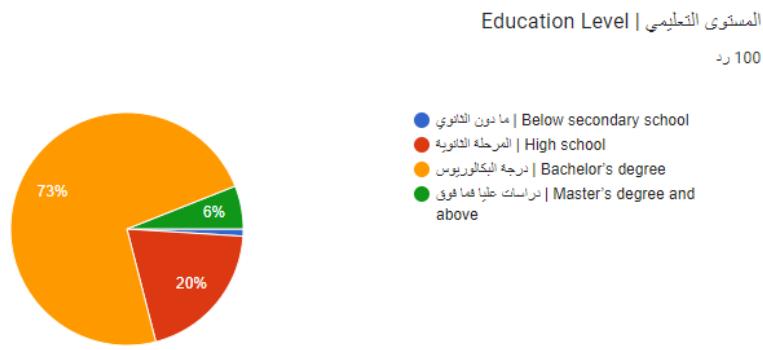


Figure 9.3 Education level-Survey analysis

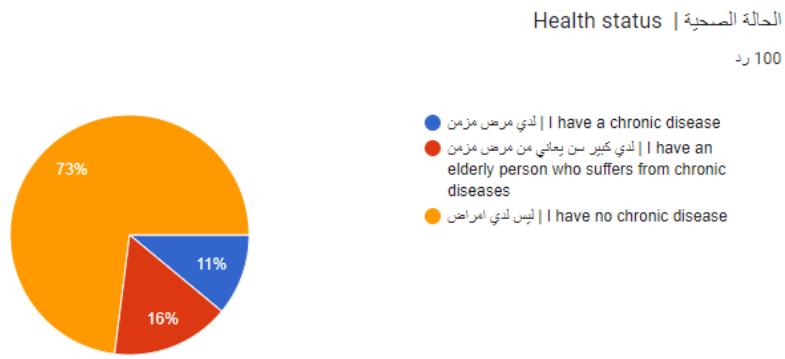


Figure 9.4 Health status-Survey analysis

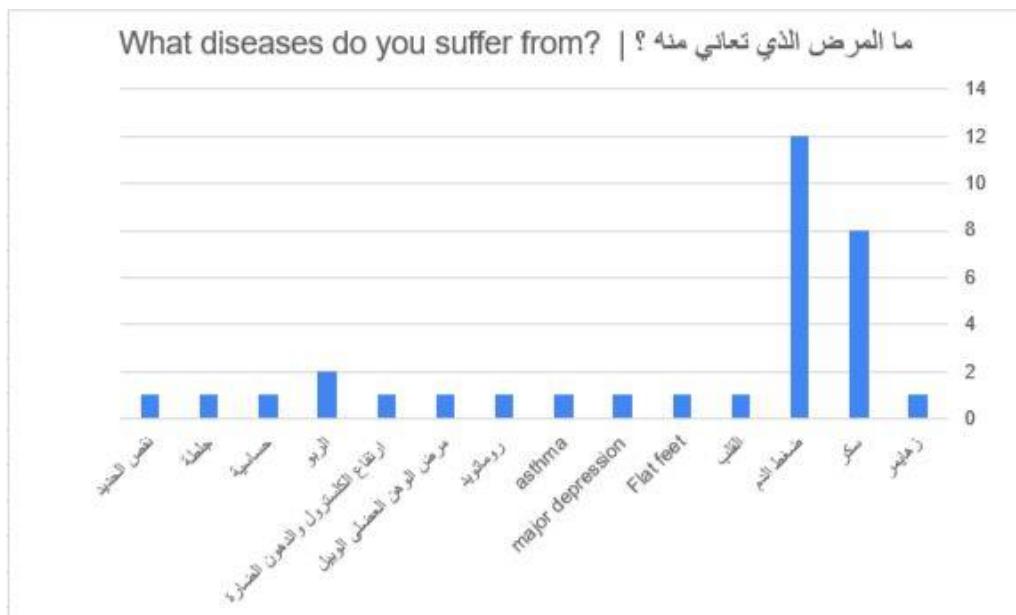


Figure 9.5 Disease-Survey analysis

عدد مرات شرائك للأدوية من الصيدلية | How often do you buy medicines from pharmacy?

رد 100



Figure 9.6 Purchase rate-Survey analysis

ما هو العامل الذي تعتبره الأكثر أهمية عند شراء دواء من الصيدلية؟ | What factor would you consider the most important when purchasing a medicine from a pharmacy

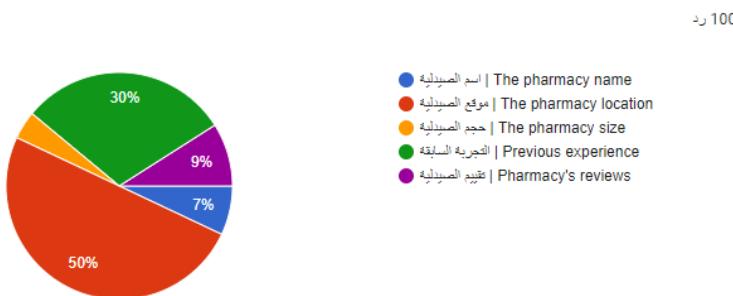


Figure 9.7 Purchase factors-Survey analysis

عندما تحتاج إلى دواء ، ماذا تفعل للتحقق من توفر ذلك الدواء؟ | When you need a medication, what do you do to check the availability of that medication

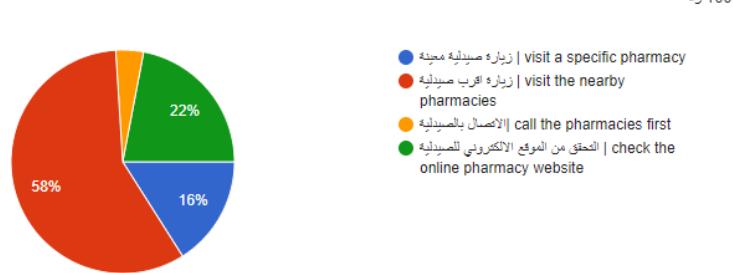


Figure 9.8 Availability check-Survey analysis

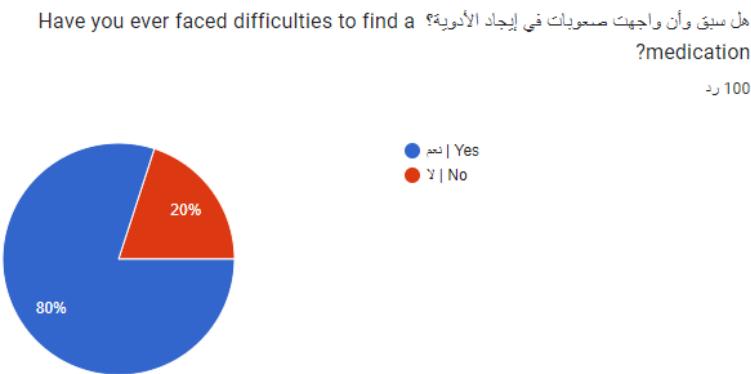


Figure 9.9 Difficulties-Survey analysis

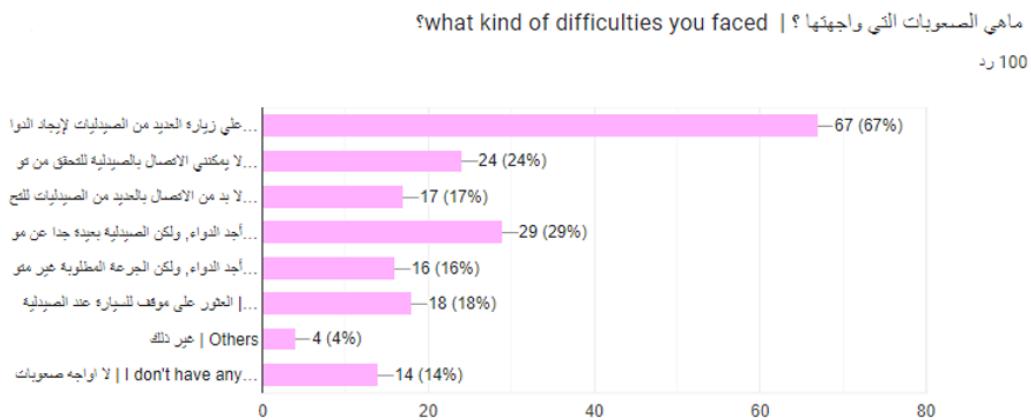


Figure 9.10 Difficulties reason-Survey analysis

?How often do you purchase medicines online | كم مرة تشتري الأدوية عبر الإنترن特؟ | رد 100

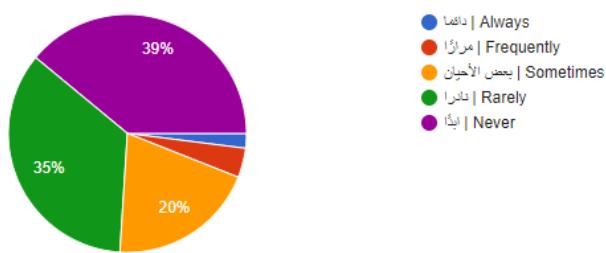


Figure 9.11 Online purchase rate-Survey analysis

عندما تطلب دواء عبر الإنترنط ، هل تفضل أن يكون لديك خيار استلام طلبك بنفسك؟ | When you order a medication online, do you prefer to have the option to pick up your order | رد 100

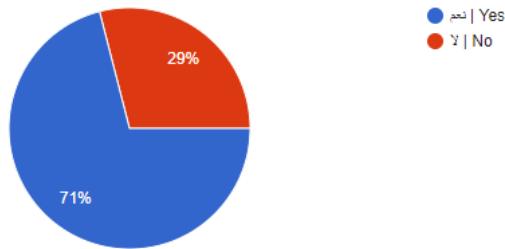


Figure 9.12 Preference-Survey analysis

إذا طلبت دواء لاستلامه من صيدلية قرية ، ما هو الوقت المتوقع الذي سيسفرقه الحصول عليه ؟  
?medication to pick up it from nearby pharmacy, how long it would take to collect it

رد 100



Figure 9.13 Expected pick-up time-Survey analysis

من وجهة نظرك ، كيف يجب على المستخدمين إدخال اسم الدواء في التطبيق؟ |  
?should users enter the medication name on the application

رد 100

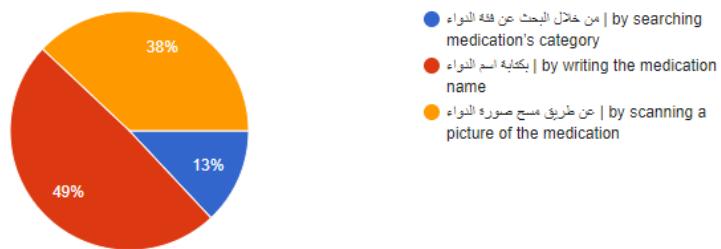


Figure 9.14 Search method-Survey analysis

عندما يحتاج الدواء إلى وصفة طبية ، هل تمانع إرفاق الوصفة على التطبيق ؟ | When the medication needs a prescription, do you mind attaching the prescription on the application

رد 100

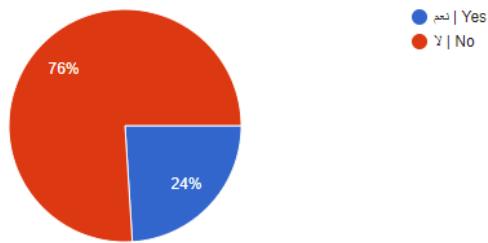


Figure 9.15 Prescription-Survey analysis

## Appendix B: Requirements elicitation and analysis interview questions

This appendix provides the questions of the interview that is conducted during the requirements elicitation and analysis section.

1. How long did it take you to work in pharmacology field?
2. What problems do you face while dealing with customers?
3. Is there a large turnout of customers to the pharmacy to get medicines?
4. Have customers ever come to the pharmacy and did not find the required medication? How do you deal with this situation?
5. How are medicines supplied to the pharmacy?
6. Are there problems in storing medicines, such as the expiration of medicines without using them, and how are these problems solved?
7. Do customers use other methods to communicate with the pharmacy other than coming to it?
8. Do customers call to check the availability of the drug or not before coming to the pharmacy?
9. How do you handle the pharmacy when it is crowded, or when there's a lot of demand for a certain medication?

10. What is the rate of customers coming without a prescription, and what is the policy in dealing with this case?
11. As a pharmacist, do you think it is good to receive orders through an application and prepare them for pick up instead of customers coming to the pharmacy to serve them, and why?
12. As a pharmacist, what is the best way to deal with medication that need a prescription and that is requested to be prepared by the users of the application?
13. As a pharmacist, what is the most appropriate way for you to inform the customer that his order is ready for collection?
14. As a pharmacist, how would you prefer the application to allow you to communicate with customer about their order status?
15. What features do you want to add to the app, something you believe will help you in your work?

## Appendix C: Data description

This appendix provides a description about Tiryaq dataset attributes as shown in table (9.1).

Table 9.1 SFDA dataset

Attribute Name	Type	Description	Unique values
<b>RegisterNumber</b>	Character	Identification number for each drug.	-
<b>ProductType</b>	Character	The type of creature to use the drug.	<i>Human</i>
<b>DrugType</b>	Character	Identifies if the drug is from new entity or same as already marketed brand-name.	<i>Generic, NCE</i>
<b>Sub-Type</b>	Character	Identifies if the biological drug type has a sub type.	-
<b>Scientific Name</b>	Character	The scientific name of the drug.	-
<b>Trade Name</b>	Character	The trade name of the drug.	-
<b>Strength</b>	Character	A number describing the strength of the drug.	-
<b>StrengthUint</b>	Character	The unit of the drug strength.	-
<b>PharmaceuticalForm</b>	Character	Pharmaceutical Form and shape of the drug, for example: solution or capsule.	<i>Solution, Tablet, Capsule Injection, Powder, Lozenge Drops, Cream, Syrup Suspension, Nebuliser, Liquid Enema, Lyophilizate, Lotion Spray, Suppository, Granules Caplet, Patch, Medicinal gas Sealant matrix, Emulsion Ointment, Ophthalmic strip Pressurised inhalation, Gel</i>

			<i>Aerosol, Shampoo, Mouthwash</i> <i>Intrauterine delivery system</i> <i>Vaginal delivery system</i> <i>Pessary, foam</i> <i>Endotracheal Pulmonary</i>
<b>Administrationroute</b>	Character	The method of using the drug, for example: parental use or oral use.	<i>Parenteral use, Ophthalmic use</i> <i>Auricular use, Vaginal use</i> <i>Nasal use, Rectal use</i> <i>Intraperitoneal, subcutaneous</i> <i>Intradermal use</i> <i>Intratracheal use</i> <i>Intravenous, Subcutaneous</i> <i>Intrapulmonary use</i> <i>Epilesional use, Intrathecal use</i> <i>Intravenous, Intravesical</i> <i>Subretinal use, Cutaneous use</i> <i>Oral use, Topical</i> <i>Intramuscular use, Dental use</i> <i>Inhalation use, Sublingual use</i> <i>Hemodialysis, Ocular use</i> <i>Intraarticular use</i> <i>Intravitreal use</i> <i>Intraabdominal use</i> <i>Intrathecal, Oromucosal use</i>
<b>AtcCode1</b>	Character	Atc code1 is a unique code assigned to a medicine according to the organ or system it works on, how it works and its strength.	-

<b>AtcCode2</b>	Character	Atc code2 is a unique code assigned to a medicine according to the organ or system it works on, how it works and its strength.	-
<b>Size</b>	Numeric	Drug size	-
<b>SizeUnit</b>	Character	The size unit of drug.	-
<b>PackageTypes</b>	Character	The type of drug package, for example: bottle or dropper container.	<i>Bottle, Pre-filled syringe</i> <i>Dropper Container, Ampoule</i> <i>Implanter, Bag</i> <i>Pre-filled pen, Injection Syringe</i> <i>Multidose container, PFS</i> <i>Strip, Patch, Aluminum Can</i> <i>Tablet Container, Sachet, Tube</i> <i>Cartridge, Applicator, Box</i> <i>Single-dose container</i> <i>Nasal Applicator</i> <i>Automatic Injection Device</i> <i>Blister, Vial, Spray Container</i> <i>Inhaler, Spray Pump</i> <i>Pressurised container, Pouch</i> <i>Ovule, Jar</i>
<b>PackageSize</b>	integer	The size of drug package.	-
<b>Legal Status</b>	Character	Whether the drug need a prescription or it's OTC medicine.	<i>Prescription, OTC</i>
<b>Product Control</b>	Character	Classify the drug whether it is controlled by the government or not.	<i>Controlled, Uncontrolled</i>
<b>Distribute area</b>	Character	The place where drug will be distributed and stored, for example: pharmacy or hospital.	<i>Hospital, Pharmacy</i>

<b>Public price</b>	Numeric	The price of the drug.	-
<b>shelfLife</b>	Numeric	the time period over which the drug is safe for use.	-
<b>Marketing Company</b>	Character	The marketing company name of the drug.	-
<b>Marketing Country</b>	Character	The country name of drug marketing company.	<i>Saudi Arabia, Oman, Belgium</i> <i>Australia, Italy, Denmark</i> <i>Lebanon, Iceland, Morocco</i> <i>Greece, Slovenia, Mexico</i> <i>Malaysia, South Korea, Canada</i> <i>Spain, Jordan, Germany</i> <i>Egypt, Norway, Tunisia</i> <i>Hong Kong, India, Portugal</i> <i>Liechtenstein, Luxembourg</i> <i>Ukraine, United Kingdom</i> <i>France, Kuwait, Switzerland</i> <i>United Arab Emirates, Romania</i> <i>Japan, Finland, New Zealand</i> <i>Bosnia and Herzegovina</i> <i>Turkey, Latvia, Indonesia</i> <i>United States, Austria, Ireland</i> <i>Netherlands, Malta, Sweden</i> <i>Cyprus, Singapore, Hungary</i> <i>Czech Republic, Croatia</i> <i>Argentina, Russia</i>
<b>Manufacture Name</b>	Character	The name of drug manufacturing company	-

<b>Manufacture Country</b>	Character	The country name of drug manufacturing company.	-
<b>Secondary package manufacture</b>	Character	The name of the manufacturing company of secondary packaging which is the exterior packaging of the primary packaging that assembles the packages and protects or labels the drug.	-
<b>Main Agent</b>	Character	The first agent of the drug.	-
<b>Second Agent</b>	Character	The second agent of the drug.	-
<b>Third Agent</b>	Character	The third agent of the drug.	-

## Appendix D: Tiryaq dataset

Figure (9.16) presents sample of the dataset that is used in Tiryaq system, to view the complete Tiryaq dataset visit this link: <https://www.dropbox.com/s/7b4594jiczt70vh/Tiryaq%20dataset.csv?dl=0>

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	ScientificName	TradeName	Strength	StrengthUnit	PharmaceuticalForm	UsageMethod	PackageTypes	LegalStatus	Publicprice	MarketingCompany	MarketingCountry			
2	TRETINOIN	ACRETIN	0.025	percent	Cream	Topical	Tube	Prescription	17.1	JAMJOOM PHARMACEUT	Saudi Arabia			
3	TRETINOIN	ACRETIN	0.05	percent	Cream	Topical	Tube	Prescription	17.65	JAMJOOM PHARMACEUT	Saudi Arabia			
4	XYLOMETAZOLINE HYDROCHLORIDE	XYLOMET Peadiatric	0.05	percent	Nasal drops	Nasal use	Bottle	OTC	7.45	RIYADH PHARMA	Saudi Arabia			
5	FLUTICASONE PROPIONATE	FLIXONASE AQUEOUS	0.05	percent	Nasal spray	Nasal use	Pressurised cont	OTC	26	GLAXO SAUDI ARABIA	Saudi Arabia			
6	ADAPALENE	WATENE	0.1	percent	Gel	Topical	Bottle	OTC	21.95	Jazeera Pharmaceutical I	Saudi Arabia			
7	KETOTIFEN	HISTOFEN SYRUP	0.2	milligram(s)/	Eye drops	Ocular use	Bottle	OTC	22.65	RIYADH PHARMA	Saudi Arabia			
8	BETAMETHASONE DIPROPIONATE, MICO BETAZOL		0.05	percent	Cream	Topical	Bottle	Prescription	13.6	JAMJOOM PHARMACEUT	Saudi Arabia			
9	CLOBETASOL PROPIONATE	DERMOVATE OINTMENT	0.05	percent	Ointment	Topical	Tube	Prescription	9.45	GLAXO SAUDI ARABIA	Saudi Arabia			
10	CETIRIZINE HYDROCHLORIDE	RIZINO	1	milligram(s)/	Syrup	Oral use	Bottle	OTC	6.6	BATTERJEE PHARMACETI	Saudi Arabia			
11	SODIUM BICARBONATE	SODIUM BICARBONATE	8.4	percent	Solution	Intravenous us	Bottle	Prescription	8.35	Pharmaceutical Solution	Saudi Arabia			
12	SODIUM BICARBONATE	BASIC BICARBONATE	8.125	percent	Solution	Intravenous us	Bag	Prescription	35.5	Pharmaceutical Solution	Saudi Arabia			
13	CLOBETASOL PROPIONATE	CLOBEDERM	0.05	percent	Cream	Topical	Tube	Prescription	7.55	RIYADH PHARMA	Saudi Arabia			
14	PHENYLEPHRINE HYDROCHLORIDE	Iphen	10	percent	Eye drops, solution	Ocular use	Single Dose Cont	OTC	22.95	JAMJOOM PHARMACEUT	Saudi Arabia			
15	BUDESONIDE, FORMOTEROL	BUFOMIX	160	microgram(s)	Inhalation powder	Inhalation use	Inhaler	Prescription	122.7	Jazeera Pharmaceutical I	Saudi Arabia			
16	NAPHAZOLINE HYDROCHLORIDE	RIAZOLIN	0.1	percent	Eye drops	Ophthalmic us	Dropper Containv	Prescription	11.6	RIYADH PHARMA	Saudi Arabia			
17	MOMETASONE FURATE	AVOCOM	0.1	percent	Ointment	Topical	Tube	Prescription	14.35	Middle East Pharmaceuti	Saudi Arabia			
18	MOMETASONE FURATE	AVOCOM	0.1	percent	Cream	Topical	Tube	Prescription	14.35	Middle East Pharmaceuti	Saudi Arabia			
19	PREDNISOLONE SODIUM PHOSPHATE	Zylone	0.1	percent	Syrup	Oral use	Bottle	Prescription	15	BATTERJEE PHARMACETI	Saudi Arabia			
20	CLOBETASOL PROPIONATE	DERMOVATE	0.05	percent	Scalp solution	Topical	Bottle	Prescription	17	GLAXO SAUDI ARABIA	Saudi Arabia			
21	CLOBETASOL PROPIONATE	DERMOVATE CREAM	0.05	percent	Cream	Topical	Tube	Prescription	9.45	GLAXO SAUDI ARABIA	Saudi Arabia			
22	GENTAMICIN	GENTACIN	0.3	percent	Ointment	Ophthalmic us	Bottle	Prescription	12	RIYADH PHARMA	Saudi Arabia			
23	GENTAMICIN	GENTACIN	0.3	percent	Ear/eye drops, soluti	Topical	Tube	Prescription	8.1	RIYADH PHARMA	Saudi Arabia			
24	PREDNISOLONE SODIUM PHOSPHATE	Zylone	0.3	percent	Syrup	Oral use	Bottle	Prescription	34	BATTERJEE PHARMACETI	Saudi Arabia			
25	ZINC OXIDE	CALMAR	10	percent	Cream	Topical	Tube	OTC	20.85	SPIMACO	Saudi Arabia			
26	IRON POLYMALTOSSE	FEROSE SYRUP	10	milligram(s)/	Syrup	Oral use	Bottle	OTC	14.35	SPIMACO	Saudi Arabia			
27	MINOXIDIL	HAIRGROW	5	percent	Solution	Topical	Bottle	OTC	59.05	DAR ALDAWA	Jordan			
28	FUSIDIC ACID	OPTIFUCIN EYE DROP	1	percent	Eye drops	Ophthalmic us	Dropper Containv	Prescription	11.25	Amman Pharmaceutical I	Jordan			
29	MINOXIDIL	HAIRGROW	2	percent	Solution	Topical	Bottle	OTC	52.7	DAR ALDAWA	Jordan			
30	ACICLOVIR	IMAVIR CREAM	5	percent	Cream	Topical	Tube	Prescription	12.65	Amman Pharmaceutical I	Jordan			
31	ACICLOVIR	IMAVIR CREAM	5	percent	Cream	Topical	Tube	Prescription	38	Amman Pharmaceutical I	Jordan			
32	DICLOFENAC SODIUM	DICLOFEN CREMOGEL	1	percent	Cream	Topical	Tube	OTC	7.8	UNITED PHARMACEUTIC	Jordan			
33	KETOTIFEN	Keta	0.025	percent	Eye drops	Ophthalmic us	Bottle	OTC	21.5	Amman Pharmaceutical I	Jordan			
34	LEVOCETIRIZINE DIHYDROCHLORIDE	LAYAL Syrup	0.5	milligram(s)/	Syrup	Oral use	Bottle	OTC	11.55	Jordan Sweden Medica	Jordan			
35	CEFDINIR	SEFARIX Powder	25	milligram(s)/	Powder for oral suspi	Oral use	Bottle	Prescription	41.85	Pharma International Co.	Jordan			
36	CEFDINIR	SEFARIX Powder	25	milligram(s)/	Powder for oral susp	Oral use	Bottle	Prescription	65.3	Pharma International Co.	Jordan			
37	OFLOXACIN	EYLOX EYE DROPS	0.3	percent	Eye drops	Ophthalmic us	Dropper Containv	Prescription	13.15	Amman Pharmaceutical I	Jordan			
38	CEFACLOR	FORTICEF POWDER	25	milligram(s)/	Powder for suspensic	Oral use	Bottle	Prescription	13.2	Ram Pharmaceutical Ind	Jordan			
39	CEFACLOR	FORTICEF POWDER	50	milligram(s)/	Powder for suspensic	Oral use	Bottle	Prescription	22.3	Ram Pharmaceutical Ind	Jordan			
40	VALPROATE SODIUM	EPIVAL SYRUP	40	milligram(s)/	Syrup	Oral use	Bottle	Prescription	7.5	UNITED PHARMACEUTIC	Jordan			
41	TIMOLOL MALEATE	APIMOL EYE DROPS	0.5	percent	Eye drops	Ophthalmic us	Dropper Containv	Prescription	9.95	Amman Pharmaceutical I	Jordan			
42	TIMOLOL MALEATE	APIMOL EYE DROPS	0.25	percent	Eye drops	Ophthalmic us	Dropper Containv	Prescription	9.15	Amman Pharmaceutical I	Jordan			
43	GENTAMICIN	APIGEN EYE OINTMENT	0.3	percent	Eye ointment	Topical	Tube	Prescription	3.25	Amman Pharmaceutical I	Jordan			
44	GENTAMICIN	APIGEN EYE DROPS	0.3	percent	Ear/eye drops, soluti	Ophthalmic us	Dropper Containv	Prescription	3.4	Amman Pharmaceutical I	Jordan			
45	XYLOMETAZOLINE HYDROCHLORIDE	DECOCAL NASAL SPRAY	0.1	percent	Spray	Nasal use	Nasal Applicator	Prescription	7.55	Amman Pharmaceutical I	Jordan			
46	XYLOMETAZOLINE HYDROCHLORIDE	DECOCAL NASAL DROPS	0.1	percent	Nasal drops	Nasal use	Dropper Containv	OTC	5.6	Amman Pharmaceutical I	Jordan			
47	XYLOMETAZOLINE HYDROCHLORIDE	DECOCAL NASAL DROPS	0.05	percent	Nasal drops	Nasal use	Dropper Containv	OTC	5.5	Amman Pharmaceutical I	Jordan			
48	CEFURXOME AXETIL	CEFUREX POWDER	50	milligram(s)/	Powder for suspensic	Oral use	Bottle	Prescription	27.45	Middle East Pharmaceuti	Jordan			
49	CEFURXOME AXETIL	CEFUREX POWDER	25	milligram(s)/	Powder for suspensic	Oral use	Bottle	Prescription	18.5	Middle East Pharmaceuti	Jordan			
50	FUSIDIC ACID	DERMOFUCIN OINTMENT	2	percent	Ointment	Topical	Tube	Prescription	5.95	Amman Pharmaceutical I	Jordan			
51	SIMETHICONE	DEFLAT ORAL DROPS	40	milligram(s)/	Drops	Oral use	Dropper Containv	OTC	11.4	HAYAT PHARMACEUTICA	Jordan			
52	CEFACLOR	MEDACEF	500	milligram(s)	Capsule, hard	Oral use	Blister	Prescription	48.95	MEDPHARMA PHARMACI	United Arab Emirates			
53	CEFACLOR	MEDACEF	250	milligram(s)	Capsule, hard	Oral use	Blister	Prescription	28.2	MEDPHARMA PHARMACI	United Arab Emirates			

Figure 9.16 Tiryaq dataset

## Appendix E: UAT

This part provides the questions of the user acceptance testing questionnaire, and the responses of the questionnaire in form of charts.

### a. UAT Questions

1. I think that I would like to use this system frequently.
2. I found the system unnecessarily complex.
3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use this system.
5. I found the various functions in this system were well integrated.
6. I thought there was too much inconsistency in this system.
7. I would imagine that most people would learn to use this system very quickly.
8. I found the system very cumbersome to use.
9. I felt very confident using the system.
10. I needed to learn a lot of things before I could get going with this system.

### b. UAT Questionnaire charts

1- I think that I would like to use this system frequently.

20 responses

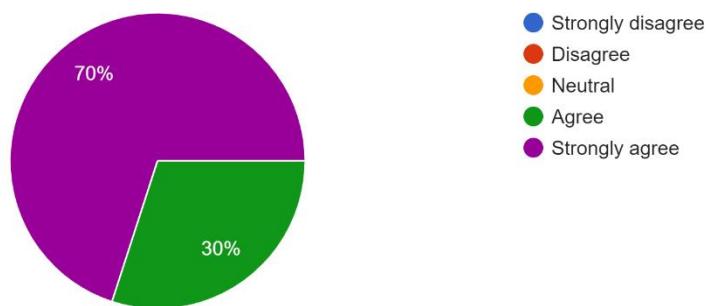


Figure 9.17 UAT-System frequency usage

2- I found the system unnecessarily complex.

20 responses

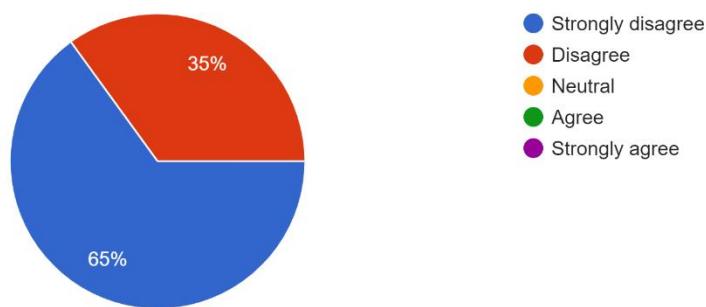


Figure 9.18 UAT- System complexity

3- I thought the system was easy to use.

20 responses

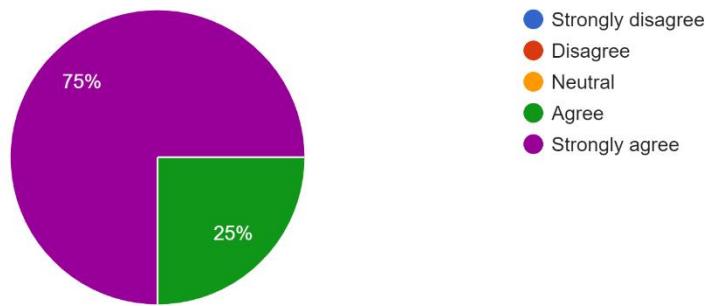


Figure 9.19 UAT-System ease of use

4- I think that I would need the support of a technical person to be able to use this system.

20 responses

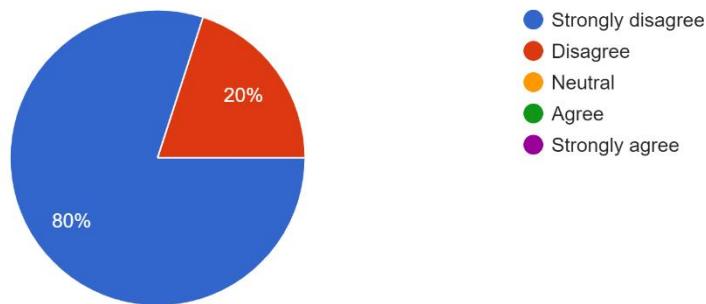


Figure 9.20 UAT-Technical support

5- I found the various functions in this system were well integrated.

20 responses

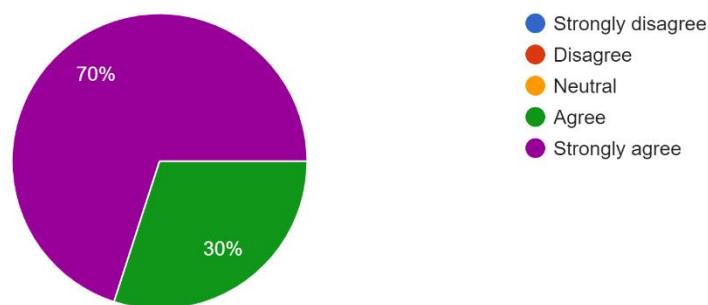


Figure 9.21 UAT-System integration

6- I thought there was too much inconsistency in this system.

20 responses

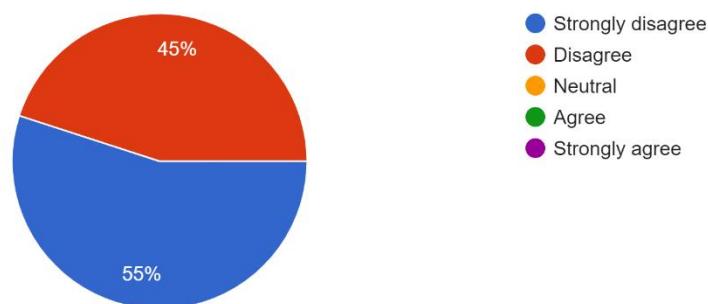


Figure 9.22 UAT-System consistency

7- I would imagine that most people would learn to use this system very quickly.

20 responses

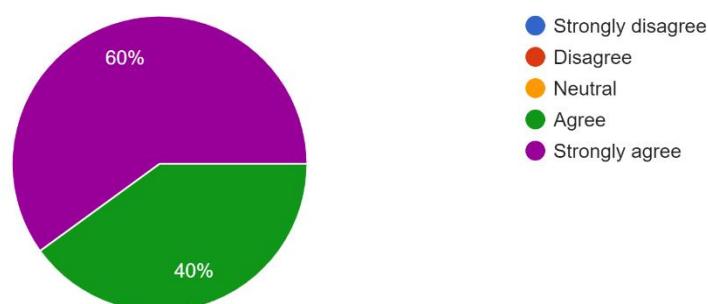


Figure 9.23 UAT-System learnability time

8- I found the system very cumbersome to use.

20 responses

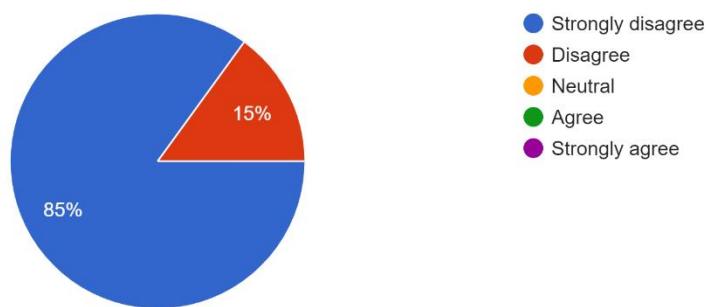


Figure 9.24 UAT- Cumbersomeness of the system

9- I felt very confident using the system.

20 responses

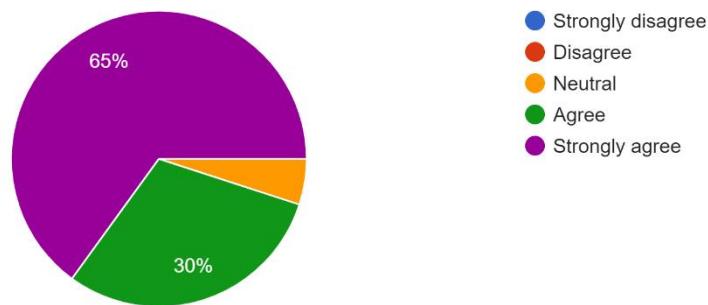


Figure 9.25 UAT- Confidence of system usage

10- I needed to learn a lot of things before I could get going with this system.

20 responses

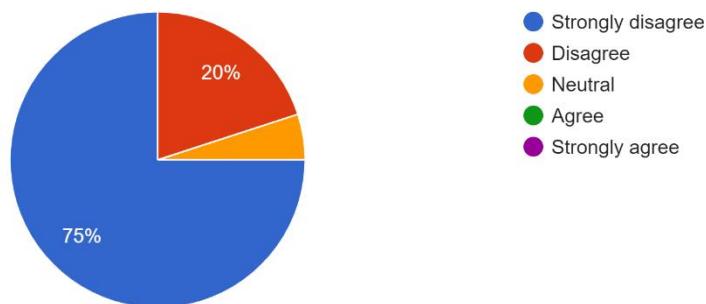


Figure 9.26 UAT-Learnability