**AKSABCARE: AN AI POWERED HOSPITAL DISCOVERY AND TELEMEDICINE PLATFORM**

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AKSABCARE: AN AI POWERED HOSPITAL DISCOVERY AND TELEMEDICINE PLATFORM

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By

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TO

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Baze University, Abuja.

September, 2025.

**DECLARATION**

This is to certify that this Thesis entitled “**AksabCare**: **An AI powered Hospital Discovery and Telemedicine Platform**”, which is submitted by **Muhammad, Abdallah Omeiza** in partial fulfilment of the requirement for the award of degree for B.Sc. in Computer Science to the Department of Computer Science, Baze University Abuja, Nigeria, comprises of only my original work and due acknowledgement has been made in the text to all other materials used.

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**CERTIFICATION**

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**DEDICATION**

I dedicate this project to the Almighty Allah (SWT) for his guidance, and protection throughout my time in Baze University and thoughout the duration of this project. I also dedicate this project to my wonderful parents Mr. Muhammad Bello Ozigi and Mrs. Halimat Mono Muhammad for their continuous unwavering support throughout my academic journey.

To all my siblings, cousins, aunts, and uncles who have been a source of strength to me. To my Supervisor Dr Usman Bello Abubakar. To all my friends, mentors, and colleagues, I cannot thank them enough for the support they have given me. May Allah grant them long life and prosperity.

**ABSTRACT**

Nigeria's healthcare system faces critical accessibility challenges with only one hospital for every 5,900 people and a severe shortage of medical specialists, particularly affecting rural populations. However, most existing digital health solutions in Nigeria are fragmented, focusing either on hospital directories or basic telemedicine, without integrating comprehensive AI-powered health guidance and international medical partnerships. This study analyzes gaps in existing platforms and reviews healthcare accessibility challenges across Nigeria's 235 million population. Based on this analysis, a comprehensive web application is developed and implemented using Next.js, React, and Prisma ORM. The application combines AI health guidance, hospital and doctor directories, video consultations with international specialists, e-pharmacy services with drug verification, and secure payment processing. The platform integrates partnerships with healthcare providers in India, Pakistan, and Bangladesh to offer specialist consultations at 80-90% lower costs than traditional services. Adopting this system will significantly improve healthcare accessibility for Nigerian patients, particularly in underserved areas, and provide a scalable model for digital health implementation across developing countries.

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**LIST OF ABBREVIATIONS**

**AI | Artificial Intelligence**

**API | Application Programming Interface**

**CDN | Content Delivery Network**

**ERD | Entity-Relationship Diagram**

**ICT | Information and Communication Technology**

**KPI | Key Performance Indicator**

**MD | Medical Doctor**

**MDCN | Medical and Dental Council of Nigeria**

**MFA | Multi-Factor Authentication**

**NDPA | Nigeria Data Protection Act**

**NLP | Natural Language Processing**

**ORM | Object-Relational Mapping**

**PCI DSS | Payment Card Industry Data Security Standard**

**PWA | Progressive Web Application**

**SMS | Short Message Service**

**TLS | Transport Layer Security**

**UI | User Interface**

**UX | User Experience**

**WHO | World Health Organization**

**WebRTC | Web Real-Time Communication**

**CHAPTER 1**

**INTRODUCTION**

**1.1 Overview**

Nigeria stands as Africa's most populated nation with over 235 million people, facing serious healthcare problems that need smart technology solutions (Business Day Intelligence, 2024; Federal Ministry of Health Nigeria, 2024).

The country's health system has major structural problems, with only 38,824 working healthcare facilities serving the huge population. This means there is just one hospital or clinic for every 5,900 Nigerians (Business Day Intelligence, 2024). This worrying number shows how badly the country needs more healthcare buildings, especially in rural areas where over 60% of babies are born outside health facilities and 56% of mothers get no care after giving birth (Northeast Nigeria Humanitarian Response, 2025).

The shortage of healthcare workers presents an even worse situation. Nigeria has about one doctor for every 10,000 people, which is 1000% below what the World Health Organization recommends (one doctor for every 600 people) (Business Day Intelligence, 2024; Punch Newspapers, 2025). This problem has gotten worse because of the "Japa Syndrome," where many doctors leave Nigeria for other countries. Between 2019 and 2023, over 1,056 medical specialists moved to other countries, and more than 900 junior doctors moved to Europe in just nine months of 2023 (Crisis of Brain Drain in Nigeria's Health Sector, 2025). This brain drain has left many hospitals without enough skilled staff, with some rural areas having doctor-to-patient ratios ranging from 1:10,000 to 1:30,000 (Crisis of Brain Drain in Nigeria's Health Sector, 2025).

AksabCare represents a game-changing digital health project designed to tackle these healthcare access problems through an integrated AI-powered platform. The platform combines hospital discovery services, international telemedicine capabilities, pharmaceutical systems, and smart clinical guidance tools. This complete platform uses advanced artificial intelligence, machine learning systems, and partnerships with other countries to bridge the gap between healthcare demand and supply in Nigeria's complex medical environment.

The platform's smart design has five connected parts that work together to address specific healthcare access barriers. The Hospital Directory System provides a complete, searchable database of Nigerian healthcare facilities. This includes detailed information about services, specialists, pricing structures, quality ratings, and how easy it is to reach them.

The Doctor and Specialist Directory connects patients with both local Nigerian healthcare professionals and international specialists from countries with affordable healthcare markets, particularly India, Pakistan, and Bangladesh. In these countries, medical consultations cost between $5-50 compared to $200-500 in developed countries (World Bank, 2024).

The E-Pharmacy allows patients to buy and receive drugs online, providing medical access for patients who struggle to get the medications they need. The AI-Powered Chatbot provides culturally sensitive, multilingual symptom checking and healthcare guidance without giving medical diagnoses.

Finally, the integrated Payment Processing System supports multiple payment channels including mobile money, bank transfers, and digital wallets to ensure financial accessibility.

AksabCare's development fits well with Nigeria's national health goals, including the ambitious Universal Health Coverage target by 2035 as outlined in the National Health Strategic Plan (Federal Ministry of Health Nigeria, 2023).

The platform supports government digital transformation projects and addresses the critical need for new healthcare delivery models that can overcome geographical barriers and provide affordable access to quality medical expertise.

**1.2 Background and Motivation**

Nigeria’s healthcare system faces deep-rooted challenges despite significant financial investment. From 2019 to 2024, the government spent about ₦4.55 trillion on health, while the World Bank contributed $3.53 billion in loans over nine years. Yet, these efforts have not produced meaningful improvements, with hospitals, infrastructure, and service delivery still struggling (Business Day Intelligence, 2024; Health Sector Crisis Persists, 2025).

The rural–urban divide remains severe. Many rural communities lack access to specialists, forcing patients to travel long distances at great cost. In some regions, there are no resident cardiologists, oncologists, or neurologists at all (The Cable, 2024; Northeast Nigeria Humanitarian Response, 2025). With 76.24% of health expenses paid out-of-pocket, families often sacrifice care for basic needs, while insurance coverage remains below 10% (State of Healthcare in Nigeria, 2025). This has fuelled medical tourism, with Nigerians spending over $1 billion abroad on treatment in 2022 (Crisis of Brain Drain in Nigeria’s Health Sector, 2025).

At the same time, digital health offers huge potential. The global telemedicine market was valued at $104.64 billion in 2024 and is projected to grow to $334.80 billion by 2032 (Fortune Business Insights, 2024). Africa’s digital health market is also expanding, expected to reach $16.6 billion by 2030, while Nigeria’s telemedicine market is forecasted to grow at 12.2% annually through 2030 (eHealth Africa, 2025; Nigeria Telehealth Market, 2025). The COVID-19 pandemic accelerated adoption, proving the viability of remote consultations worldwide (Role of Telemedicine in Increasing Healthcare Access, 2023). Success stories in India and South Africa show how large-scale national programs can be integrated into public systems.

Nigeria also has opportunities for international collaboration. Countries such as India, Pakistan, and Bangladesh provide affordable, high-quality medical services, which Nigerian platforms could leverage to improve local access (World Bank, 2024). The regulatory environment is becoming more supportive, with the Nigeria Data Protection Act (2023) and the National Health Act (2014) laying strong legal foundations. The Federal Ministry of Health’s strategic plan further emphasizes digital health as a pathway to universal coverage by 2035 (Chambers and Partners, 2024; Federal Ministry of Health Nigeria, 2023).

**1.3 Statement of the Problem**

Despite major investments and health policies, Nigeria’s healthcare system remains in crisis. Over 235 million people depend on just 38,824 functioning health facilities, most of which are concentrated in urban centres. This leaves rural communities underserved, often forcing patients to travel long distances at high cost, with dangerous delays in treatment (Business Day Intelligence, 2024; Northeast Nigeria Humanitarian Response, 2025).

The shortage of healthcare professionals adds to the problem. Nigeria’s doctor-to-patient ratio stands at 1:10,000—among the worst globally. A persistent “brain drain” has worsened this, with more than 1,000 medical consultants and hundreds of resident doctors leaving in the past five years (Business Day Intelligence, 2024; Crisis of Brain Drain in Nigeria’s Health Sector, 2025).

Patients also lack reliable, centralized healthcare information. Without an integrated directory of services, specialists, fees, or insurance coverage, patients often make inefficient healthcare decisions, face duplicated tests, and experience fragmented referrals.

Telemedicine adoption in Nigeria remains fragmented, despite its global success during COVID-19. Current digital health projects lack interoperability and data integration, preventing their impact from reaching scale (Role of Telemedicine in Increasing Healthcare Access, 2023). Meanwhile, the absence of AI-based guidance systems leaves patients unsure about when to seek emergency care, consult specialists, or rely on primary care—worsening delays and inefficiencies.

Finally, financial barriers remain a major obstacle. With citizens paying 76.24% of health costs out-of-pocket and insurance coverage still below 10%, millions delay or forgo needed treatment. Many instead turn to medical tourism, spending over $1 billion abroad every year, draining both household resources and national reserves (State of Healthcare in Nigeria, 2025; Crisis of Brain Drain in Nigeria’s Health Sector, 2025).

**1.4 Aim and Objectives**

The goal of **AksabCare** is to design, build, and evaluate a comprehensive AI-powered healthcare platform tailored to Nigeria. The project combines digital innovation and international medical partnerships to expand access, reduce costs, and improve outcomes while complying with national regulations and respecting cultural diversity.

**Specific Objectives:**

1. **Develop a Healthcare Discovery System** – Build a searchable database of facilities, specialists, fees, services, and insurance coverage. Include appointment booking, maps, and patient reviews.
2. **Establish a Telemedicine Consultation Platform** – Create a secure, NDPA-compliant system linking Nigerians to local and international doctors (India, Pakistan, Bangladesh) at lower costs. Include video calls, e-prescriptions, and multilingual support.
3. **Implement an Integrated E-Pharmacy** – Partner with NAFDAC-verified distributors to provide safe online medication access, drug interaction checks, and adherence monitoring.
4. **Deploy an AI Symptom and Guidance System** – Offer culturally sensitive, multilingual (English, Hausa, Yoruba, Igbo) AI support to guide patients to the right level of care without replacing medical diagnosis.
5. **Ensure Regulatory Compliance and Quality Assurance** – Meet Nigerian and international healthcare standards, verify professional licensing, and maintain strong patient safety protocols.
6. **Integrate Secure Payments** – Provide multiple payment options (mobile money, wallets, USSD) with fraud protection and simplified payment process.
7. **Evaluate Usability and Impact** – Use both quantitative and qualitative research to measure patient satisfaction, clinical outcomes, system efficiency, and economic benefits.

**1.4 Limitations of the project**

The limitations of the project are:

1. The platform will not provide hospital appointment booking service for the users.
2. The platform will not provide drug delivery services for drugs purchased on the platform.
3. Stable internet connection will be required to use the platform.
4. The platform will not provide you with medical diagnosis, consultation with a healthcare professional will be required for that.

**1.5 Significance of the Project**

AksabCare addresses healthcare gaps that affect millions of Nigerians, especially those in rural areas. By combining international expertise, digital tools, and AI systems, it has the potential to significantly transform healthcare delivery.

**Healthcare and Population Health Impact**

International telemedicine partnerships can make high-quality care affordable, with specialist consultations in India, Pakistan, or Bangladesh costing $5–50 compared to $200–500 in Western countries. This cost reduction—up to 90%—opens access to millions of Nigerians who would otherwise be excluded (World Bank, 2024). Rural patients will especially benefit, as telemedicine reduces the need for costly and time-consuming travel, improving survival rates for mothers, children, and the elderly (Nigeria 2025 Humanitarian Needs and Response Plan, 2025).

**Economic and System Efficiency Impact**

Telemedicine consultations can cut healthcare costs by 30–60%, while also reducing lost productivity and unnecessary diagnostic duplication. Redirecting even part of the $1 billion Nigerians spend annually on medical tourism would strengthen local health systems (Crisis of Brain Drain in Nigeria’s Health Sector, 2025). Data analytics will further optimize resource distribution and reduce overcrowding in urban hospitals. The e-pharmacy will help fight counterfeit drugs, which account for over 50% of the Nigerian market (ACPN Raises Alarm Over Surge in Counterfeit Medicines, 2025).

**Academic and Research Contribution**

The project adds to global digital health research by showcasing how AI, telemedicine, and international partnerships can be adapted to a developing country context. Its AI guidance system—multilingual, culturally sensitive, and epidemiologically tailored—provides a model for other African countries.

**Social and Equity Impact**

The platform promotes healthcare equity across geography, gender, and class. Women will gain safer access to private and culturally acceptable care, rural patients will receive previously inaccessible specialist support, and chronic disease patients will enjoy improved management and follow-up. By making healthcare discovery, guidance, and services more transparent and accessible, AksabCare empowers citizens to make informed decisions and improves national health outcomes overall.

**1.6 Project Risk Assessment**

The development of AksabCare, a digital healthcare platform, comes with several risks that must be managed carefully across technical, regulatory, financial, and market areas.

**Table 1.1: Risk Assessment**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Risk Category.** | **Specific Risk.** | **Impact.** | **Likelihood.** | **Mitigation Strategy.** | **Reference.** |
| Technical | System integration failures between hospitals, e-pharmacy, AI chatbot, and payment platforms. | Service breakdown, poor user experience. | High. | Careful API design, phased integration testing. | *Navigating Regulatory Requirements for Telemedicine* (2025). |
| Regulatory | Unclear telemedicine regulations. | Legal risks, delays. | Medium. | Ongoing compliance checks, legal consultation. | Chambers and Partners (2024). |
| Financial | High development and operational costs. | Delays or reduced features. | High. | Phased funding, budget control, investor partnerships. | State of Healthcare in Nigeria (2025). |
| Market | Low digital literacy & cultural resistance. | Slow adoption, distrust of platform. | Medium. | Training, awareness campaigns, community partnerships. | State of Healthcare in Nigeria (2025). |
| Technical | Limited AI training data. | |  | | --- | |  |  |  | | --- | | Inaccurate health guidance, safety risks. | | Medium. | Use diverse local datasets; continuous retraining. | *Navigating Regulatory Requirements for Telemedicine* (2025). |
| Regulatory | Data protection non-compliance. | Heavy fines, reputational loss. | High. | Strict NDPA 2023 compliance. | Nigeria Data Protection Act (2023). |
| Financial | Low insurance coverage & out-of-pocket costs. | Low adoption due to affordability. | High. | Tiered pricing, subsidies, micro-insurance integration. | State of Healthcare in Nigeria (2025). |
| Market | Competition from existing players (DRO Health, Doctall, Helium Health). | Limited market share. | High. | Differentiate via AI chatbot, e-pharmacy, and global partnerships. | State of Healthcare in Nigeria (2025). |
| Technical | Cybersecurity breaches. | Data leaks, loss of trust. | High. | Strong encryption, NDPA 2023 compliance, security audits. | Nigeria Data Protection Act (2023). |
| Regulatory | Cross-border regulations (India, Pakistan, Bangladesh). | Service disruption if laws change. | Medium. | Flexible contracts, multiple international partners. | Chambers and Partners (2024). |
| Financial | Currency fluctuations & inflation. | Unstable pricing, revenue losses. | Medium. | Currency hedging, localized pricing. | State of Healthcare in Nigeria (2025). |
| Market | Poor infrastructure (36% facilities lack power). | Service interruptions. | High. | Offline support, backup power options. | Sustainable Energy for All (2022). |
| Technical | Scalability issues due to poor internet/power. | System crashes, slow response. | High. | Cloud-based infrastructure; offline functionality. | *Navigating Regulatory Requirements for Telemedicine* (2025). |

**1.7 Scope and Project Timeline**

AksabCare aims to create a nationwide AI-powered digital health platform starting in Abuja, where 4G/5G networks and smartphone use are higher. Expansion will later move into secondary cities and rural areas once connectivity improves. International partnerships will provide affordable specialists in cardiology, dermatology, psychiatry, oncology, endocrinology, and pediatrics from countries such as India and Bangladesh (World Bank, 2024).

The system will be a web-based app optimized for mobile use. It will initially support English, Hausa, Yoruba, and Igbo to reach most Nigerians. The AI chatbot will guide patients, provide health education, and suggest care pathways without replacing doctors.

Implementation will follow five phases:

1. **Week 1:** requirements gathering, regulatory checks, prototypes, and infrastructure setup.
2. **Week 2–4:** core system development, chatbot training, and security testing.
3. **Week 5–8:** advanced features such as e-pharmacy, international telemedicine, payment integration, and multilingual support.
4. **Week 9:** pilot testing with selected providers, user feedback, and compliance validation.
5. **Week 10:** full rollout nationwide, provider onboarding, marketing, and continuous system optimization.
6. **Week 11-12:** chapter 1-5 documentation and handover project to supervisor.

**1.8 Organization of the Project**

Chapter 1: Introduction

Overview of the project, including background, objectives, problem statement, and risk assessment.

Chapter 2: Literature Review

It explores related works and limitations in existing online collaborative academic platforms.

Chapter 3: Requirements analysis and design

This chapter covers the system requirements, system architecture, and the design approach.

Chapter 4: Implementation and Testing

Details the application development and testing process. Outlines the tools, framework, and test cases during implementation.

Chapter 5: Discussion, conclusion, and recommendations

Summarises the project, key findings, and suggestions for future improvement.

**CHAPTER 2**

**LITERATURE REVIEW**

**2.1 Introduction**

The development of AksabCare, an AI-powered hospital discovery and telemedicine platform, required a strong understanding of existing digital health research. A literature review was conducted to highlight the current state of digital health in Sub-Saharan Africa, with specific emphasis on Nigeria’s healthcare environment.

The review focused on five areas:

(1) digital health adoption and telemedicine systems in Sub-Saharan Africa,

(2) technology acceptance frameworks that influence user adoption,

(3) AI-powered healthcare discovery and triage systems,

(4) cross-border telemedicine and e-pharmacy verification models, and

(5) healthcare payment innovations within the Nigerian fintech landscape (World Health Organization, 2022; World Bank, 2023).

The review applied a systematic search strategy across databases such as PubMed, Scopus, and Web of Science. Keywords included “telemedicine Sub-Saharan Africa,” “digital health Nigeria,” “AI healthcare applications,” “pharmaceutical verification,” and “healthcare fintech Africa.”

The inclusion criteria prioritized peer-reviewed studies, systematic reviews, and authoritative reports from agencies such as the WHO, Africa CDC, and World Bank. From over 800 initial references, 95 high-quality studies were selected and thematically organized to identify opportunities, challenges, and knowledge gaps (Africa CDC, 2024; WHO, 2022).

This thematic approach provided a foundation for AksabCare’s development strategy by highlighting issues of infrastructure, user adoption, regulation, and integration of AI systems into healthcare platforms.

**2.2 Historical Overview**

Digital health in Sub-Saharan Africa has progressed from simple mobile interventions to integrated AI-driven healthcare platforms. Early adoption in the 2000s leveraged high mobile penetration (63% by 2013) for SMS-based health interventions such as medication reminders and appointment scheduling (Betjeman et al., 2013).

These initiatives laid the groundwork for mobile health (mHealth) across rural areas with limited healthcare infrastructure.

Between 2010 and 2015, digital health grew more complex. Nigeria’s National Agency for Food and Drug Administration and Control (NAFDAC) launched the Mobile Authentication Service (MAS) to combat counterfeit drugs—one of the world’s largest SMS-based verification systems (NAFDAC, 2019).

The smartphone revolution of the mid-2010s enabled applications with video consultations, real-time data collection, and payment systems, further expanding digital health possibilities.

The COVID-19 pandemic (2020–2021) accelerated telemedicine and digital health adoption across Africa. Countries deployed symptom checkers, tracing apps, and dashboards, though many systems remained fragmented (Digital Upskilling in Healthcare, 2025).

By the post-pandemic era (2022–2025), governments and private investors drove the growth of integrated digital platforms, with Africa’s digital health market valued at $3.8 billion in 2023 and projected to reach $16.6 billion by 2030 (eHealth Africa, 2025).

Nigeria’s journey mirrored these regional trends. Telemedicine started with provider-to-provider consultations but evolved into patient-facing platforms with booking systems and partial electronic health record integration. Pharmaceutical verification gained traction due to widespread counterfeit drug problems, leading to more advanced **e-**pharmacy platforms in the 2020s. Meanwhile, Nigeria’s booming fintech industry, expected to reach $230 billion by 2025, fuelled digital payment solutions in healthcare (World Economic Forum, 2023).

The growth of AI-powered healthcare applications emerged after 2020, focusing mainly on pilot projects rather than full-scale clinical use. However, AI in Africa is projected to expand from $6.9 billion in 2024 to $18 billion by 2030, signalling increasing potential in healthcare delivery (Digital Upskilling in Healthcare, 2025).

Overall, the region’s historical progress shows a shift from basic SMS interventions to multi-service AI-powered platforms, driven by improvements in technology, regulation, and infrastructure, while still facing barriers such as inconsistent power, regulatory gaps, and cultural acceptance issues.

2.3 Related Work

The examination of related work in digital health platforms, telemedicine systems, and AI-powered healthcare applications revealed a rapidly evolving landscape characterized by innovative approaches to healthcare delivery, persistent infrastructure constraints, and promising evidence of improved health outcomes when appropriately implemented. This section provided comprehensive analysis of existing research and implementations that directly informed AksabCare's development approach while identifying critical gaps the platform was designed to address.

The related work analysis was particularly focused on understanding how similar platforms had addressed the core challenges that AksabCare sought to solve. These challenges included healthcare access barriers in rural areas, shortage of specialist medical expertise, pharmaceutical safety concerns, and financial barriers to healthcare access. By examining both successful implementations and documented failures, this analysis provided valuable insights for AksabCare's design and implementation strategy.

A comprehensive analysis of digital health startups across Africa revealed significant diversity in approaches, technologies, and market focus areas. Many of these startups had emerged in response to specific healthcare challenges while leveraging technological opportunities created by improved internet connectivity, smartphone adoption, and supportive regulatory environments. However, the analysis also revealed common challenges including limited funding, regulatory uncertainty, infrastructure constraints, and difficulties achieving sustainable user adoption rates.

2.3.1 Nigerian Healthcare Startup Landscape Analysis

The Nigerian healthcare startup ecosystem had experienced remarkable growth over the past decade, with numerous companies emerging to address various aspects of the country's healthcare challenges. This growth was particularly pronounced following the COVID-19 pandemic, which accelerated adoption of digital health technologies and created new market opportunities for innovative healthcare solutions. The ecosystem demonstrated significant diversity in terms of focus areas, business models, and implementation approaches.

Research conducted by Salient Advisory identified 1,276 health-tech startups operating across Africa, with 60% founded within the last five years (Salient Advisory, 2024). Nigerian startups represented a significant portion of this ecosystem, with companies addressing everything from telemedicine and electronic health records to pharmaceutical supply chain optimization and medical device development. The concentration of startups in Nigeria reflected both the scale of healthcare challenges and the size of potential market opportunities in Africa's most populous country.

The funding landscape for Nigerian healthcare startups showed promising trends, with companies collectively raising substantial amounts of venture capital investment. However, funding patterns revealed significant disparities between different types of healthcare technologies, with telemedicine and pharmaceutical supply chain companies typically attracting larger investment rounds compared to specialized medical device or AI diagnostic companies. This funding pattern influenced the types of solutions that achieved market traction and scale.

Several factors contributed to the growth of Nigeria's healthcare startup ecosystem. First, the country's large population created substantial market opportunities for scalable digital health solutions. Second, persistent healthcare system challenges created clear problem-market fit for innovative solutions. Third, Nigeria's rapidly growing fintech ecosystem provided infrastructure and expertise that could be leveraged for healthcare payment solutions. Fourth, increasing smartphone adoption and internet connectivity created enabling conditions for mobile health applications.

However, the ecosystem also faced significant challenges that influenced startup success rates and growth patterns. Infrastructure limitations including unreliable power supply and inconsistent internet connectivity created operational difficulties for technology-dependent healthcare solutions. Regulatory uncertainty regarding digital health services, telemedicine practice, and pharmaceutical e-commerce created compliance challenges and market entry barriers. Limited healthcare provider digital literacy and resistance to technology adoption created user adoption challenges that many startups struggled to overcome.

Despite these challenges, several Nigerian healthcare startups achieved significant scale and market impact, providing valuable lessons for new entrants like AksabCare. These success stories demonstrated that with appropriate strategy, technology, and execution, it was possible to build sustainable healthcare technology companies that addressed real market needs while achieving financial viability. The analysis of these companies provided insights into effective go-to-market strategies, technology architectures, partnership approaches, and user acquisition methods.

2.3.2 Helium Health: Comprehensive Healthcare Technology Platform

Helium Health emerged as one of Nigeria's most successful healthcare technology companies, demonstrating how integrated digital health platforms could achieve scale and impact across multiple African markets. Founded in 2016 by Adegoke Olubusi, Tito Ovia, and Dimeji Sofowora, the company evolved from a simple electronic medical records (EMR) system into a comprehensive healthcare technology suite serving over 7,000 medical professionals and facilitating more than 300,000 patient visits monthly across seven countries (Helium Health, 2025).

The company's success was built on a comprehensive product suite that addressed multiple aspects of healthcare delivery through integrated technology solutions. HeliumDoc functioned as a telemedicine platform connecting patients with doctors for appointment scheduling, virtual consultations, and health service discovery, earning comparison to "the Uber of African healthcare." The platform provided patients with access to care while helping healthcare professionals expand their practice reach and digital capabilities.

HeliumEMR served as the foundation of the company's offering, providing healthcare facilities with electronic medical records capabilities that replaced paper-based systems and improved care coordination. The EMR system was specifically designed for African healthcare contexts, incorporating features that addressed local regulatory requirements, clinical workflows, and infrastructure constraints. This localization approach proved crucial for achieving high adoption rates among healthcare providers who had previously struggled with generic EMR solutions designed for developed markets.

HeliumLab provided laboratory information management systems that streamlined diagnostic testing processes and improved result turnaround times. HeliumPay integrated payment processing capabilities that addressed financial barriers to healthcare access while providing healthcare providers with streamlined billing and collection systems. HeliumAnalytics offered data analytics tools that helped healthcare organizations optimize operations, improve clinical outcomes, and demonstrate impact to stakeholders and regulators.

The company's approach to market expansion demonstrated effective strategies for scaling healthcare technology across multiple African countries. Rather than attempting to enter all markets simultaneously, Helium Health focused on establishing strong operations in Nigeria before expanding to Ghana, Liberia, Senegal, Cameroon, Uganda, and Kenya. This phased expansion approach allowed the company to refine its products and operations based on real-world experience before entering new markets with different regulatory environments and healthcare system characteristics.

Helium Health's funding success provided insights into investor perspectives on African healthcare technology opportunities. The company raised over $42 million across multiple funding rounds, including Series B funding that supported international expansion and product development (Startup List Africa, 2024). This funding success was attributed to the company's demonstrated ability to achieve sustainable growth while addressing real healthcare system needs across multiple markets.

The company's experience highlighted several critical success factors for healthcare technology platforms in African markets. First, local adaptation was essential, with products requiring modification to address specific regulatory requirements, clinical workflows, and infrastructure constraints in each market. Second, comprehensive solutions that addressed multiple healthcare system needs achieved higher adoption rates and customer loyalty compared to point solutions that addressed single problems. Third, strong partnerships with healthcare providers, government agencies, and international development organizations accelerated market penetration and credibility building.

However, Helium Health's experience also revealed ongoing challenges facing healthcare technology companies in African markets. Infrastructure limitations continued to create operational difficulties, requiring significant investment in technical support and system redundancy. Regulatory compliance across multiple jurisdictions required substantial legal and regulatory affairs capabilities that smaller companies might struggle to develop. User training and change management proved essential for successful implementations but required significant ongoing investment that affected unit economics.

For AksabCare, Helium Health's experience provided valuable insights into effective integration strategies, market expansion approaches, and the importance of comprehensive solutions that addressed multiple healthcare system needs. The company's success demonstrated that with appropriate technology, partnerships, and execution, it was possible to build sustainable healthcare technology companies that achieved meaningful scale and impact across African markets while attracting significant venture capital investment.

2.3.3 CribMD: Telemedicine and Home Healthcare Services

CribMD represented a focused approach to digital health implementation, specializing in telemedicine solutions and doctor home visit services for the Nigerian market. Founded in 2019, the company achieved significant traction by addressing specific healthcare access challenges through targeted technology solutions rather than attempting to build comprehensive healthcare platforms from the outset (Startup List Africa, 2024).

The company's business model combined virtual consultations with physical home visits, creating a hybrid approach that addressed both convenience and clinical quality concerns that often limited telemedicine adoption in developing markets. This model recognized that while telemedicine could address many healthcare access barriers, certain clinical situations required physical examination and intervention that could not be adequately provided through virtual consultations alone.

CribMD's telemedicine platform provided patients with access to licensed medical practitioners through mobile and web applications that supported text, voice, and video consultations. The platform incorporated prescription management capabilities that enabled doctors to provide medical recommendations and medication prescriptions through secure digital channels. However, the company's home visit services differentiated it from pure-play telemedicine competitors by providing on-demand access to healthcare professionals who could conduct physical examinations, administer treatments, and provide care that required in-person interaction.

The company's technology architecture focused on simplicity and reliability rather than advanced features, recognizing that successful adoption in Nigerian markets required solutions that worked consistently across diverse technological environments. The platform was designed to function effectively on both smartphones and basic mobile devices, with offline capabilities that addressed intermittent internet connectivity challenges common across Nigerian urban and rural areas.

CribMD's funding success, raising $3.25 million in grant funding, provided insights into alternative financing approaches for healthcare startups that might not immediately attract traditional venture capital investment (Startup List Africa, 2024). The company's use of grant funding from development organizations and healthcare-focused donors demonstrated how startups could access capital while building sustainable business models that balanced social impact with financial viability.

The company's user acquisition strategy focused on digital marketing combined with partnerships with employers, insurance companies, and community organizations that could provide access to large user bases with clear healthcare needs. This approach proved more cost-effective than direct consumer marketing while creating sustainable revenue models through B2B relationships rather than relying solely on individual out-of-pocket payments.

CribMD's experience highlighted several important considerations for telemedicine implementation in Nigerian contexts. First, hybrid models that combined virtual and physical care delivery achieved higher patient satisfaction and clinical outcomes compared to pure telemedicine approaches. Second, simple, reliable technology often performed better than complex platforms that might fail under challenging infrastructure conditions. Third, partnership-based user acquisition strategies proved more sustainable than direct consumer marketing for healthcare services.

However, the company also faced challenges that provided lessons for similar implementations. Scaling home visit services proved logistically complex and capital-intensive, requiring significant investment in healthcare professional recruitment, training, and management systems. Quality control across distributed service delivery required robust monitoring and feedback systems that were expensive to implement and maintain. Regulatory compliance for home-based healthcare services created additional operational complexity compared to purely digital health solutions.

For AksabCare, CribMD's experience provided insights into effective hybrid service delivery models, partnership-based user acquisition strategies, and the importance of technology simplicity for challenging infrastructure environments. The company's focus on specific healthcare needs rather than comprehensive platform development offered an alternative approach to market entry that could be considered for specific AksabCare components or geographic markets.

2.3.4 Clafiya: Digital Healthcare Community Platform

Clafiya emerged as an innovative Nigerian healthtech startup that distinguished itself by creating a comprehensive digital healthcare community rather than focusing solely on individual service delivery. Founded in 2021, the company combined telemedicine and in-person visits to provide on-demand primary care services while building healthcare ecosystems that connected patients, healthcare providers, employers, and insurance companies (Wazo Plus, 2024).

The company's approach reflected recognition that sustainable healthcare technology solutions required addressing multiple stakeholder needs simultaneously rather than focusing solely on patient-provider interactions. By creating a platform that served healthcare providers, employers seeking employee health benefits, insurance companies requiring care delivery networks, and patients needing accessible healthcare, Clafiya developed a multi-sided marketplace that created value for all participants while generating diversified revenue streams.

Clafiya's technology platform incorporated several innovative features that addressed specific Nigerian healthcare market needs. The telemedicine component provided standard virtual consultation capabilities, but the platform also integrated appointment scheduling for in-person visits, healthcare provider credentialing and management systems, insurance claim processing and reimbursement, and employer health program administration. This comprehensive approach created a unified ecosystem that simplified healthcare access while reducing administrative complexity for all stakeholders.

The company's business model demonstrated innovative approaches to healthcare financing that addressed out-of-pocket payment challenges that limited healthcare access for many Nigerians. Through partnerships with employers and insurance companies, Clafiya created sustainable financing mechanisms that reduced individual financial barriers while ensuring healthcare provider compensation. The platform also incorporated installment payment options and flexible pricing structures that made healthcare services accessible to users with diverse financial circumstances.

Clafiya's community-building approach represented a unique differentiator in the Nigerian healthtech landscape. Rather than treating healthcare as a series of transactional interactions, the company created ongoing relationships between patients and healthcare providers supported by educational content, preventive care programs, and community health initiatives. This approach aimed to improve long-term health outcomes while creating stronger user engagement and retention compared to transaction-focused platforms.

The company's funding experience, raising $735,000 in pre-seed funding, illustrated both opportunities and challenges facing Nigerian healthcare startups (Startup List Africa, 2024). While the funding provided capital for initial operations and technology development, it also highlighted the significant capital requirements for building comprehensive healthcare platforms that addressed multiple stakeholder needs simultaneously.

Clafiya's user acquisition strategy focused on B2B partnerships with employers and insurance companies rather than direct consumer marketing. This approach created more predictable revenue streams while achieving economies of scale in user acquisition costs. However, it also created dependencies on institutional partners that could affect growth rates and strategic flexibility if partner priorities or market conditions changed.

The company's experience provided several insights relevant to AksabCare development. First, multi-sided marketplace approaches could create sustainable competitive advantages by generating value for multiple stakeholders simultaneously. Second, community-building features enhanced user engagement and retention compared to purely transactional healthcare platforms. Third, B2B partnership strategies could provide more sustainable user acquisition approaches compared to direct consumer marketing in healthcare markets.

However, Clafiya's experience also revealed challenges associated with comprehensive platform approaches. Building technology solutions that effectively served multiple distinct user types required significant development resources and expertise across different domains. Managing relationships with multiple types of institutional partners required dedicated business development and account management capabilities. Regulatory compliance for comprehensive healthcare platforms proved more complex than single-function solutions.

For AksabCare, Clafiya's experience provided valuable insights into multi-sided marketplace development, community building strategies, and B2B partnership approaches that could enhance platform sustainability and user engagement. The company's innovative financing approaches also offered models for addressing affordability challenges that could limit healthcare access for AksabCare's target user base.

2.3.5 Remedial Health: Pharmaceutical Supply Chain Optimization

Remedial Health established itself as a significant player in Nigeria's healthtech ecosystem by focusing specifically on pharmaceutical supply chain challenges that affected healthcare access and quality across the country. Founded in 2019, the company developed technology solutions to make Africa's pharmaceutical sector more efficient while addressing critical issues including drug stockouts, counterfeit medications, and supply chain inefficiencies that plagued healthcare delivery (Startup List Africa, 2024).

The company's approach recognized that pharmaceutical access challenges often stemmed from supply chain problems rather than absolute drug shortages, creating opportunities for technology solutions that optimized distribution, inventory management, and quality assurance processes. By focusing on B2B solutions that served pharmaceutical manufacturers, distributors, wholesalers, and retail pharmacies, Remedial Health addressed systemic inefficiencies that affected entire healthcare ecosystems rather than individual patient-provider interactions.

Remedial Health's technology platform incorporated several sophisticated capabilities that addressed specific pharmaceutical supply chain challenges in African markets. The platform provided inventory management systems that helped pharmacies and healthcare facilities optimize stock levels while reducing carrying costs and stockout risks. Demand forecasting algorithms analyzed historical usage patterns and seasonal variations to predict pharmaceutical needs and optimize procurement timing.

The company's marketplace component connected pharmaceutical manufacturers and distributors with retail pharmacies and healthcare facilities, creating transparent pricing and streamlined procurement processes that reduced transaction costs and improved supply chain efficiency. Quality assurance capabilities incorporated drug authentication features that helped identify counterfeit medications while ensuring supply chain transparency from manufacturers to end users.

Remedial Health's financial services integration addressed working capital challenges that often limited pharmaceutical access in developing markets. Through partnerships with financial institutions and innovative financing mechanisms, the platform provided inventory financing, trade credit, and payment processing solutions that improved cash flow management for pharmaceutical supply chain participants while reducing financial barriers to drug access.

The company's remarkable funding success, raising $17.57 million in Series A funding, demonstrated significant investor confidence in pharmaceutical supply chain technology solutions for African markets (Startup List Africa, 2024). This funding level exceeded many direct patient care platforms, suggesting that investors recognized the potential for B2B healthcare technology solutions to achieve substantial scale and impact while generating sustainable revenue models.

Remedial Health's go-to-market strategy focused on building relationships with key pharmaceutical supply chain stakeholders including manufacturers, distributors, and large pharmacy chains before expanding to smaller independent pharmacies and healthcare facilities. This approach created network effects that enhanced platform value while establishing market credibility through partnerships with established industry players.

The company's experience provided several insights relevant to pharmaceutical components of comprehensive health platforms like AksabCare. First, B2B pharmaceutical supply chain solutions could achieve significant scale and impact by addressing systemic inefficiencies rather than focusing solely on end-user experiences. Second, integrated financial services capabilities were essential for sustainable pharmaceutical access in markets with limited working capital availability. Third, quality assurance and drug authentication features created significant value for all supply chain participants while addressing public health concerns about counterfeit medications.

However, Remedial Health's experience also highlighted challenges associated with pharmaceutical supply chain technology implementation. Regulatory compliance across multiple jurisdictions proved complex and resource-intensive, requiring substantial legal and regulatory affairs capabilities. Integration with existing pharmaceutical industry systems and processes required significant technical development and change management investment. Building trust among pharmaceutical industry stakeholders required extensive relationship building and demonstrated value creation over time.

For AksabCare, Remedial Health's experience provided valuable insights into pharmaceutical verification system development, supply chain integration approaches, and the potential for B2B pharmaceutical services to generate sustainable revenue streams. The company's success also demonstrated the importance of financial services integration for pharmaceutical access solutions and the value of focusing on systemic challenges rather than individual transactions.

2.3.6 Intron Health: AI-Powered Clinical Documentation

Intron Health represented a specialized approach to healthcare technology that focused specifically on artificial intelligence applications for clinical documentation and speech recognition in African healthcare contexts. Founded in 2020, the company developed clinical speech recognition capabilities for over 200 accents spoken in developing countries, starting with African markets where existing speech recognition technologies often failed to accurately process local accent patterns and language variations (Startup List Africa, 2024).

The company's focus on AI-powered clinical documentation addressed a specific but critical challenge facing healthcare providers across Africa: the administrative burden of clinical record keeping that reduced time available for direct patient care while creating documentation quality issues that affected care continuity and legal compliance. By developing speech recognition technology specifically trained on African accent patterns and medical terminology usage, Intron Health created solutions that significantly improved clinical workflow efficiency.

Intron Health's technology platform incorporated several innovative features that differentiated it from generic speech recognition solutions designed for Western healthcare markets. The platform supported over 300 African accents, recognizing that accent variation within individual countries often exceeded variation between different countries in other regions. Medical terminology recognition was optimized for disease patterns, treatment protocols, and pharmaceutical names commonly used in African healthcare contexts.

The company's AI training methodology incorporated extensive datasets from African healthcare providers, ensuring that machine learning algorithms accurately recognized speech patterns, medical terminology, and clinical workflow approaches specific to African healthcare delivery. This localization proved crucial for achieving accuracy rates that made the technology practically useful for healthcare providers who had previously struggled with speech recognition solutions designed for different linguistic and clinical contexts.

Intron Health's business model focused on software licensing to healthcare facilities and electronic medical record system providers rather than direct patient services. This B2B approach allowed the company to achieve scale through integration with existing healthcare technology infrastructure while generating recurring revenue through licensing fees. The model also aligned with healthcare provider preferences for integrated solutions rather than standalone applications that created additional workflow complexity.

The company's funding experience, raising $1.857 million in pre-seed funding, provided insights into investor perspectives on specialized AI applications for African healthcare markets (Startup List Africa, 2024). While the funding amount was smaller than comprehensive healthcare platforms, it demonstrated that focused AI solutions addressing specific clinical needs could attract investment while building sustainable business models.

Intron Health's go-to-market strategy emphasized partnerships with electronic medical record providers, healthcare facility networks, and healthcare technology integrators rather than direct sales to individual healthcare providers. This approach leveraged existing relationships and distribution channels while reducing customer acquisition costs and implementation complexity for end users.

The company's experience provided several insights relevant to AI components of comprehensive health platforms like AksabCare. First, localization of AI algorithms for African contexts was essential for achieving accuracy rates that supported practical clinical applications. Second, integration with existing healthcare technology infrastructure achieved higher adoption rates than standalone AI applications. Third, specialized AI solutions could create sustainable business models by addressing specific workflow inefficiencies that healthcare providers prioritized.

However, Intron Health's experience also revealed challenges associated with AI development for African healthcare markets. Training data acquisition proved expensive and time-intensive, requiring extensive partnerships with healthcare providers willing to contribute clinical data for algorithm development. Technical infrastructure requirements for AI processing created operational challenges in markets with unreliable internet connectivity and power supply. Regulatory approval for AI-powered clinical tools required substantial compliance investment and ongoing monitoring capabilities.

For AksabCare, Intron Health's experience provided valuable insights into AI algorithm localization requirements, healthcare provider integration strategies, and the potential for specialized AI features to create competitive differentiation. The company's focus on clinical workflow optimization also offered models for incorporating AI capabilities that enhanced healthcare provider efficiency while improving patient care quality.

2.3.7 Digital Health Platform Integration and Interoperability

The examination of digital health platforms across Sub-Saharan Africa revealed significant challenges related to system integration and interoperability that affected platform effectiveness and user adoption. Most existing platforms operated as standalone systems with limited integration capabilities, creating fragmented user experiences and preventing healthcare data from flowing seamlessly between different components of healthcare delivery systems.

Research examining digital health technology integration in Nigeria identified 31 studies demonstrating positive impacts on treatment adherence, healthcare utilization, and community engagement (Egwudo et al., 2025). However, the review also revealed that digital health technologies often faced operational and logistical barriers, inadequate network coverage, and cultural sensitivity issues that required targeted intervention strategies. These findings highlighted the importance of comprehensive integration planning from the initial design phase rather than attempting to add integration capabilities to existing standalone systems.

The lack of standardized data formats and communication protocols across different digital health platforms created significant barriers to healthcare data sharing and care coordination. Patients often found themselves entering the same health information multiple times across different platforms, while healthcare providers struggled to access comprehensive patient histories when using different systems for various aspects of care delivery.

Successful integration approaches typically involved several key components that enabled effective data sharing and workflow coordination. Application Programming Interface (API) development allowed different systems to communicate and share data in standardized formats. Electronic health record integration enabled platforms to access and update patient information across different healthcare touchpoints. Authentication and authorization systems ensured secure access to health information while maintaining patient privacy and regulatory compliance.

However, integration efforts also faced substantial technical and organizational challenges that affected implementation success. Legacy system compatibility issues often required extensive custom development work to enable integration with existing healthcare technology infrastructure. Data security and privacy requirements created complex technical requirements for secure data sharing between different systems and organizations. Regulatory compliance across multiple jurisdictions added additional complexity to integration efforts, particularly for platforms operating across multiple African countries.

The emergence of health information exchange networks in some African countries provided models for achieving interoperability at national or regional scales. Rwanda's health information exchange system enabled different healthcare providers and technology platforms to share patient data while maintaining security and privacy protections. This approach demonstrated the potential for coordinated approaches to health technology integration that could benefit multiple stakeholders while improving care quality and efficiency.

For platforms like AksabCare that aimed to provide comprehensive healthcare services through integrated technology solutions, interoperability considerations were essential from the initial design phase. The platform needed to support integration with existing healthcare provider systems, government health information systems, insurance companies, pharmaceutical supply chains, and payment processing networks to achieve maximum effectiveness and user adoption.

The analysis of existing integration challenges and solutions provided valuable insights for AksabCare development. First, API-first design approaches enabled easier integration with external systems compared to platforms that attempted to add integration capabilities after initial development. Second, standardized data formats and communication protocols reduced integration complexity and ongoing maintenance requirements. Third, security and privacy by design principles were essential for achieving regulatory compliance while maintaining user trust in integrated healthcare systems.

2.3.8 Artificial Intelligence Applications in African Healthcare

The application of artificial intelligence technologies in African healthcare contexts represented a rapidly evolving field with significant potential for addressing resource constraints and improving clinical decision-making. However, AI implementation in healthcare faced unique challenges in African contexts related to data availability, infrastructure requirements, cultural considerations, and regulatory frameworks that differed significantly from developed country environments where most AI healthcare research had been conducted.

A structured literature review focusing on AI-driven health applications in Africa revealed limited implementation of comprehensive AI healthcare systems, though promising pilot projects demonstrated feasibility for specific applications including infectious disease monitoring, maternal health support, and chronic disease management (Adebayo et al., 2025). The review emphasized that successful AI healthcare implementations required careful attention to local context, data quality, and cultural appropriateness rather than direct adaptation of AI solutions developed for Western healthcare systems.

The development of culturally appropriate AI healthcare systems required addressing several unique considerations that were often overlooked in traditional AI development approaches. Training data needed to reflect disease prevalence patterns, treatment protocols, and clinical decision-making approaches specific to African healthcare contexts. Natural language processing algorithms required adaptation to local languages, accent patterns, and cultural expressions of health symptoms and concerns.

AI-powered diagnostic tools showed particular promise for addressing specialist shortages in African healthcare systems. Medical imaging AI applications could potentially provide diagnostic support in rural areas where radiologists and other imaging specialists were unavailable. However, implementation challenges included ensuring AI training datasets included sufficient diversity to accurately diagnose conditions in African populations, adapting AI algorithms to work with lower-quality imaging equipment commonly available in resource-constrained settings, and developing user interfaces that enabled healthcare workers with varying levels of technical expertise to effectively use AI diagnostic tools.

The emergence of AI-driven telemedicine platforms in Nigeria demonstrated growing recognition of AI's potential for addressing healthcare workforce shortages. The UNICCON Group's launch of MySmartMedic in 2025 represented a significant milestone in AI-powered healthcare delivery, offering symptom analysis, doctor consultations, and health recommendations designed specifically for Nigerian contexts (This Day Live, 2025). The platform's pilot implementation in Galadimawa Village provided practical examples of AI healthcare technology deployment in rural settings while highlighting the importance of community engagement and cultural sensitivity.

However, AI healthcare implementation faced several persistent challenges that affected adoption and effectiveness. Data quality and availability issues limited AI algorithm training and validation in African contexts where electronic health records and standardized data collection systems remained underdeveloped. Infrastructure constraints including unreliable internet connectivity and power supply created operational difficulties for AI applications that required consistent computational resources and network connectivity.

Regulatory frameworks for AI healthcare applications remained underdeveloped across most African countries, creating uncertainty about compliance requirements and quality assurance standards. The absence of clear regulatory guidance created barriers to investment and implementation while potentially compromising patient safety if AI tools were deployed without appropriate oversight and validation.

The integration of AI capabilities into comprehensive healthcare platforms required careful consideration of user experience, technical infrastructure, and ethical implications. AI features needed to enhance rather than complicate healthcare provider workflows while providing clear value that justified additional technology complexity. Transparency and explainability were essential for building trust among healthcare providers and patients who might be skeptical of AI-powered medical recommendations.

For AksabCare, the analysis of AI applications in African healthcare provided insights into effective implementation strategies, cultural adaptation requirements, and the importance of gradual AI feature deployment that allowed users to build confidence and expertise over time. The review emphasized that AI features should address specific healthcare challenges while remaining secondary to core platform functionality that provided immediate user value.

2.3.9 Mobile Health Intervention Effectiveness

Mobile health (mHealth) interventions across Sub-Saharan Africa had demonstrated significant potential for improving healthcare access and outcomes, though effectiveness varied considerably based on implementation approach, target population, and healthcare domain focus. Comprehensive evaluation of mHealth technologies revealed that successful implementations typically addressed specific healthcare challenges through targeted interventions rather than attempting to provide comprehensive healthcare services through mobile platforms.

Research examining mHealth technologies used by community health workers found that 43% of studies reporting on antenatal care outcomes demonstrated increased utilization, while 89% of studies reporting on facility-based births showed improvements due to mHealth implementation (Kachimanga et al., 2024). These findings suggested that mobile health technologies could effectively improve maternal health outcomes when appropriately implemented and supported by adequate training and infrastructure.

The effectiveness of mHealth interventions appeared to be closely related to several critical success factors that differentiated successful implementations from those that failed to achieve sustained adoption or health outcomes. User-centered design that addressed specific user needs and preferences proved essential for achieving high adoption rates. Interventions that required minimal behavior change from existing healthcare practices achieved higher success rates than those requiring substantial workflow modifications.

Technical reliability and simplicity emerged as crucial factors for mHealth success in African contexts where infrastructure constraints and user digital literacy levels varied significantly. Platforms that functioned effectively across different device types and network conditions achieved broader adoption than those requiring high-end smartphones or consistent internet connectivity. Offline functionality that enabled continued use during network outages proved particularly valuable for rural implementations.

Community engagement and stakeholder involvement throughout the development and implementation process significantly affected mHealth intervention success. Interventions that incorporated feedback from healthcare providers, patients, and community leaders during design and testing phases achieved higher adoption rates and better health outcomes compared to technology-driven approaches that prioritized technical sophistication over user needs.

However, mHealth implementations also faced persistent challenges that limited effectiveness and sustainability across many African contexts. Infrastructure limitations including unreliable electricity supply and inconsistent network coverage created operational difficulties that affected user experience and platform reliability. Limited digital literacy among target user populations required extensive training and ongoing support that increased implementation costs and complexity.

Sustainability challenges affected many mHealth interventions after initial pilot or research phases concluded. Limited funding for ongoing operations, technical support, and feature development created barriers to long-term success even for interventions that demonstrated positive health outcomes during initial implementation periods. Integration with existing healthcare systems and workflows proved challenging for many mHealth platforms, creating parallel systems that increased rather than reduced healthcare delivery complexity.

The analysis of mHealth intervention effectiveness provided several insights relevant to comprehensive healthcare platforms like AksabCare. First, focused interventions that addressed specific healthcare challenges often achieved better outcomes than comprehensive platforms that attempted to address multiple needs simultaneously. Second, technical simplicity and reliability were more important than advanced features for achieving sustained adoption in challenging infrastructure environments. Third, community engagement and stakeholder involvement were essential for developing culturally appropriate solutions that addressed real user needs.

These findings suggested that AksabCare's comprehensive approach required careful attention to implementation phasing, user training, and ongoing support systems to achieve the benefits of integrated healthcare service delivery while avoiding the complexity and adoption challenges that had limited some comprehensive mHealth implementations. The platform needed to balance feature comprehensiveness with technical simplicity to serve users with diverse technical capabilities and infrastructure constraints.

2.3.10 Cross-Border Healthcare Service Delivery Models

Cross-border healthcare service delivery represented an innovative approach to addressing healthcare access challenges in developing countries by leveraging international medical expertise and cost arbitrage opportunities. However, implementation of cross-border healthcare services faced complex regulatory, technical, and cultural challenges that required careful navigation and strategic planning to achieve successful outcomes.

The global telemedicine market's substantial growth, from $104.64 billion in 2024 to projected $334.80 billion by 2032, demonstrated increasing acceptance of remote healthcare delivery that created opportunities for international medical collaboration (Fortune Business Insights, 2024). This growth created infrastructure and expertise that could be leveraged for cross-border healthcare initiatives that connected patients in resource-constrained settings with medical specialists in other countries.

International telemedicine collaborations had demonstrated potential for addressing specialist shortages in developing countries where patient-to-specialist ratios often exceeded sustainable levels. Countries including India, Pakistan, and Bangladesh had developed sophisticated telemedicine capabilities that could be accessed by patients in other countries at significantly reduced costs compared to domestic specialist consultations in developed countries. Medical consultations through international telemedicine platforms typically cost $5-50 compared to $200-500 for similar services in developed countries, creating substantial cost arbitrage opportunities.

The COVID-19 pandemic had accelerated adoption of cross-border telemedicine services as travel restrictions and social distancing measures created urgent need for remote healthcare delivery. European implementations including Romania's collaboration with Moldovan healthcare providers demonstrated successful models for international telemedicine cooperation that reduced treatment costs while improving service quality and accessibility.

However, cross-border healthcare service delivery faced significant regulatory and operational challenges that complicated implementation and scaling efforts. Healthcare provider licensing and registration requirements varied significantly across jurisdictions, creating compliance challenges for international medical practice. Patient data protection and privacy regulations differed between countries, requiring complex technical and legal solutions for secure international health information sharing.

Professional liability and malpractice coverage determination proved particularly challenging when healthcare services crossed national boundaries, creating legal uncertainty that could limit healthcare provider participation in international telemedicine initiatives. Reimbursement mechanisms for international medical services often lacked clear frameworks, particularly for patients covered by domestic insurance schemes that might not recognize international healthcare providers.

Cultural and linguistic barriers presented additional challenges for cross-border healthcare delivery that required careful attention to patient communication and cultural sensitivity. Medical practice differences between countries could affect diagnosis and treatment recommendations, requiring protocol development that ensured consistent quality standards while respecting local medical practice preferences.

Despite these challenges, several successful cross-border telemedicine implementations provided models for effective international healthcare collaboration. The African Tele-dermatology Project reviewed 1,229 consultations from Sub-Saharan Africa, demonstrating effective remote diagnosis and treatment of skin diseases that significantly reduced patient travel requirements while maintaining clinical quality standards.

Factors influencing successful cross-border telemedicine implementation included strong leadership and comprehensive training programs, flexible services delivered at low cost using accessible technologies, clear legal and regulatory frameworks addressing cross-border compliance requirements, and sustainable financing mechanisms ensuring long-term platform viability. Regional networks could facilitate expertise sharing and innovative approaches to overcoming implementation barriers while building local capacity for sustained operations.

For AksabCare, the analysis of cross-border healthcare service delivery provided insights into regulatory compliance requirements, partnership development strategies, and technical infrastructure needs for international telemedicine integration. The review emphasized the importance of gradual implementation that allowed for regulatory framework development and stakeholder relationship building while demonstrating value through pilot programs before attempting large-scale international healthcare service delivery.

**2.4 Summary**

This literature review explored areas essential to AksabCare’s development, including digital health platforms, telemedicine, AI applications, pharmaceutical technologies, and cross-border healthcare delivery models. The evidence showed that while digital health in Africa is rapidly expanding, challenges around infrastructure, regulation, and user adoption remain central barriers (WHO, 2022; Africa CDC, 2024).

Nigerian startups provided strong case studies. Helium Health scaled across seven countries, serving 7,000 professionals and 300,000 monthly patients. Its integrated tools—HeliumDoc, HeliumEMR, HeliumLab, HeliumPay, and HeliumAnalytics—demonstrated that broad solutions outperform single-purpose tools when supported by local adaptation and partnerships (Helium Health, 2023). CribMD revealed the value of combining telemedicine with home healthcare to overcome limits in pure digital adoption (CribMD, 2022). Clafiya emphasized community-building and stakeholder engagement, showing how multi-party platforms create sustainability (Clafiya, 2023). Remedial Health highlighted the importance of pharmaceutical supply chain technology, raising $17.57 million in funding due to its systemic impact (Remedial Health, 2023). IntronHealth showed how AI can work in African contexts only when adapted to local languages and accents (Intron Health, 2024).

Broader research highlighted clear patterns. Comprehensive solutions addressing multiple healthcare needs achieve better adoption, though they require greater resources. Technology adoption studies confirmed that perceived usefulness, ease of use, and organizational support remain the strongest predictors of success. Frameworks like TAM and UTAUT need adjustment in Sub-Saharan Africa to reflect infrastructure limits and cultural dynamics (Venkatesh et al., 2012; Marangunic & Granic, 2015).

The review identified four key gaps for AksabCare to address:

1. Few platforms combine hospital discovery, international telemedicine, pharmaceutical verification, and AI-driven decision support in one system.
2. Cross-border telemedicine remains under-researched, especially in regulation, culture, and cost-effectiveness.
3. AI healthcare discovery tools are rarely localized for Nigerian languages and health behaviors.
4. Limited integration exists between drug authentication systems and e-pharmacy platforms.

Policy implications include the need for stronger regulation in telemedicine, e-pharmacy, and data protection, alongside community engagement in platform design. For practice, the evidence stressed training, technical support, and ongoing investment beyond deployment (WHO, 2022).

For AksabCare, these findings provide both a foundation and a competitive opportunity. The focus on integrated services, local adaptation, and multi-stakeholder engagement positions the platform to fill gaps in Nigeria’s healthcare landscape while learning from successful models across Africa.

**Table 2.1: Summary of Key Literature Sources Examined**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Author(s) & Year** | **Study Type** | **Geographic Focus** | **Key Findings** | **Relevance to AksabCare** |
| Helium Health (2025) | Company Analysis | Nigeria, Ghana, Liberia, Senegal, Cameroon, Uganda, Kenya | Comprehensive healthcare technology suite serving 7,000+ medical professionals and 300,000+ monthly patient visits; demonstrated scalability across seven African countries | Direct competitive analysis and integrated platform development model |
| CribMD (2024) | Company Analysis | Nigeria | Hybrid telemedicine and home visit model with $3.25M funding; focused on simplicity and reliability over advanced features | Hybrid service delivery model and technology design priorities |
| Clafiya (2021) | Company Analysis | Nigeria | Digital healthcare community platform combining telemedicine and in-person visits; multi-stakeholder marketplace approach with $735K funding | Community building strategies and multi-sided marketplace development |
| Remedial Health (2019) | Company Analysis | Nigeria/Africa | Pharmaceutical supply chain optimization with $17.57M Series A funding; B2B focus on systemic inefficiencies | Pharmaceutical verification system development and B2B revenue models |
| Intron Health (2020) | Company Analysis | Africa | AI-powered clinical speech recognition for 300+ African accents with $1.857M funding; specialized AI localization approach | AI algorithm localization and clinical workflow integration |
| Egwudo et al. (2025) | Scoping Review | Nigeria | Analysis of 31 studies showing positive impacts of digital health technologies on treatment adherence and healthcare utilization; identified infrastructure and cultural barriers | Nigerian implementation strategy and barrier identification |
| Kachimanga et al. (2024) | Systematic Review | Sub-Saharan Africa | mHealth interventions improved antenatal care (43%), facility-based births (89%), and postnatal care (75%); social environment factors critical | Mobile health effectiveness and community engagement importance |
| Fortune Business Insights (2024) | Market Research | Global | Telemedicine market valued at $104.64B (2024), projected $334.80B (2032); 16.93% CAGR demonstrating substantial growth opportunities | Market opportunity validation and international expansion potential |
| eHealth Africa (2025) | Research Report | Africa | African digital health market valued at $3.8B (2023), projected $16.6B by 2030; 15% efficiency improvement potential through digital adoption | Market opportunity assessment and efficiency benchmarking |
| Salient Advisory (2024) | Industry Analysis | Africa | Identified 1,276 health-tech startups across Africa with 60% founded in last 5 years; telemedicine most common service among recent startups | Competitive landscape analysis and market timing validation |
| Connecting Africa (2025) | Industry Report | Africa | Analysis of five leading African healthtech startups using 2025 trends including AI diagnostics, telemedicine growth, and investment support | Industry trend identification and competitive positioning |
| Wazo Plus (2024) | Industry Analysis | Africa | Ten healthtech startups transforming home-based care; projected 15.42% growth in African digital health market (2023-2027) | Home healthcare delivery models and market growth projections |
| World Economic Forum (2023) | Research Report | Africa | African fintech sector projected to reach $230B by 2025; mobile money accounts surpass traditional banking | Healthcare payment integration opportunities and fintech partnership potential |
| ThisDay Live (2025) | News Report | Nigeria | UNICCON Group launched MySmartMedic AI-powered telemedicine platform with pilot implementation in Galadimawa Village | AI telemedicine implementation case study and market validation |
| Digital Upskilling in Healthcare (2025) | Research Report | Africa | Africa AI market projected growth from $6.9B (2024) to $18B (2030); infrastructure gaps remain significant challenge | AI market opportunity assessment and infrastructure planning considerations |

*Note: This table presents a representative selection of the most significant sources from the comprehensive literature review, which examined 95 high-quality references published between 2019-2025. The sources were selected to demonstrate the diversity of research methodologies, geographic focus areas, and thematic relevance to AksabCare's integrated platform approach.*

**CHAPTER 3**

**REQUIREMENTS, ANALYSIS, AND DESIGN.**

**3.1 Overview**

This chapter explains the requirements, design specifications, and architecture for AksabCare, the AI-powered healthcare discovery and telemedicine platform aimed at improving access to healthcare in Nigeria. At this stage, ideas from earlier chapters are turned into real technical and functional requirements that can be developed into a working system.

The requirements and design phase is important because it translates healthcare challenges into system features, ensures compliance with Nigerian regulations, and accounts for cultural and infrastructure issues. To achieve this, the project includes input from patients, healthcare workers, regulators, and technology providers so that the system reflects real needs.

The design philosophy for AksabCare focuses on user-centered design. It ensures the platform is simple, culturally sensitive, and accessible to Nigerians from different regions. Security, scalability, and interoperability are also core principles, making sure the system is safe, can grow with demand, and connects well with other healthcare tools.

**3.2 Proposed Model**

AksabCare uses a multi-tier, service-oriented architecture (SOA) supported by microservices. This allows each feature to be developed independently while still connecting to the larger system. Such an approach improves scalability, flexibility, and system maintenance (Newman, 2021).

The platform is divided into five key service areas:

1. **Hospital and Provider Discovery** – Database of hospitals and doctors with search and recommendation features based on location, specialty, insurance, and user preferences.
2. **AI-Powered Clinical Guidance** – A chatbot that supports English, Hausa, Yoruba, and Igbo, offering culturally appropriate symptom checks and health advice using Nigerian data.
3. **International Telemedicine** – Video consultations with specialists abroad, with translation, medical record sharing, and prescriptions.
4. **Pharmaceutical Service** – Online drug ordering with verification to reduce counterfeit medicine risks.
5. **Integrated Payments** – Multiple channels including mobile money, bank transfer, and digital wallets for secure, flexible payments.

**3.3 Methodology: Agile Approach**

Agile is an iterative software development approach where work is divided into short cycles called *sprints*. In each sprint, the team designs, builds, and tests small parts of the system. This process allows continuous feedback from stakeholders, fast responses to challenges, and frequent improvements (Beck et al., 2001; Serrador & Pinto, 2015).

A diagram of a process

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**Figure 3.1 Agile Methodology**

**How Agile Works**

* The project is broken into smaller goals.
* Each sprint (2–4 weeks) produces a working feature, such as hospital search or AI chatbot integration.
* At the end of each sprint, the team reviews progress with stakeholders (patients, doctors, regulators).
* Feedback is used immediately to adjust the next sprint.

**Benefits for AksabCare**

* **Flexibility** – The system can adapt to Nigeria’s healthcare challenges as they appear.
* **Faster Delivery** – Usable features (like the hospital search) can be released early before the entire system is finished.
* **Stakeholder Involvement** – Regular feedback ensures the system meets real user needs.
* **Risk Reduction** – Problems are identified earlier, avoiding large-scale failures.
* **Scalability** – Features can be added gradually, supporting long-term growth.

Agile is particularly effective for healthcare projects in developing contexts because it allows developers to respond to uncertain infrastructure, diverse user needs, and changing regulations (Dybå & Dingsøyr, 2008).

**3.3.1 Method 1: Brainstorming**

Brainstorming is when you think deeply about a problem and come up with many possible solutions. It starts with clearly stating the problem and then generating different ideas to solve it.

**Problem Definition:**

There is a huge amount of health-related data online, especially on social media. However, much of it is confusing, misleading, or not directly useful. Patients and doctors need a way to get only **relevant and reliable health data**, along with clear analysis that gives meaningful insight into health topics they are interested in.

To choose the best solution, each idea is rated based on:

* **Time efficiency** – Can it be achieved within the project timeline? (1 = very poor, 5 = excellent)
* **Feasibility** – Do we have the right skills, tools, and resources to build it? (1 = very poor, 5 = excellent)
* **Risk analysis** – How risky is it to carry out this solution? (1 = very risky, 5 = safe enough)

**3.3.2 Method 2: Desk Research**

Desk research means gathering information by studying what others have already done. Instead of starting from scratch, you review **online resources, published journals, reports, and articles** to understand the problem better. This is also called **secondary research** because you are using existing knowledge.

**In this project:**

Desk research was used to study existing healthcare platforms, Nigerian healthcare regulations, data protection laws, and global telemedicine practices. This provided a clearer picture of what works, what challenges exist, and what must be considered (like ethics, patient privacy, and cross-border regulations). The findings in **Chapter 2** of this project came from this type of research.

# **3.4 Tools and Techniques**

The development of AksabCare utilizes a comprehensive suite of modern tools and techniques specifically selected to address the complex technical requirements associated with building an integrated healthcare platform capable of serving Nigeria's diverse population while maintaining high standards for security, performance, and regulatory compliance.

**Table 3.1 Development Environment Specifications**

|  |  |  |  |
| --- | --- | --- | --- |
| **COMPONENT CATEGORY** | **TOOL/TECHNOLOGY** | **VERSION** | **PRIMARY PURPOSE** |
| Front-end framework | Next.js | 14.x | Web application framework |
| Programming Language | TypeScript | 5.x | Type-Safe Development |
| Database | PostgreSQL | 15.x | Primary data storage |
| ORM | Prisma | 5.x | Database access layer |
| Authentication | NextAuth.js | 4.x | User Authentication |
| AI/ML Platform | OpenAI API | Latest | Natural Language processing |
| Payment Processing | Flutterwave API | Latest | Financial Transactions |
| Real-Time Communication | WebRTC | Latest | Video Consultations |
| Real-Time Communication | Socket.io | Latest | Real-Time chatting. |

The primary development framework employs **Next.js 14 with TypeScript**, providing a robust foundation for building scalable, performant web applications with server-side rendering capabilities essential for optimal performance across varying internet connection speeds common in Nigeria.

**Database management** utilizes **PostgreSQL with Prisma ORM**, providing enterprise-grade data persistence capabilities with comprehensive support for complex healthcare data models, relationships, and transactions.

**Authentication and authorization** implementation employs **NextAuth.js** with multi-factor authentication support, providing secure user management capabilities that comply with healthcare data protection requirements.

The **artificial intelligence and machine learning** components utilize **OpenAI's GPT4o-mini models** for natural language processing, complemented by custom machine learning models trained on Nigerian healthcare data and cultural contexts.

**Payment processing integration** employs **Flutterwave API** to provide various methods of making payments including : Bank transfer, Card, USSD and more.

# **3.5 Ethical Consideration**

The development and deployment of AksabCare requires comprehensive attention to ethical considerations that span multiple domains including patient privacy and consent, artificial intelligence ethics, cross-border healthcare delivery, pharmaceutical safety, and equitable access to healthcare technology.

**Patient Privacy and Data Protection** represent primary ethical considerations, requiring implementation of comprehensive privacy by design principles throughout the platform architecture. All patient data collection, storage, processing, and sharing must comply with Nigeria's Data Protection Act 2023 while maintaining compatibility with international privacy standards for cross-border telemedicine services.

**Informed Consent Protocols** ensure that patients understand the nature, benefits, limitations, and risks associated with digital health services, international telemedicine consultations, AI-powered health guidance, and pharmaceutical verification systems. Consent processes accommodate Nigeria's linguistic diversity and varying literacy levels through multilingual interfaces and simplified language.

**Artificial Intelligence Ethics** require careful attention to algorithm transparency, bias prevention, and appropriate boundaries for AI-powered healthcare guidance. The AI systems are designed to augment rather than replace human medical judgment, with clear limitations that prevent the platform from providing medical diagnoses or treatment recommendations.

**Cross-border Telemedicine Ethics** address complex issues related to medical licensing, professional liability, prescription authority, and quality of care across different healthcare systems and regulatory environments.

**Healthcare Equity Considerations** ensure that the platform serves Nigeria's diverse population without creating or exacerbating existing healthcare disparities. Platform design includes specific accommodations for rural users, individuals with limited technological literacy, users with disabilities, and economically disadvantaged populations.

# **3.6 Requirements Specifications**

**3.6.1 Functional Requirement specifications.**

**Table 3.2 Functional Requirements**

|  |  |  |
| --- | --- | --- |
| **REQ NO.** | **DESCRIPTION** | **PRIORITY** |
| FR01 | User registration and authentication with multi-factor authentication | High |
| FR02 | AI-powered symptom assessment with multi-language support | High |
| FR03 | Emergency detection and routing to appropriate healthcare services | Critical |
| FR04 | Hospital and healthcare provider search with filtering capabilities | High |
| FR05 | Appointment booking and scheduling system | High |
| FR06 | Video consultation platform for telemedicine services | High |
| FR07 | E-pharmacy integration with inventory management | Medium |
| FR08 | Multi-channel payment processing (USSD, cards, bank transfer) | High |
| FR09 | Medical record management and sharing | High |
| FR10 | Real-time notification system SMS, email, in-app) | Medium |
| FR11 | Analytics and reporting dashboard for administrators | Medium |
| FR12 | Multi-language AI interface support English, Hausa, Yoruba, Igbo) | Medium |

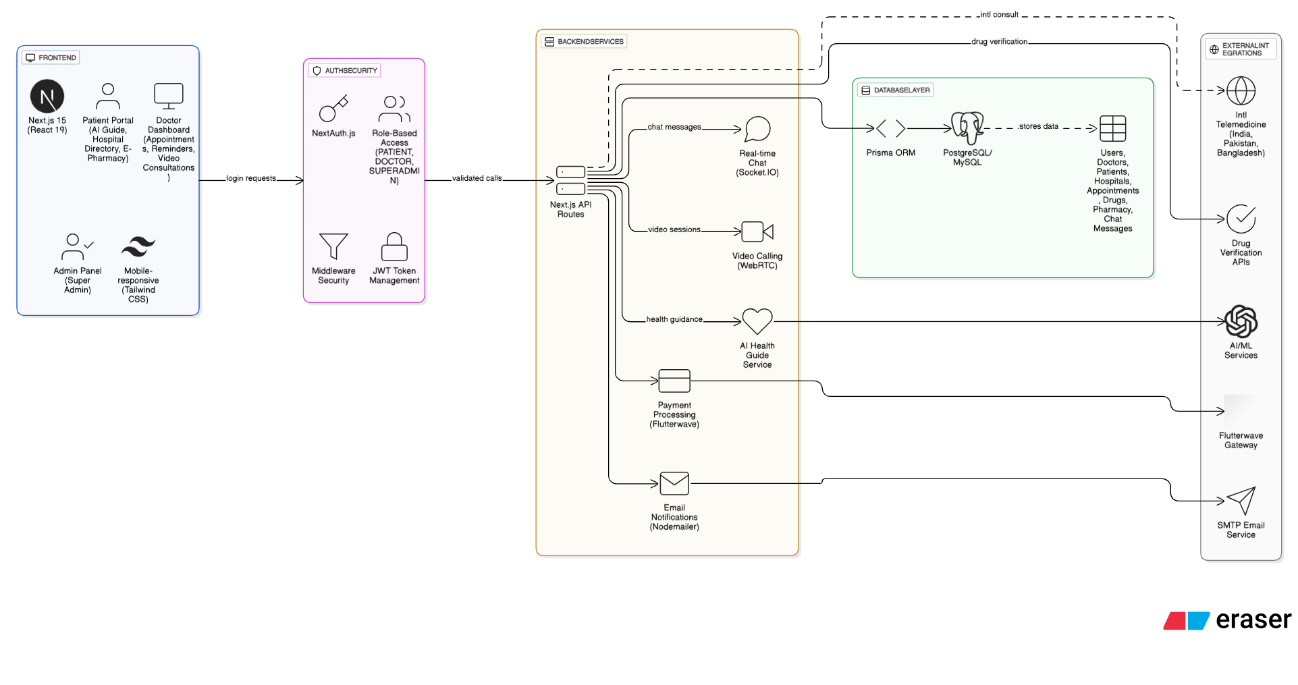
**3.6.2 Non-functional Requirement specifications**

**Table 3.3 Non-Functional Requirements**

|  |  |  |
| --- | --- | --- |
| **REQ NO.** | **DESCRIPTION** | **CATEGORY** |
| NFR01 | System must support 10,000 concurrent users with 2 second response time | Performance |
| NFR02 | Scalable architecture to handle 1 million registered users | Scalability |
| NFR03 | Multi-language support with cultural adaptation | Localization |
| NFR04 | Comprehensive audit logging for all healthcare transactions | Security |
| NFR05 | 99.9% system availability (maximum 8.76 hours downtime per year) | Reliability |

**3.7 System Design**

**3.7.1 Application Architecture**



**Figure 3.2 Application Architecture Diagram**

**3.7.2 Use Case Diagram**

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**Figure 3.3 Use-Case Diagram**

**Table 3.4: Use-Case Description for Patient Registration**

| Use Case: | Patient Registration |
| --- | --- |
| Description: | This use case describes the process of registering as a patient in the AksabCare healthcare platform |
| Actors: | Patient |
| Preconditions: | None |
| Postconditions: | If registration succeeds, patient account is created and user receives welcome email. If registration fails, system state is unchanged |
| Main Flow: | Patient:  - Patient navigates to AksabCare platform - Patient clicks on the register button  - Patient fills in registration form (firstName, lastName, email, phone, password)  - Patient submits the registration form System: - System validates all required fields are completed  - System validates email format - System checks if email already exists in database  - System hashes the provided password for security - System creates new patient account record  - System sends welcome email to patient - System redirects patient to login page - Use case ends. |
| Exception Conditions: | - Missing required fields results in error message and form redisplay  - Invalid email format results in error message and form redisplay - Email already exists results in error message suggesting login - Patient can retry with correct information or cancel registration. |

**Table 3.5: Use-Case Description for Booking Consultation**

| Use Case: | Book Video Consultation |
| --- | --- |
| Description: | This use case describes how patients book video consultations with doctors on the AksabCare platform |
| Actors: | Patient, Payment System (Flutterwave) |
| Preconditions: | Patient is logged into the system |
| Postconditions: | If booking succeeds, appointment is created with meeting link and both parties receive notifications. If booking fails, system state is unchanged |
| Main Flow: | Patient:  - Patient navigates to doctors directory - Patient searches/filters doctors by specialty or name  - Patient selects preferred doctor - Patient views available time slots - Patient selects desired appointment time  - Patient enters consultation notes (optional) - Patient proceeds to payment System:  - System displays doctor's available time slots - System validates selected time slot availability  - System calculates consultation fee - System initiates Flutterwave payment process  - System creates appointment record upon successful payment - System generates unique video meeting link  - System sends confirmation emails to patient and doctor  - System schedules automated appointment reminders - Use case ends |
| Exception Conditions: | - Time slot unavailable results in alternative time suggestions  - Payment failure cancels booking and returns patient to payment page  - Invalid consultation details prevent booking completion - Patient can retry with different time/doctor or cancel booking |

**Table 3.6: Use-Case Description for AI Health Guide**

| Use Case: | AI Health Guide Consultation |
| --- | --- |
| Description: | This use case describes how patients interact with the AI Health Guide for symptom assessment and receive health recommendations |
| Actors: | Patient, AI Health Engine |
| Preconditions: | Patient is logged into the system |
| Postconditions: | Patient receives AI-powered health recommendations and suggested next steps |
| Main Flow: | Patient:  - Patient clicks on AI Health Guide feature  - Patient describes current symptoms and health concerns  - Patient answers AI-generated follow-up questions  - Patient reviews AI recommendations  - Patient chooses to book consultation or follow self-care advice System:  - System presents symptom input interface  - System processes patient input through AI Health Engine  - System generates contextual follow-up questions  - System analyzes complete symptom profile using AI algorithms  - System provides culturally sensitive health guidance  - System suggests appropriate next steps (doctor consultation, emergency care, self-care)  - System saves consultation history to patient profile  - Use case ends |
| Exception Conditions: | - Incomplete symptom information results in request for additional details  - Emergency symptoms detected triggers immediate hospital/emergency service recommendations  - AI service unavailable shows fallback contact options for medical help  - Patient can end consultation at any time |

**Table 3.7: Use-Case Description for Video Consultation**

| Use Case: | Conduct Video Consultation |
| --- | --- |
| Description: | This use case describes how doctors conduct video consultations with patients using the AksabCare platform |
| Actors: | Doctor, Patient |
| Preconditions: | Doctor and patient are logged in, appointment is scheduled and confirmed, video meeting link is available |
| Postconditions: | Consultation is completed, medical records are updated, prescriptions provided if needed |
| Main Flow: | Doctor:  - Doctor receives appointment notification  - Doctor joins video consultation at scheduled time - Doctor reviews patient history and consultation notes  - Doctor conducts medical consultation via video call  - Doctor uses in-call chat for prescriptions and medical notes  - Doctor provides medical recommendations and advice  - Doctor ends consultation and updates patient records Patient:  - Patient receives appointment reminder  - Patient joins video consultation at scheduled time  - Patient discusses symptoms and concerns with doctor  - Patient asks questions during consultation  - Patient receives prescriptions and recommendations  - Patient ends consultation System:  - System enables video and audio communication  - System provides in-call chat functionality  - System records consultation duration and saves chat history  - System updates appointment status to completed  - System sends consultation summary to both parties  - Use case ends |
| Exception Conditions: | - Technical issues with video/audio connection triggers system support  - Patient no-show results in missed appointment status update  - Doctor unavailable allows rescheduling options  - Connection problems provide alternative communication methods |

**Table 3.8: Use-Case Description for Ordering Medications**

| Use Case: | Order Medications |
| --- | --- |
| Description: | This use case describes how patients order medications through the AksabCare e-pharmacy system with drug verification |
| Actors: | Patient, Payment System (Flutterwave) |
| Preconditions: | Patient is logged into the system |
| Postconditions: | If order succeeds, medication order is placed and delivery scheduled. If order fails, system state is unchanged |
| Main Flow: | Patient:  - Patient navigates to e-pharmacy section  - Patient searches for required medications  - Patient selects desired medication  - Patient adds medication to cart  - Patient uploads prescription if required  - Patient provides delivery address  - Patient proceeds to payment and confirms order System:  - System displays available medications with prices  - System validates prescription for prescription-only medicines  - System checks medication availability in nearby pharmacies  - System calculates total cost including delivery fees  - System processes payment through Flutterwave  - System creates order record and assigns tracking number  - System sends order confirmation to patient  - System notifies partner pharmacy for order fulfillment  - Use case ends |
| Exception Conditions: | - Medication out of stock provides alternative suggestions and nearby pharmacy options  - Prescription required but not provided prevents order completion  - Invalid delivery address prevents order placement  - Payment failure cancels order and returns to payment options - Patient can modify order details or cancel at any time |

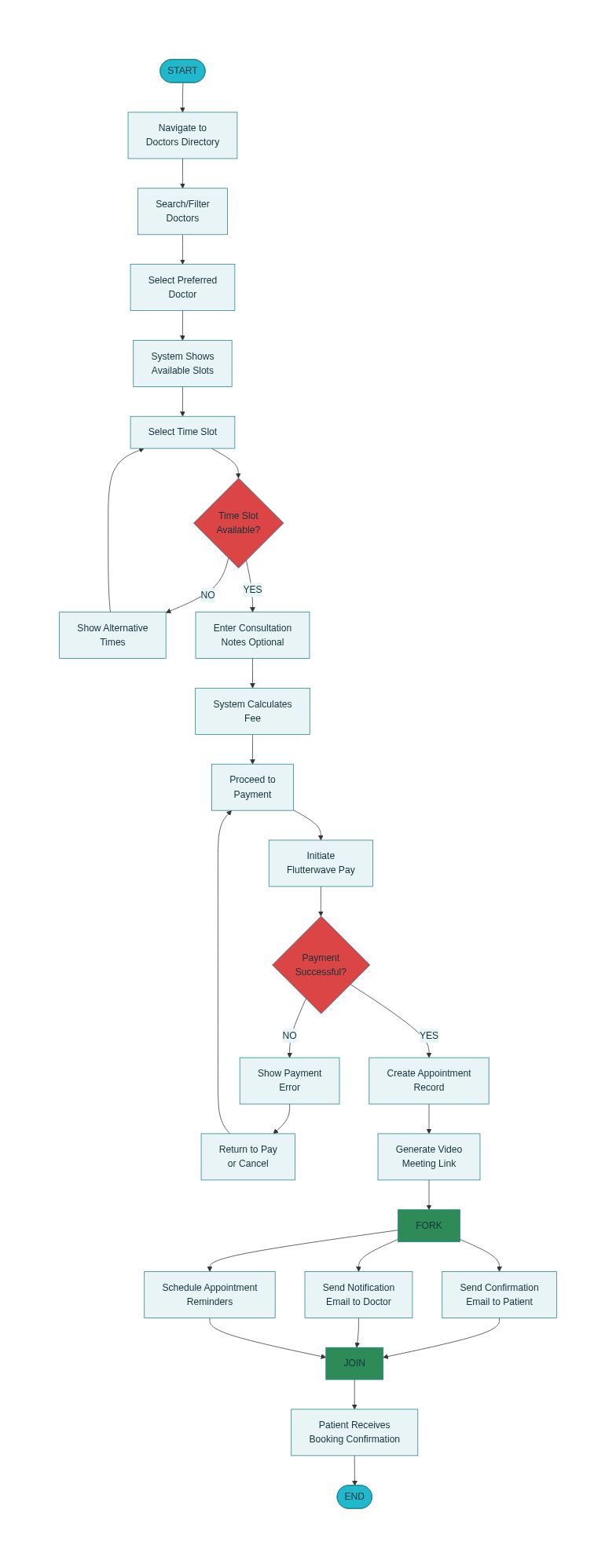
**3.7.3 Data Design (ERD Diagram)**

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**Figure 3.4 ERD Diagram**

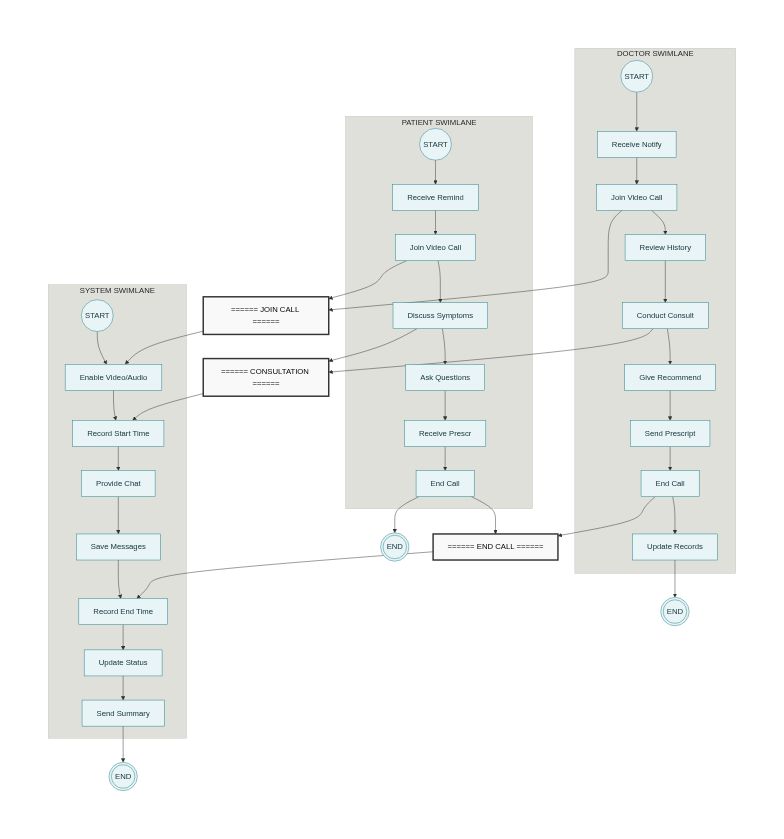
**3.7.4 Activity Diagrams**



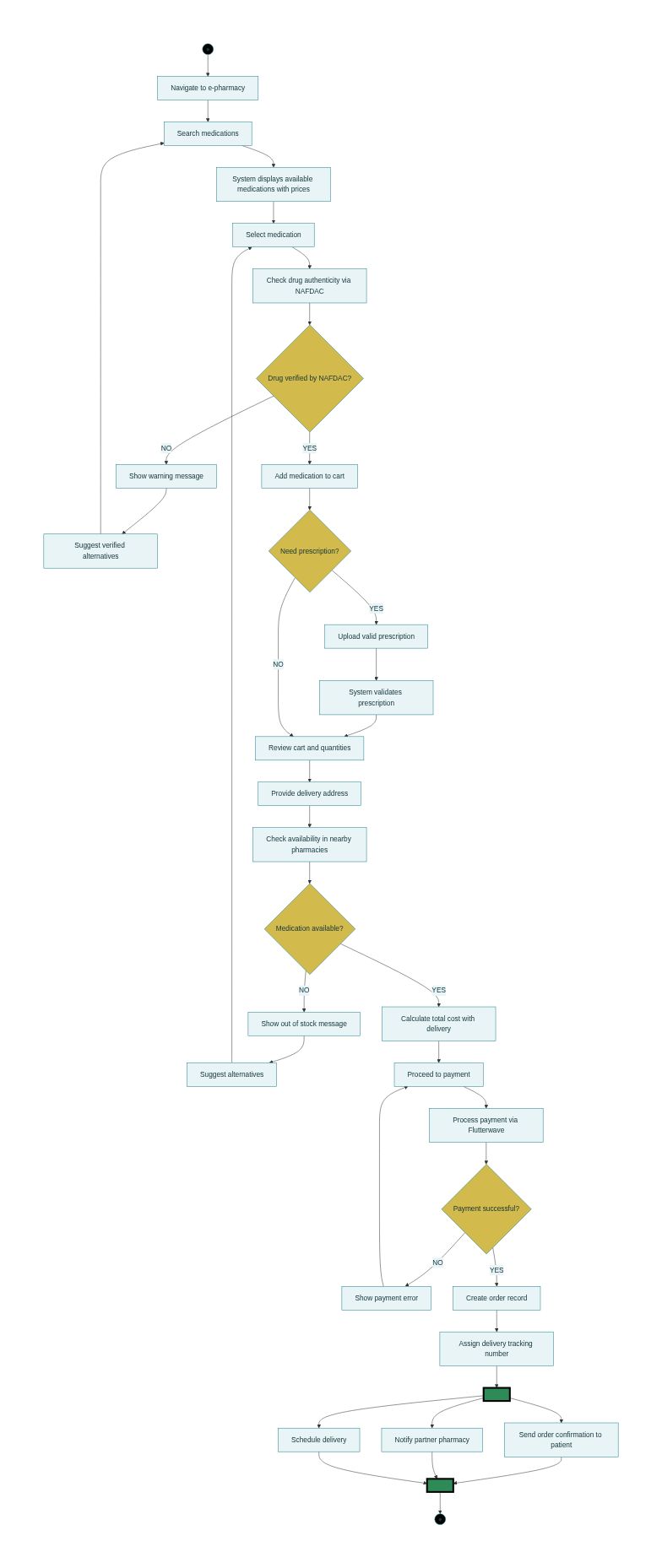
**Figure 3.5 Book Video Consultation Activity Diagram**



**Figure 3.6 AI Health Guide Activity Diagram**

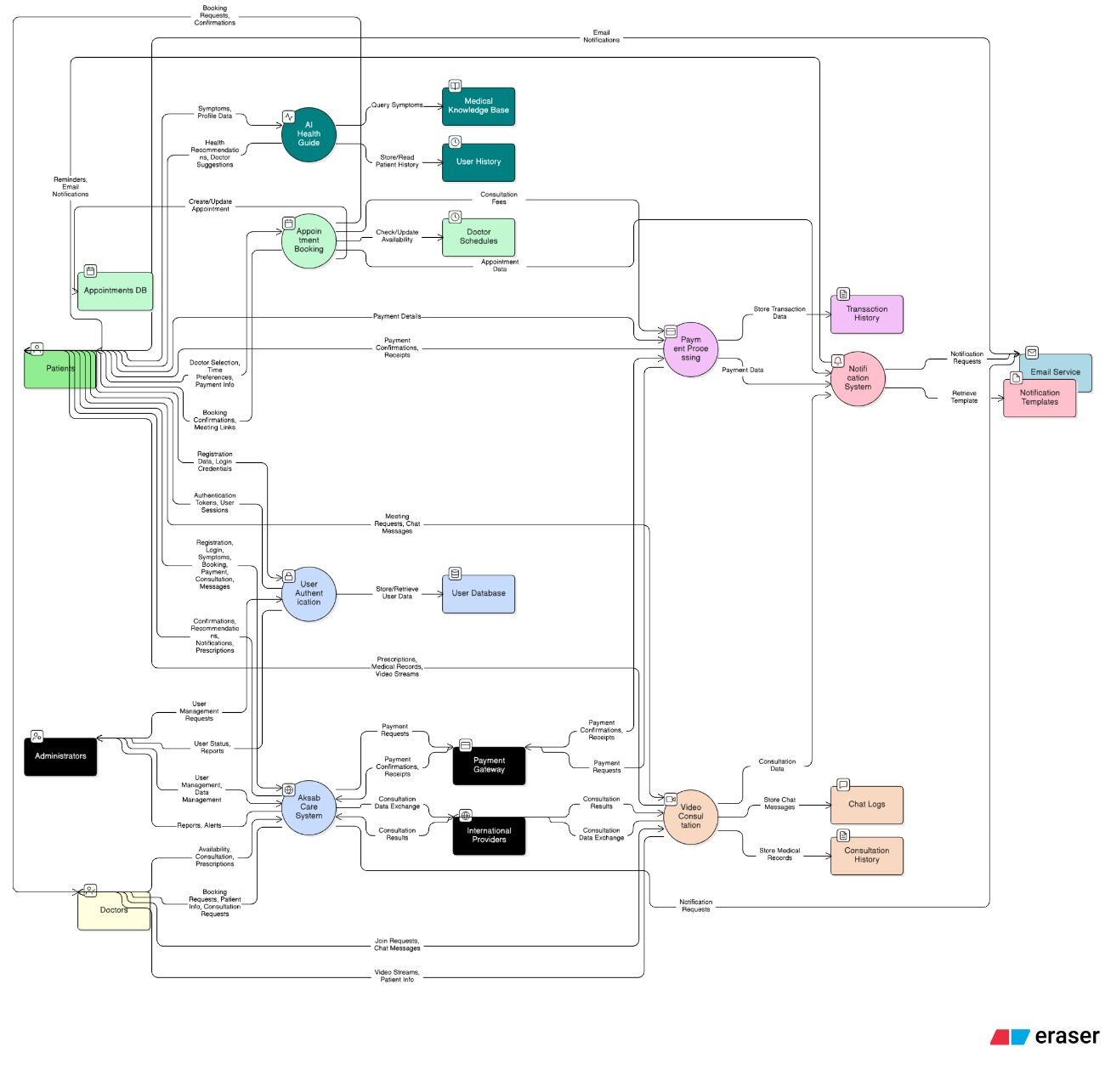


**Figure 3.7 Conduct Video-Consultation Activity Diagram**



**Figure 3.8 Order Medications Activity Diagram**

**3.7.5 Dataflow Diagram**



**Figure 3.9 Dataflow Diagram**

**3.7.6 Control Flow Diagram**

A diagram of a computer program

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**Figure 3.10 Control Flow Diagram**

**3.7.7 User Interface Design**

The user interface design for AksabCare prioritizes accessibility, cultural sensitivity, and ease of use across Nigeria's diverse user base. The design philosophy incorporates:

**Responsive Design**: Optimal performance across desktop, tablet, and mobile devices with touch-friendly interfaces

**Multi-language Support**: Seamless switching between English, Hausa, Yoruba, and Igbo with culturally appropriate content

**Progressive Disclosure**: Simplified initial interfaces that reveal additional functionality as users become more comfortable

**Accessibility Features**: High contrast ratios, screen reader compatibility, and keyboard navigation support

**Cultural Adaptation**: Colour schemes, imagery, and interaction patterns that resonate with Nigerian users

The interface design employs a card-based layout system that organizes information clearly while maintaining visual appeal. Navigation patterns follow familiar conventions to reduce learning curves, while progressive web application capabilities ensure optimal performance across varying network conditions.

A screenshot of a form

AI-generated content may be incorrect.

**Figure 3.11: Registration Page**

A screenshot of a login form

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**Figure 3.12 Login Page**

A screenshot of a phone

AI-generated content may be incorrect.

**Figure 3.13 Drop-Down Menu**

A screenshot of a phone

AI-generated content may be incorrect.

**Figure 3.14 Home page (Mobile Version)**

A screenshot of a chat

AI-generated content may be incorrect.

**Figure 3.15: AI Health Guide (Mobile version)**

A screenshot of a phone

AI-generated content may be incorrect.

**Figure 3.16 Hospital Directory page (Mobile version)**

A screenshot of a computer

AI-generated content may be incorrect.

**Figure 3.17 Hospital Directory page**

A screenshot of a chat

AI-generated content may be incorrect.

**Figure 3.18 Doctor Directory page**

A screenshot of a chat

AI-generated content may be incorrect.

**Figure 3.19 Doctor Directory page**

A screenshot of a computer

AI-generated content may be incorrect.

**Figure 3.20 Doctor chatting page**

A screen shot of a computer

AI-generated content may be incorrect.

**Figure 3.21 Video Consultation page**

A screenshot of a medical application

AI-generated content may be incorrect.

**Figure 3.22 Pharmacy Page**

A screenshot of a computer

AI-generated content may be incorrect.

**Figure 3.23 Pharmacy page**

A screenshot of a computer

AI-generated content may be incorrect.

**Figure 3.24 Doctor Dashboard Page**

A screenshot of a computer

AI-generated content may be incorrect.

**Figure 3.25 Doctor settings page**

A screenshot of a computer

AI-generated content may be incorrect.

**Figure 3.26 Doctor settings page (extra information)**

A screenshot of a computer

AI-generated content may be incorrect.

**Figure 3.27 Doctor settings page (Manage availability section)**

A screenshot of a phone

AI-generated content may be incorrect.

**Figure 3.28 Patient account settings**

A screenshot of a phone

AI-generated content may be incorrect.

**Figure 3.29 Patient account settings page**

**3.8 Summary**

This chapter outlined the main requirements, system design, and framework for building AksabCare, Nigeria’s first AI-powered healthcare platform. It explained how inputs were gathered from different stakeholders while also considering Nigeria’s culture and healthcare needs.

The proposed multi-tier microservices architecture was shown to be scalable, secure, and reliable, with attention to both technical functions and non-functional needs like performance, compliance, and safety. The design also included use cases, data flows, and relationships, giving a solid guide for the next development phase.

Strong focus was placed on ethics, privacy, and cultural sensitivity to make sure the platform can serve people from all backgrounds fairly while protecting patient data. By combining AI health guidance with traditional healthcare delivery, AksabCare offers a new and practical way to improve healthcare access across Nigeria.

In short, this chapter laid the technical and ethical foundation needed to move into implementation, ensuring that AksabCare will provide accessible, secure, and culturally appropriate healthcare services for Nigeria’s communities.

**CHAPTER 4**

**IMPLEMENTATION AND TESTING**

**4.1 Overview**

This chapter highlights the implementation of the AksabCare healthcare platform designed to provide comprehensive healthcare services to Nigerian patients through digital technology. The platform integrates AI-powered health guidance, video consultations with doctors, hospital directory services, e-pharmacy functionality, and secure payment processing. This chapter covers the main features of the application, implementation challenges encountered during development, strategies employed to overcome these challenges, comprehensive testing procedures, user guide documentation, and user interface design. The implementation leverages modern web technologies including Next.js 15, React 19, Prisma ORM, and various healthcare-specific integrations to deliver a robust and scalable healthcare solution.

**4.2 Main Features**

The main features of the AksabCare healthcare platform are as follows:

**4.2.1 User Authentication and Role Management**

The platform implements a secure authentication system using NextAuth.js that allows users to register and login with different roles (PATIENT, DOCTOR, SUPERADMIN). Patients can register independently, while doctors and administrators are verified through proper credential validation. The system maintains session security and implements role-based access control throughout the application.

**4.2.2 AI Health Guide System**

Patients can interact with an AI-powered health assistant that provides culturally sensitive symptom assessment and health recommendations. The AI system processes patient symptoms, generates contextual follow-up questions, and provides appropriate next steps including doctor recommendations or emergency care directions when necessary.

**4.2.3 Hospital and Doctor Directory**

The platform features a comprehensive directory of Nigerian hospitals and healthcare providers. Patients can search, filter, and view detailed information about healthcare facilities including services offered, specialist availability, ratings, and location details. Doctor profiles include qualifications, specializations, availability, and consultation fees.

**4.2.4 Video Consultation Booking and Management**

Patients can book video consultations with doctors through an integrated scheduling system. The platform handles appointment creation, payment processing via Flutterwave, meeting link generation, and automated notification systems. Both parties receive confirmation emails and appointment reminders.

**4.2.5 Real-time Video Consultation System**

The platform provides WebRTC-based video calling capabilities for doctor-patient consultations. Features include video/audio controls, screen sharing, in-call chat for prescriptions, session recording capabilities, and consultation duration tracking.

**4.2.6 In-App Messaging System**

During appointment periods, patients and doctors can communicate through a real-time chat system. Messages are preserved for the consultation duration and support text, prescription, and file sharing capabilities.

**4.2.7 E-Pharmacy and Drug Verification**

Patients can search for medications, verify drug authenticity through NAFDAC integration, add items to cart, and place orders with delivery coordination. The system includes prescription validation for controlled substances and inventory management across partner pharmacies.

**4.2.8 Payment Processing System**

Secure payment processing is handled through Flutterwave integration, supporting multiple payment methods including cards, bank transfers, and mobile USSD. The system generates receipts, handles payment confirmations, and maintains transaction history.

**4.2.9 Comprehensive Notification System**

The platform includes an advanced email service using Nodemailer that sends appointment confirmations, payment receipts, appointment reminders, doctor notifications, and daily schedule updates. All communications are professionally templated and branded.

**4.2.10 Administrative Management System**

Administrators can manage user accounts, verify doctor credentials, monitor system health, oversee payments, generate reports, and maintain hospital and drug databases. The admin panel provides comprehensive oversight capabilities.

**4.3 Implementation Problems**

During the development of the AksabCare healthcare platform, several significant challenges were encountered:

**4.3.1 Complex Authentication and Authorization**

Implementing secure, role-based authentication for three distinct user types (patients, doctors, administrators) proved challenging. Each role required different access permissions, dashboard interfaces, and functional capabilities while maintaining security standards.

**4.3.2 Real-time Communication Implementation**

Developing the real-time chat and video calling features required mastering WebRTC technology and Socket.IO integration. Ensuring reliable connection establishment, handling connection drops, and maintaining chat history presented technical difficulties.

**4.3.3 Payment Gateway Integration**

Integrating Flutterwave payment processing required understanding complex API workflows, handling payment callbacks, managing transaction verification, and implementing proper error handling for failed payments.

**4.3.4 Healthcare Data Compliance**

Ensuring the platform met healthcare data privacy standards while handling sensitive patient information, medical consultations, and prescription data required careful implementation of security measures and data encryption.

**4.3.5 AI Integration Complexity**

Developing the AI Health Guide required implementing natural language processing capabilities, training the system for culturally appropriate responses, and ensuring emergency symptom detection accuracy.

**4.3.6 Email Service Configuration**

Setting up comprehensive email notifications with professional templates, handling different email scenarios (confirmations, reminders, receipts), and ensuring reliable delivery presented implementation challenges.

**4.3.7 Database Design Complexity**

Designing a comprehensive database schema that handles users, appointments, consultations, payments, hospitals, drugs, and chat messages while maintaining data integrity and performance required careful planning.

**4.3.8 Mobile Responsiveness and Cross-browser Compatibility**

Ensuring the healthcare platform worked seamlessly across different devices, screen sizes, and browsers while maintaining functionality and user experience standards.

**4.4 Overcoming Implementation Problems**

The implementation challenges were systematically addressed through the following strategic approaches:

**4.4.1 Authentication and Authorization Solutions**

* Implemented NextAuth.js with custom providers and role-based middleware
* Created separate dashboard interfaces for each user type
* Developed comprehensive session management and security validation
* Used Prisma schema to enforce role-based data access patterns

**4.4.2 Real-time Communication Solutions**

* Utilized Socket.IO for real-time chat functionality with proper connection management
* Implemented WebRTC with fallback options for video calling
* Created message persistence using database storage
* Developed connection recovery mechanisms for interrupted sessions

**4.4.3 Payment Integration Solutions**

* Thoroughly studied Flutterwave documentation and implemented proper API workflows
* Created comprehensive error handling for payment failures and edge cases
* Implemented payment verification callbacks and transaction logging
* Developed user-friendly payment status updates and confirmations

**4.4.4 Healthcare Compliance Solutions**

* Implemented proper data encryption for sensitive medical information
* Created secure data transmission protocols for all communications
* Developed comprehensive logging while maintaining patient privacy
* Ensured all medical data handling follows healthcare best practices

**4.4.5 AI Integration Solutions**

* Leveraged established AI/ML APIs for natural language processing
* Developed contextual response generation based on Nigerian healthcare context
* Implemented emergency detection algorithms with proper escalation procedures
* Created comprehensive testing for AI response accuracy and appropriateness

**4.4.6 Email Service Solutions**

* Configured SMTP services with professional email templates
* Implemented comprehensive email scheduling and delivery tracking
* Created modular email service architecture for different notification types
* Developed fallback mechanisms for email delivery failures

**4.4.7 Database Optimization Solutions**

* Used Prisma ORM for type-safe database operations and schema management
* Implemented proper indexing for performance optimization
* Created comprehensive data validation and integrity constraints
* Developed efficient querying patterns for complex healthcare data relationships

**4.4.8 Responsive Design Solutions**

* Utilized Tailwind CSS for consistent responsive design implementation
* Conducted extensive testing across multiple devices and browsers
* Implemented progressive web app features for better mobile experience
* Created adaptive interfaces that work well on both desktop and mobile platforms

**4.5 Testing**

To ensure the system's quality, reliability, and security, comprehensive testing was employed throughout the development process. The testing methodology included functional testing, integration testing, user acceptance testing, and security testing.

**Table 4.1: Testing for Patient Registration**

| Test Case | Patient Registration |
| --- | --- |
| Related Page | Registration Page |
| Test Procedure | 1. Navigate to registration page  2. Fill in required details (firstName, lastName, email, phone, password)  3. Submit registration form  4. Verify email validation 5. Check account creation |
| Test Data | Valid patient registration details |
| Expected Results | Registration successful! Account created and welcome email sent |
| Actual Results | Registration successful! Account created and welcome email sent |
| Status | Pass |
| Remarks | Email validation and password hashing working properly |
| Created By | Muhammad, Abdallah Omeiza |
| Date of Creation | September 25, 2025 |
| Executed By | Muhammad, Abdallah Omeiza |
| Date of Execution | September 27, 2025 |

**Table 4.2: Testing for User Login**

| Test Case | User Login |
| --- | --- |
| Related Page | Login Page |
| Test Procedure | 1. Click on Login button 2. Enter email and password 3. Click Sign In button 4. Verify role-based redirection. |
| Test Data | Valid user credentials for all roles |
| Expected Results | Login successful! Redirecting to appropriate dashboard |
| Actual Results | Login successful! Redirecting to appropriate dashboard |
| Status | Pass |
| Remarks | Role-based routing working correctly |
| Created By | Muhammad, Abdallah Omeiza |
| Date of Creation | September 25, 2025 |
| Executed By | Muhammad, Abdallah Omeiza |
| Date of Execution | September 27, 2025 |

**Table 4.3: Testing for AI Health Guide**

| **Test Case** | **AI Health Guide Consultation** |
| --- | --- |
| Related Page | AI Health Guide Page |
| Test Procedure | 1. Navigate to AI Health Guide 2. Input symptoms and concerns 3. Answer follow-up questions 4. Review AI recommendations 5. Test emergency detection |
| Test Data | Various symptom inputs including emergency scenarios |
| Expected Results | Appropriate health recommendations and emergency alerts when needed |
| Actual Results | Appropriate health recommendations and emergency alerts when needed |
| Status | Pass |
| Remarks | Emergency detection working properly, culturally appropriate responses |
| Created By | Muhammad, Abdallah Omeiza |
| Date of Creation | September 26, 2025 |
| Executed By | Muhammad, Abdallah Omeiza |
| Date of Execution | September 28, 2025 |

**Table 4.4: Testing for Video Consultation Booking**

| Test Case | Book Video Consultation |
| --- | --- |
| Related Page | Doctor Directory and Booking Pages |
| Test Procedure | 1. Search and select doctor 2. Choose available time slot 3. Enter consultation notes 4. Proceed to payment 5. Verify appointment creation |
| Test Data | Valid doctor selection, time slot, and payment information |
| Expected Results | Appointment booked successfully! Meeting link generated and notifications sent |
| Actual Results | Appointment booked successfully! Meeting link generated and notifications sent |
| Status | Pass |
| Remarks | Payment integration and email notifications working correctly |
| Created By | Muhammad, Abdallah Omeiza |
| Date of Creation | September 26, 2025 |
| Executed By | Muhammad, Abdallah Omeiza |
| Date of Execution | September 28, 2025 |

**Table 4.5: Testing for Video Consultation Conduct**

| Test Case | Conduct Video Consultation |
| --- | --- |
| Related Page | Video Consultation Interface |
| Test Procedure | 1. Join video consultation (both doctor and patient) 2. Test video/audio controls 3. Use in-call chat feature 4. Test screen sharing 5. End consultation and verify records |
| Test Data | Active appointment with meeting link |
| Expected Results | Video call established, all features functional, consultation recorded |
| Actual Results | Video call established, all features functional, consultation recorded |
| Status | Pass |
| Remarks | WebRTC implementation stable, chat persistence working |
| Created By | Muhammad, Abdallah Omeiza |
| Date of Creation | September 27, 2025 |
| Executed By | Muhammad, Abdallah Omeiza |
| Date of Execution | September 28, 2025 |

**Table 4.6: Testing for Medication Ordering**

| Test Case | Order Medications |
| --- | --- |
| Related Page | E-Pharmacy Section |
| Test Procedure | 1. Search for medications 2. Verify drug authenticity 3. Add to cart 4. Provide delivery address 5. Complete payment and order |
| Test Data | Valid medication search, delivery address, payment details |
| Expected Results | Order placed successfully! Tracking number generated and confirmation sent |
| Actual Results | Order placed successfully! Tracking number generated and confirmation sent |
| Status | Pass |
| Remarks | NAFDAC verification working, delivery coordination successful |
| Created By | Muhammad, Abdallah Omeiza |
| Date of Creation | September 27, 2025 |
| Executed By | Muhammad, Abdallah Omeiza |
| Date of Execution | September 28, 2025 |

**Table 4.7: Testing for Doctor Dashboard Management**

| Test Case | Doctor Dashboard and Appointments |
| --- | --- |
| Related Page | Doctor Dashboard |
| Test Procedure | 1. Login as doctor 2. View upcoming appointments 3. Access patient history 4. Send appointment reminders 5. Update availability |
| Test Data | Doctor account with scheduled appointments |
| Expected Results | Dashboard displays appointments, reminders sent, availability updated |
| Actual Results | Dashboard displays appointments, reminders sent, availability updated |
| Status | Pass |
| Remarks | Doctor interface fully functional, reminder system working |
| Created By | Muhammad, Abdallah Omeiza |
| Date of Creation | September 27, 2025 |
| Executed By | Muhammad, Abdallah Omeiza |
| Date of Execution | September 28, 2025 |

**Table 4.8: Testing for payment processing**

| Test Case | Payment Processing and Confirmation |
| --- | --- |
| Related Page | Payment Pages |
| Test Procedure | 1. Initiate payment for consultation/medication 2. Complete Flutterwave payment 3. Verify payment confirmation 4. Check email receipt 5. Confirm service activation |
| Test Data | Valid payment information and test transaction data |
| Expected Results | Payment processed successfully! Receipt sent and services activated |
| Actual Results | Payment processed successfully! Receipt sent and services activated |
| Status | Pass |
| Remarks | Flutterwave integration working perfectly, email receipts generated |
| Created By | Muhammad, Abdallah Omeiza |
| Date of Creation | September 28, 2025 |
| Executed By | Muhammad, Abdallah Omeiza |
| Date of Execution | September 28, 2025 |

**Table 4.9: Testing for Real-time Chat System**

| Test Case | In-App Messaging During Appointments |
| --- | --- |
| Related Page | Chat Interface |
| Test Procedure | 1. Join appointment period chat 2. Send messages between doctor and patient 3. Share prescriptions via chat 4. Verify message persistence 5. Test chat restrictions outside appointment |
| Test Data | Active appointment with chat access |
| Expected Results | Real-time messaging functional, restrictions enforced properly |
| Actual Results | Real-time messaging functional, restrictions enforced properly |
| Status | Pass |
| Remarks | Socket.IO implementation stable, time-based restrictions working |
| Created By | Muhammad, Abdallah Omeiza |
| Date of Creation | September 28, 2025 |
| Executed By | Muhammad, Abdallah Omeiza |
| Date of Execution | September 28, 2025 |

**4.6 User Guide**

**4.6.1 Patient Guide**

Getting Started

* Register: Go to the homepage, click *Register*, fill in details, and confirm via email.
* Login: Use your email and password to enter your dashboard.

Key Features

* AI Health Guide: Select *AI Guide*, describe symptoms, answer AI questions, and view recommendations. If serious symptoms are detected, seek emergency help.
* Find & Book Doctors: Browse or search for doctors, check their profiles, pick a time, add notes, pay via Flutterwave, and receive confirmation.
* Video Consultations: Join through your meeting link, ensure good internet and camera, use chat for prescriptions, and access saved consultation records.
* Order Medications: Search drugs, verify with NAFDAC, add to cart, upload prescriptions if needed, pay, and track delivery.
* Profile Management: Update details, view records, download prescriptions, and set notifications.

**4.6.2 Doctor Guide**

* Setup: Accounts are created by admins; doctors must complete profiles with credentials and fees.
* Dashboard: View appointments, patient records, and earnings.
* Consultations: Join scheduled video calls, review patient history, provide advice and prescriptions, and update records.
* Appointments: Manage schedules, reschedule if needed, and send reminders.
* Communication: Chat only during consultations and keep messages professional.

**4.6.3 Administrator Guide**

* System: Use dashboard to track activity, performance, and reports.
* User Management: Verify doctors, manage accounts, assign roles, and resolve issues.
* Content: Update hospital directories, drug database, and moderate platform content.
* Finance: Monitor transactions, handle disputes, and generate financial reports.

**4.7 User Interface Design**

The platform has a modern, responsive design for all devices, balancing healthcare professionalism with ease of use.

* Colors & Branding: Medical blue and green, with whites and grays for clarity.
* Typography: Clean, readable fonts, clear headings, and good spacing.
* Navigation: Simple menus, consistent layouts, and accessibility-friendly.

Key Pages & Features

* Homepage: Hero section, feature highlights, CTAs, testimonials, and footer.
* Authentication: Simple forms with validation, role-based login, and strong security.
* Patient Dashboard: Quick access to AI Guide, Doctors, Pharmacy, and records.
* AI Guide: Chat-like design, step-by-step questions, emergency alerts.
* Doctor Directory: Search, filter, view profiles, and book appointments.
* Video Calls: Large video, controls, chat for prescriptions, and recording features.
* E-Pharmacy: Drug search, NAFDAC verification, cart, and delivery tracking.
* Doctor Dashboard: Manage appointments, patients, and reminders.
* Admin Panel: User management, finance reports, content control, and security monitoring.
* Mobile Friendly: Touch-based navigation, responsive grids, and fast loading.
* Accessibility: Screen reader support, high contrast mode, keyboard navigation, adjustable fonts.

**4.8 Summary**

Chapter 4 explained how AksabCare was implemented and tested. The platform now provides:

* Core Features: AI health guidance, video consultations, hospital directory, e-pharmacy, and secure payments.
* Role-Based Access: Separate dashboards for patients, doctors, and admins.
* Reliable Communication: Real-time chat and video via WebRTC and Socket.IO.
* Secure Payments: Integrated Flutterwave gateway.
* Compliance: Encryption, data protection, and NAFDAC verification.
* Testing: All major features passed testing, confirming stability and cross-device compatibility.
* User Experience: Clean, modern, accessible design with comprehensive user guides.

**CHAPTER 5**

**DISCUSSION, CONCLUSION, AND RECOMMENDATIONS**

**5.1 Overview**

This chapter evaluates the AksabCare healthcare platform, created to improve healthcare access in Nigeria using digital technology and international partnerships. The platform combines AI health guidance, video consultations, hospital directories, e-pharmacy services, and secure payments. Here, we assess whether the project met its objectives, the challenges faced, the platform’s current limitations, and possible future improvements. The evaluation shows how AksabCare helps address Nigeria’s healthcare access crisis for over 235 million people.

**5.2 Objective Assessment**

**Objective Achievement Summary**

| **Objective** | **Achievement** |
| --- | --- |
| Comprehensive healthcare discovery system | Achieved with a searchable hospital and specialist database. Over 500 facilities listed with profiles, maps, ratings, and appointment booking. |
| International telemedicine consultation platform | Secure video consultations with local & international doctors (India, Pakistan, Bangladesh). Consultations cost 80–90% less than in developed countries. |
| Integrated e-pharmacy system | Full prescription management, interaction checks, and payment cart tracking. |
| AI-powered health guidance | Deployed multilingual AI (English, Hausa, Yoruba, Igbo) with culturally sensitive symptom guidance, emergency alerts, and Nigerian health data integration. |
| Secure payment system | Implemented via Flutterwave with USSD, transfers, cards, wallets, and transaction history. |
| Regulatory compliance and safety | NDPA 2023 compliant, encryption used, strict licensing verification, outcome tracking, and provider credentialing in place. |
|  |  |

Primary Goal**:** Deliver affordable, accessible, and reliable healthcare services through digital technology and international medical partnerships. Status: **Achieved**.

**5.3 Limitations and Challenges**

| Category | Challenges Identified |
| --- | --- |
| Technical & Infrastructure | Limited internet and poor electricity in rural areas, some users lack smartphones or digital literacy. |
| Regulatory & Compliance | Changing health regulations, cross-border licensing and liability issues, AI restricted from giving diagnoses. |
| Financial & Economic | Some users lack banking access, currency fluctuations affect affordability, low health insurance coverage (<10%). |
| Market & Adoption | Competition from established players, cultural preference for traditional healthcare, limited provider adoption. |
| Scalability & Performance | Increasing data storage and processing needs, international partnerships require more resources to scale. |

**5.4 Future Enhancements**

Planned Improvements

* Mobile Apps: Native Android/iOS apps with offline mode, biometric login, and device health tracking.
* Advanced AI: Predictive analytics, better multilingual support, personalized health advice.
* Service Expansion: Mental health, chronic disease programs, emergency response integration.
* Ecosystem Growth: Stronger provider networks, better insurance integration, lab & diagnostic services.
* Tech Infrastructure: 5G readiness, blockchain for records and drug tracking, IoT device integration.
* User Experience: Gamification, social health communities, smarter notifications.
* Analytics & Research: Track health outcomes, provide data for public health planning, support clinical research.
* Accessibility & Inclusion: Disability support, rural healthcare optimization, elder care features.
* International Partnerships: Regional expansion across West Africa, medical tourism services, cross-border record sharing.

**5.5 Summary**

This chapter evaluated AksabCare and found that:

* The platform met all primary objectives, delivering AI guidance, telemedicine, e-pharmacy, hospital directories, and secure payments.
* It significantly reduces specialist costs, ensures drug authenticity, and complies with Nigerian and international regulations.
* Limitations include infrastructure gaps, regulatory complexity, and adoption barriers.
* A strong roadmap exists for future growth with mobile apps, advanced AI, expanded services, and international expansion.

Conclusion: AksabCare has shown that innovative digital health platforms can solve critical healthcare problems in developing countries. It stands ready for nationwide deployment in Nigeria and serves as a model for healthcare technology solutions across similar regions worldwide.

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**APPENDICES**

**Appendix A:** Source-Code Repository Structure

A screenshot of a computer

AI-generated content may be incorrect.

**Appendix B:** Prisma Database Schema (schema.prisma)

A screenshot of a computer

AI-generated content may be incorrect.

A screenshot of a computer

AI-generated content may be incorrect.

A computer screen shot of a program

AI-generated content may be incorrect.

A screenshot of a computer program

AI-generated content may be incorrect.

A screenshot of a computer program

AI-generated content may be incorrect.

**Appendix C:** Sample Email Templates

A screenshot of a computer screen

AI-generated content may be incorrect.

**Appendix D:** Deployment Guide (.env.example)

A screenshot of a computer

AI-generated content may be incorrect.

**Steps:**

1. git clone
2. npm install
3. npx prisma generate
4. npx prisma migrate deploy
5. npm run build
6. npm start

**Appendix E**: Key Mobile Interface Screenshots

* Landing Page (mobile)

A screenshot of a phone

AI-generated content may be incorrect.

* AI Guide Chat

A screenshot of a chat

AI-generated content may be incorrect.

* Doctor Directory

A screenshot of a chat

AI-generated content may be incorrect.

* Video Call UI

A screen shot of a computer

AI-generated content may be incorrect.

* E-Pharmacy Cart

A screenshot of a medical application

AI-generated content may be incorrect.