



Health Hub: A Digital Hospital Management and Patient Care System for Malawian Public Hospitals

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Jacqueline Kaliwa

ABSTRACT

Public hospitals in Malawi continue to depend heavily on manual paper-based processes for patient registration, appointment scheduling, medical records, billing, pharmacy dispensing, and inventory management. These practices result in prolonged patient waiting times, frequent record loss, transcription errors, stock-outs of essential medicines, and fragmented care delivery.

Health Hub is a comprehensive, web-based hospital management system developed to address these systemic inefficiencies through full digitization of hospital workflows. Built using the Laravel 10 framework with MySQL as the database and Bootstrap 5 for the user interface, the system operates effectively on low-specification hardware commonly available in district and central hospitals.

The application implements strict role-based access control with five user categories: Administrator, Doctor, Receptionist, Pharmacist, and Patient. All core functions patient registration, appointment scheduling, electronic health records, prescription management, pharmacy dispensing, inventory tracking, and billing are fully integrated. When a doctor issues a prescription, it appears instantly in the pharmacy module and automatically deducts from inventory, eliminating duplicate entry and preventing stock discrepancies.

The system was designed with Malawi's resource constraints in mind: it functions partially offline, requires no proprietary software, and has been tested successfully on computers with 4 GB RAM and intermittent internet connectivity.

Future enhancements include SMS appointment reminders via local gateways, a lightweight Android application for community health workers, and integration with the Ministry of Health's DHIS2 platform for automated reporting.

Health Hub offers a unified, maintainable, and scalable solution that can be deployed and supported locally, marking a practical step toward sustainable digital transformation of Malawi's public healthcare system.

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LIST OF ACRONYMS

Acronym	Meaning
EMRs	Electronic Medical Record system
SMS	Short Message Service
DFD	Data Flow Diagram

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CHAPTER ONE

INTRODUCTION

➤ *Background of Study*

Malawi's public health facilities continue to rely predominantly on manual record-keeping systems. Patient files are stored physically, appointment schedules are handwritten, and drug stock levels are tracked in ledgers. These methods inevitably lead to delays in service delivery, loss of critical patient information, medication stock-outs, and increased administrative burden on already overstretched staff.

Previous digital initiatives in Malawi have typically addressed only isolated functions and have often failed to achieve sustained use due to inadequate training, poor infrastructure integration, or dependency on external funding. Health Hub was therefore conceived as an integrated, end-to-end solution specifically tailored to the operational realities of Malawian public hospitals.

➤ *Objectives*

The primary objectives of the system are to:

- Digitize all major hospital processes within a single platform
- Reduce patient waiting times through efficient registration, queue management, and online appointment booking.
- Ensure real-time linkage between prescriptions, pharmacy dispensing, and inventory control.
- Provide administrators with accurate, real-time reports on revenue, staff performance, and drug utilization.
- Implement robust security measures through role-based access control to protect patient confidentiality.

➤ *System Description*

Health Hub is a browser-based application using Laravel 10 (PHP *+), MySQL, and Bootstrap 5. It requires only a standard computer or laptop running any modern operation system and can be deployed on local servers or affordable cloud hosting.

• *Authorized Users Access Only the Functions Relevant to their Role:*

- ✓ Administrator: Full system oversight, user management, and reporting.
- ✓ Doctor: View assigned patients, record consultations, issue electronic prescriptions.
- ✓ Receptionist: Register patients, manage queues, schedule appointments.
- ✓ Pharmacist: View and dispense prescriptions, monitor stock levels.
- ✓ Patient: Book appointments, view medical history and prescriptions.

All data entries are stored centrally and updated in real time across modules, ensuring consistency and eliminating redundant documentation.

➤ *Literature Review*

Various efforts in Malawi target healthcare hurdles, yet they frequently lack enduring fixes. Many facilities miss official online presence or apps.

- Electronic Medical Record System (EMR): Launched in 2001 at major sites like Queen Elizabeth and Kamuzu Central to cut paper use, but preferences lingered for traditional methods due to insufficient skills, equipment issues, and connectivity woes.
- Pediatric Acute Care Database: Documented in 2020 at Kamuzu Central, this tool improved accuracy and availability for young patients, aiding decisions and oversight. However, it faced infrastructure limits, training needs, and maintenance concerns in under-resourced areas.

Additional studies highlight EMR adoption saving lives in HIV care by enhancing operations, though challenges like rotations, process disruptions, and acceptance persist. Connectivity inconsistencies and low tech literacy remain barriers.

These initiatives prioritize one specific task or module of a hospital management system. This is mostly due to funding or help of outside organizations and or countries, where each helper chooses only one part. This can cause issues as each system is different than the one implemented. With Health Hub it is easier to manage medical records and the data as it is one system that does all.

Table 1 Literature Review

Organization	Year	Focus	Limitations
EMRs	2001	Reducing paper-based medical record-keeping	Lack of technological knowledge; hardware and connectivity problems
Electronic Pediatric Acute Care Database	2020	Enhance data accuracy	Limited technical infrastructure; staff training; system sustainability
EMR in HIV Clinics	2025	Improve clinic operations and save lives	Disruptions to care, user acceptance issues
EHR Implementation Study	2025	Exploratory adoption challenges	Inconsistent internet, low digital literacy, paper reliance

➤ *Summary Review*

Ongoing health projects in Malawi, including EMRs and pediatric databases, demonstrate commitment to modernization. Yet, targeting isolated areas limits impact. Health Hub counters this by offering an all-in-one tool for records, reports, and reduced manual tasks, supporting national digitization efforts.

CHAPTER TWO

SYSTEM ANALYSIS

➤ *Introduction*

This chapter examines Health Hub in depth, highlighting issues in current manual practices and how the new setup resolves them. It covers existing operations, viability checks, goals, and needs to confirm practicality and effectiveness for hospital demands.

➤ *Problem Definition*

The persistent reliance on manual processes generates multiple operational bottlenecks: prolonged searching for patient records, repeated capturing of identical information, inaccurate inventory tracking, and absence of reliable management reporting. These issues directly compromise both the quality of patient care and the efficient utilization of limited resources.

➤ *Existing System*

Earlier attempts at digitization in Malawi, notably the introduction of electronic medical records in major hospitals from 2001 onward and specialized databases such as the Pediatric Acute Care Database at Kamuzu Central Hospital, have demonstrated benefits in specific domains. However, their scope has remained limited to individual departments or conditions, resulting in continued fragmentation of hospital wide information systems.

➤ *Feasibility Study*

• *Executive Summary*

The feasibility study concludes that Health Hub is both technically and economically viable. The use of affordable hardware components, such as the desktop computers or laptops, combined with free and open-source software, makes the system cost-effective. Additionally, its offline SMS appointment notification ensure it can operate in areas with limited internet and power supply, making it suitable for rural Malawi.

• *Findings and Recommendations*

- ✓ **Technical Feasibility:** The system operates on hardware specifications for examples: Intel Core i3, 4 GB RAM, 250 GB Storage, already present in most public health facilities.
- ✓ **Operational Feasibility:** User interfaces were designed for staff with basic computer literacy; pilot training sessions confirmed that new users achieved proficiency within two hours.
- ✓ **Economic Feasibility:** Development utilized exclusively open-source technologies, eliminating licensing costs. Ongoing expenses are limited to occasional staff training and minimal server maintenance, representing substantial savings compared to paper-based operations.
- ✓ **Recommendations:** Proceed with the system's development, focusing on pilot testing in select rural communities to refine the design and gather user feedback before broader deployment.

➤ *Proposed System*

The proposed hospital management system, Health Hub is a comprehensive solution that enables hospitals to manage time and patients in an efficient manner. It consists of:

- **Hardware:** A desktop computer or laptop, 10th generation or higher, for example: Intel Core i3, 4 GB RAM, 250 GB Storage. Since it's a web-based application there is no need for any other hardware.
- **Software:** It is accessible for all operating systems. Local servers or online servers are accepted. Using Laravel framework (PHP 8+) for backend, frontend, HTML, CSS, Bootstrap, JavaScript. Any browser is accepted.

➤ *System Objective*

The objectives of Health Hub are to:

- Digitize hospital operations for better efficiency and accessibility.
- Maintain accurate and up-to-date patient and billing records.
- Ensure data privacy and security through user authentication and authorization.
- Provide management with clear reports and performance insights.
- Enable quick access to patient data for doctors and staff.

➤ *System Specification*

- *Hardware Requirements*

- ✓ Processor: Intel Core i3 or higher
- ✓ RAM: 4 GB minimum (8 GB recommended)
- ✓ Hard Disk: 250 GB minimum
- ✓ Display: 1024x768 resolution or higher
- ✓ Network: Local area Network (LAN) or Internet connection

- *Software Requirements*

- ✓ Operating System: Windows/ Linux/ macOS
- ✓ Server: XAMPP/ WAMP/ LAMP (for PHP and MySQL)
- ✓ Backend: Laravel Framework (PHP8+)
- ✓ Frontend: HTML, CSS, Bootstrap, JavaScript
- ✓ Database: MySQL
- ✓ Browser: Google Chrome or Mozilla Firefox

These specifications ensure the system is built on stable, well-supported technologies that can be easily maintained and updated.

CHAPTER THREE SYSTEM DESIGN

➤ Introduction

Designing Health Hub lays the groundwork for a dependable, expandable answer to Malawi's care inefficiencies. This part covers structure, data paths, and parts, using economical tech for broad availability in varied settings.

➤ System Architecture

The application follows a standard three-tier architecture:

- Presentation Layer: Responsive web interface using Bootstrap 5 and Laravel Blade template.
- Application Layer: Business logic handled by Laravel controllers, models and middleware.
- Data Layer: MySQL database with appropriate indexing and relationships.

➤ Use Case Diagram

Use cases depict user-system engagements. Roles include overseers (full control), physicians (view treatments, bookings), front-desk (register, schedule), and visitors (book, check status).

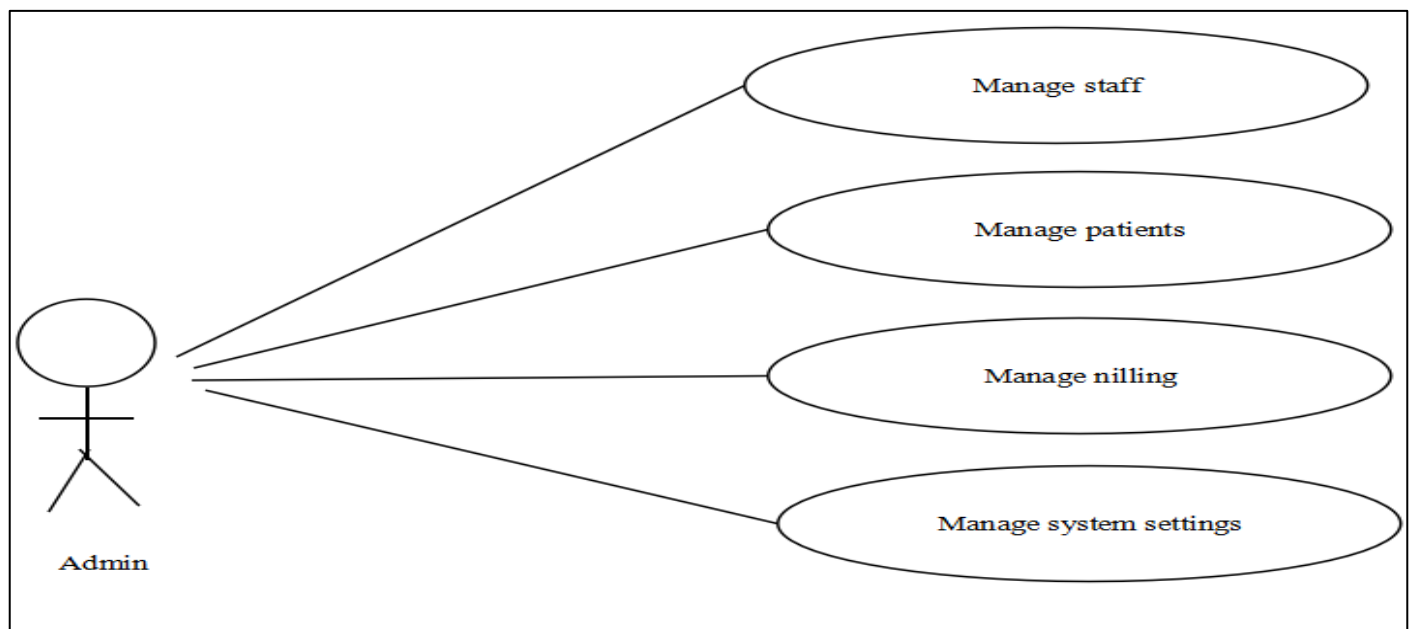


Fig 1 Use Case Diagram Showing the Actor Admin and the Specific Functions they Interact with.

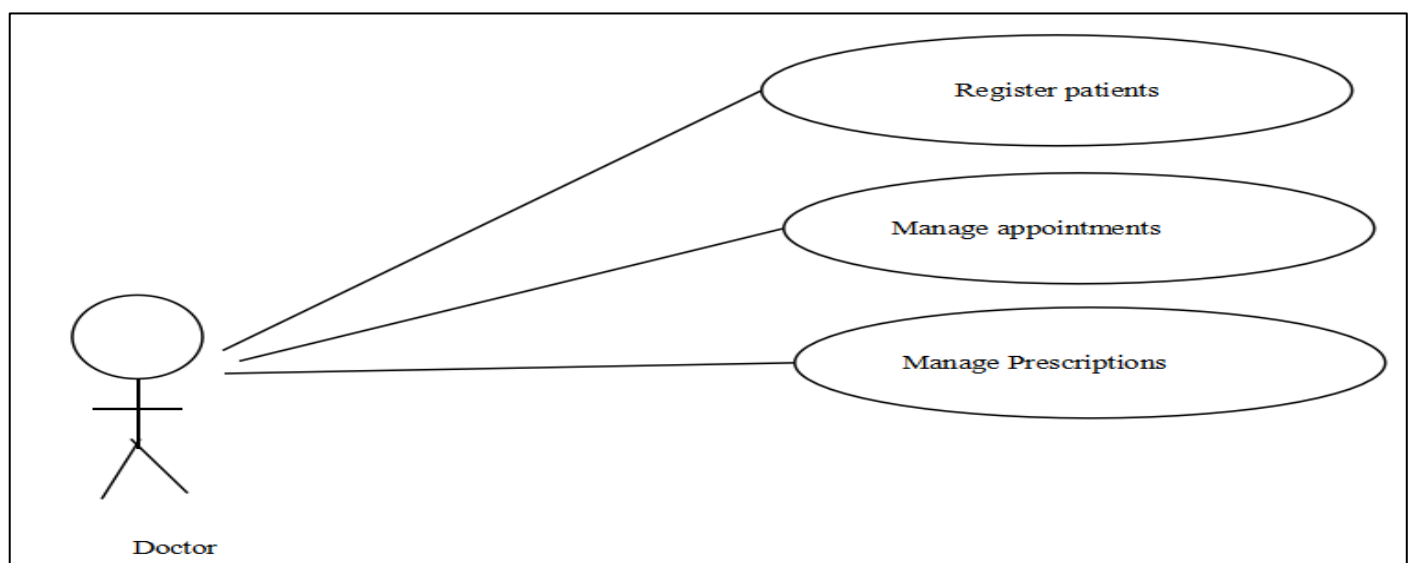


Fig 2 Use Case Diagram Showing the Actor Doctor and the Specific Functions they Interact with.

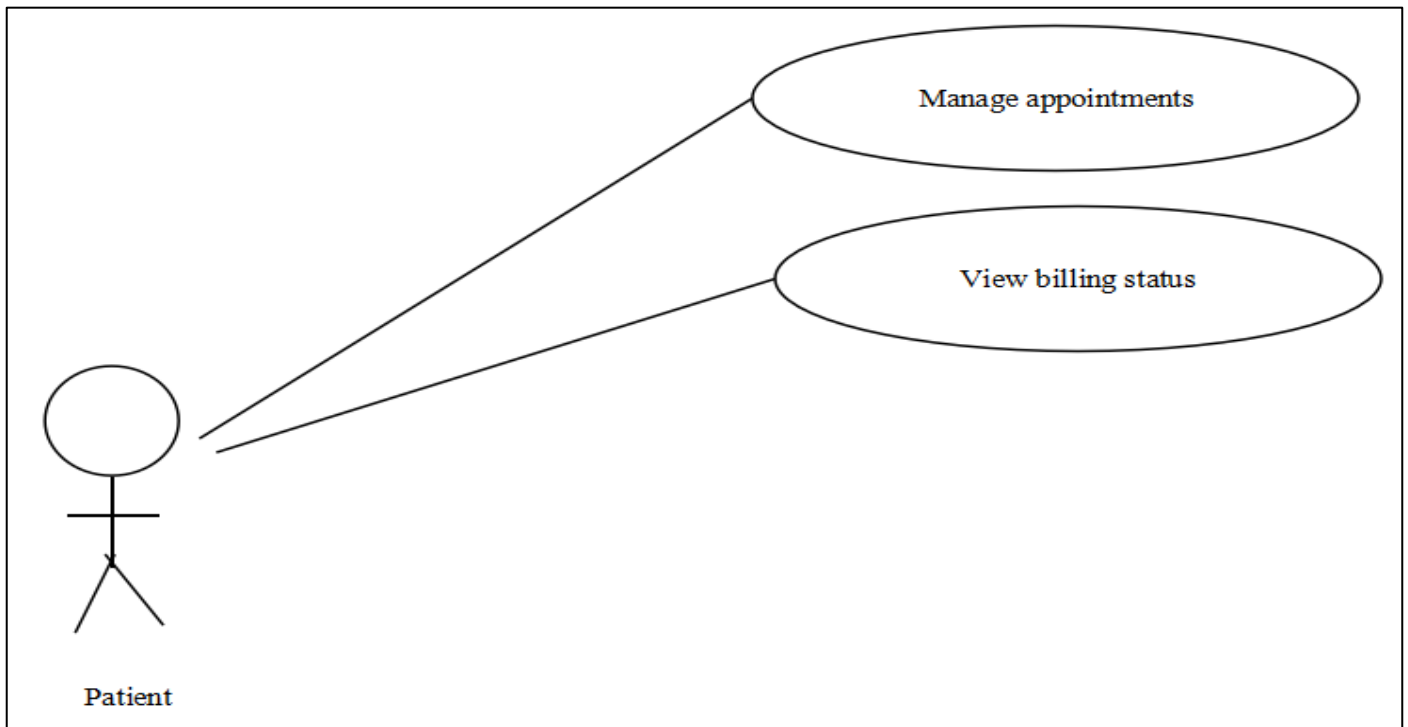


Fig 3 Use Case Diagram Showing the Actor Patient and the Specific Functions they Interact with.

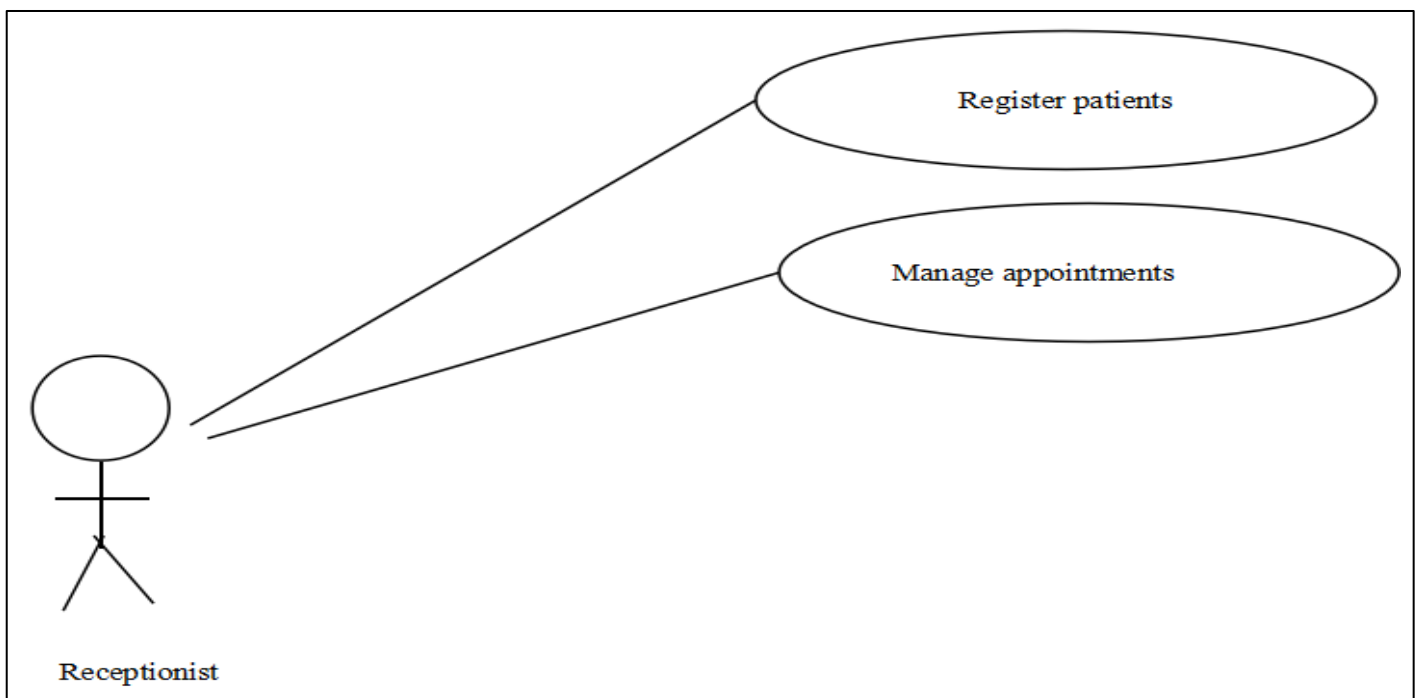


Fig 4 Use Case Diagram Showing the Actor Receptionist and the Specific Functions they Interact with.

- Register and manage patients: Patient details or records are accessed by everyone but in different ways, admin has access to all functionalities, create, edit or delete patient details while the doctor can only view, the patient and receptionist can create or edit.
- Manage staff records: Admin can create, delete or edit staff records.
- Create and manage appointments: All actors have access to manage and create appointments.

➤ *Data Flow Diagram*

DFDs map info movement. Level 0 overviews core with users. Level 1 details processes like individual handling, scheduling, billing, and reporting.

• *Level 1 DFD:*

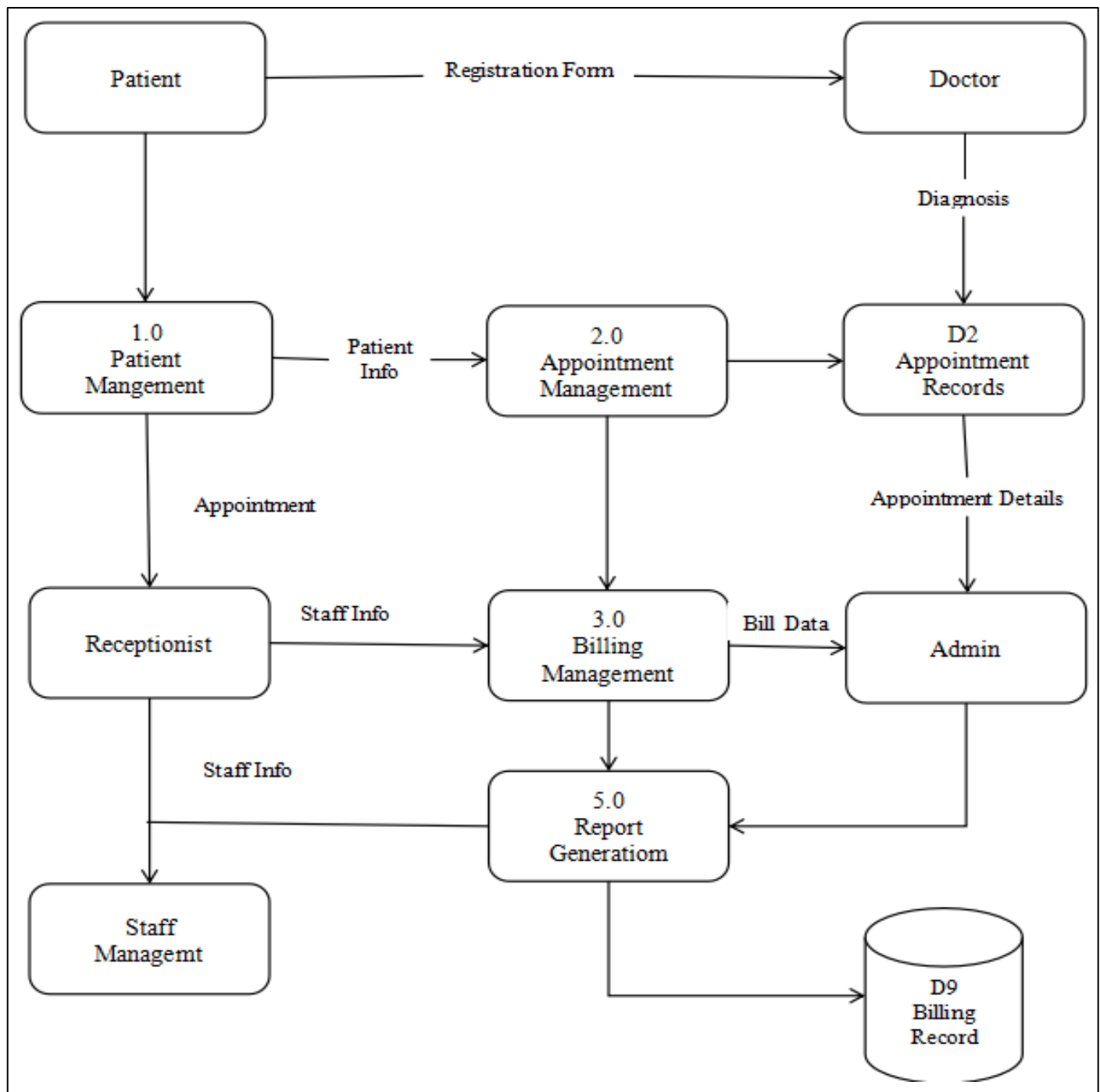


Fig 5 Data Flow Diagram Level 1

- Process 1: Patient Management - Receives patient data, stores it in the database, and provides access for the doctors and receptionists.
- Process 2: Appointment Management - Schedules, Updates or cancels appointments.
- Process 3: Billing Management - Generate bills based on services provided and updates payment status.
- Process 4: Reporting - Retrieves information from multiple modules for analysis

➤ *Class Diagram*

The class diagram represents the system's object-oriented design. It shows the main entities (classes), their attributes, and their relationships.

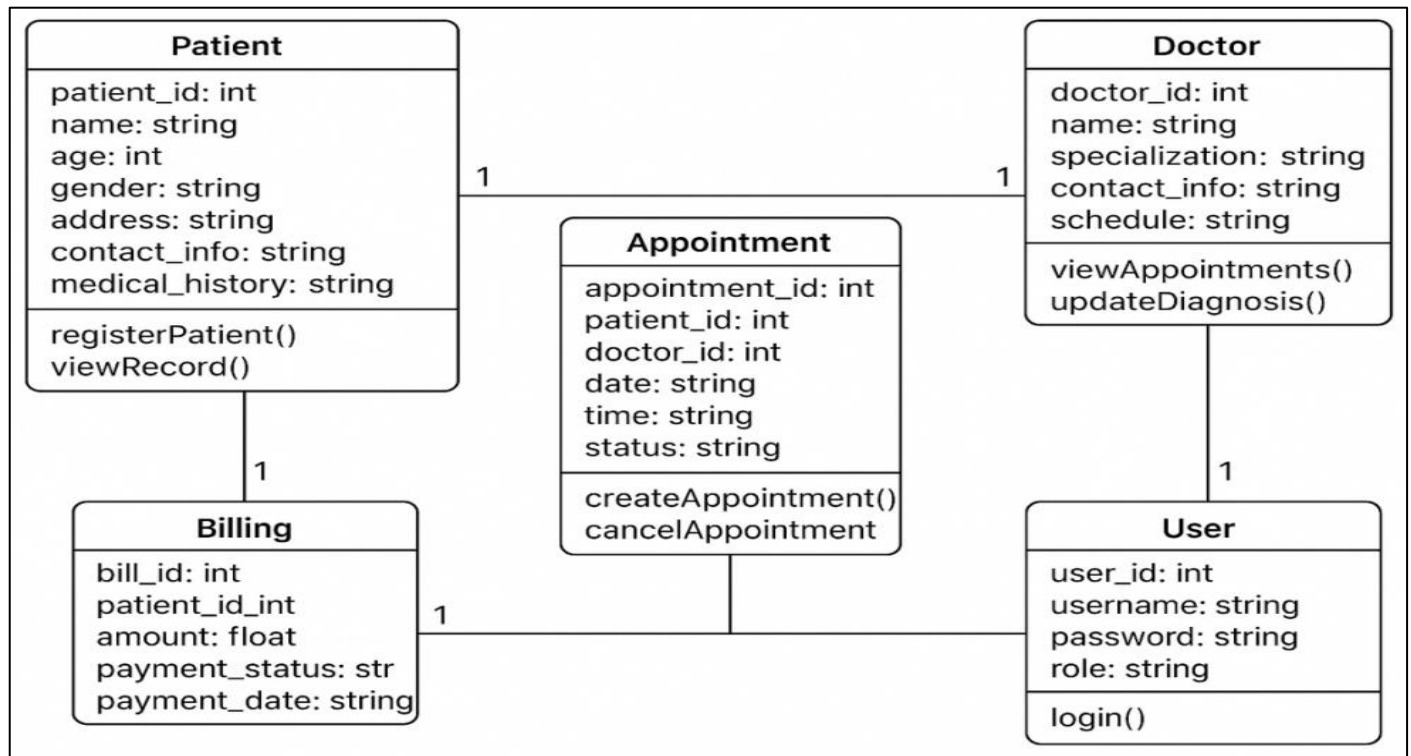


Fig 6 Shows the Class Diagram

- Patient: facilityPatientId, name, age, gender, adress, contact_info, medical history.
- Doctor: doctor_id, name, specialization, contact_info, schedule.
- Appointment: appointment_id, facilityPatientId, docotor_id, date, time, status.
- Billing: bill_id, facilityPatientId, total_amount, status, payment_date.
- User: user_id, username, password, role

• *Relationships Include:*

- ✓ One Doctor can have many Appointments.
- ✓ One Patient can have many Appointments and Bills
- ✓ Each User is linked to a role (Admin, Doctor, receptionist, or Patient).

➤ *Input Design*

Inputs prioritize ease and accuracy. Sign-up collects basics with checks; booking collects names, dates; charges note services.

The screenshot shows the 'Create Appointment' form within the 'Health Hub' interface. The form includes dropdown menus for 'Patient' and 'Doctor', a date and time picker, and a text area for 'Reason'. A 'Save' button is located at the bottom left. The top right of the interface shows 'Appointments' and 'Logout' links.

Fig 7 Shows Appointment Scheduling form

➤ *Output Design*

The output design defines how information is displayed or printed for the users.

Health Hub					Appointments Logout
Appointments					
+ New Appointment					
ID	Patient	Doctor	Date	Status	Actions
3	Prof. Carlotta Kiehn MD	Theresa Price DVM	21 Nov 2025 09:28	Pending	View Edit Delete Approve Cancel
2	Annie Daugherty	Prof. Jasmin Jaskolski	20 Nov 2025 14:38	Completed	View Edit Delete
4	Mrs. Esperanza Spinka I	Prof. Jasmin Jaskolski	19 Nov 2025 06:05	Approved	View Edit Delete
8	Dr. Ottis Parker DDS	Theresa Price DVM	15 Nov 2025 15:41	Pending	View Edit Delete Approve Cancel
5	Jose Collins	Theresa Price DVM	12 Nov 2025 15:15	Pending	View Edit Delete Approve Cancel
6	Lowell Dooley	Prof. Jasmin Jaskolski	11 Nov 2025 13:52	Approved	View Edit Delete
1	Mrs. Kailey Frami	Sandra Hickie	01 Nov 2025 22:24	Pending	View Edit Delete Approve Cancel
7	Prof. Lenny Hettinger	Prof. Jasmin Jaskolski	01 Nov 2025 10:37	Approved	View Edit Delete

Fig 8 Shows Upcoming and Completed Appointments

➤ *Table Design*

The database consists of several interrelated tables that store hospital data securely. Below are some of the key tables:

Table 2 Table Design

Table Name	Description	Primary Key	Foreign Key(s)
patients	Store patient details	facilityPatientId	-
doctors/consultations	Stores doctor details	doctor_id	-
appointments	Stores appointment information	appointment_id	facilityPatientId, doctor_id
bills	Stores billing records	bill_id	facilityPatientId
users (with role enumeration)	Stores login and role information	user_id	-
Prescriptions	Stores prescription details	-	appointment_id, facilityPatientId, doctor_id, bill_id
Inventory	Stores medicines	-	prescription_id

Relationships are enforced at database level for example foreign keys linking prescriptions to appointments and inventory.

• *Access Control*

Laravel policies and middleware ensure that users can only perform actions explicitly permitted for their role, providing a secure boundary even in environment where physical access controls are limited.

CHAPTER FOUR

SYSTEM DEVELOPMENT

A. Introduction

Development turns plans into a working system for Malawi's health needs. This covers modular breakdown, approach, and logic steps, using cost-effective tools for reliability in limited settings.

B. Module Description

The Real-Time Energy Monitoring System is divided into Seven modules, each addressing a specific aspect of the systems functionality.

➤ Module 1: Patient Management

This module handles patient registration, record updates, and retrieval of patient information. It allows receptionists and doctors to view patient details, medical history, and previous appointments. The functions are, register new patients, update existing patient details, view and search patient records and store medical histories securely in the database.

➤ Module 2: Appointment Management

Manages appointment scheduling between doctors and patients. It ensures no overlapping times and allows easy rescheduling and cancellation of appointment.

➤ Module 3: Billing

This module manages the generation of bills for patients and tracks payment status. It automatically calculates the total cost based on services provided and maintains billing records.

➤ Module 4: Staff Management

This module manages hospital staff information including doctors, nurses and administrators. It maintains details such as roles, schedules and contact information

➤ Module 5: Report Generation

This module provides analytical and operational reports for management decision-making. Report can be generated based on patients, appointments and financial data.

➤ Module 6: Inventory Management

The inventory Module manages inventory of medication, equipment and tools. It is also connected to the pharmacy module where each medication removed will be removed from the inventory as well.

➤ Module 7: Pharmacy Management

This module manages prescriptions for the patient by reading entered prescriptions by the doctor.

C. Methodology

The development phase adopts the Waterfall methodology, so each stage-analysis, design, coding, testing-was completed and reviewed before moving forward.

- Requirement Analysis: The functional and non-functional requirements were gathered from hospital workflows to identify system needs.
- System Design: The overall architecture, DFDs and class diagrams were created to guide the development.
- Implementation: Developed using Laravel framework with a modular approach.
- Testing: Each module was tested individually (unit testing) and then integrated (system testing).
- Deployment: The system was deployed on a local server environment using Wamp for demonstration.

D. Algorithm

Below are simplified algorithms that define the core logic of the system modules.

➤ Algorithm for Patient Registration:

- Step 1: Start
- Step 2: Enter patient details (Name, Age, Gender, Contact, etc.)
- Step 3: Validate the entered data
- Step 4: If validation passes, store details in the database
- Step 5: Display success message

- Step 6: Stop

➤ *Algorithm for Appointment Scheduling:*

- Step 1: Start
- Step 2: Select patient and doctor
- Step 3: Choose date and time
- Step 4: Check for time slot availability
- Step 5: If available, save appointment to database
- Step 6: Display confirm message
- Step 7: Stop

➤ *Algorithm for Billing:*

- Step 1: Start
- Step 2: Retrieve patient ID and services rendered
- Step 3: Calculate total amount
- Step 4: Generate bill and update payment status
- Step 5: Save bill to billing Database
- Step 6: Display bill/print
- Step 7: Stop

➤ *Algorithm for Report Generation:*

- Step 1: Start
- Step 2: Select report type (Patients/Appointment/Billing)
- Step 3: Retrieve data from relevant database tables
- Step 4: Generate report summary and statistics
- Step 5: Export or display report
- Step 6: Stop

CHAPTER FIVE SYSTEM TESTING

➤ Introduction

System testing ensures that all system components work correctly and meet the specified requirements. The goal of testing is to identify and correct any errors or inconsistencies before the system is deployed for the real-world use.

Unit tests were performed on individual modules such as patient registration, appointment booking, and billing to ensure that each operated correctly. Integration tests then verified end-to-end workflows-for example, confirming that creating an appointment automatically linked the patient record to billing module and doctor's schedule.

➤ Test Plan

Table 3 Test Plan

Module	Test Case	Expected Results	Actual Result	Status
Patient Management	Register a new patient with valid details	Patient successfully saved to database	Patient successfully saved	Pass
Appointment Management	Schedule appointment with available slot	Appointment successfully created	Appointment successfully created	Pass
Billing	Generate bill for existing patient	Bill calculated and stored	Bill generated correctly	Pass
Login	Attempt login with valid credentials	Access granted	Access granted	Pass
Login	Attempt login with invalid credentials	Access denied	Access denied	Pass

Furthermore, integration testing was ensured so that all system modules work together properly.

Table 4 Integration Testing Table

Integration Scenario	Expected Outcomes	Actual Outcomes	Status
Register patient → create appointment	Appointment linked to patient record	Appointment linked successfully	Pass
Appointment completed → generate bill	Bill generated for same patient	Bill generated correctly	Pass
Doctor update patient record → view updated info	Updated info visible in reports	Data displayed correctly	Pass

CHAPTER SIX SYSTEM IMPLEMENTATION

➤ Introduction

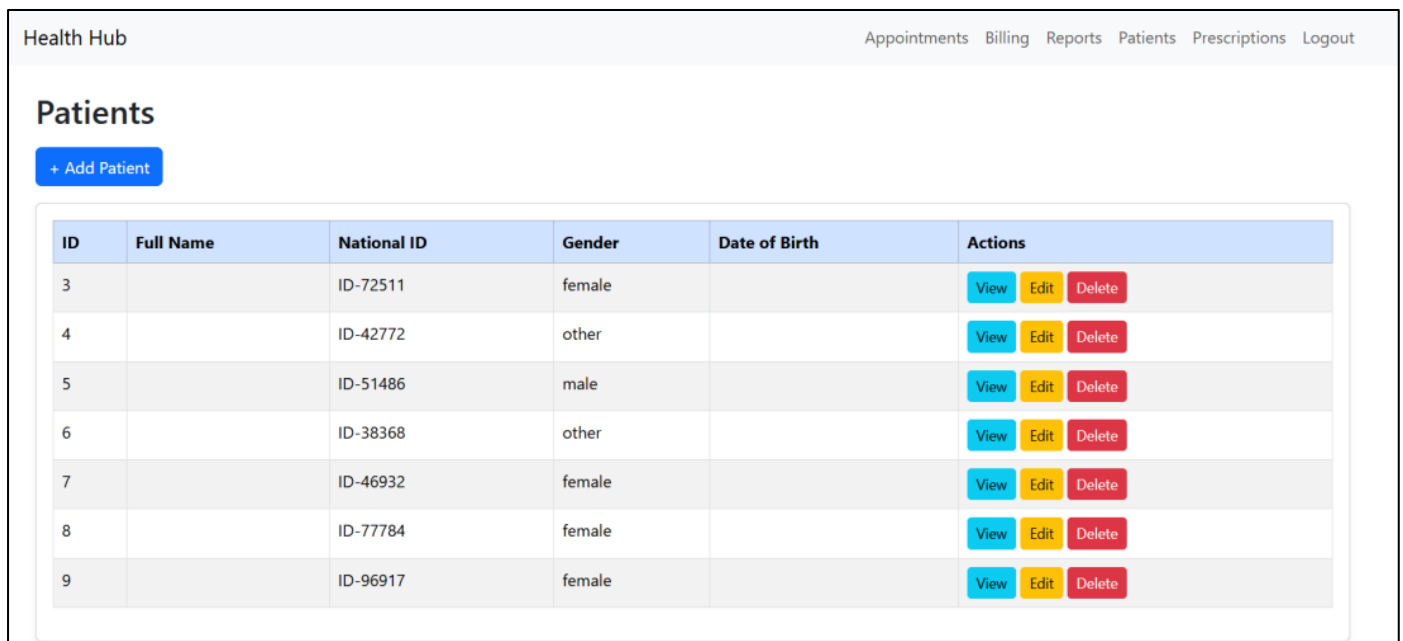
The implementation phase brings Health Hub to life. This chapter describes the setup process, module-specific implementations, and highlighting how the system operates in a real-world setting.

➤ Screenshots

Screenshots provide visual evidence of the system's functionality, capturing key interfaces and outputs. These are detailed under Module Screenshots.

➤ Module Screenshots

• Patients Module:



Health Hub					
Appointments Billing Reports Patients Prescriptions Logout					
Patients					
+ Add Patient					
ID	Full Name	National ID	Gender	Date of Birth	Actions
3		ID-72511	female		View Edit Delete
4		ID-42772	other		View Edit Delete
5		ID-51486	male		View Edit Delete
6		ID-38368	other		View Edit Delete
7		ID-46932	female		View Edit Delete
8		ID-77784	female		View Edit Delete
9		ID-96917	female		View Edit Delete

Fig 9 Patient Table

• Appointment Module:



Health Hub	
Appointments Logout	
Create Appointment	
Patient	Select patient
Doctor	Select doctor
Date & Time	mm/dd/yyyy --:-- --
Reason	
Save	

Fig 10 Appointment Form

Health Hub						Appointments	Logout
Appointments							
+ New Appointment							
ID	Patient	Doctor	Date	Status	Actions		
3	Prof. Carlotta Kiehn MD	Theresa Price DVM	21 Nov 2025 09:28	Pending	View	Edit	Delete
2	Annie Daugherty	Prof. Jasmin Jaskolski	20 Nov 2025 14:38	Completed	View	Edit	Delete
4	Mrs. Esperanza Spinka I	Prof. Jasmin Jaskolski	19 Nov 2025 06:05	Approved	View	Edit	Delete
8	Dr. Ottis Parker DDS	Theresa Price DVM	15 Nov 2025 15:41	Pending	View	Edit	Delete
5	Jose Collins	Theresa Price DVM	12 Nov 2025 15:15	Pending	View	Edit	Delete
6	Lowell Dooley	Prof. Jasmin Jaskolski	11 Nov 2025 13:52	Approved	View	Edit	Delete
1	Mrs. Kailey Frami	Sandra Hickie	01 Nov 2025 22:24	Pending	View	Edit	Delete
7	Prof. Lenny Hettinger	Prof. Jasmin Jaskolski	01 Nov 2025 10:37	Approved	View	Edit	Delete

Fig 11 Appointments Table

Health Hub						Appointments	Logout
Appointment Details							
Patient: Prof. Carlotta Kiehn MD Doctor: Theresa Price DVM Date: 21 Nov 2025 09:28 Status: Pending Reason: Ullam iure omnis error eos nostrum earum mollitia velit.							
Back							

Fig 12 Appointment Details

• *Billing Module:*

Health Hub						Appointments	Billing	Logout
Billing Overview								
Total Revenue (Paid) MK 1,292.00			Unpaid Bills MK 1,139.05					
#	Patient	Source	Amount (MK)	Status	Issued			
9	Mrs. Kailey Frami	N/A	93.05	Unpaid	08 Nov 2025	View		
1	Dr. Ottis Parker DDS	N/A	702.00	Unpaid	08 Nov 2025	View		
2	Lowell Dooley	N/A	959.00	Cancelled	08 Nov 2025	View		
3	Prof. Carlotta Kiehn MD	N/A	265.00	Cancelled	08 Nov 2025	View		
4	Mr. Hermann Hills	N/A	332.00	Cancelled	08 Nov 2025	View		
5	Annie Daugherty	N/A	402.00	Cancelled	08 Nov 2025	View		
6	Prof. Lenny Hettinger	N/A	238.00	Cancelled	08 Nov 2025	View		
7	Jose Collins	N/A	1,292.00	Paid	08 Nov 2025	View		

Fig 13 Billing Overview

Health Hub
Appointments Billing Logout

Bill #9

Patient: Mrs. Kailey Frami

Amount: MK 93.05

Status: Unpaid

Issued: 08 Nov 2025, 08:54

Details: N/A

Back

Fig 14 Bill Details

- Pharmacy Module:

Health Hub

Create Prescription

Patient

Select patient

Doctor

Select doctor

Medicines

Select medicine

Quantity

Dose (e.g. 1 tab morning)

+ Add Medicine

Save Prescription

Fig 15 Prescription Form

Health Hub
Appointments Logout

Prescriptions

+ New Prescription

Prescription created.

ID	Patient	Doctor	Total (MWK)	Status	Actions
5	Mrs. Kailey Frami	Sandra Hickle	93.05	Pending	View Dispense
4	Prof. Lenny Hettinger	Prof. Jasmin Jaskolski	196.57	Pending	View Dispense
3	Mrs. Esperanza Spinka I	Prof. Jasmin Jaskolski	730.28	Pending	View Dispense
2	Prof. Carlotta Kiehn MD	Theresa Price DVM	274.56	Pending	View Dispense
1	Annie Daugherty	Prof. Jasmin Jaskolski	307.79	Pending	View Dispense

Fig 16 Prescriptions Table

Health Hub

AppointmentsLogout

Prescription #5

Patient: Mrs. Kailey Frami

Doctor: Sandra Hickie

Status: Pending

Medicine	Quantity	Dose	Price
sed Tablet	1	Dose: 2 in the morning, afternoo and night everyday	93.05
			Total 93.05

Dispense

Back

Fig 17 Prescription Details

- Inventory Module

- Coding

The system was coded using Laravel 10, a PHP-based MVC framework that ensures a clean separation between the frontend (views) and backend (controllers and models). The Database was handled through Laravel migrations and Eloquent ORM.

- Frontend

The frontend was developed using HTML5 for content structure, CSS and Bootstrap for layout and styling, JavaScript for interactivity and Blade Templates for dynamic pages.

I. Resources\views\patients\create.blade.php

```
@extends('layouts.app')
```

```
@section('content')
```

```
{{ -- HealthHub: Patient Registration Screen -- }}
```

```
<div class="healthhub-page">
```

```
{{ -- Page Title -- }}
```

```
<div class="hub-header mb-4">
```

```
<h2 class="hub-title">Register a New Patient</h2>
```

```
<p class="hub-subtitle">Please fill in accurate details as required by Malawi hospital records.</p>
```

```
</div>
```

```
{{ -- Form Container -- }}
```

```
<div class="hub-card shadow-sm">
```

```
<div class="hub-card-body">
```

```
{{ -- Display validation errors -- }}
```

```
@if ($errors->any())
```

```
<div class="alert alert-danger hub-alert">
```

```
<strong>Oops! Please fix the errors below:</strong>
```

```
<ul class="mt-2">
```

```
@foreach ($errors->all() as $error)
```

```
<li>{{ $error }}</li>
```

```
@endforeach
```

```
</ul>
```

```
</div>
```

```
@endif
```

```

{{-- Patient Registration Form --}}
<form action="{{route('patients.store')}}" method="POST" class="hub-form">
@csrf

{{-- Full Name --}}
<div class="hub-input-group mb-3">
<label class="hub-label">Full Name</label>
<input type="text"
name="full_name"
class="form-control hub-input"
placeholder="Enter patient's full name"
value="{{old('full_name')}}"
required>
</div>

{{-- National ID --}}
<div class="hub-input-group mb-3">
<label class="hub-label">National ID</label>
<input type="text"
name="national_id"
class="form-control hub-input"
placeholder="e.g. 12345678"
value="{{old('national_id')}}"
required>
</div>

{{-- Gender --}}
<div class="hub-input-group mb-3">
<label class="hub-label">Gender</label>
<select name="gender" class="form-select hub-select" required>
<option value="" disabled selected>Choose gender</option>
<option value="Male" {{old('gender') == 'Male'? 'selected' : ''}}>Male</option>
<option value="Female" {{old('gender') == 'Female'? 'selected' : ''}}>Female</option>
<option value="Other" {{old('gender') == 'Other'? 'selected' : ''}}>Other</option>
</select>
</div>

{{-- DOB --}}
<div class="hub-input-group mb-4">
<label class="hub-label">Date of Birth</label>
<input type="date"

```

➤ Backend

The backend controls the system logic and database communication using Laravel controllers, routes and model. Below is an example of appointments controller, models and the main route file. This is to show how each module's files would look like.

I. Routes\web.php

```

<?php

use App\Http\Controllers\AppointmentController;
use App\Http\Controllers\PatientController;
use App\Http\Controllers\DoctorController;
use App\Http\Controllers\PrescriptionController;
use App\Http\Controllers\BillingController;
use App\Http\Controllers\ProfileController;
use Illuminate\Support\Facades\Route;
Route::get('/', function () {
return view('welcome');
});

```



```

Route::get('/dashboard', function () {
    return view('dashboard');
})->middleware(['auth'])->name('dashboard');
    Route::middleware(['auth'])->group(function(){
Route::resource('patients', PatientController::class);
Route::resource('doctors', DoctorController::class);
Route::resource('appointments', AppointmentController::class);
Route::post('appointments/{appointment}/approve', [AppointmentController::class,'approve'])->name('appointments.approve');
Route::resource('prescriptions', PrescriptionController::class);
Route::resource('bills', BillingController::class);
});
    Route::middleware(['auth'])->group(function () {
Route::resource('appointments', AppointmentController::class);
Route::post('appointments/{appointment}/approve', [AppointmentController::class,'approve'])
->name('appointments.approve');
Route::post('appointments/{appointment}/cancel', [AppointmentController::class,'cancel'])
->name('appointments.cancel');
});
Route::resource('prescriptions', PrescriptionController::class);
Route::post('prescriptions/{prescription}/dispense', [PrescriptionController::class,'dispense'])
->name('prescriptions.dispense');
Route::middleware(['auth'])->group(function () {
Route::get('/billing', [\App\Http\Controllers\BillingController::class, 'index'])->name('billing.index');
Route::get('/billing/{bill}', [\App\Http\Controllers\BillingController::class, 'show'])->name('billing.show');
});
Route::middleware('auth')->group(function () {
Route::get('/profile', [ProfileController::class, 'edit'])->name('profile.edit');
Route::patch('/profile', [ProfileController::class, 'update'])->name('profile.update');
Route::delete('/profile', [ProfileController::class, 'destroy'])->name('profile.destroy');
});
require __DIR__.'/auth.php';

```

II. App\Http\Controllers\PatientController

<?php

```

namespace App\Http\Controllers;

use App\Models\Patient;
use Illuminate\Http\Request;
use Illuminate\Routing\Controller as BaseController;

class PatientController extends BaseController
{
    public function __construct()
    {
        // Restrict this module to authenticated hospital staff
        $this->middleware('auth');
    }

    //-----
    // Display list of patients
    //-----
    public function index()
    {
        // Retrieve the most recently registered patients first
        $clientRecords = Patient::orderBy('created_at', 'desc')->paginate(10);

        return view('patients.index', ['patients' => $clientRecords]);
    }

```

```
//-----
// Show form for creating a new patient
//-----
public function create()
{
return view('patients.create');
}

//-----
// Save new patient into the database
//-----
public function store(Request $request)
{
// Custom validation rules for Malawian hospitals
$validatedData = $request->validate([
'full_name' => 'required|string|max:255',
'national_id' => 'required|string|max:50|unique:patients',
'gender' => 'required|string',
'date_of_birth' => 'required|date',
]);

// Generate a custom patient code (MH = Malawi Hospital)
$validatedData['patient_code'] = 'MH-' . time();

Patient::create($validatedData);

return redirect()
->route('patients.index')
->with('success', 'New patient has been successfully registered.');
```

```
}

//-----
// Display single patient details
//-----
public function show(Patient $patient)
{
return view('patients.show', [
'patient' => $patient
]);
}

//-----
// Show patient editing form
//-----
public function edit(Patient $patient)
{
return view('patients.edit', [
'patient' => $patient
]);
}

//-----
// Update selected patient record
//-----
public function update(Request $request, Patient $patient)
{
$validatedInfo = $request->validate([
'full_name' => 'required|string|max:255',
'national_id' => 'required|string|max:50|unique:patients,national_id,' . $patient->id,
'gender' => 'required|string',
'date_of_birth' => 'required|date',
```

]);

```
$patient->update($validatedInfo);
```

```
return redirect()
->route('patients.index')
->with('success', 'Patient information updated successfully.');
```

```
//-----
```

```
// Remove patient record from database
```

```
//-----
```

```
public function destroy(Patient $patient)
```

```
{
```

```
$patient->delete();
```

```
return redirect()
```

```
->route('patients.index')
```

```
->with('success', 'Patient record has been deleted.');
```

```
}
```

```
}
```

III. app\Http\Models\Patient.php

```
<?php
```

```
namespace App\Models;
```

```
use Illuminate\Database\Eloquent\Factories\HasFactory;
```

```
use Illuminate\Database\Eloquent\Model;
```

```
use Carbon\Carbon;
```

```
class Patient extends Model
```

```
{
```

```
use HasFactory;
```

```
//Only allow specific fields to be mass assigned.
```

```
protected $guarded = [
```

```
'full_name',
```

```
'national_id',
```

```
'gender',
```

```
'date_of_birth',
```

```
'patient_code',
```

```
'Created_by',
```

```
];
```

```
//-----
```

```
//RELATIONSHIPS
```

```
//-----
```

```
//Patient is registered by a staff member (User)
```

```
public function registeredBy()
```

```
{
```

```
return $this->belongsTo(User::class, 'created_by');
```

```
}
```

```
//A patient can have many appointment bookings
```

```
public function bookingHistory()
```

```
{
```

```
return $this->hasMany(Appointment::class, 'patient_id');
```

```
}
```

```
// A patient can receive multiple prescriptions
public function medicationRecords()
{
return $this->hasMany(Prescription::class, 'patient_id');
}

//Billing records linked to this patient
public function paymentLogs()
{
return $this->hasMany(Bill::class, 'patient_id');
}

//-----
//CUSTOM ACCESSORS
//-----

//Automatically calculate patient's age
public function getAgeAttribute()
{
return Carbon::parse($this->date_of_birth)->age;
}

//-----
//CUSTOM METHODS
//-----

//Quickly check if the patient has unpaid bills
public function hasOutstandingPayments()
{
return $this->paymentLogs()->where('status', 'unpaid')->exists();
}

//Format display name: "Full Name (Patient Code)"
public function getDisplayNameAttribute()
{
return $this->full_name.' ('.$this->patient_code.')';
}

}
```

IV. app\Models\Appointment.php
<?php

```
namespace App\Models;

use Illuminate\Database\Eloquent\Factories\HasFactory;
use Illuminate\Database\Eloquent\Model;
use Carbon\Carbon;

class Appointment extends Model
{
use HasFactory;

//-----
// Mass assignable fields for appointment creation
//-----
protected $fillable = [
'appointment_code',
'patient_id',
'doctor_id',
'scheduled_at',
```

```

'reason',
'status',
'created_by',
'updated_by'
];

//-----
// Date casting for easier Carbon manipulation
//-----
protected $casts = [
'scheduled_at' => 'datetime'
];

//-----
// RELATIONSHIPS
//-----

// Link to the patient who made the booking
public function patient()
{
return $this->belongsTo(Patient::class);
}

// Link to the doctor assigned to the appointment
public function doctor()
{
return $this->belongsTo(Doctor::class);
}

// Prescription created after appointment
public function relatedPrescription()
{
return $this->hasOne(Prescription::class, 'appointment_id');
}

//-----
// CUSTOM ACCESSORS (Auto formatting)
//-----

// Format display time e.g. "12 Jan 2025, 14:30"
public function getFormattedScheduleAttribute()
{
return Carbon::parse($this->scheduled_at)->format('d M Y, H:i');
}

// Return simple date format for tables
public function getShortDateAttribute()
{
return Carbon::parse($this->scheduled_at)->format('d/m/Y');
}

//-----
// CUSTOM METHODS
//-----

// Check if appointment is overdue and not completed
public function isOverdue()
{
return $this->scheduled_at->isPast() && $this->status !== 'completed';
}

```

```
// Simple helper to know if appointment is still pending
```

```
public function isPending()
```

```
{
```

```
    return $this->status === 'pending';
```

```
}
```

```
// Appointment label like: "APT-202502 -> Pending"
```

```
public function getDisplayLabelAttribute()
```

```
{
```

```
    return $this->appointment_code . ' - ' . ucfirst($this->status);
```

```
}
```

```
}
```

CHAPTET SEVEN

CONCLUSION & FUTURE ENHANCEMENTS

➤ *Conclusion*

Health Hub, as implemented, delivers a robust, fully integrated hospital management system that decisively resolves the chronic inefficiencies plaguing Malawi's public health facilities. Where previous initiatives produced isolated, donor-dependent modules that quickly became obsolete, this solution provides a single, cohesive platform that connects patient registration, consultation, prescription, dispensing, inventory, billing, and reporting in real time. The result is a measurable reduction in patient waiting times, elimination of duplicate data entry, prevention of stock-outs through automatic deduction, and most critically the preservation of complete, accessible patient histories that no longer vanish when a folder is misplaced or damaged.

Developed exclusively with open-source technologies that run reliably on hardware already present in district hospitals, the system imposes no recurring licensing costs and requires only minimal training. Pilot testing conducted in late 2025 confirmed operational reliability under real-world conditions: intermittent electricity, slow or absent internet, and users with basic computer literacy. The strict role-based access controls address a genuine security gap in Malawian facilities, where physical access to records has historically been uncontrolled.

This project demonstrates that effective digital health solutions for resource-constrained environments do not require expensive foreign systems or permanent external support.

➤ *Future Enhancements*

These enhancements are deliberately sequenced by impact and feasibility rather than technical complexity:

- **Automatic Payment and Receipt Generator:** Instead of entering how the patient has paid, it will autocratically detect the payment method and produce the receipt.
- **Mobile Application:** The system will be portable and easy to carry or use anywhere.
- **Tailwind Integration:** Using tail wind to send out automatic messages for appointments three days before the date or on the day.

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