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FACULTY OF APPLIED SCIENCES AND TECHNOLOGY

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SUPERVISED BY:

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SUBMISSION DATE:

SEPTEMBER/2021

DECLARATION

I hereby declare that it is my original work and has not been presented previously in another institution for any academic certificate.

Sign:

Date:

SUPERVISORS

The Technical University of Kenya

Sign:

Date:

The Technical University of Kenya

Sign:

Date:

DEDICATION

I dedicate this work to my parents who has seen me to the end of it all. To my sisters, brother for their great support financially, motivationally and morally, to all my classmates who have helped in brain storming the project, to friends for their support and to the almighty God for his divine protection and provision of all necessities.

ACKNOWLEDGEMENT

First, I will like to thank the Almighty God for great health and knowledge.

I would like to thank my supervisors Mr. Edgar and Mrs. Abuodha for the support, critic and guidance accorded during the development and documentation of this project.

My gratitude also goes to the spine clinic Africa located in Parklands, for the information and help offered during the development of this project.

Lastly I want to thank myself, for believing and trusting in me. The hard work and effort towards this work. This is a milestone and a great achievement.

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ABSTRACT

Medical adherence in any patient's life is vital in ensuring better recovery and improved quality of life. Medical errors are among the major reason as to why the hospitals are filled with patients who otherwise would have recovered. OrthoSpi android app is designed to help the users maximize their medical orders and achieve them effectively. The spine and orthopedic patients have revealed a need for a m-health solution to their illness journey and recovery process. The innovative technology world has led to the idea for developing a mobile application to help the patients in medical adherence.

The target user that will be using this application are patients or care-givers to patients with spine and orthopedic issues. The major functions that the OrthoSpi application will perform include, remind patients time to take drugs, allow patients to record their daily symptoms which can be generated and used as a medical report and also offer relevant information to the users on various spine issues and how major medical decision are made.

The main source codes used in writing Graphical User Interface (GUI) and the overall system coding is using android studio. The backend platform will be developed using firebase API. Various prototypes will be developed and issued to the users whose feedback will be used to better the application. The iterative and interactive process with the users will continue until the final fulfilling product is developed. More details about the system will be further discussed in this report.

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CHAPTER 1: INTRODUCTION

1.1 Introduction

Discharged patients from hospitals need more medication order compliance creating the essential need for adherence which decreases the chances for hospitalization and mortality, and increases patient quality of life. The most common medical error is lack of patient adherence to physician orders. 5% of hospitals' admissions are because of medication errors that patients themselves commit. The most common patients' mistakes are their in-correct interpretation of physician prescriptions. Apart from the kind of disease, medications interactions, and the quality of patient non-adherence schedules measures, the medication non-adherence mean in chronic diseases is about 50 percent%. Medication non-adherence can be intentional or accidental, these cases include; forgetting to take the medication because of amnesia or dizziness, incorrect dose administration, lack of enough information for the correct administration of the medication, incorrect timing, the incorrect use of the instruments of the medication administration e.g. inhalation medications, lack of enough self-confidence for managing the disease due to being uninformed, lack of enough awareness from the disease condition. Therefore, there is need for a way to remind and keep track of medical administration for patients.

This problem can be averted by use of an interactive mobile application that will constantly remind the patients and caregivers of all the necessary requirements for medication. The application will give all the required information to curb if not all then minimize chance of medical or patient errors.

1.2 Background of the Study

A health reminder application, specifically for Spine and orthopedic conditions patients. Medical orders non-adherence is the most important problem of the health system. Medications' non-adherence causes almost between 43% of the hospitalization and 27% of the nursing home services in the Kenya which in turn costs up to 10 million for the health system. M-health for orthopedic department in the health system is the core of this study. The use of mobile applications is growing and gaining use rapidly over the years in different sectors. With the busy schedules and lots of responsibility and stress people tend to forget about their health and they need to be informed (DiMatteo et al (2004)). Since our lives are dependent on smartphones and technology, we use this

opportunity to maximize their health progress through the reminder apps. Mobile healthcare applications have greatly been accepted in the healthcare organizations and by patients. However, most health reminder applications send the reminder the users through SMSs or Emails depending on the user's preference. This project aims at creating a reminder application for spine and orthopedic patients using the various forms of reminders. The application should also give detailed information and up to date guides on various spine and orthopedic conditions, including treatment, managing side effect, cost of care and latest blogs on orthopedic issues. The proposed system is aimed at enhancing medical applications by making it more specific for patients in the orthopedic and spine department in the health system.

1.3 Problem statement

For many people in the world, remembering to take a daily medication can be the difference between life and death. However, the medical adherence has been a challenge. Road traffic injuries (RTIs) are responsible for a substantial proportion of deaths and injuries and are responsible for more years of life lost than most human diseases. The RTIs contribute greatly to orthopedic and spine issues. Lack of medicine adherence has approximately caused about 125,000 deaths yearly (Murray, et al (2020)). The lack of adequate care for the spine and any orthopedic department issues mostly caused by injuries bring about opportunistic diseases such as septicemia, pulmonary emboli, and pneumonia which arise to inadequate care. Lack of adherence has caused about 9% death rate in the orthopedic and trauma department yearly. Missing appointments is highly directly proportional to an increased mortality rate especially for patients with long term and chronic conditions (Stinner, et al (2017)). The main intent of this project is to have an effective self-care mechanism than depending on the healthcare giver by notifying and reminding the users through alarms and giving them more information that is necessary to manage their conditions. I intend to develop an interactive mobile app with a user friendly user interface that can be used to have a great medical adherence for the patients. It will remind the users the perfect and right time to handle their crucial medical activities to better their conditions. This will in turn be of great benefit to both the users and caregivers.

1.4 Objectives

1.4.1 General objectives

To develop an m-health application specifically for the spine and orthopedic conditions.

1.4.2 Specific Objectives

1. To develop an application that can capture the medical routine of the users and remind them at the right time.
2. To develop an application that allows users to record daily symptoms and how they feel which can be used to generate a medical report.
3. To develop an application that can avail information about spine and orthopedic issues to the patients who are the users.

1.5 Justification

Presently, technology is rapidly growing and almost all specific diseases have various m-health solutions to better their medication activities and orders, there is no better time than now to develop a m-health approach to the spine and orthopedic sector. There is a concerning lack of documentation of health care professional (HCP) involvement during app development. This study will collaborate with the well-known spine and orthopedic specialists to ensure development of high quality and relevant adherence app specifically for this department. Also there is need for patient involvement in the creation of apps. This study will involve focus groups and qualitative assessment with patients in this specific health department to help better the health services. Following are the advantages should this project be realized:

- The patients will have an easy time with scheduling appointments with the specialists.
- Improved patient health and better healthcare delivery.
- The doctors, physicians and patients can use the reports from the application.
- Improved health services for patients in rural and distant areas using the internet.

1.6 Scope of the Study

This is an android based application in which an automatic reminder and alarming system is implemented. It will mainly focus on reminding patients of their main activities and will have the following features:

- i. Capturing their medication routine and reminding them at the right time and the right dosage
- ii. Remind them for their appointment dates.

- iii. Post operation care information such as pain management.
- iv. Information on orthopedic issues.
- v. Allow recording of their daily symptoms and how they feel which can be used as a medical report for these patients to assess their condition by caregivers.

The project will be completed in the second semester academic year 2021/2022. The project targets users, patients with spine issues, orthopedic issues and must regularly follow a medication regimen.

1.7 Limitations of the proposed system

This project is biased to the orthopedic and spine department patients or users. Unclear System Requirement Specification can hinder quality progress of the project. Language barrier to people who do not understand English. Requires a smartphone of android version 4.4 and above.

1.8 Project Risk and Mitigation

- Devices such as laptops, may have technical glitches (crashing) which may lead to data loss. It is advised to have a backup of the work done (code) on GitHub which is a cloud storage and can help recover the lost data in a situation of hardware failure.
- Users of the application may have extreme and unexpected expectations. To avoid this talk through what the project is supposed to do with the users and collect enough data to have the correct System Requirement Specifications (SRS) so as to meet them fully meet their needs and also clearly define the functionalities and all activities of the application to the user.
- The final product being faulty, such as the user interface is difficult to understand and use or the system does not complete its tasks. To mitigate this run tests at each and every stage of development before going to the next stage makes it easy to identify errors and correct them.

1.9 Project Schedule

This gives a brief description of the projects' workload breakdown. All this will be done with the help of my supervisors. The whole project is divided into two major sections Project A and Project B. For the first semester of January- April 2021, I will work on my project A which is made up of

the project proposal document that as 4 chapters. The proposal document gives the design and layout of the application on paper. For the second semester May- August 2021, I will work project B which involves the development, coding, testing and deployment of my application. This can be as demonstrated in the Gantt chart below:

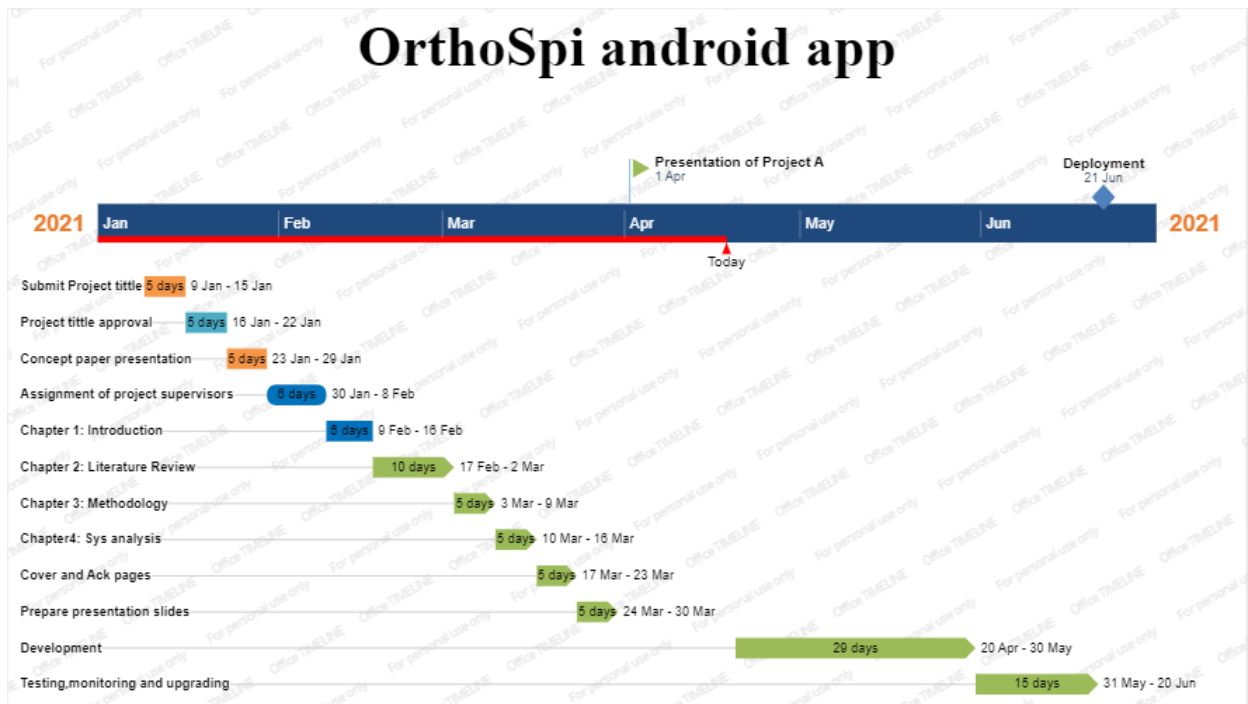


Figure 1:Gantt Chart

1.10 Budget and Resources

The following are the resources I will use.

Hardware

- i. A laptop – for the coding of the mobile application which will have a minimum of core i3 processor, RAM 4GB, hard disk 500GB.
- ii. Ethernet cable- for internet access.
- iii. Mobile phone- an android handset to use for testing of the application.
- iv. USB cable – for connecting the mobile phone and laptop

Software

- i. Android studio version 3.3 with SDK
- ii. Windows operating system for the laptop

iii. Antivirus.

Below is the budgeting:

Budget		
	Item	Amount
	Laptop	Ksh. 30,000
	USB cables (2)	Ksh. 300 each
	Ethernet cable	Ksh. 150
	Mobile phone	Ksh. 15,000
	Internet access	Ksh. 2000 monthly
	Miscellaneous	Ksh. 3000
	Total	Ksh. 54, 750

Figure 2: Budget

CHAPTER 2: LITERATURE REVIEW

Introduction

The idea of a health reminder application is not a new one and has been in existence in the market for some time now. Most patients and healthcare givers have greatly started using the advanced and growing technology in the health system. According to Sanchez et al. (2019), the lack of medical adherence has been categorized as a global problem. In Kenya alone, it is estimated that up to 35% of patients do not take medications correctly, and reasons to lack of adherence are varied from patient to patient (Ogwel et al, 2020). It could be intentionally or unintentionally. These medication errors are therefore a common thing to happen hence there is need to foster and develop more efficient and better methods to enhance medical adherence and minimize the risks due to medical errors.

Various studies show that new technology has been accepted and adopted by literally every population be it in urban, rural and far fetch areas. For instance, the new m-health products have been greatly accepted and adopted by most of the population in Kenya (Ogwel et al, 2020). Currently there exists more than 400,000 m-health applications. Many products have come in existence; some are still in use while others failed. However, the gap to be filled still exists especially for products that are disease or condition specific. Medical reminder applications for various conditions have been developed however, there are no several options for the spine and orthopedic department conditions. The fields of medicine that have received much attention in the upcoming and rapidly growing technology include; oncology department, Comprehensive Care Clinic (CCC) department, Renal (dialysis patients), Cardiac and Heart conditions, Hypertension (blood pressure), Diabetes. M-health applications have proven to be a success to many more specialties all being non-spine patients and it will be very important in spine specialty.

The spinal surgery patients face various challenges in post-operation rehabilitation, pain management, and complications. Developing an application specifically for this will increase quality of life and patient satisfaction from healthcare providers. It will help track their post-operative progress and enhance communication with their care givers (von Glinski et al, 2020).

2.1 Reviewed Similar Systems

2.1.1 The Spine app

This is an application designed to help patients, spine related patients to get information about spine diseases including the causes, possible treatments and protocols for decision making regarding surgery both preoperative and postoperative. The Spine App can be used to prepare for a doctor's appointment especially when preparing for a scheduled surgery or to help understand a doctor's recommendation for the post-op care. This application only gives information on spine diseases and aid in understanding how surgery decisions were made but does incorporate reminders.

2.1.2 Cancer.Net Mobile

This is an application designed and developed to help cancer patients. The application includes features that allow patients to get up to date information on various types of cancer, log and track their treatments, receive advice on how to manage side effects, provide cost of care information, and connect to links for cancer-related podcasts, videos, and blogs. This application solves the similar problem however, for cancer patients (Cancer.Net, 2020).

2.1.3 MyTherapy

A pill reminder and medication tracker. MyTherapy is open-source and free platform that is easy to use to remind the users to take their medication. It also allows to keep track and take vitals and symptoms. The application also has a feature of a built in health journal that allows the user to keep a record of their symptoms (Farooq et al, 2020).

2.2 Tools and Methodologies used in Reviewed Systems.

2.2.1 The spine app

The application was developed and created by a vetted spine doctor. The application designed to help patients from all over the world to get in-depth information about spine diseases including the causes, possible treatments and protocols for used to make decisions regarding surgery. It is used to prepare for a doctor's appointment or to help understand a doctor's recommendation. The supplication basically just gives a comprehensive guide on the most common spine issues. Once logged in the user can access various features supported by the application. The features include:

1. The application gives sufficient information which helps the user to learn and know when to visit a doctor.
2. Gives necessary information about treatment of various spine diseases.
3. Aid in understanding how the surgeons make the surgery decisions.
4. Receive detailed and up to date information on various common spine issues.

2.2.2 Cancer.Net Mobile

This is a similar system to the proposed system. It was developed and created by the American Society of Clinical Oncology. It is a free application, available on both iOS and Android devices. Cancer.Net Mobile provides a fully-featured set of tools to help manage cancer care, as well as trusted, oncologist-approved information from Cancer.Net. The application has the following functionalities and features:

1. Appointments - Enter appointments with health care providers, view upcoming appointments, history, and sync with device calendar.
2. Get Information - Up-to-date guides on 120 plus types of cancer, including treatment, managing side effects, cost of care, and living with cancer, as well as the latest videos, podcasts, and Cancer.Net Blog posts.
3. Record Questions- this feature tracks questions for your doctors and record their answers. Link questions to providers, medications, and symptoms.
4. Log Medications – allows taking of photos of medication labels and bottles. Input dosage, frequency, and prescribing provider. Set reminders and log when medications are taken. Link medications to symptoms, providers, and questions.
5. Providers - Records health care providers' full contact information. This allows assigning medications, questions, symptoms, and appointments to specific providers.

Cancer.net Mobile offers an easy, user-friendly interface for people with cancer and for those helping them. Once the basic information is logged, it is simple and fast to track side effects, questions as they occur. When used consistently, this app can help manage symptoms and facilitate communication with health care providers, during or after cancer treatment.

2.2.3 MyTherapy

MyTherapy reminds you to take your medication, to get active and to track your vitals and symptoms. This application is not disease specific, it is general and all it does is track and remind about pills. For registration you need nothing but a valid email address. The application is free for android and iOS and was developed by SmartPatient GmbH based in Germany. This system has the following feature and functionalities:

1. Reminder for medication, measurements and activities
2. Supports a wide range of measurements such as blood pressure, weight and blood sugar.
3. Built in journal with a monthly .pdf report

2.3 Gaps in the existing system and proposed solution

There is still space for design and features to be included in the current systems. The features include;

1. Making a user friendly application.
2. A disease specific application, the proposed system is specific to the spine and orthopedic conditions.

Even though there have been different modifications of the various applications that have been created to try and help patients, there still lies a window of improvement as some issues remain unsolved. While trying to solve one problem, more problems may be created and therefore there will always be a gap with the rapidly and frequently growing technology. However, with more research and the development in technology, the room for improvement is wide.

CHAPTER 3: METHODOLOGY

Introduction

The proposed system is meant to help patients, specifically the spine and orthopedic patients adhere to medical orders. While at it should be user friendly and meet all its requirements. This project aims at helping patient effectively maintain their medical conditions and minimize the most common medical error. Its immediate goal is to keep the users fully informed on the various spine and orthopedic medical conditions. The proposed system will always allow printing out of the daily symptoms recorded which can be used as medical reports.

To accomplish this project, there is need to collect data. This will be done using various techniques such as observations and questionnaires. The data collected will help in designing and developing a system that will fully satisfy the users.

The final product of the project will be a mobile application that will run on smartphones. Once it is complete, users will interact with it to suggest changes or modifications. The application will be published on Goggle App Store. It will be advertised over social media platforms such as Twitter, Facebook and Instagram.

3.1 Methodology and Tools

3.1.1 Methodology

To develop the system, I will use one of the system development methodologies that will be best suitable for this project. Rapid Application Development(RAD) method will be used. RAD is an agile project management strategy popular in software development. The chosen methodology will help reduce the cost of development as well as the time needed to develop the mobile application. In accordance to the methodology, I will depend on prototyping and user involvement. This methodology allows users to examine the working model as early as possible, determine if it meets their needs and suggest necessary changes. Based on their input, I will modify the prototype while continuing the interactive and iterative process until the system is fully modified and fully meets the user's expectations and needs.

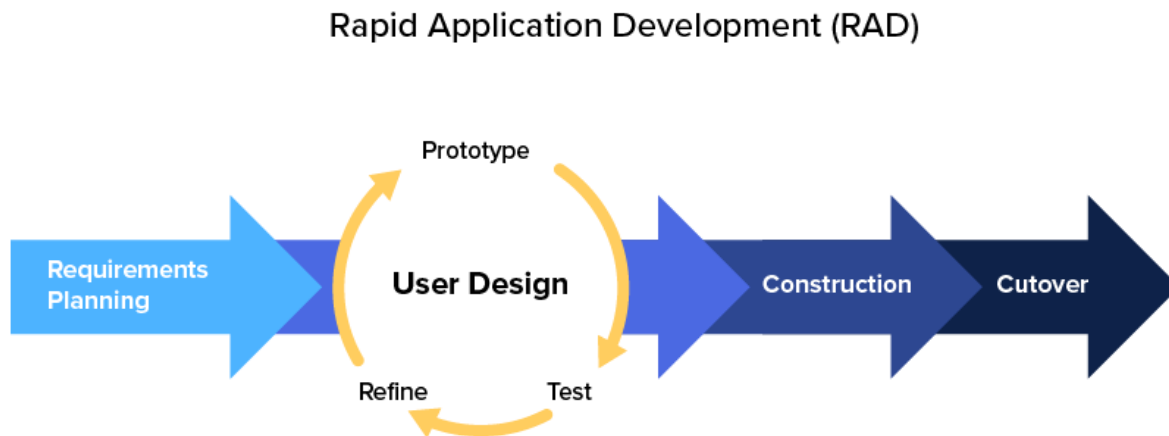


Figure 3: RAD methodology

3.1.1.2 Justification for choosing RAD

I choose RAD methodology because of the following reasons:

- i. It accommodates changes in design of the interface and requirements at any stage during the development process.
- ii. The prospective users will be given multiple chances to share out their requirements and feedback. Their input will in turn be used to modify the prototypes until the final product is produced.
- iii. Developing the system using RAD is less costly and less time consuming.

3.1.1.3 Steps in RAD

1) Requirements Planning

This is the first phase of the whole process and involves planning and analysis. It majorly involves the project scoping. I will meet with the spine Health Care Professionals, patients and caregivers who are the prospective users and get their insights which will be used to finalize on the requirements of the system.

2) User Design

After the project scope is defined. The building and development process of the system kicks off. I will interact with the users develop prototypes that represent all system process, inputs and outputs which will be presented to the users. The users will test the prototype and give feedback which will be used to refine the system until it fully meets the users' needs This stage will be a continuous interactive process that will allow the prospective users to understand, modify and finally approve the working model that meets their needs.

3) Construction

I will focus majorly on program and application development. This phase will involve the coding and getting hands on developing the working product. However, users will still be allowed to suggest changes or improvements as actual interfaces are developed. They can suggest alterations, changes, or even new ideas that can solve problems as they arise.

4) Cutover

This is the implementation phase and the product is launched. I will publish the application, and upload its installation file to google play store.

3.1.2 Tools to be used in the methodology

This methodology will use various system design tools to show the conceptual and logical flow of the processes in the application. This system design tools use shapes that have distinct logical meaning to describe the whole system.

3.1.2.1 Flowcharts

A flowchart a graphical representation of steps in sequential order. I will use flowcharts to show the breakdown of the application process into logical parts that are easily understood by the user. They will show how various processes such as user registration, login, log medications etc. occurs in the system. They will be drawn using an open-source tool for drawing flow charts called flowchart maker.

3.1.2.2 Data flow diagram

A Data Flow Diagram (DFD) assists in visualizing how the information flows within the application. It shows the data required to complete a particular process and the result produced. It also shows the actors involved.

3.1.2.3 Use case diagram

A use case diagram is a representation of the user's interaction with the system. They are used to show what the user can do in the system under development. They represent the functional requirements of the system. I will draw the use case diagram using Visual Paradigm online free edition, an open source tool for drawing use case UML diagram.

3.2 Source of Data

There are various methods to collect and gather data. I will use both source of data in the development of this project. This data will be collected using the various methods and techniques available.

3.2.1 Primary data

This the first hand information, it is collected for the first time ever and is usually considered most reliable. This is the data I will personally collect from the prospective users.

3.2.2 Secondary data

This is second-hand information and it is obtained from already existing sources of information. They are not originally collected but obtained from other sources.

3.3 Data collection methods

In order to ensure that the data I collect is reproducible, accurate and stable, I will use the following data collection techniques.

3.3.1 Questionnaires.

Questionnaires will be used to gather information. I will use questionnaires since they are relatively easy to administer and analyze. Their format is also widely used, common to many people and thus no user training is required. Questionnaires will also be cost effective. The respondents of the questionnaire will be the prospective users.

3. 3.2 Interviews

Interviews involve a structured conversation where one participant asks questions, and the other provides answers. I will use this method because of its fast feedback. I can also measure the sincerity of the user who is the interviewee by observing his/her facial expressions. The interviewee can present suggestions that I might have overlooked.

3.4 Resources required/materials

Hardware specifications

1. A Laptop -Running at-least a Core i3 processor, with at-least 500GB hard disk capacity and 4GB RAM.
2. USB cables.
3. An Android handset to debug and test the application.
4. Ethernet cable.

Software Specifications

1. Operating system -Windows.
2. Antivirus- Kaspersky Antivirus.
3. Android Studio 3.3 with SDK.
4. Backend platform –Firebase API

3.5 Time schedule

This project will take a minimum of 3 months (the duration in which we cover the second semester) to develop to a full and working solution. The duration will be broken down into 4 timeslots for each and every module of the RAD development methodology. The project should be complete within this time.

3.6 Project cost

The cost of the project is as the estimated cost in the budget. The cost is Ksh 54,750, this has broken down below;

Item	Amount
Laptop	Ksh. 30,000
USB cables (2)	Ksh. 300 each
Ethernet cable	Ksh. 150
Mobile phone	Ksh. 15,000
Internet access	Ksh. 2000 monthly
Miscellaneous	Ksh. 3000
Total	Ksh. 54, 750

Figure 4: Cost

CHAPTER 4: SYSTEM ANALYSIS AND REQUIREMENT MODELING

4.1 Introduction

This entails the structural analysis of the existing system with the aim of gaining insights for improvement. There are various systems aiming medication reminders for medical adherence. With new needs and need for more sense and relevance to users there have been need for disease specific applications.

With the new emerging trends in technology, more possibilities are available and open for the problem solvers to venture into mobile health, m-health.

4.2 Objectives of the system analysis

The major objective of system analysis is to understand how things are currently being done and what improvements are needed. It will help in building the new proposed system that will better meet the users' needs and satisfaction.

The system analysis will help identify the gaps in the application available for use by patients. It will in turn improve delivery to users and improve the quality of life in the long run.

4.3 Problem definition

Managing and treating of spine surgery patients has been a challenge to both care workers and medical practitioners. The process requires a care worker or an alert patient with strong self-discipline to diligently follow the treatment process to achieve a positive treatment reaction. The patients also need to get enough information on their conditions in order to know how well to manage themselves to improve quality of life.

4.4 Feasibility Study

There is need to assess the viability of the proposed system. I carry out a study that will provide the management with enough information regarding the proposed project to determine whether the project should be accepted, discarded, or the objective redefined (Hafiz et al, 2019).

4.4.1 Technical feasibility

This was carried out to ensure that the hardware, software and other requirements on technology required to deliver the project were available. The technical requirement for the proposed system are as follows:

Hardware Requirements.

- i.) A laptop – for the coding of the mobile application which will have a minimum of core i3 processor, RAM 4GB, hard disk 500GB.
- ii.) Ethernet cable- for internet access.
- iii.) Mobile phone- an android handset to use for testing of the application.
- iv.) USB cable – for connecting the mobile phone and laptop

Software

- i. Android studio version 3.3 with SDK
- ii. Windows operating system for the laptop
- iii. Kaspersky - Antivirus.

4.4.2 Economic feasibility

The system is studied and a cost benefit analysis done. It outlines the costs for developing the mobile app and the support it will need. The benefits of the system were compared to the development cost. The benefits of the system included;

- i. Improved health of patients
- ii. Reduced medical errors which reduce the health care provision cost to both the patients and governments
- iii. Easy access to information necessary to the patients.

4.4.3 Operational feasibility

Operational feasibility checks if the system proposed conforms to the normal ways that are currently in use. It also assures its user friendliness. The report on operational feasibility will show how well the proposed system solves the problem defined early. In the current system the patients are given their medical prescriptions and they have to constantly remember in order to keep up with it. Alternatively, they can use the general purposes applications that are available and try

tailor them to their needs. The available applications can only offer a way to remember when to take drugs and maybe remind them for their scheduled appointments.

The proposed system is going to be more specific to the orthopedic and spine patients and will fully be functional to all their needs. Most importantly it will provide information about various spine and any complications which help improve the patients care. The proposed system does not in any way affect the delivery of services in the healthcare system but rather improves patient care. There will be no altercation nor change in the normal way of delivery of services as a result of implementing the proposed system's use. All that will be needed is an android mobile phone and ability to navigate through the application.

4.4.4 Schedule feasibility

This is a feasibility study done to assess the time frame within which the system will be developed and availed for deployment. The time of beginning and termination that is realistic and achievable. The time frame for the proposed system is based on the semester dates. The project should be complete by the end of the second semester. The project time line was divided into 4 slots that will each achieve a milestone. The final product is to be completed within the stipulated time.

4.5 System analysis tools

4.5.1 Use case diagram

A system analysis tool used to capture the functional requirements of the system while showing the user's interaction with the system. The actor of this system is the user who is the patient or caregiver.

4.5.2 Flowchart

This is a system analysis tool that I will use to show the steps in sequential order. It will therefore, present the flow of algorithms, workflow or processes of the proposed android application.

4.5.3 Entity Relationship diagram

I will use an ER diagram to explain the logical structure of the database of the proposed system. ER diagrams are created based on three basic concepts entities, attributes and relationships. They will be used to give a visual representation of different data using conventions that describe how these data are related to each other.

4.6 System investigation

4.6.1 Introduction

This is the process of finding out what the proposed system is being developed to do and if it is feasible. The analysis is done to ensure that the proposed system does the work the existing system does and even more innovative. The proposed system should be able to fulfill all the functions it is expected to have. The process of system investigation is done using the various available techniques such as questionnaires, interviews, observation of the current system operations and surveys. The results of this technique gives necessary data to be used in building and developing the proposed new system.

4.6.2 Data collection

Data was gathered and analyzed using various methods. The sample set used in the research was a definitive part of the population expected to use the application. The techniques I used to collect data were, interviews, questionnaires and observation.

4.6.2.1 Questionnaire

I collected data for this project using questionnaires created using Google Forms and shared online via social media platforms. I also issued the questionnaires to the patients and health care professionals at the Spine and Speciality Hospital. I used open and closed questions. The figures 25 and 26 at the appendix show the questions that were asked. The questionnaire got 60 respondents. The questionnaire was administered online and the feedback from the respondents were as reported below. I used pie charts to record the response from the questionnaires.

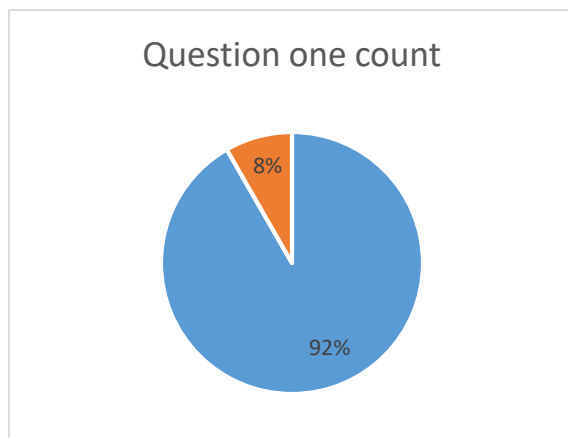


Figure 5: Response 1

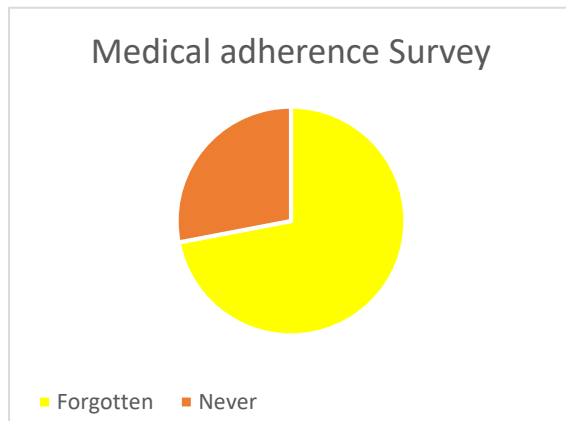


Figure 6: Response 2

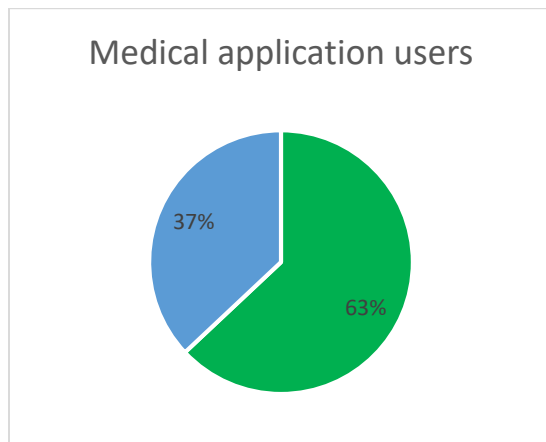


Figure 7: Response 3

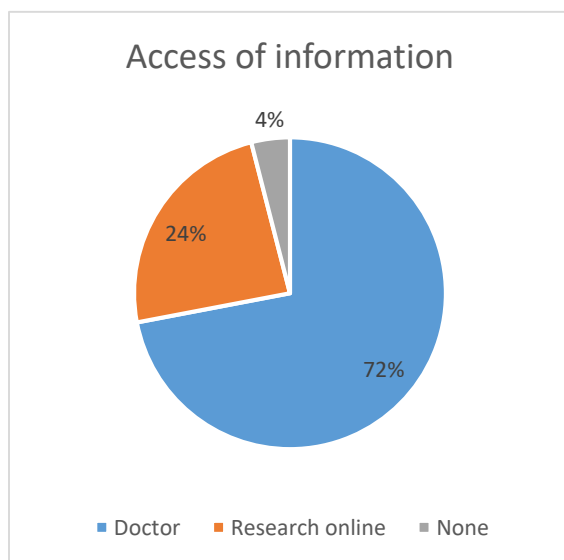


Figure 8: Response 4

Most of the respondents keep track of their medical instruction due to their own initiative. They have to remember or a member of the family who is in charge of ensuring there are no medical errors reminds them. Some also indicated that they set alarms using their phones.

4.6.2.2 interview

I conducted an in-depth interview to the key informants of the proposed system. I conducted the interview at the Spine and Speciality hospital located at parklands. At the appendix there is the interview guide I used to conduct the interview.

Data was collected through a recorded face to face interview to 3 interviewees. I interviewed a doctor, nurse and one patient. I used my phone to record the interview sessions. From their responses, there is need to incorporate m-health to the spine and Orthopedic department just like it has been done in other health departments. With the growing use of technology an application will be accepted easily.

Based on the responses and the whole data collection activity, it is evident that there is no actively used application in the orthopedic department. Most of my assumptions were made from the interview as it was more interactive compared to the questionnaire. The patient and doctors as well as the nurse all said that they did not know any m-health application that had been tailored down to the orthopedic department alone despite the existence of the spine app. However, from the questionnaire most respondents agreed to have used an m-health application at least once.

4.6.3 Fact recording

This is a recording of the system requirements. It will give a detailed definition of the system requirements and specification of the project.

4.6.3.1 System requirements

These are the functionalities of the proposed system. The core requirement of the system is that it should remind the users of their time to take drugs, scheduled appointments and training and health measurement time. It will be able to generate reports on request, which can act as medical reports. The system has only one user. Majorly the patient or a caregiver to a patient under given medical instructions. Below are the functional requirements of the system which have been tailored down and incorporated from the current system.

- i. The system should allow an aspiring user to create an account and log in.
- ii. The users should be able to add their medication regimen.
- iii. The application should allow users to add their scheduled appointments.
- iv. The application should allow recording of daily symptoms
- v. The users should be able to add their measurement taking and training times.

The systems non-functional requirements are:

- i. User-friendly – The application user interface should be simple and easy to use
- ii. Interactivity – The application prompts for input where needed and validates the format of the input.
- iii. Performance – The application performs its operations effectively and efficiently.
- iv. Adaptability – The application should be compatible to several android SDK versions and integrates their different features seamlessly.
- v. The system will be available 24/7.

4.6.3.2 Input requirements

These are the prerequisites and requirements to develop and implement the system. The android application will be developed and implemented using Android Studio with Java. The database will be implemented using Firebase.

4.6.3.3 Output requirements

The expected result is a working android application. The application should be able to remind the patients of their schedules. The application should also be able to generate an out which can be used as a medical report. It will generate a report upon request.

4.7 System analysis

This involves analyzing the program requirement in current and existing system to find out if requirements in the current system can be used in the development of the new system. The aforementioned requirements are requirements of the proposed system in this project.

4.7.1 Flowchart of the existing system

This is the flow chart of the current and existing system. The existing system has only 3 activities as shown in the flow chart.

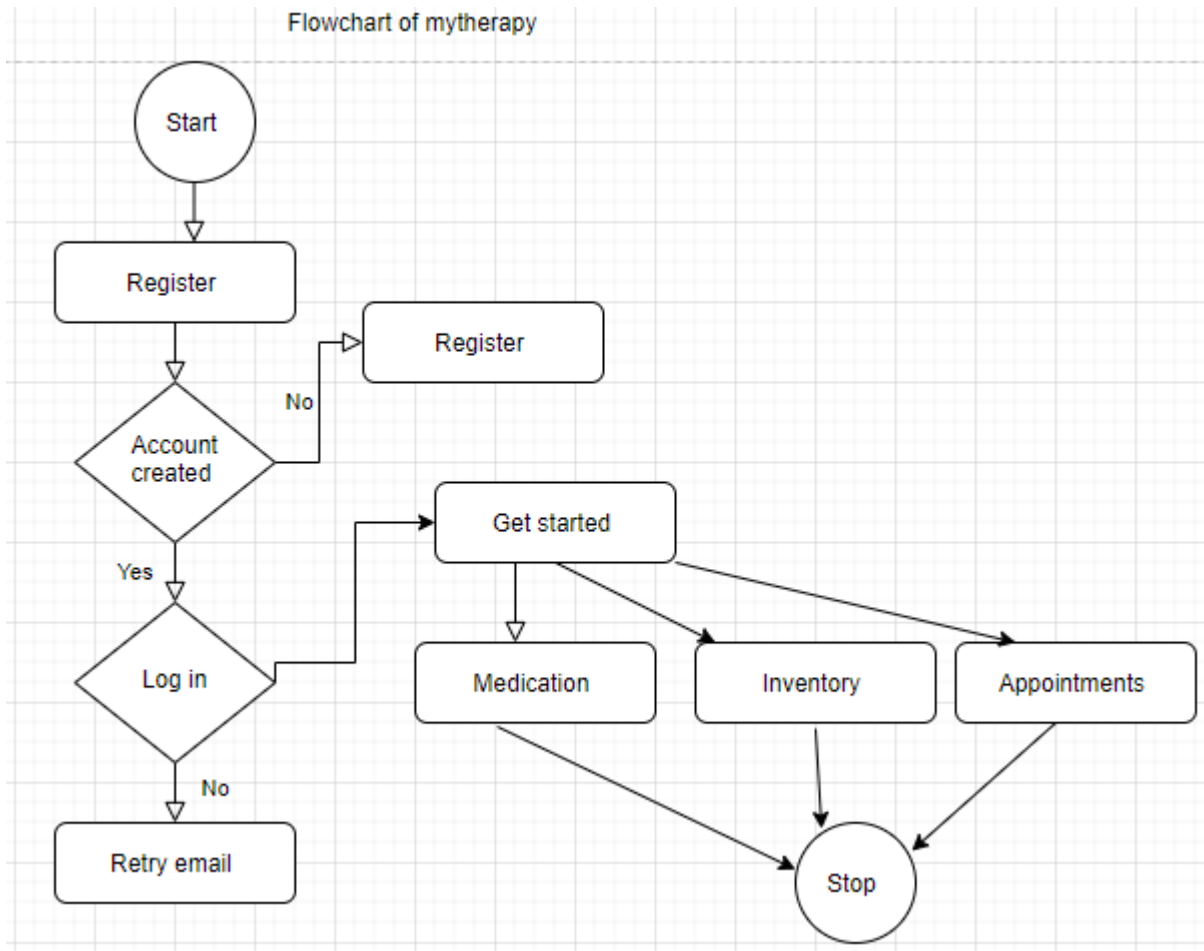


Figure 9: Flowchart to existing system

CHAPTER 5: SYSTEM DESIGN

5.1 Introduction to system design and nature of the system

This chapter involves the use of design objects to describe the various modules, interfaces, components and the data required to achieve the required functionalities of OrthoSpi android app. The app is built using the Object-Oriented Approach hence involves the project being divided into classes, methods, and functions which communicate with each other. This chapter will give a detailed description of the specified requirements outlining the design used to achieve the desired features of the app.

5.2 Design Objectives

Will designing the application, the following are the expected objectives that it should meet;

- i. User-friendliness – the design of the application aims to be easy to learn, understand, and use for any user who may want to keep track of their spine and orthopedic medical regimen.
- ii. Convenience – the application is designed to give convenience and avail a variety of informative resources to the patients.
- iii. Remind the patients of their dosage timings through an alarm ringing system cultivating a habit that helps them better meet their health goals.

5.3 Program Design Tools

These are the tools to be used in designing the application. They are the same tools discussed in chapter three, methodology.

5.3.1 Flow chart

This is the flow chart of the proposed android application. A graphical representation of the sequence of events in the system. It describes the flow of events from launch of the application, through the execution of tasks up to the completion of tasks and ending of the application.

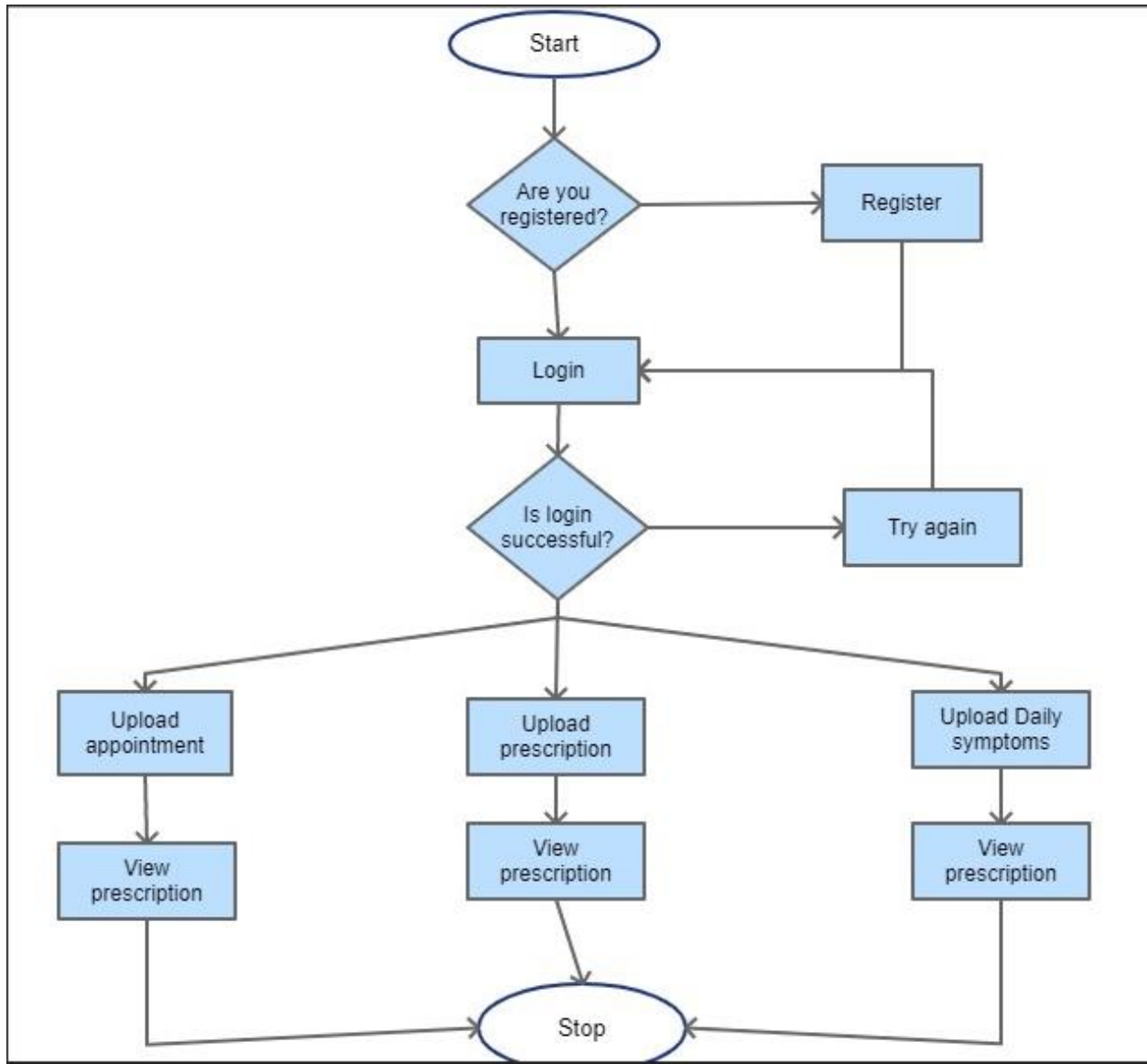


Figure 10: Flowchart diagram

5.3.2 Use case

This is the use case of the proposed android application. This system analysis tool is used show a graphical visualization of the user interaction with the developed system.

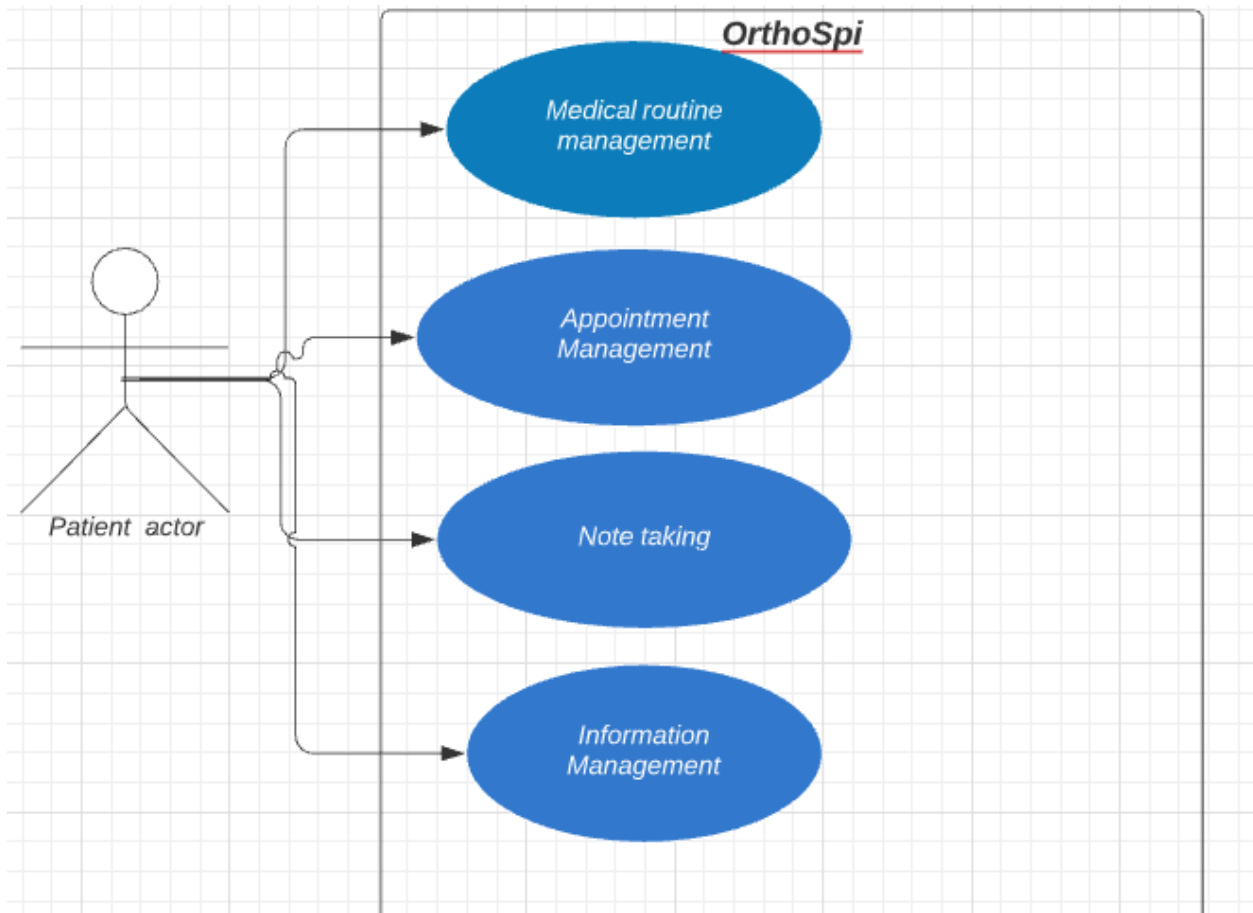


Figure 11.: Use case diagram

5.3.3 Data flow diagram

This is the data flow diagram of the proposed android application. This tool is used to show the flow of data in the system.

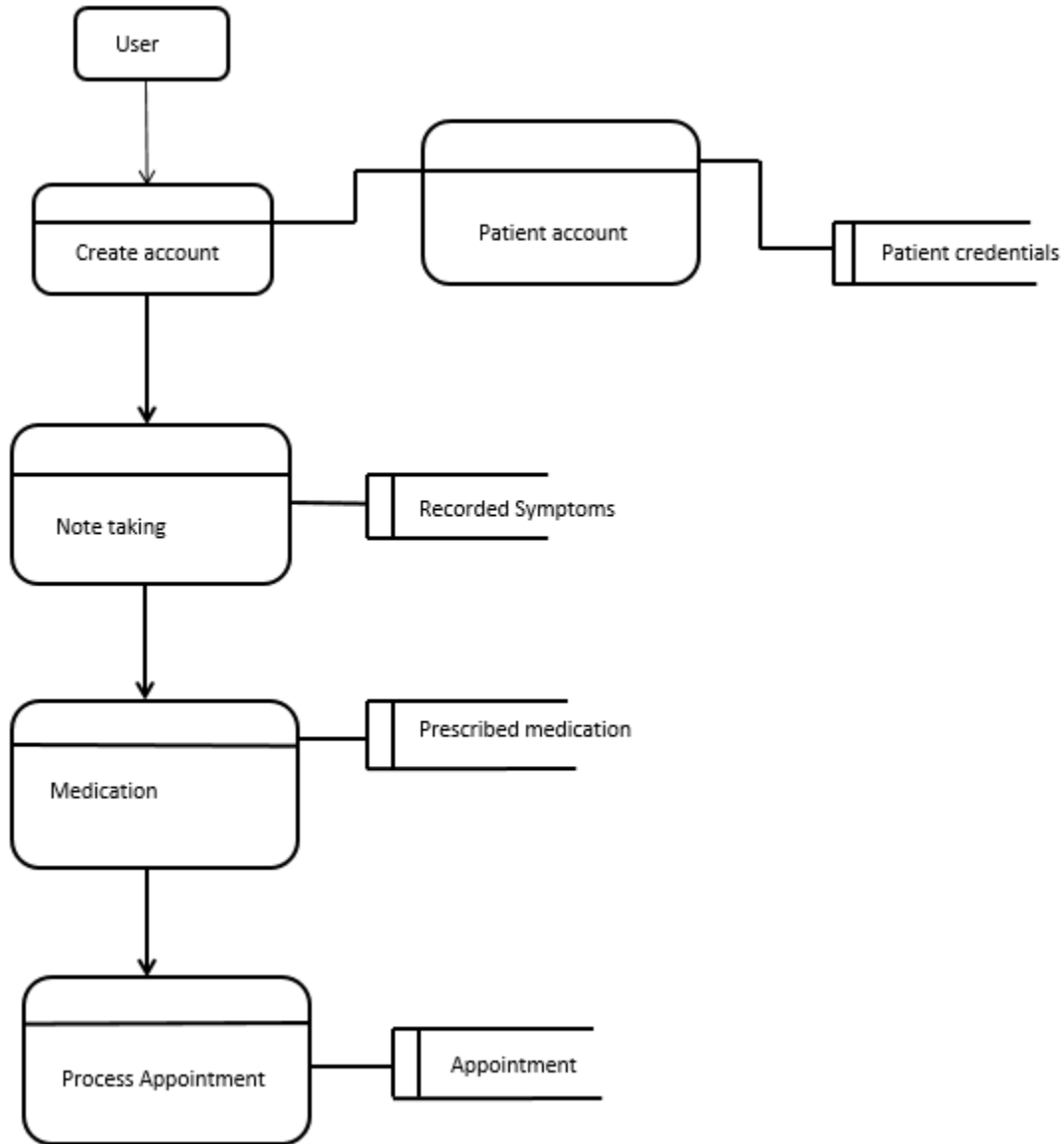


Figure 12: Dataflow diagram

5.4 Logical Design

5.4.1 Logical data design

A logical design is a conceptual, abstract design hence is developed after the conceptual model. It entails defining the types of information that will be needed. The process of logical design involves arranging data into a series of logical relationships called entities and attributes. This involves data modelling which is the first and essential process for database design. In logical design, the identified data and their relationships are mapped into a data schema for the underlying DBMS (Database Management System).

5.4.2 Entity life history

According to Beynon-Davies (1998), an entity life history is a diagrammatic method of that demonstrates how information may change over time, and models the complete list of events that can affect a data entity from the time of its creation to its deletion, the context in which each event might occur, and the order in which events may occur hence follows a strict sequence and is read from the left to right.

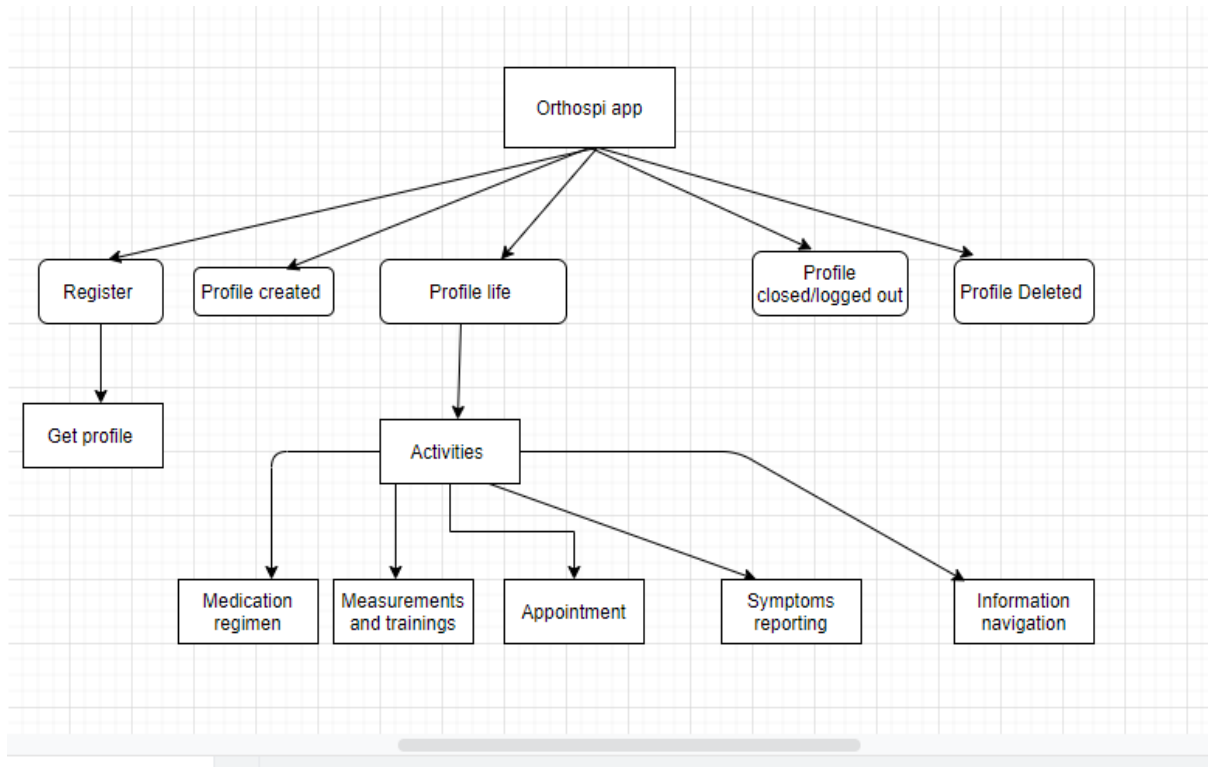


Figure 13: Entity life history diagram

5.5 Physical Design Description

5.5.1 Data dictionary

1. Medication

Data Name	Data Type	Description	Allow Null value
Name	String	Name of the medication incurred such as paracetamol	NO

Type	String	Type of the medication e.g. pills or syrup	NO
Time	Time	Indicates the time which the medication should be taken hence reminder goes up	NO
Amount	Integer	The amount that should be taken e.g. 5ml, 2 tablets	NO

Figure 14:Medication table

2. Appointment table

Data Name	Data Type	Description	Allow Null value
Name	String	Name of the scheduled appointment	NO
Time	Time	Indicates the time when the appointment is scheduled for hence reminder will go off at a given time	NO
Place	String	The place the appointment will take place	NO

Figure 15:Appointment table

3. Training table

Data Name	Data Type	Description	Allow Null value
Name	String	Name of the physiotherapy exercise	NO

Time	Time	Indicates the time when the physiotherapy will take place and time for reminder	NO
Place	String	The place	NO

Figure 16: Training table

4. Information table

Data Name	Data Type	Description	Allow Null value
Name	String	Name of the information	NO
Size	Large_Integer	Stores the file size	NO

5.5.2 Database Design

The android application will use an SQLite database system. SQLite database is mostly used to perform various database operations on android devices such as storing, manipulating, or retrieving persistent data from the database. The database of the proposed android application consists of 4 tables that will be used to store data and from which the data will be manipulated and retrieved. The stored data will be manipulated to generate reports that may act as medical reports for the doctors and physicians. The data will also be used to generate the reminder.

5.5.3 Input Screen

Below are the input screens for all table entries. The screenshots show the input screens of the android application.

5.5.4 Output Screen

The screenshots below show the output screen design of all the activities supported by the application.

5.5.5 Code Design

The application is being built by writing codes using Java Programming Language using Android Studio 3.5 Integrated Development Environment. The application will follow the Rapid Application Development methodology. It will make use of the various Java features and data structures such as Arrays and lists. Extensible Markup Language (XML) is used to build the User interface (UI).

CHAPTER SIX: SYSTEM IMPLEMENTATION

Introduction

System implementation describes how the different parts of the system are interacting with each other to give us a feasible software solution.

This chapter describes how the various functionalities of different system modules and other technical areas like databases have been successfully implemented to ensure that the whole system is functional. It explains the Tools used for coding and testing, System test plan. It also addresses the testing hence explaining the data used to test and the approach. Lastly it covers the proposed Change-over techniques.

6.1 Coding/Environment/Debugging Techniques.

6.2.1 Coding tools

The application is an android application hence the implementation of this project is android based and therefore android studio was used.

The user interfaces of this project are designed using Extensible Markup Language (XML) language and the logic implemented through Java.

The Database Management System used was SQLite Database with the connections being done using standard SQL language.

6.2.2Envrionment

The android application was developed using android studio IDE using the Java framework.

6.3.3 Debugging tools

During the development of this application I used the debuggers in android studio. Android Studio IDE has a powerful debugger that identifies and offers suggestions on how to correct syntax errors that may arise during the coding proves. Additionally, it has a logcat that may show and identify errors that occur during runtime to allow the developer to correct the errors.

6.2 Program Listing

A list of print code is provided at the appendix.

6.3 System/Program testing

According to (Huang 1975), testing refers to the comparison between the expected results and the actual results of a system. Hence the activity of testing aims at evaluating the developed application for results it produces if they are of quality and as expected. The application was subjected to test inputs or test cases and observing to see if it behaves as expected. The testing method used in this project was Unit Testing.

Unit testing involves testing each module at a time with the main aim being on checking whether the system as a whole achieves all it is supposed to. Hence the execution method used is not essential as long as it achieves effectiveness. Checking each unit individually helped to assess whether the software did the expected tasks and gave the expected results. Various data was keyed into the system to assess the system's performance. below is the data that was used for testing;

Test case 1: User logging in

Test case Summary	To verify user login using email address
Prerequisites	None
Test procedures	Enter an email address
Test data	User generated
Expected result	User is logged in to the application.
Actual results	User is logged in successfully
Status	Pass

Figure 17: Log in testing

Test case 2: Testing adding medicine

Test case Summary	User to add medication
Prerequisites	User logged in
Test procedures	The user types in the medication name.

	Sets the starting time and the interval that the notification will be sent.
Test data	User generated
Expected result	User receives a notification when the time for medication reaches.
Actual results	The user received the notification
Status	Pass

Figure 18: Adding medication testing

Test case 3: Creating an appointment

Test case Summary	User to add an appointment
Prerequisites	Logged in
Test procedures	Click on icon for creating an appointment. Add the place and time the alarm should go up
Test data	User generated
Expected result	The user creates an appointment successfully. And alarm goes up a time before the meeting time.
Actual results	The appointment was keyed successfully. The alarm went up.
Status	Pass

Figure 19: Appointment testing

Test case 4: Notes taking

6.4 Proposed Change-Over techniques

I will implement a pilot change-over technique as the application is rolled out and deployed. This technique involves deploying the application to a sample group of users while increasing to a larger number with time. The technique will allow using the existing application while learning and adopting to the new system.

This technique is advantageous in that, in case of failures, there are fallback applications that will be used in place. The application is widely tested and its flaws are easily found therefore improving on its performance and quality. It is also cost effective since it requires incurring less expense to deploy to a small group rather than deploying in large scale.

6.5 Test data

This is the database schema which has been used to test the application's functionalities:

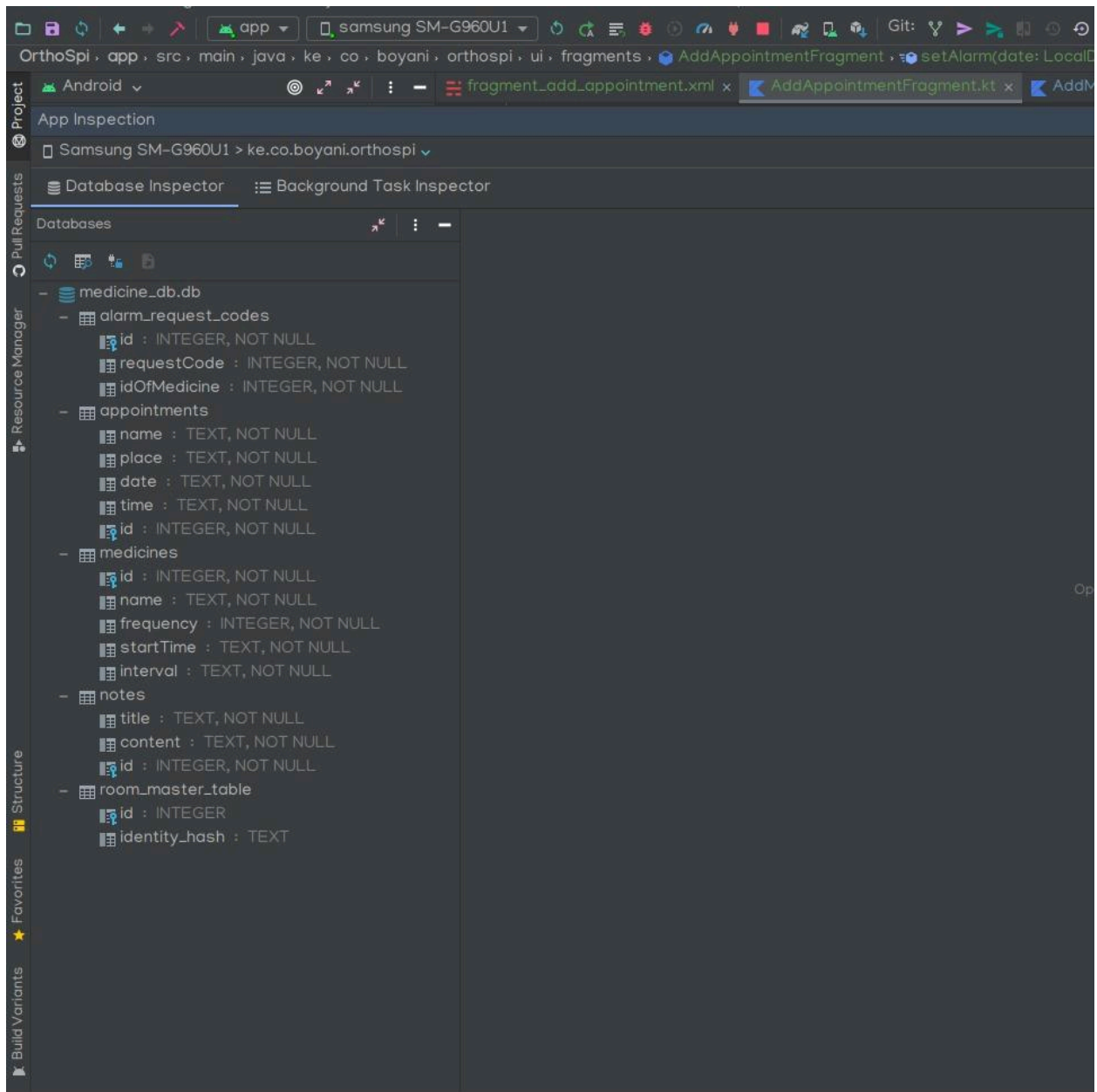


Figure 20: Database Schema

6.6 Sample Run- Output

CHAPTER SEVEN: USER MANUAL - DOCUMENTATION

7.1 Installation Environment

The project is android based hence the installation environment will be of Android operating system. Which is a mobile OS. Therefore, the application will be installed in android devices.

7.2 Installation Requirements

The system will be distributed as an APK file downloadable on Google Play Store and will be available to android devices from Android 4.4 KitKat and above labeled as OrthoSpi. Hence the user must have a mobile device with android OS of version 4.4 and above.

7.3 Installation Procedures

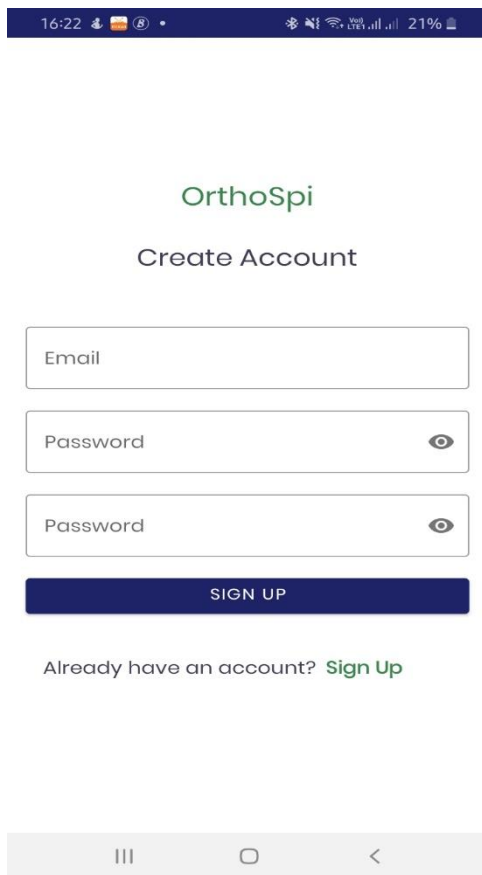
The app is pretty simple to use. However, manuals and physical tutorials will be provided to the users of the system. To use the app;

- Download the .apk file labeled as OrthoSpi which will be shared.
- Click on it after downloading, and the OS will ask you to install the app or cancel.
- Click on 'Install' and you can start using the application.

7.4 User Instructions

This are the instruction and procedure to be followed on how to use the system.

7.4.1 User sign up for an account



16:22 21%

OrthoSpi

Create Account

Email

Password

Password

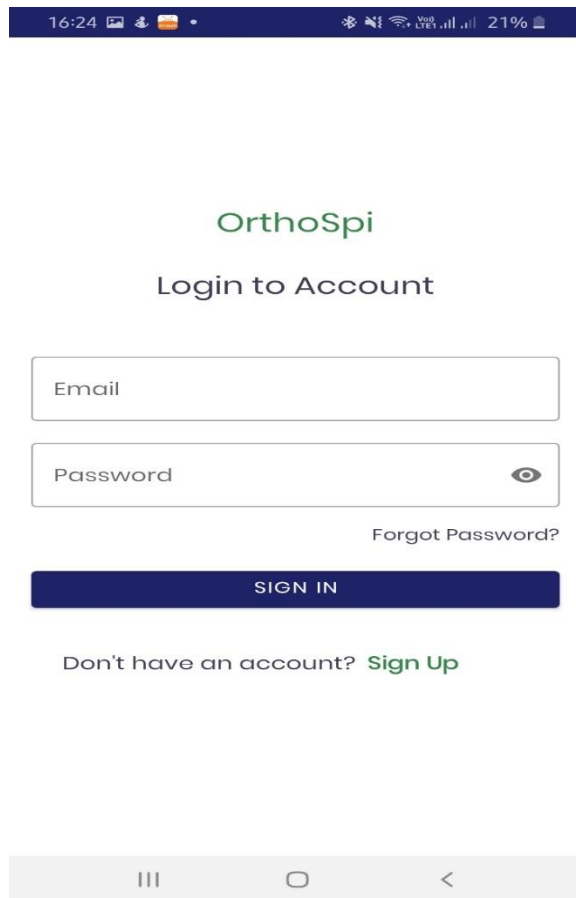
SIGN UP

Already have an account? [Sign Up](#)

Figure 21: Sign up screen

After downloading the app, the user is expected to create an account before using the application. To use the app, you must create an account. Below is a captured screen of the sign up screen of the app.

7.4.2 Sign in to account




16:24 21%

OrthoSpi

Login to Account

Email

Password 

[Forgot Password?](#)

SIGN IN

Don't have an account? [Sign Up](#)

III O <

Figure 22: Sign in screen

If the user has an account already they can log in and start using the app. Above is the Log in screen of the application.

7.4.3 Home screen

After the user is successfully signed in through the home screen, they can navigate through the app and use it. The home screen has a bottom navigation of the add medication screen and an A avatar which has my appointment screen and my notes screen. Through the avatar is where the user can log out also. The screens are as shown below.

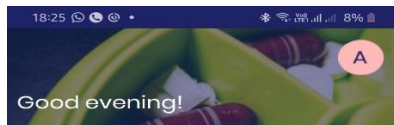


Figure 23: Home Screen

Figure 24: Add Medication Screen

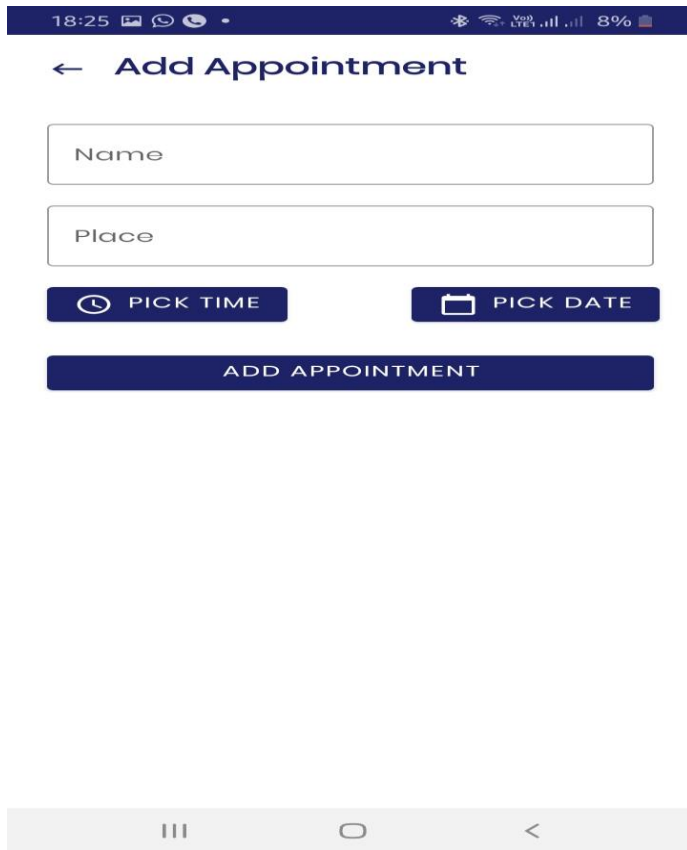


Figure 25:My appointment screen

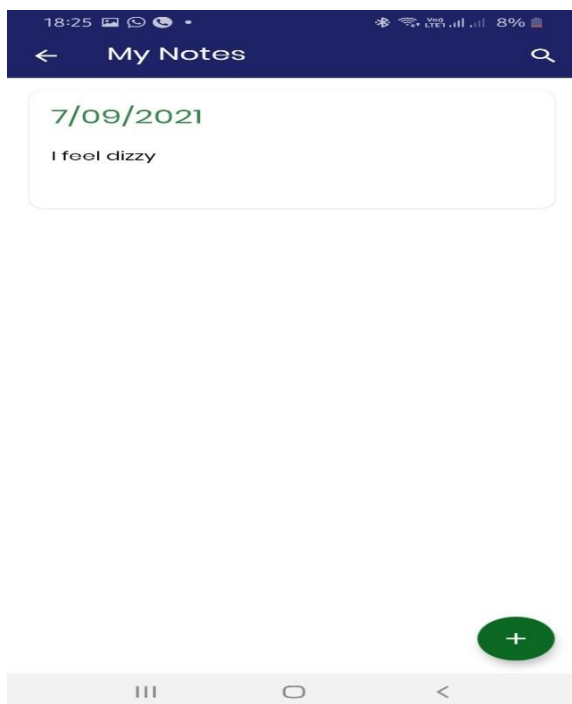
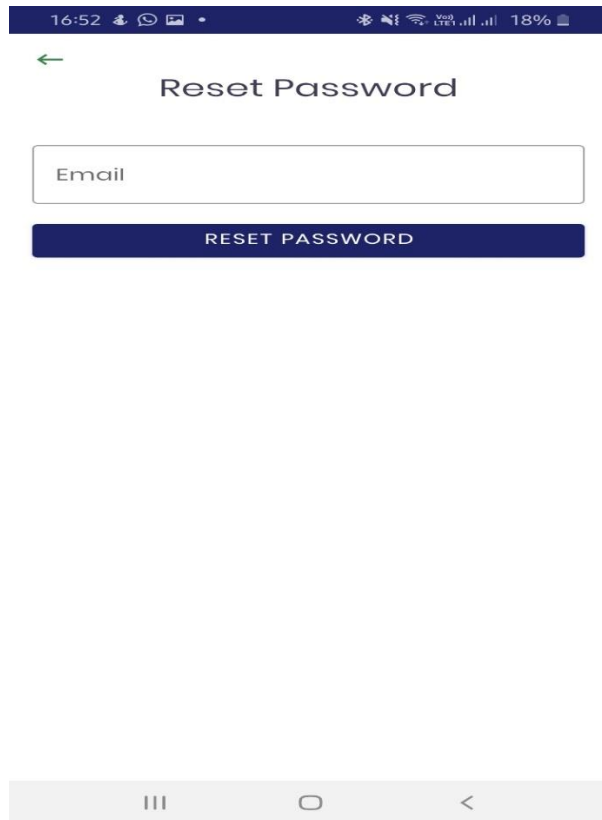


Figure 26: My Notes screen

7.4.4 How to reset password

In a situation where an existing user does not remember their password or wishes to reset their password click on 'Forgot Password' in the login to account screen. The user will be navigated to the reset password screen where they are required to enter the email address that they used to create an account and then click the 'RESET PASSWORD' button. The user will then receive an email that will then reset the password.



16:52 18%

←

Reset Password

Email

RESET PASSWORD

III O <

Figure 27: Reset password Screen

7.5 System Conversion Method

In reference to Mallach (2009), there exist various conversion methods for new systems and application. They system conversion strategies include direct changeover and parallel changeover. For this application direct changeover also called direct conversion method will be used. This is because there will be no disrupted operations if the system fails because tests have been done.

7.6 User Training

There recommended training methods is not specific this is because the application has been developed to be used with for all people even those with minimal technological knowledge. Only a smartphone knowledge is required. Additionally, the UI is simple and can be comprehended easily. One should know the English language in order to use thus can be used maximally by all people except the visually impaired persons.

7.7 File Conversions

Information about the users will be collected from signing in and using the application. Hence no file conversions are required.

CHAPTER EIGHT: LIMITATIONS, CHALLENGES, CONCLUSIONS AND RECOMMENDATIONS.

8.1 Limitations

Just like any other system, similarly OrthoSpi had some limitations. The following are some of the features which are limitations:

- The app is android based only thus Multi-Platform support for both android and iOS is a limitation.
- The time factor is a limitation, thus I was not able to achieve all the functionalities of the application within the given time since some features have a large learning curve.
- Generating reports in PDF format.

8.2 Challenges

During the development process I faced some challenges;

- i. Using the programming languages was a challenge
- ii. Accessing the internet was a challenge
- iii. The SMS notification APIs are very difficult to understand.

8.3 Degree of success

The project was a success this is because most of its basic functionalities were implemented. In addition, it laid down the basis for future improvements which will be made based on the skills and experience gathered during this project development process.

8.4 Learning experience

Throughout the development journey, I gained some experiences. I gained experience and became better in time management, planning and research skills. I gained skills and became more experience in Java and xml markup language. I also became better using Android Studio IDE and android development.

8.5 Recommendations

OrthoSpi is still a long way from being commercially viable as a product. I recommend the following for future versions:

- i. Support multi-platforms i.e. iOS
- ii. Generate PDF reports

8.6 Conclusion

Implementing the use of mobile devices in healthcare represent a valuable way to improve patient treatment and public health reporting in the developing world. Thus m-health is a step towards a better and greater direction. Spine and Orthopedic issues is believed to be contributing a portion to the increase in the mortality ratio. Based on research, there are no existing applications for specifically self-monitoring for spine patients. This finding supported the need to develop m-Health apps for spine and orthopedic patients. This system leads to the conclusion that if implemented, users would have a better way of tracking their medical regimen and improve the quality of life.

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APPENDIX

Questionnaire

OrthoSpi android app Questionnaire

I'm an undergraduate student during a project on medical application for spine and orthopedic issues. I would really appreciate it if you fill out this questionnaire. Thank you.

Required

Are you a spine or any orthopedic complication patient, or deal with someone who is

Mark only one oval.

- ☐ Yes
☐ No
☐ Other: _____

If yes, they are in a regular medication routine, have they ever forgotten to adhere to medical instructions *

Mark only one oval.

- ☐ Yes
☐ No

Do you use any medical reminder application

Mark only one oval.

- ☐ Yes
☐ No

Figure 28: Questionnaire 1

How do you keep track of your medication instructions

How do you get any information on you medical issue

Check all that apply.

- ☐ From the doctor
☐ From online searching (google)
☐ None

Figure 29: Questionnaire 2

OrthoSpi android app

My name is Cynthia an undergraduate student doing my final year project. I would like to ask some questions which will help me be more informed on spine and orthopedic issues. i hope to use this information to help me build a mobile application . I intend to build an app that aids in medical adherence for the spine and ortho patients.

1. How long have you dealt with spine and orthopedic issues

2. What is you take on use of mobile applications in the health services delivery

3. Do think there is need for an app for the spine and ortho department

4. How would you want it to look like

5. What do you think it should include

Figure 30: Questionnaire guide

PRINT CODES

```
        repository.getAllNotes(it)
    }

    fun getAlarmRequestCodes(idOfEntity: String) =
        repository.getAlarmRequestCodes(idOfEntity).asLiveData()

    val gridItems = repository.getAllGridItems().asLiveData()

    val medicines = repository.getAllMedicines().asLiveData()

    val idOfMedicine: MutableLiveData<Long> = MutableLiveData()

    val alarmRequestCode: MutableLiveData<AlarmRequestCode> = MutableLiveData()

    val medicine: MutableLiveData<Medicine> = MutableLiveData()

    val notes = noteFlow.asLiveData()

    val note: MutableLiveData<Note> = MutableLiveData()

    val appointmentId: MutableLiveData<Long> = MutableLiveData()

    val appointments = repository.getAllAppointments().asLiveData()

    fun saveMedicine(medicine: Medicine) =
        viewModelScope.launch { this: CoroutineScope
            val id = repository.saveMedicine(medicine)
            idOfMedicine.postValue(id)
        }

    fun getMedicine(id: Long) =
```

```
package ke.co.boyani.orthospi.util

class Constants {

    companion object {
        const val DB_NAME = "medicine_db.db"

        const val NOTIFICATION_CHANNEL_ID = "alarm_alert_id"
        const val NOTIFICATION_CHANNEL_NAME = "reminder_notification"
        const val NOTIFICATION_ID = 2021

        const val AFTER_SURGERY_LINK = "https://medlineplus.gov/ency/patientinstructions/000313.htm#:~:text=It%20takes"
        const val SURGERY_COSTS_LINK = "https://www.joint-surgeon.com/orthopedic-services/price-list/spine-surgery"
        const val SYMPTOMS_LINK = "https://www.healthgrades.com/right-care/spine-conditions/spine-symptoms"
        const val TIME_FOR_SURGERY_LINK = "https://www.pennmedicine.org/updates/blogs/neuroscience-blog/2020/july/type"
        const val SPINE_CONDITIONS_LINK = "https://rothmanortho.com/stories/blog/common-spine-conditions"
    }
}
```

```

package ke.co.boyani.orthospi.Util

import androidx.recyclerview.widget.DiffUtil

class MyDiffUtil<T>(
    private val oldList: List<T>,
    private val newList: List<T>
): DiffUtil.Callback() {

    override fun getOldListSize(): Int {
        return oldList.size
    }

    override fun getNewListSize(): Int {
        return newList.size
    }

    override fun areItemsTheSame(oldItemPosition: Int, newItemPosition: Int): Boolean {
        return oldList[oldItemPosition] === newList[newItemPosition]
    }

    override fun areContentsTheSame(oldItemPosition: Int, newItemPosition: Int): Boolean {
        return oldList[oldItemPosition] == newList[newItemPosition]
    }
}

```



```

package ke.co.boyani.orthospi.data

import ...

@Dao
interface MedicineDao {

    @Query(value: "SELECT * FROM medicines")
    fun getMedicines(): Flow<List<Medicine>>

    @Query(value: "SELECT id, name, frequency FROM medicines")
    fun getGridItems(): Flow<List<GridItem>>

    @Query(value: "SELECT * FROM alarm_request_codes WHERE idOfEntity = :idOfEntity")
    fun getAlarmRequestCodes(idOfEntity: String): Flow<List<AlarmRequestCode>>

    @Query(value: "SELECT * FROM medicines WHERE id = :id")
    suspend fun getMedicine(id: Long): Medicine

    @Insert(onConflict = OnConflictStrategy.REPLACE)
    suspend fun insert(medicine: Medicine): Long

    @Update
    suspend fun update(medicine: Medicine)

    @Delete
    suspend fun delete(medicine: Medicine)

    @Insert(onConflict = OnConflictStrategy.REPLACE)
    suspend fun insert(alarmRequestCode: AlarmRequestCode)

```