**A Web-based Patient Scheduling and Priority Management System**

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# Declaration and Approval

We declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of our knowledge and belief, the research proposal contains no material previously published or written by another person except where due reference is made in the research proposal itself.

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# Abstract

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# List of Abbreviations

# Introduction

## Background Information

Kenya’s health system is organized into six levels, from community health services (level 1) up to national referral hospitals (level 6), with most outpatient care delivered at dispensaries, clinics, health centres (levels 2–3), and sub-county or county hospitals (levels 4–5) (Republic of Kenya MoH, 2014). Despite this structured framework, clinics routinely struggle with inefficient scheduling, unpredictable practitioner availability, and long waiting times (Njoroge et al., 2021). The combination of these factors means planned appointments overlap and delays compound as the day progresses (Njoroge et al., 2021). Without an efficient system to manage overlaps and communicate changes, clinics find it difficult to maintain an orderly patient flow (Karanja et al., 2019). By focusing on coordinating operations within outpatient clinics, this study addresses a core operational challenge in Kenya’s public health sector.

There are several factors that contribute to this situation, with the first one being unpredictable doctor availability. A doctor may fail to attend an appointment due to unforeseen circumstances or a doctor’s strike, leaving patients stranded and forced to return without any assistance (Keats et al., 2022). Second, the existing manual or semi-digital systems lack the flexibility to prioritize patients such as the chronically ill and the elderly or manage overlaps through built-in buffers (Karanja et al., 2019). Third, emergency cases disrupt the schedule of the day, forcing other appointments to start late. In Kenya, Emergency Departments often receive patients with life-threatening conditions. However, most Kenyan EDs operate without a standardized triage protocol, leading to inconsistent assessment and prioritization of patients (Wachira & Martin, 2011). Only 17% of patients arrive by ambulance. The majority rely on public transport, increasing the likelihood of delays or missed appointments altogether (Musyoka & Kioko, 2021; Broccolli et al., 2015). Without a proper triage system, critically ill patients may be left waiting in the queue, increasing their risk of mortality. \*add process of how patients get to see the doctors

These scheduling inefficiencies don’t exist in isolation — they have ripple effects across the entire healthcare ecosystem. Vulnerable patients such as the elderly and children are most at risk. In Homa Bay and Kisumu Counties, antenatal clinics reported missed appointment rates of 42% and 35% in 2019; of those, 78% in Homa Bay and 70% in Kisumu cited long waiting times as the primary reason for defaulting on scheduled appointments (Opon et al., 2020). Families must deal with the extra financial and emotional burdens as they travel to and from clinics. In one survey of low-income Kenyan families, 86% of clinic-visiting patients incurred expenses averaging Ksh 143 per trip, which represents up to a week’s wages for many (Munge & Briggs, 2020). Caregivers of children with tuberculosis in Kenya faced average household costs of USD 120 for non-medical needs, with half reporting catastrophic expenditures just to access free services (Barasa et al., 2017). Healthcare workers also face higher workloads as they attempt to manage overcrowded waiting rooms and make on-the-spot triage decisions. In Western Kenya, 61% of maternal care providers identified high workload as their top stressor (Namusonge et al., 2022). Failure to solve these problems leads to a chain of other issues that affect the entire health system. Patients who miss their scheduled appointments risk delayed detection of complications and interrupted treatment plans. Families end up spending more on travel and missing work just to keep appointments, pushing them further into poverty, and healthcare workers under constant stress face a higher risk of mistakes and fatigue.

Previous efforts such as the 2011–2017 Kenya National eHealth Strategy and the 2016–2030 National eHealth Policy have laid a foundation for electronic health records and mobile health platforms (Republic of Kenya MoH, 2011; Republic of Kenya MoH, 2016). Researchers in Western Kenya found that, while many level 3 and level 4 facilities now have basic e-health services in place, these systems rarely go beyond electronic record-keeping or simple apportionment calendars; they do not dynamically tag high-risk groups such as the elderly, perform real-time triage, or absorb schedule disruptions with buffer slots (Karanja et al., 2019). Studies of electronic queue-management systems (EQMS) at Premier Hospital in Mombasa demonstrated modest improvements in patient satisfaction and reduced average wait times by 15%, but the systems did not integrate clinician availability or emergency prioritization, limiting their impact during sudden patient surges (Muturi & Kamau, 2021). Despite these advances, no current platform in Kenya offers a unified, web-based interface that ensures predictable doctor availability, allows real-time tagging and re-prioritization of patients by emergency status, and manages dynamic queue buffers for inevitable delays. This project proposes a focused web-based application to coordinate operations in a clinic.

## Problem Statement

The current outpatient scheduling in Kenyan Clinics fails to guarantee timely care: patients check in only to face unpredictable doctor availability and long waiting periods. A study at the University of Nairobi staff clinic found that the average outpatient waiting time was around fifty-five minutes; fifty two percent of respondents cited “improving staff availability” as the key way to reduce waiting time (Mwangi et al., 2024).

When patients face long wait times, they often miss or arrive late for their appointments, struggle to follow through treatment plans and delay starting their care. A study at Aga Khan University Hospital, Nairobi, found that fifty one percent of outpatients waited 31 to 60 minutes and 25.4% waited over an hour before seeing a provider (Patel el al., 2025).

If left unchecked, these pending appointments increase burden on administration, increase patient mortality rates especially for the elderly or chronically ill patients who miss critical treatment windows. A third delay analysis in Kenyan secondary-level public hospitals demonstrated that suboptimal patient flow management, inadequate continuity of care resources, and scheduling inefficiencies directly contributed to delays starting essential treatments, compounding risks for time-sensitive conditions (Mathenge & Ochieng, 2023).

## Aim/ Specific Objectives

To develop a web-based application to coordinate operations in a clinic that optimizes patient scheduling, enhances queue management and improves service delivery in outpatient healthcare settings.

### Specific Objectives

1. To assess factors influencing operational efficiency in outpatient clinic settings.
2. To review existing appointment management solutions and identify their strengths and weaknesses.
3. To implement SMS-based reminders and notifications for patients regarding appointments and schedule changes.
4. To design a web-based application that supports real-time doctor availability tracking, patient priority tagging and dynamic queue buffering.

### Research Questions

1. What are they key operational challenges affecting scheduling and patient flow in Kenyan outpatient clinics.
2. What limitations exist in the current appointment management systems used in clinics?
3. How can digital solutions be used to prioritize patients based on urgency and vulnerability?
4. How effective is a web-based application in reducing waiting times and improving coordination in clinical operations?

## Justification

This project addresses a key challenge in Kenyan clinics: long delays caused by inflexible appointment systems. A dedicated priority scheduling system will benefit:

* + 1. Patients by cutting wait times especially for the elderly and emergency cases.
    2. Clinics and doctors will experience smoother daily operations, fewer missed appointments and better use of their time.
    3. Health regulators and policymakers will obtain accurate data on booking trends to inform staffing levels and infrastructure planning.

## Scope

The system will provide modules for patient profile management, automated appointment booking with dynamic queue prioritization, SMS confirmation and update notifications anda rel-time administrative dashboard

The system will not include clinical functionalities such as medical diagnosis, e-prescription and integration with national health information systems.

## Limitations

Anticipated challenges include user resistance to adopt new digital workflow and limited access to real-time data from hospitals for testing.

## Delimitation

To address these limitations, the application will be user friendly with an intuitive administrative dashboard and the project will use simulated datasets that reflect typical hospital appointment flows, patient categories and doctor availability scenarios.

# Literature Review

## Introduction

This chapter reviews the existing literature on outpatient scheduling and queue management in clinics. It begins by describing the current appointment processes and contextual factors, then examines the key challenges that affect efficient patient flow. Next, three representative systems are reviewed to understand their designs, strengths, and limitations. From the review of the existing systems, we identify the gaps present in current approaches. Finally, we look at the technologies commonly used in related solutions and present a conceptual framework that situates our proposed web-based scheduling and priority-management system within the broader health‐care context.

## Current Processes / Pipelines / Existing Technologies

Appointment scheduling in many Kenyan clinics typically relies on manual or semi-digital methods such as paper registers to record patient bookings and staff rosters (Karanja et al., 2019). The staff at the front-desk enter patient details into a daily log, assign timeslots based on clinician availability, and provide a written or printed appointment slip. Patients are expected to arrive at their allocated times, but there is no built-in mechanism to adjust for late arrivals.

Our study focuses on outpatient booking for non-emergency consultations. In this process, clerks allocate 25-minute slots, often without buffers for delays or emergencies (Muturi & Kamau, 2021). Clinicians manually update their availability at the start of each day. If appointments run over their allocated time or a doctor is unexpectedly absent, subsequent patients are left waiting.

Guidelines from the World Health Organization recommend that patients should not wait more than 30 minutes for consultation (WHO, 2010). Policies from the Ministry of Health in Kenya similarly recommend timely service (MoH, 2016). In reality, however, the average wait times exceed one hour at major hospitals (Catherine, 2019). The gap between expectation and actual performance stems from inflexible scheduling, lack of real-time clinician updates, and absence of automated reminders—all deficiencies this research aims to address.

## Challenges in Appointment and Queue Management

### Deficiencies and their origin

Key deficiencies include (a) high rates of missed appointments due to lack of reminders, (b) compounding delays when one appointment overruns, and (c) absence of real-time visibility on doctor availability (Seif et al., 2025). These arise from reliance on manual record-keeping, limited IT infrastructure, and lack of dynamic scheduling algorithms.

### Impact on Clinic Operations

When appointments overlap, patients experience long waits, staff frustration increases, and the throughput of a clinic declines. Vulnerable groups such as the elderly or chronically ill are heavily affected, often waiting hours beyond their scheduled time (Opon et al., 2020). Extended waits also lead to missed follow-up visits and treatment interruptions.

### Consequences

Unaddressed, these issues contribute to poorer health outcomes, increased operational costs, and patient dissatisfaction. Some clinics have experimented with SMS reminders to reduce the rate of missed appointments, reporting up to a 20 % improvement (Muturi & Kamau, 2021), but these efforts have not been integrated with real-time scheduling or priority tagging.

## Related Works

### Premier Hospital EQMS

Premier Hospital in Mombasa deployed an Electronic Queue-Management System (EQMS) in 2019 to digitize check-in and notify patients via SMS when their turn approached (Muturi & Kamau, 2021). Patients register on arrival; the system calculates an estimated wait time and sends a text reminder before their consultation. It uses PHP backend, MySQL database, and a third-party SMS API. Though it addressed the long wait times and congested waiting areas, it lacks integration with clinician schedules and cannot reprioritize for emergencies or high-risk patients.

### I-Clinic mHealth Platform

i-Clinic is a mobile-first platform piloted in Kilifi County that allows patients to book appointments via USSD or smartphone app (Wachira et al., 2021). USSD menus guide patients through booking, and confirmation codes are stored on the device. SMS reminders are sent 24 hours prior. It uses USSD gateway, Laravel PHP framework, and PostgreSQL. It addressed the low literacy and limited smartphone penetration, but it has no administrative dashboard; staff must manually reconcile USSD bookings with paper logbooks.

### OpenMRS Appointment Module

OpenMRS, an open-source electronic medical record system used in several Kenyan facilities, includes an appointment module that supports basic booking and reminders (OpenMRS Community, 2020). Clinicians and clerks share a unified patient record; appointment details are stored alongside clinical data. SMS reminders can be configured via plug-ins. It addressed fragmented record-keeping across departments, but its configuration is complex; no built-in priority-tagging or buffer management.

## Gaps in Related Works

Although each system offers improvements, none simultaneously provides real-time clinician availability updates to prevent booking conflicts, dynamic priority tagging for elderly, chronic, or emergency cases, automated buffer-slot insertion to absorb overruns without compounding delays, integrated administrator dashboard for end-to-end visibility of patient flow and service metrics.

## Technology to be used

Our system will leverage the following technologies:

• SMS Gateway for appointment confirmations and reminders.

• Web frontend built with HTML, CSS, and JavaScript to ensure compatibility on desktops and tablets.

• PHP with AJAX for asynchronous updates of clinician availability and queue status.

• MySQL for relational data storage of patients, appointments, and priorities.

# Methodology

## Introduction

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## Applied Development Approach

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## System Analysis

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## System Design

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# References

# Appendix

## Appendix 1: Gantt Chart