A COVID-19 Pandemic Tracking System for Healthcare Organizations.

101196

GROUP B

An Information Systems Project Documentation Submitted to the Faculty of Information Technology in partial fulfilment of the requirements for the award of a Bachelor's Degree in Business Information Technology of Strathmore University

January, 2021

Declaration

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

Student's signature:

Sign: D.M.M Date: 27th January 2021.

Supervisor's Signature:

Sign: _____ Date: _____

Abstract

In late 2019, Corona Virus was detected in the Hunan Seafood Market in Wuhan region of China and has proved to be a pandemic by rapidly spreading to other parts of China and other nations despite efforts to contain the virus. The disease has been spreading rapidly as it is a respiratory disease easily transmitted between people through respiratory droplets when people cough or sneeze or it can be spread on contact with a person infected with the virus. Due to so much uncertainty about the virus as well as lack of enough appropriate supplies like medical masks, gloves, hospital beds and blankets, the number of confirmed cases increases everyday which affects the country in that the spread of the virus becomes more rampant and they are not able to prevent it in time. Mapping of the number of cases and of the spread of the virus by use of a digital healthcare system helps slow the spread of the virus due to timely and effective epidemic monitoring and response. Tools that have been used in the project development would include JavaScript programming language. In conclusion, the project will benefit the government by providing an efficient tool for them to plan their budget accordingly in order to curb the virus. This shall in turn, be a valuable tool for the healthcare department to keep track of the number of confirmed cases and manage them accordingly.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

OECD - Organisation for Economic Co-operation and Development.

GDP – Gross Domestic Product.

CSS – Cascading Style Sheet.

USSD – Unstructured Supplementary Service Data.

OOAD – Object Oriented Analysis and Design.

JSON – JavaScript Object Notation.

Chapter 1: Introduction

1.1 Background

In the public mind, the origin story of coronavirus seems well fixed: in late 2019 someone at the now world-famous Hunan Seafood Market in Wuhan was infected with a virus from an animal. Scientists say it is highly likely that the virus came from bats but first passed through an intermediary animal in the same way that another coronavirus – the 2002 Severe Acute Respiratory Syndrome (SARS) outbreak – moved from horseshoe bats to cat-like civets before infecting humans. The animal implicated as an intermediary host between bats and humans is the pangolin which is the most illegally traded mammal in the world and is prized for its meat and the claimed medicinal properties of their scales. The rest is part of an awful history still in the making, with Covid-19 spreading from that first cluster in the capital of China's Hubei province to a pandemic that has killed so many people so far (Readfearn, 2020).

The virus spreads through respiratory transmission whereby it is mainly transmitted between people through "respiratory droplets" when people sneeze or cough. It can also be spread through aerosol transmission which involves the ability by which the virus is somehow able to suspend in the air for long enough to infect passers-by. The virus can also be spread through contact transmission in which viral particles emitted from the respiratory tract of an infected individual land on a surface and if another person touches that object, then touches their nose, mouth or eyes, the virus is able to sneak into the body therefore infecting the second person (Ghose,2020). The virus has been able to spread at an alarming rate due to the fact that people dismissing it as a flu and not adhering to the prevention measures being provided such as remaining in isolated and avoiding movement when they can, making use of protective wear like masks and gloves when outside as well as avoiding contact or rather staying 5 to 6 feet apart from each other.

Slowing the spread of the new virus is important while the world awaits vaccines and medications. The more people are infected at once in a given area, the greater the strain on local health-care systems and when those systems are overrun, people will die who could have been saved in less demanding circumstances (Hamblin, 2020). Adequate information on the spread of the virus as well as supplies are needed to deal with this pandemic in order to be able to curb it effectively and fast. Supplies such as masks, hand sanitizers, appropriate quarantine facilities for those infected and for the doctors tending to them are thus needed to prevent further spread of the virus.

1.2 Problem Statement

There is so much uncertainty with the rapid spread of the Covid-19 virus in the country. The number of people getting infected increases every day and the lack of the adequate information about the spread of the virus affects the country in that the spread of the virus becomes more rampant and they are not able to prevent it in time. The general public also deteriorate in health because they do not have a clear view of the situation and how serious it is around them. The country in general is also affected since all the management, planning and operations that the government makes don't work since they neither have a clear view of the situation nor know how to slow the spread of the virus without this information. Therefore, there is a need to make that data public in hopes of helping researchers and policymakers as they seek to slow the pandemic and prevent future ones.

1.3 Aim

This project proposed to develop a system that would be able to provide a simple, interactive way to visualise the impact of COVID-19. The system would help the country in planning ahead in order to curb the spread of the disease effectively by making sure that the government is ready when numbers rise to a certain point. The proposed system would track the total cumulative cases of COVID-19 from around the world. The data also shows how many people have recovered after being diagnosed with coronavirus as well as the number of people that have died after being diagnosed with the virus.

1.4 Specific Objectives

i. To investigate the challenges associated with current models of dealing with the Covid-19 pandemic.
ii. To review related systems handling management in crises and pandemics.
iii. To design and develop a Covid-19 tracking system that will address the challenges identified.
iv. To test/validate the developed system

1.5 Research Questions

i. What are the current challenges being faced in the current systems being used to prevent further spread of the virus?
ii. How would a Covid-19 tracking reduce the strain on local healthcare systems?

1.6 Justification

This system needed to be developed because it would track the total cumulative cases of COVID-19 from around the world. The data also shows how many people have recovered after being diagnosed with coronavirus as well as the number of people that have died after being diagnosed with the virus. This would slow down the spread of the pandemic and enable the government to manage their budget since more informed decisions on how to curb the pandemic would be made.

1.7 Scope and Limitations

The project scope was to understand the requirements of the project, design and develop the information system.

The limitations that might be brought about by this system is slow internet connectivity could also affect the design of such a large system and limit the project from reaching its full potential.

Chapter 2: Literature Review

2.1 Background

It is well recognized that applications aimed at providing healthcare information such as those providing information on a patients' medical case history directly, checking treatments online, advisories, patient progress and health trackers are significant to people worldwide. According to OECD (2020), healthcare performance is strongly dependent on the economy, but also on the health systems themselves. These applications are even viewed as the backbone of the economy. This link should not be underestimated**.** Furthermore, these ICT applications have also contributed significantly to higher growth of employment, output as well as increasing the rate of growth of a country's GDP since the healthcare spending tends to be reduced.

A survey was conducted by the Kenyan County Health Records Information Officers to determine the extent to which digital health systems in public hospitals in Kenya are adopted. The survey revealed that Kenya is now adopting digital systems in healthcare and beginning to replace paper-based systems. (BMC Medical Informatics and Decision Making, n.d.).

Along with the growth of digital health systems in Kenya, it has been noted that the quality of healthcare in the country has been growing exponentially. The proliferation has not only happened in the developed countries, but also in developing countries. This has been due to the fact that digitized healthcare systems facilitate engagement between providers and the patients concerning their health, allow administrators to make fully formed decisions based on complete and up to date information through predictive analytics (Xelphahealth, 2018).

The growth of digital healthcare systems has given rise to business opportunities for entrepreneurs. As going online requires management changes, the business entrepreneurs have the advantage of implementing strategic and organizational changes much more quickly and at lower costs. In Kenya, the entrepreneur's opportunities to set up an IT entrepreneurship system are backed up by this fact: In the last several years the Internet users have been increasing exponentially (Munge, 2020).

Through the interlacing of technology, business models and value based healthcare, digital healthcare platforms are able to address the unique challenges in resource and supply limited environments effectively thus improving healthcare. According to the Digital Authority Partners (2020), innovation is the name of the game here, with the main goal of streamlining physicians' work, optimizing systems, improving patient

outcomes, reducing human error, and lowering costs through amazing web and mobile experiences.

2.2 Challenges associated with Covid-19 tracking systems

2.2.1 Privacy Concerns and Data Management

According to the World Economic Forum (2020), tracking technologies using smartphones and web-based applications could help monitor the evolution of the virus among the population and quickly prevent new clusters of confirmed cases from building up therefore ensuring countries emerge from lockdowns. But these tracking systems also bring about privacy risks associated with collecting health data from citizens and tracking movements. These tools may lead to an unprecedented infringement of our freedoms, unless governments and tech companies turn to robust governance frameworks.

Nicole Wetsman (2020) also states that Google and Apple have partnered to build a Bluetooth-based tracking system that can automatically log people's interactions. Due to the limitation of contact, experts are turning towards technology to take over the contact process. The tracking system has to ensure it follows privacy by design thus making it a priority.

2.2.2 Poor uptake of the technology

According to Melbourne et al. (2020), if there is poor uptake of the tracking system, plans to curb the virus would appear to be a waste of time and yet, making the app compulsory would raise a plethora of legal, constitutional, human rights, civil liberty, and ultimately, democratic questions. Some governments are also hesitant to adopt apps for a wide range of reasons such as Belgium highlighting that investment in people and expertise is key and New Zealand suggesting that people should keep a diary of their contact with others. Some people simply don't trust their governments and thus will avoid having their data collected by resisting the applications.

2.2.3 Kenya Covid-19 Corona Tracker

The Kenya Covid-19 Corona Tracker uses a related system as the tracking system that is to be developed by allowing users to view the statistics of those infected, those recovered as well as the number of deaths through the use of a graph. The Corona Tracker also gives an estimation of the recovery rate as well as the fatality rate in relation to the country's population.

Figure 1. Corona Tracker (Weiseng, n.d.).

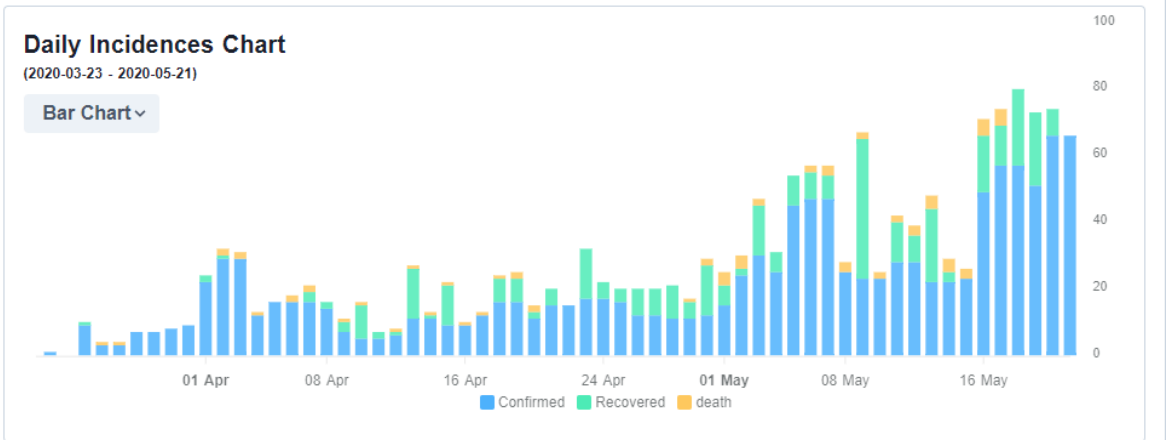


Figure 2. Corona Tracker (Weiseng, n.d.).

2.2.4 Bing Covid-19 tracker

Bing Covid-19 tracker is a system that enables one to view the number of confirmed Covid-19 cases in a country. The system is able to show the number of recovered cases as well as the number of active ones. The tracker not only shows the number of cases

in a specified country but globally as well. The tracker also includes a map with specifies areas with a large number with a dark shade of colour whereas those with fewer numbers, with a lighter shade of colour. This system is similar to the proposed Covid-19 supply system since it is able to show the confirmed cases not only in one country but globally.

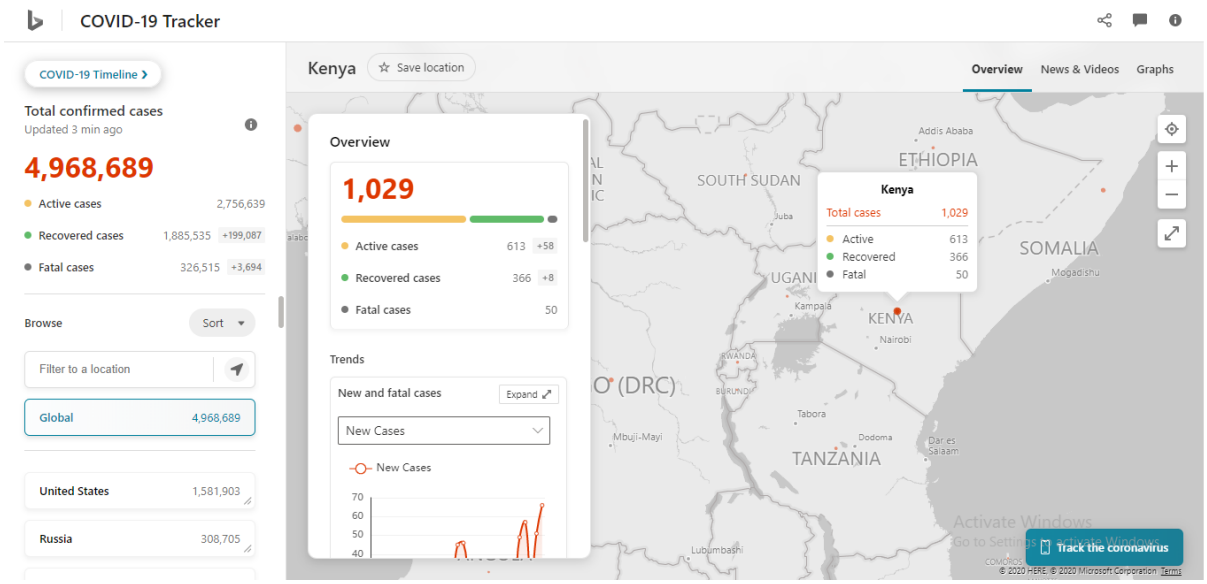


Figure 3. Covid-19 Tracker (Microsoft Bing Covid-19 Tracker, 2020)

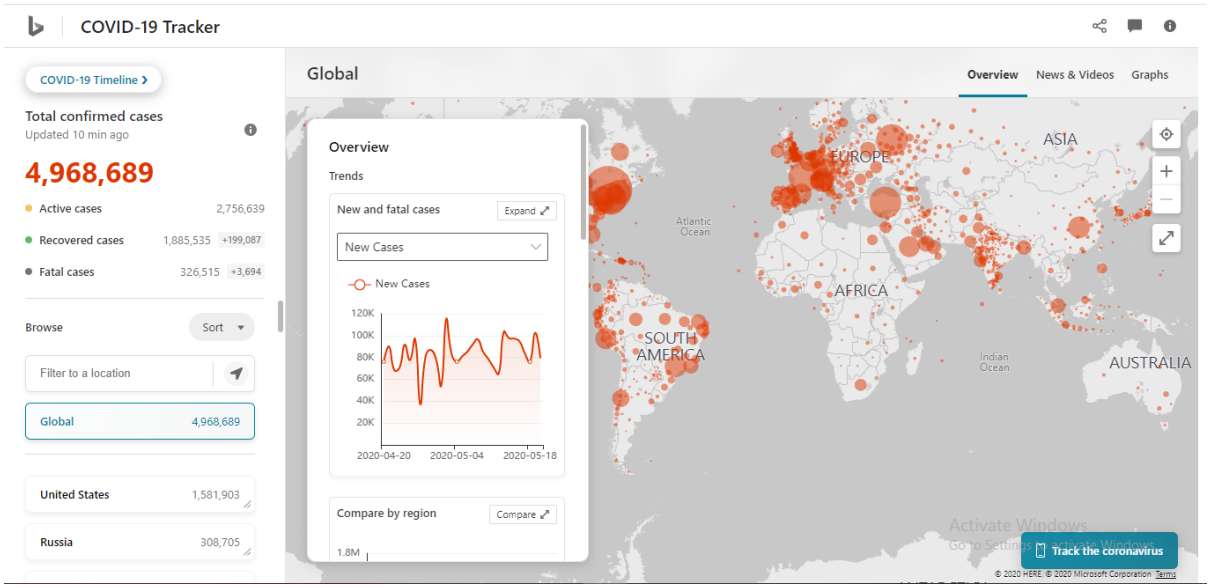


Figure 4. Covid-19 Tracker (Microsoft Bing Covid-19 Tracker, 2020)

2.3 Conceptual Framework

When accessing the system, one would require to select a country. The system then directs the user to the country chosen on the map as well as displays the number of confirmed cases, the recovered cases and the number of deaths that the country the user has chosen has.

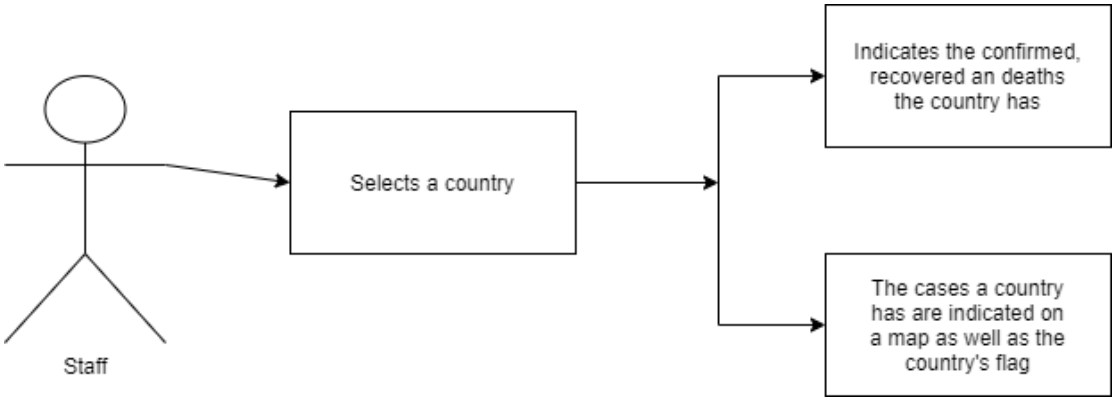


Figure 5. Conceptual Framework.

2.4 Wireframe

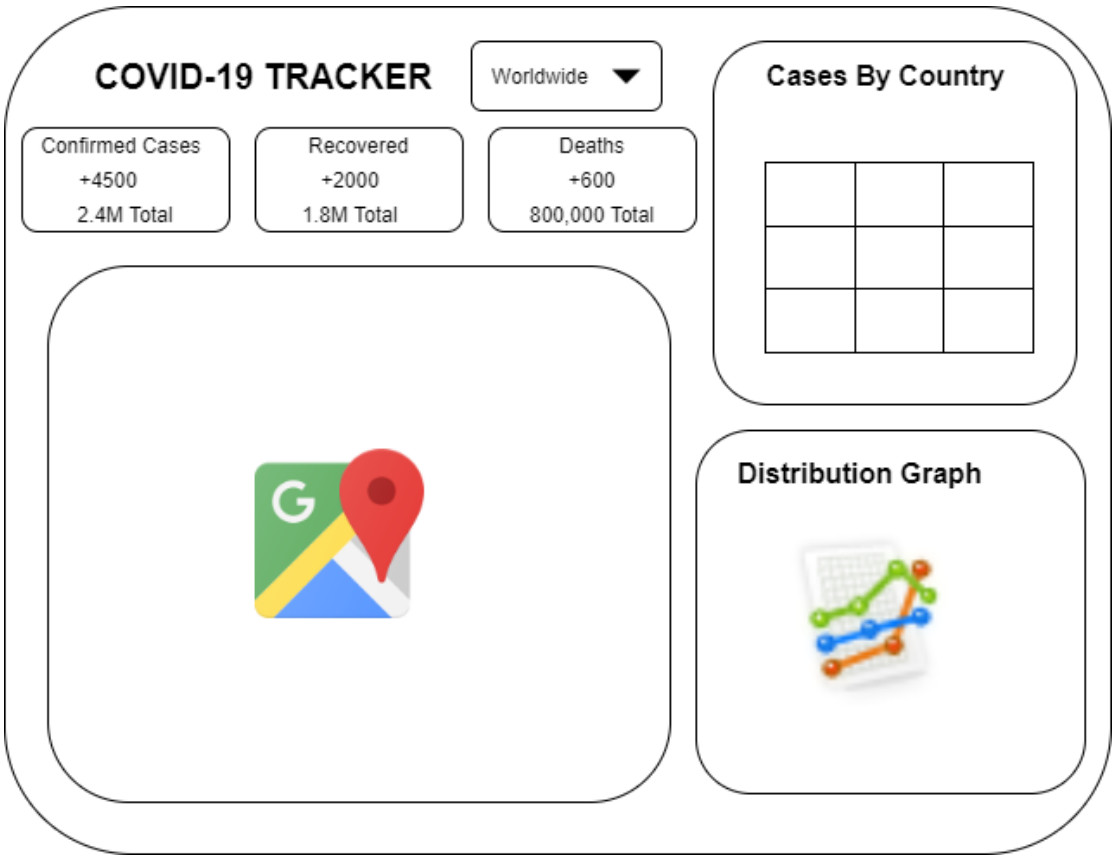


Figure 6. Wireframe.

Chapter 3: System Development Methodology

3.1 Introduction

This chapter highlights the system development methodology to be used in development of the system. The requirements of the system such as functional and non-functional requirements have also been explained in order to understand the development of the system. What the system aims to deliver and the tools and techniques that will enable estimation in the project are discussed in detail in this chapter. The chapter also talks about OOAD which is the paradigm to be used in the development of the system. OOAD is to be used because of its simplicity in that it is easy for a developer to identify an object in a system and its behaviour as well. OOAD encourages encapsulation in that it encourages planning and development of systems that are truly independent of each other.

3.2 Software Development Methodology

The Rapid Application Development model is most preferred for this project. The model is based on prototyping and iterative development with no specific planning involved. The process of writing the software itself involves the planning required for developing the product. This was due to its emphasis and on its attempts to reduce inherent project risk by breaking a project down into smaller segments and providing more ease of change during the development process. Rapid Application Development (RAD) is a form of agile software development methodology that prioritizes rapid prototype releases and iterations. Unlike the Waterfall method, RAD emphasizes the use of software and user feedback over strict planning and requirements recording (Singh,2019). The benefit of early feedback from end users ensures that changing requirements is accommodated effectively, time between prototypes and iterations is short, customer feedback is also encouraged and reviews are quick as well.

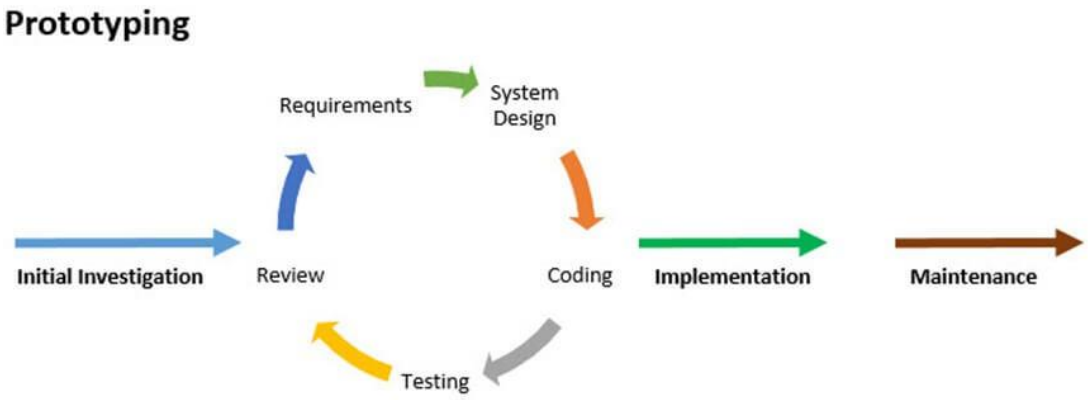


Figure 6. Prototyping System Methodology (Guru99,2020).

3.2.1 Requirements Definition

The requirements of the project were supposed to be well as defined to enable effective scope management as well as it reduces risks. This also avoids projects from failing.

3.2.2 Analysis

In this phase, Analysis of the requirements for the system are established to assist with revealing important information on the need of stakeholders, tools needed to develop and test the application and what will be needed to make the application development process a success.

3.2.3 Design

This involves defining an architecture, modules, interfaces and data for a system to satisfy specified requirements

3.2.4 Coding and Testing

Test driven development will help in optimizing your code before you even write it. It also helps save time greatly.

3.2.5 Build Prototype

This is the process of defining how the information system will be built as well as ensuring that the information system is operational and used. This will involve coming up with a web application all connected to a central remote database. The application development environments that have been employed are:

a) Web Application

The platform for application implementation for the public is a USSD and web portal connected to a central database. The web portal has been developed using JSON and hosted on an online apache HTTP server.

3.3 Functional Requirements

Most of the systems requirements focus mainly on the functional requirements. It generally depicts what the system should accomplish. They are categorised as follows:

3.3.1 Usability requirements

a) The users can search a country of their choice.

b) The users can also be able to view the number of confirmed cases, recovered cases and deaths the country has had.

3.3.2 Reliability requirements

The system allows users to enter their inputs correctly and process the desired output without failure. The system is robust in that it does not fail if there is any interruption.

3.3.3 Performance Requirements

The system is adequately scalable in terms of handling work-load bearing in mind that there are many users who will be using it. The response time would be minimal so as to provide the users with up to date information regarding the already confirmed Covid-19 cases.

3.4 Non-Functional Requirements

Non-functional requirements are used to describe aspects of a system that doesn't relate to its execution but rather to its evolution over time. Examples include maintainability, extensibility and documentation among others.

Non- functional requirements of my system include:

viii. System response time which is the measure of how long the application takes to complete a process.

ix. Privacy of the system. This is how well people's information is protected.

x. The system maintainability which is how the application can be maintained.

xi. System scalability which is the ability of the system to be able to handle a lot of users without losing its quality.

xii. System efficiency. That is how systematic is the application.

xiii. System accessibility. It is how well the application can be accessed.

3.5 Method used to Gather the Functional and Non-Functional Requirements

The method most applicable in this case are;

Questionnaires- these involve a series of questions for the purpose of gathering information from respondents. I plan to gather important information about what the project requires.

3.6 List of Design Diagrams drawn in Chapter 4

i. The Use Case Diagram.
ii. The Class Diagram.
iii. The Sequence Diagram.
iv. The Entity Relationship Diagram

3.7 List of Development Tools that were used

3.7.1 Programming tools

The system is developed using React JS and JavaScript as the appropriate programming language while CSS will be incorporated for the design.

3.7.2 Documentation tools

Microsoft word 2013 was used to document some deliverables of the project such as the user manual. It is user friendly, has many features and due to familiarity.

3.8 Method that was used to test the developed system

Unit testing – this involves a software testing method in which the individual units or components of a software are tested.

3.9 Domain of Execution

The project is a web-based application that involves use of the internet to access.

3.10 Deliverables

3.10.1 Search Module

A user of the system searches a country of choice. The user is required to select a country from a list of options by use of a dropdown button.

3.10.2 Cases module

The user is able to view the number of cases that have been confirmed in the country, the number of people that have recovered and the number of deaths. The number of cases per day are shown with a plus sign to indicate additional cases.

3.10.3 Map module

This module allows the user to view the number of cases that have been confirmed in the country, the number of people that have recovered and the number of deaths on an interactive map that changes colour depending on the type of cases chosen. The map also indicates the flag of the country chosen.

3.10.4 Graph module

This allows system users to view the number of cases confirmed, the number of people that have recovered and the number of deaths worldwide by the use of a graph. The graph used shows either a rise or a decrease in the number of cases over a period of time.

3.10.5 Table module

This allows system users to view the number of live cases worldwide by the use of a table. The table used shows the number of cases from the country with the highest cases to the country with the least.

Chapter 4: System Analysis and Design

4.1 Introduction

This chapter deals with the requirements and design that enables a developer to have an overview of what is to be done. It also gives an overview of how the system will look like. Due to this, it is the key chapter in determining the development of a system.

4.2 Functional Requirements

Most of the systems requirements focus mainly on the functional requirements. It generally depicts what the system should accomplish. They are categorised as follows: -

4.2.1 Usability requirements

a) The staff who are the users of the system can search a country of their choice to view the number of cases, recovered and deaths the country has.

b) The customers shall be able to zoom in on a country using the interactive map and view the number of cases as well as the country's flag.

4.2.2 Reliability requirements

The system will be able to allow users to enter their inputs correctly and process the desired output without failure. The system will also be robust in that it shall not fail if there is any interruption.

4.2.3 Performance Requirements

The system shall be adequately scalable in terms of handling work load bearing in mind that there are many users who will be using it. The response time would be minimal so as to provide the users with up to date information regarding available rental houses.

4.3 Non-Functional Requirements

Non-functional requirements are used to describe aspects of a system that doesn't relate to its execution but rather to its evolution over time. Examples include

: Maintainability, extensibility and documentation among others.

Non- functional requirements of my system include:

i. System response time which is the measure of how long the application takes to complete a process.

ii. Privacy of the system. This is how well people's information is protected.

iii. The system maintainability which is how the application can be maintained.

iv. System scalability which is the ability of the system to be able to handle a lot of users without losing its quality.

v. System efficiency. That is how systematic is the application.

vi. System accessibility. It is how well the application can be accessed.

4.4 Data Models

A data model is a conceptual representation of the data structures that are required by a database. The first step in the development of the system is by having data models in the analysis phase like the use case diagram, the sequence diagram, class diagram, the ERD and the DFD. Models needed in the design phase are the database schema, wireframes and the architectural design.

4.4.1 The Use Case Diagram

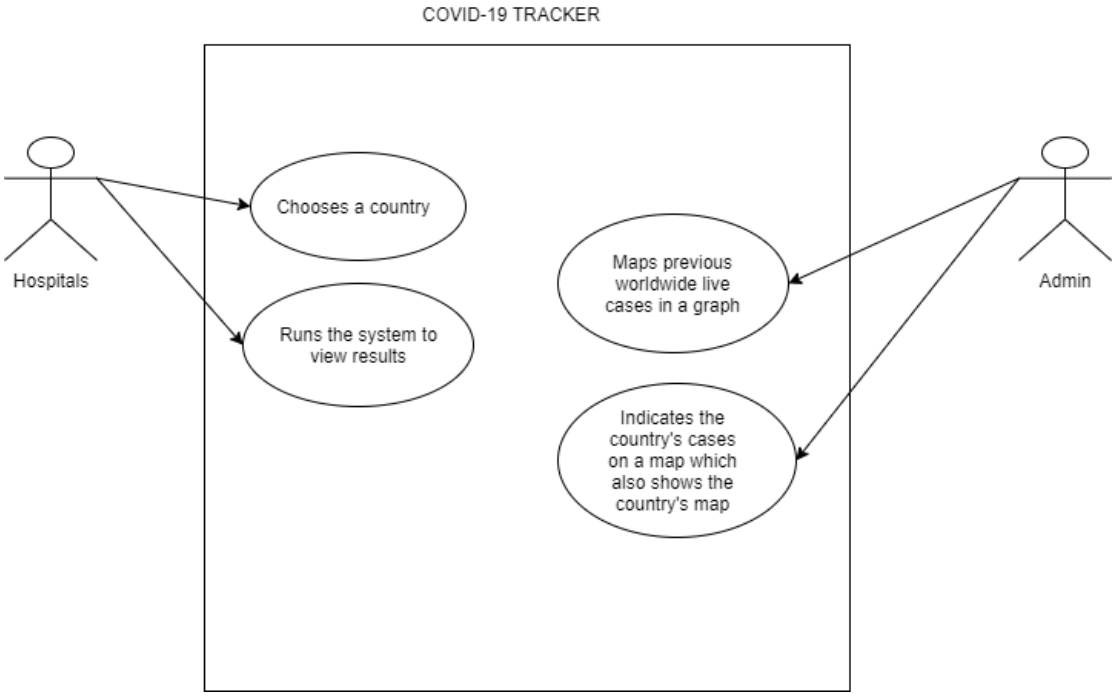


Figure 7. Use Case Diagram.

4.4.2 The Sequence Diagram

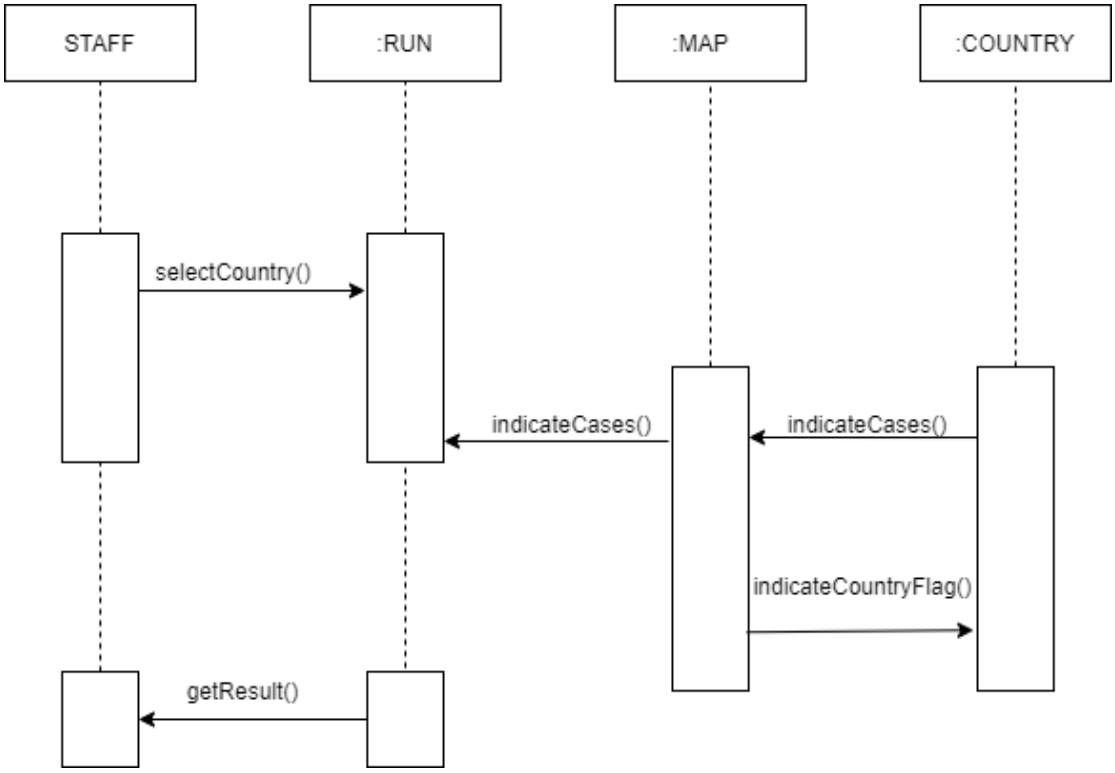


Figure 8. Sequence Diagram.

4.4.3 The Class Diagram

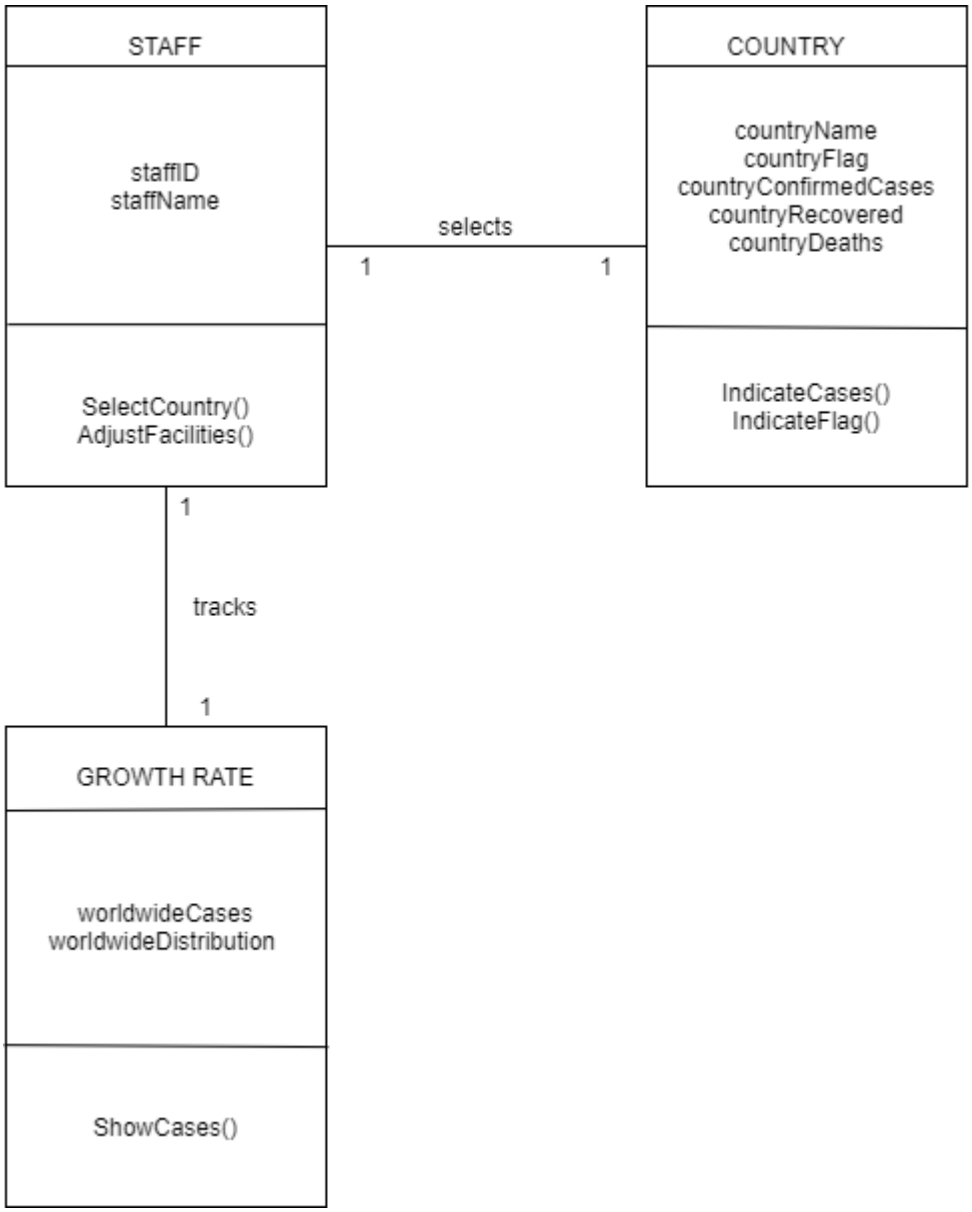


Figure 9. Class Diagram.

4.4.4 Entity Relationship Diagram

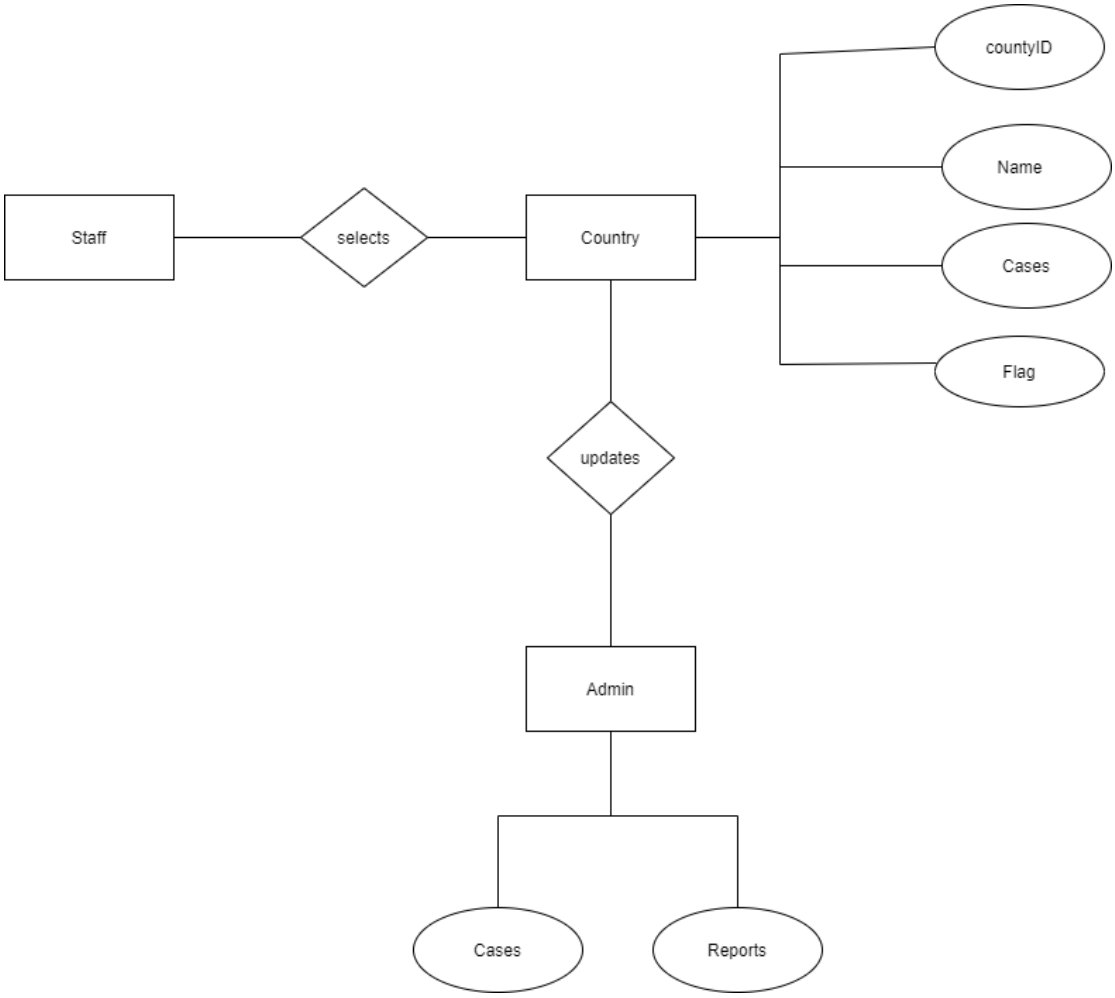


Figure 10. ERD.

Chapter 5: System Implementation and Testing

5.1 Introduction

System implementation is the stage whereby the theoretical design part for developing the system is turned into a working system. This chapter discusses the technology tools used to develop the system, how the system operates and tests the system techniques carried out on the system. This chapter also includes the testing section, which includes functional testing and usability testing in order to establish if the system met the objectives of the proposed solution.

5.2 Description of Implementation Environment

The system comprises of a front-end subsystem whereby a web application is the frontend subsystem. React Js and JavaScript programming language was used in implementing the web application. The administrator and web dashboard were developed using a web-based platform. React allows developers to create large web applications that can change data, without reloading the page. The main purpose of React is to be fast, scalable, and simple. It works only on user interfaces in the application.

5.2.1 Software Specifications

Software specifications is a comprehensive description of the environment and the software that was used in the development of the website. Windows 10 is the operating system that is used in the functionality of the web application. Windows 10 was used because of its extended built in mobile device management capabilities making it easier to manage a device from the cloud, windows 10 interface. Chrome web browser version 77 was used in the development of the web application. It has chrome development tools which is a set of web developer tools built directly into the google chrome browser. These tools can help you edit pages on the fly and diagnose problems quickly, which ultimately helps you build better websites, faster.

5.3 How testing was done

There were approaches that were used to test the system. The approach that was used is unit testing. Unit testing was done to test each module individually and find out if there are errors in the code of the module tested. Where there were errors, the code of the module was reviewed and debugged until the errors were resolved. Each module

was tested with a sample data. Component testing was also performed to test each functionality. The entire system was integrated and tested using integration testing to ensure the different modules can work together.

5.4 Test Data and Results

Functional Requirements

5.4.1 Test identifier: Select

Table 1 shows results of test identifier one whose main assessment was to check if a user can select a country using the system. The observed and expected behaviour were consistent. Test Identifier one passed the trial and outcome was deemed successful.

Utilized Use Case	**Select**
Test Parameters	User can select a country
Expected Behaviour	Selection Successful
Observed Behaviour	Selection Successful
Test Outcome	Pass

Table 1. Select Test Case

5.4.2 Test Identifier: Universal Authentication

Table 2 shows results of test identifier two whose main assessment was to check if the administrator was able to perform universal authentication. The observed and expected behaviour were consistent. Test Identifier two passed the trial and outcome was deemed successful.

Utilized Use Case	**Universal Authentication**
Test Parameters	Admin can perform authentication
Expected Behaviour	Successful Authentication
Observed Behaviour	Successful Authentication
Test Outcome	Pass

Table 2. Universal Authentication Test Case

5.4.3 Test Identifier: View

Table 3 shows results of test identifier three whose main assessment was to check if the hospital staff can view how results after selection of a country. The observed and

expected behaviour were consistent. Test Identifier three passed the trial and outcome was deemed successful.

Utilized Use Case	**View**
Test Parameters	Administrator can view the results of the selection done
Expected Behaviour	Successful
Observed Behaviour	Successful
Test Outcome	Pass

Table 3. View Test Case

5.4.4 Test Identifier: Map

Table 4 shows results of test identifier four whose main assessment was to check if the hospital staff can view how results on an interactive map after selection of a country. The observed and expected behaviour were consistent. Test Identifier four passed the trial and outcome was deemed successful.

Utilized Use Case	**Map**
Test Parameters	Administrator can view the results of the selection done as well as the country's flag
Expected Behaviour	Successful
Observed Behaviour	Successful
Test Outcome	Pass

Table 4. Map Test Case

5.4.5 Test Identifier: Graph

Table 5 shows results of test identifier five whose main assessment was to check if the hospital staff can view different results when either confirmed cases, recovered cases or deaths are selected. The observed and expected behaviour were consistent. Test Identifier five passed the trial and outcome was deemed successful.

Utilized Use Case	**Graph**
Test Parameters	Administrator can view the worldwide confirmed cases, recovered and deaths against a period of time.

Expected Behaviour	Successful
Observed Behaviour	Successful
Test Outcome	Pass

Table 5. Graph Test Case

5.5 Discussion of Results

5.5.1 Select module

This module basically allows a user to select a country using the system.

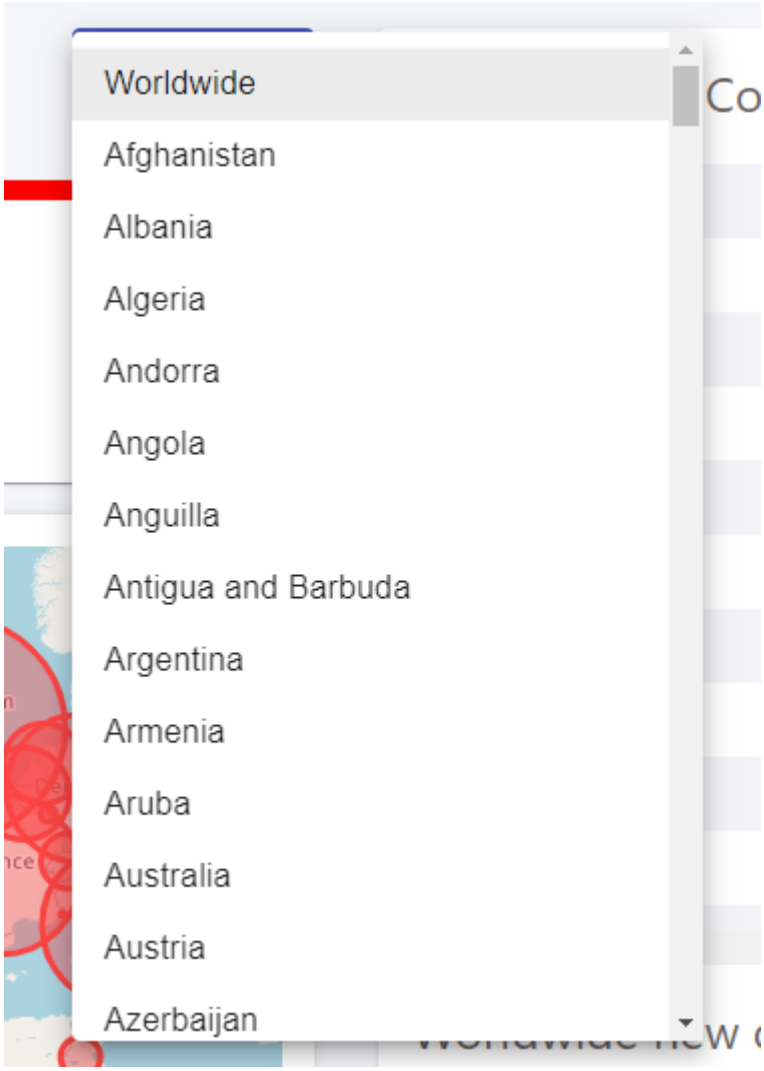


Figure 11. Select

5.5.2 Cases Module

After selection, cases are displayed in terms of the number of confirmed cases, recovered and deaths that the country has.

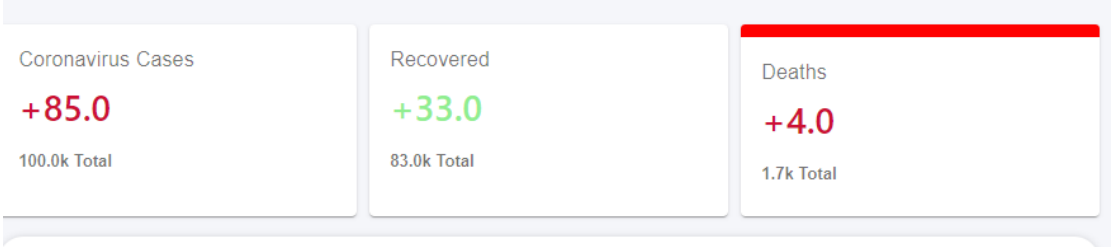


Figure 12. Cases

5.5.3 Map Module

The map module allows the user to view the cases after selection. The types of cases are displayed with different colours and sizes. Big sizes indicate large number of cases while small sizes indicate a small number of cases.

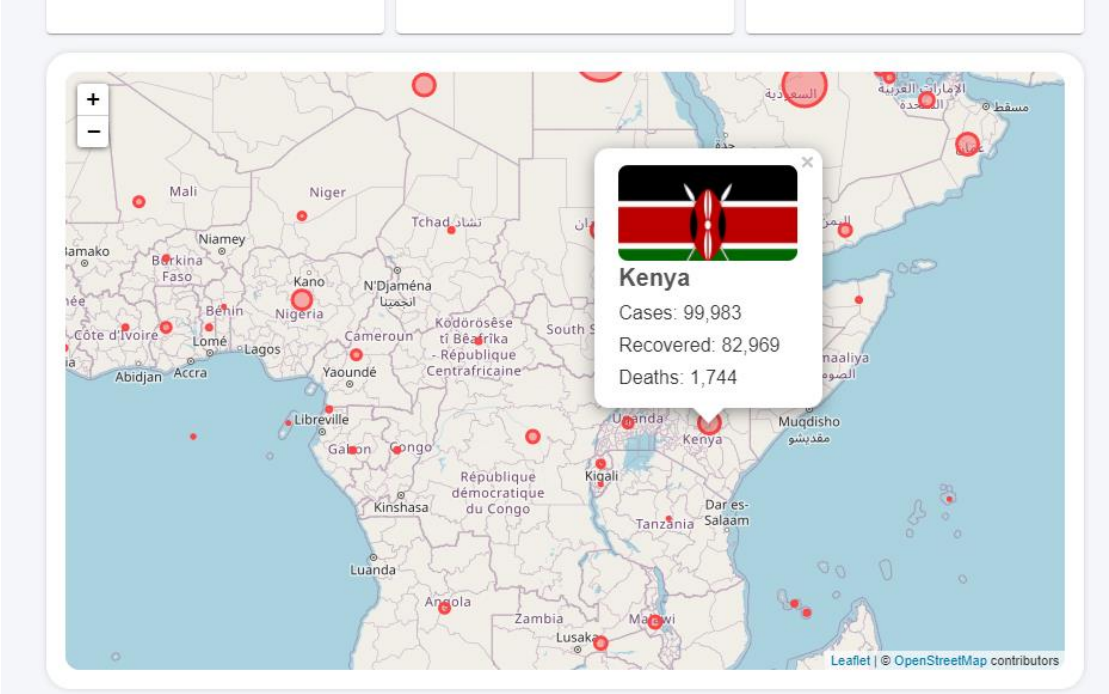


Figure 13. Map

5.5.4 Graph Module

The graph module indicates the worldwide number of cases over a period of time.

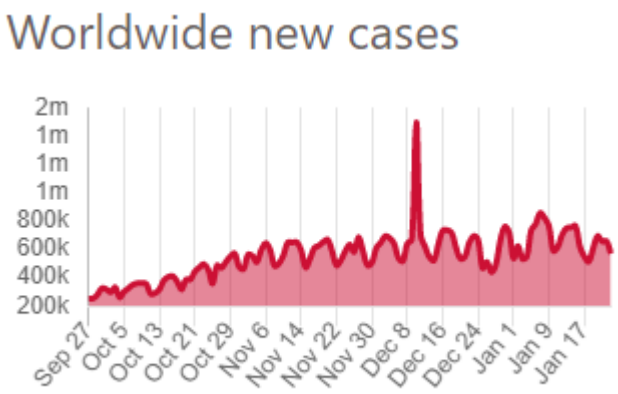


Figure 14. New Cases

Figure 15. New Recovered

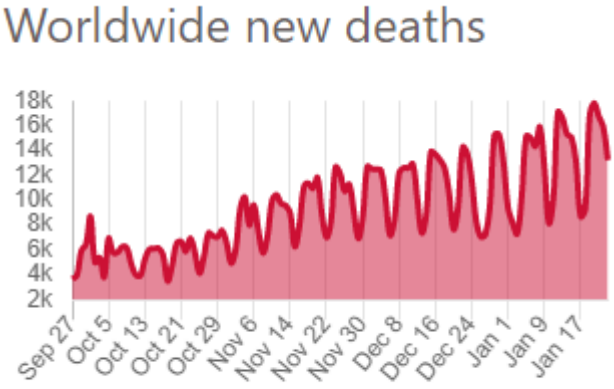


Figure 16. New Deaths

Chapter 6: Conclusion

Combined with more widespread testing, COVID-19 Trackers are the first step in the next stage of fighting the pandemic as well as an essential part of the strategy for keeping the coronavirus in check after the first wave recedes and the economy reopens. As the virus that causes COVID-19 began to spread from person to person in communities (community transmission), scientists needed to track the disease and try to slow its spread. To do so, they needed a common definition for a case of COVID-19. Having a case definition helps to make sure cases are counted the same way everywhere. In the United States, a confirmed case of COVID-19 is defined as a person who tests positive for the virus that causes COVID-19. COVID-19 became a nationally notifiable disease, meaning that health departments are required to report cases of COVID-19.

Future works: Our proposed method is mainly applicable for developing new COVID-19 tracking websites for hospital and medical institutions. For businesses that already have a tracking system, a new approach will be needed, where estimation of hospital facilities should be used as the inputs of the requirements elicitation. A model of IS development that uses the artefacts of the exciting systems has been proposed in this documentation.

References

Digital Health Systems in Kenyan Public Hospitals: A Mixed-Methods Survey . (n.d.). Retrieved from BMC Medical Informatics and Decision Making : https://bmcmedinformdecismak.biomedcentral.com/articles/10.1186/s12911-019-1005-7

Digital Transformation in Healthcare in 2020: 7 Key Trends. (2019, November 19). Retrieved from Digital Authority Partners: https://www.digitalauthority.me/resources/state-of-digital-transformation-healthcare/.

Ghose, T. (2020, April 7). *How are people being infected with Covid-19?* Retrieved from livescience.com: https://www.livescience.com/how-covid-19-spreads-transmission-routes.html

Hamblin, J. (2020, March 3). *What you can do right now about the Corona Virus*. Retrieved from The Atlantic: https://www.theatlantic.com/health/archive/2020/03/coronavirus-what-you-can-do-help-slow-outbreak/607369/.

Health and the Economy: A Vital Relationship. (2020). Retrieved from OECD Observer: https://oecdobserver.org/news/archivestory.php/aid/1241/Health_and_the_economy:_A_vital_relationship_.html.

How to Create a Trustworthy COVID-19 Tracking Technology. (2020). Retrieved from World Economic Forum: https://www.weforum.org/agenda/2020/04/covid-19-coronavirus-tracking-technology/.

Melbourne, K. L. (2020, April 24). *Do We Really Need a Tracking App and Can We Trust It?* Retrieved from https://pursuit.unimelb.edu.au/articles/do-we-really-need-a-tracking-app-and-can-we-trust-it.

Microsoft Bing Covid-19 Tracker. (2020). Retrieved from https://www.bing.com/covid?ref=share.

MIS Development Process with SDLC & Agile. (2020). Retrieved from Guru99: https://www.guru99.com/mis-development-process.html.

Munge, J. (2020). *Embracing Digital Healthcare in Kenya*. Retrieved from The Standard: https://www.standardmedia.co.ke/article/2000229164/embracing-digital-healthcare-in-kenya.

Readfearn, G. (2020, April 28). *'How Did Coronavirus Start and Where Did It Come from?* Retrieved from The Guardian: https://www.theguardian.com/world/2020/apr/28/how-did-the-coronavirus-start-where-did-it-come-from-how-did-it-spread-humans-was-it-really-bats-pangolins-wuhan-animal-market.

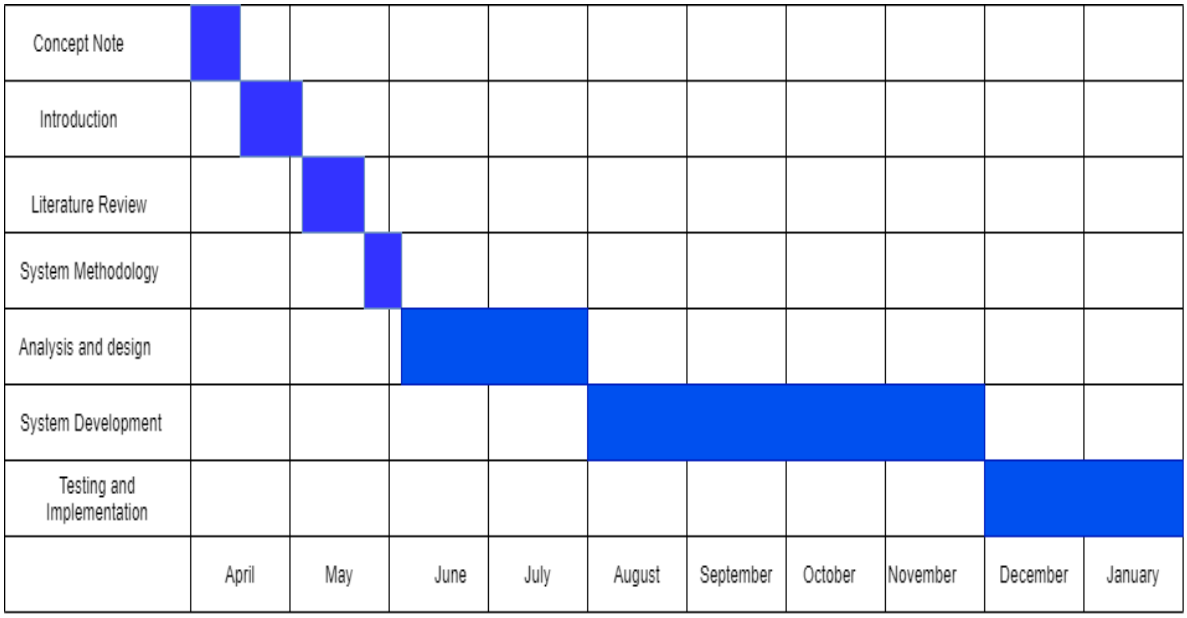
Singh, A. (2019, December 06). *What is Rapid Application Development(RAD)*. Retrieved from Capterra: https://blog.capterra.com/what-is-rapid-application-development/.

Weiseng. (n.d.). *Kenya COVID-19 Corona Tracker*. Retrieved from https://www.coronatracker.com/country/kenya/

Wetsman, N. (2020). *Google and Apple's COVID-19 System Can't Save Lives All on Its Own* . Retrieved from The Verge: https://www.theverge.com/2020/4/15/21222161/apple-google-bluetooth-contact-tracing-system-coronavirus-health.

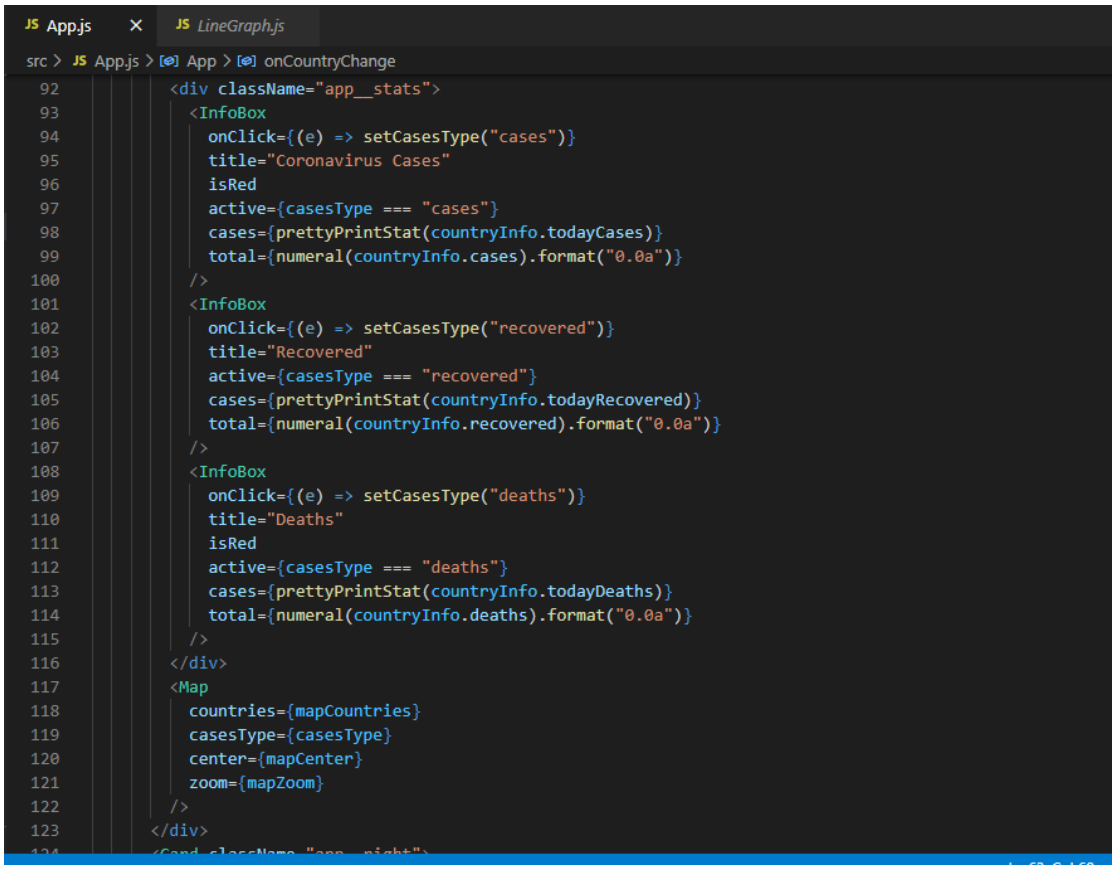
Xelphahealth. (2018). Retrieved from https://xelphahealth.com/?gclid=CjwKCAjwwMn1BRAUEiwAZ_jnEuC7KJy0MBeHFepKQODtSN27glP3-QNmtYewi52vcFcghNCRYjiuWBoCUbQQAvD_BwE.

Appendix A: Time schedule



Appendix B: Interesting Code

This code helped to make the information boxes for the confirmed cases, the number of people who recovered as well as the number of deaths.

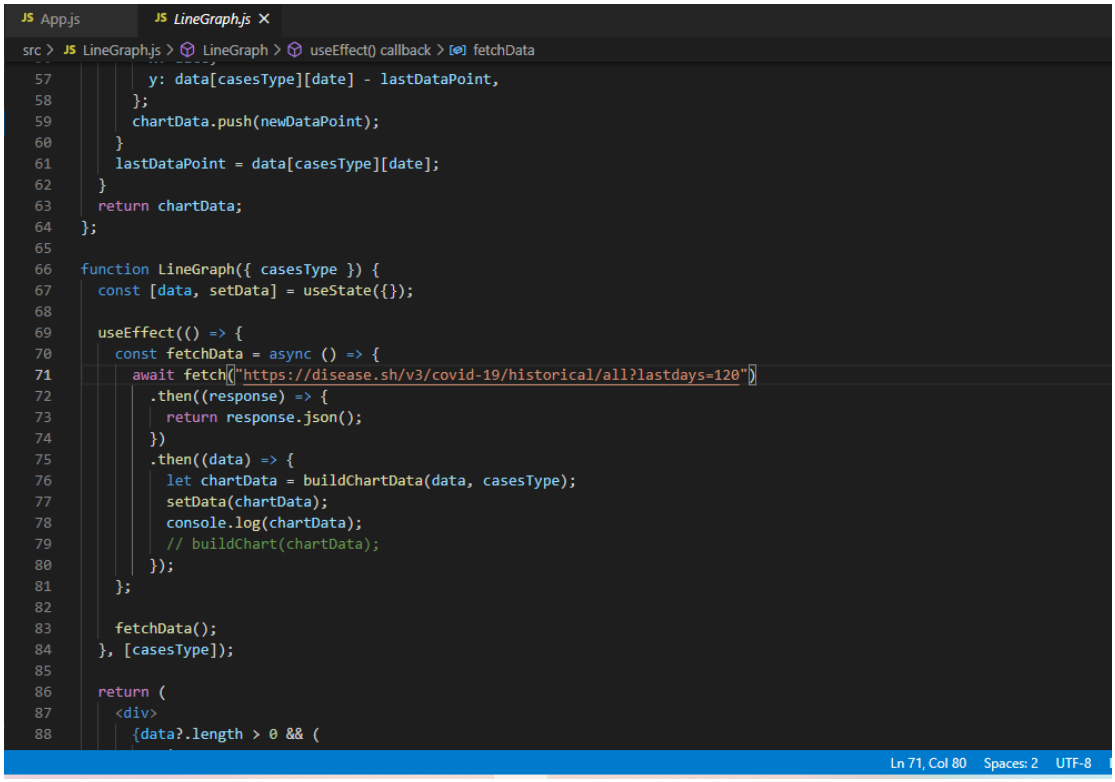


```
JS App.js  JS LineGraph.js
src > JS App.js > App > onCountryChange
92          <div className="app__stats">
93            <InfoBox
94              onClick={(e) => setCasesType("cases")}
95              title="Coronavirus Cases"
96              isRed
97              active={casesType === "cases"}
98              cases={prettyPrintStat(countryInfo.todayCases)}
99              total={numeral(countryInfo.cases).format("0.0a")}
100           />
101           <InfoBox
102             onClick={(e) => setCasesType("recovered")}
103             title="Recovered"
104             active={casesType === "recovered"}
105             cases={prettyPrintStat(countryInfo.todayRecovered)}
106             total={numeral(countryInfo.recovered).format("0.0a")}
107           />
108           <InfoBox
109             onClick={(e) => setCasesType("deaths")}
110             title="Deaths"
111             isRed
112             active={casesType === "deaths"}
113             cases={prettyPrintStat(countryInfo.todayDeaths)}
114             total={numeral(countryInfo.deaths).format("0.0a")}
115           />
116         </div>
117         <Map
118           countries={mapCountries}
119           casesType={casesType}
120           center={mapCenter}
121           zoom={mapZoom}
122         />
123       </div>
```

Leaflet maps which is a JavaScript library for interactive maps was used. The leaflet map URL was copied into the system.

```
JS App.js  JS Map.js
src > JS Map.js > Map
1   import React from "react";
2   import { Map as LeafletMap, TileLayer } from "react-leaflet";
3   import "./Map.css";
4   import { showDataOnMap } from "./util";
5
6   function Map({ countries, casesType, center, zoom }) {
7     return (
8       <div className="map">
9         <LeafletMap center={center} zoom={zoom}>
10          <TileLayer
11            url="https://{s}.tile.openstreetmap.org/{z}/{x}/{y}.png"
12            attribution='&copy; <a href="http://osm.org/copyright">OpenStreetMap</a> contributors'
13          />
14          {showDataOnMap(countries, casesType)}
15        </LeafletMap>
16      </div>
17    );
18  }
19
20  export default Map;
21
```

This code helped fetch data from disease.sh which contains information about all countries regarding the virus. The data was pulled into the system for the line graph.



This code helped to sort out data into the types of cases which are the confirmed cases, the number of those who recovered and the deaths that a country has.

```
export const sortData = (data) => {
  let sortedData = [...data];
  sortedData.sort((a, b) => {
    if (a.cases > b.cases) {
      return -1;
    } else {
      return 1;
    }
  });
  return sortedData;
};
```