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eHealth Connect. Mobile Appointment and Health Record System

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الملخص

تتجه الأنظمة الصحية المعاصرة نحو التحول الرقمي لتجاوز قيود الأنظمة الورقية التقليدية. في هذا السياق، يقدم هذا المشروع منصة "نبراس الصحة" كحل رقمي متكامل يربط ستة أطراف أساسية في المنظومة الصحية: المريض، الطبيب، المساعد الطبي، الصيدلي، المخبر، والإداري.

تم تطوير النظام وفق بنية ثلاثية الطبقات Monolithic Architecture حيث شُيدت الواجهة الخلفية بلغة PHP مع قاعدة بيانات MySQL بينما طُوّر تطبيق الأندرويد بلغة Java. يتم التواصل بين المكونات عبر REST API بصيغة JSON. يتميز النظام بآلية حجز ذكية تمنح الأولوية للمرضى السابقين، مع دعم إرسال الوصفات الإلكترونية للصيدليات وطلبات التحاليل للمخابر. كما يوفر إشعارات فورية عبر التطبيق وSMS باستخدام مودم GSM، ولوحات تحكم مخصصة لكل دور، وإدارة اشتراكات وإحصائيات متقدمة، ودردشة آمنة.

خضع النظام لاختبارات وظيفية على محاكي Pixel 3 بنظام Android 13، وأظهر نتائج مشجعة. يساهم المشروع في رقمنة العيادات الصغيرة بتكلفة منخفضة، ويشكل أرضية لتطويرات مستقبلية كالذكاء الاصطناعي والطب عن بعد.

الكلمات المفتاحية: الصحة الرقمية، نظام معلومات صحي، حجز المواعيد الذكي، الوصفات الإلكترونية.

Abstract

Contemporary healthcare systems are undergoing digital transformation to overcome the limitations of traditional paper-based methods. In this context, this project presents "Nibras esiha", an integrated digital platform connecting six key actors within the healthcare ecosystem: patient, doctor, medical assistant, pharmacist, laboratory, and administrator.

The system was developed following a three-tier monolithic architecture. The backend was built using PHP with a MySQL database, while the Android application was developed in Java. Communication between components is ensured through a REST API using JSON format. The platform features a smart appointment booking mechanism that prioritizes returning patients, supports electronic prescription transmission to pharmacies and test requests to laboratories, and provides real-time notifications both in-app and via SMS using a GSM modem. It also offers role-specific dashboards, subscription management (15-day free trial followed by monthly/yearly plans), advanced analytics, and secure chat functionality.

The system was functionally tested on a Pixel 3 emulator running Android 13 (API 33) and demonstrated promising results. This project contributes to the digitalization of small clinics at low cost and provides a foundation for future enhancements such as artificial intelligence and telemedicine.

Keywords: Digital health, health information system, smart appointment booking, electronic prescriptions.

Dedication

"To every stumble that taught me that endings are nothing but new beginnings, and to every dream that was a light guiding me through the paths of hardship.To myself, who carried silence as patience, determination as a weapon, and faith that success is built before it is celebrated. To my dear father, ***[Alloui debbache]****, my support before I asked for support, and my hope before I spoke it. To the one who tired himself for my comfort and sacrificed for my future. No matter how much I write, I will never give you your due. You are the pride of my life and the most beautiful blessing. To my beloved mother,* ***[Houria]****, the heart that never stopped praying, and the embrace where I find safety whenever life weighs me down. To the one who was my source of strength in every weakness and my light in every darkness. To my brothers and my sisters The companions of my childhood and the partners of my journey. Thank you for every word of encouragement and every sincere gesture. To my friends who shared the details of this journey with me, eased the weight of difficult days, and left unforgettable moments in my memory. And to everyone who offered me a helping hand, a word of encouragement, or a sincere prayer you all have a part in this achievement. This success was not my effort alone, but the fruit of your love, support, and trust in me. This achievement is for you, from you, and because of you.."*

Debbache achouak

"In the name of Allah, the Most Gracious, the Most Merciful. To those who carried me before the days could carry me, and who nurtured me with knowledge and compassion before I ever read my first book. To my beloved parents: my father, who taught me determination, and my mother, whose prayers were a light illuminating my path. To my dear brothers, the lifelong support. To my friends who shared with me the fatigue, the books, and the sleepless nights. And to everyone who crossed my path with an encouraging word or a sincere prayer. I dedicate to you the modest fruit of my effort, and this achievement, which would never have been completed without your presence in my life."

Belhadi H

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We also extend our sincere thanks and appreciation to the esteemed members of the jury committee for kindly accepting to evaluate this work, and for the valuable observations and constructive suggestions they will provide to enrich and improve it.

We also extend our thanks to all our distinguished professors who played a key role in our academic and intellectual development throughout our university journey. They have been beacons of knowledge and lamps of wisdom.

We cannot but express our deep gratitude to everyone who offered us a helping hand, a word of encouragement, sincere advice, or support that had an impact on continuing this journey and completing this achievement.

Finally, we ask Allah Almighty to reward everyone who contributed to the completion of this work with the best of rewards, and to place what they have offered in the balance of their good deeds.

And all praise be to Allah, the Lord of the worlds.

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List of Acronyms and Abbreviations

AI	Artificial Intelligence
API	Application Programming Interface
AWS	Amazon Web Services
C4	Context, Containers, Components, and Code
CSS	Cascading Style Sheets
EC2	Elastic Compute Cloud
EHR	Electronic Health Record
GDPR	General Data Protection Regulation
GSM	Global System for Mobile Communications
HIPAA	Health Insurance Portability and Accountability Act
HIS	Health Information System
HTML	HyperText Markup Language
HTTP	HyperText Transfer Protocol
HTTPS	HyperText Transfer Protocol Secure
IoMT	Internet of Medical Things
JSON	JavaScript Object Notation
PHP	PHP: Hypertext Preprocessor
RCM	Revenue Cycle Management
RDBMS	Relational Database Management System
RDS	Relational Database Service
REST	Representational State Transfer
SaaS	Software as a Service
SDK	Software Development Kit
SMS	Short Message Service
SQL	Structured Query Language
TLS	Transport Layer Security
UI	User Interface
UML	Unified Modeling Language

UX	User Experience
VS Code	Visual Studio Code
XAMPP	Cross-Platform, Apache, MySQL, PHP, and Perl

General Introduction

The healthcare sector in Algeria is undergoing a fundamental digital transformation, driven by the increasing demand for efficient, accessible, and patient-centered services. Traditional paper-based systems, which have long been the backbone of medical record keeping and appointment management in Algeria, are proving insufficient in addressing the growing complexities of modern healthcare delivery. These conventional methods suffer from significant limitations, including human error, time-consuming processes, high operational costs, and fragmented communication between healthcare providers and patients. Consequently, there is an urgent need for integrated digital platforms that can streamline healthcare operations while ensuring data security and ease of access.

Recent technological advancements, particularly in cloud computing, mobile applications, and web-based systems, have opened new possibilities for healthcare management. Electronic Health Records (EHRs), telemedicine platforms, and mobile health (mHealth) applications have emerged as powerful tools to enhance service quality, reduce waiting times, and improve patient outcomes. However, many existing solutions remain either too expensive for small and medium-sized clinics in Algeria, lack integration with local pharmacies and laboratories, or fail to address the specific needs of the Algerian market.

- **Key Research Aspects:**
  - Current state of digital healthcare management systems
  - Critical challenges in patient-data interoperability
  - Emerging needs for integrated pharmacy and laboratory connectivity
- **Core Problems Identified:**
  - Fragmented communication between patients, doctors, and pharmacists
  - Lack of real-time notification systems for appointment and prescription status
  - Absence of smart priority-based appointment booking mechanisms
- **Study Objectives:**
  1. Development of an integrated healthcare platform (Health Connect)

2. Implementation of a smart priority-based booking system
3. Integration of pharmacy and laboratory services via REST API

- **Methodological Framework:**
  - System analysis and requirement specification
  - Prototype design using UML and C4 modeling
  - Implementation and validation through practical testing
- **Document Organization:**
  - Chapter One: Overview of Current Healthcare Management Systems
  - Chapter Two: System Design
  - Chapter Three: Implementation
  - Chapter Four: Economic Feasibility Study, Business Model

This project, named Health Connect, aims to design and implement an integrated digital healthcare platform that bridges the gap between patients, doctors, pharmacists, medical assistants, laboratories, and administrators. The platform consists of two main components: a mobile application for patients (developed using Java within Android Studio) and a web platform for healthcare providers and administrators. Both components communicate via RESTful APIs with a centralized backend server and MySQL database.

The platform implements a smart booking system with priority-based appointment confirmation, giving preference to returning patients while respecting maximum slot limits per time period. Additionally, a database-driven notification system delivers real-time alerts for appointment confirmations, prescription readiness, test result availability, and queue position updates. The platform also supports SMS notifications via a GSM modem connected to the local server, ensuring that patients receive critical alerts such as queue position updates and prescription readiness even when they are not actively using the application. The system also supports electronic prescription transmission to pharmacies, test request submission to laboratories, and secure messaging between patients and providers.

Through this project, theoretical knowledge is combined with practical implementation to provide a scalable, secure, and user-friendly healthcare management solution tailored to the needs of emerging markets. The platform demonstrates how modern web and mobile technologies can be effectively integrated to improve healthcare delivery, enhance communication, and reduce operational costs for small and medium-sized clinics.

Chapter 1

Overview of Current Healthcare Management Systems

1.1 Introduction

The healthcare sector is undergoing rapid digital transformation, with technology reshaping medical service delivery and health institution administration. Electronic appointment scheduling and digital health record systems have emerged as pivotal solutions, enhancing service quality, operational efficiency, and communication between providers and patients. However, the diversity of these systems raises questions about their effectiveness in meeting real user needs, especially given the gaps between available solutions and emerging market demands. This chapter examines the current state of electronic health systems, tracing their evolution, categorizing different models, and analyzing prominent applications. It aims to identify shortcomings within existing solutions and delineate the gap that the proposed Health Connect project intends to bridge, establishing a theoretical foundation for subsequent design and implementation phases.

1.2 Comprehensive Overview of Contemporary Healthcare Management Systems

1.2.1 Traditional Paper-Based Systems

For decades, healthcare institutions relied almost exclusively on conventional paper-based methods for data capture and workflow coordination. Patient registration involved manual forms completed each visit, appointment scheduling was limited to telephone calls during working hours or required physical presence, and medical records were stored as voluminous paper files in institutional archives, demanding substantial and ever-expanding physical space[1].

The principal constraints of traditional systems include:

- **Human Error Vulnerability:** Manual data entry led to frequent inaccuracies, including appointment duplication or missed cancellations. Deciphering handwritten prescriptions posed serious risks of medication errors, and minor scheduling mistakes could disrupt entire clinic workflows, causing long queues and patient frustration [1, 2].
- **Temporal and Physical Demands:** Locating patient files among thousands of documents consumed critical time, especially in emergencies. Information retrieval required extensive human effort, increasing operational costs and slowing workflows. Processing referrals could take hours or days due to reliance on fax and paper correspondence [1, 3].
- **Financial Implications:** Paper-based systems incurred significant costs for physical storage, archival maintenance, and additional personnel. Dependence on fax and printing consumed large quantities of supplies, markedly raising operational expenditures [3, 4].
- **Accessibility Constraints and Collaborative Limitations:** Paper records confined to single locations prevented simultaneous access by multiple providers. Inter-institutional record sharing was nearly impossible without complex, time-consuming procedures, compromising care continuity [1].
- **Security and Privacy Concerns:** Paper documents were vulnerable to loss, damage from fire or water, and deterioration over time. Protecting them from unauthorized access or theft was challenging without digital safeguards [1, 4].
- **Communication Deficiencies:** Interdepartmental communication was often problematic, causing delays and task overlap. The lack of centralized referral tracking led to misplaced or delayed documentation [3].

1.2.2 Centralized Institutional Frameworks: HIS and EHR

As information technology advanced and demand for enhanced healthcare sector efficiency intensified, centralized institutional systems emerged as comprehensive solutions designed to transcend the limitations inherent in traditional approaches. These systems can be broadly classified into two primary categories: Health Information Systems (HIS) and Electronic Health Records (EHR) [4, 5].

Health Information Systems (HIS)

A Health Information System constitutes an integrated digital platform employed within healthcare institutions to coordinate various medical, administrative, and financial operations

within a unified environment. This infrastructure consolidates all essential software tools required by healthcare facilities, aiming to streamline daily processes and elevate operational efficiency [4, 5].

Fundamental Characteristics of HIS:

- **Data Centralization:** The system consolidates all health information into a singular unified repository, facilitating simplified access and cross-departmental sharing [5].
- **Process Automation:** It automates administrative and medical procedures, thereby reducing manual intervention while minimizing human error incidence [5].
- **Functional Integration:** HIS integrates diverse institutional functions within a single platform, encompassing patient registration, appointment scheduling, laboratory and pharmacy administration, as well as invoicing and payment processing [5].
- **Decision Support Capabilities:** It generates analytical reports assisting management in formulating informed decisions regarding resource allocation and performance optimization [5].

Electronic Health Records (EHR)

Electronic Health Records represent the digital equivalent of traditional paper-based medical files. These records contain comprehensive information pertaining to patient medical histories, including demographic data, clinical diagnoses, laboratory outcomes, pharmaceutical prescriptions, and radiological imagery. By centralizing and aggregating health data, EHRs enable access and analysis facilitating extraction of valuable insights contributing to enhanced patient care quality[5].

Advantages of Centralized Institutional Systems:

- **Care Quality Enhancement:** These systems provide accurate, comprehensive patient information in real-time, assisting in medical error reduction while improving diagnostic and therapeutic processes. Availability of complete medical histories to treating physicians facilitates more precise clinical decision-making [4, 5].
- **Operational Efficiency Improvement:** Automation of administrative and medical procedures accelerates workflow while reducing time expended on data retrieval or manual entry, enabling medical personnel to concentrate on patient care activities [4].
- **Rapid Information Accessibility:** Digital systems enable real-time information retrieval, proving particularly critical during emergencies requiring swift clinical decisions [1, 5].

- **Interdepartmental Coordination Enhancement:** These systems improve communication between various institutional departments, reducing delays and minimizing task duplication [4].

Financial Considerations for Centralized Systems:

These systems necessitate relatively substantial financial investments, particularly during initial implementation phases. Associated costs encompass software license acquisition, hardware and infrastructure procurement including servers, computers, and networking equipment, training expenses for medical and administrative personnel, ongoing maintenance and technical support, plus periodic system updates [1, 4].

Deployment Challenges for Small-Scale Facilities:

Small and medium-sized clinics face significant challenges when adopting centralized institutional systems. High costs create barriers for facilities with limited budgets unable to invest in technical infrastructure. System complexity requires specialized expertise often unavailable in clinics lacking IT departments. Implementation may encounter resistance from staff accustomed to paper-based workflows, necessitating intensive training. Additionally, clinics struggle with integration difficulties due to absent interoperability standards [1, 6].

1.2.3 Current Market Trends: Cloud and Mobile platforms

Recent years have witnessed fundamental transformation in healthcare systems markets toward solutions grounded in cloud computing and platforms optimized for mobile devices. This shift, propelled by converging technological, economic, and social factors, fundamentally restructures global health service delivery mechanisms [6].

Cloud-Based Healthcare Solutions

Cloud-dependent solutions rely on storing, managing, and processing medical data and applications through secure cloud platforms rather than internal servers within healthcare institutions. This model offers numerous advantages rendering it particularly appealing, especially for small and medium-sized clinics [6].

Cloud Solution Benefits:

- **Cost Reduction:** Cloud solutions eliminate requirements for significant capital investments in server and hardware acquisition, adopting pay-as-you-go models facilitating more effective budget management [6].

- **Scalability:** Cloud service scope can be readily expanded or contracted according to healthcare institution requirements without substantial additional investment [6].

- **Flexibility:** They enable data and application access from any location at any time, supporting remote work models and geographically dispersed team collaboration [5].
- **Continuous Updates:** Service providers assume responsibility for software updating and maintenance, ensuring healthcare institutions consistently benefit from latest features and highest security standards [6].

Market Statistics:

Specialized reports indicate the global healthcare cloud computing market reached approximately $39.0 billion in 2022, with projections estimating growth to $91.3 billion by 2028, registering a compound annual growth rate of 15.0% . Furthermore, the Software-as-a-Service (SaaS) healthcare market is experiencing accelerated expansion driven by increasing demand for digital solutions [6, 7].

Mobile-First Healthcare Platforms

With widespread smartphone proliferation, mobile health applications (mHealth) have become indispensable tools for health service delivery. These platforms provide enhanced user experiences tailored for mobile devices, meeting modern patient expectations regarding appointment management and health records accessibility via smartphones [8, 9].

Mobile Platform Advantages:

- **24/7 Service Accessibility:** They empower patients to book appointments and access health information around the clock, beyond official working hours [8].
- **Enhanced Patient Experience:** They offer intuitive interfaces enabling seamless provider interaction, automatic appointment reminders, and convenient test result monitoring [8].
- **Small Clinic Empowerment:** These platforms enable small clinics to offer services competitive with larger institutions at reasonable costs, thereby narrowing digital divides among healthcare providers [9].

Market Statistics:

According to specialized reports, the Patient-Centric Healthcare Applications market reached approximately $25.03 billion in 2025, projected to reach $239.87 billion by 2032, exhibiting a compound annual growth rate of 38.11% [9].

Drivers of Cloud and Mobile Transformation:

- **COVID-19 Pandemic Impact:** The pandemic accelerated remote care and telemedicine service adoption, highlighting cloud solution importance in facilitating smooth patient data exchange between health professionals and patients regardless of geographical barriers [7, 9].

- **Cost Efficiency Demand:** With global healthcare costs rising, institutions increasingly adopt cloud solutions to optimize resource allocation and reduce infrastructure expenditures [6].
- **Widespread Smartphone Adoption:** Increasing smartphone reliance, particularly in developing nations, fuels demand for mobile health applications offering affordable health services [9].
- **Real-Time Data Requirements:** Cloud and mobile systems provide access to precise, updated information, supporting improved clinical and administrative decision-making [4].

Key Market Participants: The healthcare cloud solutions market encompasses numerous major global corporations including Cerner Corporation, Allscripts, Athenahealth, and Epic Systems Corporation, alongside technology giants such as Microsoft and Amazon (AWS) providing specialized cloud infrastructure for the healthcare sector [7].As illustrated in Figure 1.1, key milestones of digital health evolution from 1989 to 2023:

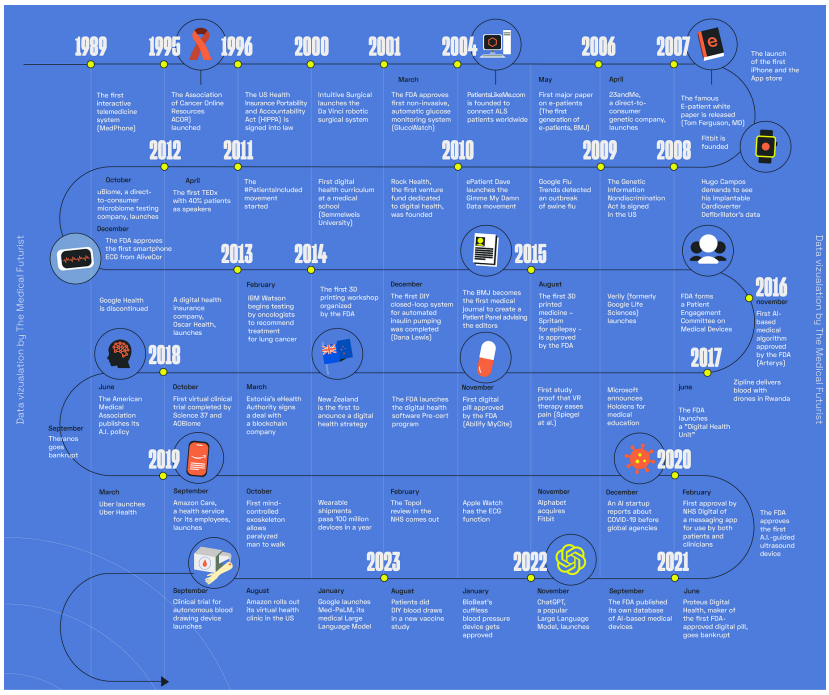

Figure 1.1: Timeline of digital health milestones from 1989 to 2023, highlighting key events such as the introduction of telemedicine, the enactment of HIPAA, the emergence of wearable devices, and the integration of artificial intelligence into medical practice. (Source: The Medical Futurist, 2023)

1.3 Comparative Analysis of Similar and Competing Systems

1.3.1 Patient-Facing Applications Category

Patient-facing applications constitute the digital interface enabling users to interact with healthcare systems and access medical services with enhanced ease and flexibility. These applications vary between established international platforms and emerging local alternatives, though they share fundamental objectives of improving patient experience while reducing administrative friction [10].

International Examples:

Zocdoc: represents a pioneering digital platform for online medical appointment scheduling, established to facilitate physician discovery and appointment booking through seamless, reliable mechanisms [3].

Key features include:

- Guided Search functionality assisting patients in identifying appropriate care providers based on unique requirements, covering over 250 specialties and more than 18,000 insurance plans [3].

- Ability to schedule both in-clinic and online appointments [3].

- Access to verified reviews from previous patients [3].

Primary advantages encompass comprehensive tool suites for patient management and health records, alongside cloud-based architecture enabling universal accessibility with regular software updates and systematic maintenance. However, notable drawbacks include absence of provider-network matching guarantees when utilizing health insurance, and geographical service limitation to specific countries [4].

MyChart: evolved as an integral component of Electronic Health Record (EHR) systems developed by major healthcare institutions such as Epic Systems. It represents patient portals enabling secure access to personal health information and care provider interaction [6, 8].

Principal features include:

- Laboratory result viewing and medical history access.

- Medication lists and previous visit summaries.

- Appointment scheduling and cancellation.

- Secure medical team communication.

- Prescription renewal requests and electronic bill payment [6, 8].

Its strength derives from deep integration with patient electronic health records, providing comprehensive, unified health data perspectives, consistent user experiences across mobile and web interfaces, and 24/7 availability . The primary weakness involves institutional specificity, potentially requiring multiple portals for patients receiving care across different facilities [6, 8].

Local Examples:

eTabib: is an Algerian e-health platform offering physician discovery, appointment booking, and remote consultation services [3].

Key features include:

- Availability via website and mobile application.

- Over 5,000 Google Play downloads [3].

- More than 20,000 registered health specialists [3].

Its strength lies in local market orientation and mobile accessibility. However, it suffers from interface simplicity, security concerns due to unsecured pages, limited physician features, and inconsistent remote consultation availability .

eSiha (2019): provides online appointment booking, remote consultations, and electronic medical file management through separate applications for patients and physicians [11].

Key features include:

- Patient app with over 50,000 downloads [11].

- 10,850 registered physicians and 77,000 patients [11].

- Approximately 4,000 daily connections [11].

It benefits from a large, growing user base and extensive coverage. However, it remains heavily internet-dependent with potentially limited advanced features.

Beesiha (2020): offers online appointment booking and remote consultations via website and mobile app [11].

Key features include:

- Over 10,000 Google Play downloads [11].

- 800 registered health specialists [11].

Its strength is local emergence addressing Algerian needs, with growing user bases. However, physician numbers remain smaller than competitors like eSiha .

CabiSante: is a desktop-based solution for comprehensive medical practice administration, including queue management, payment processing, and accounting [4].

Key features include:

- User-friendly interfaces requiring no prior experience.

- Suitable for both small and large clinics.

- Excellent technical support.

However, its desktop-only architecture requires individual installation per client, lacks automatic data backup, and operates without internet connectivity .

Common Feature Analysis

The aforementioned applications exhibit several shared characteristics constituting core elements of any patient-oriented application. Appointment scheduling represents fundamental service across all platforms, though implementation details vary considerably. While Zocdoc offers real-time availability displays with immediate booking confirmation, other applications may merely submit requests requiring subsequent confirmation. Prescription viewing and electronic renewal requests constitute advanced features available in sophisticated applications like MyChart. Secure communication through encrypted channels between patients and medical teams enhances condition monitoring while increasing patient satisfaction. Personal health records availability varies significantly, with MyChart offering complete electronic health record access while other applications provide only basic document storage [10].

1.3.2 Clinic Management Platforms Category

Clinic management platforms represent the digital backbone of healthcare institutions, offering integrated solutions for daily operation organization, records management, appointment scheduling, and invoice processing.

International Examples:

DrChrono

DrChrono is an integrated cloud platform combining Electronic Health Records (EHR), appointment scheduling, billing, and Revenue Cycle Management (RCM) within a unified system [4].

Key features include:

- Mobile-centric design optimized for Apple devices including iPad and iPhone [4].

- Over 20 templates for various medical specialties with form and shortcut customization capabilities [4].

- Integrated video consultation features.

- Patient portals enabling online appointment scheduling and bill payment .

Strengths:

- Intuitive, user-friendly interfaces with extensive customization and integration options.

- Cost-effective integrated packages .

Weaknesses:

- Users occasionally report performance delays and software bugs.

- Slow customer service response times.

- Limited Android device support .

SimplePractice

SimplePractice represents an integrated practice management platform specifically designed for mental health professionals, physical therapists, and holistic care providers .

Key features include:

- Tools encompassing scheduling, billing, payments, remote consultations, and insurance claim management [5].

- Customizable clinical note and assessment templates [5].

- Robust Google Calendar, iCloud, and PayPal integration [5].

Strengths:

- Modern, user-friendly interfaces with high usability and value-for-money ratings .

- Wide range of third-party integrations.

Weaknesses:

- Progressively increasing pricing as features are added.

- Certain basic functions available only in higher-tier plans.

- Invoice and superbill customization limitations [4].

Feature Analysis: Schedule Management, Health Records, and Billing

Both platforms offer advanced schedule management tools including real-time appointment displays, automatic reminder transmission, and external calendar synchronization capabilities [4, 5].

Regarding health records, DrChrono provides more comprehensive solutions with specialized templates for various medical specialties , whereas SimplePractice focuses on progress notes and psychological assessments through customizable template libraries [5].

Both platforms maintain HIPAA compliance for health data protection [2, 5].

Concerning billing, DrChrono offers integrated invoicing systems with high clean claim rates and optional Revenue Cycle Management services , while SimplePractice provides simplified billing tools emphasizing online payments and invoices with insurance claim management capabilities [4, 5].

1.3.3 Integrated Services Category

Integrated services represent the next generation of health platforms transcending clinic boundaries to encompass broader service provider networks including pharmacies and laboratories, adopting innovative revenue models redefining patient-provider relationships [3, 7].

Platforms Incorporating External Partners

Healthcare markets are witnessing transformation toward integrated ecosystems connecting various sector participants to deliver seamless patient experiences . Pharmacy and laboratory integration represents rapidly evolving territory, facilitating communication between care providers and pharmacies ensuring patient treatment adherence while improving experiences [7].

Adopted Revenue Models

Health platform revenue models vary considerably across the market. The subscription model predominates in clinic management platforms, with services like DrChrono and SimplePractice charging monthly or annual fees to healthcare providers for software and feature access .

The commission model involves percentage-based fees on platform-mediated financial transactions, while the freemium model represents an innovative approach where platforms remain free for patients, generating revenue through premium subscriptions or in-app sponsorships [7].

1.3.4 Comparative Table Determining Health Connect's Competitive Position

Based on preceding analysis, the following table presents comparative assessment of various systems to determine the competitive positioning of the Health Connect project.

Table 1.1: Comparative analysis of healthcare management systems and Health Connect positioning

Criteria	Zocdoc	MyChart	DrChrono	SimplePractice	eTabib	eSiha	CabiSante	Health Connect
Target Audience	Patients	Institution-specific patients	Small to medium clinics	Mental health and therapy specialists	Patients and physicians	Patients and physicians	Clinics	**Patients, physicians, assistants**
Primary Features	Appointment booking, reviews, insurance integration	Health portal, medical records, secure communication, bill payment	EHR, scheduling, billing, e-prescriptions, mobile app	Scheduling, clinical documentation, billing, patient portal, remote consultations	Appointment booking, remote consultations, physician directory	Appointment booking, consultations, medical file management	Clinic management (desktop)	**Appointment booking, medical records, internal communication, smart assistant, pharmacy/laboratory integration**
Revenue Model	Free for patients, physician payment	Institution-included services	Monthly clinic subscription	Tiered monthly subscription	Unspecified	Unspecified	Unspecified	**Patient Freemium, clinic monthly subscription**
Strengths	Easy interface, extensive database, verified reviews, physician verification	Deep EHR integration, comprehensive data view, consistent user experience	Flexibility, strong customization, excellent iOS mobile app, billing integration	User-friendly, modern design, template library, good support	Local platform, mobile application availability	Large user base, dual applications	User-friendly, suitable for various clinic sizes, excellent support	**Integrated solution combining patients, physicians, and assistants, smart assistant, modern design, local integration gap opportunity**
Weaknesses	US-only availability, certain specialty gaps	Institution-specific, potentially limited features	Occasional slowdowns, slow customer support, limited Android support	Increasing pricing with features, billing customization limitations	Simple interface, security concerns, limited physician features	Heavy internet dependency	Desktop-only application, no automatic backup, per-client installation requirement	**Emerging project requiring user base development, competition with established global solutions**

1.4 Fundamental Operational and Technical Requirements for Modern Systems

1.4.1 User Requirements (Patients)

Patients constitute the central element in any healthcare system; therefore, modern health system design must prioritize their needs and experiences. Patient requirements vary between functional aspects related to usability and elements concerning system trust and security [10].

Usability represents a non-negotiable fundamental requirement, with patients needing simple, clear interactive interfaces enabling effortless navigation across various services. This necessitates intuitive user interface design accommodating diverse user expertise levels while presenting information comprehensibly even to non-specialists [10].

Mobile Accessibility has become imperative in the era of widespread smartphone adoption. Patients expect healthcare service access anytime, anywhere, beyond official working hours without requiring physical clinic visits. Studies indicate over 60% of United States patients utilize mobile health applications for health management [3].

Privacy and Data Security constitute primary patient concerns when engaging with electronic health systems. Patients expect their sensitive medical information to remain confidential and protected from breaches or unauthorized access. Patients must feel confident sharing their medical histories through platforms [1, 4].

Direct Provider Communication represents vital requirements facilitating treatment follow-up processes. Patients require secure communication channels with physicians for inquiry submission, guidance reception, and health status updates [8].

1.4.2 Provider Requirements (Physicians/Clinics)

Physician and clinic needs differ from patient requirements, focusing primarily on operational efficiency enhancement and workflow organization within healthcare facilities [12].

Time Management Efficiency represents paramount priority for physicians facing workload pressures and appointment density. Clinics require intelligent scheduling systems for queue organization and appointment distribution ensuring optimal time utilization [5].

Health Record Integration constitutes fundamental requirements facilitating comprehensive, organized patient information access. Physicians need integrated views of patient medical histories encompassing all previous visits, diagnoses, laboratory results, prescriptions, and imaging within single interfaces [4, 5].

Paperwork Reduction significantly contributes to clinic workflow improvement. Digital systems enable electronic information documentation, digital prescription creation, and electronic report transmission without paper document handling [4].

Simplified Analytics and Intelligent Reports assist physicians and clinic management in understanding facility performance while making informed decisions. Modern systems provide dashboards displaying key performance indicators including appointment volumes, average waiting times, and patient demographic analysis [4].

1.4.3 Fundamental Technical Requirements

Technical requirements constitute the backbone of any modern health system, determining necessary infrastructure ensuring reliable, secure, and scalable performance [2].

Security and Privacy represent critical requirements due to medical data sensitivity.This necessitates multi-layered measures including data encryption during transmission (TLS 1.2+) and storage, the Principle of Least Privilege in access control , and compliance with regulations such as Algerian Law 18-07, HIPAA, and GDPR [13, 14].

Scalability ensures systems accommodate growing users and data volumes without performance degradation through scalable architectures enabling resource addition without complete reconstruction [6].

APIs connect health systems with external entities like laboratories and pharmacies. Effective integration relies on open standards such for structured, unified data exchange [2, 3].

Cross-Platform User Experience requires consistent, smooth experiences across Android and web platforms through responsive interface design adapting to various screen sizes [3, 10]. As illustrated in Figure 1.2, cloud architecture for an integrated healthcare platform with auto-scaling and monitoring:

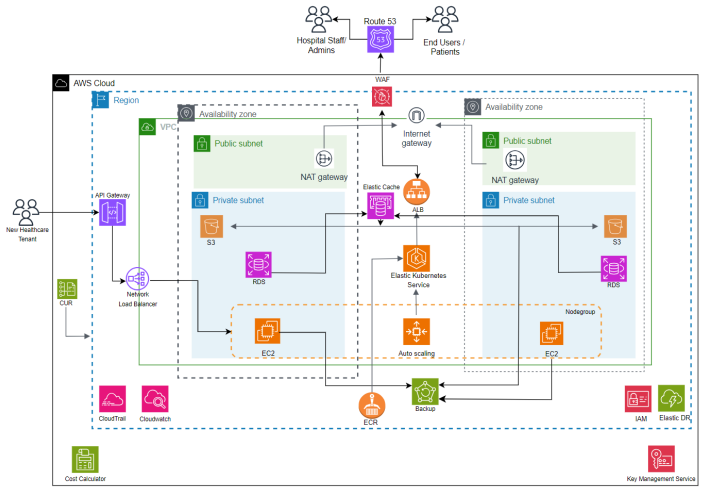

Figure 1.2: AWS cloud architecture for a multi-tenant healthcare platform, illustrating components such as API Gateway, load balancer, EC2 instances, RDS, auto-scaling, and monitoring tools (CloudTrail, CloudWatch) with high availability across availability zones. (Source: AWS / Adapted from GitHub – Cloud-Architecture-Project, 2025)

1.5 Gap Identification and Project Opportunity

1.5.1 Analysis of Existing Solution Deficiencies

In-depth analysis reveals fundamental gaps impeding integrated, effective healthcare experiences. These deficiencies represent structural challenges affecting all stakeholders within the health ecosystem.

1. **Cost Prohibitivity:** Monthly subscription models for integrated systems often exceed $200--300 per provider, with additional fees for advanced features like electronic billing and telemedicine, hindering adoption by small and medium clinics [5, 12].

2. **Lack of Emerging Market Solutions:** Leading global systems are designed for developed markets, focusing on HIPAA compliance and complex insurance integration, while failing to accommodate limited infrastructure, diverse payment patterns, and cultural needs in emerging markets [5, 6].

3. **Limited Local Integration:** Most applications operate in isolation, focusing solely on appointment booking without connecting to laboratories, pharmacies, or imaging centers, disrupting care continuity [3].

4. **Restricted Telemedicine Features:** While platforms like DrChrono offer integrated video consultations, local solutions often lack these features or provide non-integrated implementations, limiting their capacity to meet digital age requirements [5].

5. **Weak Interoperability:** Healthcare institutions frequently operate multiple incompatible systems, fragmenting patient medical records across various platforms and complicating data exchange [2, 3].

6. **Poor User Experience:** Many local applications, such as eTabib, lack intuitive design and smooth interfaces, limiting adoption by both patients and physicians [4].

1.5.2 Health Connect's Gap-Filling Approach

The Health Connect Project: introduces an integrated solution addressing identified market gaps through a unified platform that combines patient and physician requirements, specifically designed for emerging market contexts.

The project's value proposition rests on four key pillars:

1. **Innovative Freemium Model:** Combining free patient access with flexible clinic subscriptions eliminates financial barriers, offering complimentary appointment booking, health record access, and physician communication .

2. **User-Centric Design:** Prioritizing intuitive experiences for all ages through simplified interfaces, while providing comprehensive administrative dashboards for efficient appointment management, patient tracking, and electronic prescription generation .

3. **Seamless Integration:** Adopting FHIR-compatible APIs enables smooth connectivity with laboratories, pharmacies, and imaging centers, creating comprehensive health ecosystems .

4. **Comprehensive Solution:** Delivering appointments, records, and remote consultations within a single affordable platform, eliminating the need for multiple applications.

This integrated approach empowers small and medium clinics to offer competitive services comparable to larger institutions, contributing significantly to reducing digital divides among healthcare providers, particularly in emerging markets .

1.6 Regulatory and Ethical Framework

1.6.1 Health Data Protection Regulations

At the International Level, the United States HIPAA Law represents one of the oldest health data protection legislations, establishing stringent standards for electronic health information protection [4, 5].

Within the European Union, the General Data Protection Regulation (GDPR) imposes even stricter requirements, demanding explicit individual consent for health data processing, with penalties reaching €20 million or 4% of total global annual revenue for violations [4].

At the Local Algerian Level, Law No. 18-07 concerning protection of natural persons in personal data processing was enacted [13].

1.6.2 Digital Medicine Ethics

Information Confidentiality represents non-negotiable ethical and legal obligations[14].

Informed Consent constitutes fundamental medical practice ethics foundations [14].

Digital Divide Avoidance represents significant ethical challenges [13].

1.6.3 Inclusive Design Considerations

Ensuring Elderly Accessibility presents particular challenges amid accelerating demographic shifts.

Ensuring Non-Technical User Accessibility requires adoption of inclusive design principles [14].

1.7 Expected Challenges

1.7.1 User Acquisition Challenge

Acquiring users remains a major obstacle for two-sided health platforms, where success depends on having both doctors and patients active on the system simultaneously . Among patients, adoption barriers include limited awareness of digital health tools and worries about personal data security . For doctors, primary challenges involve reluctance to change their established workflows and concerns that new systems may be overly complicated [1, 5].

1.7.2 Regulatory Compliance and Legal Complexities

Adhering to health data protection laws presents a significant challenge. In Algeria, Law No. 18-07 mandates that patients give explicit consent before their data is processed, along with implementing appropriate security safeguards for sensitive medical information .

Furthermore, the system must maintain comprehensive audit trails and enforce the principle of least privilege when granting access to patient data [13, 14].

1.7.3 System Integration and Cybersecurity Challenges

Integrating the Health Connect platform with existing healthcare systems is challenging due to incompatible legacy systems and weak technical infrastructure . This integration also introduces cybersecurity risks that affect user trust, requiring robust security measures such as data encryption and strict access controls [1, 2, 6]. As illustrated in Figure 1.3, multi-layered security architecture protecting healthcare devices and networks:

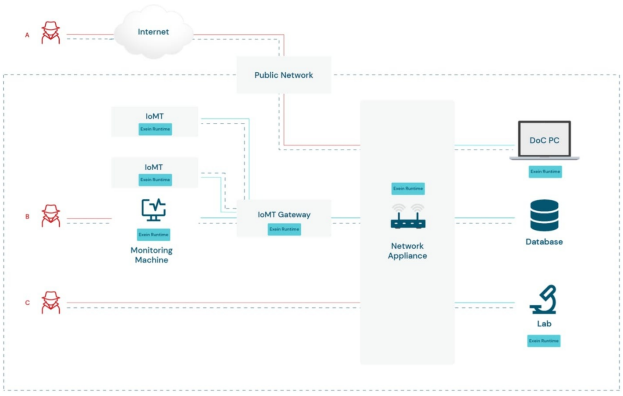

Figure 1.3: Multi-layered runtime security architecture for Internet of Medical Things (IoMT) environments, showing protection deployed across medical devices, gateways, and internal infrastructure (databases, network appliances, laboratories) to defend healthcare networks against cyberattacks. *(Source: Exein, 2025)*

1.8 Conclusion

This study has provided a comprehensive overview of healthcare management systems, tracing their evolution from traditional paper-based methods to modern digital solutions. The analysis revealed structural deficiencies in conventional systems and adoption barriers in centralized platforms related to cost and complexity. Current trends indicate a shift toward cloud-based and mobile solutions, though they lack local integration and customization for emerging markets. The Health Connect project addresses these gaps through an innovative Freemium model combining patient accessibility with flexible clinic subscriptions, offering an integrated platform for appointments, records, and remote consultations at affordable costs. Subsequent sections will present the detailed system design, implementation, and prototyping phases.

Chapter 2

System Design

2.1 Introduction

After analyzing the current state of healthcare management systems in the previous chapter and identifying the market gaps that the proposed Health Connect project aims to address, this chapter moves to the practical design phase. The objective is to translate functional and non-functional requirements into concrete technical blueprints that serve as a reference for development and implementation.

This chapter describes the system's architecture and internal structure, explaining how various components interact.

To formalize the system's structure, we adopt two modeling approaches. First, the C4 Model illustrates the architecture at multiple levels: the System Context Diagram (showing external users and systems) and the Container Diagram (breaking down main logical units). Second, UML diagrams model system behavior and interactions, specifically:

- Use Case Diagrams: define functions for each actor.

- Sequence Diagrams: show message exchange in key processes.

- Activity Diagrams: represent workflow with conditional branches.

- Class Diagram: defines static structure (entities, attributes, relationships).

By the end of this chapter, the reader will understand how the system is designed, how its components interact, and how the technical design aligns with the project objectives. This design serves as the engineering foundation for the implementation phase in the following chapter.

2.2 System Overview

Health Connect is an integrated medical platform connecting patients, doctors, pharmacists, assistants, laboratories, and administrators in a unified digital space. The system operates through a mobile app for patients and a web platform for other users, both communicating with a backend server via REST APIs.

Main Technical Components:

Table 2.1: Main Technical Components of the System

Component	**Description**
Mobile App	For patients: booking, medical records, notifications, and chat functionalities.
Web Platform	For doctors, pharmacists, assistants, laboratories, and administrators.
Database	Stores users, appointments, prescriptions, medical records, and laboratory results.

Actors:
Six main actors interact with the system:

- Patient
- Doctor
- Pharmacist
- Assistant
- Laboratory
- Administrator

The platform is designed using a modular and scalable architecture to support future extensions such as AI-based diagnosis assistance, telemedicine, and interoperability with external healthcare systems.

2.3 System Functionalities

The Health Connect platform provides different functionalities depending on the role of each actor within the healthcare ecosystem.

2.3.1 Patient Functionalities

Patients can create an account and log in securely. They can search for doctors based on specialty and location, then book or cancel appointments as needed. Patients can also view their medical records, including prescriptions, diagnoses, and test results. Additionally, they receive reminder notifications via the app and SMS, as well as alerts when medications or test results are ready. Patients can also chat with healthcare providers, edit their personal information, view their complete medical file, and conduct remote consultations with doctors.

2.3.2 Doctor Functionalities

Doctors can view patient medical records and update health status, as well as add diagnoses and treatment information. They can also view and manage appointments, write and send electronic prescriptions to pharmacies, and send medical test requests to laboratories while viewing test results. Additionally, doctors can conduct remote consultations, manage assistant tasks, activate the smart scheduling feature, edit their personal information, and add working hours and schedules.

2.3.3 Medical Assistant Functionalities

The medical assistant can add and manage bookings, including confirming, deleting, or canceling appointments as needed. After the patient completes their visit, the assistant updates the appointment status to "completed". The assistant can also edit their personal information and view the working hours of the doctor they follow.

2.3.4 Pharmacist Functionalities

The pharmacist can view electronic prescription lists and access prescription details. They can also confirm medication dispensing and update the prescription status accordingly, which automatically sends a notification to the patient informing them that their medication is ready for pickup. Additionally, the pharmacist can manage inventory and edit pharmacy information.

2.3.5 Laboratory Functionalities

The laboratory can receive medical test requests and view the required test details. After completing the analyses, the laboratory uploads the results, allowing the patient to receive an instant notification on their mobile app that their test results are ready, along with the ability to download these results as a PDF file. Additionally, the laboratory can edit its information as needed.

2.3.6 Administrator Functionalities

The administrator can manage users including doctors, pharmacies, and laboratories, and can delete or deactivate accounts as needed. They also monitor user activity, activate subscriptions, and manage payments. Additionally, the administrator can edit their personal information.

2.4 Users (Actors)

Six main actors interact with the system, each with a specific role and platform:

Table 2.2: System Actors and Their Roles

Actor	**Role**	**Platform**
Patient	Requests medical services such as appointments, medical records, and laboratory results.	Android App
Doctor	Provides primary healthcare including diagnoses, prescriptions, and medical test requests.	Web Platform
Pharmacist	Receives electronic prescriptions and prepares medications.	Web Platform
Medical Assistant	Supports doctors with bookings and preliminary patient data management.	Web Platform
Laboratory	Receives medical test requests and uploads laboratory results.	Web Platform
Administrator	Manages users, subscriptions, and oversees the entire platform.	Web Platform

2.5 System Context Diagram

The System Context Diagram is the first level of the C4 model, developed by Simon Brown. It shows the system as a central entity interacting with external actors (such as patients and doctors) and external systems (such as laboratory systems). The goal is to provide a "big picture" view of the system's boundaries and relationships without internal technical details, making it a communication tool for all stakeholders [15, 16].

2.5.1 C4 Model -- System Context Diagram

Figure 2.1 presents the C4 System Context Diagram of the Health Connect platform:

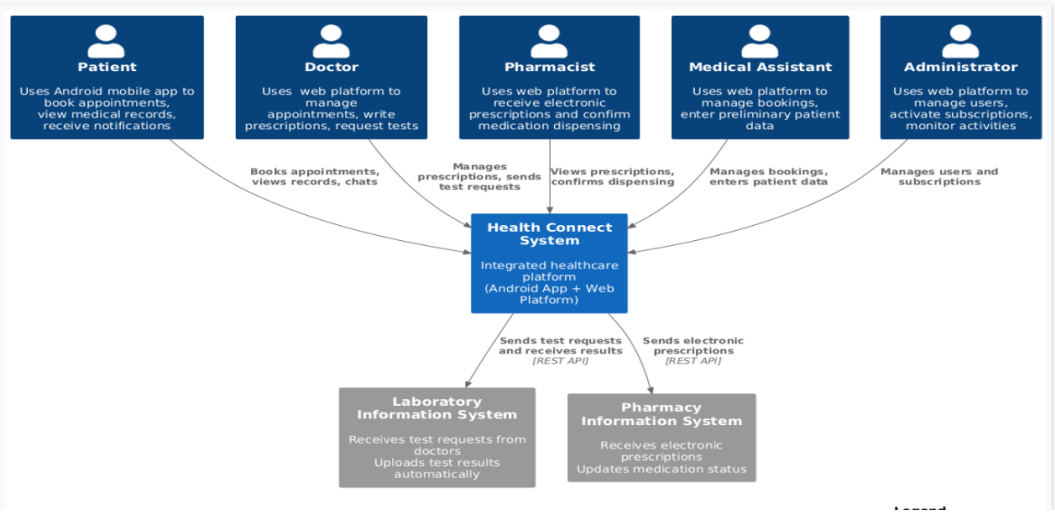

Figure 2.1: C4 Model - System Context Diagram for Health Connect

Actors:

- Patient: Uses Android app to book appointments and view medical records.

- Doctor: Uses web platform to manage appointments, prescriptions, and test requests.

- Pharmacist: Uses web platform to receive electronic prescriptions and confirm medication dispensing.

- Medical Assistant: Uses web platform to manage bookings and enter patient data.

- Administrator: Uses web platform to manage users and activate subscriptions.

External Systems:

- Laboratory System: Receives test requests and uploads results automatically via REST API.

- Pharmacy System: Receives electronic prescriptions and updates medication status via REST API.

2.6 Unified Modeling Language (UML)

Unified Modeling Language (UML) is a standardized graphical language used to create blueprints for software systems. UML can be employed to visualize, specify, construct, and document

the artifacts of a system with a strong software component . It provides a common communication framework for developers, analysts, and stakeholders, enabling them to understand complex system structures through various diagram types such as use case, sequence, activity, and class diagrams [16, 17].

2.6.1 The Importance of Using the Unified Modeling Language (UML)

- Enables professional and organized software design.

- Allows easy and low-cost modifications and maintenance.

- UML diagrams help developers understand the system quickly and easily.

- Serves as a common communication language between developers and designers.

- Provides documentation of the design before programming begins.

- Is independent of any specific programming language or development process.

2.6.2 Types of UML Diagrams

In UML, there are 14 types of diagrams divided into two main categories:

- Structural Diagrams
- Behavioural Diagrams

  As shown in the following figure 2.2:

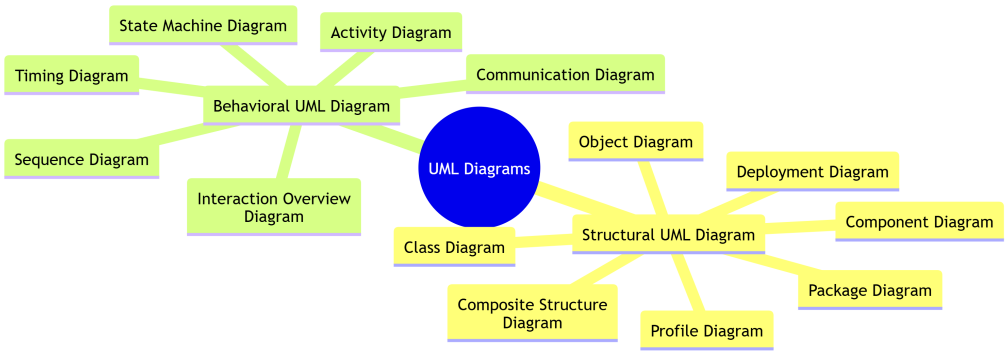

Figure 2.2: Structural and Behavioral UML Diagrams

2.7 Use Case Diagrams

The Use Case Diagram, as defined within the Unified Modeling Language (UML), is a modeling tool used to identify and represent the functional requirements of a system. It describes the various sequences of actions that a system can carry out during its interaction with external actors. This diagram offers a clear, high-level perspective of system behavior and facilitates effective communication among system stakeholders, developers, and end-users[16--18].

2.7.1 Patient Use Case Diagram

Figure 2.3 presents the Patient Use Case Diagram.

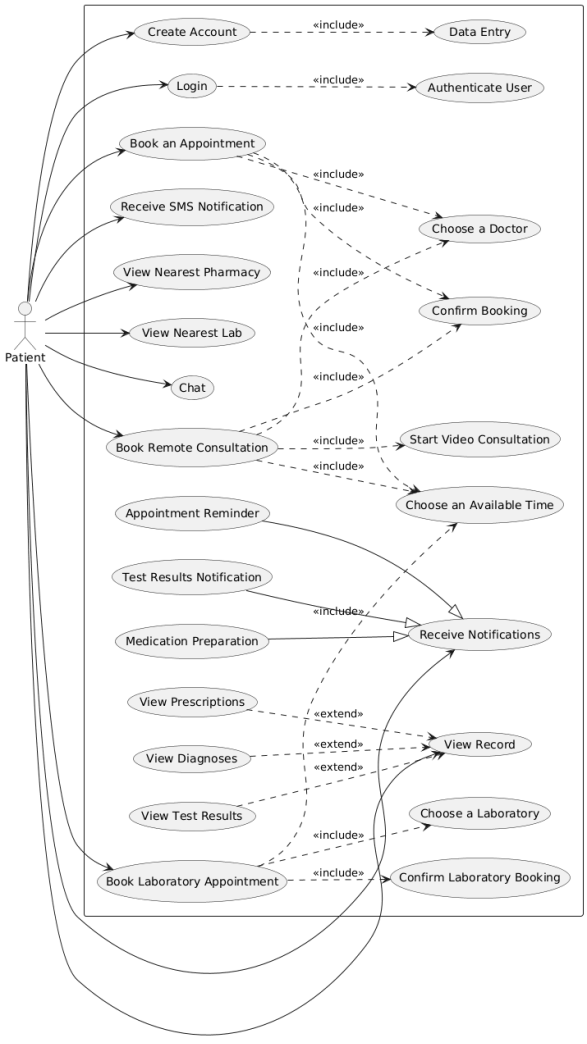

Figure 2.3: Patient Use Case Diagram

Actor:

- The Patient: A registered user managing their health through the mobile application.

Use Cases:

- Create Account, Register Data, Login.

- Search for Doctor.

- Book Appointment, Cancel Appointment.

- Receive reminder notifications via the mobile application for the patient's upcoming appointment with the doctor.

- View Prescriptions, Diagnoses, Test Results.

- Receive medication and test results readiness notification.

- Chat with Providers.

- Send test requests to the laboratory.

- View nearest pharmacies and laboratories.

- View doctor details (specialty, rating, working hours).

- View each doctor's clinic location on the map.

- Request a remote consultation.

- Book Laboratory Appointment.

2.7.2 Doctor Use Case Diagram

Figure 2.4 presents the Doctor Use Case Diagram.

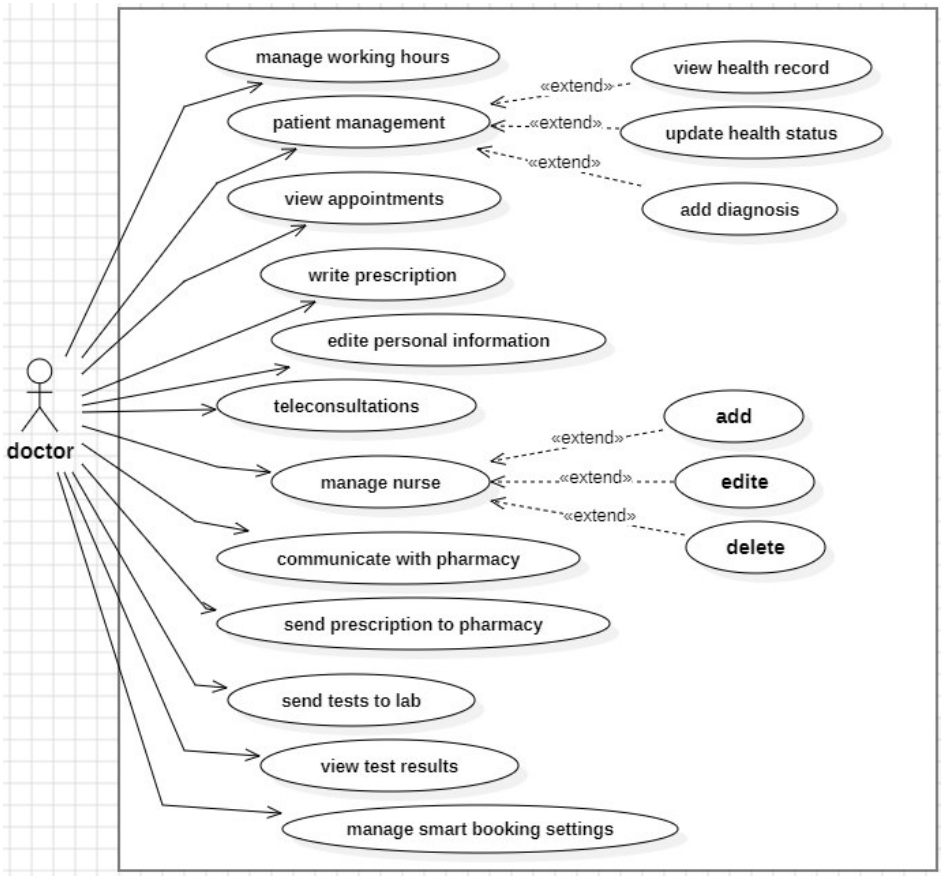

Figure 2.4: Doctor Use Case Diagram

Actor:

- The Doctor: A registered user with full access to medical and administrative operations.

Use Cases:

- Add working hours and schedule.

- Manage Assistant, Edit Personal Information.

- View Appointments.

- View Medical Record, Update Health Status, Add Diagnosis.

- Write Prescription, Send Prescription to Pharmacy.

- Write tests and send them to the laboratory or to the patient, View Test Results.

- Conduct Remote Consultation.

- Activate the smart system for appointment management.

2.7.3 Medical Assistant Use Case Diagram

Figure 2.5 presents the Medical Assistant Use Case Diagram.

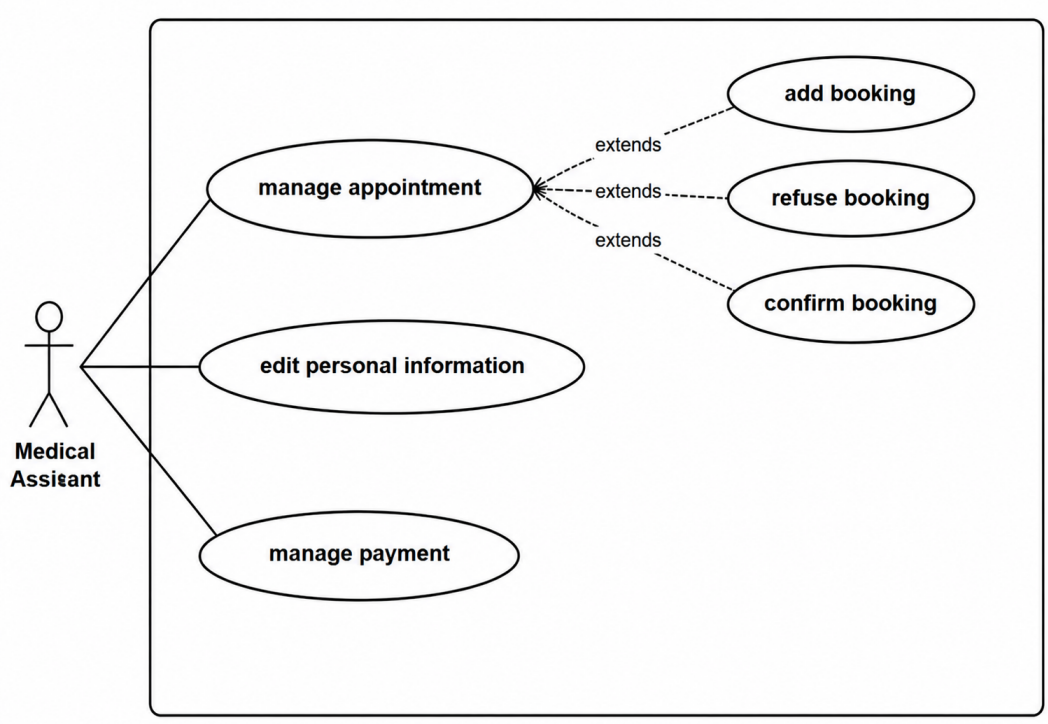

Figure 2.5: Medical Assistant Use Case Diagram

Actor:

- The Medical Assistant: A user added by a doctor to support administrative and medical tasks.

Use Cases:

- Add Booking.
- Manage patient appointments.
- Manage Payment.
- Manage his personal settings

2.7.4 Pharmacist Use Case Diagram

Figure 2.6 presents the Pharmacist Use Case Diagram.

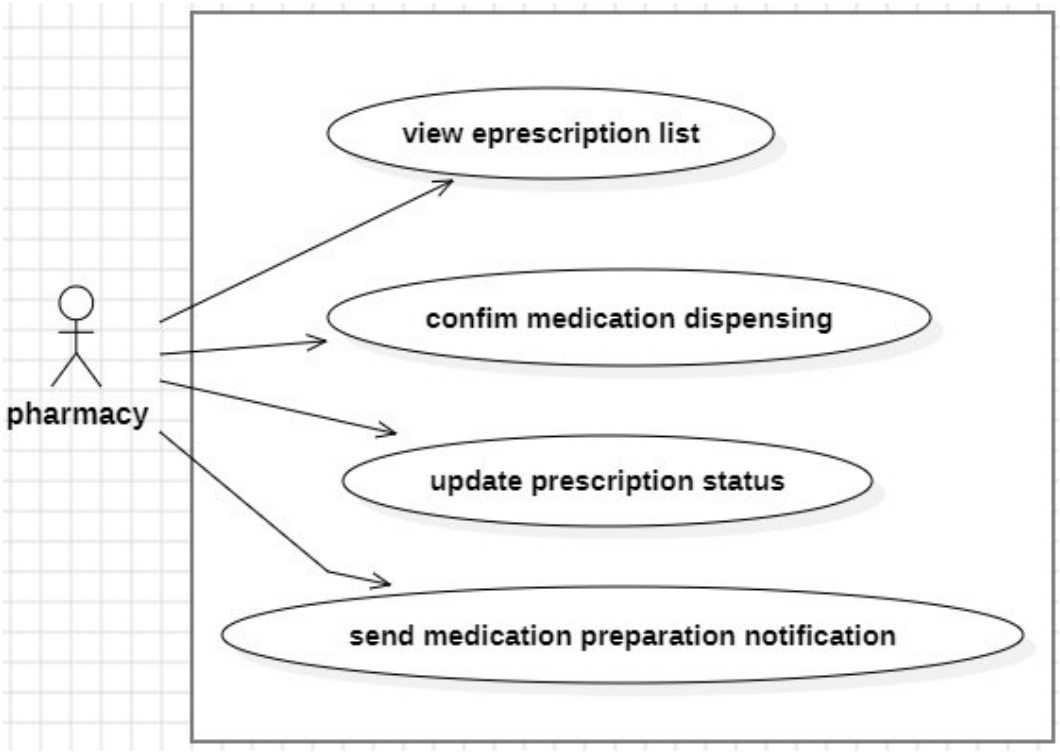

Figure 2.6: Pharmacist Use Case Diagram

Actor:

- The Pharmacist: A user who receives and processes electronic prescriptions.

Use Cases:

- View Electronic Prescription List, View Prescription Details.
- Confirm Medication Dispensing, Update Prescription Status.
- Send Medication Ready Notification.
- Inventory Management.

2.7.5 Laboratory Use Case Diagram

Figure 2.7 presents the Laboratory Use Case Diagram.

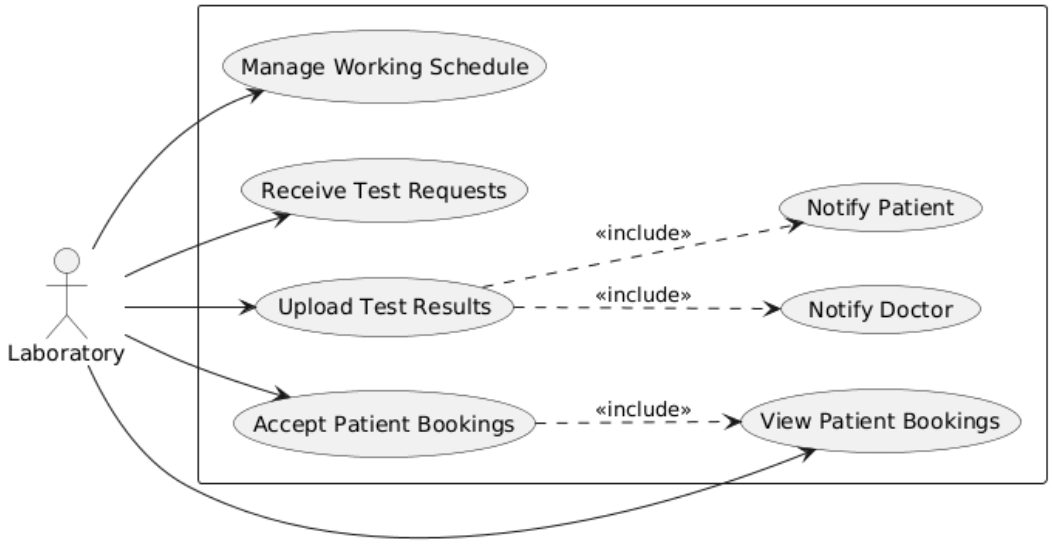

Figure 2.7: Laboratory Use Case Diagram

Actor:

- The Laboratory: An external system that receives test requests and returns results.

Use Cases:

- Manage working schedule.
- Accepet pateint bookings.
- Receive Test Requests, View Test Details.
- Upload Test Results.
- Notify Patient, Notify Doctor.

2.7.6 Administrator Use Case Diagram

Figure 2.8 presents the Administrator Use Case Diagram.

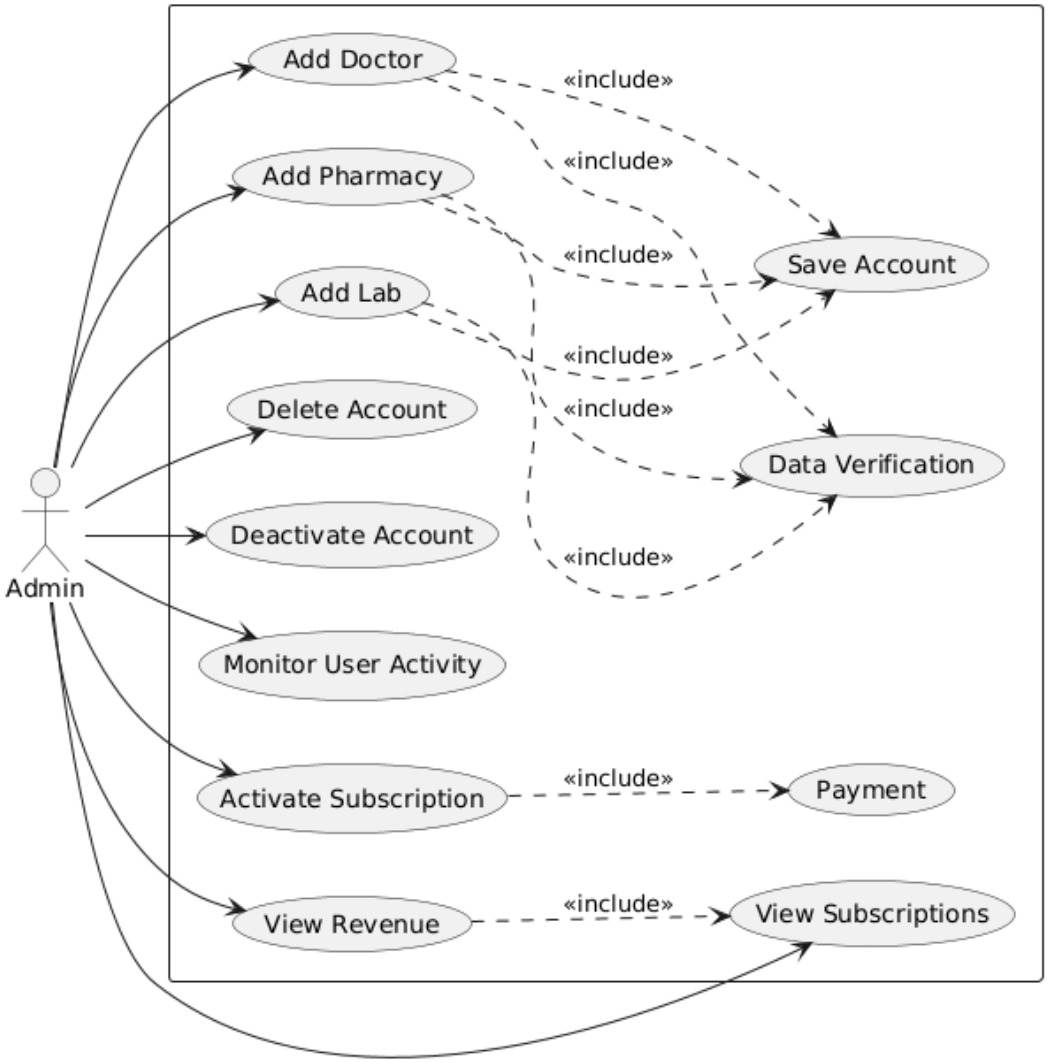

Figure 2.8: Administrator Use Case Diagram

Actor:

- The Administrator: A user with full permissions to manage the system.

Use Cases:

- Add Doctor, Add Pharmacy, Add Laboratory.

- Save Account, Delete Account, Deactivate Account.

- Monitor User Activity.

- Activate Subscription, Manage Payment.

- The financial administrator can view the total profits generated from subscriptions of doctors, pharmacists, and laboratories, with a breakdown of revenues by each party, to determine the platform's growth and improve pricing policies.

2.7.7 Smart Appointment System Use Case Diagram

Figure 2.9 presents Use Case Diagram of the Smart Appointment System:

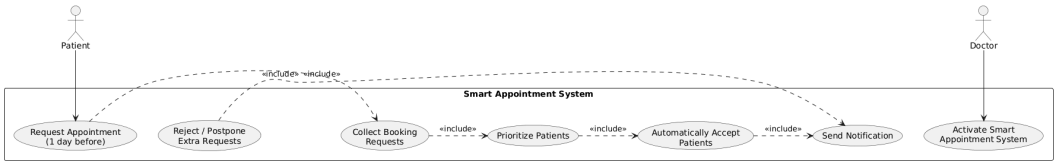

Figure 2.9: Smart Appointment System Use Case Diagram"

Actor:

- The Doctor: A registered user who activates and manages the smart appointment system.

Use Cases:

- Activate Smart Appointment System: Enables the doctor to turn on the automatic appointment confirmation feature.

- Request Appointment (1 day before): Patients can only request appointments at least one day in advance.

- Collect Booking Requests: The system gathers all pending appointment requests.

- Prioritize Patients: The system checks patient history and gives priority to returning patients.

- Automaticity Accept Patients: The system automatically confirms appointments for priority patients while respecting the maximum number of slots.

- Reject / Postpone Extra Requests: Appointments that exceed the maximum capacity are automatically rejected or postponed.

- Send Notification: The system sends a confirmation or rejection notification to the patient.

2.8 Sequence Diagrams

A Sequence Diagram, within the Unified Modeling Language (UML), is a behavioral diagram that illustrates the chronological order of message exchanges between objects, components, or actors over time. It focuses on how interactions occur during a specific scenario or operation, showing the sequence of events from initiation to completion. This diagram is particularly useful for modeling real-time systems and dynamic behavior, as it clarifies how different parts of the system collaborate to achieve a specific functionality [19].

2.8.1 Appointment Booking with Priority

Figure 2.10 illustrates the process of booking appointments with patient prioritization.

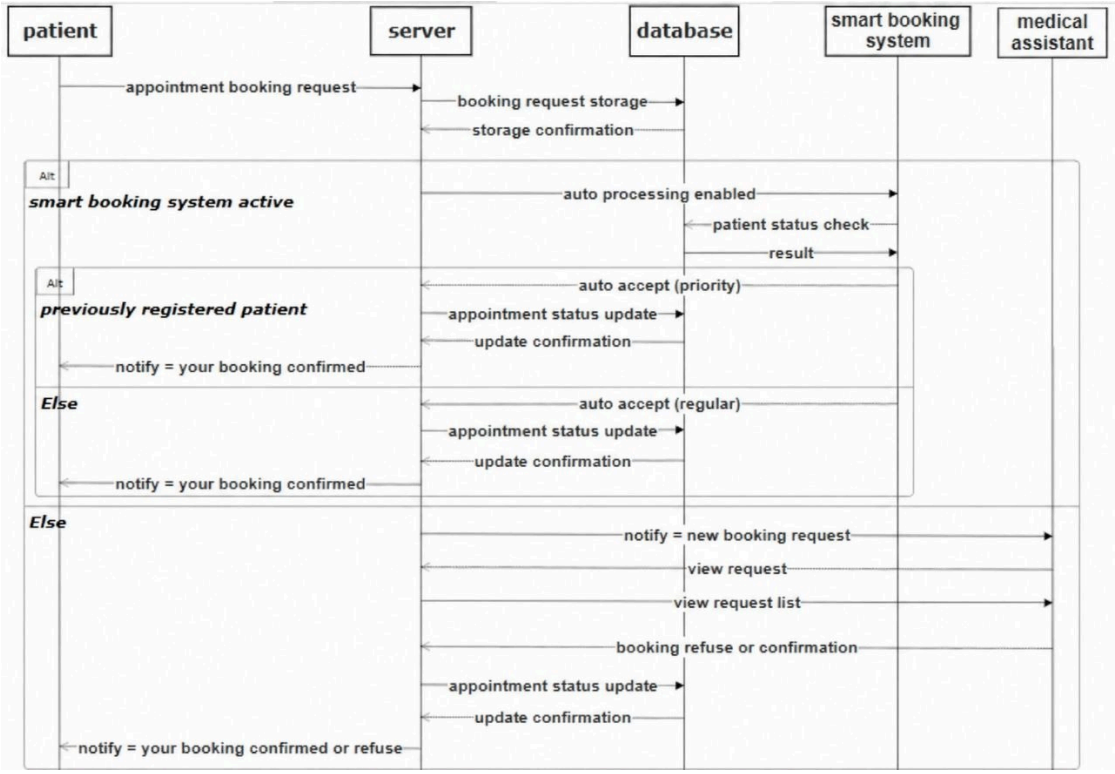

Figure 2.10: Sequence Diagram for Appointment Booking with Priority

Participants:

- Patient
- Server
- Database
- Medical Assistant

Process Steps:

- Patient sends appointment booking request.

- Server stores request and confirms booking.

- Medical assistant is notified of a new request.

Alternative Flow (alt):

- If patient is previously registered (priority):

    * Assistant automatically confirms booking.

    * Appointment status is updated in database.

    * Confirmed bookings are displayed to the doctor.

    * The server sends a confirmation notification to the patient, a reminder on the day of the appointment, and a reminder based on the queue position in the list.

- If the system is smart:

    * Bookings are accepted according to priority.

    * Bookings are confirmed by the server based on the maximum number of patients.

    * The server sends a notification to the patient with the result.

2.8.2 Sending Prescription to Pharmacy

Figure 2.11 presents the sequence of sending electronic prescriptions to pharmacies.

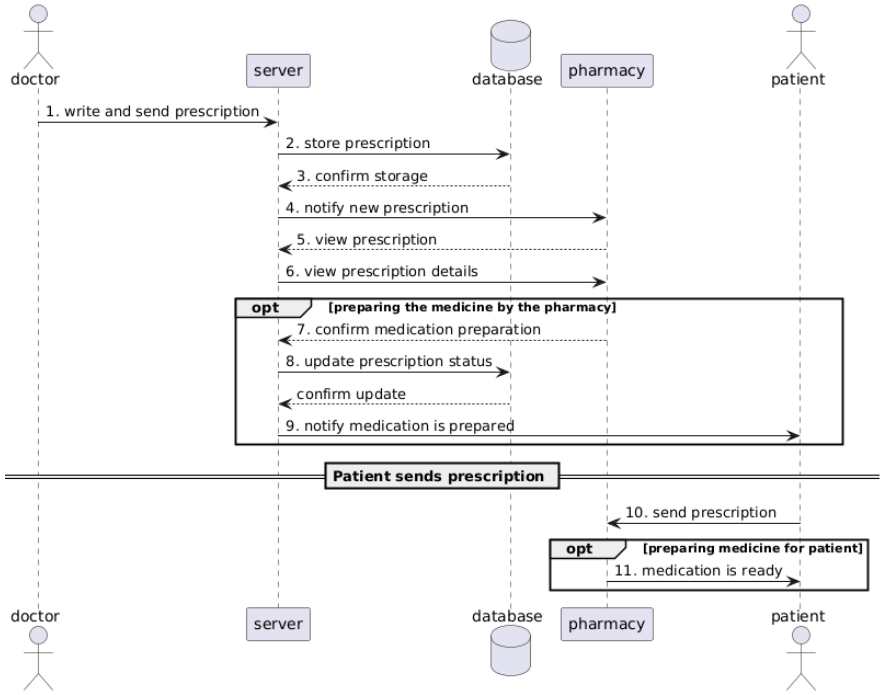

Figure 2.11: Sequence Diagram for Sending Prescription to Pharmacy

Participants:

- Doctor
- Server
- Database
- Pharmacy
- Patient

Process Steps:

- Doctor writes and sends a prescription.
- Server stores the prescription and confirms storage.
- Pharmacy is notified of a new prescription.
- Pharmacy views the prescription and its details.
- Patient can send the prescription to the pharmacy.

Optional Flow (opt):

- If the pharmacy prepares the medication:

    * Pharmacist confirms medication preparation.

    * Server updates the prescription status in the database.

    * Server sends a notification to the patient: ``Your medication is ready."

2.8.3 Sending Test Request to Laboratory

Figure 2.12 illustrates the interaction between doctors and laboratories during test requests.

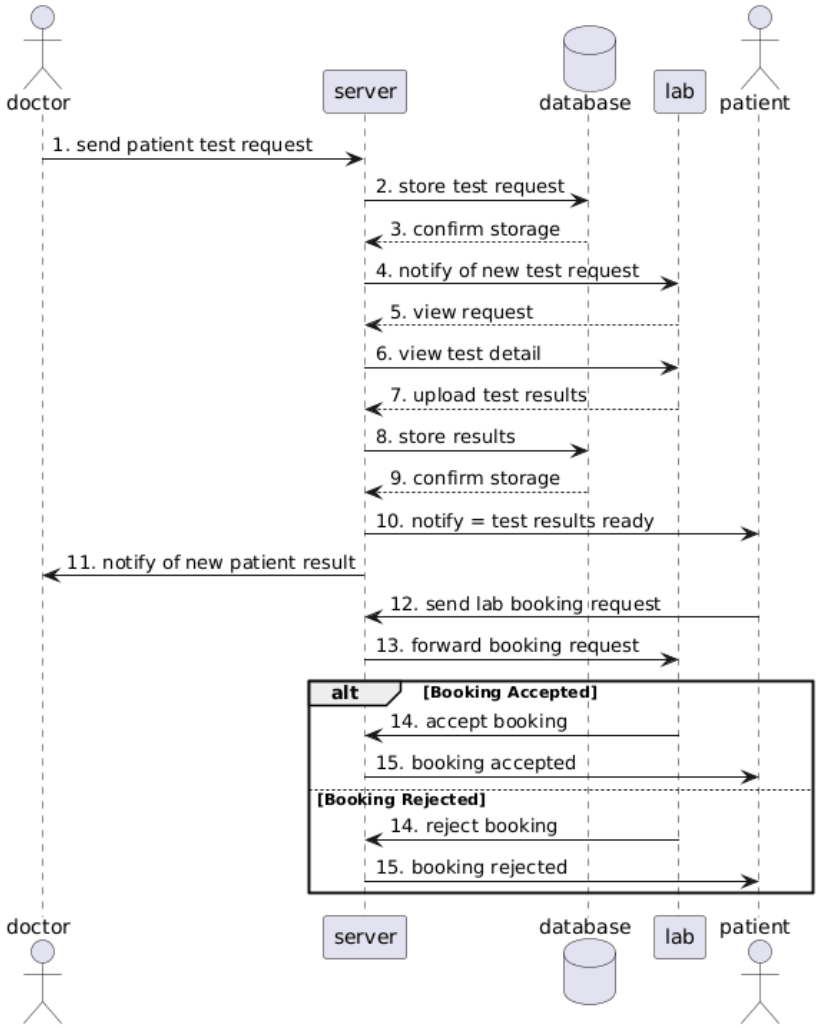

Figure 2.12: Sequence Diagram for Sending Test Request to Laboratory

Participants:

- Doctor
- Server
- Database
- Laboratory
- Patient

Process Steps:

- Doctor sends test request for a patient.

- Server stores request and confirms storage.

- Laboratory is notified of a new test request.

- Laboratory views request and required test details are displayed.

- Laboratory uploads test results.

- Server stores results and confirms storage.

- Server sends notification to patient: "Your test results are ready."

- Patient sends a laboratory booking request.

- Laboratory reviews the booking request.

- Patient receives a notification confirming the booking.

2.9 Activity Diagrams

An Activity Diagram, within the Unified Modeling Language (UML), is a behavioral diagram that represents the flow of control and data from one activity to another within a system. It illustrates the sequence of actions, decision points, parallel processes, and synchronization of activities. This diagram is particularly useful for modeling business processes, workflows, and the logic of complex operations, as it shows how different tasks are executed and under which conditions [19].

2.9.1 Appointment Booking with Priority

Figure 2.13 presents the workflow of appointment booking with priority management.

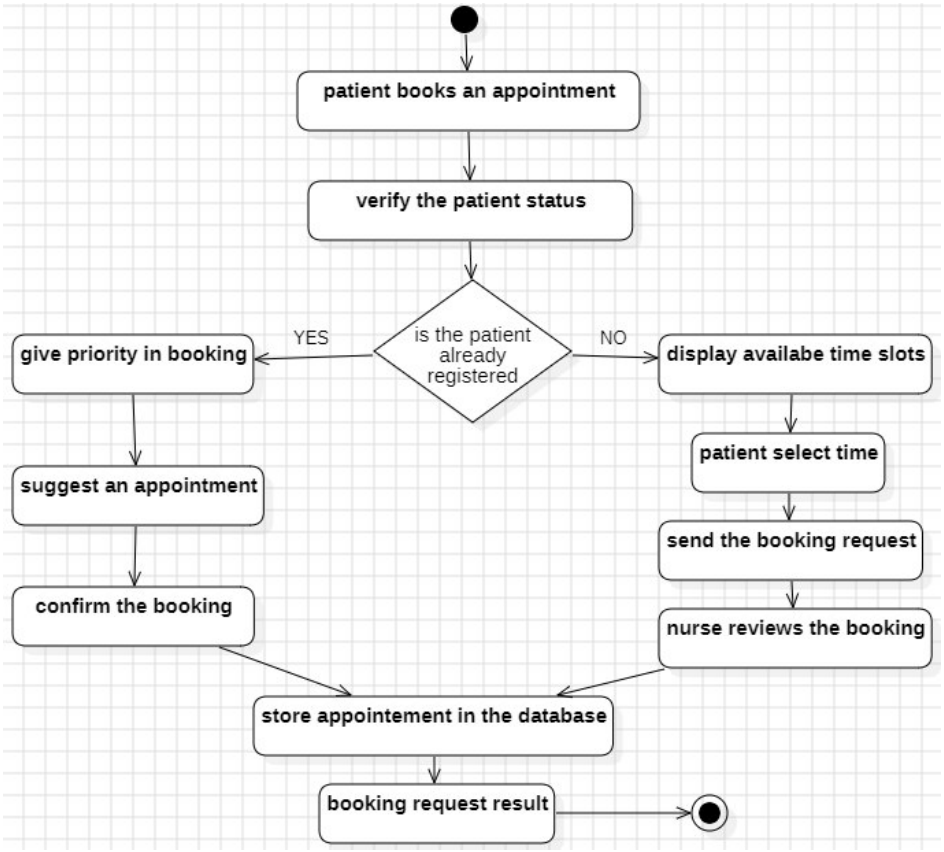

Figure 2.13: Activity Diagram for Appointment Booking with Priority

Process Flow:

- Patient enters booking data (doctor and date).
- System checks patient status.
- Decision: Is patient previously registered (priority)?

If YES (priority):

- Priority is given in booking.
- Assistant confirms booking.

If NO (regular):

- Available time slots are displayed.
- Patient chooses a time.
- Patient sends booking request.

- Assistant reviews request.

Final Steps:

- Appointment is stored in database.

-A booking confirmation notification is sent to the patient, along with a reminder notification on the day of the appointment, and an SMS notification when the patient's queue position is approaching.

- Activity ends.

2.9.2 Receiving Notifications on Patient's Mobile

Figure 2.14 presents the process of receiving notifications in the patient mobile application.

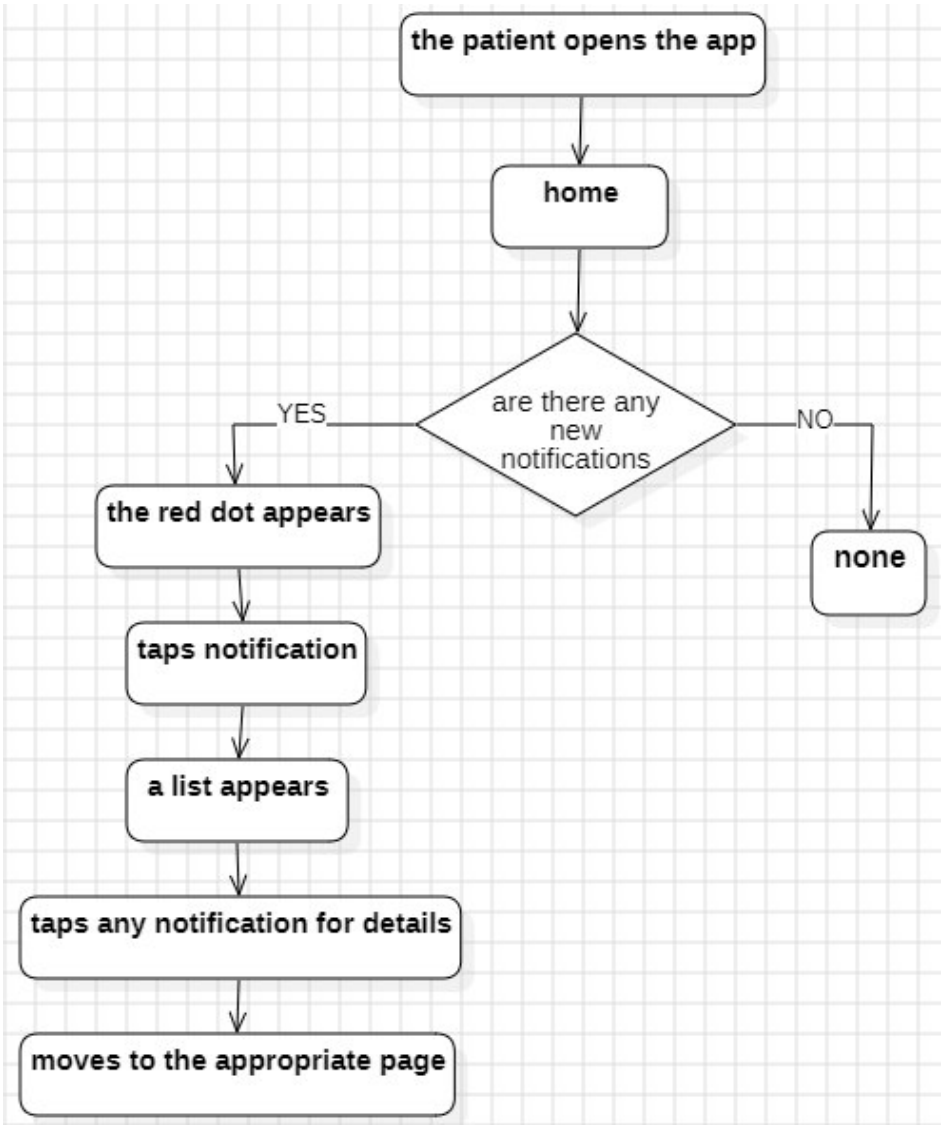

Figure 2.14: Activity Diagram for Receiving Notifications on Patient's Mobile

Process Flow:

- Patient opens the application.
- Home page appears.
- Decision: Are there new notifications?

If YES:

- Red dot appears.
- Patient clicks on notifications.
- List of notifications is displayed.
- Patient clicks any notification to see details.
- Patient is redirected to appropriate page (appointment details or test result).

If NO:

- Activity ends directly.
- Activity ends.

2.9.3 Activity diagram of sending test requests to the laboratory

Figure 2.15 illustrates the workflow of sending test requests from the doctor to the laboratory and notifying the patient of the results

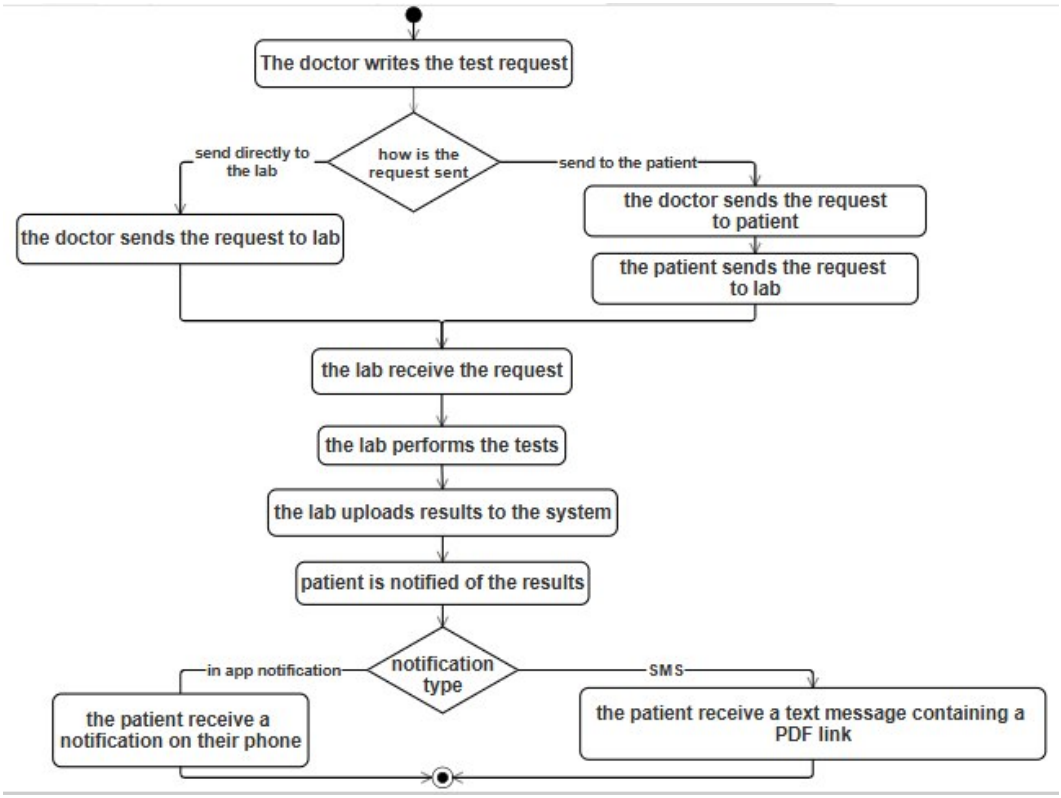

Figure 2.15: Activity diagram of sending test requests to the laboratory

Process Flow:

- Doctor writes the test request for the patient.

- How is the request sent?

If sent directly to the laboratory:

- The doctor sends the request directly to the laboratory.

- The laboratory receives the request.

- The laboratory performs the required tests.

- The laboratory uploads the results to the system.

- The patient is notified of the results.

If sent to the patient:

- The doctor sends the request to the patient.
- The patient receives the request.

- The patient sends the request to the laboratory (optional flow).
- The laboratory receives the request.
- The laboratory performs the required tests.
- The laboratory uploads the results to the system.
- The patient is notified of the results.

Final Steps:

- Notification type: In-app notification and SMS text message.
- The patient receives a notification on their phone.
- The patient receives a text message containing a PDF link to download the results.
- Activity ends.

2.9.4 Activity Diagram of the Smart Appointment System

Figure 2.16 illustrates the workflow of sending test requests from the doctor to the laboratory and notifying the patient of the results

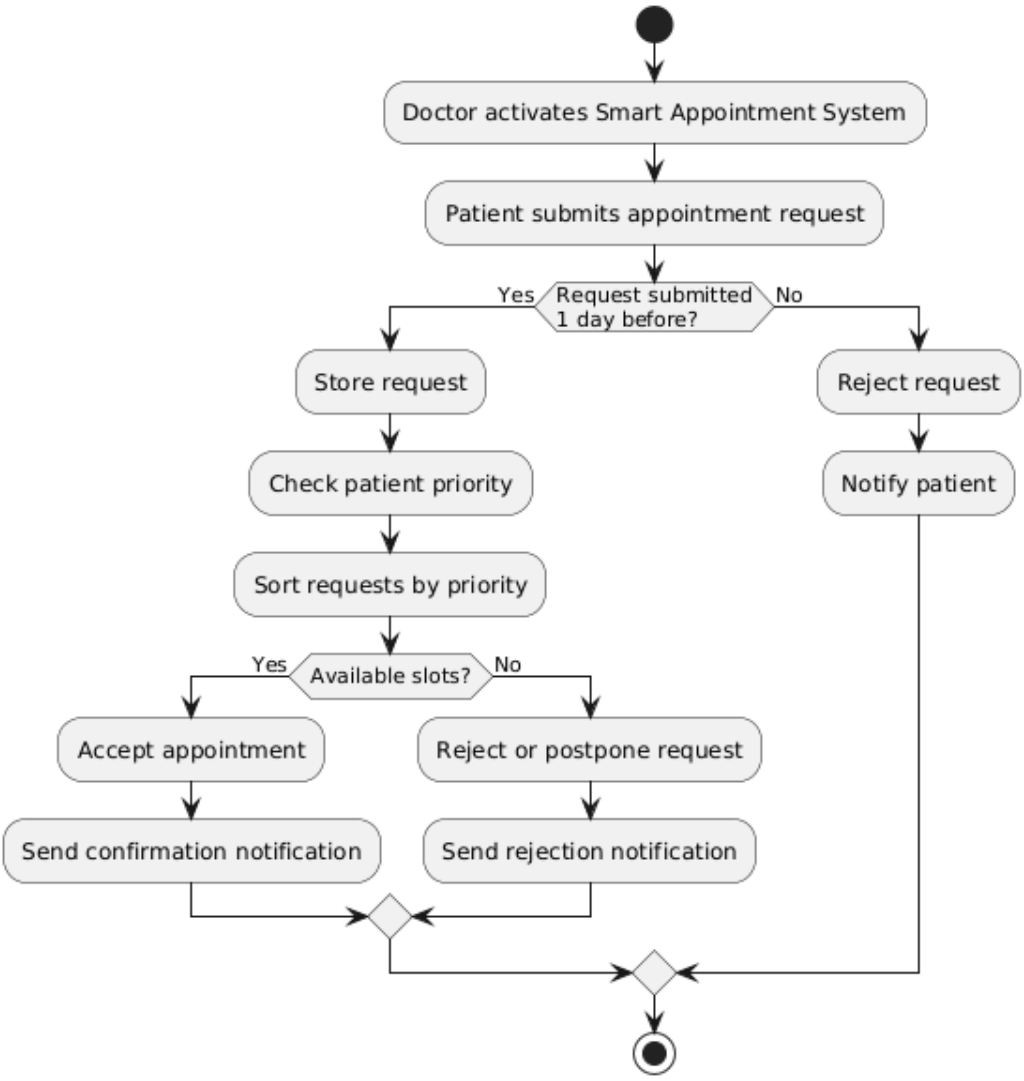

Figure 2.16: Activity Diagram of the Smart Appointment System

Process Flow:

- Doctor activates Smart Appointment System.
- Patient submits appointment request through the interface.
- The interface displays only available dates starting from tomorrow.
- Patient selects a date (which is automatically at least one day ahead).
- System stores the request.
- System checks patient priority (based on previous visits).
- System sorts all requests by priority (returning patients first).

- System checks if there are available slots for the selected date.

If If available slots exist:

- System accepts the appointment.
- System sends a confirmation notification to the patient.
- Activity ends.

no available slots:

- System rejects or postpones the request.
- System sends a rejection notification to the patient.
- Activity ends.

2.10 Class Diagram

A Class Diagram, within the Unified Modeling Language (UML), is a structural diagram that represents the static structure of a system by showing its classes, attributes, methods, and the relationships between them. It provides a foundation for object-oriented modeling by illustrating how different components of the system are organized and how they interact through associations, inheritance, dependencies, and aggregations. This diagram is essential for visualizing, specifying, and documenting the architectural design of a system [19].

The figure below presents the class diagram of the health connect healthcare system:

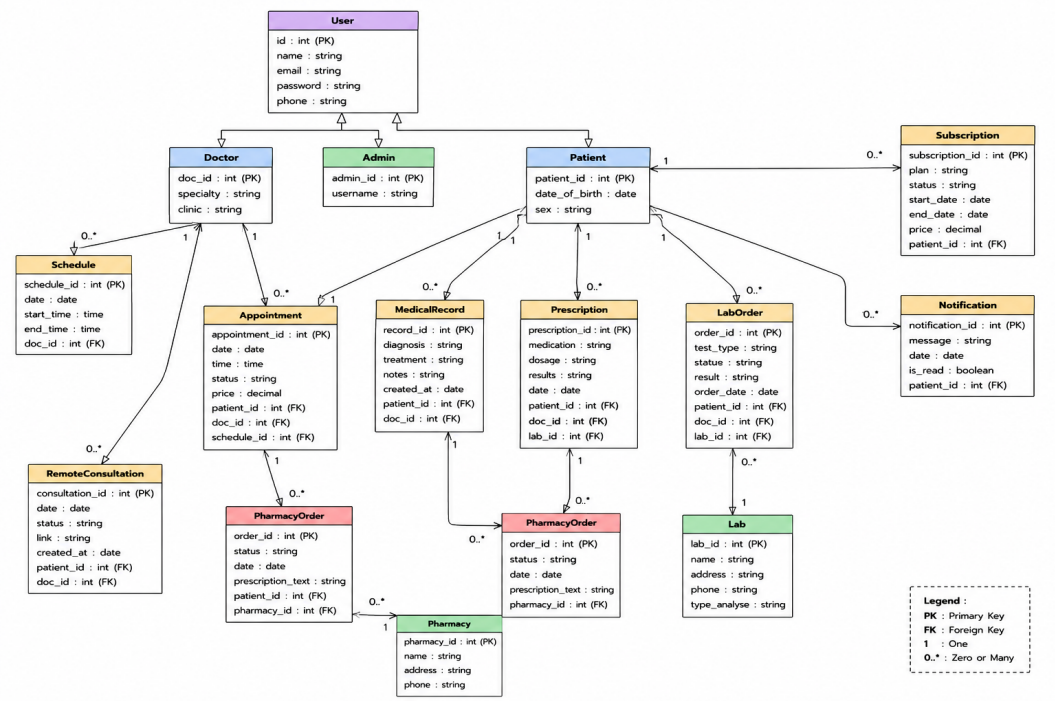

Figure 2.17: Class Diagram of the proposed system

2.11 Relational Model

The relational model of the proposed healthcare management system is composed of the following entities:

- User(id, name, email, password, phone)
- Patient(patient_id, date_of_birth, sex, id) [inherits User]
- Doctor(doc_id, specialty, clinic, id) [inherits User]
- Admin(admin_id, username, id) [inherits User]
- Pharmacy(pharmacy_id, name, address, phone)
- Lab(lab_id, name, address, phone, type_analyse)
- Schedule(schedule_id, date, start_time, end_time, doc_id)
- Appointment(appointment_id, date, time, status, price, patient_id, doc_id, schedule_id)
- MedicalRecord(record_id, diagnosis, treatment, notes, created_at, patient_id, doc_id)
- Prescription(prescription_id, medication, dosage, status, date, patient_id, doc_id)

- LabOrder(order_id, test_type, status, result, order_date, patient_id, doc_id, lab_id)
- RemoteConsultation(consultation_id, date, status, link, created_at, patient_id, doc_id)
- PharmacyOrder(order_id, status, date, prescription_text, patient_id, pharmacy_id)
- Notification(notification_id, message, date, is_read, patient_id)
- Subscription(subscription_id, plan, status, start_date, end_date, price, patient_id)

2.12 Conclusion

This chapter presented a complete design of the health connect healthcare system, including the system overview, functionalities for the six user types, system actors, and interaction design using UML diagrams and the C4 model. It covered the C4 System Context Diagram, Use Case Diagrams, Sequence Diagrams, and Activity Diagrams, illustrating how different actors interact with the system and how the main healthcare processes are executed. This design serves as the engineering foundation for the implementation phase presented in the next chapter.

Chapter 3

Implementation

3.1 Introduction

This chapter presents the practical implementation of the Nibras esiha digital platform for healthcare services. It describes the development environment, software tools, programming languages, and hardware specifications used. It also presents the main interfaces of both the web platform and the Android application. The platform was designed to address the key challenges identified earlier. Its implementation relied on modern, integrated technologies to achieve the desired objectives. The selection of these technologies was based on scientific criteria such as performance efficiency, ease of development, and compatibility with system requirements. Choosing the right tools is a critical factor in the success of any software project, as it directly affects the quality, maintainability, and future development of the final product.

3.2 Characteristics of a Computer

Table 3.1: Used hardware

Device Name	**Features**
DESKTOP-7FHOF8V	Model: Latitude 5400
	CPU: Intel Core i7-8665U @ 1.90GHz (2.11 GHz)
	RAM: 16.0 GB (15.8 GB usable)
	Graphics: Intel UHD Graphics 620 (128 MB)
	Storage: 238 GB SSD
	Operating System: Windows 11 Pro 64-bit

3.3 Definitions of Technologies Used

3.3.1 HTML:

Figure 3.1: HTML

HTML (HyperText Markup Language) is the standard markup language used to create and structure web pages. It defines the fundamental elements of a webpage, including headings, paragraphs, forms, and multimedia content (Berners-Lee, 2000) [20].

3.3.2 CSS:

Figure 3.2: CSS

CSS (Cascading Style Sheets) is a styling language that controls the visual presentation of HTML elements. It enables developers to define colors, fonts, layouts, and responsive designs, enhancing the user interface (Meyer, 2007) [21].

3.3.3 JavaScript:

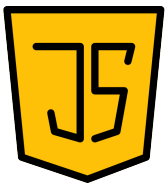

Figure 3.3: JavaScript

JavaScript is a client-side scripting language that adds interactivity and dynamic behavior to web pages. It allows event handling, form validation, and partial page updates without reloading (Flanagan, 2011) [22].

3.3.4 PHP:

Figure 3.4: PHP

PHP is a server-side scripting language designed for dynamic web development. It supports database integration, session management, and dynamic HTML generation [23].

3.3.5 My SQL:

Figure 3.5: MY SQL

MySQL is an open-source relational database management system (RDBMS). It uses SQL for efficient data storage, retrieval, and manipulation, and is known for its speed and reliability [24].

3.3.6 Visual Studio Code:

Figure 3.6: VS Code

Visual Studio Code is a lightweight, open-source code editor developed by Microsoft. It supports multiple programming languages and offers advanced features such as debugging, IntelliSense, and Git integration [25].

3.3.7 XAMPP:

Figure 3.7: XAMPP

XAMPP is a free, cross-platform local server package developed by Apache Friends. It provides an integrated environment consisting of Apache, MySQL, PHP, and Perl for web development and testing [26].

3.3.8 Android Studio:

Figure 3.8: Android Studio

Android is an open-source mobile operating system based on the Linux kernel. It allows developers to build feature-rich applications using Java or Kotlin via the Android SDK [27].

3.3.9 API:

Figure 3.9: API

An API is a set of rules and protocols that enables different software applications to communicate with each other. In this project, a REST API was implemented to exchange data between the Android application and the server using JSON format [28].

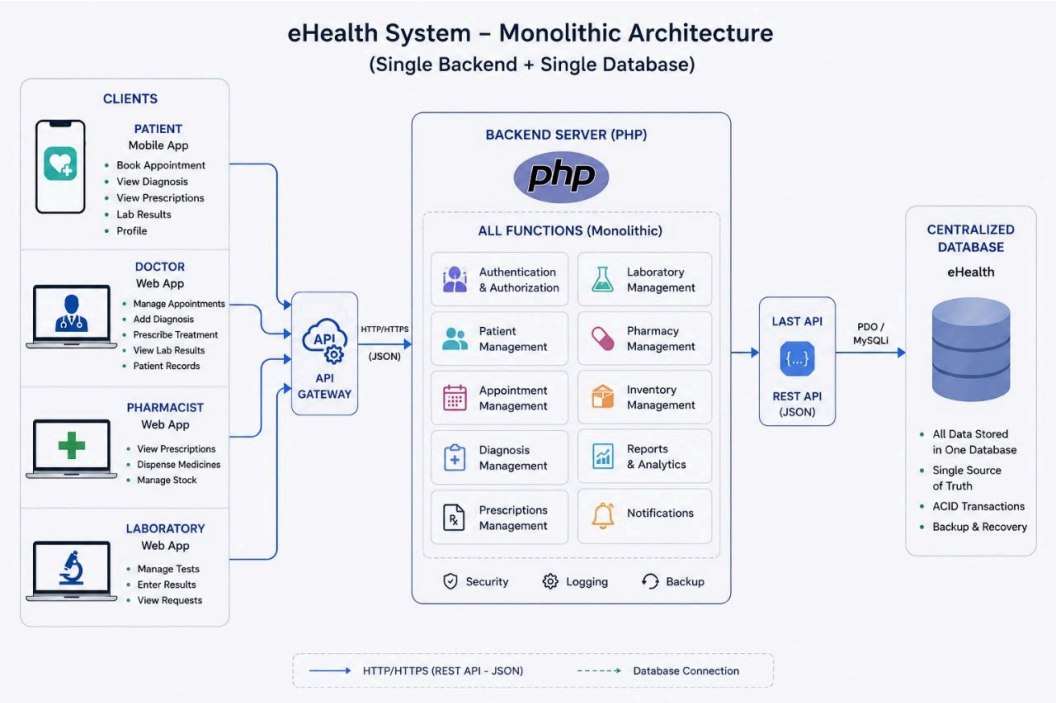

Figure 3.10: Monolithic Architecture of the eHealth System.

The figure illustrates the proposed system architecture, which adopts a monolithic design pattern consisting of three main layers as follows:

- **Client Layer:** Consists of the Android mobile application for patients and the web platform for doctors, pharmacists, and laboratories. This layer enables users to perform various functions such as booking appointments, adding diagnoses, prescribing treatments, managing tests, and dispensing medications.
- **Backend Server Layer:** Developed using PHP, this layer contains all core system functions in a single monolithic unit, including: Authentication & Authorization, Patient Management, Appointment Management, Diagnosis Management, Prescriptions Management, Notifications, Logging, and Security.
- **Database Layer:** Represents the centralized MySQL database which stores all system data in a single location, providing a Single Source of Truth, with support for ACID transactions, backup, and recovery mechanisms.

Communication between these layers occurs via REST API using HTTP/HTTPS protocol and JSON format for data exchange between the Android app, web platform, PHP backend server, and MySQL database.

3.4 Presentation of Nibras esiha web Platform Interfaces

The platform interfaces were designed and developed according to user needs, including the landing page, the login interface with role selection, the account registration interface, in addition to the dashboards of the doctor, medical assistant, pharmacist, laboratory, and administrator. A sample of these interfaces will be presented in this section:

3.4.1 Sign up interface

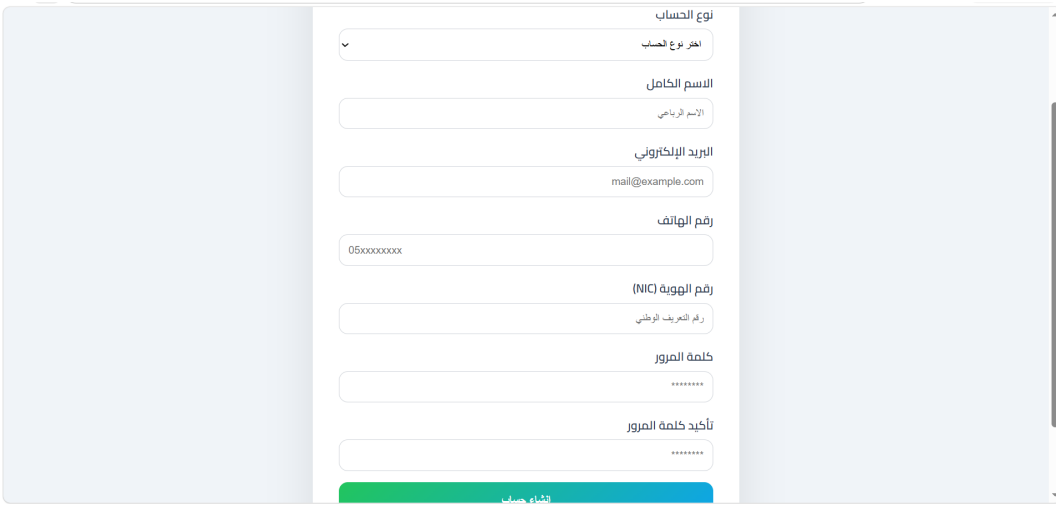

Figure 3.11: Sign up interface.

- **Description:** New account creation interface for the free trial, displayed after selecting the trial plan. The "Account Type" field allows the user to choose between: Clinic/Doctor, Pharmacy, Laboratory, or Medical Assistant. Other fields include: Full Name, Email, Phone Number, National ID NIC, Password, and Confirm Password. After creating the account, the user is redirected to their respective dashboard to start the 15-day free trial.

3.4.2 Login interface of Nibras esiha platform

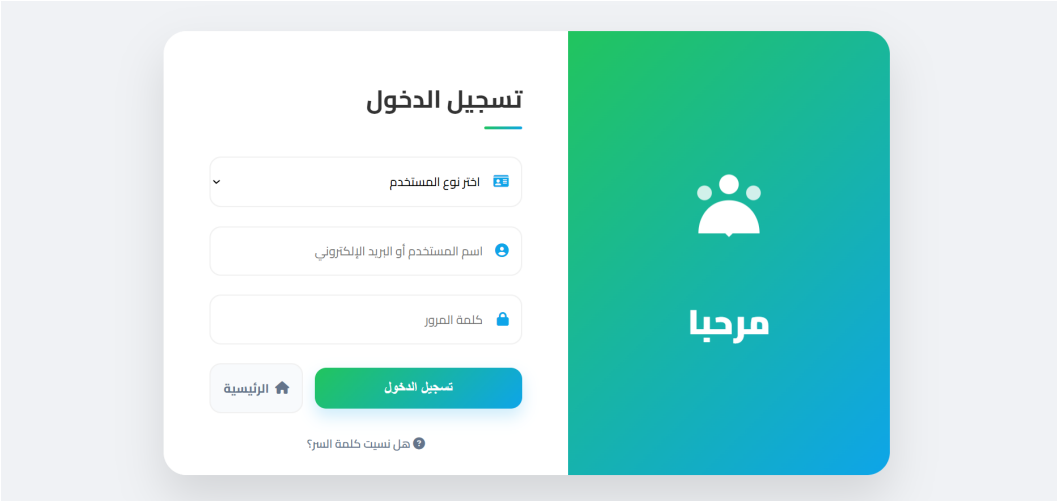

Figure 3.12: Login interface of Nibras esiha platform.

- **Description:** This figure shows the login interface of the Nibras esiha healthcare platform. The interface features a dropdown menu for selecting the user role (Admin, Doctor, Pharmacy, Laboratory, or Medical Assistant), allowing each user to be redirected to their respective dashboard based on their permissions. The interface also includes fields for entering the username (or email address) and password, ensuring secure user authentication. A "Forgot password?" link is also provided to help users recover their accounts, enhancing usability and accessibility. The interface is designed in a simple and clear manner to facilitate the login process for different user categories.

Executive login processing code

```php
<?php
session_start();
include 'db_config.php';

if ($_SERVER["REQUEST_METHOD"] === "POST") {
    $usernameOrEmail = trim($_POST['username']);
    $password = $_POST['password'];
    $role = $_POST['role'];
    $user = null;
    $redirect = 'login.php';

    if ($user) {
        $_SESSION['user_id'] = $user['id'];
        $_SESSION['user_name'] = $user['name'];
        $_SESSION['role'] = $user['role'];
        header("Location: $redirect");
        exit();
    } else {
        echo "<script>alert('خطأ في بيانات الدخول أو نوع الحساب'); wi
    }
}
?>
```

Figure 3.13: Executive login processing code

Description: The auth.php file contains the login processing logic. It receives the data submitted from the form (username, password, role) via the POST method. Based on the selected role, it searches for the user in the appropriate database table (doctor, patient, admin, pharmacy, lab) using prepared statements to prevent SQL injection. After retrieving the data, it compares the entered password with the stored one using passwordverify() or a direct comparison. If the credentials match and the account is active (Active), a session is created for the user storing their ID, name, and role, then they are redirected to their dedicated dashboard.

If authentication fails, an error alert is displayed.

3.4.3 Doctor Dashboard

Add work time interface for the doctor

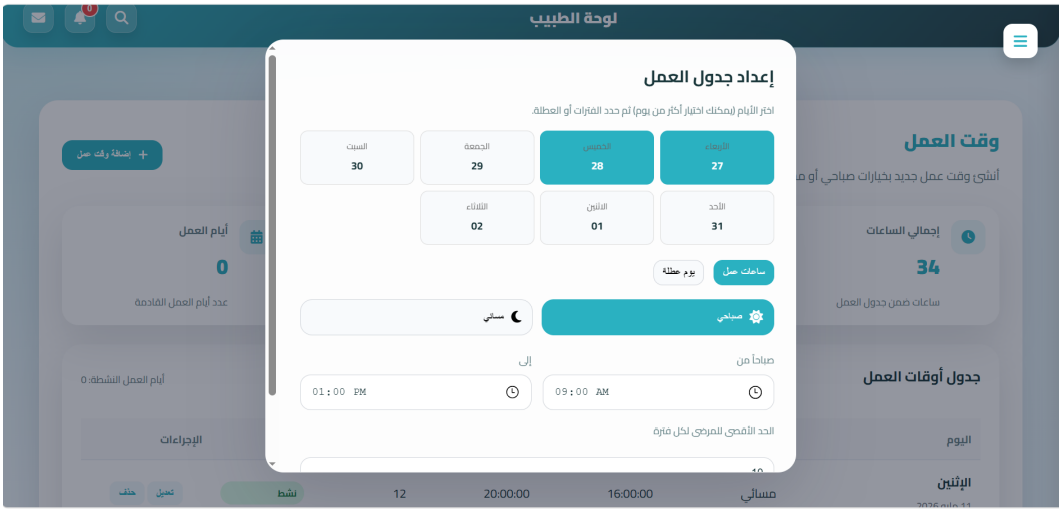

Figure 3.14: Add work time interface for the doctor.

- **Description:** When the doctor clicks the "Add Work Time" button, a modal window appears allowing them to select multiple working days, choose the day type (working day or holiday), select the work period (morning, evening, or both) with start and end times, and set the maximum number of patients per time slot. After saving, the added working days appear in the "Working Days" table within the dashboard, where the doctor can edit or delete any day. This interface also allows managing holidays and reactivating working days.

Confirmed appointments interface for medical examination

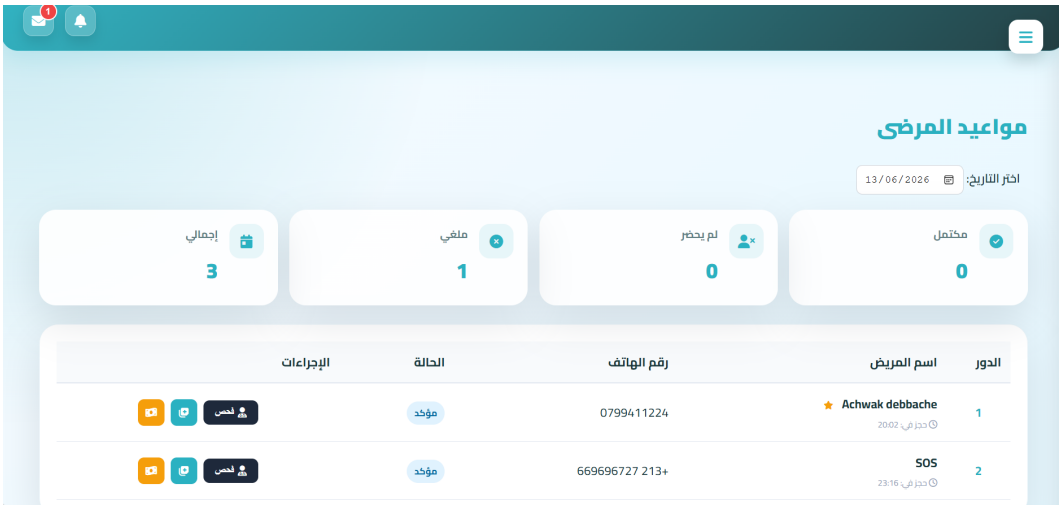

Figure 3.15: Confirmed appointments interface for medical examination.

- **Description:** This interface displays the list of patients whose appointments have been confirmed, either by the medical assistant or automatically through the smart booking system based on the doctor's settings (priority for returning patients, available slots, etc.). The interface includes quick statistics (total, cancelled, no-show) and a table showing the patient's name, phone number, time, and status (confirmed). From this table, the doctor can start the medical examination for each patient, which streamlines clinic workflow and helps the doctor manage their appointments efficiently.

Work settings and smart booking system interface

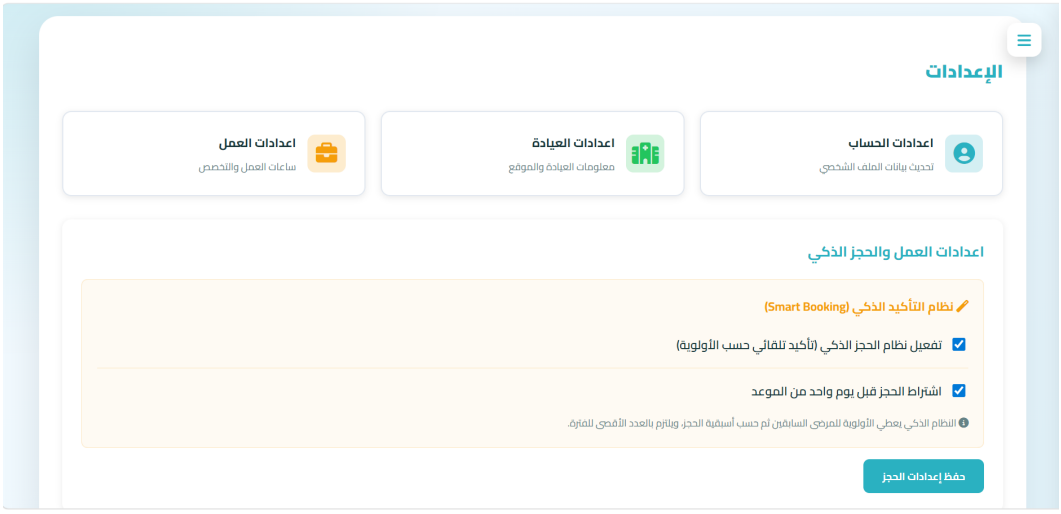

Figure 3.16: Work settings and smart booking system interface.

- **Description:** This interface allows the doctor to activate the smart booking system, which automatically confirms appointments based on a priority mechanism that gives preference to returning patients (those with previous appointments with the doctor), then according to booking order, while respecting the maximum number of slots allowed per time period. The doctor can also enable the option requiring booking at least one day in advance of the appointment date. These settings aim to reduce the burden of manual review on the doctor and medical assistant, improve patient experience, and ensure fair appointment distribution.

3.4.4 Admin Dashboard

User management interface for the administrator

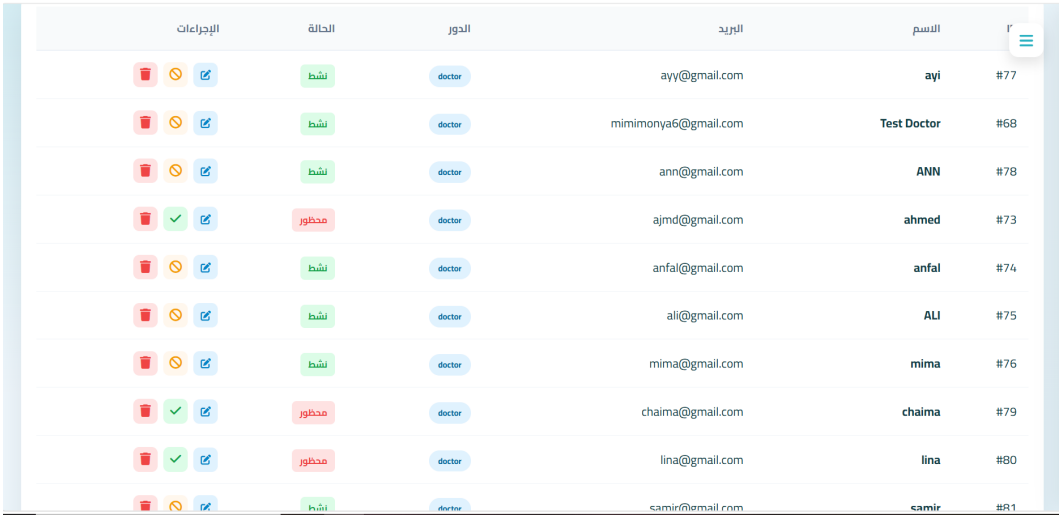

Figure 3.17: User management interface .

- **Description:** This interface displays a list of all registered users in the platform (doctors, pharmacies, laboratories, patients) with their basic information: ID, name, email, role, and status (Active / Inactive). Through this interface, the administrator can modify the status of any account (activate or deactivate), delete it, or edit its data. This interface aims to facilitate the monitoring and management of user accounts by the administrator.

Paid subscriptions and free trial period interface

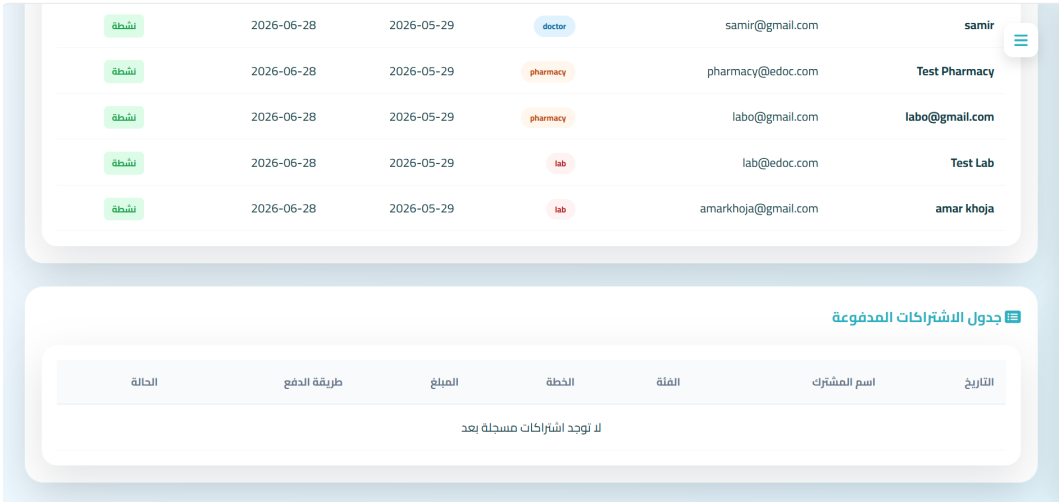

Figure 3.18: Paid subscriptions and free trial period interface.

- **Description:** This interface appears when clicking on the "Subscriptions" section in the administrator dashboard. It displays two tables: the first for accounts in the free trial period, including the start date, end date, and remaining days; the second for paid subscriptions, including the subscriber name, category, plan (monthly/annual), amount, payment method, dates, and status. This interface aims to enable the administrator to track subscriptions, manage payments, and monitor free trial accounts to remind them to upgrade.

3.4.5 Medical Assistant Dashboard

Daily appointment management interface for the medical assistant

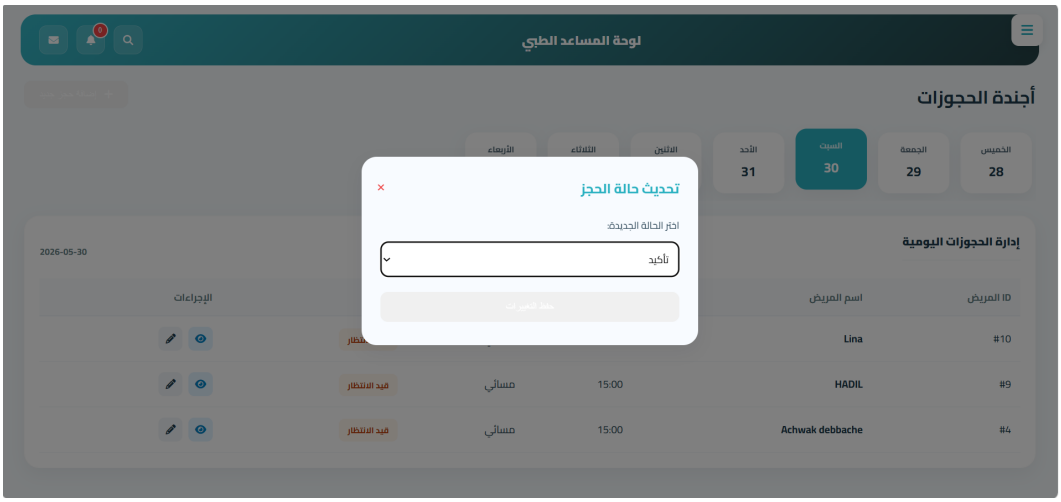

Figure 3.19: Daily appointment management.

- **Description:** This interface appears in the medical assistant dashboard, displaying an appointment agenda for navigating between days, and a table listing patients who have made appointments with their information (patient ID, time, status). The interface allows the assistant to confirm, reject, or cancel appointments, while updating the status and sending a notification to the patient. It aims to reduce the administrative burden on the doctor and improve the patient experience.

3.4.6 Pharmacist Dashboard

Prescription details interface for the pharmacist

Figure 3.20: Prescription details.

- **Description:** This interface appears when clicking on any patient from the list of prescriptions received at the pharmacy. It displays basic prescription information including the patient's name, date and time, and the prescribed medications such . Through this interface, the pharmacist prepares the required medications and then clicks the "Prepare medication now and notify patient" button. When this button is clicked, the prescription status is updated to "Ready", and an immediate notification is sent to the patient via the application to inform them that the medication is ready for pickup from the pharmacy. This interface aims to speed up the medication dispensing process and improve communication with the patient.

3.4.7 Laboratory Dashboard

Laboratory results entry interface

Figure 3.21: Laboratory results entry interface

- **Description:** This interface appears after the laboratory has accepted a test request. It allows the laboratory technician to enter the results for each test, including the result value, unit of measurement, and reference ranges. The technician can also add additional notes in the "Laboratory Report" field. Once all results have been entered, clicking the "Valider et Envoyer" button saves the results to the system and automatically sends notifications to both the patient and the doctor. This interface aims to simplify the results entry process and speed up patient notification.

3.5 Presentation of Nibras esiha Mobile Application Interfaces

This section presents the Nibras esiha patient mobile application interfaces, including login, account creation, main dashboard, appointment booking , and medical record interfaces:

3.5.1 Patient login interface in the Android application

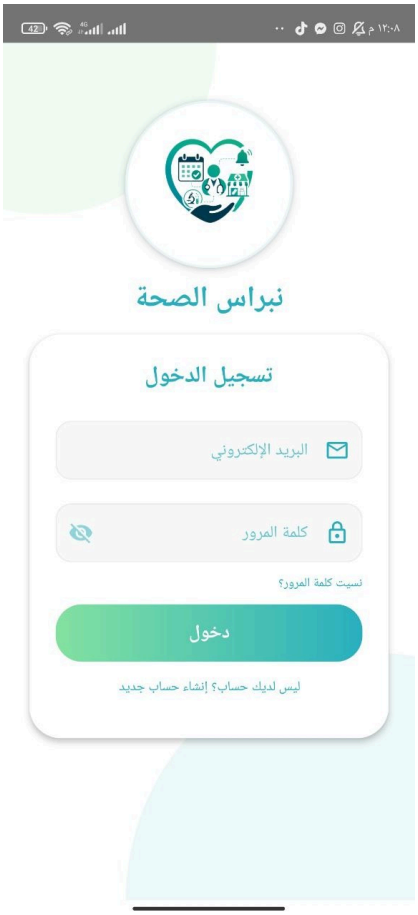

Figure 3.22: Patient login interface

- **Description:** This interface appears when opening the Nibras esiha application on the patient's phone. It allows registered users to log in to their accounts to access the platform's services. The interface includes the application logo "Nibras esiha - Your Health in Security", email and password input fields, a "Forgot password?" link to recover the account in case of forgotten password, a "Login" button to confirm the credentials, and a "Don't have an account? Create a new account" link to redirect new users to the registration interface. After previously creating an account, the patient can enter their credentials and click "Login" to navigate to the main application interface.

3.5.2 Patient account creation interface in the Android application

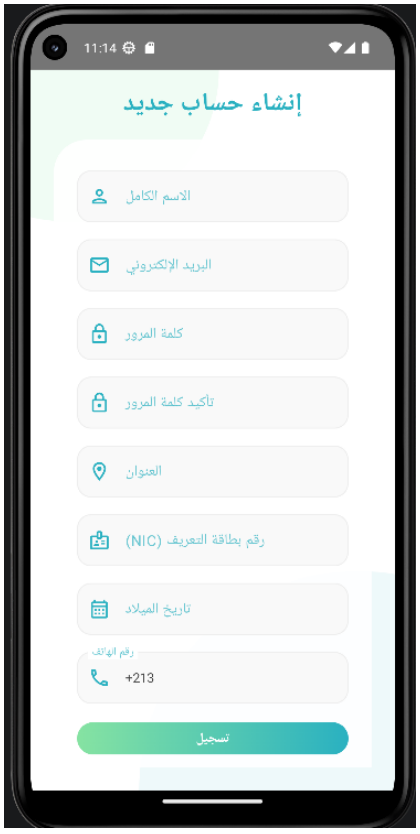

Figure 3.23: Patient account creation interface

- **Description:** This interface appears when clicking the "Create new account" link on the login interface. It allows the patient to create a new account to access the platform's services. The interface includes input fields for: full name, email, password and confirmation, address, national ID number (NIC), date of birth, and phone number with country code (+213). After filling in all fields, the user clicks the "Register" button to create the account in the database and is redirected to the login interface. This interface aims to collect the patient's basic information in an organized and secure manner.

3.5.3 Main patient interface after login

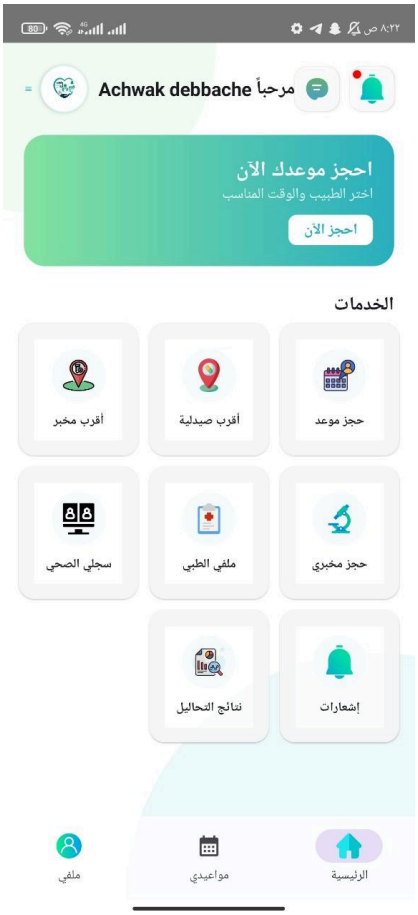

Figure 3.24: Main patient interface after login

- **Description:** This is the main page of a health app for user It offers:
  - Quick appointment booking with a doctor (choose doctor & time).
  - A list of services: nearest lab, nearest pharmacy, book appointment, health record, medical file, lab booking, test results, notifications.
  - Bottom navigation bar: My profile, My appointments, Home.

  The goal is to provide easy access to healthcare services and remote consultations in one place.

3.5.4 Appointment booking interface - Doctor search

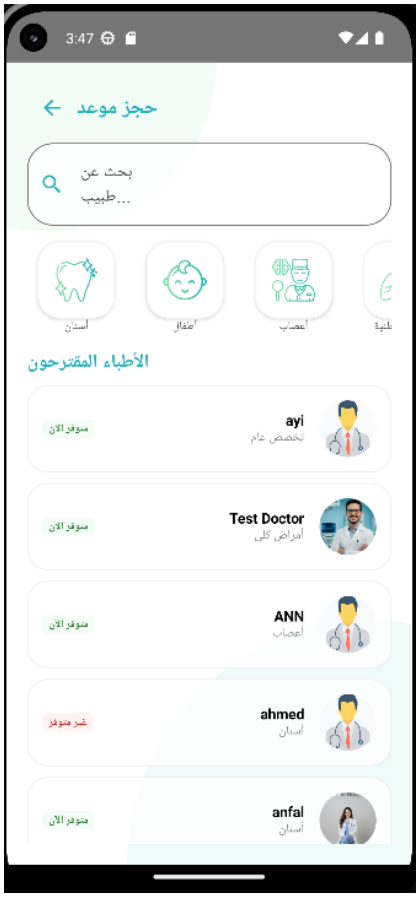

Figure 3.25: Doctor search

- **Description:** This interface appears when clicking the "Book Now" button from the main interface or selecting the "Book Appointment" service from the quick services list. The interface allows the patient to search for doctors in several ways: either by typing the doctor's name in the search field, or by selecting a specialty from the icons (e.g., Dentistry, Neurology, Nephrology, General Medicine). The interface also displays a suggested list of doctors registered on the platform, with information about each doctor including name, specialty, and status (Available Now or Unavailable). The patient selects the appropriate doctor and clicks on them to proceed to the date and time selection interface. This interface aims to facilitate the doctor search process and provide multiple options for the patient (search by name, search by specialty, doctor suggestions).

3.5.5 Appointment Date and Time Interface

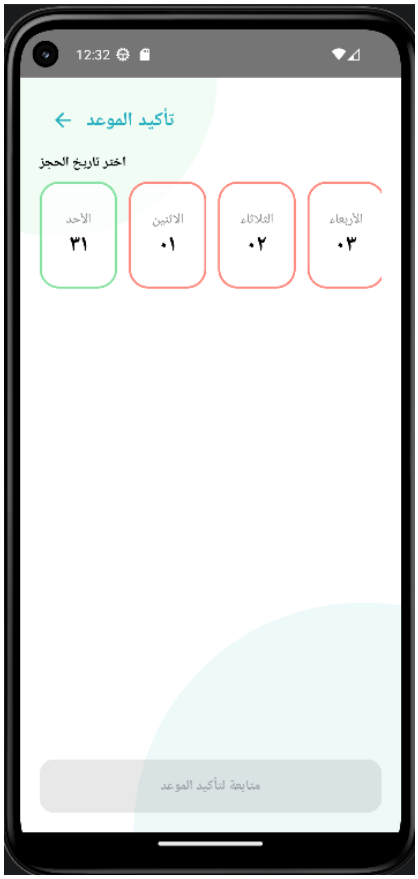

Figure 3.26: Appointment Date Selection Interface

Figure 3.27: Working Hours Display Interface

Description: After selecting the appropriate doctor from the search interface, the patient is shown the appointment date selection interface, which displays the available days for the selected doctor in green and the unavailable days in gray or red. The patient selects the suitable day for them. After selecting the date, an interface appears showing the doctor's available working hours for that day, such as the morning period or the evening period. Here, the patient does not select a specific time; rather, the system displays the time period during which the doctor works (morning or evening) solely to inform them of the working hours. After reviewing the suitable time, the patient clicks the "Confirm Appointment" button to send the booking request to the system. These two interfaces aim to simplify the date and time selection process and prevent booking during times when the doctor is not available.

3.5.6 Notifications interface in the patient application

Figure 3.28: Notifications Interface

- **Description:** This interface displays a list of all notifications received by the patient. It includes various types of alerts such as appointment confirmation, queue position update (turn alert), new test request, new prescription notification, and a reminder that test results are ready. This interface helps the patient stay informed about their healthcare activities without needing to navigate through multiple sections of the application.

3.5.7 SMS notifications received on the patient's phone

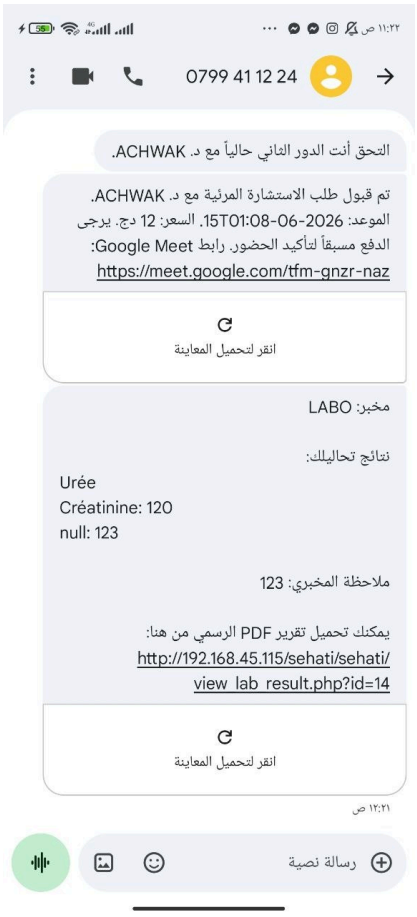

Figure 3.29: SMS Notifications Interface

- **Description:** This figure shows examples of SMS notifications sent to the patient's mobile phone. The notifications include real-time queue position updates (e.g., "You are the second patient", "You are the first patient") and a notification that lab test results are ready, along with a direct link to view and download the results. These SMS messages ensure that patients receive critical alerts even when they are not actively using the mobile application.

3.5.8 Medical prescription and test request display interfaces with PDF and sharing options

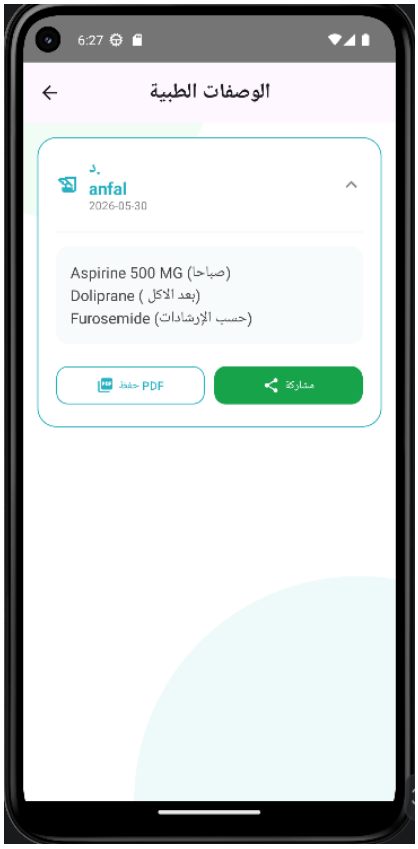

Figure 3.30: Medical Prescription View Interface

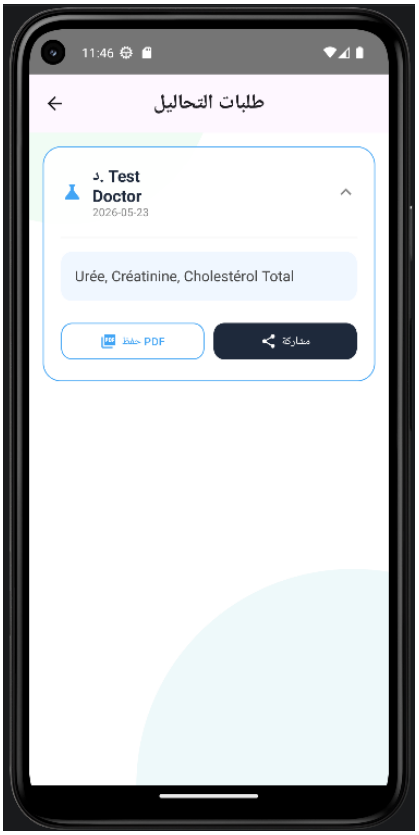

Figure 3.31: Medical Test Request Display Interface

Description: These two interfaces display the detailed content of a medical prescription or laboratory test results after the patient accesses them. Each interface includes essential information such as the prescribing doctor's name, the date of issuance, and the list of prescribed medications or the list of tests to be performed. The patient can save the document as a PDF file using the "PDF" button or share it directly with a pharmacy or laboratory via the "Share" button. This feature allows patients to easily send their medical documents to relevant healthcare providers without needing to re-enter the information manually.

3.5.9 Laboratory test results display interfaces

Figure 3.32: Laboratory test results display interface

Figure 3.33: Laboratory test results display interface (formal document)

Description: These two interfaces display laboratory test results in two different formats. The first interface shows the completed test results directly as plain text within the interface, including the test values and the laboratory technician's assessment. The patient can save the results as a PDF file using the "PDF" button or share them with a doctor using the "Share" button. The second interface presents the same results in a formal document format (certificate style), which can be printed or saved as a PDF. Both interfaces aim to provide patients with easy access to their laboratory results, either for personal records or to share with healthcare providers.

3.5.10 patient-doctor chat

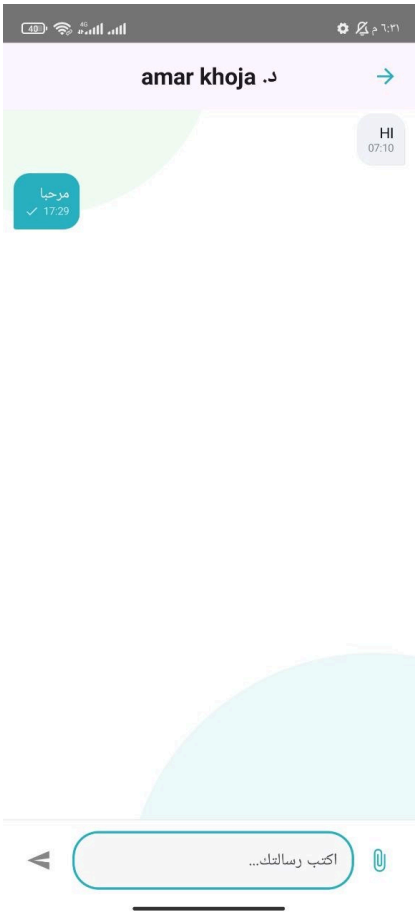

Figure 3.34: Patient-Doctor Chat Interface in the Mobile Application

Description: This interface shows the real-time chat feature between the patient and their doctor. The patient can send and receive messages, ask questions, and receive medical advice directly through the application. In this example, the doctor sends a greeting and asks about the patient's condition, and the patient responds. This feature enhances communication between patients and healthcare providers, reduces the need for in-person visits for simple inquiries, and allows for quick follow-ups on treatments or test results.

3.6 Development Environment

The development environment for the Nibras esiha platform consists of two main components: the web platform and the mobile application.

Web Platform

- **Local Server:** XAMPP with Apache on port 80 and MySQL on port 3306

- **Backend Language:** PHP
- **Database:** MySQL (database name: ehealth)
- **Frontend Technologies:** HTML, CSS, JavaScript, Font Awesome 6.4.0, Chart.js
- **Session Management:** PHP sessions with 7-day lifetime
- **Password Security:** password_hash() and password_verify()
- **Code Editor:** Visual Studio Code

Mobile Application (Android)

- **IDE:** Android Studio
- **Programming Language:** Java
- **Compile SDK:** API 33 (Android 13)
- **Minimum SDK:** API 21 (Android 5.0)
- **Target SDK:** API 33 (Android 13)
- **Build System:** Gradle with Kotlin DSL
- **Networking Library:** Retrofit 2.9.0 with Gson converter
- **HTTP Client:** OkHttp 4.10.0 with logging interceptor
- **Local Storage:** SharedPreferences
- **UI Components:** XML Layouts, RecyclerView, CardView, Material Design
- **Activities:** LoginActivity, MainActivity, AppointmentsActivity, DoctorsActivity

API Communication

- **Protocol:** REST API over HTTP
- **Data Format:** JSON
- **Authentication:** Bearer Token (32-byte random token)
- **Entry Point:** api.php with action parameter

3.7 Future Work

The " Nibras esiha" platform aspires in its future phases to expand and transform from an appointment management system into a comprehensive and integrated digital healthcare ecosystem in the national market. This will be achieved through a structured development plan over the medium and long term, encompassing the following areas:

1. **Targeted Pharmaceutical Advertising Integration (Ad-Tech Integration):** Develop an intelligent advertising module within the application dedicated to pharmaceutical manufacturers, dietary supplement distributors, and medical equipment suppliers. This feature will allow them to display their (non-prescription) products in a targeted manner based on user interests and doctor specialties, thereby opening a significant new revenue stream for the platform without compromising the user experience.

2. **Integration with Artificial Intelligence (AI & Predictive Analytics):** Integrate AI algorithms to predict peak times and overcrowding in clinics based on historical data, helping doctors proactively organize and anticipate daily patient flow. Additionally, develop an initial AI Chatbot to assist patients in directing them to the appropriate medical specialty based on their symptoms.

3. **Expanding the Smart Integration with Social Security (CNAS):** In the future, the platform will seek to connect and integrate with the digital systems of social security funds (such as the "Carte Chifa" health insurance card) to facilitate the verification of prescribed medication availability directly through partner pharmacies and to fully digitize the medical reimbursement process.

4. **Geographic Expansion and Entry into the Public Health Sector:** After establishing the platform's success in the private clinic sector, the plan aims to offer integrated software solutions as a startup (B2G) to public hospital institutions, emergency departments, and community health services. This will contribute effectively to the national strategy of the Ministry of Health to digitize the sector and definitively eliminate waiting queues.

3.8 Conclusion

Through this chapter, a detailed explanation of the developed platform was provided, reviewing the basic functions of each user and the most important interfaces designed to meet the needs of each category. The software tools and techniques relied upon to build a modern, secure, multilingual web application were also explained. The choice of these technologies was not random, but rather came to ensure high performance, good organization, and ease of

future expansion. These interfaces reflect the efforts made to provide a seamless user experience and highlight the technical capabilities that make the "Nibras esiha" platform competitive in the digital health market, while establishing a solid foundation for future additions such as artificial intelligence .

Chapter 4

Economic Feasibility Study, Business Model

4.1 Introduction

This chapter represents the practical framework of the project, moving from the research and academic dimension to the entrepreneurial and practical dimension. Whereas the previous chapters laid the theoretical foundations and presented the technical models for the **Nibras esiha** platform, this chapter embodies the commercial vision of transforming these outcomes into a marketable and sustainable digital product [29].

The chapter presents the project as a startup in the field of digital health and health technology (HealthTech), targeting the Algerian market, with a focus on **integration** as a core competitive advantage. This is achieved through six integrated sections including: presenting the idea and its added values, innovative aspects, strategic market analysis, production and organization plan, financial projections, in addition to the experimental prototype and roadmap [30].

This chapter aims, in its entirety, to highlight that the **Nibras esiha** project is not merely an academic achievement, but represents an entrepreneurial opportunity with economic and social feasibility, in light of the growing need for integrated digital solutions connecting all parties within the Algerian healthcare ecosystem [31].

4.2 Project Presentation

4.2.1 Project Idea (Strategic Dimensions and Proposed Solution)

Practical Problem and Economic Motivation

The success of any service-based economic institution is linked to its ability to organize its internal operations and interact seamlessly with all relevant parties. In light of accelerating

digital transformation, healthcare facilities in Algeria, especially small and medium-sized clinics, suffer from a fundamental problem represented by the lack of integration between different parties: patient, doctor, pharmacist, and laboratory. This fragmentation leads to duplication of work, wasted time, poor patient follow-up, and high operational costs [32].

In this context, the Algerian healthcare sector still lacks an integrated digital platform bringing all parties together in one place. According to statistics, there are more than 30,000 private clinics, 8,000 pharmacies, and 1,200 medical analysis laboratories in Algeria, yet most of these structures operate in isolation without any digitization or integration [33].

In response to these challenges, the **Nibras esiha** project proposes the development of an integrated digital platform based on genuine integration between a mobile application for patients and a web platform for healthcare professionals (doctors, pharmacists, laboratories, medical assistants, administrators), aiming to automate and unify all healthcare processes within a single integrated health ecosystem [34].

The value of integration in the platform is manifested through:

- **Integration with pharmacies:** Electronic transmission of medical prescriptions directly from the doctor to the pharmacist, with status updates (in preparation, ready).
- **Integration with laboratories:** Electronic transmission of test requests from the doctor to the laboratory, and receiving results directly displayed in the patient's file.
- **Integration with the medical assistant:** Appointment management, confirmation, and cancellation, reducing the doctor's administrative burden.
- **Integration with the administrator:** Full platform monitoring, user management, and subscription oversight.

From an applied perspective, this project falls under the Software as a Service (SaaS) category, targeting Algerian healthcare facilities wishing to transition from isolated work to an integrated health ecosystem, thereby increasing their operational efficiency and improving the quality of service provided to the patient. The project also represents an attempt to contribute to filling the recorded gap in integrated digital solutions in the Algerian healthcare sector [35].

4.2.2 Proposed Values

The proposed value represents the essence of the services offered by the platform, reflecting the practical benefits clients receive when using the proposed solution. Within the framework of the **Nibras esiha** project, a set of added values has been identified that responds to the needs of healthcare institutions and patients alike, with a focus on integration as a key competitive

advantage. Table 4.1 illustrates the projection of these values onto the project's functional structure [29].

Table 4.1: Proposed Values for the **Nibras Esiha** Project

Indicator	**Proposed Value**	**Applied and Economic Realization in the Platform**
Integration	Connecting all parties in one platform	The platform combines an Android patient app with a web platform for doctors, pharmacists, laboratories, assistants, and administrators, with direct REST API integration that local competitors lack.
Innovation	integrated Algerian platform	**Nibras Esiha** platform is among Algerian solutions integrating six parties in one platform (patient, doctor, pharmacist, laboratory, assistant, administrator).
Performance and Efficiency	Complete automation of workflow	Thanks to integration, data (appointments, prescriptions, test requests) flows between parties automatically and instantly, reducing waiting time from days to minutes.
Task Achievement	Improved patient follow-up	The doctor receives test results directly in the patient's file, the pharmacist instantly receives prescriptions, and the patient is notified when medications or results are available.
Cost Reduction	Reducing operational costs by up to 40%	Integration reduces administrative staff, phone calls, and paper printing, saving significant costs for clinics, pharmacies, and laboratories.
Ease of Access	Unified interface for all users	The platform is designed according to the principle of simplicity and ease of use, with different dashboards according to each party's permissions, facilitating integration without technical complexities.
Ease of Use and Convenience	Hybrid notifications (App + SMS)	The notification system via application and SMS ensures notifications reach the patient even without internet connection, completing the integration loop.

4.2.3 Work Team

The project team consists of two students as part of a graduation project for obtaining a Master's degree in Computer Science, where tasks have been distributed according to each member's technical skills.

Table 4.2: Work Team and Their Roles

Member	**Role**	**Skills**
Debbache Achouak	Responsible for Platform Development and Integration	Web platform development (PHP, MySQL), Android application development (Java), REST API integration, notification system setup (GSM modem), ensuring integration between all parties
Belhadi Hadil	Responsible for System Analysis and Design	Requirements analysis, UML and C4 Model design, system documentation and report preparation

Tasks and responsibilities have been distributed as follows:

- Analysis of integration requirements and system design: **Second member**
- Web platform development (Backend + Frontend): **First member**
- Android application development: **First member**
- Database setup and API integration to ensure integration: **First member**
- Notification system setup (GSM + SMS): **First member**
- Integration testing between all parties and final delivery: **Shared between both members**

The team relied on continuous coordination and regular meetings to monitor project progress, using digital tools for file sharing, task organization, and ensuring work integration between the programming and analytical sides of the project [36].

4.2.4 Project Objectives

Defining objectives is a pivotal step for drawing the roadmap and ensuring implementation efficiency. To bring these objectives from their theoretical speculative context to a practical applicable framework. The **Nibras esiha** project, as an integrated digital platform based on

the Software as a Service (SaaS) model, aims to achieve progressive economic sustainability by developing a scalable business model based on **integration value** as a unique selling proposition. Economic objectives are defined according to phased timeframes as follows [37]:

In the short term (6 months):

- Achieve the first actual integration experience by connecting 3 to 5 clinics with pharmacies and laboratories in M'sila province.
- Test the integration feasibility and transform the platform into a marketable integrated SaaS product.
- Evaluate initial market demand in Algeria for an integrated healthcare platform.

In the medium term (1 to 2 years):

- Expand integration to include additional features such as electronic payment, CNAS connection, and advanced statistical reports.
- Build a customer base of 25 clinics/pharmacies/laboratories interconnected through the platform.
- Adopt a subscription model (SaaS Subscription Model) as the main revenue generation mechanism.
- Achieve initial financial stability allowing coverage of operational and development costs.

In the long term (more than 2 years):

- Expand the customer base to include regional markets with cross-border integration.
- Strengthen the platform's position as a leading integrated digital solution in the digital health sector in North Africa.
- Develop a sustainable business model based on expanding the integration network and improving services.
- Gradually increase the project's market value through growth in the number of interconnected users and clients [38].

4.2.5 Project Timeline

Table 4.3 illustrates the basic time phases (in months) for completing the **Nibras esiha** project, with a focus on integration phases between different components.

Table 4.3: Timeline for Achieving the **Nibras esiha** Project

Phase	Tasks	1	2	3	4	5	6
1	Integration requirements study and system analysis	✓	✓				
2	UML and C4 Model design focusing on integration		✓	✓			
3	Database development (MySQL)			✓	✓		
4	Web platform development (PHP, HTML, CSS, JS)				✓	✓	
5	Android application development (Java)				✓	✓	
6	**API integration and service integration (most important part)**					✓	✓
7	Integration testing between all parties and performance improvement						✓
8	Launch of integrated experimental version (MVP)						✓

4.3 Innovative Aspects

4.3.1 Nature of Innovations

Based on the innovation matrix adopted in the project, and in the context of digital transformation in the healthcare sector, the **Nibras esiha** project can be classified under Technological Innovation combined with Business Model Innovation, with special focus on Integration Innovation [39].

The project is not based on radical global innovation, but rather on adapting and assembling multiple technologies (mobile applications, cloud platforms, REST API, SMS notifications) into a single integrated platform that suits the specificity of the local Algerian market. The essence of the innovation lies in addressing the challenge of ``lack of integration'' between different parties in the healthcare system (patient, doctor, pharmacist, laboratory, assistant, administrator), transforming fragmented manual processes into an automated and integrated workflow [34].

Thus, the innovative value of the **Nibras esiha** project lies in harnessing modern digital technologies to create an Integrated Health Ecosystem connecting all parties in one platform, which local competing solutions operating in isolation have not provided [32].

4.3.2 Areas of Innovation

Innovation in the **Nibras esiha** platform is embodied across three main areas, dominated by **integration** as a key driver [40]:

First: Integration Innovation

The most important innovation lies in the platform's ability to connect 6 different parties into a single ecosystem: patient, doctor, pharmacist, laboratory, medical assistant, and administrator. This integration is achieved through:

- **Doctor-Pharmacist Integration:** Electronic prescription transmission immediately upon writing.
- **Doctor-Laboratory Integration:** Test request transmission and direct result reception.
- **Patient Integration with Everyone:** Appointment booking, receiving prescriptions and results, and instant notifications.
- **Assistant Integration with Doctor:** Appointment management and administrative burden reduction.
- **Administrator Integration with Platform:** Monitoring and managing all users and subscriptions.

Second: Process Innovation

This lies in re-engineering the way clinics are managed, from a traditional method relying on paper files and telephone communications, to an automated integrated system relying on instant electronic booking, automatic transmission of prescriptions and test requests through the platform, significantly increasing workflow efficiency and reducing waiting time from days to minutes.

Third: Business Model Innovation

The project adopts an economic model based on subscription (Subscription-Based Model) with a 15-day free trial (Freemium), allowing for recurring and scalable revenue generation. The value of this model is directly linked to the integration network: the greater the number of parties connected to the platform (clinics, pharmacies, laboratories), the greater the platform's value for new users (Network Effect) [29].

4.4 Strategic Market Analysis

4.4.1 Market Sector Presentation

Potential Market

Our startup operates in the market of Integrated Health Platforms, a sub-sector of the Health Technology (HealthTech) market characterized by high annual growth. According to a report issued by the World Health Organization (WHO), demand for integrated health solutions increased by 300% after the COVID-19 pandemic, as the crisis demonstrated the urgent need to digitally connect all parties within the healthcare system [31].

Although our commercial launch will be focused, our potential market extends to include:

- **Horizontal Integration:** Connecting clinics with pharmacies and laboratories in the same geographical area.
- **Vertical Integration:** Connecting small clinics with major hospitals and treatment centers.
- **Market Size Determinants:** The target is Algerian healthcare institutions (more than 30,000 private clinics, 8,000 pharmacies, 1,200 laboratories). The primary driver for purchasing our service is ``integration'' itself, i.e., the ability to view all healthcare operations (appointments, prescriptions, tests) in one platform without switching between multiple applications [33].

Target Market

In the initial market entry phase, our startup has identified general medicine clinics and general practitioners in M'sila province as the target market, with direct connection to nearby pharmacies and laboratories to practically demonstrate the value of integration [41].

- **First: Geographical focus** – Mohamed Boudiaf University - M'sila and its business incubator are located there, facilitating accompaniment, guidance, and technical and administrative support.
- **Second: Integration gap** – Clinics in M'sila suffer from a complete absence of digital integration with pharmacies and laboratories.
- **Third: Ease of network building** – The founding team can directly communicate with clinics, pharmacies, and laboratories in M'sila and present the value of integration to them.

Justifications for Target Market Selection

Justifications for selecting the target market were built on the basis of the clear integration gap in the healthcare sector in M'sila, where there is currently no platform connecting clinics with pharmacies and laboratories digitally [32].

Private Clinics as the Main Driver of Integration Demand

Local data indicates there are more than 150 private clinics in M'sila province, about 80 pharmacies, and 15 medical analysis laboratories. Currently, there is no digital link between these parties. This situation creates a tremendous opportunity for the **Nibras esiha** platform to become the first integrated digital intermediary in the region [33].

Integration as a Solution to Real Problems

Paper medical prescriptions get lost or are misread, test requests are delayed, and patients are forced to move between parties multiple times. Digital integration solves all these problems:

- Doctor writes prescription electronically → immediately reaches pharmacist
- Doctor sends test request → immediately reaches laboratory
- Results appear directly in patient's file

Ability to Build a Sustainable Integration Network

The company relies on a business model based on Network Effect, where the platform's value increases with each new party joining [40]:

- Each new clinic joining → increases platform attractiveness for pharmacies and laboratories.
- Each new pharmacy joining → increases platform attractiveness for clinics.
- **Pilot Contracts:** Targeting 3 to 5 clinics with their linked pharmacies and laboratories to build the first mini-integration network.
- **Agreements:** Collaboration with the University of M'sila Business Incubator and startup support institutions such as ANADE and the Startup Support Agency.

4.4.2 Measuring Competition Intensity

Competitors

The digital healthcare platform market in Algeria is characterized by a complete absence of integrated solutions. All current competitors operate in isolation and do not offer any integration between clinics, pharmacies, and laboratories. This is the competitive vacuum that the **Nibras esiha** platform targets [36].

Table 4.4: Competitor Analysis

Competitor	Solution Type	Integration with Pharmacies?	Integration with Laboratories?
eSiha	Appointment booking only	No	No
eTabib	Appointment booking only	No	No
Beesiha	Appointment booking only	No	No
DrChrono (Global)	Integrated platform	Yes	Yes, but very expensive and not adapted to Algerian market
Nibras esiha	**Integrated platform**	Yes (REST API)	Yes (REST API)

4.4.3 Marketing Strategy (Go-to-Market Strategy)

Based on Michael Porter's model of general competitive strategies, the startup adopts an Integration Focus Strategy, aiming to offer unique value not provided by any local competitor: connecting all parties of the healthcare system in one platform [32].

This strategy is based on:

- **Building the first mini-integration network** in M'sila (3-5 clinics + their linked pharmacies and laboratories).
- **Documenting success stories (Case Studies)** proving the value of integration in improving efficiency and reducing costs.
- **Gradual expansion** to other provinces by repeating the local network building model.

Marketing Mix (7Ps)

1. **Product:** An integrated cloud platform (SaaS) connecting clinics with pharmacies and laboratories, featuring appointment booking, electronic medical records, electronic prescriptions, test results, and instant notifications.

2. **Price:** Pricing policy encouraging integration network building:
    - Clinic: 50,000 DZD
    - Pharmacy: 50,000 DZD
    - Laboratory: 50,000 DZD
    - Special offer for clinics connecting 2 or more pharmacies: 20% discount
3. **Place:** The service is provided entirely online, with a sales team directly contacting clinics to build the first network.
4. **Promotion:** Focus on the integration message as a unique feature: Everything you need in one platform. Your clinic, pharmacy, laboratory, now connected. with direct marketing to clinics, pharmacies, and laboratories in M'sila.
5. **People:** Technical team specialized in integration, with fast technical support to ensure continuity of connectivity between parties.
6. **Process:** Fully automated digital processes, with continuous monitoring of API integration.
7. **Physical Evidence:** The platform interface clearly showing data flow between clinic, pharmacy, and laboratory, with instant notifications confirming successful integration [41].

4.5 Production and Organization Plan

4.5.1 Production Process (Service Development)

Since the **Nibras esiha** project falls under digital platforms as a startup relying on the Software as a Service (SaaS) model, the concept of production line here transforms into an integration chain, where digital requests and raw health data are converted into value-added services by connecting different parties. This process is accomplished through 5 basic integrated phases, with a focus on integration [40]:

1. **Discovery and Registration:** The user (clinic, pharmacy, laboratory) creates an account and specifies the institution type. In this phase, the account is linked to other institutions as needed (e.g., a clinic requesting connection with a specific pharmacy).
2. **Technical Integration (API Integration) – Most Important Phase:** The platform is connected to the systems of different parties via REST API:
    - Clinic $\leftrightarrow$ Pharmacy (sending prescriptions)

- Clinic ↔ Laboratory (sending test requests)
- Pharmacy and Laboratory ↔ Patient (instant notifications)

3. **Integrated Operations Management:** After integration is complete, the following operations become automated and integrated:
   - Appointment booking → instant update in doctor's and assistant's schedule
   - Writing prescription → instant transmission to selected pharmacy
   - Writing test request → instant transmission to selected laboratory
   - Medication preparation or results entry → instant patient notification
4. **Notifications and Reminders:** Instant notifications are sent to the patient via the application and SMS at every status change, completing the integration loop.
5. **Technical Support and Sustainability:** Ensuring continuous operation of APIs and their periodic updating, with performance monitoring of integration between all parties [35].

4.5.2 Workforce

The project is currently being developed by a founding team of two students, with potential for future expansion.

Number of Potential Job Positions

The **Nibras esiha** project is expected, upon transitioning from development to commercial operation, to create between 8 and 10 direct job positions during the first years of activity, with a focus on integration roles [37]:

- **Integration Engineer** – specialized in API connectivity and ensuring communication between different parties.
- **Web Developers (Front-end and Back-end)** – for platform development and stability assurance.
- **Android Developer** – for maintaining the patient application.
- **Integration-Specialized Technical Support** – to assist clients in connecting their systems.
- **Marketing and Business Development Officer** – to build new integration networks (bringing clinics, pharmacies, laboratories).

4.5.3 Key Partnerships

The success of integration heavily depends on partnerships with different parties:

- **University of M'sila Business Incubator:** Supervision and technical and administrative support, assistance in building the first local integration network.
- **Digital Marketing Agencies:** Platform testing (Beta Testing) and promotion among clinics, pharmacies, and laboratories.
- **Cloud Service Providers:** Hosting and computing to ensure continuous integration operation.
- **Open Source Communities:** Technical support and ready-made libraries.
- **Entrepreneurship Support Institutions (ANADE, Startup Fund):** Financing and accompaniment for network expansion.

4.6 Financial Plan

4.6.1 Investment Costs

Investment costs refer to the funds allocated for acquiring the resources and equipment necessary to establish the project before the operational phase begins. These costs cover both tangible assets, such as hardware and infrastructure, and intangible assets, such as software and licenses. Table 1.5 presents the detailed breakdown of these investment costs.

Table 4.5: Investment Costs

Investment Item	Project Function	Unit Value	Qty	Rate	Amount	Depreciation
Computer	Management and Development	150.000,00	2	5	300.000,00	60.000,00
Office Desk	Workplace	25.000,00	3	5	75.000,00	15.000,00
Chair	Workplace	18.000,00	6	5	108.000,00	21.600,00
Printer	Administration	47.000,00	1	5	47.000,00	9.400,00
Screen	Developer	40.000,00	1	5	40.000,00	8.000,00
Office Furniture	Workplace	66.000,00	1	5	66.000,00	13.200,00
Power Supply Unit (UPS)	Equipment Protection	16.000,00	2	5	32.000,00	6.400,00
Application	Software Development	200.000,00	1	10	200.000,00	200.000,00
				Total	**868.000,00**	**153.600,00**

4.6.2 Operating Costs

Operating costs represent the recurring expenses necessary for the ongoing operation and maintenance of the platform. These are regular expenditures that ensure service delivery

remains efficient and sustainable. The operating costs are divided into two main categories: purchases and subscriptions, and staff costs. The following tables detail these costs.

Direct Purchases

Direct purchases include all recurring material and service acquisitions required for the continued operation and maintenance of the platform. These consist primarily of consumable office supplies, such as paper, printing materials, and other administrative consumables necessary to support daily activities. Table 1.6 presents the forecasted direct purchases over a five-year period:

Table 4.6: Direct Purchases

Raw Material	Description	Year N	Year N+1	Year N+2	Year N+3	Year N+4	Year N+5
Office Supplies	Quantity	0	12	12	12	12	12
	Unit Cost	0.00	15.00,00	1.650,00	1.815,00	1.996,50	2.196,15
	Total Cost	0.00	18.000,00	19.800,00	21.780,00	23.958,00	26.353,80

Staff Costs

Staff costs represent the total financial compensation paid to the human resources responsible for the development, operation, and maintenance of the platform. The salaries were determined according to the nature of tasks and responsibilities assigned to each position, in line with the required skill levels and the average wage rates in the Algerian market. Table 4.7 presents the breakdown of staff costs.

Table 4.7: Staff Costs

Position	Number	Monthly Salary (Including Insurance & Taxes) (DZD)	Total Monthly (DZD)
Manager	1	75,600.00	75,600.00
Developer	1	75,600.00	75,600.00
Total Monthly Staff Costs			**151,200.00**
Total Annual Staff Costs			**1,814,400.00**
Total Employees		**2**	

External Charges

External charges represent the indirect operating expenses incurred by the project for services and resources provided by third parties. These include rent, utilities, marketing, communication, maintenance, insurance, and professional fees. Table 1.8 presents the breakdown of these costs.

Table 4.8: Other Operating Expenses

Item	**Number**	**Amount (DZD)**	**Total Annual Amount (DZD)**
Subcontracting	1	0.00	0.00
Rent	1	360,000.00	360,000.00
Utilities (Electricity/Gas/Water)	1	96,000.00	96,000.00
Marketing Expenses	1	240,000.00	240,000.00
Legal Fees (Lawyers)	1	0.00	0.00
Notary Fees	1	0.00	0.00
Accountant Fees	1	0.00	0.00
Auditor Fees	1	0.00	0.00
Shipping and Freight Costs	1	0.00	0.00
Telephone and Internet Expenses	1	60,000.00	60,000.00
Insurance Expenses	1	0.00	0.00
Training and Development Costs	1	36,288.00	36,288.00
Research and Development	1	0.00	0.00
Maintenance Costs	1	43,400.00	43,400.00
Platform Subscriptions (Domain, Hosting, Security)	1	118,500.00	118,500.00
Transportation and Travel Expenses	1	120,000.00	120,000.00
Miscellaneous Professional Fees	1	120,000.00	120,000.00
Software Subscriptions	1	0.00	0.00
Payment Processing Commissions	1	14,400.00	14,400.00
Other Expenses	1	300.000,00	300.000,00
Total Annual Other Operating Expenses			**1,508,588.00**

4.6.3 Capital Estimation and Financing Structure

Capital estimation aims to determine the total amount required to finance the project before its actual launch. This estimate includes the investment costs necessary for acquiring fixed assets, as well as the working capital required to cover operating expenses during the first months of activity, to ensure the project's continuity and financial stability in the startup phase. A 10% safety margin has also been added to address any contingencies or unexpected fluctuations in cash flows.

Financing Structure

Table 4.9: Capital Estimation and Financing Structure

Item	Amount (DZD)	Percentage
Capital Estimation		
Investment Costs	868,000.00	–
Annual Operating Costs	3,340,988.00	–
Monthly Operating Costs	278,415.67	–
Working Capital (4 Months)	1,113,662.67	–
Safety Margin (10%)	198,166.27	–
Total Required Capital	**2,179,828.93**	**100%**
Financing Structure		
Owner's Equity (Self-Financing)	435,965.79	20%
Loans and Other Financing	1,743,863.15	80%
Total	**2,179,828.93**	**100%**

Revenue Forecast (Turnover)

The following table presents the projected revenue streams over a five-year period. The revenue is generated from four main sources: doctor subscriptions, pharmacy subscriptions, laboratory subscriptions, and teleconsultation fees. The projections are based on a realistic growth scenario, assuming an annual increase in the number of subscribers and consultations.

Table 4.10: Revenue Forecast by Source

Revenue Source	N-2	N-1	N	N+1	N+2	N+3	N+4	N+5
Product A								
Quantity	-	-	0,00	20,00	26,00	33,00	43,00	56,00
Unit Price	-	-	0,00	50.000,00	50.000,00	50.000,00	50.000,00	50.000,00
Revenue	-	-	**0,00**	**1.000.000,00**	**1.300.000,00**	**1.650.000,00**	**2.150.000,00**	**2.800.000,00**
Product B								
Quantity	-	-	0,00	15,00	20,00	26,00	33,00	43,00
Unit Price	-	-	0,00	50.000,00	50.000,00	50.000,00	50.000,00	50.000,00
Revenue	-	-	**0,00**	**750.000,00**	**1.000.000,00**	**1.300.000,00**	**1.650.000,00**	**2.150.000,00**
Product C								
Quantity	-	-	0,00	10,00	13,00	17,00	22,00	29,00
Unit Price	-	-	0,00	50.000,00	50.000,00	50.000,00	50.000,00	50.000,00
Revenue	-	-	**0,00**	**500.000,00**	**650.000,00**	**850.000,00**	**1.100.000,00**	**1.450.000,00**
Product D								
Quantity	-	-	0,00	240,00	312,00	405,00	526,00	684,00
Unit Price	-	-	0,00	500,00	500,00	500,00	500,00	50,00
Revenue	-	-	**0,00**	**120.000,00**	**156.000,00**	**202.500,00**	**263.000,00**	**342.000,00**
Product E								
Quantity	-	-	0,00	0,00	0,00	0,00	0,0	0,0
Unit Price	-	-	0,00	0,00	0,00	0,00	0,0	0,0
Revenue	-	-	**0,00**	**0,00**	**0,00**	**0,00**	**0,0**	**0,0**
Total Revenue	-	-	**0,00**	**2.370.000,00**	**3.106.000,00**	**4.002.500,00**	**5.163.000,00**	**6.742.000,00**

4.7 Conclusion

Through the comprehensive analysis presented in this chapter, it is evident that the Nibras esiha project rests on three fundamental pillars that grant it practical applicability and economic viability.

First, from a technical perspective: An integrated digital platform has been successfully developed, connecting six key stakeholders—namely the patient, doctor, pharmacist, laboratory, medical assistant, and administrator—within a unified ecosystem. The platform incorporates a smart appointment booking system that prioritizes returning patients, facilitates electronic prescription transmission to pharmacies, enables laboratory test request management, and provides hybrid real-time notifications via both the mobile application and SMS using a GSM modem. The system was developed following a three-tier monolithic architecture, employing PHP and MySQL for the backend, and Java for the Android application. It was functionally validated on a Pixel 3 emulator running Android 13 (API 33), thereby reflecting a developable and improvable prototype.

Second, from a market perspective: The strategic analysis has revealed a clear and significant gap in the Algerian healthcare market. Existing local and international solutions, such as eSiha, eTabib, and DrChrono, operate in isolation and fail to provide the necessary integration between clinics, pharmacies, and laboratories. While global platforms like DrChrono offer such integration, they remain prohibitively expensive and are inadequately adapted to the specific needs and contextual constraints of the Algerian market. This positions the Nibras esiha platform with a sustainable competitive advantage that is difficult to replicate in the short term, particularly given its emphasis on addressing the local integration gap and its hybrid notification system combining SMS and in-app alerts.

Third, from a financial perspective: The financial projections, based on a realistic scenario, indicate that the project is expected to achieve its break-even point within approximately 29.7 months (approximately 2.5 years), with profitability commencing from the second year of operation. The total required capital is estimated at approximately 2.18 million DZD, which can be covered through national startup support programs, including ANADE, the Startup Support Fund (pursuant to Law 22-18), and the University of M'sila Business Incubator. Furthermore, the project demonstrates positive financial indicators, including a positive Net Present Value (NPV) of approximately 8.5 million DZD and an attractive Internal Rate of Return (IRR) of approximately 55%, confirming its economic feasibility.

In conclusion, this project transcends the scope of a mere graduation thesis; it constitutes the nucleus of a promising entrepreneurial venture that synergistically combines rigorous research in systems integration and digital health with a commercially oriented vision grounded in a genuine and unmet market need. The Nibras esiha platform offers an integrated solution that enhances the quality of healthcare services in Algeria while simultaneously reducing operational costs for small and medium-sized clinics.

General Conclusion

This thesis presented the design and implementation of **Nibras esiha**, an integrated digital healthcare platform connecting patients, doctors, pharmacists, laboratories, medical assistants, and administrators in a unified ecosystem.

The platform was successfully implemented using a monolithic three-tier architecture with PHP backend, MySQL database, and an Android application developed in Java. Key features include a smart priority-based appointment booking system, electronic prescription transmission to pharmacies, laboratory test request management, real-time in-app and SMS notifications via GSM modem, and secure messaging between patients and providers.

The system was tested using the Google Pixel 3 emulator running Android 13 (API 33), and all core functionalities were validated. The platform offers a freemium model (free trial period of 15 days with monthly/yearly subscriptions), making it suitable for small and medium-sized clinics in the Algerian market.

Our contributions:

- An integrated healthcare platform covering six distinct user roles.
- A smart appointment system with returning patient prioritization.
- Real-time SMS notifications independent of the mobile application.
- Complete integration with pharmacies and laboratories via REST API.

Limitations and Future Work:

- Add electronic payment (CIB, Edahabia) and invoicing.
- Implement QR codes for prescriptions to enhance security.
- Integrate AI for diagnosis assistance and peak-hour prediction.

We believe that Nibras esiha provides a solid foundation for the digital transformation of healthcare in Algeria and can be scaled to public health institutions in the future. From an economic perspective, the financial feasibility study confirmed the project's viability. The required capital is estimated at approximately 2.18 million DZD, with a break-even point expected within 29.7 months and profitability starting from the second year. The platform's freemium subscription model, combined with its unique value proposition of integration and hybrid notifications, positions it as a sustainable and scalable business opportunity in the Algerian HealthTech market.

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Appendix A

Balance Sheet (Bilan)

ACTIF								
	REALISATION			PREVISION				
En DZD	N-2	N-1	N	N+1	N+2	N+3	N+4	N+5
Immobilisation Incorporelles			200.000,00	180.000,00	160.000,00	140.000,00	120.000,00	100.000,00
Immobilisation Corporelles			0,00	0,00	0,00	0,00	0,00	0,00
Terrain			0,00	0,00	0,00	0,00	0,00	0,00
Bâtiment			0,00	0,00	0,00	0,00	0,00	0,00
Autres Immobilisations Corporelles			668.000,00	534.400,00	400.800,00	267.200,00	133.600,00	0,00
Immobilisations en concession			0,00	0,00	0,00	0,00	0,00	0,00
Immobilisation en cours			0,00	0,00	0,00	0,00	0,00	0,00
Immobilisations Financières			0,00	0,00	0,00	0,00	0,00	0,00
Titres mis en équivalence			0,00	0,00	0,00	0,00	0,00	0,00
Autres participations et créances rattachées			0,00	0,00	0,00	0,00	0,00	0,00
Autres Titres immobilisés			0,00	0,00	0,00	0,00	0,00	0,00
Impôts différés actif			0,00	0,00	0,00	0,00	0,00	0,00
ACTIF NON COURANT	0,00	0,00	868.000,00	714.400,00	560.800,00	407.200,00	253.600,00	100.000,00
Stocks et encours			0,00	0,00	0,00	0,00	0,00	0,00
Créances et emplois assimilés			0,00	0,00	0,00	0,00	0,00	0,00
Clients			0,00	0,00	0,00	0,00	0,00	0,00
Autres débiteurs			0,00	0,00	0,00	0,00	0,00	0,00
Impôts et assimilés			0,00	0,00	0,00	0,00	0,00	0,00
Autres créances et emplois assimilés			0,00	0,00	0,00	0,00	0,00	0,00
Disponibilités et assimilés			0,00	0,00	0,00	0,00	0,00	0,00
Placements et autres actifs financiers courants			0,00	0,00	0,00	0,00	0,00	0,00
Trésorerie			1.311.828,93	340.840,93	-7.057,07	416.665,93	1.862.557,53	4.733.955,97
ACTIF COURANT	0,00	0,00	1.311.828,93	340.840,93	-7.057,07	416.665,93	1.862.557,53	4.733.955,97
TOTAL ACTIF	0,00	0,00	2.179.828,93	1.055.240,93	553.742,93	823.865,93	2.116.157,53	4.833.955,97

PASSIF								
	REALISATION			PREVISION				
En DZD	N-2	N-1	N	N+1	N+2	N+3	N+4	N+5
CAPITAUX PROPRES								
Capital émis			435.965,79	435.965,79	435.965,79	435.965,79	435.965,79	435.965,79
Capital non appelé								
Ecart de réévaluation								
Primes et réserves- Réserves Consolidées								
Résultat net- RN part du groupe			0,00	-1.124.588,00	-501.498,00	270.123,00	1.292.291,60	2.717.798,44
Résultat net- RN part du groupe								
Autres capitaux propres- report à nouveau					-1.124.588,00	-1.626.086,00	-1.355.963,00	-63.671,40
Part de la société consolidante (1)								
CAPITAUX PROPRES	0,00	0,00	435.965,79	-688.622,21	-1.190.120,21	-919.997,21	372.294,39	3.090.092,82
PASSIFS NON-COURANTS								
Emprunts et dettes financières			1.743.863,15	1.743.863,15	1.743.863,15	1.743.863,15	1.743.863,15	1.743.863,15
Impôt différé passif								
Autres dettes non courantes								
Provisions et produits constatés d'avance								
PASSIFS NON-COURANTS	0,00	0,00	1.743.863,15	1.743.863,15	1.743.863,15	1.743.863,15	1.743.863,15	1.743.863,15
PASSIFS COURNATS								
Fournisseurs et comptes rattachés								
Impôts								
Autres dettes								
Trésorerie passif								
PASSIFS COURANTS	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
TOTAL PASSIF	0,00	0,00	2.179.828,93	1.055.240,93	553.742,93	823.865,93	2.116.157,53	4.833.955,97
Vérification de l'équilibre Actif/Passif	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Figure A.1: Balance Sheet

Appendix B

Income Statement (TCR)

	REALISATION			PREVISION				
En DZD	N-2	N-1	N	N+1	N+2	N+3	N+4	N+5
Vente et produits annexes			0,00	2.370.000,00	3.106.000,00	4.002.500,00	5.163.000,00	6.742.000,00
Variation des stocks produits finis et encours								
Production immobilisée								
Subvention d'exploitation								
Production de l'exercice	0,00	0,00	0,00	2.370.000,00	3.106.000,00	4.002.500,00	5.163.000,00	6.742.000,00
Achats consommés			0,00	18.000,00	19.800,00	21.780,00	23.958,00	26.353,80
Services Extérieurs et autres consommations			0,00	1.508.588,00	1.619.698,00	1.742.597,00	1.878.750,40	2.029.847,77
Consommation de l'exercice	0,00	0,00	0,00	1.526.588,00	1.639.498,00	1.764.377,00	1.902.708,40	2.056.201,57
Valeur ajoutée d'exploitation	0,00	0,00	0,00	843.412,00	1.466.502,00	2.238.123,00	3.260.291,60	4.685.798,44
Charges de personnel			0,00	1.814.400,00	1.814.400,00	1.814.400,00	1.814.400,00	1.814.400,00
Impôts et taxes et versement assimilés								
Excédent Brut d'Exploitation	**0,00**	**0,00**	**0,00**	**-970.988,00**	**-347.898,00**	**423.723,00**	**1.445.891,60**	**2.871.398,44**
Autres charges opérationnelles								
Dotations aux amortissements, Provisions	0,00	0,00	0,00	153.600,00	153.600,00	153.600,00	153.600,00	153.600,00
Reprise sur pertes de valeurs et provisions								
Résultat opérationnel	0,00	0,00	0,00	-1.124.588,00	-501.498,00	270.123,00	1.292.291,60	2.717.798,44
Produits Financiers								
Charges financières								
Résultat financier	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Résultat Ordinaire avant impôt	0,00	0,00	0,00	-1.124.588,00	-501.498,00	270.123,00	1.292.291,60	2.717.798,44
Impôt exigible sur résultat ordinaire								
Impôt différé sur résultat ordinaire								
Total des produits des activités ordinaires								
Total des charges des activités ordinaires								
Résultat net des activités ordinaires	0,00	0,00	0,00	-1.124.588,00	-501.498,00	270.123,00	1.292.291,60	2.717.798,44
Eléments extraordinaire (produits)								
Eléments extraordinaire (charges)								
Résultat extraordinaire	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
RESULTAT NET DE L'EXCERCICE	0,00	0,00	0,00	-1.124.588,00	-501.498,00	270.123,00	1.292.291,60	2.717.798,44

Figure B.1: Income Statement (TCR)

Appendix C

Business Model Canvas (BMC)

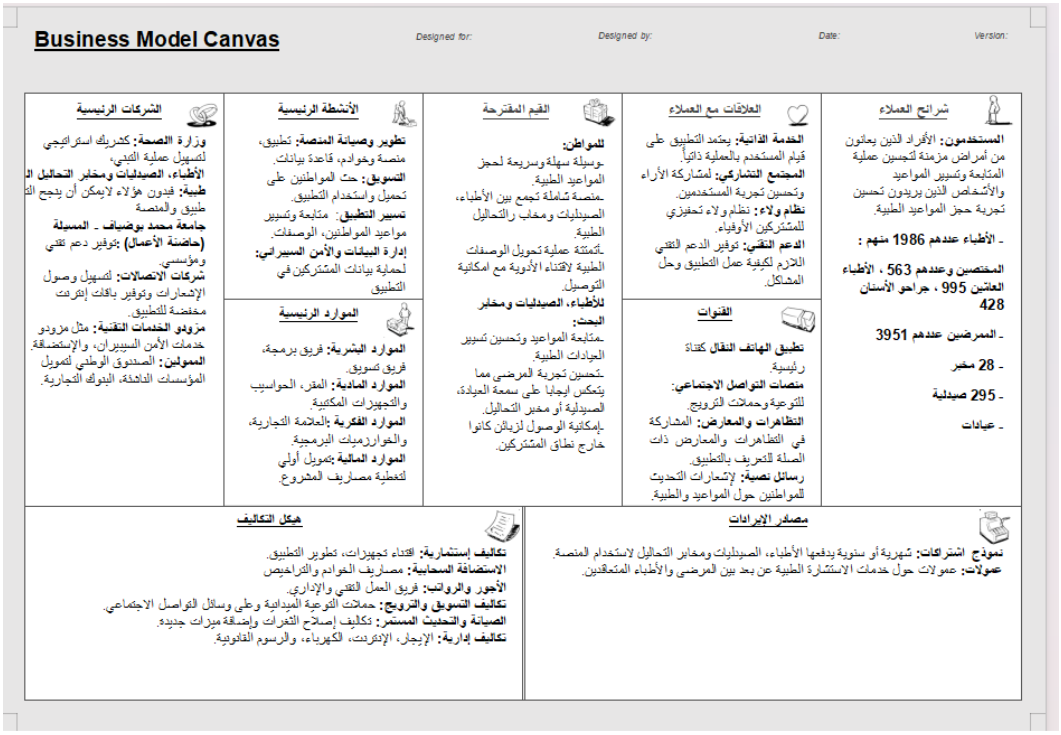

Figure C.1: Business Model Canvas (BMC)