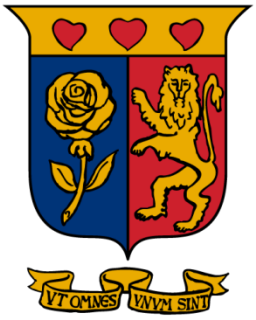

Strathmore UNIVERSITY

MediQR: A mobile application for prescription tracking using QR codes.

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An Information Systems Project Documentation Submitted to the Faculty of Information in partial fulfillment of the requirements for the award of a degree in Bachelor of Science in Informatics. **Date of Submission**: 29th February 2016

Declaration

I declare that this project has not been submitted to any other university for the award of Bachelor of Science in Informatics Degree.

Student Name: Richard Karsan

Admission No: 077353

Signature: …….. Date: …….

I certify that this work is being submitted for examination with my approval.

Supervisor Name: Dr. Joseph Orero

Signature: …….. Date: …….

Acknowledgement

I wish to pass my sincere gratitude to my supervisor, Dr. Joseph Orero, for his guidance and advice during the actualization of this project. I also wish to give thanks to the panel of judges for the project who gave me very insightful input on the project, its usability and validity. Finally I would like to thank my parents, friends and colleagues for accepting nothing but the best from me and encouraging me to deliver just that.

Abstract

Medicinal drugs are important to human life as they serve many purposes. Some of these include curing of diseases, containment of infections and provision of relief to those in pain. In some cases, medication may be a lifelong requirement for some people especially after surgery and during the containment of certain diseases such as HIV. It is therefore important to track the various medications that the patient has been taking for future reference and to assist doctors in decision. It is also important to collect data on the movement of this medication so as to streamline and provide better more efficient delivery of these commodities to their consumers.

There exists a gap in the provision of patient information between dispensing points such as hospitals and pharmacies about patients. Information about the patient's past prescriptions can assist in the diagnosis of possible prescription related allergies and in the decision making of drugs to prescribe for them in the present and future.

The more medications a patient is on, the more difficult it is to remember to take them. Few patients in developed countries adhere to treatment regimens. This project assists in changing that by providing electronic prescription.

The proposed project uses QR code technology to provide information to about the lifetime of drugs that have been issued to consumers from the source of the commodity to its dispensing point. The outcomes of the project include an Android application for reading the QR Codes, an API to allow for processing of the data and a web based interface for managing them and displaying the information on computers.

The application provides a simple means to retrieve information about dispensing points and information on patient prescriptions of these drugs i.e. an e-card for medicine prescriptions.

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CHAPTER 1: INTRODUCTION

1.1 Background of Study

Emergencies stretch any health institutions organization's capacity to deliver the most appropriate supplies (health commodities) where and when needed. (Adzimah, Awuah-Gyawu, Aikins, & Duah, 2014)

Hospitals in Kenya are lacking in medical equipment and drugs with the most heavily hit hospitals being those in rural areas and villages. This makes it difficult for the hospitals to treat ailments such as Malaria and Tuberculosis that are serious pandemics in the region. Malaria accounts for 30-50% of all outpatient attendance and 20% of all admissions to health facilities (Kenya malaria fact sheet, 2016) while about 120,000 people a year develop TB (48,000 of them being HIV-positive) and 18,600 people die from it. (Kenya Perspective: Tuberculosis, 2016)

The government has made efforts to curb this situation such as the allocation of 6.2 Billion in the 2015 financial year and 6.5 billion proposed for the year 2016 – 2017. (Hospitals plagued by lack of drugs and medical equipment, 2016)

In the last 10 years, the percentage of people over 60 who take five or more medicines, also known as polypharmacy, has jumped from 22% to 37%. As we grow older, the number and types of medications we take change frequently, and with each added drug, the risk of interaction increases. (Skaggs, 2016) Nearly 20% of patients in an HIV treatment program in Kenya have suffered major interactions between their HIV drugs and other prescribed medicines. (One in five Kenyan patients suffers major interactions with HIV drugs, 2008)

In Kenya we lack a unified national healthcare database. This means that every healthcare facility that a patient goes to, there exists a new file on that patient. The repercussions of this are that the patient's prescription history can be scattered over multiple hospitals and clinics and is dependent on whether or not the patient records this information somewhere which is rarely the case.

This project uses QR codes, stored data and locational data to track patient prescriptions and provide this information to them for reference and if needed for future prescriptions. This is in

the form of an e-card for prescriptions. It seeks to have a QR code that can be scanned to retrieve patient information.

The system also has an API that will allow for integration with multiple systems such as the Health Commodities Management Platform (HCMP) that is an initiative assisting dispensaries to order medical supplies from the government through the Kenya Medical Supplies Authority (KEMSA).

It is useable in various ways, starting from tracking of commodities in hospitals, tracking of delivery, provision of statistics and breaching of gaps in the current system. It is aimed at reducing the number of drug interaction situations and provide a simple means to track the Patient's medicine history while providing this information to aid in future prescription decision making by doctors and other medical professionals.

1.2 Problem Statement

Currently, there exist multiple platforms that track the shelf life of a commodity such as the Health Commodities Management Platform, (HCMP Kenya, 2016) (that helps the government track stock levels and keep instant records on medication and supplies in all hospitals and dispensaries in Kenya as well as update on deficits to allow timely replenishing. (Strathmore whizz kids offer medical supplies solution, 2015)

These systems focus on the availability of the commodities in the health facilities, providing data on the lifetime of a commodity from source to distribution point and the information is not available for the public. They are also dependent on user data entry which is prone to errors and delays.

There also exist prescription tracking software such as the Electronic Prescription Tracker (EPS) (Electronic Prescription Tracker, 2016).This software makes use of smartcards to identify users and a computer system to track the prescriptions.

These systems are aimed at tracking the prescriptions using a unified hospital database which is something we lack.

1.3 Aim of the project

This project is aimed at creating an application that uses QR codes and smart phones in the tracking of patient prescriptions. It allows for the digitizing of prescriptions in the form of an e-card to allow for future reference and aid in the decision making of future decisions on prescriptions.

1.4 Objectives

1.4.1 Main objective

To develop a system that enables medical commodity sources to track the shelf life of distributed commodities and assist consumers to track their prescriptions and medicine consumption history.

1.4.2 Specific research objectives

i) To research and analyze current commodity tracking methods, the data they collect and how they work.
ii) To investigate the various challenges faced during commodity tracking and information dissemination
iii) To develop a system that utilizes QR codes and smart phones to collect, analyze and track commodity shelf life.
iv) To develop and API that assists with integration of the tool with other existent systems.
v) To test and implement the developed application.

1.5 Research Questions

i) What methods are currently used to track health commodities and patient prescriptions?
ii) What are the challenges faced during the tracking of commodities and distribution of collected information?

1.6 Justification

The provision of electronic prescription tracking will provide many benefits to patients and consumers of medicinal drugs. Some of these benefits include a reduction in the number of drug

interactions as doctors can now access a patient's drug history allowing them to make more informed decisions. It also allows for the movement of the patient's drug history from one health facility to another, currently the creation of a new file at every health station that a patient visits results in it being difficult to track their medical history when moving from one hospital or health facility to another. This project allows for movement of the patient's data by only requiring the patient to have their QR code which allows them to give access to their data.

It also provides a simple and fast means for patients to track their medicine consumption and have access to those records anywhere and everywhere. It enables the patient to track the dispensing points of their drugs which is important since many patients buy medicines over the counter.

This project also provides reports for the dispensing points pertaining to the drugs they have issued. It will also alert users when their drugs are depleted in the case of patients with recurring prescriptions.

1.7 Scope and Limitations

The project will be limited to users with access to android phones and will be limited based on the drug data that is saved for referencing of the drugs.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter details the history and current situation on medical commodity tracking and prescription drugs. It also looks into definitions of various terms and the existing systems in place to track health commodities, the implementation of the proposed system and the challenges it will pose.

2.2 Prescription drugs and commodity management

2.2.1 Commodity tracking and prescription monitoring

Tracking is to observe or follow the course of progress of; keep track of. (Dictionary.com, 2016) Commodity tracking is therefore following the status of a commodity during its lifetime.

Prescription drugs are medications legitimately prescribed by doctors to treat a variety of health problems. (Drug Facts, 2016)

Prescription monitoring refers to the tracking of medical commodities that are dispensed to patients. The definition of a Prescription drug monitoring program (PDMP), according to the U.S. Department of Justice, Drug Enforcement Administration (DEA), following the National Alliance for Model State Drug Laws (NAMSDL), is a statewide electronic database that collects designated data on substances dispensed in the state. (Prescription Drug Monitoring Program: A Helpful Resource in Your State?, 2016)

2.2.2 Health commodities management

Many developing countries spend sizeable sums on the purchase of health commodities yet an estimated 60–80% of their populations; particularly in rural areas do not have constant access to even the most essential health commodities. (Adzimah, Awuah-Gyawu, Aikins, & Duah, 2014)

Currently in Kenya there are various platforms and systems that aid in the tracking of health care commodities. They however stop the tracking at the level of arrival at the designated points of distribution. They also are only web based and therefore require training to be used.
Public hospitals in our country are also heavily understaffed with scenarios like Masogo Sub county Hospital in Muhoroni has only three medics serving more than 300 patients every day.

(Kenya: Understaffed Muhoroni Hospital Riles Patients, 2016) Resulting in the use of such systems being difficult and overwhelming to the staff.

2.3 Related Works

2.3.1 Health Commodities Management Platform

This is a commodity management system that allows public health facilities to order for commodities from suppliers such as the Kenya Medical Supplies Authority (KEMSA) or Mission for Essential Drugs and Supplies (MEDS). The system allows for tracking of the commodity from its order to its receipt on an administrative level. It does not track the commodity beyond being received at a health facility.

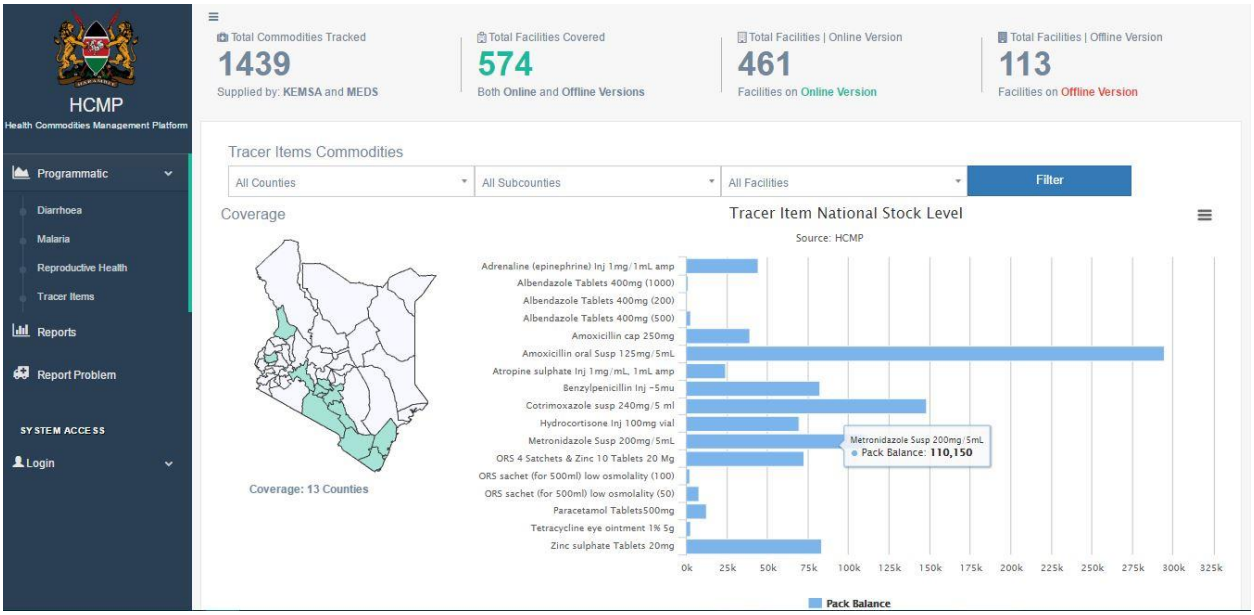


Figure 1: HCMP National Dashboard

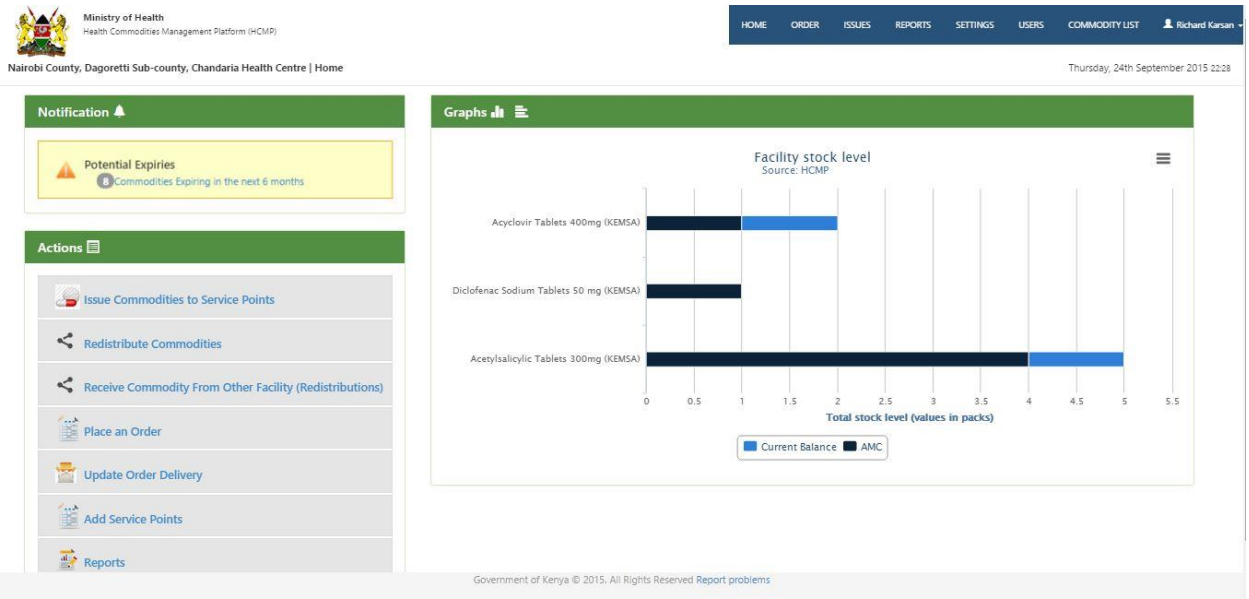


Figure 2: HCMP Facility Dashboard

2.3.2 Electronic Prescription Service (EPS)

EPS enables prescribers - such as GPs and practice nurses - to send prescriptions electronically to a dispenser (such as a pharmacy) of the patient's choice. This makes the prescribing and dispensing process more efficient and convenient for patients and staff. (Electronic Prescription Service (EPS), 2016)

2.3.3 Problems with existent systems

The existent systems that track prescriptions are not in Kenya. We also do not have a centralized patient database which the medical facilities can refer to. The proposed project will develop a user profile and history based on their usage of the tool. It will also provide this patient information to the patient and health facilities for reference.

The systems present in Kenya do not track drugs beyond arrival in the health facility. This therefore means that there is potential for more robust and extensive data collection by the proposed system.

The information collected by the systems currently present in Kenya is not free for the public. It is owned and contained within organizations that own it.

2.4 QR Codes

Figure 3: QR Code

2.4.1 QR Codes

QR code stands for Quick Response Code. It is a type of matric barcode (two dimensional bar code) that is square in appearance. QR codes were first created in 1994 by a Toyota subsidiary named Denso Wave in order to assist in the manufacturing process. They assisted them to track vehicles and parts. (History of QR Codes, 2016)

They were favored due to fast decoding speeds and gained popularity due to this. They have multiple functionalities and are more diversified than bar codes.

Due to their increasing popularity and use, the demand for a smaller QR code that held more information was high. Various methods were used to increase the capacity of the codes inclusive of increasing the number of digits on the code and improving the layout to hold multiple codes resulting in the QR code being developed into a 2D image.

They have the capacity to hold roughly 350 times the information that could generally be stored in a typical one dimensional bar code. (qrcodesinmarketing.net, 2016)

The first QR Code scanner was released in the year of 2010 and in 2011 it gained traction as large companies such as Best Buy began using the codes for many things.

2.4.2 Anatomy of a QR Code

A QR code is made up of various components. These components include:

Figure 4: QR Code Anatomy

Format information contains the mask pattern and correction rate. This is the first read information when the code is scanned.

The quiet zone or margin. This part is used to isolate the code from other packaging info or surrounding data. It is four modules wide.

Finders or position detection patterns. Located on three of the four corners of the square, they assist with 360 degree fast scanning of the code.

Error correction. This is used when part of the QR code is missing to ‘fill in the gaps’.

Alignment. These only occur in version 2 or higher of QR codes. They are found at the bottom right of the square and assist the scanner to correct for distortion when the code is bent or curved.

Timing pattern. This assists with the detection of each position in each cell of the code.

Version Information. QR codes span from version 1, to version 40, with 21 x 21 to 177 x 177 modules respectively.

Figure 5: Version 1 QR Code

Figure 6: Version 40 QR Code

QR codes are generated using software that is available online both in premium and free versions. An example of this software is QR Code Software. This is an application by QRCodeSoftware.org and is free for use to the public.

2.5 Application Programming Interface (API)

An Application program interface (API) is a set of routines, protocols, and tools for building software applications and systems. They basically describe how a program should act with its components and with components of other systems. APIs allow for integration of multiple

systems together in various ways. Some APIs share data and information when interacted with. Others take in various parameters and perform various functions on these parameters.

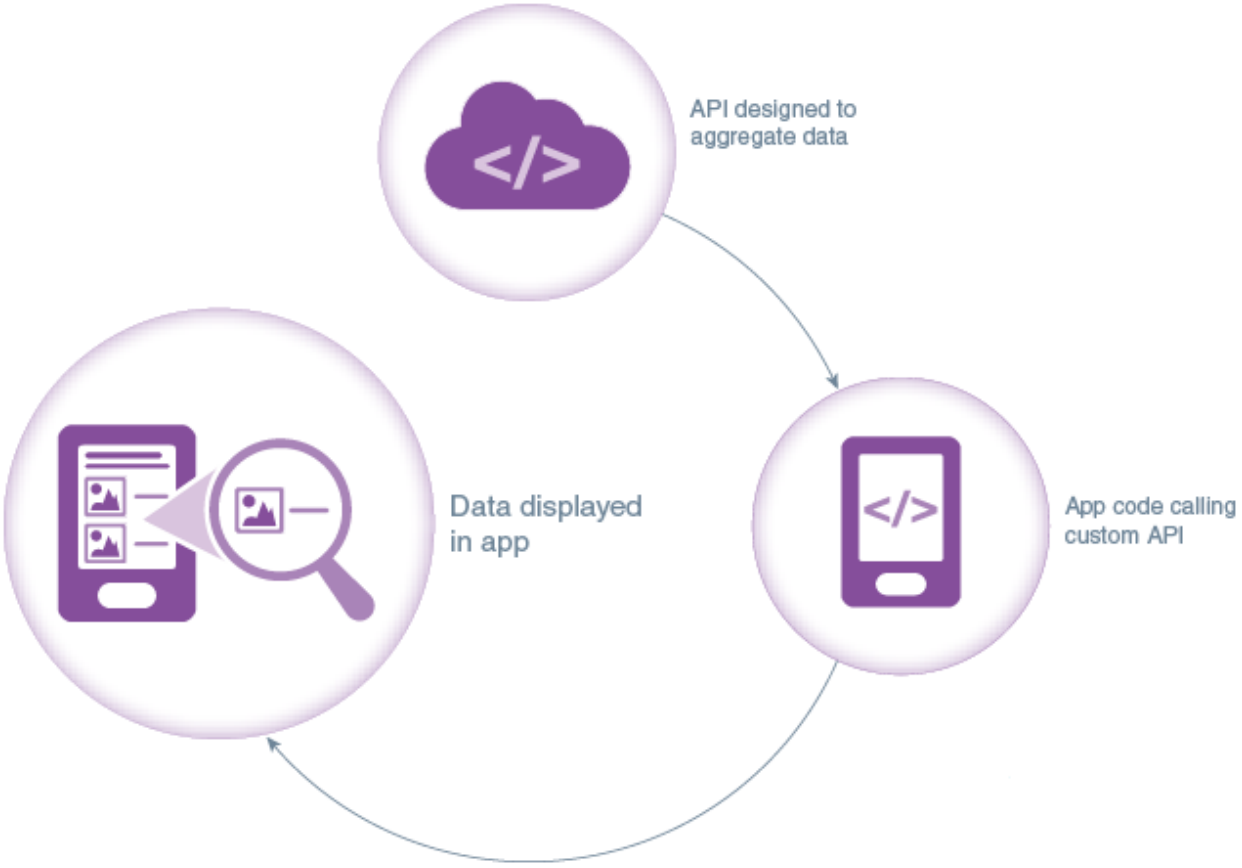


Figure 7: Structure of an API

2.5.1 Types of APIs

2.5.1.1 Restful APIs:

These use HTTP requests to perform GET, POST, PUT and DELETE on data. REST stands for Representational State Transfer and relies on a stateless client-server architecture. It is light weight and simple to create. The proposed project runs on a restful API.

2.5.1.2 Internal APIs

These are APIs developed to be used within organizations. Most organizations still use this kind of API that has been developed using the .NET service from Microsoft.

2.5.1.3 External APIs

These are APIs that are available to the public. Most of the external APIs written follow the REST and JSON approach to allow for easy integration and use for other systems and software's.

Some popular examples of APIs include:

Google Maps API that allows programmers to embed Google Maps on websites using a JavaScript and libraries.

YouTube API that lets developers integrate YouTube videos and integrate functionality into their websites or applications. Included sub APIs include YouTube Analytics, YouTube Live Streaming among others.

Twitter APIs: The REST API from Twitter allows developers to access core Twitter data while the Search API provides methods for developers to interact with Twitter Search and trends data.

Facebook API: This API allows developers to build applications that can be used by the users of the Facebook platform. It also allows for integration of features such as publishing activities to the news feed and profile pages, updating status and many other functionalities. It is a restful API and uses JSON format for its data.

2.6 Conceptual framework

A theoretical structure of assumptions, principles, and rules that holds together the ideas comprising a broad concept. (Conceptual framework, 2016)

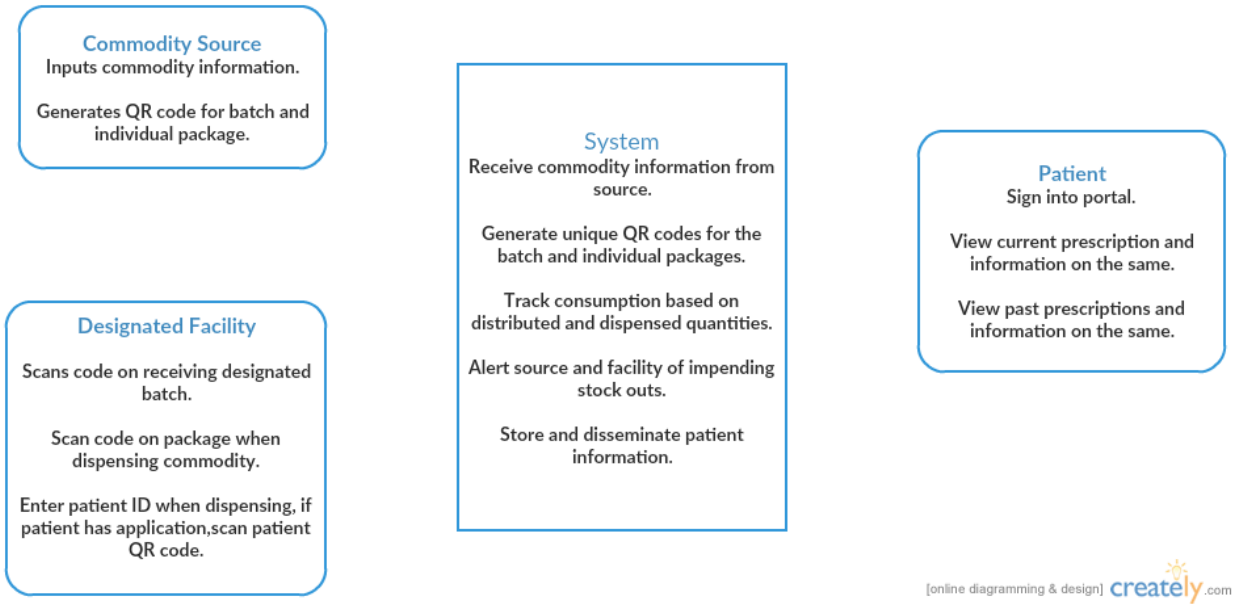


Figure 8: Conceptual Framework

2.6.1 Proposed System

The proposed system consists of an online web platform, an API and a smart phone application. The web platform allows for viewing of reports, management of information of the system, data entry and data manipulation. The web interface allows the system administrators to view available commodities, view patient data, view statistics such as locational data from the queries and present dispensing records.

The API allows for linking of the web portal to the android application and potentially linking to any other systems that are available and currently functional in the country. This allows for seamless integration when the time comes and it aids in the provision of more comprehensive services and the ability to expand the project's horizon.

The mobile phone application provides a QR code scanner that will return information based on the code that has been scanned, and various interfaces for the users to view and receive data.

Patients are be able to download the application, register as users and have their QR code generated for them via the mobile application. They are then able to track their prescriptions by providing this QR code when purchasing or being issued to medicines.

The doctors are be able to register on the application as prescription points. They are then able to scan patient codes through the application, enter the patient's randomly generated short code shown on the scan results interface and be able to prescribe drugs via the web interface to allow for ease of viewing and maneuverability over the drugs list and user interface.

The dispensing points such as hospitals, clinics and pharmacies download the application and register as dispensing points. They can view their dashboard and be allowed to scan patient's QR codes, view the patient's name and phone number and the patient's prescriptions. They can then proceed to dispense as they check the list of prescribed commodities. Once the dispensing is complete, the patient then receives a list with the issued commodities and they will confirm that they have received them.

Patients are able to view the commodities that they have been prescribed to in the past and are also able to get alerts on recurring prescriptions and whether they should get more medication soon.

Figure 9: EPS Banner

Figure 10: EPS Instructions

Chapter 3: Methodology

3.1 Introduction

A system development methodology refers to the framework that is used to structure, plan, and control the process of developing an information system. (Selecting a development approach, 2016)

For this project, we shall be using Rapid Application Development (RAD) so as to minimize on development time and maximize on receivable feedback.

3.2 Development methodology

3.2.1 Rapid Application Development (RAD)

3.2.1.1 Incremental Model

RAD is a type of incremental model which means that the requirements are divided into various builds, multiple development cycles take place based on these requirements and the final product is meant to have covered all requirements. The entire project is divided into smaller modules that are then passed through requirements analysis, system design, system implementation and testing. Once a working version is produced, it is released to users and development is iterated while bugs are fixed and features are added onto the system until completed.

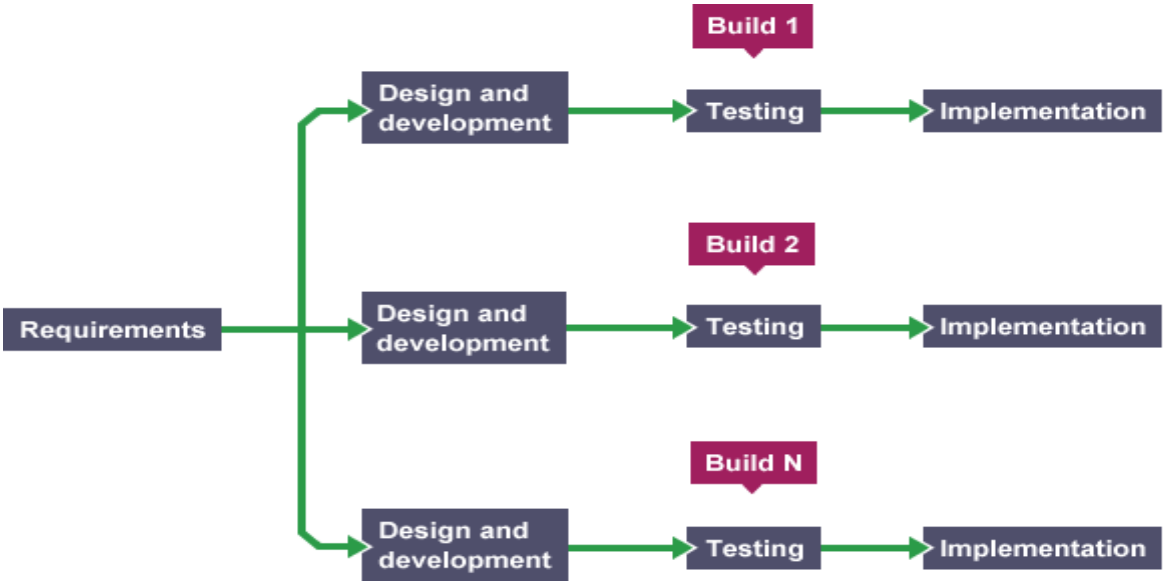


Figure 11: Incremental Life Cycle Model

3.2.1.2 Rapid Application Development (RAD)

RAD is a model where multiple functionalities are developed in parallel. The project is divided into parts and the parts are developed together to produce a working prototype. The prototype is quickly demonstrated and used by the users, feedback is collected and the cycle begins again.

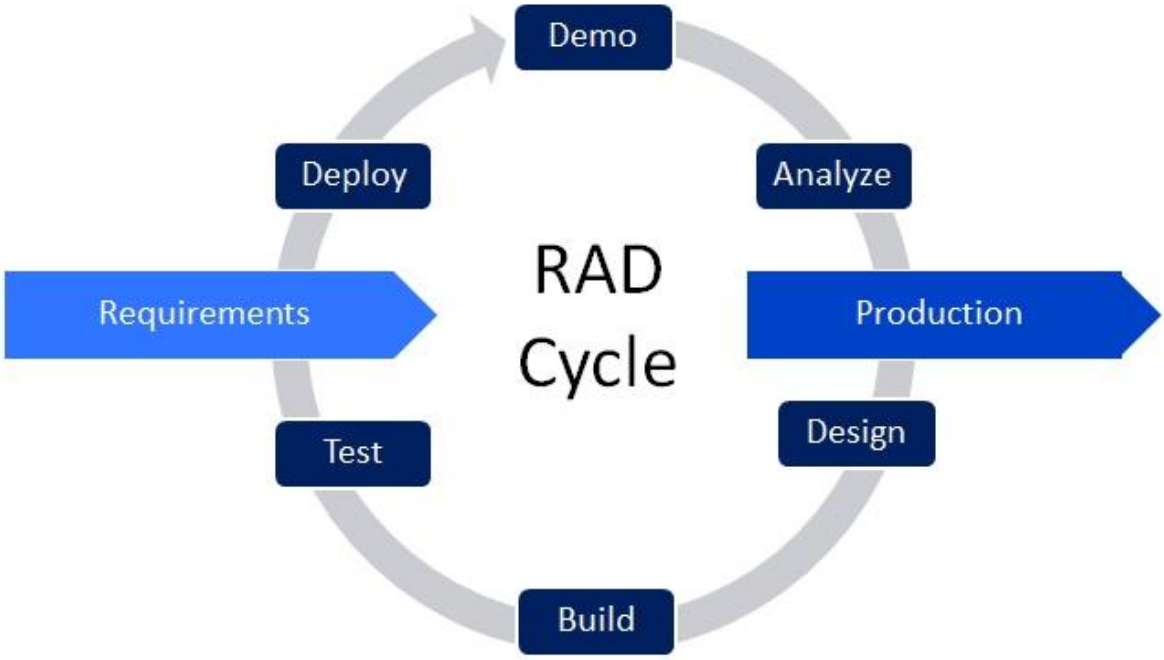


Figure 12: RAD life cycle model

3.2.1.2.1 Requirements analysis

In this phase of developments, the user and system requirements are identified. The information flow is also identified and the data model requirements are also specified.

The process flow is then established and the application development begins.

3.2.1.2.2 Application design, generation and deployment

This phase involves the development of the application using various tools, frameworks and structures. The development is mainly aimed at obtaining a working prototype with necessary functionalities.

3.2.1.2.3 Demonstration, project presentation and feedback analysis

The designated system users are exposed to the system and after some time evaluate the project based on various criteria such as initial user requirements. The project is analyzed based on feedback received by users and the cycle is started again.

3.2.2 Advantages of Rapid Application Development

Reduced development time.

Increased reusability of components during development.

Faster collection of customer feedback.

Allows for quick initial reviews to occur.

3.2.3 Disadvantages of Rapid Application Development

Is highly skill dependent and requires fast iteration and development.

3.3 System Analysis

This refers to the requirements of the system, how it should operate and its constraints of operation.

3.3.1 Functional requirements

Functional requirements specify what the system should do.

3.3.1.1 QR code generation and scanner

The system generates codes based on requirements. These codes are all unique and different. They also correspond to single records in the database with restraints on duplication to allow for authenticity.

The project should have a mobile application that allows for scanning of QR codes that is generated via the web service.

3.3.1.2 Database backup

This includes a module to allow for the application to back up all information automatically at a set interval to multiple data repositories. It uses local backups of MySQL files, remote backups on external servers and Gmail backups of the local files.

3.3.1.3 Application Programming Interface

Provide interface for interaction between mobile application and web portal. It also allows for the integration with other services and systems.

3.3.2 Nonfunctional requirements

Nonfunctional requirements specify constraints of the system's services and functionalities.

3.3.2.1 QR code generation and scanner

The QR codes generated should be unique to every commodity or drug batch that is in the system. The system should be able to handle multiple requests for generation and should be able to generate a printable sheet with all of the required codes.

The scanner should be fast in its response since there may be multiple scans taking place. It should also respond to saving information during scans quickly so as to ensure dispensing is not derailed by the application's speed.

3.3.2.2 Database backup

The database backup should be automated, run frequently and should run on a file replacement algorithm to avoid all available memory being consumed and backups not being able to work anymore.

3.3.2.3 API

It should use tokens for verification to protect the data. It should only provide for the retrieval of information and not the changing of records so as to prevent external interference.

It should have good queue management and request handling so as to provide speed and efficiency.

3.3.3 Use case diagrams

Use cases describe the interactions that take place between actors and IT systems during the execution of business processes. (Sourcemaking, 2016)

Components of a use case include:

Actors. They represent users and role that the users take when using the system. One actor can have multiple roles in the system and are not necessarily part of the system.

Use case. Represents a module of the system.

Association. This describes the connection between actors and use cases.

Include. This describes the connection between two use cases.

3.3.4 System narrative

Patients will download the application and register for to use the MediQR service. Upon registration they will receive QR codes generated for their use when purchasing or receiving medications.

Points of prescription i.e. Doctors, will be able to scan patient's QR codes and see data such as the patient's registered name and their unique numeric code. They will then use this code to prescribe medication through the online web platform since prescription over the mobile application will be tedious and it does not offer the maneuverability that the site provides.

Points of dispensing or issue i.e. Pharmacies will be able to scan patient's QR codes, upon being given access by the patient's they will then be able to view prescriptions for the patient that are pending issue. They will then proceed to select and issue the medicines as they check them off the list. Upon completion, the user/patient will receive a list showing them the commodities issued, once they have confirmed issue of these commodities, access to their records is revoked from the pharmacist.

The patient will be able to view all their information and history at any given time. On each scan of the patient's access QR code, they will receive a prompt to allow for access with the information of either the doctor or the pharmacist requesting access. Upon completion of their given tasks, the access is revoked from the granted party to ensure that there is no data access without the user/patient's knowledge.

Chapter 4: System Design

4.1 System Design

4.1.1 Interface design

This involves the creation of templates and image representations of the proposed system user interfaces. It plays an important role in the relevance of the user experience and software such as Adobe Photoshop will be used for this.

4.1.2 Database and logical design

Database design involves the creation and design of the database model while logical design involves the work flow of the system. The processes that it will handle and the logic of the system.

4.1.3 API design

This involves the creation route lists and request mapping of the API. It also involves the generation of the access tokens and preparation of the API to handle requests sent to the same.

4.2 System development tools

4.2.1 Web development tools

Restful API

Uses JSON to communicate and transfer data. Is also dependent on HTTP requests to operate.

PHP 7, JavaScript, Java, MySQL

We shall use the above languages for codebase and database management. The choice of MySQL over NoSQL database languages is so that the mobile application has no difficulties in streamlining of information and so that they can both have a similar database structure.

Postman

Browser plugin for testing of APIs.

PHPStorm

This is a text editor that has combined various useful functionalities such as Version Control and framework integration

NGINX

NGINX is a free, open-source, high-performance HTTP server and reverse proxy, as well as an IMAP/POP3 proxy server. NGINX is known for its high performance, stability, rich feature set, simple configuration, and low resource consumption. (NGINX, 2016)

Adobe Illustrator CS6

Illustrator will be used to create icons and vector images for the website.

Google Chrome

Google Chrome is a web browser that has a great element inspector which is simple to use and time saving.

Laravel

This is a PHP framework useful in the creation of hybrid applications that can act as both APIs and web portals.

Github and Gitlab

Version control used for back up of code base. It also allows for collaboration and the coordination of changes that are made by the developers without overwriting or loosing information.

4.2.2 Mobile application

4.2.2.1 Android studio and Eclipse IDE

Development environment for the android language which is based on Java. This will be used when the Android studio cannot produce or handle various functionalities.

4.2.3 Hardware requirements

The computer that will be used to develop this has the following specifications:

Processor: i7

RAM: 8GB

4.3 System implementation and testing

System implementation and testing refers to the installation and deployment of the new system. It involves exposing it to a small contained set of users for the sake of feedback and data collection. It identifies changes required to be made on the system based on user expectations and will involve various tests. These tests include user experience tests and user acceptance tests.

4.4 Proposed modules for the system

4.4.1 Web Application

This part of the review details the various components intended to be integrated into the web version of the application.

4.4.1.1 Administration module

This module will allow for the management of users, addition of administrators and viewing of various parts of the systems such as reported issues, password recovery and statistics relevant to the system administrator.

This module will also allow for various permission management options for the API and provide an interface for the management of the drugs that will be saved in the tool.

It will also contain details on the number of codes that were printed or issued.

4.4.1.2 Reports module

This module will contain reports generated from the data collected and graphs on the same.

4.4.1.3 Authentication and registration module

This will deal with the addition and registration of users with the system. It will have the option of registration and sign in using various social media platforms such as Facebook and Google.

It will have the ability of redirecting specific users to their specific interfaces or dashboards based on their access levels.

4.4.1.4 Location and tracking module

This module will track the locational and GPS information based on requests made, allowing for the generation of various statistics such as graphs and heat maps.

It will also assist in the identification of various areas that the QR codes have been scanned or accessed allowing for locational mapping.

4.4.2 Mobile Application

This part of the review covers the proposed modules for the mobile application.

4.4.2.1 Authentication and registration

The authentication will be dependent on the online/web version in that the credentials will be the same. It will also use the online database for queries and requests on login and registration

4.4.2.2 QR Code scanner

The application will contain a QR code scanner that will allow consumers to scan the bar codes on their medical products and get feedback on the same.

4.4.2.3 Scan result response

This will display the results of the QR code scan.

It will hold details for the validity of the commodity, and basic information on the same such as expiry date and commodity source. It will also have the name of the commodity and if possible, its bar code to ensure validity of the same and that the product has not been

4.4.2.4 E-prescription card module

This module will be the only module accessible by patients and consumers of the drugs. It will detail the commodities that have been dispensed to them and the points of origin. They will also be able to scan the commodities that they have and view information on them such as where they were dispensed, expiry date and source.

4.4.2.5 Dispensing module

This module will be used by pharmacists and other personnel that are involved in the issuing of drugs to consumers. It will entail scanning of commodities before dispensing and the collection of patient information during dispensing.

4.4.2.6 Feedback

This module will allow for consumers and anyone within the flow of the commodity to offer suggestions and comments on the application and ways to improve it.

4.4.3 Application Programming Interface

This will be a RESTful API that will use HTTP requests to be interacted with. The API will allow for integration of other systems and tools that may require the data collected by the tool. The API will be accessible via tokens that will be issued by the system. Applications that wish to interact with the API will have to be registered so as to be issued with an access token.

4.5 Deliverables

4.5.1 Project proposal

A proposal is a request for financial assistance to implement a project. The proposal outlines the plan of the implementing organization about the project, giving extensive information about the intention, for implementing it, the ways to manage it and the results to be delivered from it. (www.sswm.info, 2016)

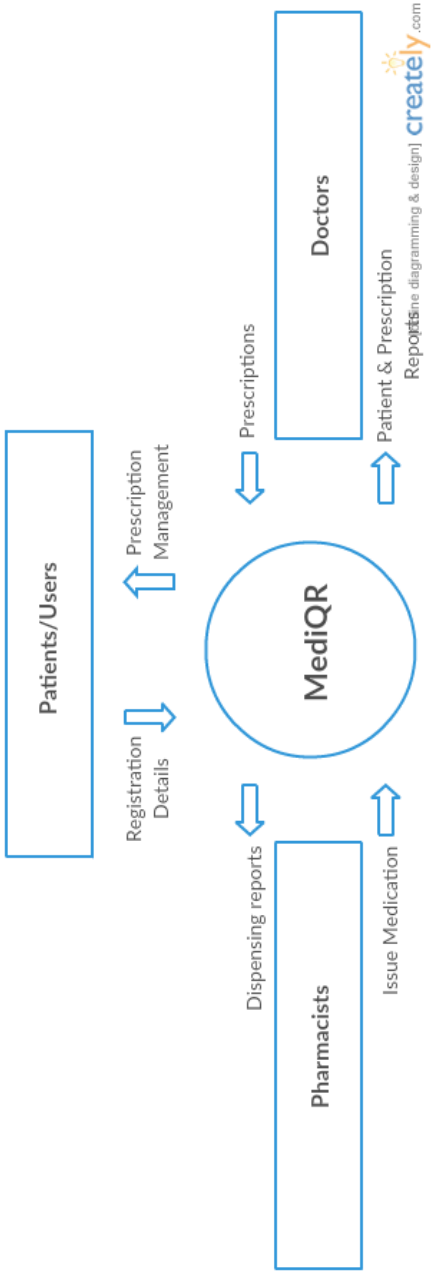
4.5.2 System Documentation

System documentation is a detailed manual and description document for a system. It explains the various available modules on the system and how they are used.

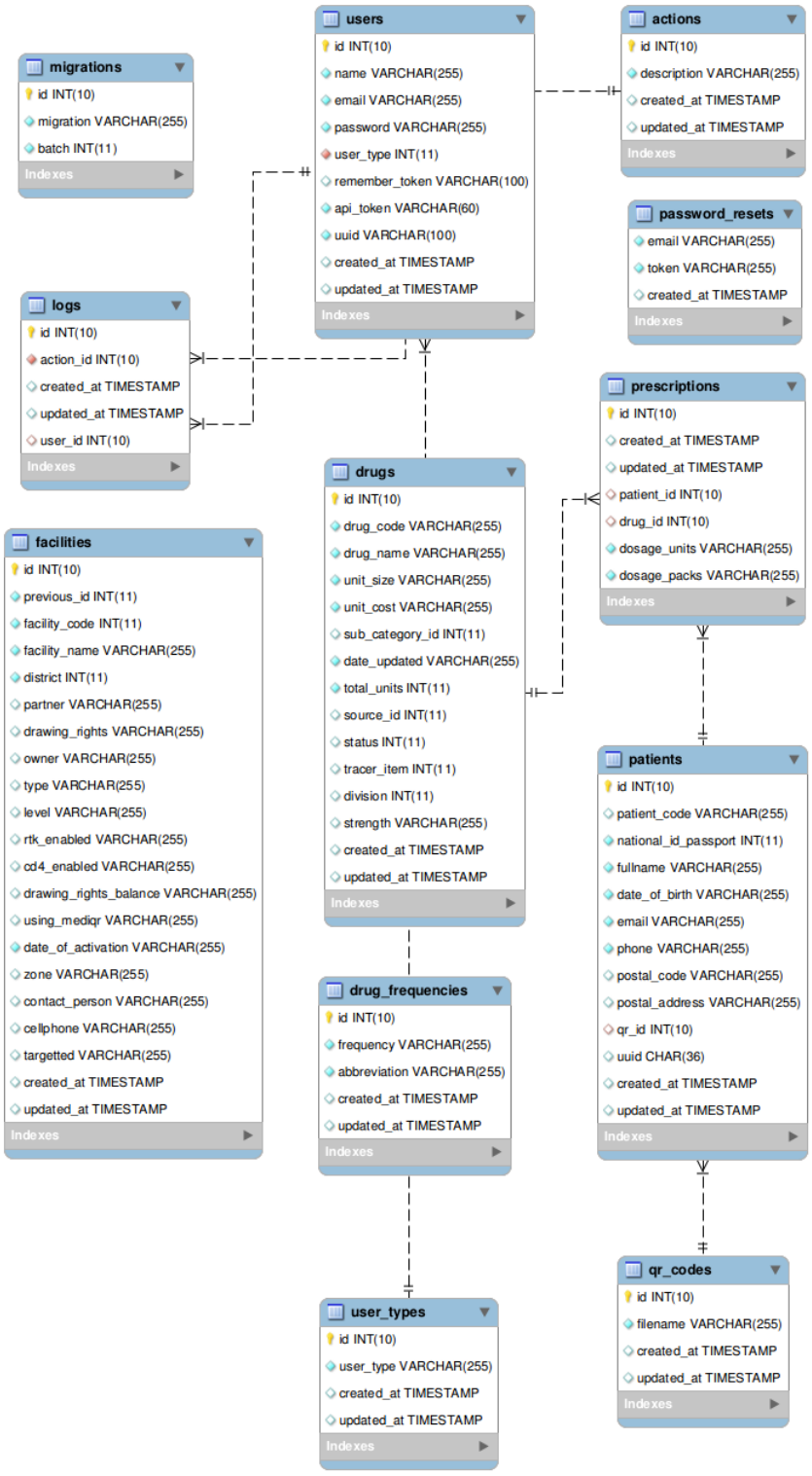
4.5.3 Complete QR code commodity tracking system

The system will have attractive user interfaces on both the mobile and application platforms. The interfaces will be based on material and flat UI design principles and will be aimed at delivery of relevant commodity information quickly and efficiently.

4.6 Context Diagram



4.7 Entity Relationship Diagram



Chapter 5: Implementation and Testing

5.1 Introduction

This chapter details the system's implementation and its testing. System implementation involves how the system was built and ensuring that it meets standards and is operational. System testing refers to ensuring that all modules in the system are functional and work as expected. It also include the tools used in its development.

5.2 Development environment and tools

5.2.1 Software requirements

Text editors. These were used to code and included Sublime Text, Atom and PHP Storm.

Postman. This is a tool that can be both a browser plugin and a stand alone application. It allowed for the sending of requests of various types such as POST and GET to test the API.

PHP 7. Language version used to develop the system.

MySQL. Language used to develop the system database.

Android Studio. The IDE that was used to develop the mobile application for the system.

Laravel, Composer. These were the frameworks used to create the application. Laravel is a PHP based framework while composer is used to run commands based on it.

Bower and Grunt. These are package managers. They are useful in the maintenance of various plugins and third party plugins used on the system's development.

5.2.2 Hardware requirements

I used my personal computer with the following specifications:

RAM 8GB, Processor i8 and Ubuntu 16.

5.3 System Implementation

This system has two segments, a mobile application and a web application/API.

5.3.1 Web Application

The web application is made to be used by doctors for registration of new patients and for prescription of drugs to patients. Once the doctor logs in to the system, they are redirected to the doctor's dashboard. This dashboard has a list of all patients and enables the doctors to add or view a patient's details. They also have the option of making prescriptions based on the patient's code that they acquire from the mobile application once a QR code is scanned. The doctor is required to search for a patient using the code, the system loads information on the patient and the doctor is allowed to prescribe medication.

The prescription interface contains the loaded patient details and a table that allows doctors to prescribe medication. It presents them with a dropdown of drugs, a duration selection and repetition. It also provides the doctor with a field to add notes if he/she feels the need to make a comment on the given drug prescription.

The system also has a drug listing that allows the doctors to view all the drugs enlisted on the system. The list is based on the drugs offered by Kenya Medical Supplies Authority (KEMSA) and has an easy to use filter allowing for quick and simple indexing and searching.

The patient's login and are able to view their QR codes and details. They are also capable of viewing their prescription history and detailed information on the same.

Finally, the system has a back end RESTful API that handles requests from both the mobile and web application. This API runs using API tokens that are generated for every user upon registration. All requests are authenticated using this token that confirms the user's identity. The request and the user that made them are logged.

5.3.2 Mobile Application

The mobile application is made to be used mostly by pharmacists and by patients. The patient logs in and is presented with the option to view their QR codes and past prescriptions. Viewing the QR codes allows the patient's to show the codes to pharmacists and doctors for scanning.

The pharmacists are redirected to the pharmacist dashboard on the application after a successful login. They are then able to view the drug listing and scan patient QR codes. Upon scanning a patient's QR code, the pharmacist is presented with an interface that has the patient's information, retrieved real time from the online database through the API. They are also shown a list of prescriptions that the patient has with the most recent at the top. They can then select the prescription and proceed to enter information on the dispensed drugs. They are then given a status report as to whether the data was saved and redirected to the dashboard. This data appears immediately on the web application and the patient can confirm the data online as soon as the pharmacist has completed the dispensing process.

5.4 System Testing

This refers to ensuring that the system meets various requirements and standards.

5.4.1 Unit Testing

Unit testing refers to assessing the system based on specific functions or procedures. The system was tested in various parts based on the various functionalities it offered. The mobile application was tested for requests to the server with authentication.

The API was tested for authentication of requests, saving of data and returning of responses in the form of JSON to be processed by the mobile application.

5.4.1 Integration Testing

This refers to testing all modules of a system for functioning together or in unison.

The system modules linked together well, all worked based on the API which was robust enough to run the entire system, both the web and mobile applications. Data was being saved and displayed correctly and the system was capable of handling the various challenges faced by the difference in structure and data format between the android and PHP versions.

Chapter 6: Conclusion

6.1 Project Summary

MediQR consists of a mobile application that allows patients to view QR codes and prescription history and pharmacists to scan those codes and dispense drugs to them. It also consists of a web application that enables patients to view their prescription history and details and doctors to view registered patients, make prescriptions and follow up on the status of these prescriptions. The system also contains a drug listing to allow for easy reference when needed.

6.2 Achievements

The web application was capable of generating QR codes that were unique and consistent in accuracy and error correction. The implementation of the QR code scanner was also successful and it managed to correct scan errors efficiently and in little time.

6.3 Challenges

The implementation of the API that would ensure both the web and mobile application got the correct data type despite the differences in platform challenging. The processing of the data that is sent by the API in Android was also challenging as the model for handling this data is different and requires the use of models, custom classes and various adapters that have to be custom made to suit the kind of response expected.

6.4 Recommendations

The addition of more modules on the Android application to enable prescription by doctors and prescription history via the mobile application would make their work relatively easier. Also, the mobile application is only in Android and can be modified to either be compatible with other operating systems or platform specific versions made.

6.3 Future Works

The implementation of the above recommendations and the testing of the system using actual patients and doctors. I also hope to get a server to host this system as it will allow more flexibility in the addition of various functionalities.

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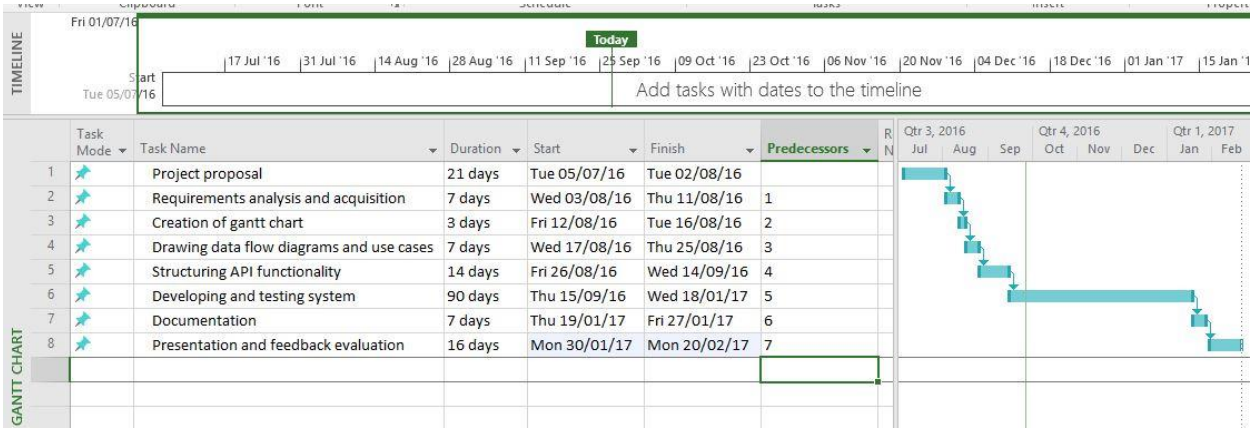
Appendix

Appendix A: Project timeline schedule



	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		Project proposal	21 days	Tue 05/07/16	Tue 02/08/16	
2		Requirements analysis and acquisition	7 days	Wed 03/08/16	Thu 11/08/16	1
3		Creation of gantt chart	3 days	Fri 12/08/16	Tue 16/08/16	2
4		Drawing data flow diagrams and use cases	7 days	Wed 17/08/16	Thu 25/08/16	3
5		Structuring API functionality	14 days	Fri 26/08/16	Wed 14/09/16	4
6		Developing and testing system	90 days	Thu 15/09/16	Wed 18/01/17	5
7		Documentation	7 days	Thu 19/01/17	Fri 27/01/17	6
8		Presentation and feedback evaluation	16 days	Mon 30/01/17	Mon 20/02/17	7

Figure 13: Project timeline

Appendix B: System screenshots

Figure 14: Login page

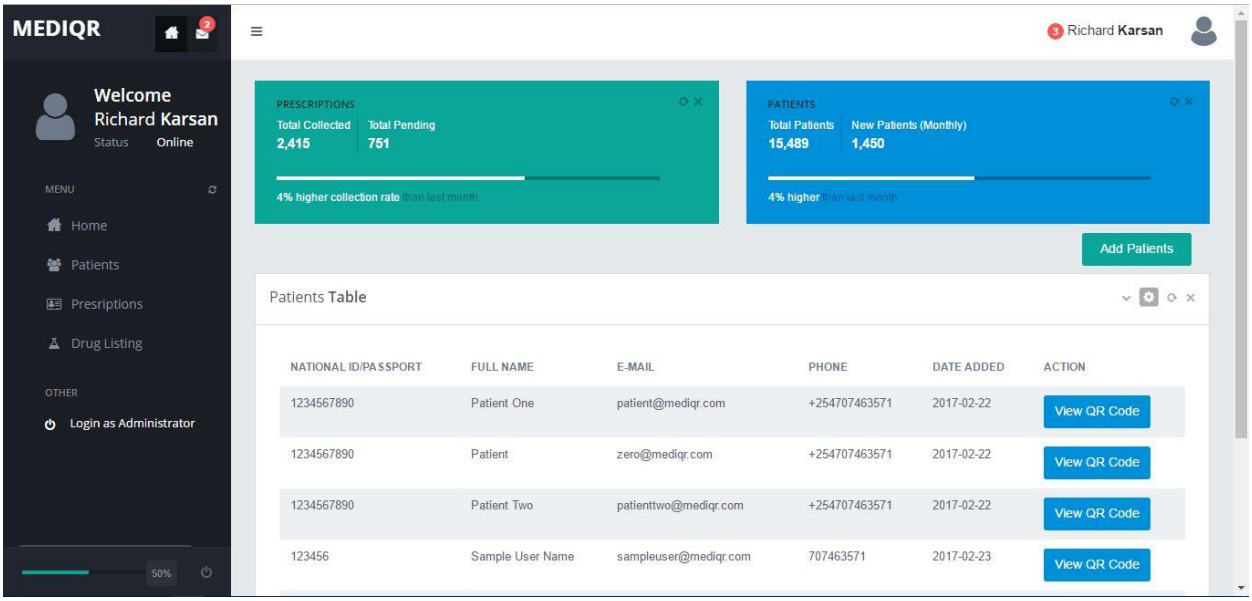


Figure 15: Doctor Dashboard

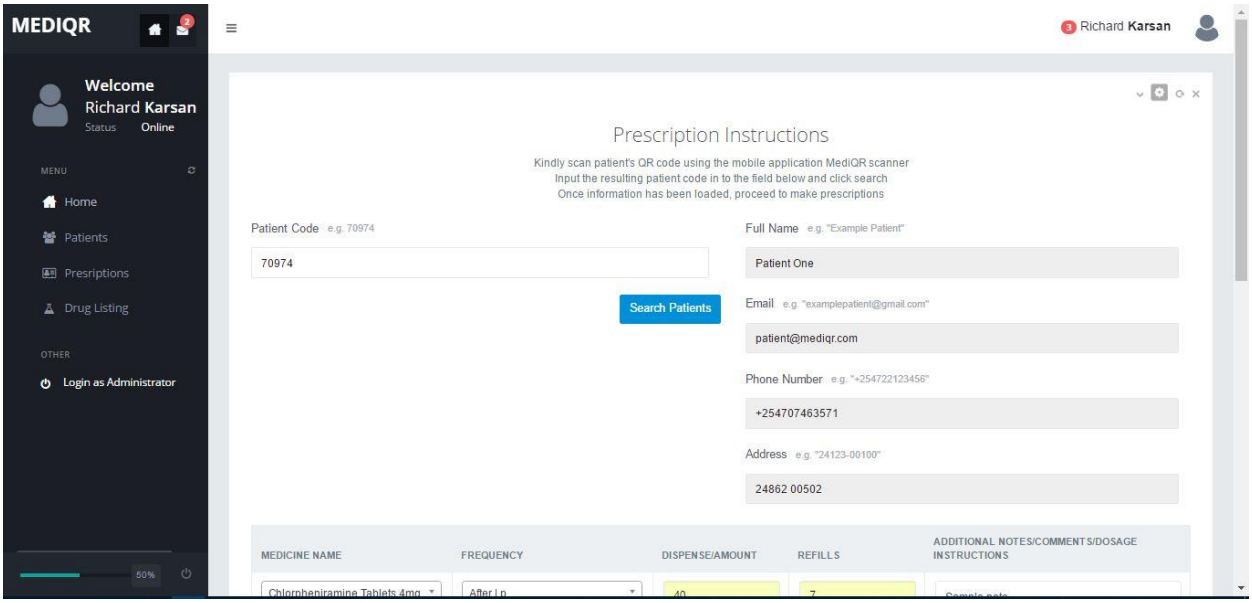


Figure 16: Prescription Interface

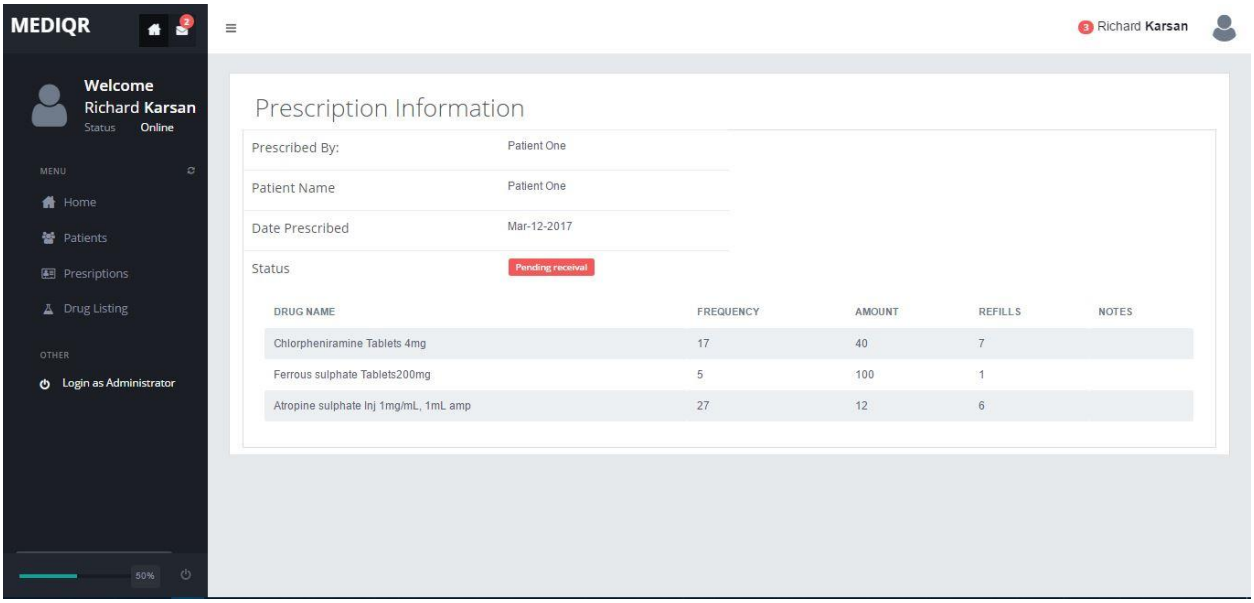


Figure 17: Specific Prescription

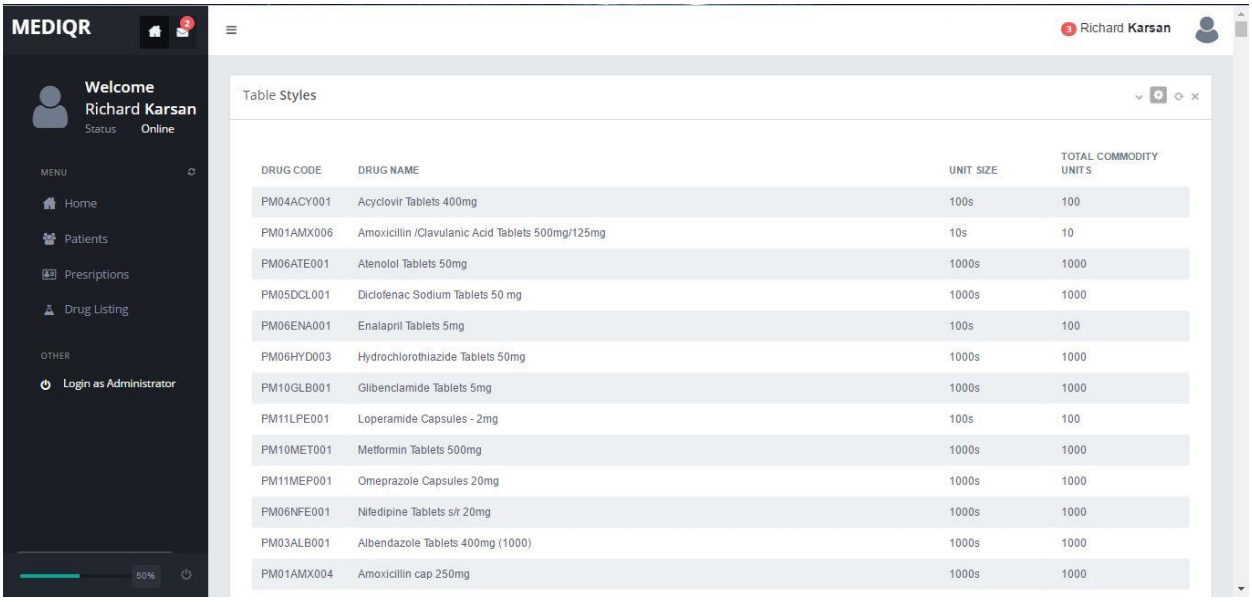


Figure 18: Drug Listing

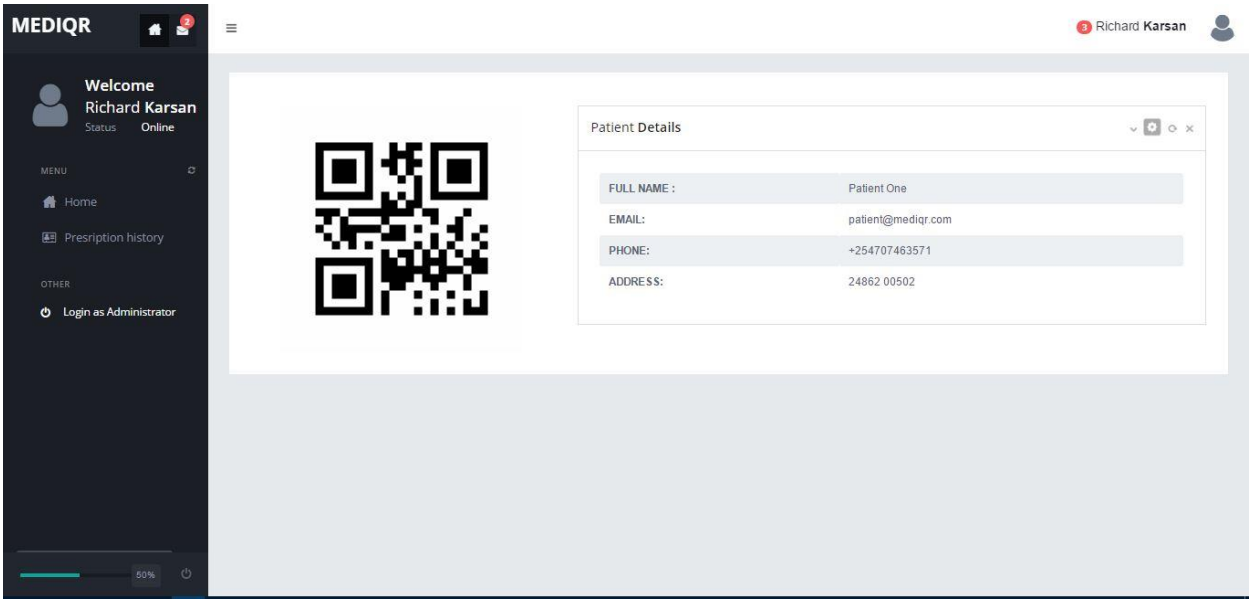


Figure 19: Patients Dashboard I

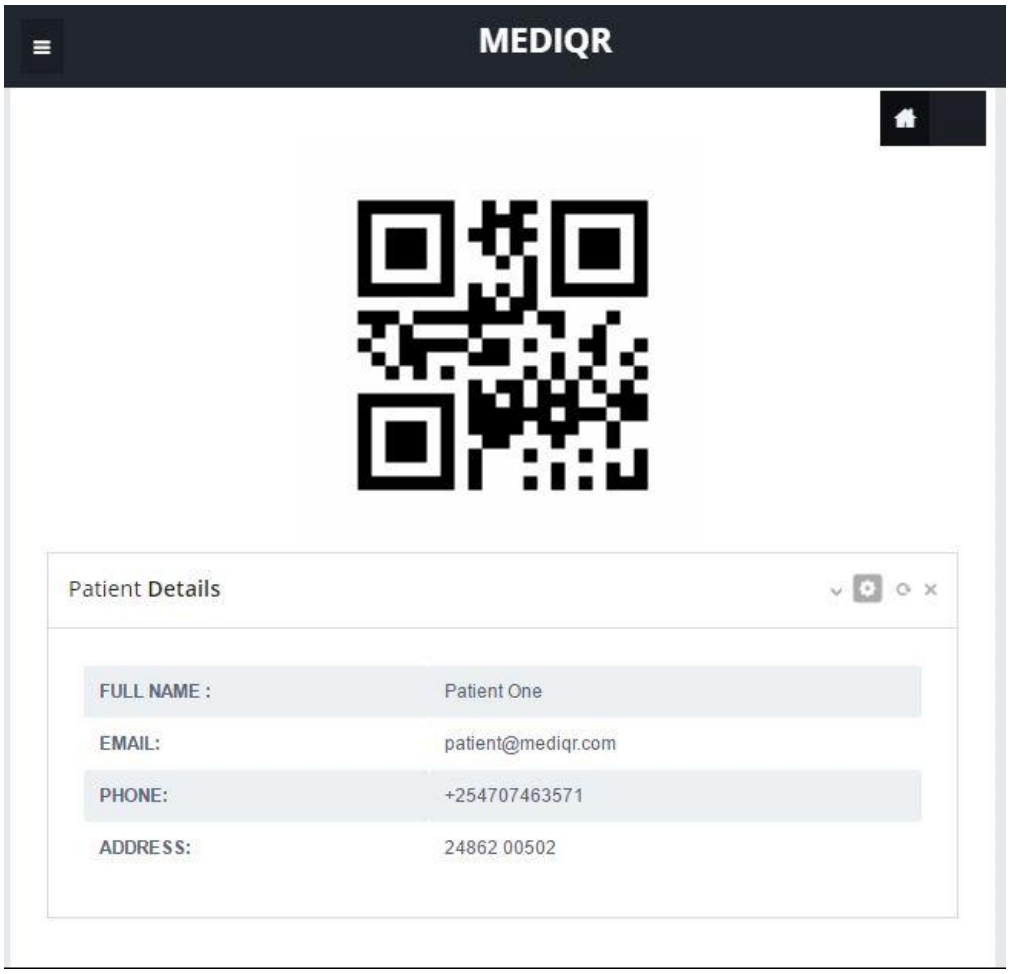


Figure 20: Patient Dashboard II

Figure 21: MediQR Splash Screen

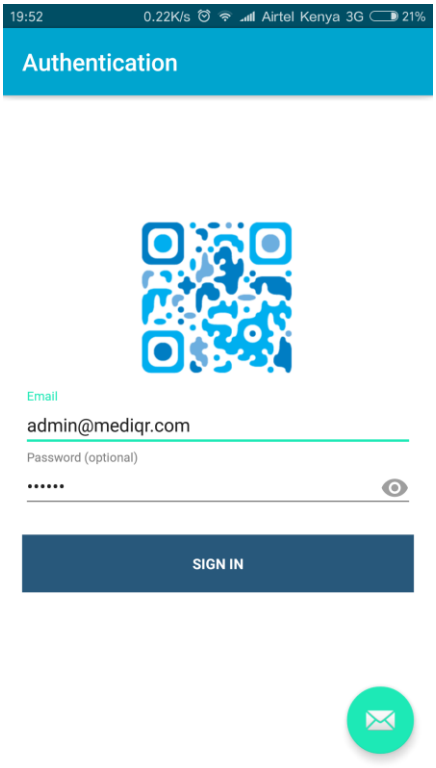


Figure 22: Mobile Application Login Interface

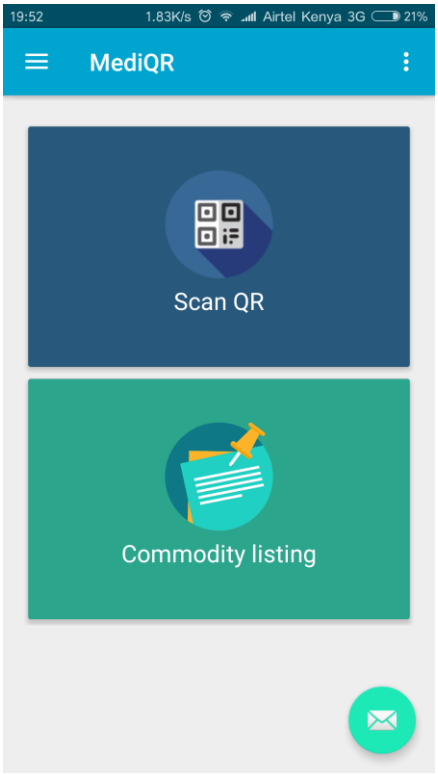


Figure 23: Mobile Application Dashboard

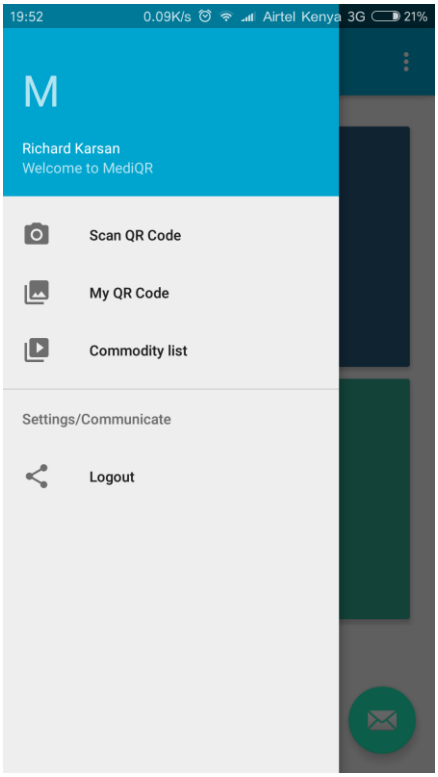


Figure 24: Mobile Application Side Menu

Figure 25: Mobile Application View QR Code

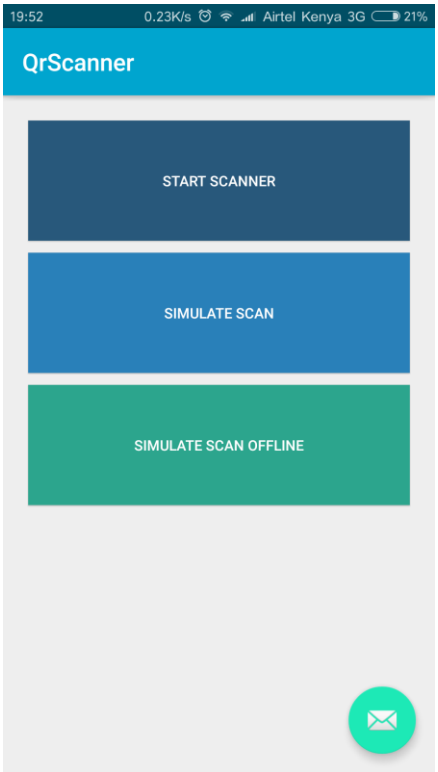


Figure 26: Mobile Application Scan/Simulate QR Scanner

Figure 27: Mobile Application Patient Data After Scan

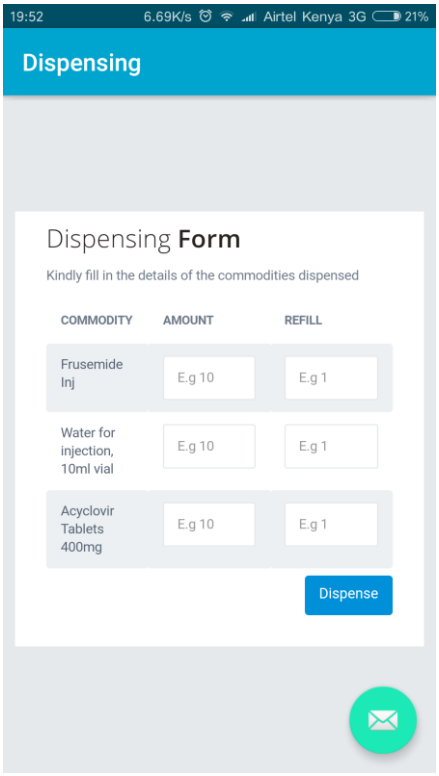


Figure 28: Mobile Application Dispensing Form

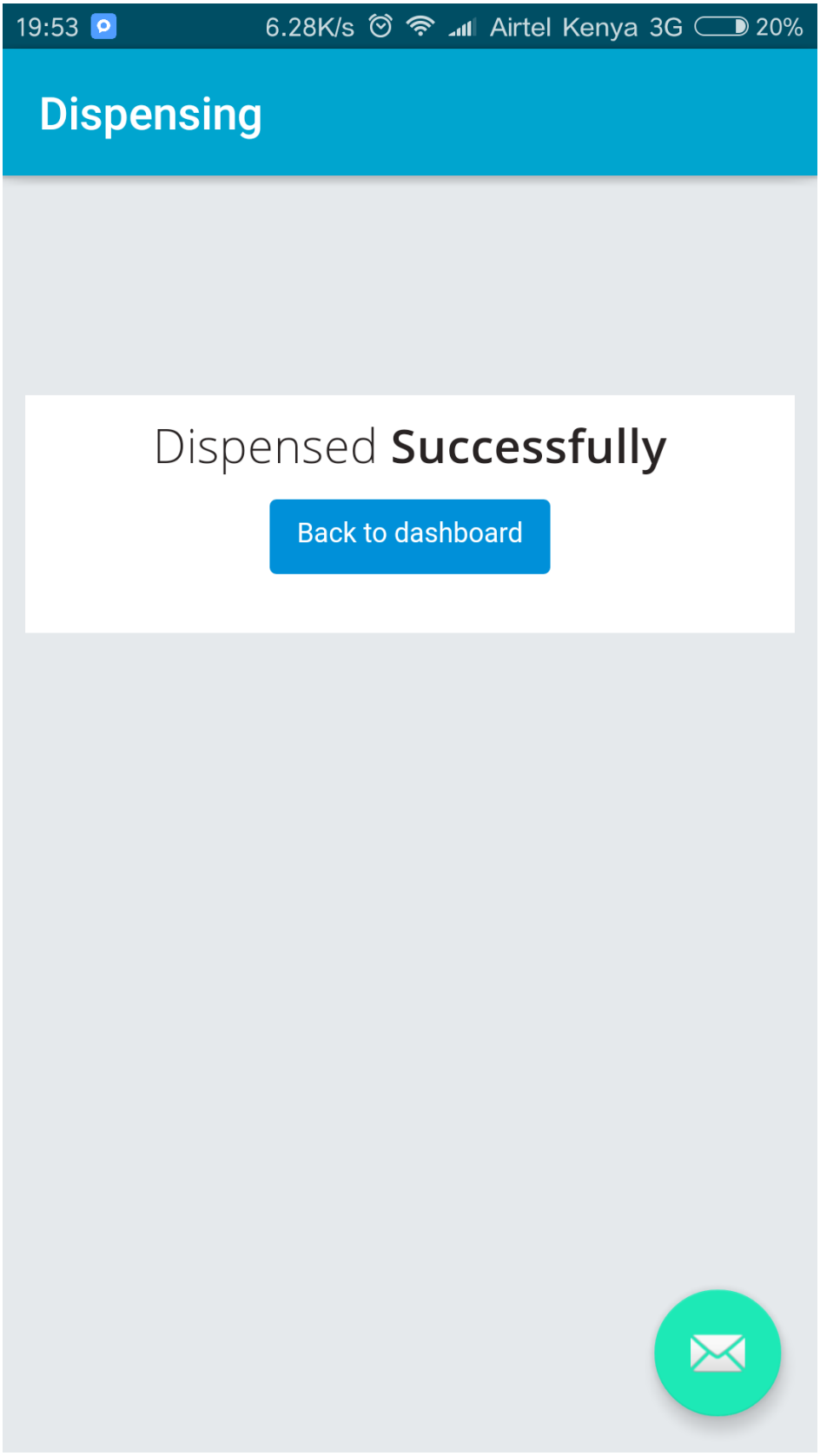


Figure 29: Mobile Application Successful Dispensing