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Design And Implementation Of a Mobile Application For Healthcare System

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ALI

ملخص

أثـــار ظهـــور الأجهـــزة المحمولـــة موجـــة تحوليـــة عـــبر عـــدد لا يحصى مـــن الصـــناعات، وتقـــف الرعايـــة الصـــحية في طليعـــة هـــذه الثـــورة. بفضـــل قـــوة تطبيقـــات الهـــاتف المحمـــول، يمكـــن لمتخصصي الرعايـــة الصـــحية الوصـــول إلى المعلومـــات الهامـــة وإجـــراء الاستشـــارات عـــن بُعـــد ومراقبـــة صـــحة المـــرضى وتبســـيط المهـــام الإداريـــة. يقـــدم تطبيقنـــا مجموعـــة شـــاملة مـــن الخـــدمات، ممـــا يتـــيح للمســـتخدمين جدولـــة المواعيـــد والوصـــول إلى الســـجلات الطبيـــة والتشـــاور مـــع المتخصصـــين في الرعايـــة الصـــحية عـــن بُعـــد. عـــلاوة عـــلى ذلـــك، يعـــزز تطبيقنـــا التواصـــل بـــين المـــرضى ومقـــدمي الرعايـــة والمتخصصـــين في الرعايـــة الصـــحية، ممـــا يســـهل اتبـــاع نهـــج تعـــاوني ومنســـق للرعايـــة. تتعمـــق هـــذه الأطروحـــة في تعقيـــدات تصـــميم و تنفيـــذ تطبيقنـــا، مـــع التركـــيز عـــلى تطـــوير واجهـــة آمنـــة و ســـهلة الاســـتخدام. بالإضـــافة إلى ذلـــك، نستكشـــف تكامـــل خـــدمات الرعايـــة الصـــحية المتنوعـــة مثـــل حجـــز المواعيـــد والتواصـــل مـــع المتخصصـــين في الرعايـــة الصـــحية والمزيـــد مـــن خـــلال التقيـــيم الـــدقيق، نقـــوم بتقيـــيم فعاليـــة تطبيقنـــا في تحســـين نتـــائج المـــرضى وتقليـــل تكـــاليف الرعايـــة الصـــحية.

الكلمات المفتاحية : تطوير تطبيقات الهاتف المحمول، التطبيب عن بعد، صناعة الرعاية الصحية نمذجة UML ، DoctoriDZ ،Firebase ،Dart، الجزائر، واجهات المستخدم .

Abstract

The advent of mobile devices has sparked a transformative wave across countless industries, and healthcare stands at the forefront of this revolution. With the power of mobile applications, healthcare professionals can access critical information, conduct remote consultations, monitor patient health, and streamline administrative tasks. Our application offers a comprehensive range of services, enabling users to schedule appointments, access medical records, and consult with healthcare professionals remotely. Moreover, our application fosters communication among patients, caregivers, and healthcare professionals, facilitating a collaborative and coordinated approach to care.This thesis delves into the intricacies of designing and implementing our application, emphasizing the development of a secure and user-friendly interface. Additionally, we explore the integration of diverse healthcare services such as appointment booking, communicating with healthcare professionals, and more. Through rigorous evaluation, we assess the efficacy of our application in enhancing patient outcomes and reducing healthcare costs.

Keywords

Mobile applications development, telemedicine, healthcare industry, UML modeling, DoctoriDz, Firebase, Dart, Algeria, user interfaces.

Résumé

L'avènement des appareils mobiles a déclenché une vague de transformation dans d'innombrables secteurs, et les soins de santé sont à l'avant-garde de cette révolution. Grâce à la puissance des applications mobiles, les professionnels de la santé peuvent accéder à des informations critiques, effectuer des consultations à distance, surveiller la santé des patients et rationaliser les tâches administratives. Notre application offre une gamme complète de services, permettant aux utilisateurs de planifier des rendez-vous, d'accéder à des dossiers médicaux et de consulter des professionnels de la santé à distance. De plus, notre application favorise la communication entre les patients, les soignants et les professionnels de la santé, facilitant une approche collaborative et coordonnée des soins. Cette thèse plonge dans les subtilités de la conception et de la mise en œuvre de notre application, en mettant l'accent sur le développement d'une interface sécurisée et conviviale. De plus, nous explorons l'intégration de divers services de santé tels que la prise de rendez-vous, la communication avec les professionnels de la santé, etc. Grâce à une évaluation rigoureuse, nous évaluons l'efficacité de notre application pour améliorer les résultats des patients et réduire les coûts des soins de santé.

Mots clés

Développement d'applications mobiles, télémédecine, industrie de la santé, modélisation UML, DoctoriDz, Firebase, Dart, L'Algérie, interfaces utilisateur.

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List of Abbreviations

AI Artificial Intelligence. 19

AR Augmented Reality. 19

ATA American Telemedicine Association. 7

GPS Global Positioning System. 1

HDD Health Data Directory. 27

HTML Hypertext Markup Language. 14

ICT Information and Communication Technology. 1

IDE Integrated Development Environment. 45

IMMAR Institut Méditerranéen de Médecine Aérospatiale et de Réadaptation. 26

IoT Internet of Things. 19

ML Machine Learning. 19

NIH National Institutes of Health. 21

QR Quick Response. 14

UML Unified Modeling Languag. 1

VR Virtual Reality. 19

WHO World Health Organisation. 1

Introduction

Mobile computing has rapidly evolved in software development, driven by advancements in mobile devices and operating systems. These advancements have made mobile applications an integral part of our daily lives, replacing traditional activities with a wide range of applications leveraging various capabilities like the Internet, gestures, Global Positioning System (GPS), accelerometer, video, and audio. This popularity is attributed to the efforts of major industry players like Google, apple, and Microsoft, who have played a significant role in promoting their products.

Since 2005, the World Health Organisation World Health Organisation (WHO) has stressed the importance of developing healthcare infrastructure in information and communication technology Information and Communication Technology (ICT) for equal, affordable, and universal access to healthcare. This collaboration aims to reduce costs and successfully implement eHealth, which can provide significant support for rehabilitation. Unfortunately, in Algeria, this notable advance introduced in medicine by technology is struggling to be felt, hence until today, the way of managing manually is still dominant. For this, we propose, through our end-of-cycle project, presented in this thesis, which consists of the design and realization of a Healthcare medical platform.

The main goal of this project is to develop a secure and reliable m-healthcare application that caters to different healthcare communities. To achieve this, we have organized this thesis as follows:

- The first chapter presents an overview of key concepts in healthcare, including the healthcare industry, mobile application development, and telemedicine.
- The second chapter will be devoted to the design of our platform using the Unified Modeling Languag (UML) and the UP process.
- The third chapter concerns the implementation and realization of our platform according to the design made and also on its presentation.

Chapter I

Fundamentals And Principles

I.1 Introduction

The healthcare industry is a vital network of organizations and professionals dedicated to delivering essential medical care and services to individuals and communities. It serves as a cornerstone of societal well-being and plays a crucial role in preserving public health. This expansive industry includes hospitals, clinics, insurance companies, and government agencies, offering a wide range of services from preventive care to rehabilitation. Additionally, it serves as a significant source of employment worldwide, contributing to global GDP through substantial healthcare expenditures.

However, the healthcare industry faces numerous challenges, including rising costs, aging populations, and increasing demand for high-quality care. Overcoming these obstacles necessitates a comprehensive understanding of the industry's fundamentals and principles.

In this chapter, we embark on a journey to explore these fundamental concepts and principles. We commence by providing a comprehensive overview of the healthcare industry and elucidate its profound significance in our society. Gaining insights into the intricacies of the healthcare landscape is paramount for comprehending the context in which our research endeavors take shape. By delving into the fundamental elements that underpin the healthcare industry, we lay the groundwork for our subsequent investigations and contribute to a more comprehensive understanding of this vital sector.

I.2 Healthcare Industry

I.2.1 Overview Of The Healthcare Industry

According to the World Health Organization (WHO) as cited in [Wornd], the healthcare industry encompasses a range of activities aimed at promoting and maintaining health. These activities include medical services, education, social policies, and environmental factors. The industry plays a crucial role in preventing and treating diseases, improving the quality of life, and reducing mortality rates. Its components include hospitals, clinics, research institutions, and government agencies. However, in low- and middle-income countries, the industry faces challenges related to limited access to healthcare services due to increasing demand, costs, and shortages of skilled workers.

To tackle these challenges, the WHO advocates for universal health coverage, which seeks to ensure that all individuals and communities have access to essential healthcare services without

experiencing financial difficulties. This involves promoting equitable access to medical services, medications, and vaccines, as well as investing in research and innovation to enhance the quality and efficiency of healthcare delivery.

In conclusion, as defined by the WHO, the healthcare industry is a vital aspect of global public health infrastructure. Its organizations and professionals work towards the promotion and maintenance of health, disease prevention and treatment, and overall improvement of quality of life for individuals and communities. Nonetheless, the industry faces significant challenges that necessitate ongoing investment and innovation to address them effectively.

I.2.2 Healthcare Definition

According to the World Health Organization (WHO), healthcare is defined as "the prevention, treatment, and management of illness and the preservation of mental and physical well-being through the services offered by the medical, nursing, and allied health professions." This definition emphasizes the importance of not only treating illness, but also promoting and maintaining health and well-being through preventive measures and health education. The WHO also emphasizes the importance of universal access to healthcare as a fundamental human right.[Org]

I.2.3 Categories Of Healthcare

As stated by [Hea22], healthcare can be divided into three levels:

I.2.3.1 Primary Care

This level of care (see Figure I.1) includes routine medical care for common health issues, preventive care, and health education. Primary care providers may include family physicians, pediatricians, and general practitioners.

Figure I.1: Primary healthcare [Hea22]

I.2.3.2 Secondary Care

As shown in (Figure I.2) secondary care level includes specialized medical care that is typically provided in a hospital setting. It may include services such as emergency care, inpatient care, and specialized medical procedures.

Figure I.2: Secondary healthcare [Hea22]

I.2.3.3 Tertiary Care

This level of care includes highly specialized medical care that is often provided in a large medical center or academic hospital. It may include services such as transplant surgery, cancer treatment, and advanced diagnostic testing.

I.2.4 Healthcare Delivery

Healthcare delivery refers to the process of providing medical services to patients. This process can include various steps such as diagnosis, treatment, and follow-up care, and involves a wide range of healthcare professionals including doctors, nurses, and administrative staff. Effective healthcare delivery requires coordination and collaboration among these different stakeholders to ensure that patients receive timely, high-quality care that meets their needs.[Lib13]

Healthcare delivery is the most prominent aspect of the healthcare system and is visible to both patients and the general public. Its focus is on the flow of patients, as well as the organization and provision of all services related to the diagnosis and treatment of disease, as well as the promotion, maintenance, and restoration of health. Healthcare delivery encompasses primary care, specialized care (often divided into secondary and tertiary care), urgent and emergency care, pharmaceutical care, rehabilitation/intermediate care, long-term care, services for informal caregivers, palliative care, mental health care, dental care, and other important areas of service provision.[Eur]

I.2.5 EHealth

eHealth is described as "an emerging field at the nexus of medical informatics, public health, and business, referring to health services and information supplied or enhanced through the Internet and related technologies." The [Eys+01] also points out that eHealth encompasses a wide range of services and applications, including telemedicine, health information websites, online support groups, health-related mobile applications, and electronic health records, among others.

eHealth has the potential to transform healthcare delivery by improving access, quality, and efficiency of care, as well as empowering patients to take an active role in their own health management.

This term started to applicationear in 1999 in the industry and marketing sector in order to group under a common term the new possibilities offered by the Internet in the field of healthcare.

Over time, the definition has evolved, so that in 2005 a systematic review highlighted the existence of at least fifty different definitions of e-health.[Eys+01]

I.2.6 Telemedicine

The term "telemedicine" refers to medical procedures made possible or aided by telecommunications. It is a branch of medicine carried out by technology that enables the provision of remote medical care and the sharing of pertinent medical data.

I.2.6.1 History

According to [Assnd] The concept of telemedicine dates back to the invention of the telephone in the late 19th century. However, it wasn't until the development of radio and television technology in the mid-20th century that telemedicine started to become a reality. The first telemedicine experiments involved the transmission of radiographic images and electrocardiograms (ECGs) over long distances. In the 1960s and 1970s, telemedicine applications expanded to include two-way audio and video communication. In the 1980s and 1990s, advancements in technology and the growth of the internet led to the development of new telemedicine applications, including remote consultations and remote monitoring of patients. Today, telemedicine is increasingly used to provide healthcare services to remote and underserved areas, as well as to improve the efficiency and accessibility of healthcare delivery.

In accordance with American Telemedicine Association (ATA), the first telemedicine demonstration took place on November 8, 1994, and it involved a tele-radiology exam that was conducted between Hôtel-Dieu in Montreal, Canada and Hôpital Cochin in Paris, France. This groundbreaking demonstration was carried out by the French Space Agency and the Canadian Space Agency using satellite technology.[Assce]

I.2.6.2 Definition

The World Health Organization (WHO) [Org10] defines telemedicine as "the delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing educa-

tion of health care providers, all in the interests of advancing the health of individuals and their communities". This definition highlights the importance of using technology to deliver healthcare services remotely and improve access to care, especially in areas where distance is a major barrier to healthcare delivery.

Jeff Bauer, a health economist and futurist, provides a comprehensive and simple definition of telemedicine, which is considered definitive. He states that "Telemedicine is the practice of medicine at a distance. At any distance."[Cin17]

I.2.6.3 Telemedicine Applications

The field of digital health, encompassing e-Health and telehealth, provides new opportunities for access to care, organization of healthcare, professional practices, and training of healthcare professionals. Telehealth applications are varied, ranging from medical teleconsultations to informative telemedicine which deals with the dissemination of medical knowledge and protocols for patient care. Telemedicine is the deployment of ICT in the medical sector, mediating medical acts by introducing communication tools between physicians or between a physician and a patient. Although it does not replace face-to-face interaction, it adds to the physician's toolkit for the benefit of the patient. Telemedicine challenges part of medical practice but represents a considerable stake in improving the living conditions of many people. The three main strengths characterizing telemedicine are that it is practiced remotely, involves the use of ICT, and integrates a medical professional (physician, nurse, or caregiver).
Based on [Org10], here are some examples of telemedicine applications:

1. **Medical Telemonitoring**
   This application involves remotely monitoring a patient's health status using various technologies, such as sensors and wearables. Telemonitoring can be used for various conditions, such as diabetes, cardiovascular disease, and respiratory disease like shown in (Figure I.3).

Figure I.3: Woman checking glucose level with a remote sensor and mobile phone[Uns]

2. **Teleconsultation**
   This application involves consulting with a healthcare provider remotely through videoconferencing or other means. Teleconsultation can be used for various medical specialties, such as radiology, psychiatry, and dermatology.

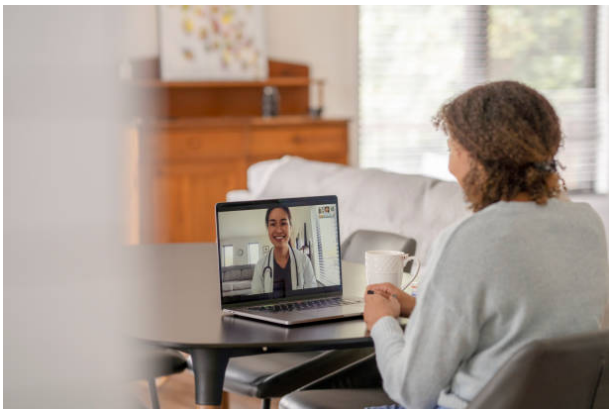

Figure I.4: Tele-consultation [Uns]

3. **Telepathology**
   Telepathology is a digital application that utilizes digital photographs of tissue samples or slides to diagnose and treat various diseases. The technology has the potential to revolutionize the field of pathology, allowing for faster and more accurate diagnoses, particularly in remote or underserved areas.

Figure I.5: Telepathology [Uns]

4. **Teledermatology**
   This application involves diagnosing and treating skin conditions using digital images, such as photographs. Teledermatology can be used for various conditions, such as acne, eczema, and psoriasis.

Figure I.6: Teledermatology [Uns]

5. **Telepsychiatry**
   In this application, mental health treatments are delivered remotely, for example, through videoconferencing or online counseling like in (Figure I.7). Depression, anxiety, and substance misuse are just a few of the diseases that can be treated using telepsychiatry.

Figure I.7: Telepsychiatry [Uns]

6. **Teleradiology**
   In this application, diseases are identified and treated utilizing digitized pictures from X-rays, CT scans, and MRI scans. Several specialities, including cardiology, neurology, and orthopedics, can benefit from teleradiology.

Figure I.8: Teleradiology [Uns]

7. **Telestroke**
   Using videoconferencing with a professional, this application entails diagnosing and treating strokes remotely. For stroke patients in isolated or underserved areas, telestroke can help assure prompt and efficient treatment.(See Figure I.9.

Figure I.9: Telestroke [Uns]

I.2.7 M-Health: Mobile Health

I.2.7.1 Definition

The term "Mobile Health" refers to the integration of health practices and mobile technology, particularly smartphones. It is characterized as the implementation of medical and public health practices with the assistance of mobile devices, such as patient monitoring devices, wireless devices, and mobile phones.[SNBF13] whereas, two decades ago, it has been defined as wireless telemedicine involving the use of mobile telecommunications and multimedia technologies and their integration with mobile healthcare delivery systems[AMM03].As a result, it can include a wide range of individuals and things, as well as the processes that link them. Information sharing is at the heart of these relationships. Although pharmaceuticals, medical personnel, and equipment cannot be physically transported between places, mobile technologies can transport and process information in a variety of formats, including text, photos, audio, video, and coded data.

I.2.7.2 Applications And Services

The United Nations Foundation[Uniar] has established the definition of M-Health, which refers to mobile health applications, and has categorized them as follows:

- applications for educating and raising awareness.
- applications for providing remote assistance.
- applications for supporting diagnosis and treatment

- applications for facilitating communication and training for healthcare professionals.
- applications for tracking diseases and epidemics.
- applications for remotely monitoring and collecting health data

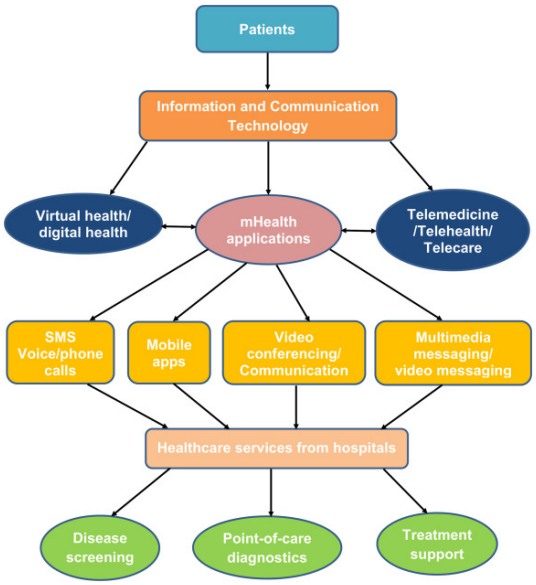

Figure I.10: M-health applications[Alj+21]

I.3 Basics On Mobile Application Development

I.3.1 Definition Of Mobile Applications

Mobile applications are software programs designed specifically for use on mobile devices such as smartphones, tablets, or some computers that work with a Windows Phone or Chrome OS operating system. These applications can be downloaded and installed directly onto a mobile device, typically from an application store or other distribution platform such as Google Play, applicationle application Store, or Microsoft Store, for free or for a fee. The ease with which they offer customers a variety of services, such as games, social networking, productivity tools, and many other kinds of content, makes mobile applications quite popular. They have become an essential part of our daily lives, providing us with quick and easy access to information and services whenever and wherever we need them. [PLB13]

Mobile applications have the ability to integrate specialized features for users due to the hard-

ware features found in mobile devices like cameras, GPS, and gyroscopes. This enhances the functional capabilities of the applications and allows for novel uses, including geolocation, Quick Response (QR) code scanning, augmented reality, and mobile commerce, which were previously not possible with information systems.

I.3.2 Types Of Mobile Applications

When it comes to technology, consumers may come across three distinct categories of mobile applications [Zer16] :

→ **Native Applications**
A native application is a mobile application that is specifically developed for a mobile operating system. It is designed using the language and tools associated with its operating system, and installed directly on the mobile device. This installation can be done through a download from the internet or through deployment from a computer connected to the mobile device. Testing the behavior of these applications requires specific technical skills and expensive devices.

→ **Web Applications**
A web mobile application is an application developed in Hypertext Markup Language (HTML), accessible and executable through an internet browser for mobile phones. It uses the smartphone's browser and does not necessarily require the application to be downloaded. Web mobile applications complement native applications that are specifically developed for an operating system and must be downloaded and installed by mobile users. Therefore, they are aimed at all mobile users, rather than a specific population using a particular brand. However, web applications must be tested for each browser, resolution, and screen size, similar to any website.

→ **Hybrid Applications**
A hybrid application is a mobile application that combines HTML5 elements in the form of a web mobile application with elements of a native application, allowing the use of native smartphone features and distribution as an application on mobile system stores.

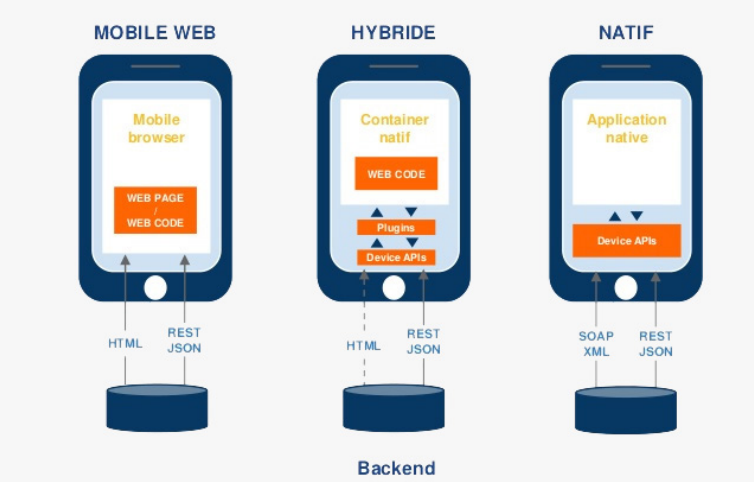

Figure I.11: The types of mobile applications [Tecbl]

I.3.3 Advantages, Disadvantages And Challenges Of Mobile Application Evolution

The evolution of mobile applications brings forth various advantages, disadvantages, and challenges [PD+18]. Let's explore them in detail:

I.3.3.1 Advantages

Mobile applications offer several benefits, contributing to their widespread popularity among users:

- **Enhanced User Experience:**
  Mobile applications provide better ergonomics than mobile websites, leading to improved user satisfaction and loyalty.
- **Optimal Performance:**
  Development processes for mobile applications consider factors like smartphone size and loading times, resulting in a more refined user experience.
- **Integration With Phone Features:**
  Mobile applications can seamlessly integrate with phone features such as cameras, GPS, and sensors, enhancing their functionality.
- **Offline Access:**

Unlike websites, mobile applications can function without requiring constant internet connectivity, providing convenience to users.

- **Discoverability:**
  Mobile applications are easily discoverable on application stores, increasing their visibility and attracting potential users.

- **Engagement:**
  Mobile applications often incorporate push notifications, attracting younger users and keeping them engaged with ongoing events.

I.3.3.2 Disadvantages

While mobile applications offer numerous advantages, they also come with certain drawbacks:

- **Platform Compliance:**
  Developing mobile applications requires adherence to standards and rules set by platform companies like apple, Google, and Windows, adding complexity to the development process.

- **Development Costs:**
  Creating mobile applications suitable for each operating system requires a significant investment compared to developing a mobile website.

- **Update Process:**
  Updating a mobile application requires users to download updates from the respective application store, whereas mobile websites update automatically.

I.3.3.3 Challenges

Mobile applications face several challenges that developers need to address in order to create successful and user-friendly applications:

- **Application Visibility:**
  Making an application stand out and gain visibility among the vast number of available applications is a significant challenge. If an application does not rank among the top applications within its category, it may struggle to attract downloads and user attention.

- **Platform Capability And Limitations:**
  Mobile applications must contend with platform-specific capabilities and limitations, which can present obstacles to their development and functionality. Some key challenges include:
  - **Small Screen Size:**
    Mobile platforms often feature smaller screens, making it challenging to display content, including text and graphics, with the same clarity and readability as on desktop computers.
  - **Lack Of Multiple Windows:**
    Unlike desktop computers, mobile platforms typically do not support multiple windows or simultaneous multitasking, posing limitations on how information and tasks can be presented to users.
  - **Navigation:**
    Mobile devices typically lack mouse-like pointers, making navigation less flexible and potentially more challenging for users.
  - **Limited File Format Support:**
    Mobile platforms may have restrictions on the types of file formats that can be accessed or opened, potentially limiting the range of content that can be displayed within the applications.
  - **Speed And Connectivity:**
    Mobile platforms may have slower processing speeds and network connectivity compared to desktop computers, affecting applications performance and responsiveness.
  - **Message And Email Size Limitations:**
    Many mobile devices impose limitations on the number of characters or file sizes allowed in messages or emails, which can impact communication and data exchange within the application.
  - **Cost:**
    The cost associated with cellphones, mobile applications, and internet connectivity can be high, potentially posing a barrier for users who are budget-conscious.

I.3.4 Mobile Platforms

A mobile platform (or operating system) consists in the software responsible for controlling and supporting a mobile device.
Next, a brief description of the three major mobile platforms (Android, iOS and Windows Phone).

1. **Android System**

   Android is an open-source operating system developed by Android Inc., a startup acquired by Google in 2007. Based on a Linux kernel, the system was first designed for smartphones and touchscreen tablets, then diversified into connected objects and computers such as TVs, cars, computers, and smartwatches. Android was designed to integrate existing Google applications such as the Gmail email service, Google Maps mapping service, and YouTube, Google Talk, and Google Calendar. In 2015, Android is the most widely used operating system in the world with over 80 percent market share in smartphones.[Fra]

2. **IOS System**

   iOS, formerly known as iPhone OS, is a mobile operating system developed by Apple and derived from Mac OS X. Initially introduced in 2007 exclusively for the iPhone, iOS has subsequently been extended to other Apple devices like the iPod Touch and iPad. Its advent brought a revolutionary change to the mobile devices market by providing users with a distinctive and superior user experience along with high-quality applications. The most recent version of iOS is iOS 8, which was launched in September 2014. As a proprietary operating system, iOS is closed source and limited to Apple devices only.

   iOS applications are primarily written in Objective-C and can be obtained from the App Store, Apple's application marketplace housing an extensive collection of over 550,000 apps.[RS14]

3. **Windows Phone**

   Developed by Microsoft for smartphones and Pocket PCs, Windows Phone succeeded Windows Mobile by offering additional basic applications such as email, internet, chat, and multimedia, as well as social media features such as Facebook and Twitter.[Rou13]

Moreover, a comparison among these platforms is presented in Table I.1.

Vendor	**Platform**	**Programming Language**	**Development Environment**	**Application Store**
Google and Open Handset Alliance	Android	Java	Eclipse/Android Studio/IntelliJ IDEA	Google Play
Apple	iOS	Objective-C/Swift	Xcode	App Store
Microsoft	Windows Phone	C#/C++	Visual Studio	Windows Phone Store

Table I.1: Comparison Between The Three Major Mobile Platforms.[RS14]

I.3.5 Emerging Trends In Mobile Application Development

Mobile application development is a dynamic field that continuously evolves to adapt to technological advancements and changing user demands. Here are a few emerging trends in mobile application development [Buind]:

1. **Internet Of Things (IoT) Integration**
   The rise of Internet of Things (IoT) alongside mobile penetration has opened up endless opportunities. Mobile applications play a crucial role in IoT, exemplified by smart home technology. These applications enable remote control of thermostats, door locks, security systems, and even household appliances.[Buind]

2. **Artificial Intelligence And Machine Learning**
   Artificial Intelligence (AI) and Machine Learning (ML) have made significant inroads in mobile application development. While virtual assistants like Siri or Alexa are commonly associated with AI, their application extends far beyond that in application development. By leveraging AI, mobile applications can become smarter and enhance performance across all levels. From backend development to frontend user experience, AI will revolutionize application construction in 2023.[Buind]

3. **Augmented Reality And Virtual Reality**
   Augmented Reality (AR) and Virtual Reality (VR) technologies are transforming the way users interact with mobile applications. In 2023, the upward trend of augmented reality (AR) is set to continue, with mobile applications utilizing AR features for various purposes. While Pokemon Go popularized AR in mobile gaming, its applications have expanded beyond

gaming to more practical use cases. A notable example is L'Oreal Paris' Style My Hair applications, which employs AR technology.[Buind]

4. **Progressive Web Applications (PWAs)**
   PWAs combine the best of web and native applications. They are web-based applications that can be accessed through a browser but offer native-like functionalities and offline capabilities. PWAs provide a seamless user experience across different devices and platforms, eliminating the need for separate application installations.[Buind]

5. **Instant Applications**
   Instant applications enable users to experience an application's functionality without installing the complete application. Users can access specific application features directly from a web link, enhancing convenience and reducing storage space requirements.[Buind]

6. **Cloud-based applications**
   Cloud technology allows applications to store and access data on remote servers, reducing device storage requirements and enabling real-time collaboration across multiple devices.[Buind]

7. **Blockchain Integration**
   Blockchain technology is being explored in mobile application development for decentralized and secure transactions, identity verification, supply chain management, and data integrity.[Buind]

8. **Predictive Analytics**
   Another significant trend in the mobile application development industry is the integration of predictive analytics. This applicationroach utilizes technologies like machine learning, AI, data mining, and modeling to forecast future events based on data analysis. Tech giants, including Netflix, have long utilized predictive analytics. For instance, Netflix suggests TV shows and movies to users based on their previous viewing habits.[Buind]

By incorporating these emerging trends in mobile application development, developers can create innovative and engaging experiences for users while keeping up with the evolving landscape of mobile technology.

I.3.6 The Role Of Mobile Applications In Healthcare

Mobile applications are becoming increasingly popular in the healthcare sector due to their potential to improve patient engagement, increase efficiency, and contribute to better health outcomes. applications can provide patients with easy access to health information and tracking tools, as well as communication channels with healthcare providers. They can also streamline administrative processes for healthcare providers, enabling them to deliver care more efficiently.

According to the National Institutes of Health (NIH), mobile health technology has the potential to transform healthcare by facilitating patient-centered care, improving access to healthcare resources, and empowering patients to take a more active role in managing their health. However, it is important to ensure that mobile health applications are evidence-based and that they adhere to established privacy and security standards.[Nat]

In summary, mobile applications are playing an increasingly important role in healthcare, and their potential benefits are being recognized by reputable organizations such as the NIH. However, it is important to carefully evaluate and select applications that are evidence-based and prioritize patient privacy and security.

I.4 Telemedicine In Algeria

I.4.1 Current Status Of Telemedicine In Algeria

Algeria's healthcare system is a mix of public and private sectors, with the public sector playing a dominant role in the provision of healthcare services. The Ministry of Health, Population, and Hospital Reform is responsible for the regulation and provision of healthcare services in Algeria.[Bra22]

The healthcare system in Algeria is divided into three levels: primary healthcare, secondary healthcare, and tertiary healthcare. Primary healthcare is provided by community health centers, while secondary healthcare is provided by general hospitals, and tertiary healthcare is provided by university hospitals. The article notes that there is a shortage of healthcare facilities in some regions of the country, particularly in rural areas.[Bra22]

Unfortunately, Algeria's healthcare system faces several challenges, including a shortage of medical personnel, inadequate funding, and poor management of healthcare services.

I.4.2 Challenges and Barriers In Telemedicine Implementation

Based on [Sar+17], some of the challenges facing the Algerian healthcare system include:

1. **Limited Infrastructure And Resources:** The healthcare infrastructure in Algeria is limited, particularly in rural areas. This makes it difficult to implement and maintain telemedicine and e-health technologies.

2. **Limited Availability Of Trained Personnel:** There is a shortage of trained personnel, particularly in specialized medical fields. This limits the ability of the healthcare system to provide quality care and hinders the adoption of new technologies.

3. **Limited Funding:** The healthcare system in Algeria is underfunded, which limits the resources available for investment in new technologies and infrastructure.

4. **Limited Awareness And Adoption Of New Technologies:** Many healthcare professionals in Algeria are not familiar with telemedicine and e-health technologies and are hesitant to adopt them. This creates a barrier to the widespread adoption and use of these technologies.

5. **Regulatory And Legal Challenges:** The legal and regulatory framework in Algeria is not fully developed to support the implementation of telemedicine and e-health technologies. This creates uncertainties and challenges for healthcare providers and patients alike.

I.4.3 Successful Telemedecine Mobile Applications

1. **Tabibe Mobile Application**
   Tabibe is a mobile application designed for scheduling appointments with doctors and specialists throughout Algeria. It aims to address the common frustration of waking up early in the morning to secure a doctor's appointment. With Tabibe, users can easily book appointments with healthcare professionals right from their beds, making the process more convenient and hassle-free.
   The application offers several benefits, including reducing stress, saving time, and providing accessibility to all users.

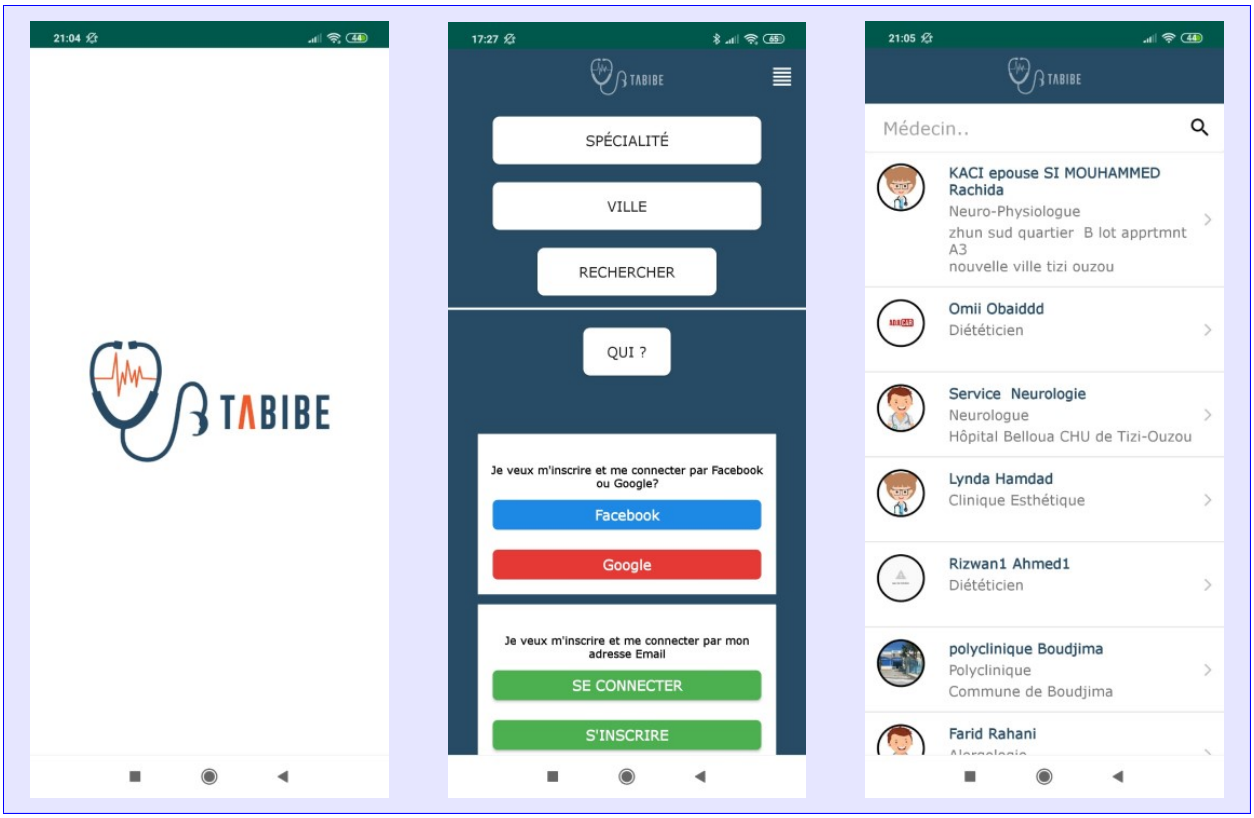

Figure I.12: Interfaces of Tabibe application

2. **SIHA DZ Mobile Application**
   SihaDZ is a mobile application developed for the healthcare industry in Algeria. It is designed to provide various health services and information to users, aiming to improve access to healthcare and facilitate communication between patients and healthcare professionals.[Min]

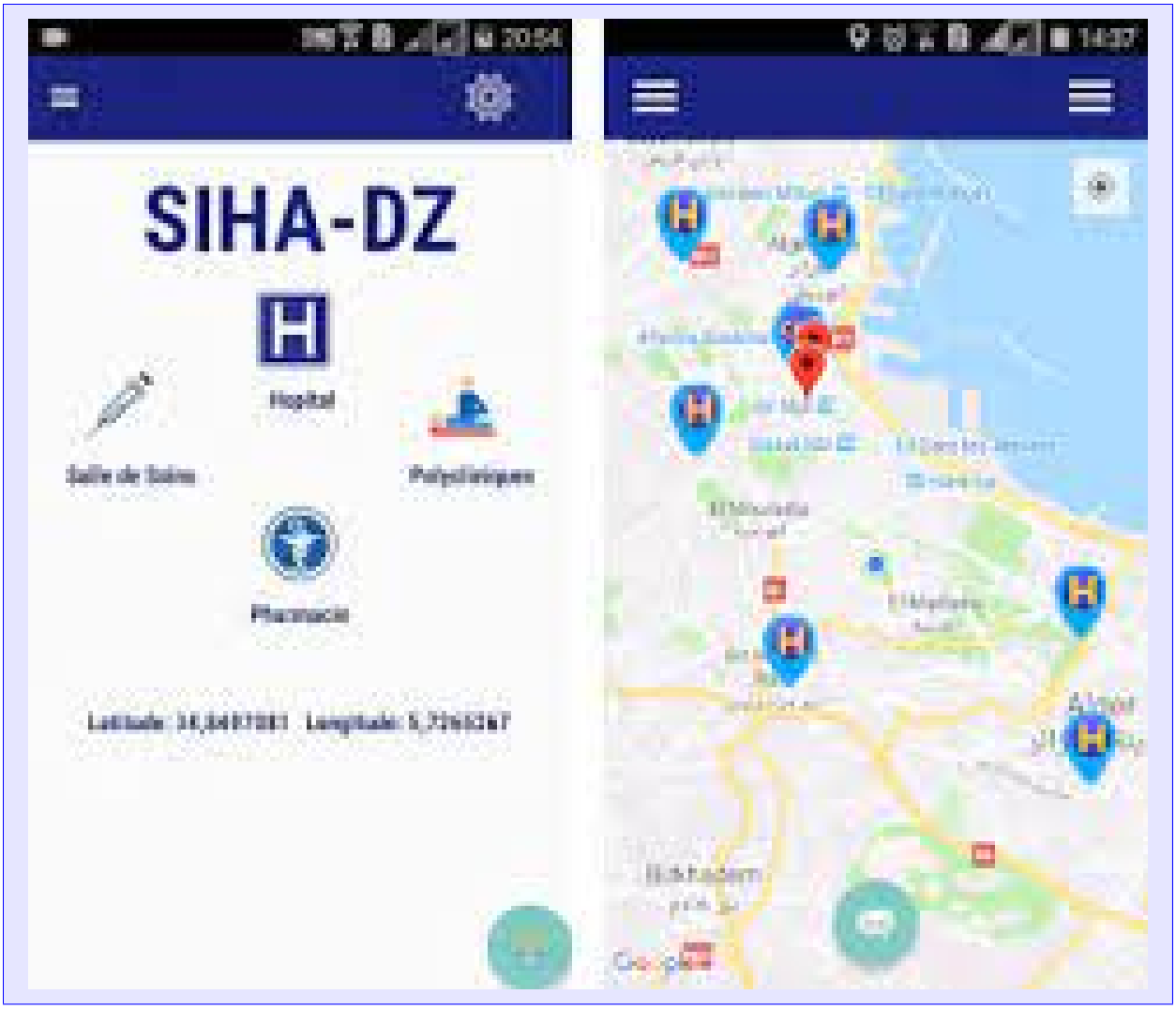

Figure I.13: SIHA-DZ Interfaces

3. **DZDOC Mobile Application**
   DZDOC is a multi-service medical platform created by Khidma Tech, an IT engineering services company with extensive expertise in information technology. In May 2015, DZDOC launched the first online appointment booking service in Algeria, aiming to provide Algerian doctors and patients with a simple, efficient, and appointments.[Khi]

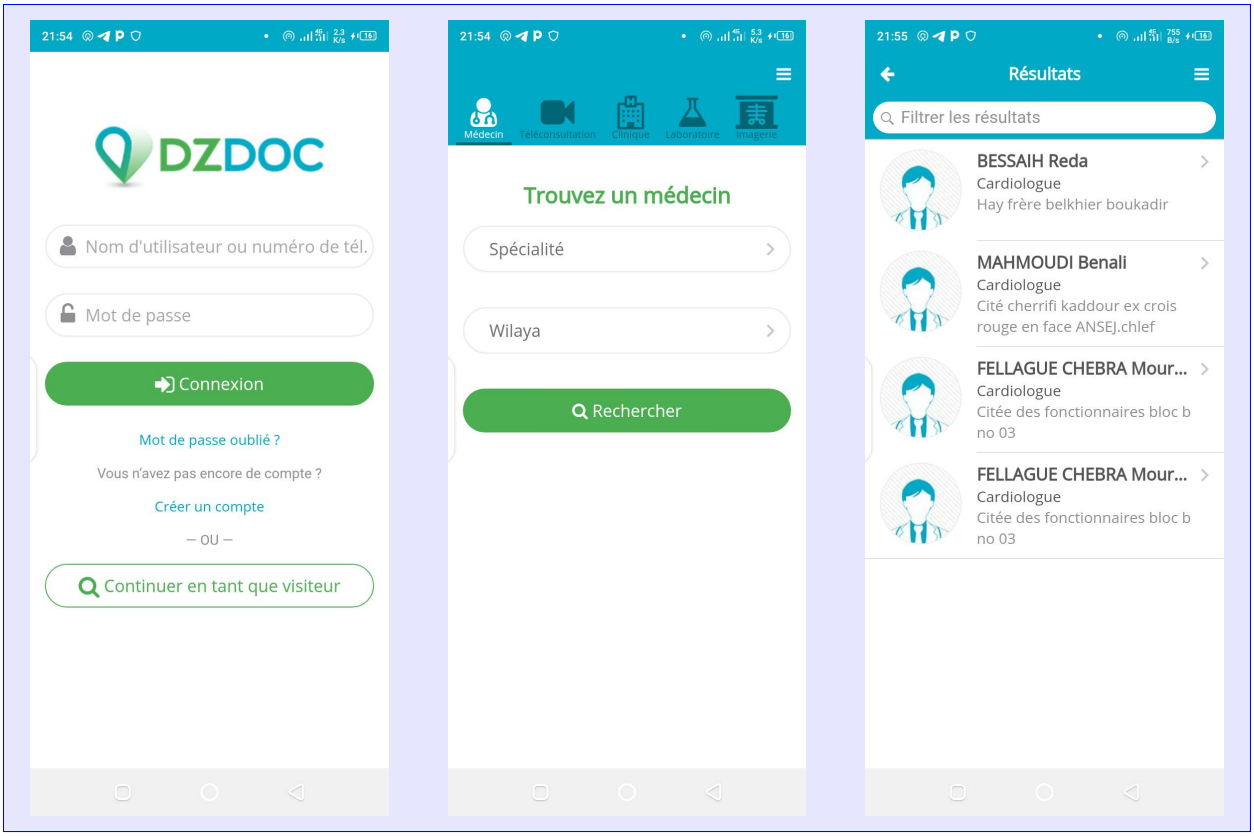

Figure I.14: Some of Interfaces of DZDOC Mobile Application

4. **CHIFA Mobile Application**

   Chifa Mobile is a professionally developed intelligent application designed to efficiently manage pharmacies by accessing data from the Chifa Officine program locally or remotely and displaying it on mobile phones in an organized and user-friendly manner. The application offers various features and services such as signed invoices, preparation of treatments in advance for chronic patients, consultation of consumption, classification of medications, and monthly statistics, among others. The pharmacist has the ability to add multiple secondary accounts with different roles and permissions.[Chi]

Figure I.15: Home Interface of CHIFA Application [Chi]

I.4.4 Perspectives Of Telemedicine In Algeria

The Institut Méditerranéen de Médecine Aérospatiale et de Réadaptation (IMMAR) consulting firm conducted a field survey on the perception of e-health in Algeria, revealing key messages that emphasize a gradual and structured applicationroach with a strategic vision towards telemedicine. The survey, involving 1,100 individuals from across the country (49 % women and 51 % men), highlighted that a significant percentage of respondents expressed their desire for an electronic medical record. Additionally, 72% of the participants wished to connect with their doctors, and a notable portion preferred receiving test results via email. However, it is concerning that 8 % of the respondents were completely unaware of telemedicine's existence, indicating the need for awareness and education in this area.[KY]

At this stage, there are important tasks to be accomplished. The recommendations resulting from

the Health Data Directory Health Data Directory (HDD) are aligned with these objectives. They can be summarized as follows:

- Establishing an ethical and regulatory framework to promote and institutionalize telemedicine.
- Creating a national body for standardizing e-health practices.
- Developing a long-term strategic plan.
- Implementing a comprehensive health information system.
- Utilizing Information and Communication Technology (ICT) to meet healthcare infrastructure needs.
- Encouraging partnerships between the private sector, associations, and ICT to promote public healthcare services and embrace e-health solutions.
- Launching computerized medical records, considered a key element for the success of such initiatives.
- Initiating pilot projects like teleradiology and teledermatology, particularly in specialties facing a shortage of human resources (specialists).
- Establishing an emergency management helpline to support general practitioners throughout the entire national territory.
- Supporting and advancing research programs in telemedicine.
- Redefining the healthcare hierarchy and emphasizing the role of general practitioners.
- Incorporating online training into specialized medical education curricula.

I.5 Conclusion

In this chapter, we first presented some definitions of healthcare industry and its main concepts and mobile applications devlopment, as well as the main operating systems on which their functioning relies. Then, we described the key stakeholders on which the medical domain relies and presented the objectives of our application. Finally, we identified the functional and non-functional requirements of our platform.

In the upcoming chapter, we will delve into a comprehensive analysis and design of our mobile healthcare delivery application. Our primary focus will be on introducing the objectives of our application, followed by the definition of both functional and non-functional requirements.Furthermore, we will explore the system modeling phase, where we utilize UML diagrams to represent the use cases, sequences, and classes of our application.

Chapter II

Analysis And Design

II.1 Introduction

To develop a mobile application, it is essential to create a model that allows predicting and analyzing the relevant information related to the application. For this purpose, we have chosen to use UML language, which provides a graphical representation of concepts and allows us to model mobile applications. Through UML modeling, we can identify the different actors involved in the application and the roles they play.Our team has employed Modelio, a powerful platform, to generate a variety of UML diagrams in order to enhance the process of mobile application development.

II.2 Requirements Engineering

II.2.1 User Needs And Objectives

The health crisis brought on by the COVID-19 pandemic has underscored the importance of leveraging technology to provide remote healthcare services. Our objective is to develop a mobile application that enables patients to receive medical treatment from their doctors either online or at home. The specific objectives of our healthcare delivery application include:

- Providing accessible, high-quality, and patient-centered care.
- Ensuring timely access to healthcare services.
- Improving health outcomes and patient satisfaction.
- Addressing health disparities.
- Fostering effective communication and coordination among healthcare providers.
- Supporting patient education and empowerment.
- Optimizing resource utilization.
- Promoting cost-effective practices.
- Continuously improving the quality and safety of healthcare delivery.

Through telemedicine, our application aims to overcome geographical barriers and enhance access to healthcare. Key goals include:

- Improving convenience and flexibility for patients.
- Facilitating timely medical care and diagnosis.
- Supporting remote monitoring and management of chronic diseases.
- Reducing healthcare costs.
- Enhancing continuity of care and communication among healthcare providers.
- Empowering patients through education and engagement.
- Revolutionizing healthcare delivery through technology.

Additionally, our mobile application incorporates a symptom checker, which aims to:

- Provide accessible and accurate healthcare information.
- Enable self-assessment of symptoms.
- Promote early detection and prevention of health issues.
- Facilitate remote healthcare support.
- Improve healthcare decision-making.
- Empower users to take control of their health.
- Contribute to better health outcomes.

In developing our application, we are focused on meeting these objectives to deliver a superior mobile application that aligns with the specified requirements.

II.2.2 Functional Requirements

In this section, we define the specific features and behaviors that our mobile application must possess to fulfill its intended purpose. These functional requirements outline what the application should do, including managing data, processing transactions, and providing specific functionalities.

By clearly defining these requirements, we ensure that the application meets the needs of its users and serves as a valuable tool to achieve desired outcomes.

Our application must address the following primary functional needs (see Table II.1):

Needs	**Functionalities**
Authentication	Creating an interface with the necessary fields
Create an account	Create a registration form
Manage an account	Create a registration space
Modify the profile	Enable the admin to modify the information of doctors
Search for a doctor	Have a 'search' section that allows patients to perform a search
Manage list of doctors	Create an area accessible by the administrator where they can modify or delete doctors' accounts
Manage the specialties	Allows the administrator to add, modify, or delete a specialty
Book an appointment	Provide functionality for users to schedule appointments with health professionals
Chat with a health professional	Enable users to communicate with health professionals through a chat feature
Logout	Add an option that allows the user to log out

Table II.1: Needs And Respective Functionalities

II.2.3 Non-functional Requirements

Non-functional requirements play a crucial role in determining how an application performs and the qualities it possesses. These requirements encompass various aspects such as security, usability, performance, reliability, and accessibility. By defining and adhering to these non-functional requirements, we can ensure that the application meets the desired standards and provides an exceptional user experience. Just as functional requirements are important for the application's core functionality, non-functional requirements significantly impact its usability, reliability, and overall success.

To meet the goals and expectations of our application, we have identified several key non-functional requirements:

→ **Code Maintainability:** The codebase should be designed in a way that facilitates future evolutions or improvements. It should be clear, well-structured, and easily understandable, allowing developers to make modifications efficiently.

→ **Usability:** The application should feature a user-friendly interface that is intuitive and easy to navigate. Users should be able to interact with the system effortlessly, with well-organized menus, logical workflows, and intuitive controls.

→ **Security:** Ensuring the confidentiality of information is of utmost importance. The application should implement robust security measures, including an authentication interface to protect user data and prevent unauthorized access.

→ **User-Friendliness:** Prioritizing ease of use, the application should provide a seamless and enjoyable user experience. This includes maintaining a logical sequence between interfaces, offering an adequate number of links for efficient navigation, and presenting text that is clear and easily readable.

→ **Availability:** The application should be accessible to users at all times, allowing them to use it whenever they desire. It should be resilient to potential downtime, with measures in place to handle high traffic and ensure uninterrupted service.

By addressing these non-functional requirements, our application will not only fulfill its core functionality but also deliver a secure, user-friendly, and reliable experience to its users.

II.3 System Design

II.3.1 The UML Modeling Language

According to Fowler [Fow03], the Unified Modeling Language (UML) is a graphical language used for visualizing, specifying, constructing, and documenting software-intensive systems. It provides a rich set of notations for modeling various systems and is widely used in the industry.

Figure II.1: Unified Modeling Language (UML) Logo

II.3.2 The Different Types Of UML Diagrams

The system design phase involves the utilization of various UML diagrams, including structural diagrams such as class diagrams, component diagrams, and deployment diagrams, as well as behavioral diagrams like activity diagrams, communication diagrams, and state machine diagrams, among others. These diagrams play a crucial role in visually representing and understanding the structure and behavior of the software system.

The UML language consists of diagrams, with a total of 13 "official" diagrams.

- **Structural UML Diagrams**
  - Class Diagram.
  - Component Diagram.
  - Composite Structure Diagram.
  - Deployment Diagram.
  - Object Diagram.
  - Package Diagram.
- **Behavioral UML Diagrams**
  - Activity Diagrams.

- Communication Diagram.
- Interaction Overview Diagram.
- State Machine Diagram.
- Timing Diagram.
- Use Case Diagram

II.3.3 Identification Of Actors

In the context of UML, an actor represents an abstraction of a role played by external entities that directly interact with the system. Actors can include users, hardware devices, or other systems. There are two categories of actors: supporting actors and principal actors. Supporting actors assist in making use cases a reality.

The main user profiles in the system include (see Table II.2):

User Profile	**Description**
Doctor	• Personalized account created by the administrator. • Access to specific features. • Management of working hours. • Ability to write notes and prescribe medication for appointments.
Patient	• Login to access application functionalities. • Search for doctors by name or specialty. • Schedule appointments based on doctor's availability. • View list of appointments. • Update account information.
Administrator	• Highest privileges and responsibilities in the application. • Addition of doctor accounts and profile information. • Management of specialties (addition, modification, deletion).

Table II.2: User Profiles In The System

II.4 System Modeling

II.4.1 Use Case Modeling

Use case diagrams provide an external view of the system and illustrate the relationship between users and system elements.

II.4.1.1 Use Case Diagram For The Actor « ADMINISTRATOR »

The figure II.2 represents the use case diagram associated with the administrator.

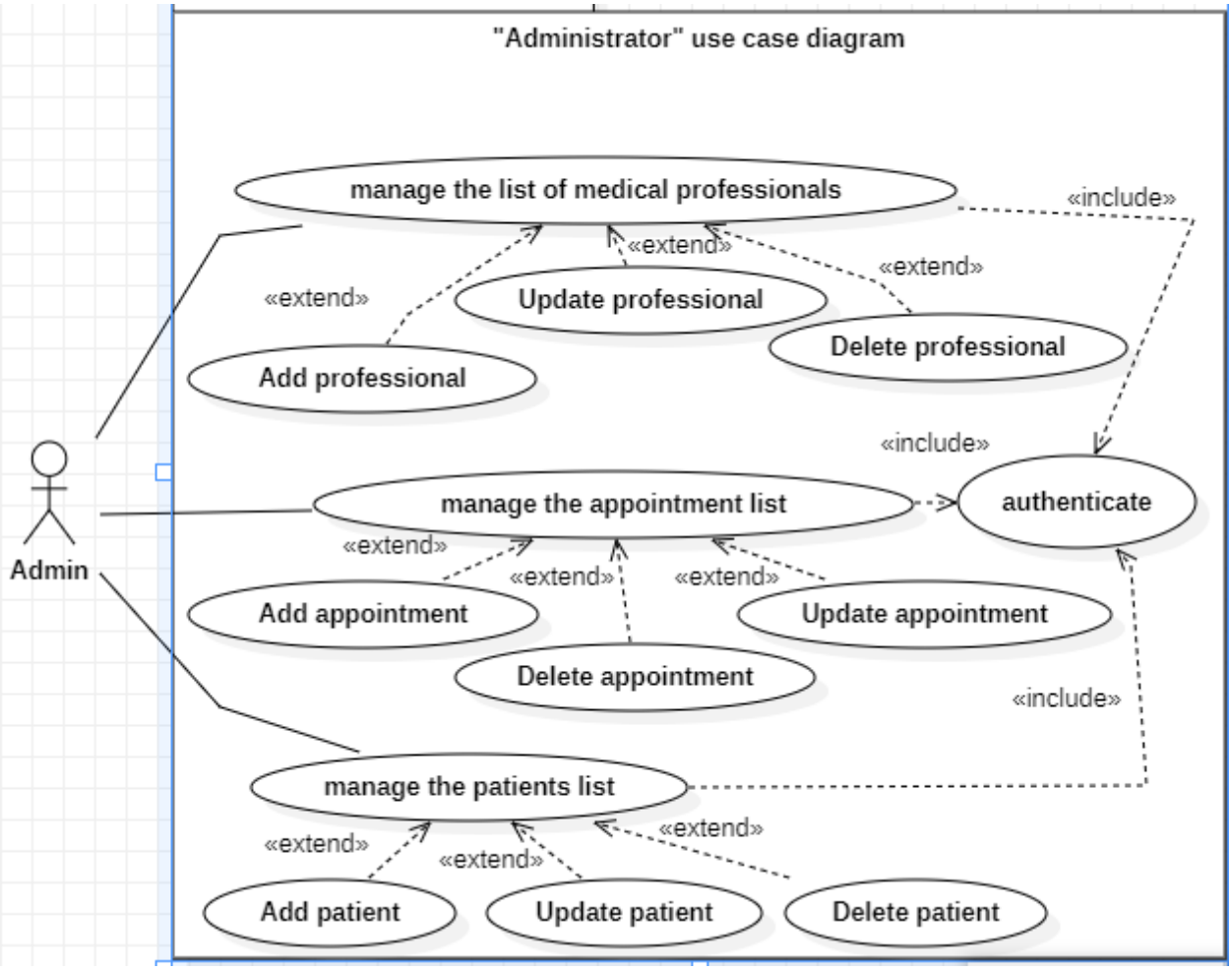

Figure II.2: Use Case Diagram For The Administrator

II.4.1.2 Use Case Diagram For The Actor « DOCTOR »

The figure II.3 represents the use case diagram associated with the doctor.

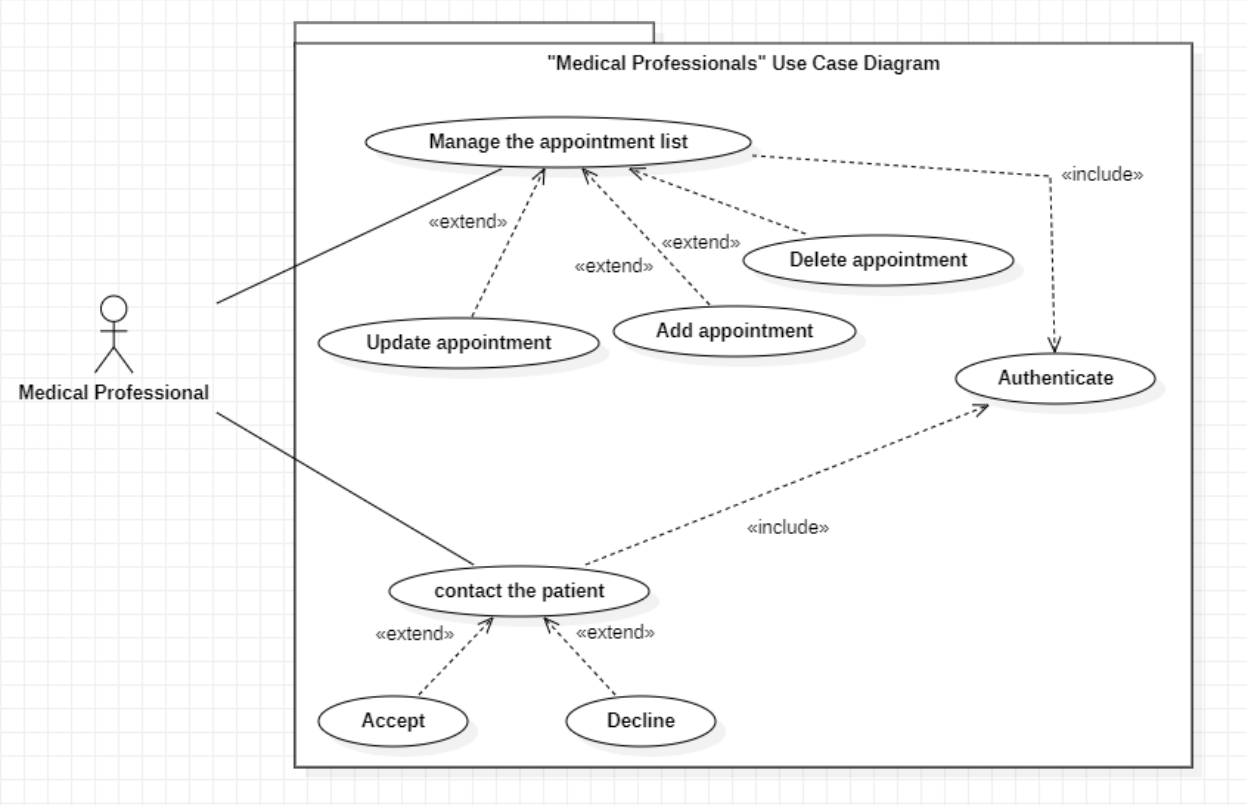

Figure II.3: Use Case Diagram For Doctors

II.4.1.3 Use Case Diagram For The Actor « PATIENT »

The figure II.3 represents the use case diagram associated with the patient.

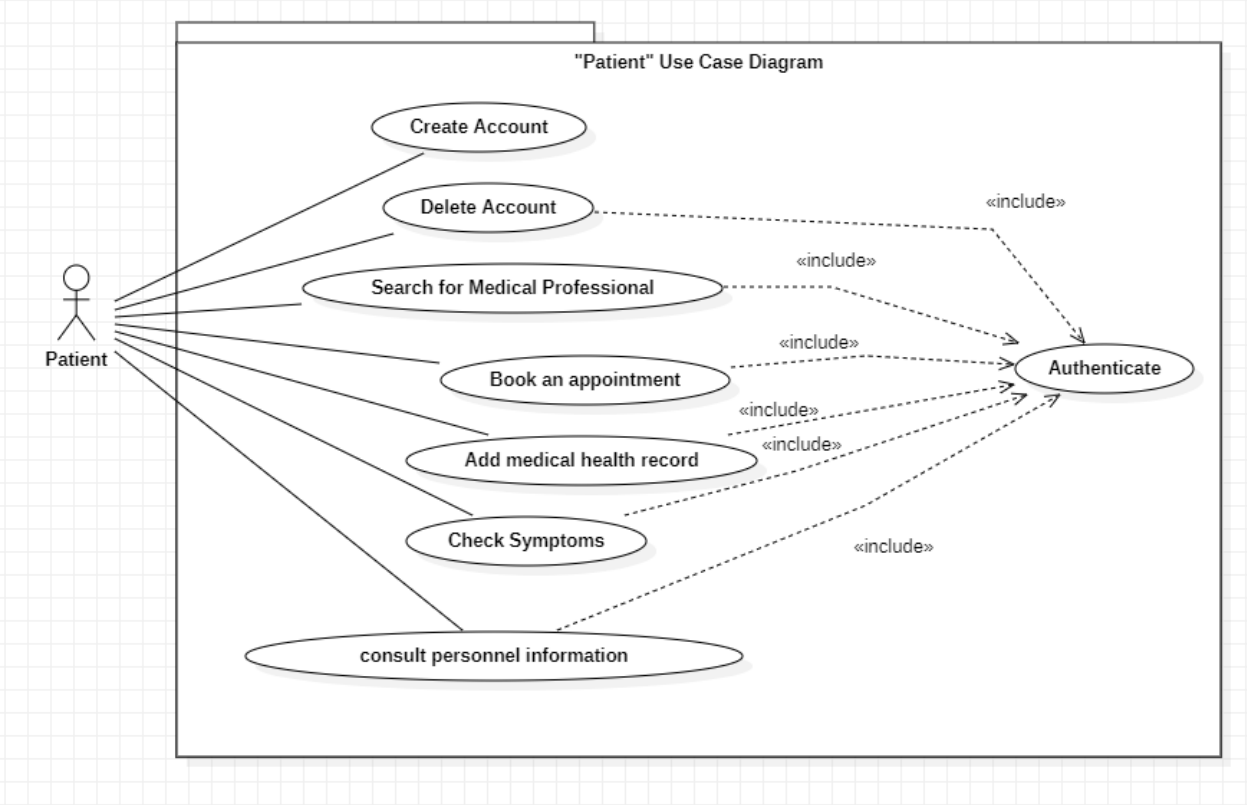

Figure II.4: Use Case Diagram For Patients

II.4.2 Sequence Modeling

To describe the use cases, we analyze different scenarios involving patient. These scenarios can be represented using sequence diagrams, which showcase the interactions between actors and the system. The interaction operators we have used in the sequence diagrams are:

1. **Reference (Ref)**: This operator indicates that the fragment refers to a previously seen case.

2. **Alternative (Alt)**: This operator indicates that the composite fragment represents a choice of behavior. At most one interaction operand will be chosen. The chosen operand must have an implicit or explicit guard expression that evaluates to 'true' at this point of the interaction.

3. **Loop**: This operator indicates that the composite fragment represents a loop.

II.4.2.1 Sequence Diagram « User Authentication »

The first scenario for the user is to authenticate themselves with the system. The chronological sequence of this scenario is represented by figure II.5.

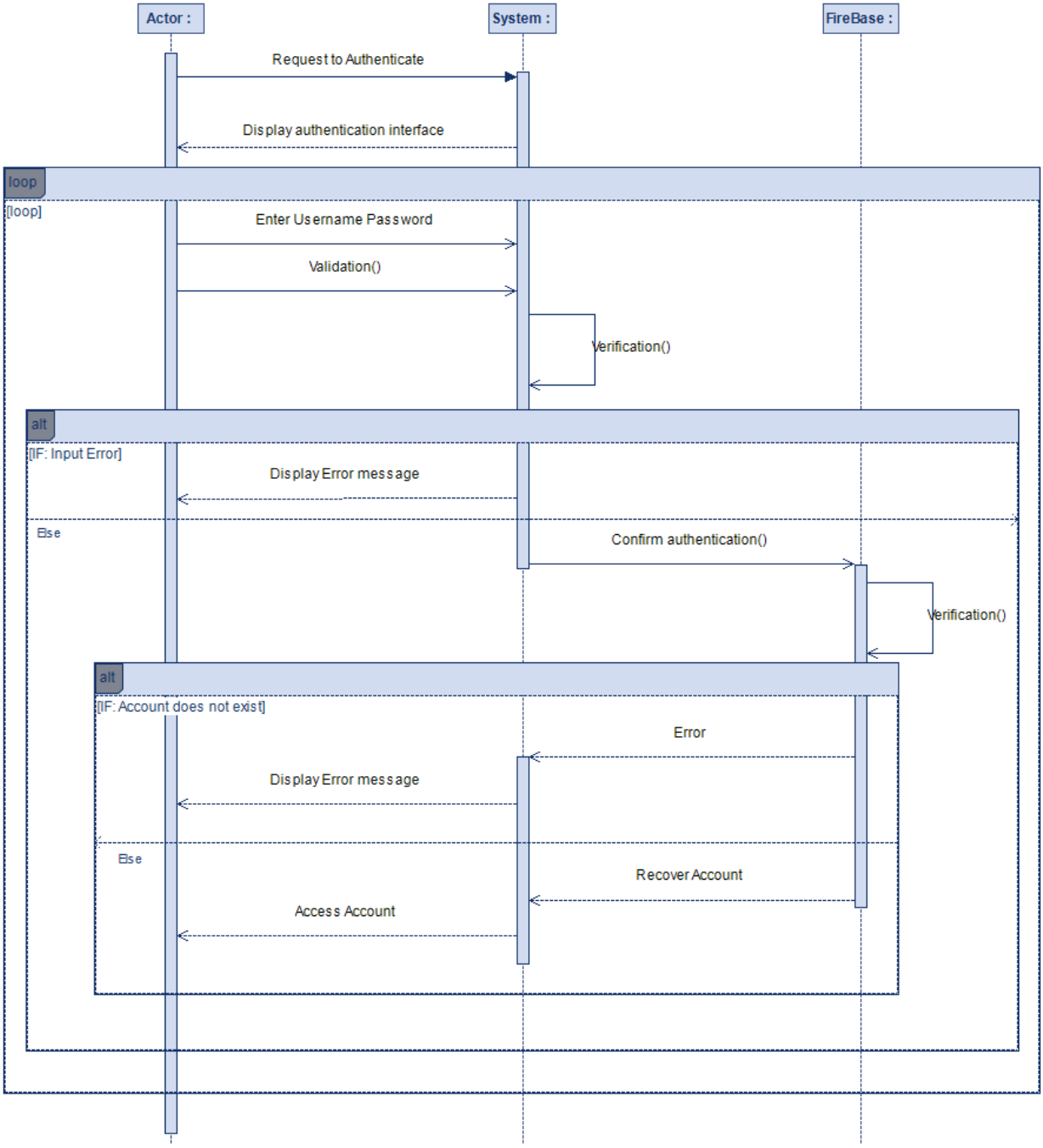

Figure II.5: Sequence Diagram - User Authentication

II.4.2.2 Sequence Diagram « Search a Doctor »

The scenario for searching a doctor follows the chronological sequence represented by figure II.6.

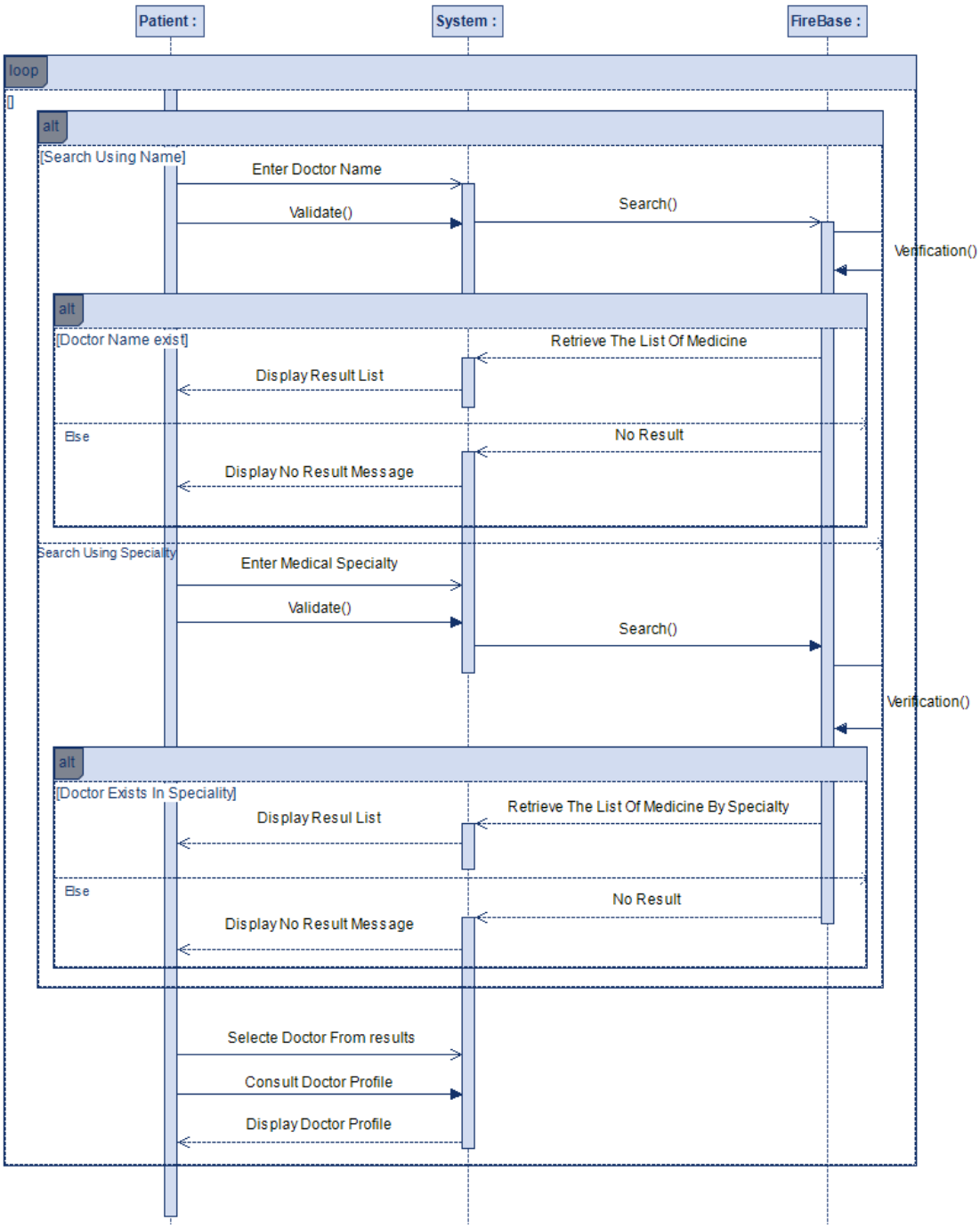

Figure II.6: Sequence Diagram - Search A Doctor

II.4.2.3 Sequence Diagram - Create An Account

The chronological sequence of the scenario related to the creation of an account is represented by figure II.7.

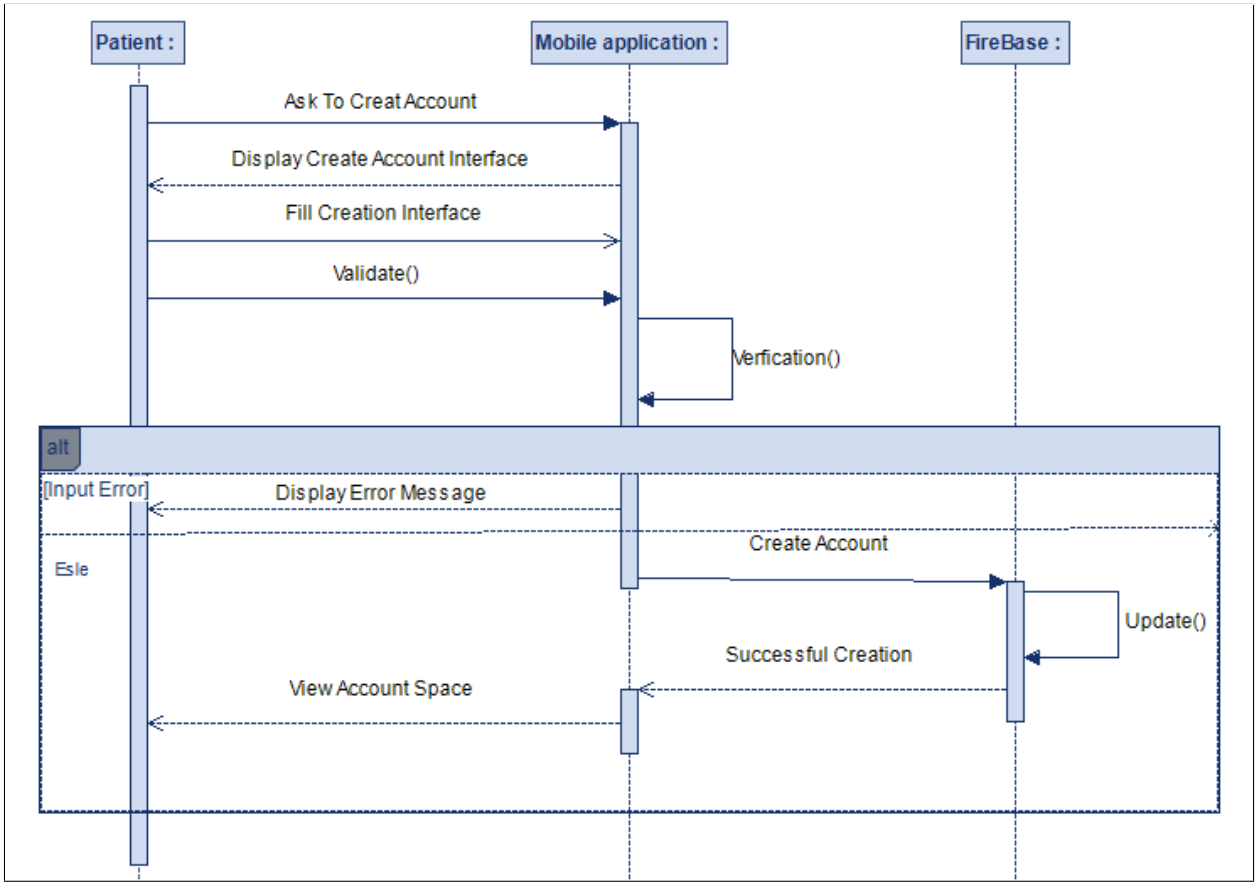

Figure II.7: Sequence Diagram - Create An Account

II.4.2.4 Sequence Diagram « Book An Appointment »

The scenario for booking an appointment follows the chronological sequence represented by Figure II.8.

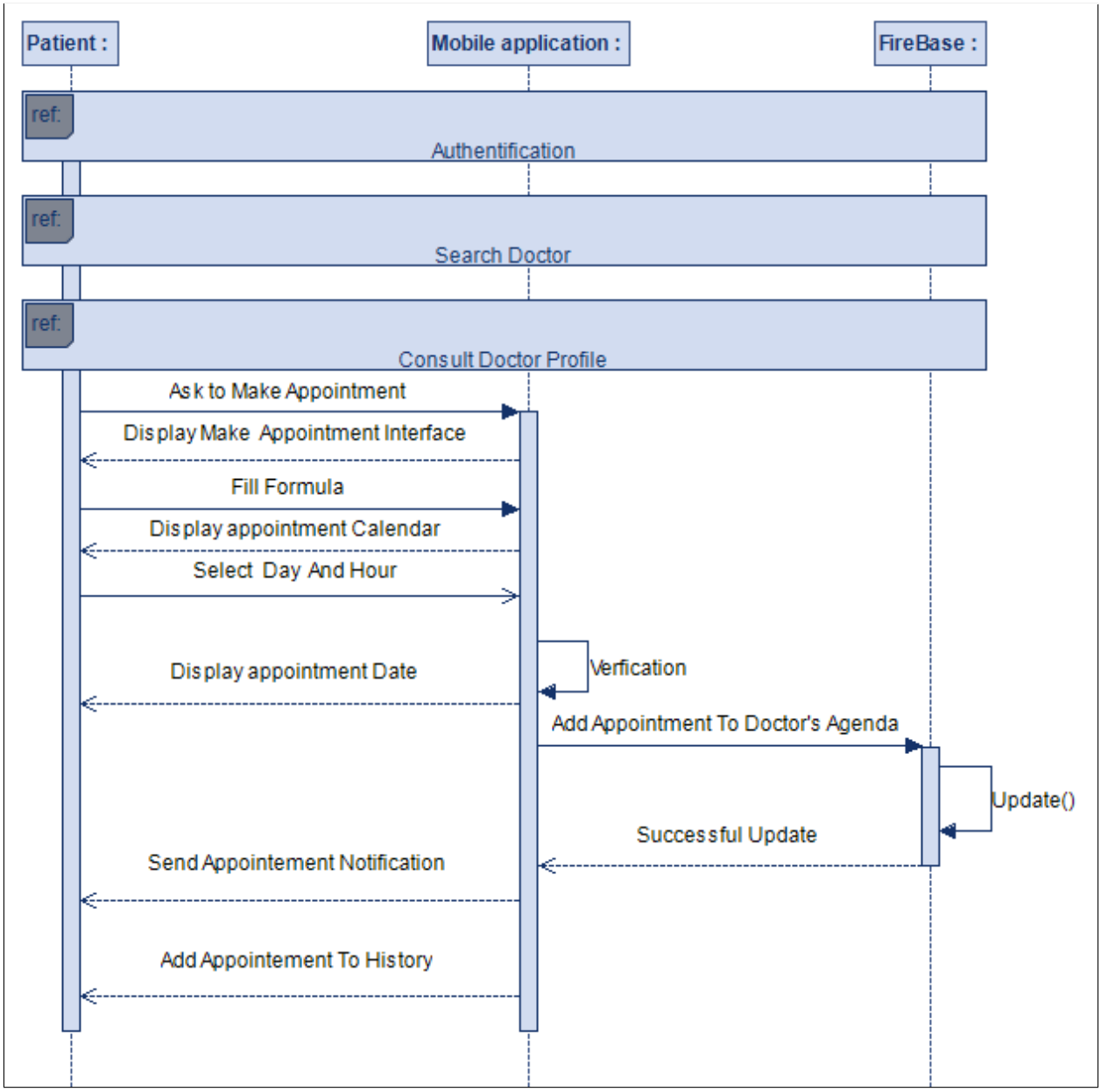

Figure II.8: Sequence Diagram - Book An Appointment

II.4.3 Class Modeling

A class diagram provides a visual representation of a group of classes with their attributes, operations, and relationships. It helps describe the responsibilities, behavior, and types of objects within the system. Classes represent a set of objects, and the relationships between classes indicate their participation and associations.

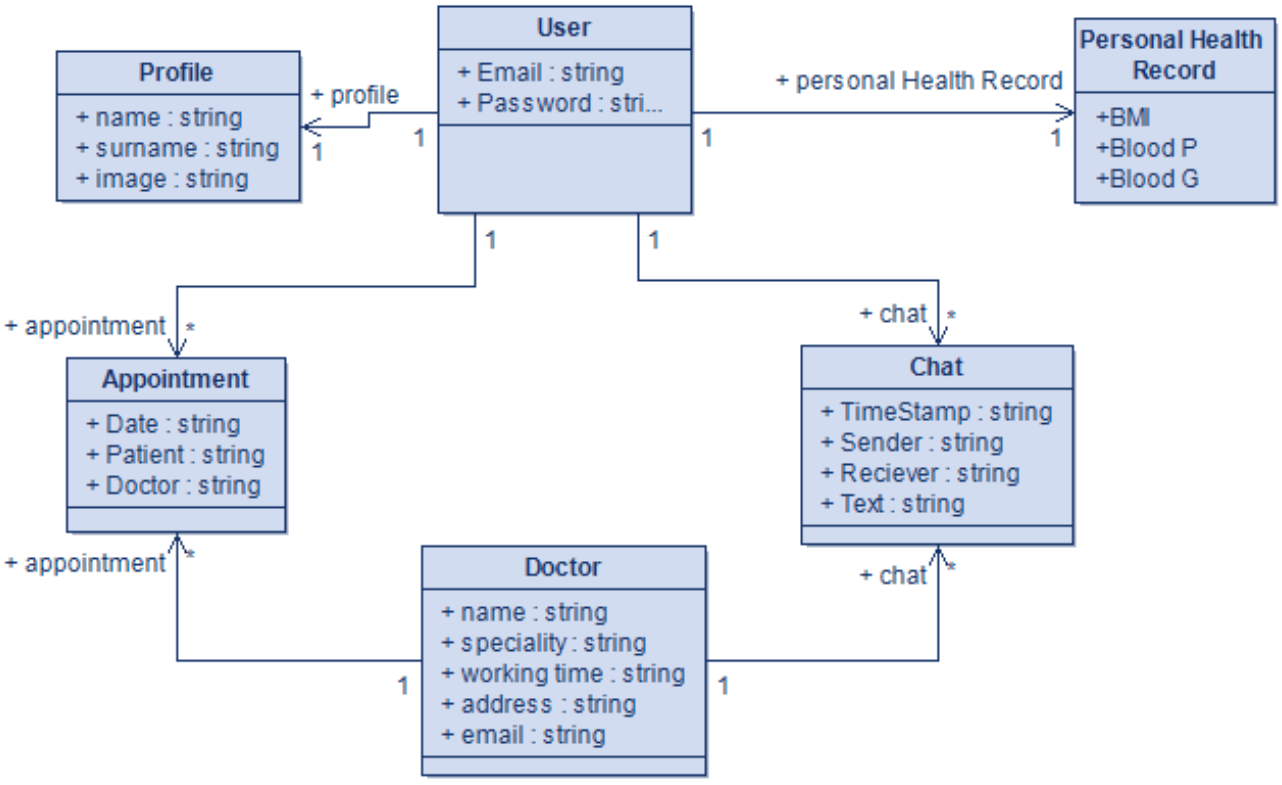

Figure II.9: General Class Diagram

II.5 Conclusion

In this chapter, we covered the analysis and design stage of our requirements for the future application after presenting its main objective . We outlined the steps involved in planning its operation and provided a comprehensive overview of the UML language diagrams used for modeling, which include the use case diagram, sequence diagram, and class diagram. By using these diagrams, we aim to streamline the application development process, which will be discussed in the subsequent chapter.

Chapter III

Implementation And Results

III.1 Introduction

In this chapter, we embark on the execution and finalization of our mobile application, where we concentrate on essential aspects such as the tools utilized for development, the programming languages employed, and a comprehensive overview of the achieved outcomes. As we delve into the practicalities of this implementation journey, we will explore the development environment, including Android Studio, Flutter, Emulator, and Android SDK, which have been instrumental in shaping the application's functionality. Additionally, we will delve into the programming languages, Dart and Firebase, that have been leveraged to bring life to the various features and services within the app. Through a thorough examination of the DoctoriDz visual identity, encompassing the healthcare graphic charter and application logo, we aim to present a cohesive and visually appealing user experience. Furthermore, we will unveil the application's architecture and diverse user interfaces, ranging from onboarding and login/register interfaces to patient and doctor profiles, appointment booking and scheduling interfaces, conversation interfaces, and various other feature interfaces. This chapter sets the stage for a comprehensive understanding of the implementation process and the tangible outcomes that result from our diligent efforts.

III.2 Development Environment

A development environment, alternatively called a dev environment or environment development, is the collection of software tools, resources, and configurations employed by software developers for the purpose of coding, testing, and debugging. This encompasses the hardware, software, and network setups that create a controlled and separate space for development.

III.2.1 Android Studio

Android Studio is an integrated development environment (IDE) for the Android operating system. It was built specifically for Android application development and is based on JetBrains' IntelliJ IDEA software. Android Studio provides developers with a user-friendly interface for creating applications for Android devices, along with various tools and features to aid in development, testing, and debugging. It also includes an Android emulator, which enables developers to test their applications on virtual Android devices. Android Studio is available for free and is the official Integrated Development Environment (IDE) for Android application development.[Goo23b]

Figure III.1: The Android Studio Workspace Logo

III.2.2 Flutter

Flutter[Flu21] is a mobile application development framework created by Google that allows developers to write code once and deploy it on multiple platforms, including Android, iOS, Linux, Mac, Windows, and the web. Flutter uses the Dart programming language and includes a rich set of pre-built widgets for building custom user interfaces. Additionally, it features a hot reload feature that enables developers to see the results of code changes in real-time. This capability makes Flutter a popular choice for creating high-performance and visually appealing applications.

Figure III.2: The Flutter Logo

III.2.3 Emulator

The Android Emulator is a software application that runs on your computer. It emulates an Android device, allowing you to run applications and games on it as if it were a physical device. The Android Emulator comes with a variety of pre-configured device profiles that enable you to emulate different Android devices. You can also create custom device profiles to emulate hardware configurations that are not available on existing virtual devices.[Goo21]

III.2.4 Android SDK

The Android SDK (Software Development Kit) is a collection of software tools and resources provided by Google to help developers create Android applications. It includes a set of development tools, such as debugging tools, software libraries, a handset emulator based on QEMU, documentation, sample code, and tutorials.

The Android SDK provides developers with everything they need to build and test Android applications. It includes a comprehensive set of tools for designing and testing user interfaces, managing device configurations, and deploying applications to various devices.[Goo23a]

III.3 Development Languages

We utilized two crucial programming languages that we enumerate below:

III.3.1 Dart

Dart is a client-optimized programming language for building fast applications on any platform. It is developed by Google and can be used to build both web and mobile applications. Dart offers a combination of features such as a modern syntax, a comprehensive standard library, optional static typing, and built-in tooling that make it easy to write, test, and deploy high-quality applications.

Dart also comes with a powerful compiler that can generate efficient machine code, making it suitable for building both small scripts and large-scale applications. Overall, Dart is a flexible and versatile programming language that can be used to build a wide range of applications across different platforms.[Darce]

Figure III.3: The Dart Logo

III.3.2 Firebase

III.3.2.1 Definition

Firebase is a Backend-as-a-Service (BaaS) platform developed by Google. It provides developers with a variety of tools and services to help them develop mobile and web applications quickly and efficiently. Firebase provides features like real-time database, hosting, authentication, and cloud messaging. It also offers a range of analytics and monitoring tools to help developers track user behavior and performance metrics. Firebase can be integrated with various programming languages, including JavaScript, Objective-C, Swift, Java, and C++. It is a popular choice for developers who want to build applications with serverless architectures and rapidly deploy their applications.[Alc19]

Figure III.4: The logo Of The Firebase Platform.

III.3.2.2 Firebase Services

Firebase is a mobile and web application development platform that provides a wide range of backend services for building and scaling applications. Some of the key services provided by Firebase include[KS18]:

1. **Realtime Database:**
   Firebase offers a range of features, including a real-time database and backend infrastructure. It equips application developers with an API that facilitates seamless synchronization of application data across multiple clients, securely storing it on Firebase's cloud platform. The company also supplies client libraries, enabling effortless integration with Android, iOS, and JavaScript applications.

2. **Authentication:**

Firebase Authentication facilitates social login integration with popular providers such as Facebook, Google, GitHub, and Twitter. This service enables user authentication using client-side code alone and is available as a paid offering. Additionally, Firebase Auth encompasses a user management system that empowers developers to enable user authentication through email and password login, securely stored within Firebase.

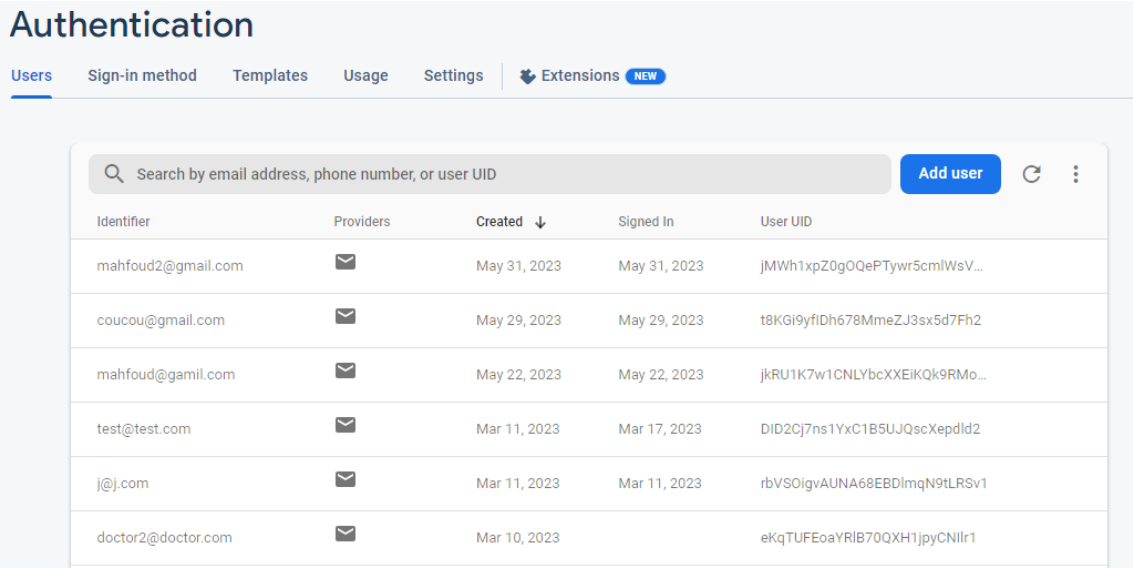

Figure III.5: Firebase Authentication

3. **Cloud Firestore:**
   A scalable, fully managed NoSQL document database that lets you store and sync data for web, mobile, and IoT applications in realtime.

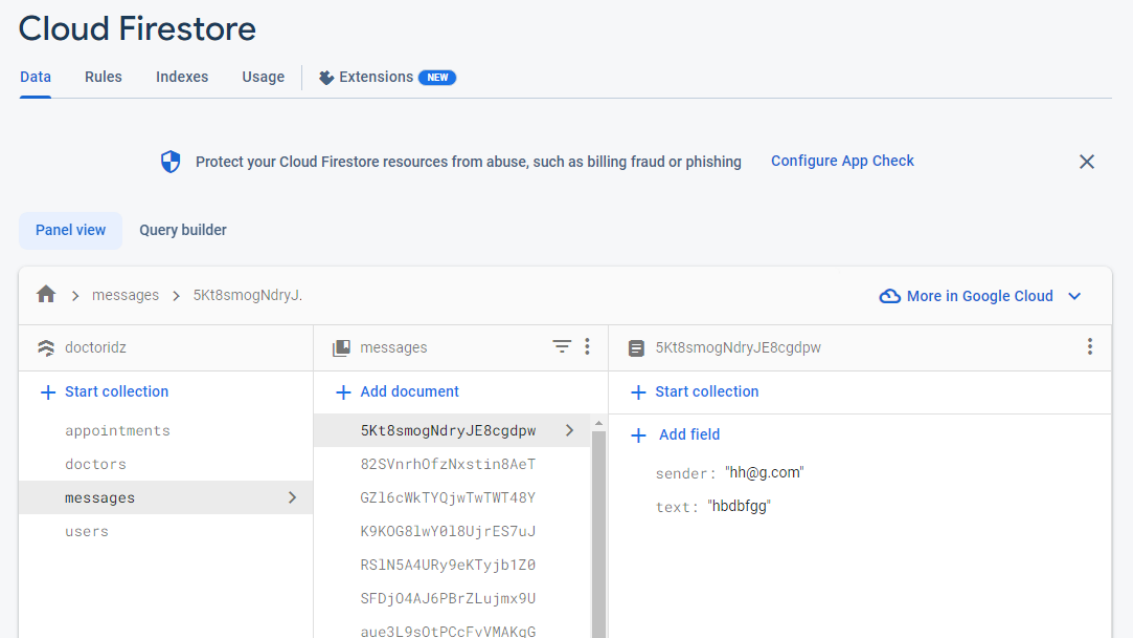

Figure III.6: Cloud Firestore

4. **Cloud Storage:**

   A cloud-based object storage service that lets you store and serve user-generated content such as photos and videos.

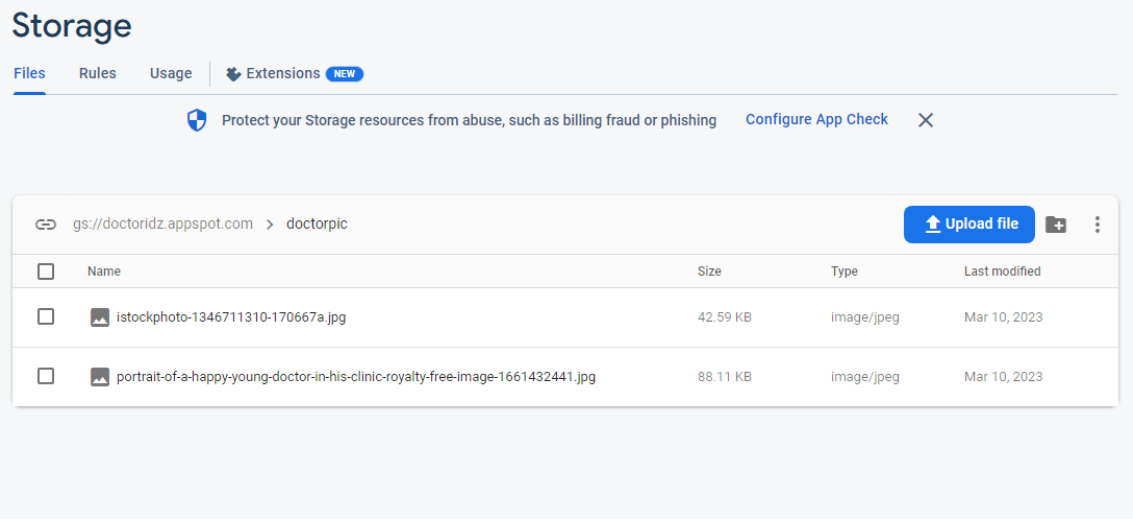

Figure III.7: Firebase Cloud Storage

5. **Cloud Functions:**

   A serverless compute platform that lets you run code in response to events triggered by Firebase and third-party services.

6. **Cloud Messaging:**
   Formerly known as Google Cloud Messaging (GCM), Firebase Cloud Messaging (FCM) is a paid service that serves as a versatile solution for sending messages and notifications across multiple platforms, including Android, web applications, and iOS.

7. **Analytics Dashboard:**
   A tool that provides real-time crash reporting and analysis for your company .

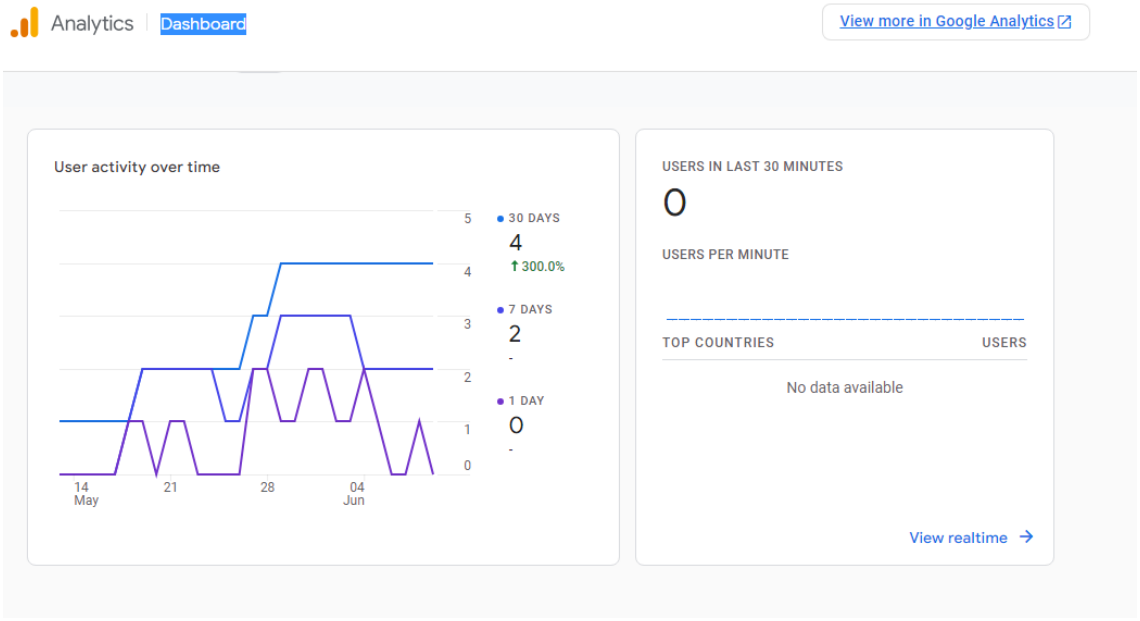

Figure III.8: analytics

III.4 DoctoriDz Visual Identity

III.4.1 The Healthcare Graphic Charter

The healthcare graphic charter refers to a set of guidelines and specifications that define the visual identity and design elements used in the healthcare industry. It outlines the rules and standards for creating and implementing graphic elements, such as logos, typography, colors, imagery, and layout, to ensure consistency and cohesiveness across various healthcare materials and communications.[Hxd]

Since HealthCare will be used in the medical field, we opted for a color that is applicationro-

priate to the theme. A blue that invites calm and rest. It is a symbol of growth, health, freshness and nature.

III.4.2 The Application Logo

The logo of our application III.9 has been chosen in such a way that it is soft, highlights the industry of healthcare that attributed to our mobile application as well as its greatest usefulness in an effective way to inform customers about our work without using any words.

Figure III.9: Presentation Of The DoctoriDz Application Logo

III.5 Unveiling The Application

In this section, we will showcase the culmination of our work through the user interfaces of the mobile application we have developed, providing a visual representation of our final output.

III.5.1 Application Architecture

Presented here is the diagram, referenced as (III.10), which visually represents the arrangement of views in our application.

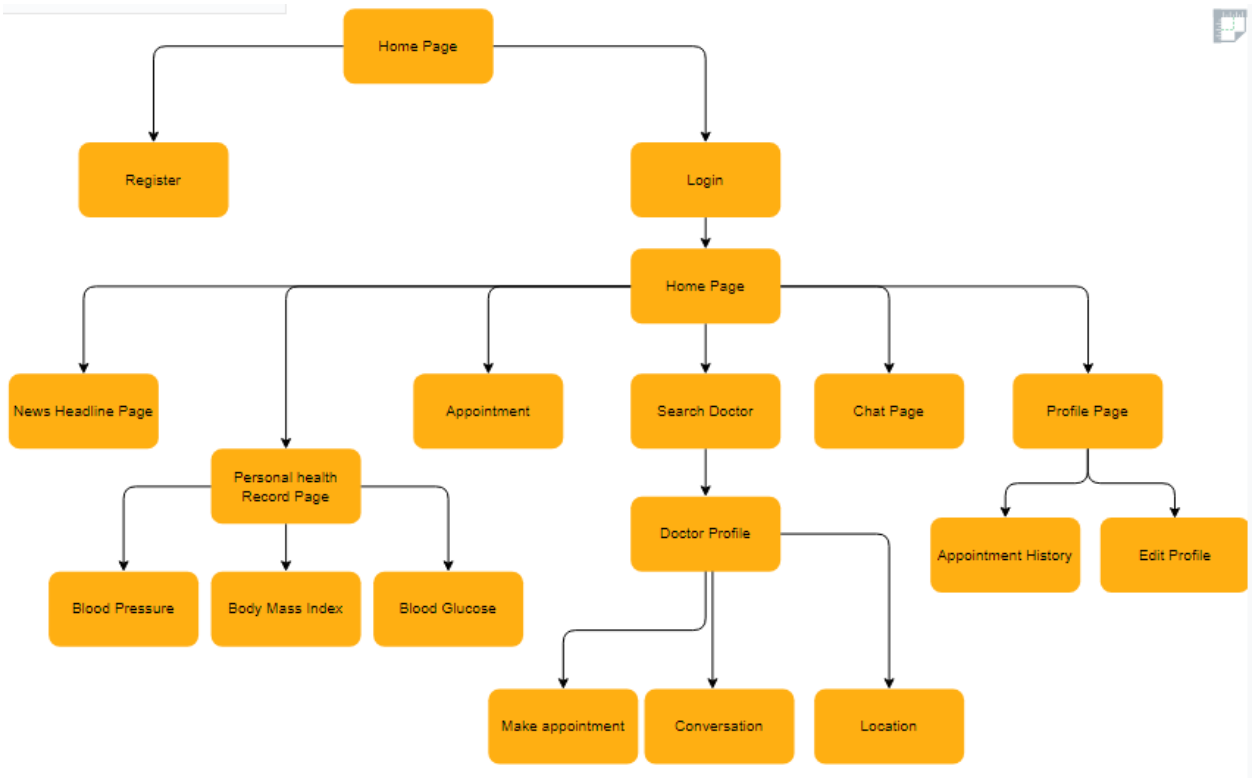

Figure III.10: Architecture Of The Application

III.5.2 User Interfaces

In this section, we present the different interfaces of our application. Each user has his own interfaces which he uses to perform certain functions, these interfaces are as follows:

III.5.2.1 On Boarding Interfaces

A section of the interface (III.19) that summarizes the basic services of our platform, providing an overall view of its fundamental functionalities.

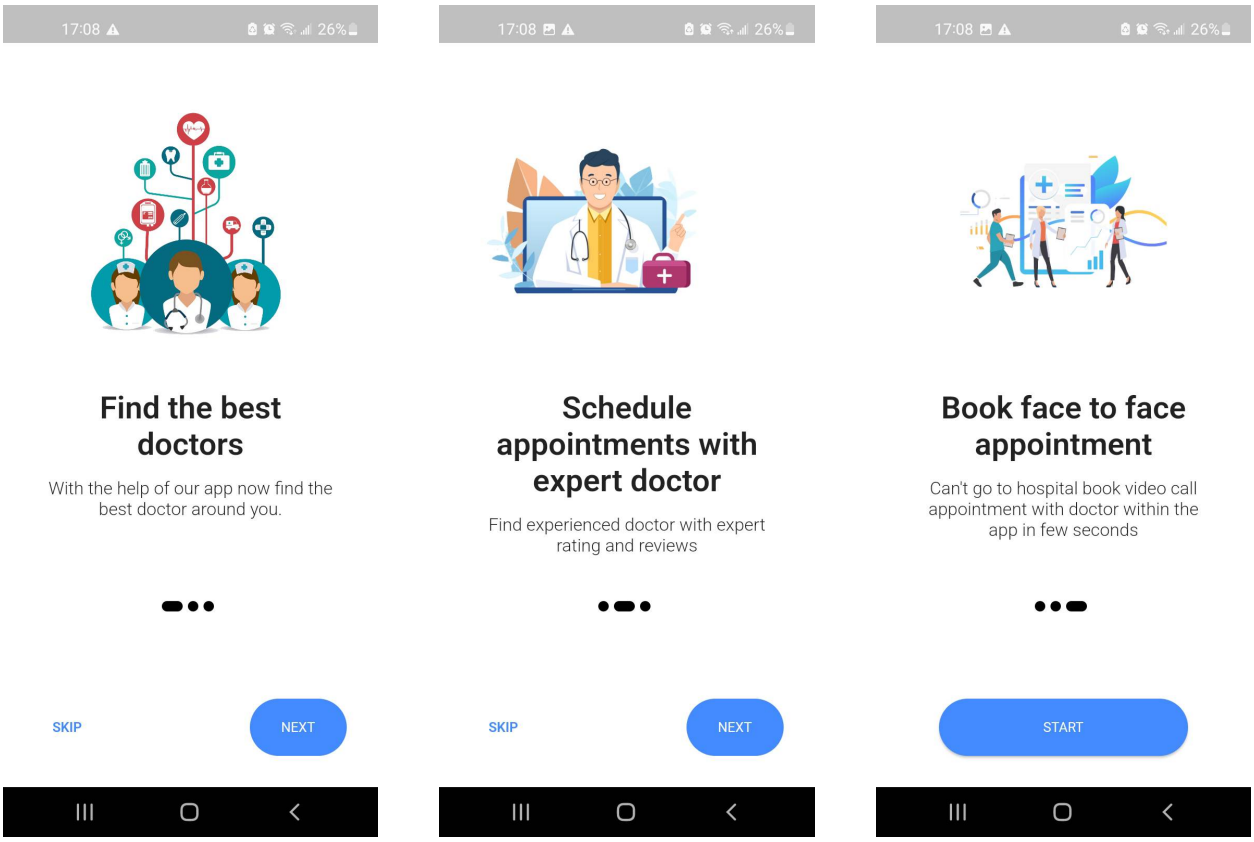

Figure III.11: On Boarding Interfaces.

III.5.2.2 Home Interface

The home interface(III.12) leads to the other interfaces, using the two vertical and horizontal swiping. The patient easily navigates to the other interfaces.

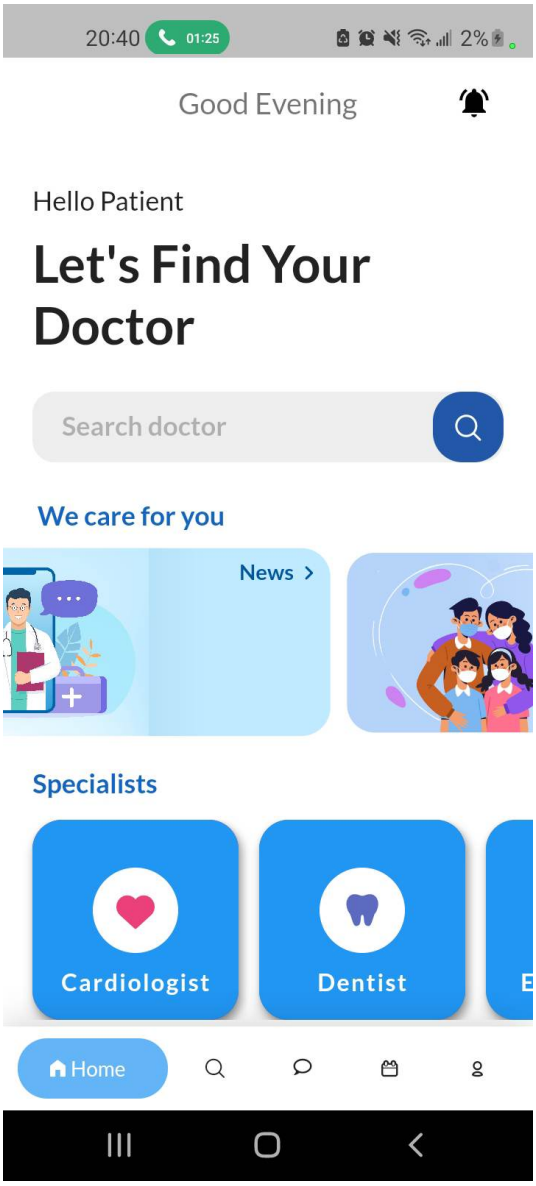

Figure III.12: The Initial Interface Displayed Upon Launching The Application Immediately Following The Login Screen.

III.5.2.3 Login And Register Interfaces

These interfaces (III.13]) contains a series of input fields that the patient should fill in with his personal information to complete his registration or to log in to his account.

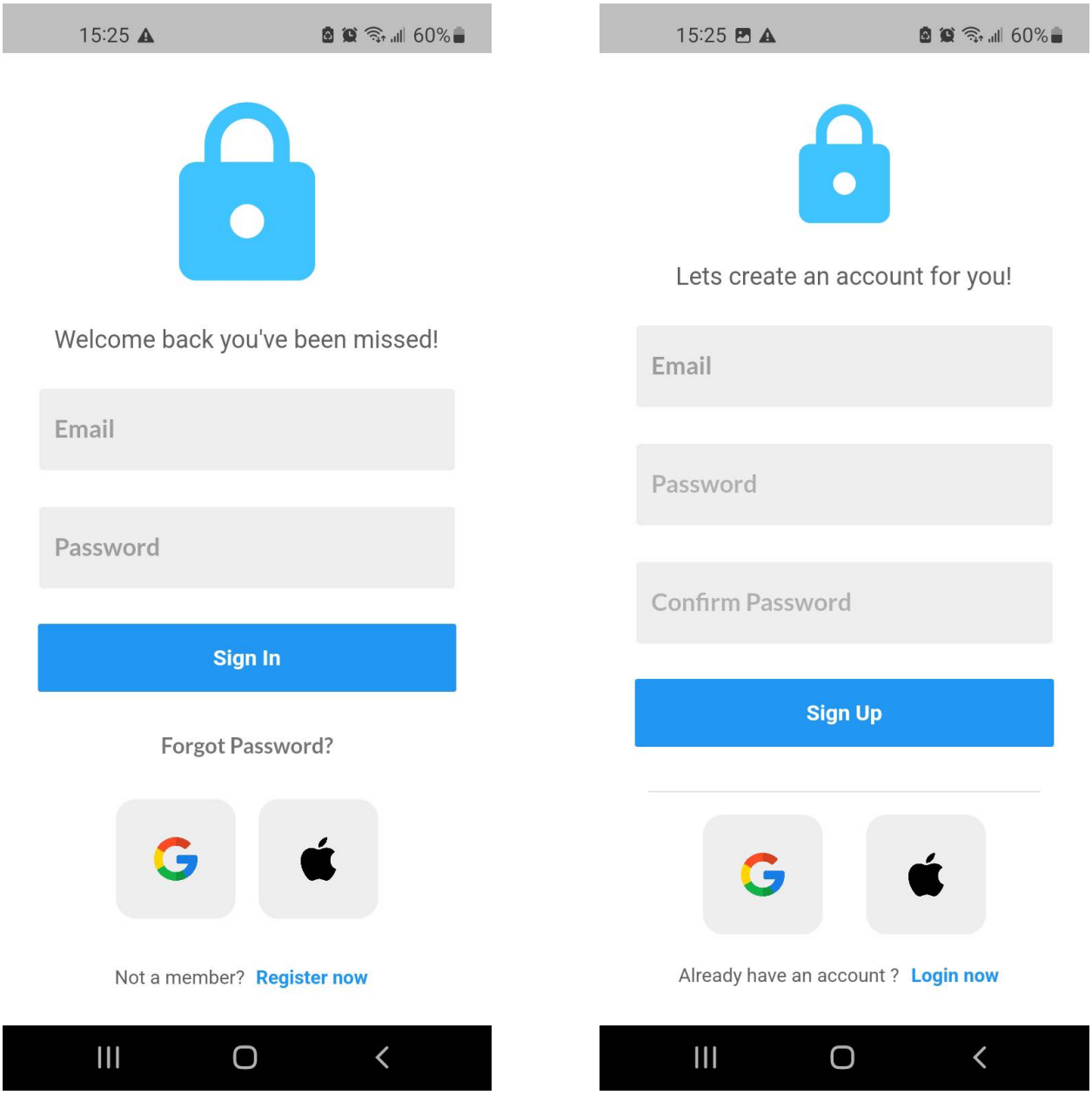

Figure III.13: Log In And Register Interfaces

III.5.2.4 Patient Profile Interface

It allows the patient to modify the personal information of his account on the application and validate it (III.14).

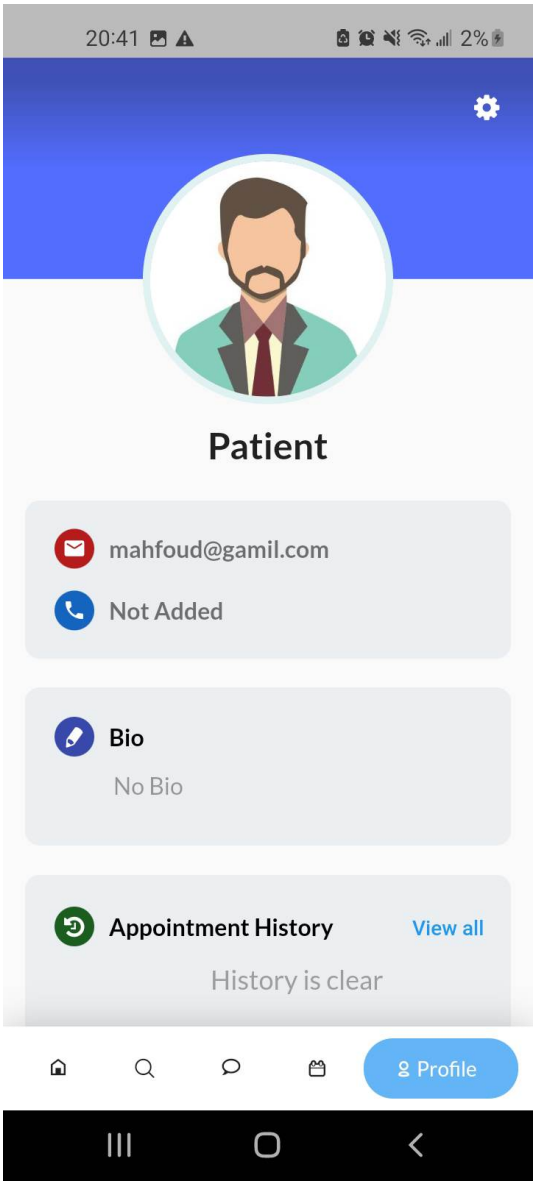

Figure III.14: The Patient Profile Interface

III.5.2.5 Doctor Profile Interface

An interface (III.15) which displays the detailed information of the selected doctor to make an applicationointment or start a chat.

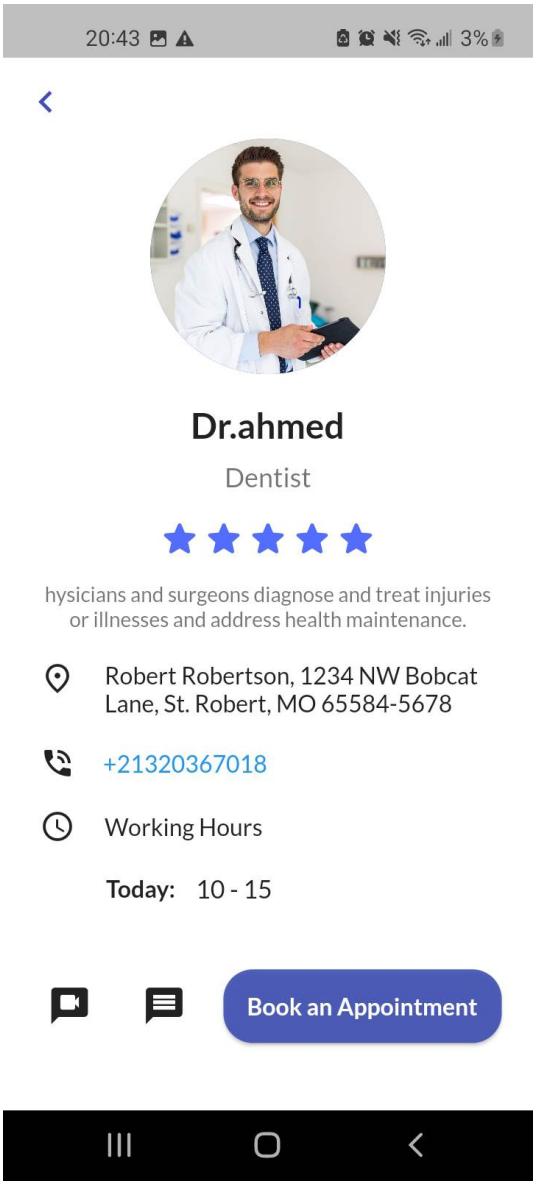

Figure III.15: The Doctor Profile Interface.

III.5.2.6 Booking Appointment Interface

An interface (III.16) which gives the possibility to the patient, to choose a time slot for the consultation according to among the available time slots of the doctor already selected and validate it.

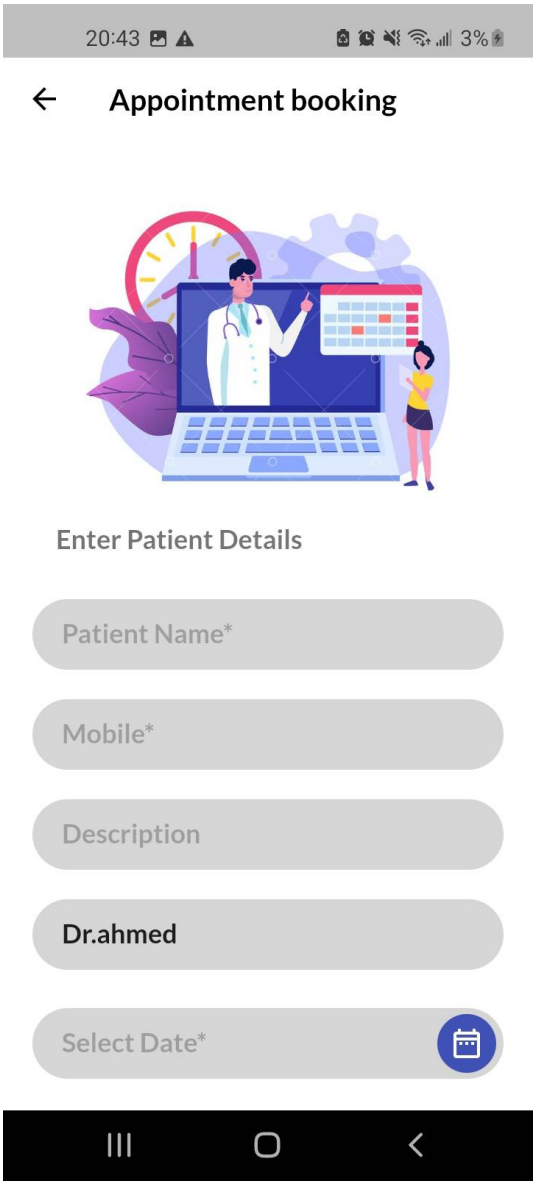

Figure III.16: Presentation Of Appointment Booking Interface.

III.5.2.7 Appointment Schedule Interface

With the interface III.17 appointment scheduling interface, users can easily book, reschedule, and cancel appointments, providing a seamless and efficient experience.

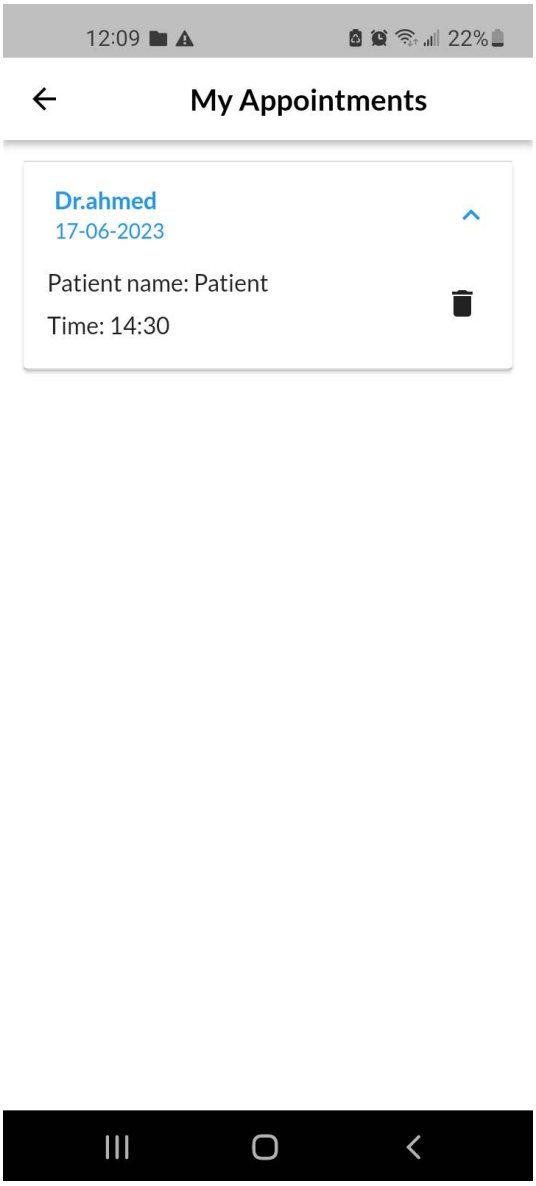

Figure III.17: Appointment Schedule Interface

III.5.2.8 Conversation Interfaces

Our mobile app facilitates seamless communication between patients and doctors through a user-friendly conversation interface, empowering patients to easily discuss their health concerns and seek medical advice.

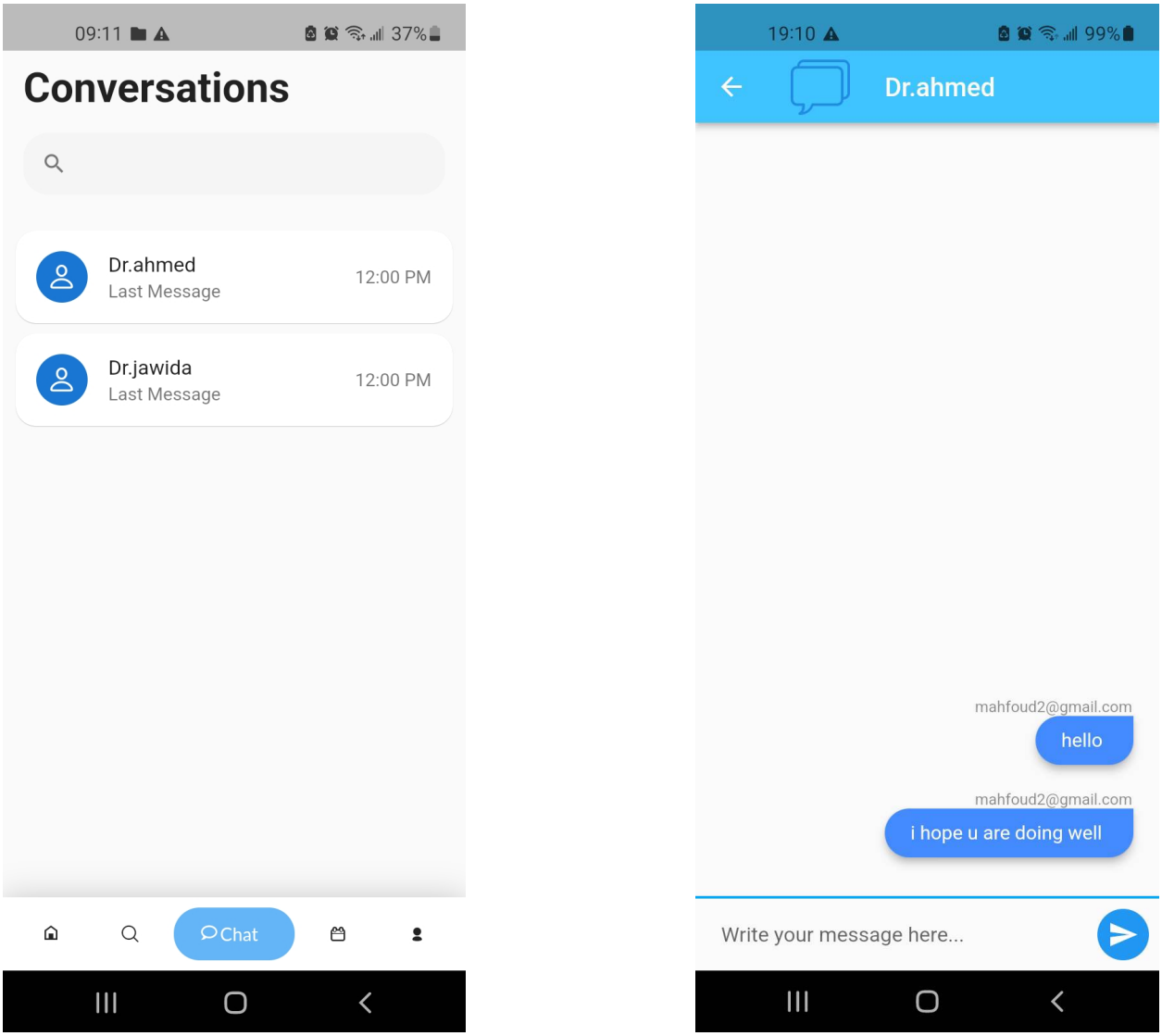

Figure III.18: Conversation Interfaces.

III.5.2.9 Other Features Interfaces

The mobile application provides 3 main features for the patient:

- Medical news to keep him updated with latest information in the medical field.
- Statistic about latest disease (covid-19).
- Personal health record where health data and other information related to the care of a patient is maintained by the patient.

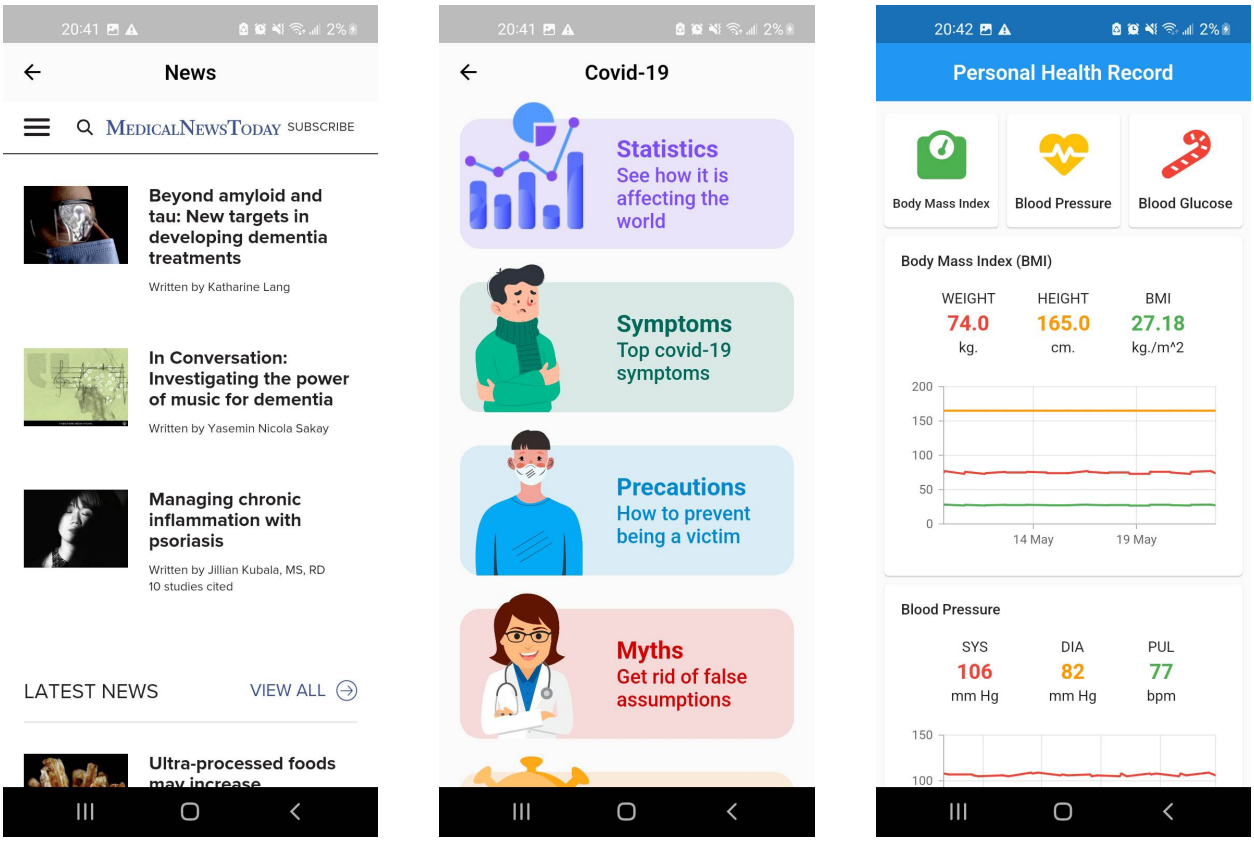

Figure III.19: Features Interfaces.

III.5.2.10 Admin Panel

Enables administrators of the application system to manage its content, and features (add and delete users and doctors freely and give full control over the data) and carry out oversight functions critical to the application. It also allows admins to view the state of the platform like the number of users and many more.

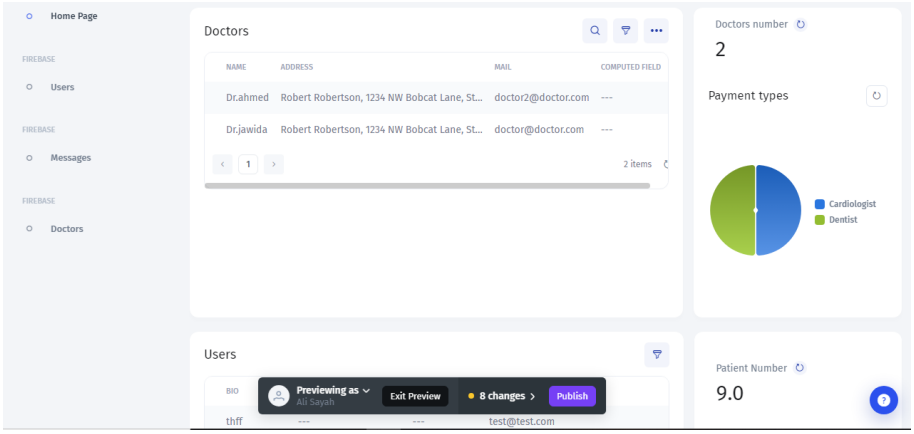

Figure III.20: Home Page Interfaces.

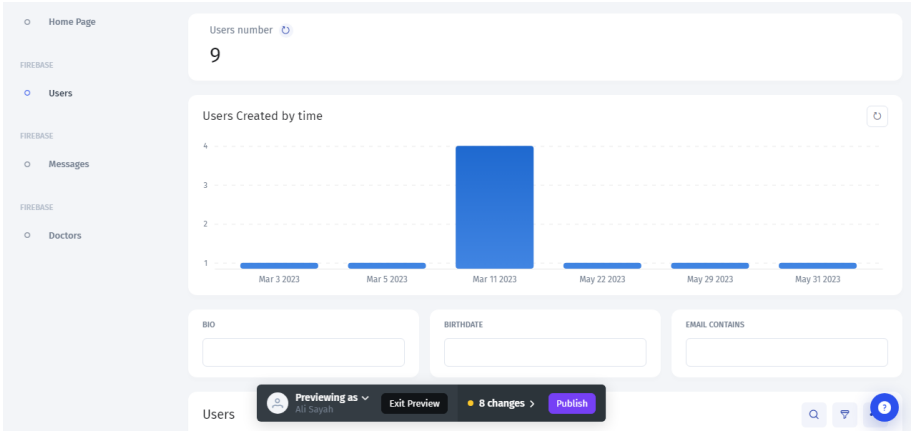

Figure III.21: User Admin Panel Interfaces.

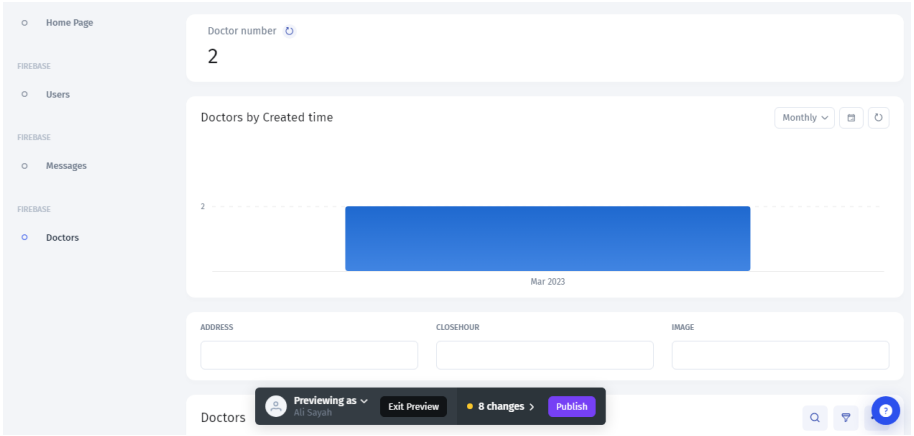

Figure III.22: Doctor Panel Interfaces.

III.6 Conclusion

In conclusion, this chapter delved into the practical aspects of developing our application, encompassing the essential development tools required for its operation. We presented an overview of the development environment, including Android Studio, Flutter, Emulator, and Android SDK. Moreover, we discussed the development languages utilized, such as Dart and Firebase, providing insights into their functionalities and services. Additionally, we explored the DoctoriDz visual identity, including the healthcare graphic charter and the application logo. Finally, we unveiled the application by showcasing its architecture and various user interfaces, ranging from onboarding and login/register interfaces to patient and doctor profile interfaces, appointment booking and scheduling interfaces, conversation interfaces, and other feature interfaces. Through this comprehensive exploration, we have laid a solid foundation for the subsequent chapters that will delve deeper into the implementation and results of our application.

General Conclusion

Our end-of-study project aimed to set up a full healthcare mobile application to facilitate communication between patients and doctors and for scheduling medical applicationointments. For this, we realized an interactive mobile application allowing to manage the different treatments of this activity and to satisfy the needs of the different users involved in this process.

This document started with a general description of the field of healthcare industry. We first defined this industry by giving an overview of Heathcare and its categories, and discussed the strategies recommended for the development of these applications. We then provided an overview of mobile applications and described the advantages that these applications have brought to the medical field, especially in the telemedicine area.

In the second part of this thesis, we identified the objectives and the main functionalities of the platform to be implemented. We presented the different stages of the design, starting with the needs analysis and the specification of the requirements. We then modeled the identified functionalities using the UML formalism to satisfy the needs of the end users of our platform. In addition, we made justified choices of technologies before moving on to implementation.

Finally, we proceeded to the realization part of our project by developing our two mobile and web applications under the Android platform with Flutter and by implementing our database with Firestore provided by Firebase.

This project was the subject of an interesting and enriching experience, which allowed us to improve our knowledge and skills in the field of development and design of complex systems.

However, there are prospects for improving our application that remain essential. We plan to add new functionalities such as call-home services, as well as the computerization of medical records, which will facilitate the follow-up of patients by their doctors and provide better management of medical practices.

Bibliography

[Alc19] Etienne Alcouffe. “A quoi sert Firebase, la plateforme mobile de Google?” In: *junto.fr/blog/firebase* (2019).

[Alj+21] Shadi A Aljawarneh et al. “A systematic review on mobile health applications in healthcare”. In: *Procedia Computer Science* 187 (2021). Accessed on March 30, 2023, pp. 150–157. DOI: 10.1016/j.procs.2021.03.037. URL: https://www.sciencedirect.com/science/article/pii/S2405844021007428.

[AMM03] Usman Arshad, Cecilia Mascolo, and Marcus Mellor. “Exploiting mobile computing in health-care”. In: *Proceedings of the demo session of the 3rd international workshop on smart appliances, ICDCS03*. Citeseer. 2003.

[Assce] American Telemedicine Association. *What is Telemedicine?* Accessed 2023. URL: https://www.americantelemed.org/resource/why-telemedicine/what-is-telemedicine/.

[Assnd] American Telemedicine Association. *A Brief History of Telemedicine*. Accessed on March 11, 2023. n.d. URL: https://www.americantelemed.org/resource/why-telemedicine/.

[Bra22] Brahim Brahamia. “The Health Care System in Algeria”. In: (2022).

[Buind] BuildFire. *Mobile App Development Trends*. https://buildfire.com/mobile-app-development-trends/. Accessed: June 13, 2023. n.d.

[Chi] *Chifa Mobile*. Website. Retrieved from https://chifamobile.com/.

[Cin17] Jacques Cinabre. *Télémédecine, la vraie médecine de proximité*. French. Strasbourg: Editions du Signe, 2017, p. 257.

[Darce] Dart official website. *What is Dart?* Accessed on 2023-03-17. URL: https://dart.dev/overview.

[Eur] European Observatory on Health Systems and Policies. *Health Care Delivery*. European Observatory on Health Systems and Policies. URL: https://eurohealthobservatory.who.int/themes/health-system-functions/health-care-delivery (visited on 03/11/2023).

[Eys+01] Gunther Eysenbach et al. “What is e-health?” In: *Journal of Medical Internet Research* 3.2 (2001), e833.

[Flu21] Flutter. *Flutter*. https://flutter.dev/. Accessed: March 17, 2023. 2021.

[Fow03] Martin Fowler. *UML Distilled: A Brief Guide to the Standard Object Modeling Language*. Addison-Wesley Professional, 2003.

[Fra] ZDNet France. *Chiffres clés: les OS pour smartphones*. https://www.zdnet.fr/actualites/chiffres-cles-les-os-pour-smartphones-39790245.htm. Consulted today.

[Goo21] Google. *Run apps on the Android Emulator*. https://developer.android.com/studio/run/emulator. Accessed: March 17, 2023. 2021.

[Goo23a] Google. *Android SDK Tools Documentation*. https://developer.android.com/studio/command-line?hl=fr. Accessed: June 22, 2023. 2023.

[Goo23b] Google. *Android Studio Documentation*. https://developer.android.com/studio/intro?hl=fr. Accessed: June 22, 2023. 2023.

[Hea22] Manzil Health. *Levels of Healthcare*. 2022. URL: https://manzilhealth.com/levels-of-healthcare/ (visited on 03/14/2023).

[Hxd] *HEALTH EXPERIENCE DESIGN CONFERENCE*. Conference. Accessed: June 22, 2023. 2022.

[Khi] Khidma Tech. *DZDOC*. https://dzdoc.com/. Accessed: June 22, 2023.

[KS18] Chunnu Khawas and Pritam Shah. “Application of firebase in android app development-a study”. In: *International Journal of Computer Applications* 179.46 (2018), pp. 49–53.

[KY] Lahchem Kasmia and Kaci Yacine. “Telemedicine and the introduction of ICT As a tool for developing the health system in Algeria”. In: ().

[Lib13] Matthew J. Liberatore. “Six Sigma in healthcare delivery”. In: *International Journal of Health Care Quality Assurance* 26.7 (2013), pp. 601–626.

[Min] Ministère de la Santé, de la Population et de la Réforme Hospitalière. *SihaDZ*. https://play.google.com/store/apps/details?id=com.sante.gov.dz&hl=fr&gl=US. Accessed: June 2023.

[Nat] National Institutes of Health. *Title of the Webpage*. https://www.nih.gov/. [Accessed: May 10, 2023].

[Org] World Health Organization. *Healthcare*. URL: https://www.who.int/health-topics/health-systems (visited on 03/12/2023).

[Org10] World Health Organization. *Telemedicine: opportunities and developments in Member States: report on the second global survey on eHealth*. Accessed March 11, 2023. 2010. URL: https://www.who.int/goe/publications/goe_telemedicine_2010.pdf.

[PD+18] Anachack Phongtraychack, Darya Dolgaya, et al. "Evolution of mobile applications". In: (2018).

[PLB13] François Poirier, Mireille Lehoux, and Louise Briand. *Étude sur les besoins de compétences dans le développement d'applications mobiles*. TechnoCompétences, comité sectoriel de main-d'oeuvre en technologies de l'informatique et des communications, 2013.

[Rou13] H. Rouini. *Introduction aux systèmes d'exploitation mobiles*. Hermes Science Publications, 2013.

[RS14] André Ribeiro and Alberto Rodrigues da Silva. "Development of mobile applications using a model-driven software development approach". In: *Instituto Superior Técnico Lisbon, Portugal* (2014).

[Sar+17] Zoubir Sari et al. "Telemedicine and e-health in Algeria facing challenges in medical practice". In: *Medical Technologies Journal* (2017).

[SNBF13] Robert Sowah, Joana Nkrumah-Buadu, and Seth Y Fiawoo. "Design and development of a personal health monitoring system on Android mobile platform". In: *Vol* 5 (2013), pp. 1313–1321.

[Tecbl] Space-O Technologies. *Types of Mobile Apps*. Space-O Technologies. Publication Year. URL: https://www.spaceotechnologies.com/blog/types-of-mobile-apps/.

[Uniar] United Nations Development Programme (UNDP) Vietnam. *Scaling a Doctor for Everyone: Telehealth System in 10 Provinces*. https://www.undp.org/vietnam/press-releases/scaling-doctor-everyone-telehealth-system-10-provinces. Accessed on Date. Year of publication.

[Uns] *Unsplash - Telemedicine*. https://unsplash.com/fr/s/photos/telemedicine. Accessed July 8, 2023.

[Wornd] World Health Organization. *Health Systems*. Accessed June 11, 2023. n.d. URL: https://www.who.int/health-systems/en/.

[Zer16] M Zerktouni. *Application mobile: Définition et typologie*. Taktil. 2016. URL: https://www.taktilcommunication.com/blog/applications-mobile/definition-typologie-applications-mobiles.html.