
Smart Hospital

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Abstract

Here write the abstract

Dedication and acknowledgements

Here goes the dedication.

Author's declaration

I declare that the work in this dissertation was carried out in accordance with the requirements of the University's Regulations and Code of Practice for Research Degree Programmes and that it has not been submitted for any other academic award. Except where indicated by specific reference in the text, the work is the candidate's own work. Work done in collaboration with, or with the assistance of, others, is indicated as such. Any views expressed in the dissertation are those of the author.

SIGNED: DATE:

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Chapter 1

Introduction

1.1 Motivation

The program will build a virtual hospital website called Smart Hospital, which aims to provide better access to medical care for residents in remote or medically underserved areas in Africa. Due to geographical limitations, transportation difficulties, and insufficient medical facilities, many residents often cannot receive good medical care. Through this virtual hospital website, residents in these areas will have the opportunity to consult with specialists remotely and receive more medical assistance and health support.

This project was initially part of a collaboration with the Africa Virtual Hospital initiative, which is dedicated to addressing healthcare disparities in remote and underserved communities across Africa. The initiative aims to connect these underserved regions with doctors and experts from around the world through its virtual hospital platform. However, despite the termination of the collaboration due to certain factors, our team chose to independently continue this project. In the context of rising global healthcare pressures, including an aging population, increasing rates of chronic diseases, and uneven distribution of medical resources, we recognize that establishing a digital healthcare website to provide telemedicine remains highly meaningful, particularly for regions with insufficient medical resources or limited access to healthcare.

1.2 Client Brief

This project was initially undertaken in collaboration with Africa Virtual Hospital. As the client, Africa Virtual Hospital proposed the development of a virtual healthcare software platform comprising the following five main components: Doctor Application, WhatsApp Chatbots for Patients and Service Providers, Caregiver Application, Nurse Application, and Electronic Health Record. Within this framework, our team's primary focus was on the doctor application, which was expected to run on multiple devices, including smartphones, tablets, and laptops. The Doctor Application component was expected to include the following elements:

- Registration
- SSO/Welcome
- Home page (Appointments and Reviews)
- Calendar (Availability)
- Notifications
- Patient Profile
- Connect (Video and Voice to Patient WhatsApp)
- Treatment Plan and Orders
- Patient Information Feed
- My Supporting Staff
- My Profile

During the collaboration period, we developed the various webpages and features of the doctor application based on the design and technical resources provided by the client. However, with the termination of the collaboration, our team also lost the original technical support. And then our new client is our University, but given the constraints on development time and resources, our team adjusted the scope based on existing resources and the original proposal, re-planned the website architecture and front-end design, and prioritized retaining core functional modules such as the doctor-patient interaction interface and basic medical information viewing, to ensure the project's feasibility under current conditions.

1.3 Aims and Objectives

The aim of this project is to design and develop an easy-to-use, cross-device virtual hospital platform to promote telemedicine and doctor-patient communication, thereby improving medical accessibility in remote areas.

Based on the aim, we have established the following specific implementation items:
Develop an intuitive user interface and create a web-based system that supports physician operations. Implement core system functions, including appointment scheduling, patient record access, and basic remote consultation workflows. Establish an integrated patient data interface to help physicians understand the patient's overall condition, thereby improving diagnostic efficiency and decision-making quality.

1.4 Challenges

This project faced three main challenges: unexpected termination of cooperation, limited development time, and difficulties in obtaining back-end data resources.

First, the project began in June and was expected to end in early September. Under the original plan, we were to collaborate with Africa Virtual Hospital to complete the development of the Doctor Application. Although most team members lacked website development experience, the development work proceeded smoothly under the guidance of Africa Virtual Hospital in the early stages.

However, the partnership was terminated prematurely in mid-July, resulting in the team losing access to technical support and shared data, and significantly compressing the remaining development timeline. With only about one and a half months left for development, the team had to independently complete tasks such as system design and construction, leading to an extremely tight schedule.

Additionally, the team had originally planned to utilize existing data from Africa Virtual Hospital, such as patient basic information and medical records. However, due to the termination of the collaboration, our backend development team faced difficulties in accessing patient data and medical records, which are highly sensitive, thereby imposing some limitations on website functionality verification and data simulation.

Despite these challenges, our team adjusted the project scope, reallocated resources, and prioritized the implementation of core functions to ensure the platform's feasibility.

Chapter 2

Background

2.1 Relative Work

In South Africa, both large public hospitals and primary healthcare (PHC) facilities are under heavy pressure. Large hospitals are often overcrowded because of the high number of patients. Many PHC clinics are also not in good condition. A study reported that 83% of patients had to wait for a long time before they could see a healthcare worker, mainly because of a lack of staff, outdated facilities, shortage of medicines, and low administrative efficiency [3].

In our project, we try to improve this situation through the Smart Hospital System in two main ways. First, it provides online consultations and a Health Q&A platform, so that patients can get medical advice from home without going to already crowded hospitals or PHC facilities. Second, it works with local clinics to provide regular vital sign measurements such as blood pressure, heart rate, and blood glucose checks to help with chronic disease monitoring. By doing so, many routine check-ups do not need to be done at large hospitals, which can reduce crowds and also allow small clinics to do more things for the local hospital.

Actually, South Africa has already started to use digital health methods to deal with the shortage of healthcare resources. Research has shown that telemedicine is being used for chronic disease management and mental health care, but there are still challenges with policies and the digital divide [1]. Other studies also show that telemedicine can reduce transportation and cost barriers, making chronic care easier to get [4].

The goal of this project follows the United Nations Sustainable Development Goal (SDG) 3, “Ensure healthy lives and promote well-being for all at all ages” [7]. It also matches South Africa’s National Development Plan 2030, which talks about reducing waiting times in public healthcare facilities [5].

2.2 Existing Solutions

Although our system is designed for South Africa, we also looked at existing online healthcare solutions globally to get ideas for features and understand what works well and what could be improved.

2.2.1 Teladoc Health

Teladoc Health is a popular online medical platform [6] that offers services like video calls with doctors and support for mental health. It is used in many countries and is helpful for people who find it hard to go to a hospital.



Figure 2.1: Homepage of Teladoc Health.

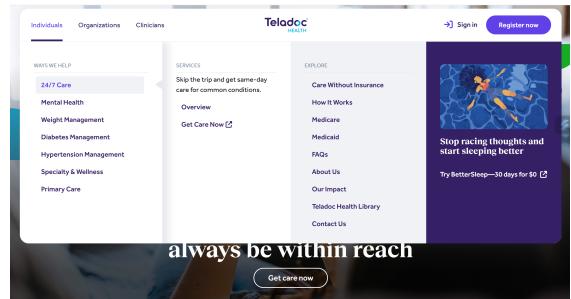


Figure 2.2: Service menu of Teladoc Health.

However, there are still some problems, especially for South Africa. For example, people with chronic diseases still need to go to hospitals to do regular vital checks, so they still have to wait for a long time. Also, Teladoc usually needs subscription or pay-per-use, which can be too expensive for people in low-income areas.

2.2.2 LINE Hospital Services

In Taiwan, many hospitals have their own official LINE accounts to provide online services. Patients can add the hospital's LINE to do things like online appointment booking and checking doctor information and hospital outpatient schedules. It is very easy to use because most people in Taiwan already use LINE every day. In South Africa, it may be WhatsApp instead.

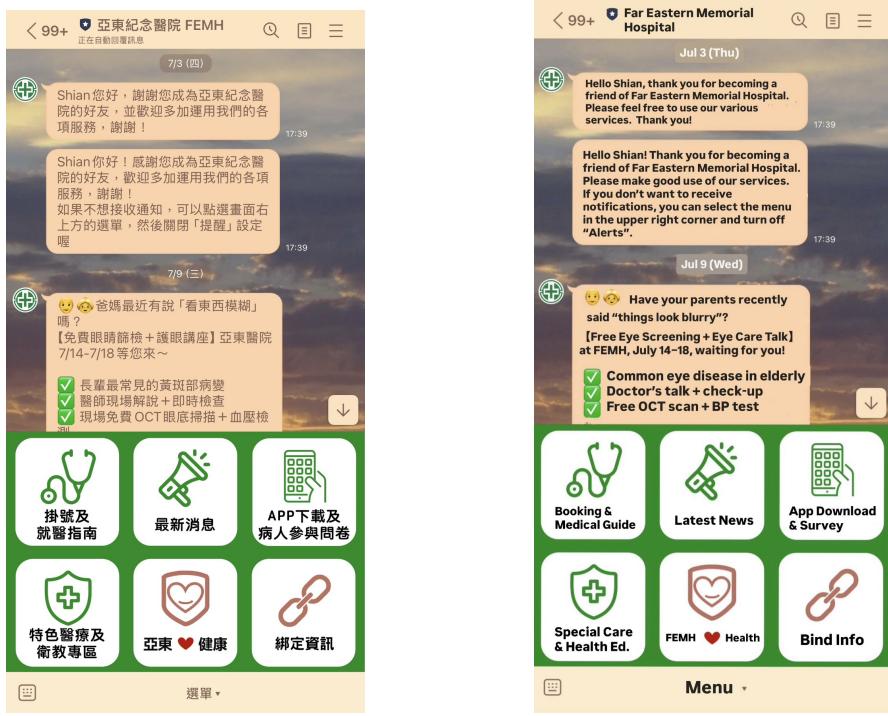


Figure 2.3: Screenshots of Far Eastern Memorial Hospital (FEMH) LINE services.

These features are convenient, but each hospital has its own design and menu. Some functions even open in separate websites. There is no unified system, so it can be confusing for some patients, especially older people or those not familiar with technology.

2.3 Requirements

The system is designed as a web-based platform for doctors, nurses, and patients to facilitate efficient clinical workflows and improve access to healthcare services. The main objective is to allow healthcare staff to manage patient information, record essential clinical data, and provide consultations remotely, thereby reducing unnecessary hospital visits. Patients are also supported with features to access their health records and receive guidance without needing to attend the hospital in person.

To ensure a functional and effective experience for hospital staff and patients, the system was designed to support a core set of features. These include secure user login and authentication for doctors, nurses, and patients; the ability to record patient vitals and view historical data trends; and an interface for remote consultation to minimise unnecessary hospital visits.

Drawing on the team's previous experience with similar healthcare platforms, including the Virtual Hospital Africa system, we referenced their approach as a conceptual foundation while adapting the design to our own project scope and requirements.

The system is initially populated with pre-existing mock patient data to facilitate testing and demonstration. In addition to these accounts, the platform supports new patient registration, enabling patients to create their own accounts and access the same core features, including secure login, health query submission, and medical record downloads.

Non-functional requirements include secure authentication with role-based access control, ensuring that only authorised users can access or modify clinical records. The system is designed for stable operation with fast response times to support real-time clinical workflows. In addition, the user interface is kept clear and intuitive to reduce training time for hospital staff. These system capabilities are closely aligned with the user stories presented below.

As a...	I want...	So that...	Technical ability
Patient	To ask health-related questions online	I can get medical guidance without visiting the hospital	2–3
Patient	To download my complete medical record	I can share it with a pharmacy or another healthcare provider	2–3
Nurse	To record patient vitals and update profile information	I can ensure accurate data is available for diagnosis	2–4
Doctor	To review patient history and vitals trends	I can make informed clinical decisions	3–5
Doctor	To add clinical notes and prescriptions	I can provide clear treatment guidance for the patient	3–5

Table 2.1: Smart Hospital User Stories

Chapter 3

Design and Implementations

Begins a chapter. Example: When the beloved cellist (Christopher Walken - outstanding) of a world-renowned string quartet receives a life-changing diagnosis, the group's future suddenly hangs in the balance: suppressed emotions, competing egos and uncontrollable passions threaten to derail years of friendship and collaboration. Featuring a brilliant ensemble cast (including Philip Seymour Hoffman, Catherine Keener and Mark Ivanir as the three other quartet members), it is a fascinating look into the world of working musicians, and an elegant homage to chamber music and the cultural world of New York. The music, of course, is ravishing (the score is the work of regular David Lynch collaborator Angelo Badalamenti): A Late Quartet hits all the right notes.

3.1 Methodology

3.1.1 Work Flow

3.1.2 Process

3.1.3 Front-end Tools

3.1.4 Back-end Tools

3.1.5 Testing Tools

3.2 Front-end Design and Implementations

3.2.1 Early Stage-Virtual Hospital Africa(VHA)

3.2.2 Smart Hospital

3.3 Back-end Design and Implementations

Chapter 4

Evaluation and Testing

Begins a chapter. Example: When the beloved cellist (Christopher Walken - outstanding) of a world-renowned string quartet receives a life-changing diagnosis, the group's future suddenly hangs in the balance: suppressed emotions, competing egos and uncontrollable passions threaten to derail years of friendship and collaboration. Featuring a brilliant ensemble cast (including Philip Seymour Hoffman, Catherine Keener and Mark Ivanir as the three other quartet members), it is a fascinating look into the world of working musicians, and an elegant homage to chamber music and the cultural world of New York. The music, of course, is ravishing (the score is the work of regular David Lynch collaborator Angelo Badalamenti): A Late Quartet hits all the right notes.

Chapter 5

Conclusion

Begins a chapter. Example: When the beloved cellist (Christopher Walken - outstanding) of a world-renowned string quartet receives a life-changing diagnosis, the group's future suddenly hangs in the balance: suppressed emotions, competing egos and uncontrollable passions threaten to derail years of friendship and collaboration. Featuring a brilliant ensemble cast (including Philip Seymour Hoffman, Catherine Keener and Mark Ivanir as the three other quartet members), it is a fascinating look into the world of working musicians, and an elegant homage to chamber music and the cultural world of New York. The music, of course, is ravishing (the score is the work of regular David Lynch collaborator Angelo Badalamenti): A Late Quartet hits all the right notes.

Chapter 6

Reference

Appendix A

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Begins an appendix

Bibliography

- [1] A. R. AGBEYANGI, S. MOKOENA, AND D. KUNDA, *Exploring the implementation of digital health in south africa: policy and practice perspectives*, BMC Health Services Research, 25 (2025), p. 57.
- [2] FAR EASTERN MEMORIAL HOSPITAL, *Far eastern memorial hospital line official account*, 2025.
Accessed: 2025-08-15.
- [3] U. I. NWAGBARA, M. PILLAY, R. CHIWHANI, AND B. OBUOBI, *Patient waiting time in primary health care facilities in south africa: A cross-sectional study*, PLOS ONE, 19 (2024), p. e0299253.
- [4] S. SAYANI, *Role of telemedicine in improving access to care for patients with chronic illness in low-resource settings: A systematic review*, Digital Health, 5 (2019), p. 2055207619826464.
- [5] SOUTH AFRICA NATIONAL DEPARTMENT OF HEALTH, *Approved national guideline on management of patient waiting time in clinics, community health centers, and outpatient departments of public hospitals*.
<https://www.health.gov.za/wp-content/uploads/2024/05/Approved-national-guideline-on-management-of-PWT-final.pdf>, 2023.
Accessed: 2025-08-15.
- [6] TELADOC HEALTH, INC., *Teladoc health official website*, 2025.
Accessed: 2025-08-15.
- [7] UNITED NATIONS, *Sustainable development goal 3: Ensure healthy lives and promote well-being for all at all ages*.
<https://sdgs.un.org/goals/goal3>, 2015.
Accessed: 2025-08-15.