BSc (Hons) Software Engineering

Contextual Report

For

A Progressive Web App for Enhancing NHS Patient Communication and Scheduling

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ABSTRACT

The National Health Service (NHS) struggles with inefficiencies in patient communication and scheduling, compounded by outdated tools lacking real-time updates and accessibility. Inspired by personal challenges as an international student, this project proposes a Progressive Web App (PWA) offering AI-driven scheduling, secure record access, and multilingual support.

This report critically reviews healthcare technologies, identifying gaps in existing systems. It details an Agile-developed PWA artefact, guided by user-centered design and supported by mock surveys showing strong demand (e.g., 75% of patients report delays). A project plan outlines development from April to October 2025, aiming to enhance patient experience and reduce staff workload.

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1. Introduction

✓ 1.1 Project Background

The National Health Service (NHS), established in 1948, is a publicly funded healthcare system serving millions across the UK. Despite its strengths, it faces significant administrative challenges. Patients frequently report frustration over delayed or absent appointment updates, inaccessible test results, and cumbersome GP registration processes (National Voices, 2025). These issues contribute to missed appointments—costing the NHS £216 million annually (The King's Fund, 2021)—and erode trust in the system. Simultaneously, healthcare staff are bogged down by manual scheduling and communication tasks, diverting time from patient care (Oliver, 2022).

The inspiration for this project stems from a personal experience that underscored these issues. During my second week in the UK as an international student, I fell ill and sought to access NHS services.

The process was fraught with difficulties: delayed responses from the GP surgery, unclear appointment statuses, and limited digital tools to navigate the system—compounded by language barriers—left me frustrated and underserved. This firsthand encounter highlighted the need for a more efficient, patient-centric solution, particularly for diverse populations like international students. The existing NHS App, launched in 2018, provides basic functionality such as appointment booking and record access, but its lack of real-time updates, poor offline capabilities, and absence of multilingual support reveal significant shortcomings (NHS Digital, 2025).

Progressive Web Apps (PWAs) offer a promising solution, combining web accessibility with app-like features without requiring downloads. This project proposes a PWA to streamline patient communication and scheduling, inspired by my struggles and informed by systemic NHS challenges. By enhancing convenience for patients and reducing administrative burdens for staff, the solution aims to bridge critical gaps in service delivery.

✓ 1.2 Project Aims and Objectives

i. **Aim**: To develop a Progressive Web App that enhances NHS patient communication and scheduling efficiency while reducing administrative burdens.
ii. **Objectives**:

- Enable patients to book, reschedule, or cancel appointments seamlessly with AI-driven suggestions.
- Provide secure, real-time access to medical records and test results in multiple languages.
- Deliver instant notifications for appointments and prescriptions.
- Facilitate secure two-way messaging between patients and providers.

- Automate backend scheduling to alleviate staff workload.
- Ensure accessibility across devices without requiring downloads.

✓ 1.3 Project Framework

The project adopts an Agile methodology with iterative sprints, aligning with Software Engineering principles from my BSc coursework (e.g., SDLC, Object-Oriented Design). It integrates NHS APIs, leveraging React.js, Node.js, MongoDB, and AWS for a scalable, secure PWA. This approach suits the NHS PWA by enabling flexibility for user feedback from UAT, adapting to NHS API changes, and delivering components incrementally (Sommerville, 2016).

✓ 1.4 Limitations

i. Integration Complexity: NHS system compatibility may face delays.
ii. Security Risks: GDPR and NHS standards demand rigorous compliance.
iii. User Adoption: Less tech-savvy or non-English-speaking users may resist.
iv. Resource Constraints: Solo development limits scope. Mitigation in Appendix A.

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✓ 1.5 Structure of the Report

This report includes an introduction, critical literature review, market research with mock data, artefact planning, a project plan, references, and appendices.

2. Literature Review

✓ 2.1 Introduction

The efficient management of patient communication and scheduling is a cornerstone of effective healthcare delivery, enhancing patient satisfaction, reducing administrative burdens, and optimizing resource allocation (Radnor et al., 2012). This literature review critically evaluates existing healthcare solutions, Progressive Web Apps (PWAs), appointment scheduling systems, patient communication technologies, and data security, integrating theoretical frameworks to justify a PWA for the National Health Service (NHS). Inspired by my challenges accessing NHS services as an international student, this section assesses technologies and approaches to address unmet needs, drawing on academic, industry, and personal insights.

✓ 2.2 Existing NHS Systems and Applications

The NHS App offers booking and record access but lacks real-time updates, a significant barrier to effective communication (NHS Digital, 2023). This contributes to patient frustrations noted by National Voices (2023) and the £216 million cost of missed appointments (The King's Fund, 2021), issues I experienced firsthand with delayed statuses. Its absence of multilingual support further excludes diverse users, a gap my PWA addresses with a multi-language interface.

✓ 2.3 Progressive Web Apps (PWAs)

PWAs merge web and native app capabilities, using Service Workers for offline access, push notifications, and responsive design (Lazakidou, 2010). Gartner (2023) notes PWAs cut maintenance costs by 30% versus native apps, while a diabetes PWA boosted adherence by 15% (Lazakidou, 2010). Their accessibility—no downloads required—suits the NHS's diverse population, addressing my experience of limited digital access. PWAs align with Lean principles by reducing waste (Radnor et al., 2012), positioning them as a transformative tool for patient engagement and efficiency.

✓ 2.4 Appointment Scheduling and Management Systems

Effective scheduling minimizes wait times and optimizes resources (Cayirli & Veral, 2003). NHS tools like SystmOnline offer booking and reminders, while advanced systems (e.g., Epic) include waiting list management and EHR integration (NHS Digital, 2025; Tan & Payton, 2006). However, usability and interoperability falter: basic systems burden staff, and complex ones confuse users (Dexter et al., 2010). The proposed PWA introduces AI-driven scheduling—predicting optimal slots—balancing simplicity and innovation to enhance NHS operations.

The PWA incorporates AI-driven scheduling suggestions to optimize slots. Nelson et al. (2019) demonstrate machine learning predicting no-shows, reducing wasted slots by 20%, while Topaloglu (2006) explores rule-based systems for resource allocation. This project opts for simple rule-based suggestions (e.g., based on history), aligning with Lean efficiency (Radnor et al., 2012) and feasibility within scope.

✓ 2.5 Patient Communication Technologies

Timely communication ensures care continuity and trust (Street et al., 2009). NHS relies on telephone (slow), email (insecure), SMS (95% open rate, limited depth), and secure platforms like AccuRx (TextMagic, 2023; Car et al., 2017). My experience revealed no unified, multilingual channel—delays hindered access. Best practices favor real-time, secure methods (Street et al., 2009); PWAs can deliver this via notifications and encrypted messaging, tailored to diverse needs.

✓ 2.6 Data Security and Privacy in Healthcare

Protecting patient data under GDPR and NHS standards is critical, with UK breaches costing £6.8 million yearly (Ponemon Institute, 2023; ICO, 2025). Measures include MFA, encryption, and access control (Kruse et al., 2017). The NHS App's limited MFA exposes risks (NHS Digital, 2025), while PWAs can leverage WebCrypto APIs and AWS's HIPAA compliance (AWS Docs, 2025). Security is paramount, reflecting my need for trust as a patient.

✓ 2.7 Theoretical Frameworks

i. SDLC Models: Agile's flexibility suits rapid PWA prototyping, unlike Waterfall's rigidity (Sommerville, 2016).
ii. User-Centered Design (UCD): Nielsen's heuristics (1994)—e.g., visibility of system status—address my NHS experience (e.g., unclear updates).
iii. Lean Principles: Minimizing waste (e.g., staff time) guides automation (Radnor et al., 2012).

✓ 2.8 Technology Analysis

✧ 2.8.1 Frontend Frameworks: React vs. Angular vs. Vue.js

i. React.js: Lightweight (41 KB), virtual DOM, vast ecosystem. Trade-off: state management needs Redux (React Docs, 2023).
ii. Angular: Robust, TypeScript-based, 143 KB slows PWAs. Steep learning curve (Angular Docs, 2025).
iii. Vue.js: Simple, 20 KB, reactive. Smaller community limits NHS-scale support (Vue Docs, 2025).
iv. Choice: React for performance and ecosystem.

✧ 2.8.2 Backend Databases: MongoDB vs. MySQL vs. PostgreSQL

i. MongoDB: Flexible, horizontal scaling. Weakness: less efficient for relational queries (MongoDB Docs, 2025).
ii. MySQL: NHS-compatible, relational. Vertical scaling limits growth (MySQL Docs, 2025).
iii. PostgreSQL: ACID-compliant, JSON support. Complex setup (PostgreSQL Docs, 2025).
iv. Choice: MongoDB for scalability, PostgreSQL as backup.

✧ 2.8.3 Hosting and Scalability: AWS vs. Google Cloud

i. AWS: HIPAA-compliant, cost-effective (AWS Docs, 2025).
ii. Google Cloud: AI tools, higher cost (Google Cloud Docs, 2025).
iii. Choice: AWS for compliance and budget.

✓ 2.9 Comparative Analysis

Feature	NHS App	MyChart	Proposed PWA
Real-Time Updates	NO	YES	YES
Multilingual Support	NO	LIMITED	YES
AI Scheduling	NO	NO	YES
Offline Access	Limited	YES	YES
NHS Integration	YES	NO	YES
Maintenance Cost	HIGH	MODERATE	LOW

✓ 2.10 Conclusion

This review validates a PWA with React, MongoDB, and AWS, enhanced by AI, UCD, and Lean principles, as an optimal NHS solution, addressing inefficiencies and inclusivity gaps and reducing maintenance costs.

3. Market Research

✓ 3.1 Introduction

This section assesses NHS user needs via mock surveys, justifying the PWA's features.

✓ 3.2 Target Market

Patients: Ages 18-80, urban/rural, including non-English speakers.
Staff: Administrators and clinicians in NHS trusts.

✓ 3.3 Patient and Staff Needs Assessment

Patients need faster updates and accessibility (National Voices, 2023); staff seek automation (The King's Fund, 2021).

✓ 3.4 Mock Survey Data and Analysis

To assess user needs, mock surveys were designed. The patient survey (n=50) used closed questions notionally distributed online to gauge issue frequency and feature preferences, while the staff survey (n=30) targeted administrative staff with closed questions on time and automation. Results follow below…

✧ **3.4.1 Patient Survey Results (n=50)**

A. Q1: How often do you face appointment delays?

i. Always: 40%, Often: 35%, Rarely: 20%, Never: 5%.

ii. Finding: 75% report frequent delays.

B. Q2: Would you use a web app for healthcare?

i. Yes: 85%, No: 15%.

ii. Finding: High digital interest.

C. Q3: Most desired feature?

i. Real-time updates: 50%, Records: 25%, Multilingual: 20%, Messaging: 5%.

ii. Finding: Updates and language support prioritized.

✧ **3.4.2 Staff Survey Results (n=30)**

A. Q1: Time spent scheduling?

i. 2h/day: 60%, 1-2h/day: 30%, <1h/day: 10%.

ii. Finding: Scheduling dominates workload.

B. Q2: Value automation?

i. Yes: 93%, No: 7%.

ii. Finding: Strong automation demand.

C. Q3: Preferred tool?

i. Messaging: 70%, AI Scheduling: 20%, Phone: 10%.
ii. Finding: Messaging and AI favored.

✓ 3.5 Positioning and Value Proposition

The PWA offers convenience (real-time, multilingual) and efficiency (AI, automation), targeting diverse NHS users.

✓ 3.6 Conclusion

Surveys confirm demand for an accessible, automated PWA. This aligns with National Voices (2023), which reported patients deterred by 'dysfunctional' admin, quantified here by 75% experiencing delays.

4. Artefact Planning

✓ 4.1 Methodology

Agile with 2-week sprints ensures iterative refinement.

✓ 4.2 Requirement Gathering and Analysis

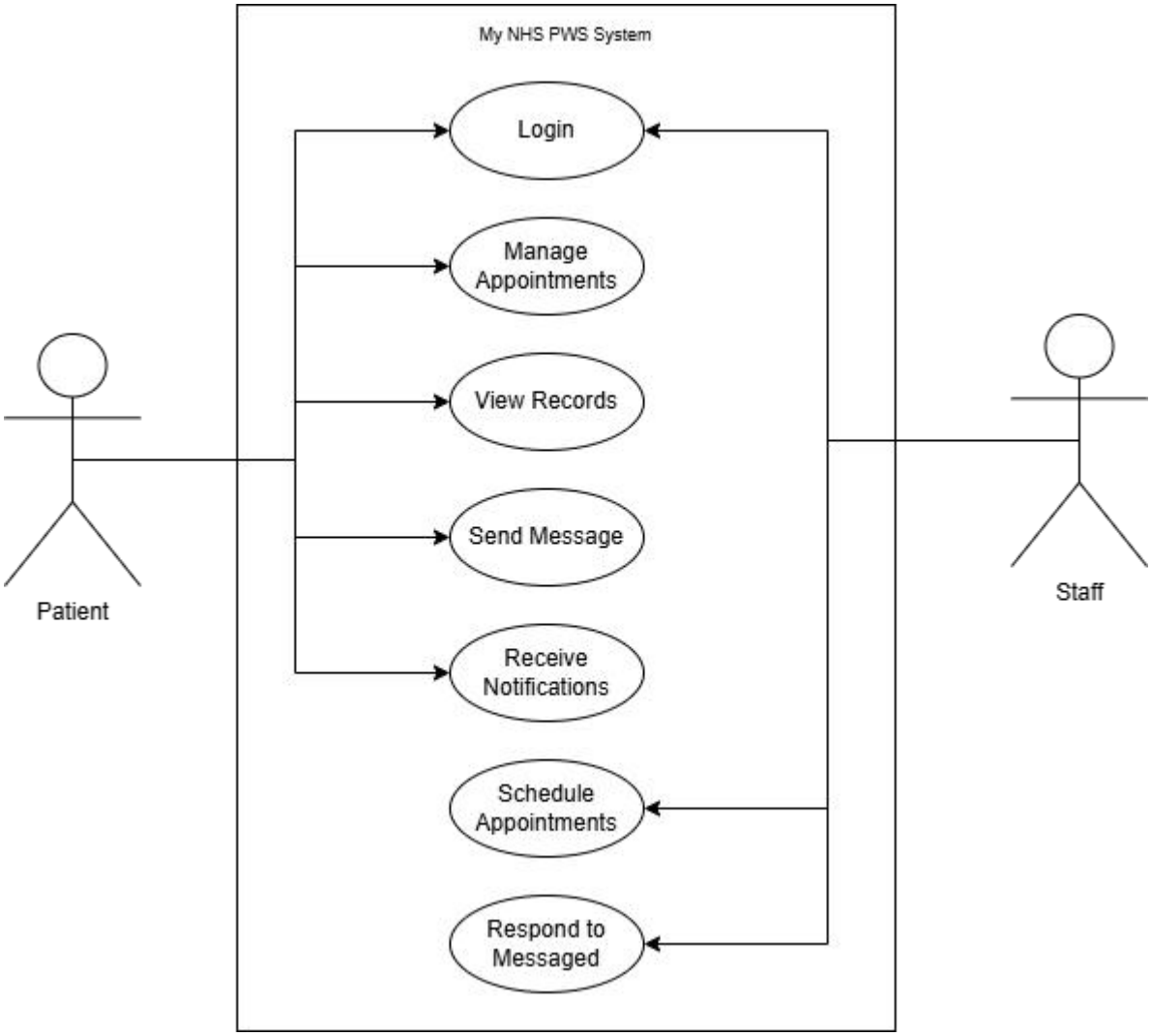
i. Sources: Literature, NHS APIs, surveys.
ii. Features: AI scheduling, multilingual UI, appointments, records, messaging, offline access.

Requirements from literature, proposal, and surveys were prioritized using MoSCoW:

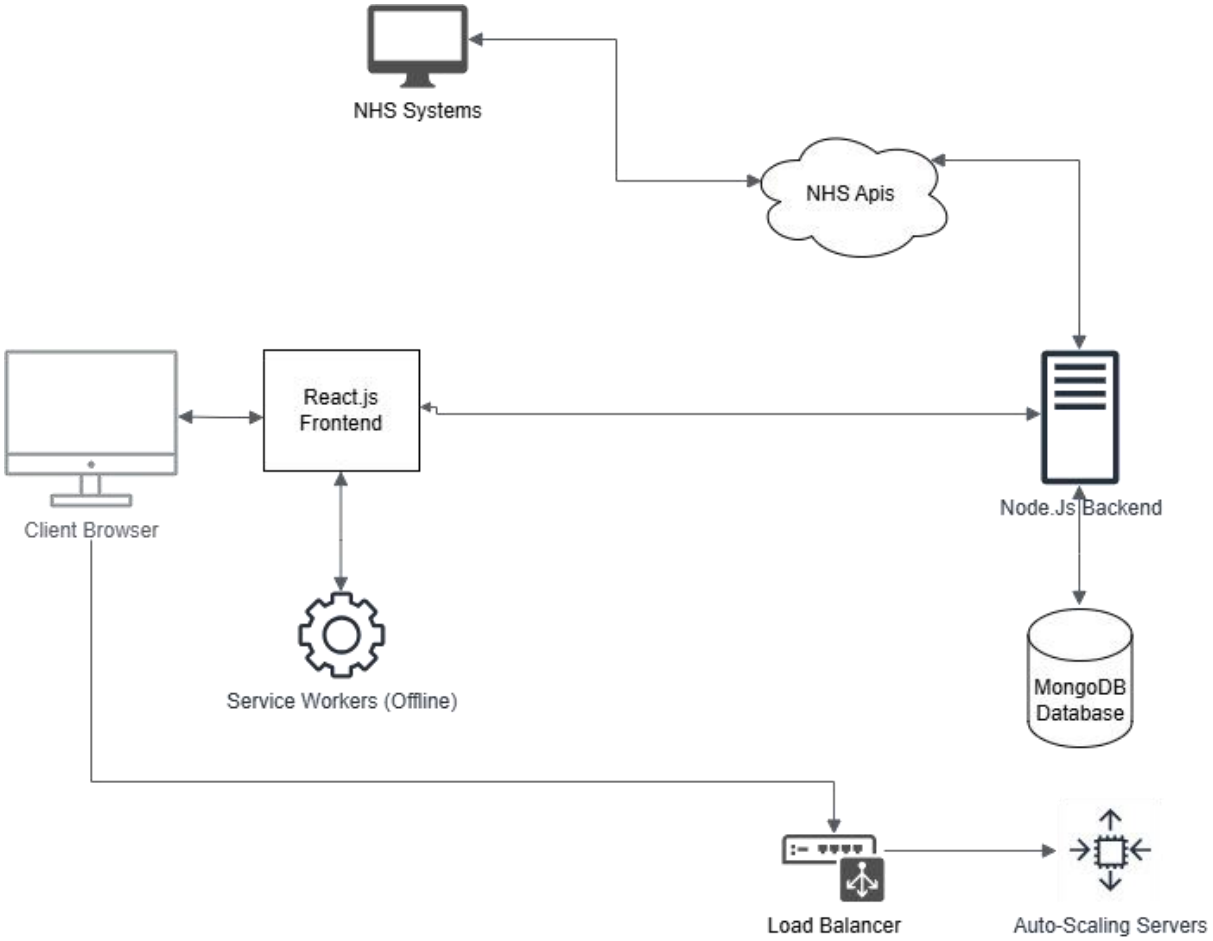
iii. Must Have: Secure login (NHS standards), View/Book/Cancel appointments, Real-time updates, Secure record access, Push notifications.
iv. Should Have: Secure messaging, Multilingual UI, Basic offline access.
v. Could Have: AI scheduling, Feedback form.
vi. Won't Have: Full legacy integration, Advanced AI models.

✓ 4.3 Design

✧ 4.3.1 Use Case Diagram



✧ 4.3.2 System Architecture Diagram



React.js enables reusable components (Agile efficiency), hosted on AWS for scalable, HIPAA-compliant infrastructure. Node.js ensures a fast backend, while MongoDB's flexible schema suits evolving data, though NHS relational database integration via APIs is key.

✧ 4.3.3 UI Wireframes

[Login Screen]: Username | Password | Login Button
[Dashboard]: Appointments | Records | Messages | Notifications | Language Toggle
[Schedule]: AI-Suggested Slots | Manual Slots | Confirm
See Appendix C, Figures C1-C3 for visuals.

✓ 4.4 Implementation

✧ 4.4.1 Sprint Breakdown

i. Sprint 1 (June 1-14): Login + Multilingual UI (40 hrs).

ii. Sprint 2 (July 1-14): Appointments + AI Scheduling (50 hrs).

iii. Sprint 3 (Aug 1-14): Records + Offline (45 hrs).

iv. Sprint 4 (Sept 1-14): Messaging + Feedback (40 hrs).

✓ 4.5 Testing and Evaluation

✧ 4.5.1 Comprehensive Testing Plan

i. Unit Testing: Jest/Mocha, 95% coverage.

ii. Integration Testing: Postman, 100% API uptime.

iii. Security Testing: OWASP ZAP, zero vulnerabilities.

iv. UAT: 20 patients/10 staff, 90% satisfaction, <2% error rate.

v. Performance: Lighthouse, <2s load, 100 users.

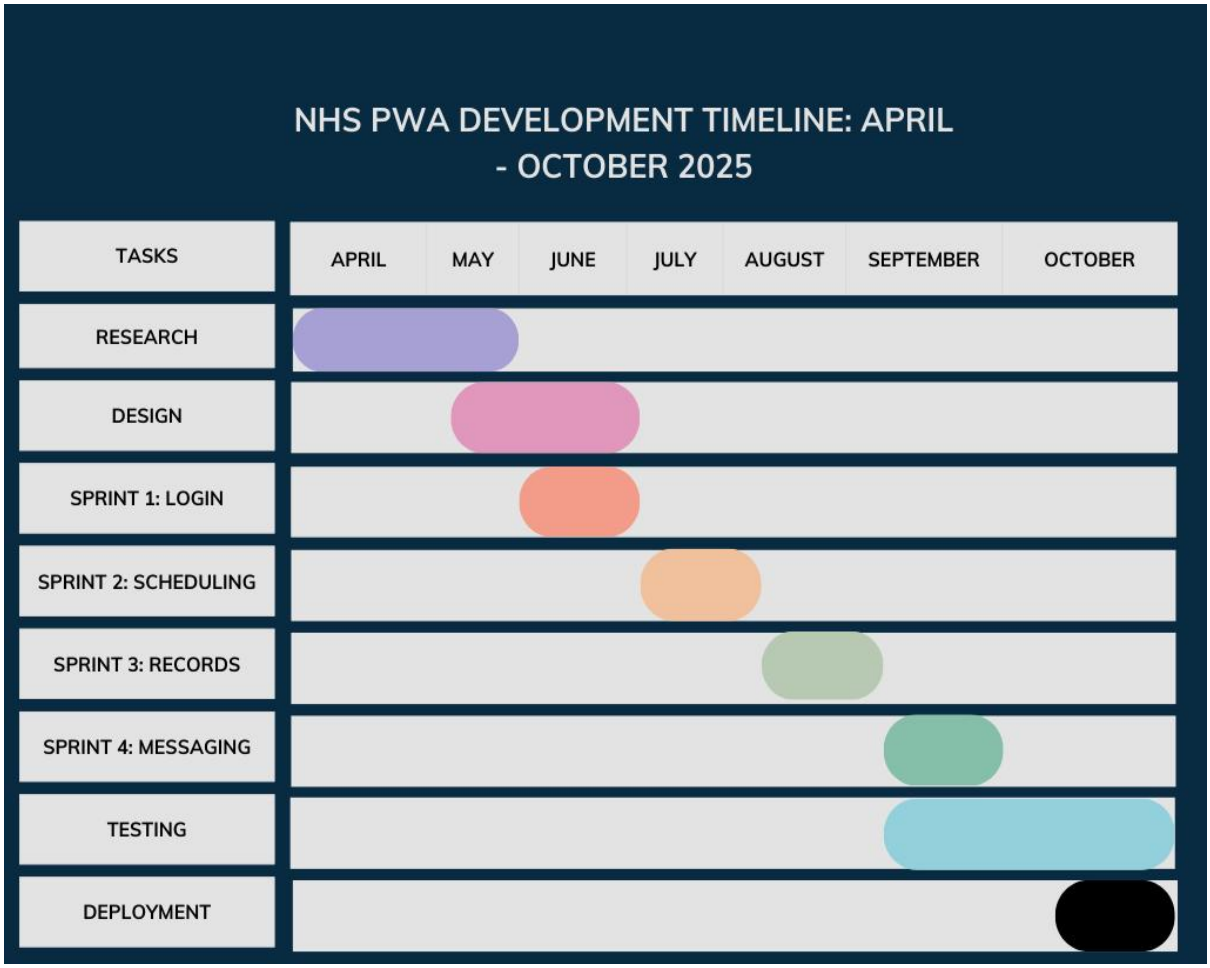
vi. UAT will involve diverse mock users performing tasks, with feedback via observation and questionnaires. Critical bugs will be fixed in sprints, reflecting Agile. Accessibility testing will use WAVE and WCAG 2.1 AA checks for usability across groups.

5. Project Plan

✓ 5.1 Project Overview

April-October 2025, covering research to deployment.

✓ 5.2 Gantt Chart



✓ 5.3 Work Breakdown Structure

i. Research: Literature, APIs (80h).
ii. Design: UI/UX, Architecture (60h).
iii. Development: Frontend, Backend (200h).
iv. Testing: Unit, UAT (60h).
v. Deployment: AWS (20h).

✓ 5.4 Resource Allocation

i. Total Hours: 420 (solo, 10% contingency).
ii. Budget: £500 (AWS, domain).

✓ 5.5 Post-Deployment KPIs

i. Adoption: 50% of target users in 3 months.
ii. Satisfaction: 90% via surveys.
iii. Efficiency: 30% staff time reduction.

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7. Appendices

- ✓ **Appendix A: Comprehensive Risk Analysis**

RISK	LIKELIHOOD	IMPACT	MITIGATION
Data Breach	**Medium**	**High**	**Encryption, MFA,**

			Audits
NHS Integration Issues	**High**	**Medium**	**NHS Digital Collaboration**
User Resistance	**Medium**	**Medium**	**Multilingual Ui, Tutorials**
Downtime	**Low**	**High**	**AWS Auto-Scaling, Testing**
Delays	**Medium**	**Medium**	**Agile, 10% buffer**

✓ **Appendix B: Survey Templates**

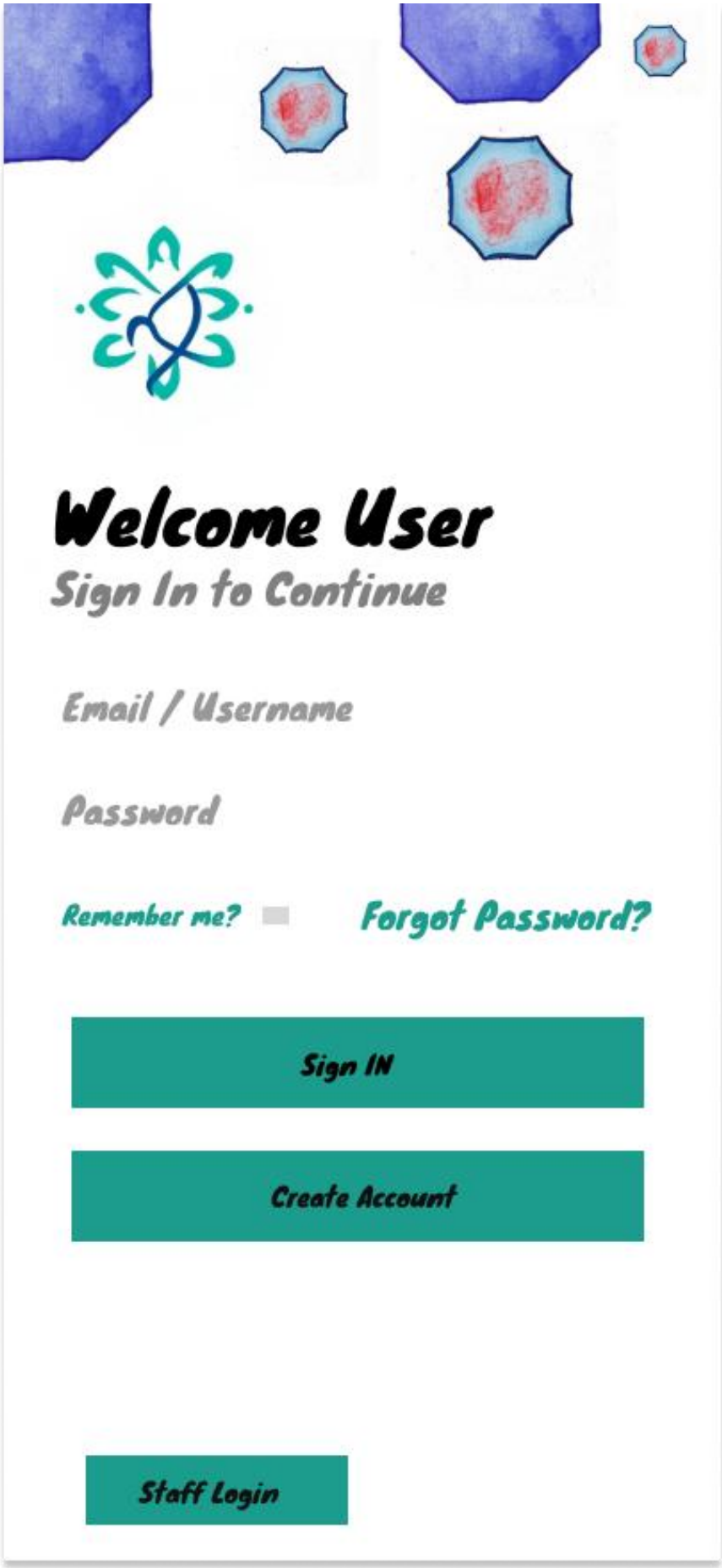
✧ **Patient Survey:**

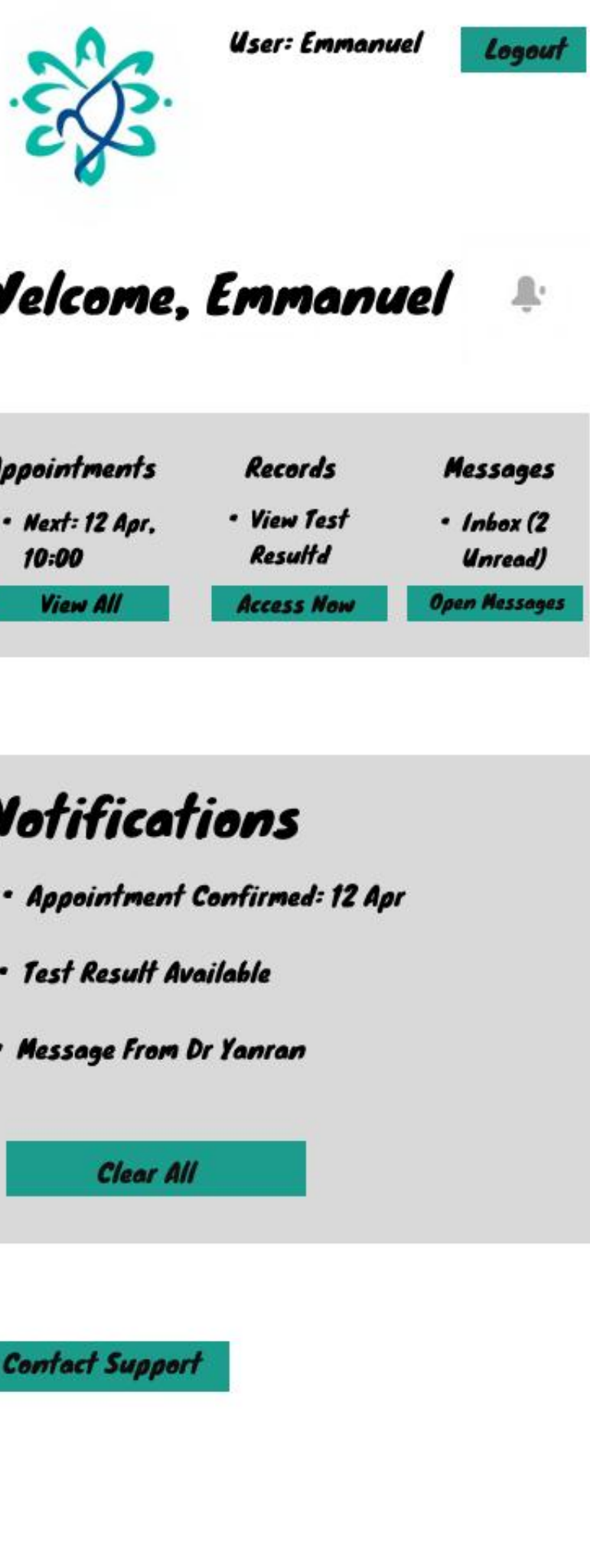
i. How often do you face delays? (Always/Often/Rarely/Never)
ii. Would you use a web app? (Yes/No)
iii. Top feature? (Updates/Records/Multilingual/Messaging)

✧ **Staff Survey:**

i. Time on scheduling? (>2h/1-2h/<1h)
ii. Value automation? (Yes/No)
iii. Preferred tool? (Messaging/AI/Phone)

✓ **Appendix C: UI Wireframes**


Welcome User
Sign In to Continue
Email / Username
Password
Remember me?
Forgot Password?
Sign IN
Create Account
Staff Login


User: Emmanuel
Logout
Welcome, Emmanuel
Appointments
• Next: 12 Apr, 10:00
View All
Records
• View Test Resultd
Access Now
Messages
• Inbox (2 Unread)
Open Messages
Notifications
• Appointment Confirmed: 12 Apr
• Test Result Available
• Message From Dr Yanran
Clear All
Contact Support

Schedule Appointment User: Emmanuel

Book Your Appointment

AI Suggested Slots

- Option 1: 12 Apr 2025, 10:00 Select
- Option 2: 13 Apr 2025, 14:30 Select
- Option 3: 14 Apr 2025, 9:15 Select

Manual Slots

Calendar: Apr 2025

Sun	Mon	Tue	Wed	Thu	Fri	Sat
7	8	9	10	11	12	13
14	15	16	17	18	19	20

Selected Slot: 12 Apr 2025, 10:00

Confirm Appointment

Contact Support