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| COM667 Computing Systems Project |
| Final Report |
| Food and Fitness Tracker - FFT |

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Abstract

The initial motivation behind the ‘Food & Fitness Tracker – FFT’ project was to create a nutritional and exercise tracking application which had all of the advantages of existing solutions but none of the drawbacks. To enable this, the role of mobile health, nutrition and exercise tracking applications in helping to tackle obesity was investigated with the aim being to discover and implement an innovative solution in which a user is encouraged to track their nutrition and exercise activities, in the hope that the end user would be encouraged into adopting a healthier lifestyle.

The project followed the Modified Waterfall software development lifecycle, with functionality testing occurring alongside the development process.

Testing of the entire application was completed after to the development process had been completed. The main technique employed was Black Box testing (i.e. manual testing).

The design phase of this project explains the data structure used to store and retrieve data. A flow map has also been included to show the thinking behind how a user may use the application. UI design have also been included to outline what the completed application should look like alongside a colour palette and app badge.

The project Implementation section of this project contains code sections that were explained in greater detail so that their purpose could be understood.

Whilst the completed application did not meet all the requirements originally stated, however, due to the ‘MOSCOW’ approach to requirement prioritisation being employed for this project and the requirements that were not met having been listed as a ‘Could Have’ it has not adversely affected outcome of this project.

Acknowledgments

I would like to take this opportunity to offer my thanks to everyone who was involved in making this project a success.

I would like to firstly offer my thanks to all the lecturers and staff at the University of Ulster for the four years of excellent teaching that has been provided to me. Thank you for the consistent support and learning provided along my academic journey here at Ulster University.

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I would also like to thank ‘Allsop – Intelligent Solutions’ for their support over the last year as member of their staff, with special thanks going to Richard Campbell (CEO) and Matt McNabb (Senior Front-End Developer) who provided me with guidance on how to best manage this project as well as mentoring me in the Iconic Framework at the start of my project.

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# Chapter 1: Introduction

## Project Background

Over the last 6 months I have gained an increased interest in my personal health and wellbeing. To help me keep a record of what I am eating and what exercises I am doing on daily basis, I employ the use of several mobile applications, as I have not been able to find an app which will do the same job as all three apps. These applications are “Apple Health”, “MyFitnessPal” and “Nike Run Club”. The main issue that I have with using these three applications is that whilst each app does record different information, and each have their own advantages such exercise route tracking, calories eaten in day and projected weight loss. They are also inefficient due the amount of crossover information that is stored on each of the application such as the total number of steps taken in a day and calories burned. The second issue I have with these apps is the number of adverts that appear (i.e. MyFitnessPal and Nike Run Club) when they are used. The third and final problem with them is that the information breakdowns tend to be quite complex and therefore not very helpful to a normal user. This app would initially be used by myself and a few of my friends who have encountered similar issues.

Due to the above reasons, I desire to create an application that will keep track of a user’s daily eating and fitness habits. The initial features for the proposed solution will allow the user to enter their daily diet and any exercises they have completed. As well as being able to track the current route a user is taking for an exercise that they are currently completing. A breakdown of the users’ daily diet and fitness habits will also be provided to the user.

## Project Aim

My project aim is to create a cross-platform application that will allow the user to track their daily diet and exercise activities and provide a breakdown of the information in an easily interpreted graphical representation.

## Copyright, Intellectual Property Rights or Commercial Sensitivity

The only area of concern that I will need to ensure that I comply with, when creating the application would be data protection as set by the General Data Protection Regulation (GDPR) by the EU. This law requires me to ensure that all personal data and the privacy of EU citizens is protected.

## Hardware and Software

The only hardware necessary for me to create the app would be my own personal pc and access to mac which contains the XCode. As well as this at this stage of my initial project planning, I am intending to create the application using the Ionic Framework.

## Dissertation Overview

Below is an overview of what is contained in the remaining chapters of the report:

**Chapter 2**

This chapter contains all research surrounding the project. This includes reviews on software development lifecycles, evaluations of possible target platforms, development environments/technologies, development methods. This section ends in a conclusion with the most appropriate approach being selected.

**Chapter 3**

Within this section, the application requirements are outlined with information on techniques used to create functional and non-functional requirements. Also included in this section is the risk analysis of the overall project.

**Chapter 4**

Presented in this chapter are the designs of the system, this includes high-level UI designs as well as database designs.

**Chapter 5**

Implementation is documented in this chapter with an in-depth insight into how all elements of the system were developed. Requirements outlined in Chapter 3 and designs included in chapter 4 are used as references throughout this section.

**Chapter 6**

Testing is contained within this chapter which details the strategies used during and after implementation was complete. All testing methods are defined and explained with reference to how they were used.

**Chapter 7**

This chapter evaluates the completed mobile application. Project planning and maintenance is reviewed alongside the feedback from end users. Requirements outlined in Chapter 3 are reviewed against the end-product.

**Chapter 8**

The conclusion of the report evaluates the success of the project and includes the proposal of future enhancements.

# Chapter 2: Literature Review

## Background Research

### Obesity

The term obese can be used to describe any person who is very overweight (i.e. with a lot of body fat). This is becoming a common problem in the UK with it currently being estimated that obesity affects around 1 in every 4 adults and around 1 in every 5 children aged 10 to 11 in the UK.

Whilst there is no definitive way to diagnose someone as obese, the most commonly used method to indicate if someone can be classified as healthy weight, overweight or obese is by measuring a persons Body Mass Index (BMI).

BMI is used to determine if a person is of a healthy weight for their height. The NHS has created a simple tool that can be used to determine you BMI and if you are of a Healthy weight. It can be accessed via <https://www.nhs.uk/live-well/healthy-weight/bmi-calculator/>.

“For most adults, a BMI of:

* 18.5 to 24.9 means you're a healthy weight
* 25 to 29.9 means you're overweight
* 30 to 39.9 means you're obese
* 40 or above means you're severely obese”

(NHS, 2016)

In more general terms men with a waist circumference of 94cm (37in) or more and women with a waist circumference of 80cm (about 31.5in) or more are considered to be more at risk to develop obesity-related health problems in the future than someone who either of a healthy weight or just overweight.

The figure below shows the rise obesity levels in men and women since 1993 in England.

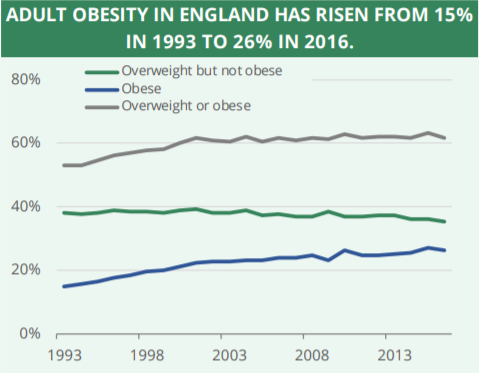


Figure 2.2.1 Adult Obesity levels from 1993 to 2016 in England (Baker, 2019)

The figure below shows the obesity levels for both men and women in the UK.

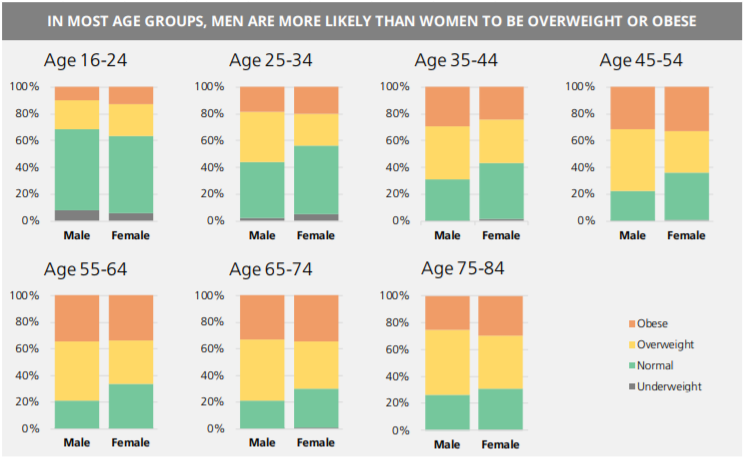


Figure 2.2.2 Obesity levels by age group(Baker, 2019)

#### Risks of Obesity

Whilst being obese will lead to the obvious physical changes, it can also lead to a number of serious and potentially life-threatening conditions if it is not tackled. These conditions include Type 2 diabetes, Coronary Heart Disease, some types of cancer (i.e. breast and bowel cancer) and stroke. As well as these conditions obesity can also affect a person quality of life and could also result in a person developing depression and low self-esteem.

#### Causes of Obesity

Whilst there is sometimes an underlying health condition that can attribute to weight gain such as underactive thyroid gland (hypothyroidism), the most common cause of obesity is generally caused by consuming more calories, particularly those in fatty and sugary foods, than you burn off through physical activity. This excess energy which is not burned off is then stored by the body as fat, resulting in weight gain.

Our modern lifestyles are also an attributing factor to the increased number of people being diagnosed as obese. This is because for many people, modern living involves eating excessive amounts of cheap, high-calorie food and spending a lot of time sitting down, either at desks in work, on sofas or in cars.

#### Treating Obesity

The NHS recommends that the best way for a person to treat obesity is by eating a healthy, reduced calorie diet and to exercise regularly. Is suggested by the NHS that in order to do this that they should:

1. “eat a balanced, calorie-controlled diet as recommended by your GP or weight loss management health professional (such as a dietitian)
2. join a local weight loss group
3. take up activities such as fast walking, jogging, swimming or tennis for 150 to 300 minutes (2.5 to 5 hours) a week
4. eat slowly and avoid situations where you know you could be tempted to overeat”

(NHS, 2016)

The app that will be created as part of this project, will help users tackle their obesity problem allow them to track the foods that they are eating and their daily calorie intake. The app will also allow them to track the amount of exercise that they do.

### Mobile Health

Mobile Health (mHealth) is the general term which is used to describe the use of mobile phones and other wireless technology in medical care. Mobile Health is most commonly applied to mobile devices so that the user can be educated about preventative healthcare services. The application that will be created as a result of this project can be described as a Mobile Health application due to the aim of the application to educate the user about their daily diet and exercise routine which in turn should help them to try tackle their Obesity/weight issues.

#### Benefits of Mobile Health

The main benefit behind Mobile Health for consumers is the matter of convenience. As mobile applications and wearable devices allow users to constantly track and manage data without having to manually collect data which can take a long time. Another benefit is the sheer number of Mobile Health applications that available to consumers with there being 325,000 mHealth apps available for download from app stores as of 2017, according to digital health consulting firm research2guidance.

#### Mobile Health Trends

A consumer survey carried out by Accenture in 2018 found that 46% of respondents used their mobile phone or tablet to manage their health, compared to 36% in 2016. Further, 36% said technology was very important for managing health, up from 30% in 2016. 90% of respondents from the same survey were also willing to share information from their wearable devices with their physician.

#### Activity Tracking

Mobile Health applications have a proven record of increasing a user’s activity levels, with a study conducted by Sherry Boschert using control group, finding that those who used Mobile Health applications to track their activity levels increased their step count by on average 22 (half a mile) after 8 weeks compared to those who did not use a Mobile Health application to track their activity levels.

#### Diet and Nutritional Tracking

In a study conducted by West, et al. examining the potential of behavioural change theory integrated into mobile nutrition apps. The results of this study discovered the following results:

“The majority of study participants agreed or strongly agreed with statements regarding app use increasing their motivation to eat a healthy diet, improving their self-efficacy, and increasing their desire to set and achieve health diet goals. Additionally, majority of participants strongly agreed that using diet/nutrition apps led to changes in their behavior, namely increases in actual goal setting to eat a healthy diet (58.5%, 127/217), increases in their frequency of eating healthy foods (57.6%, 125/217), and increases in their consistency of eating healthy foods (54.4%, 118/217).”

(Joshua H West, 2017)

From the results found by this study it can be clearly seen that a Mobile Health application that is used to track a user diet also ends up motivating the user to eat healthier due to them not releasing just how bad some of the foods that they originally ate our for the body. By increasing a users motivation to eat healthier means that it will also likely help people to lose weight which is aim of my app in helping to reduce worldwide obesity levels.

## Software Development Life Cycles

A Software Development Life Cycle (SDLC) also known as a Software Development Process is a process used by people who work in the software industry to help them design, develop and test software to ensure that the finished software is of a high quality. A SDLC aims to create high-quality software that either meets or exceeds the customers’ expectations whilst ensuring that the end software is completed on-time and within cost estimates.

In an attempt to ensure that software is completed to the same standard when utilising a SDLC the international standard ‘ISO/IEC 12207’ was developed. This standard for software development processes aims to be the standard that defines all of the tasks that are required for developing and maintaining software. (Tutorialspoint, 2018)

### What is a SDLC?

A SDLC is a framework which defines the tasks to be performed at each stage of the software development process. It consists of a detail plan describing how to develop, maintain, replace and alter or enhance specific software. The SDLC defines a methodology that can be used to improve the quality of the software and the overall development process. (Tutorialspoint, 2018)

A close up of text on a white background

Description automatically generatedThe following figure is graphical representation of several of the stages in a typical SDLC:

Figure 2.2.3 *Stages of a Software Development Life Cycle* (Wisdomjobs.com, 2018)

### Stages of a SDLC

The typical Software Development Life Cycle will be comprised of the following stages:

#### Planning and Requirement Analysis

Requirement Analysis is the most important stage of the SDLC, as it is this stage that determines if a project should proceed or if it should be cancelled. The Requirement Analysis stage should be carried by senior members of the development team and any key stakeholders such as the customer, sales team and any experts on the project area. The information gathered is the used to help plan how the project will be approached as well as to conduct a feasibility study into the operational, economical and technical areas of the project and if it should go ahead. (Wisdomjobs.com, 2018)

Planning for the quality assurance will also usually be carried out at this stage. This includes quality assurance requirements and the identification risks. This allows for a software project to be implemented with minimum risks. (Wisdomjobs.com, 2018)

#### Defining Requirements

Upon the Requirement Analysis has been completed the next stage in a life cycle is to define and document the product requirements and for them to be approved by either the customer or group who requested the project to be developed. Requirements a documented in a Software Requirement Specification (SRS) which will contain all of the project requirements that are to designed and development as part of the project life cycle.

#### Design

A Document Design Specification (DDS) will then usually be produced, which uses the SRS created earlier as a reference. A DDS can be either a very high-level document or a very low level document. A high-level DDS may only contain screenshots of what the user interface should look and where requirements are implemented. Whereas a low-level DDS will also describe of the software architecture that should be implement such as any databases, APIs and the classes and modules the code will include. Typically, more than one design will be produced for this document. (Tutorialspoint, 2018)

The DDS will then be reviewed by the key stakeholders involved in the project and depending on various the project parameters such as risk, cost and development time the most appropriate design will be chosen for implementation.

#### Building the Project

It is at this point in the SDLC that the actual development of the projects programming code is started. The code that is developed will follow the chosen design laid out in the DDS that was approved for implementation. It is important during the development process that the code written follows the organisations coding guidelines such as their choice of programming language and development tools.

#### Testing

Whilst testing should be carried out during all stages of the SDLC, this stage refers to the testing of the proposed completed project. Due to this stage of testing all bugs/issues should be reported, tracked and retested until the product is deemed to be stable and of a high enough standard as defined in the SRS that it can be released.

#### Deployment to the Market and Maintenance

Upon the completion of the Testing stage the product is then released formally into its intended market. Occasionally, the product will be released in a limited capacity to a User Acceptance Testing (UAT) environment. So that the intended end-user/customer can test the product and decide if they are satisfied with the product or if further development is required before formal release.

### Software Development Models

There are numerous approaches that can be followed for a software development lifecycle, with each methodology having their own advantages and disadvantages. The following software methodologies where reviewed and evaluated as part of my project, so that I could determine the most suitable methodology to follow for my project development life cycle.

* Waterfall Model
* Modified Waterfall Model
* Scrum Model
* Spiral Model

#### Waterfall Model

The Waterfall Model was developed in 1970 by Dr Winston W. Royce, it was the first process model that was introduced. The Waterfall model is very simple to understand and use with it emphasising a logical progression through the various stages of a SDLC. As such it requires that work is completed in a sequential manner which means a new piece of work cannot be started until the previous task has been completed. (TryQA.com, 2013)

Recently the popularity of the Waterfall model has fallen, due to the rise of the agile methodologies. This however does not mean that it is obsolete, as the logical nature of the waterfall model still retains its desirability for many software developers.



Figure 2.2.4 Waterfall Model(Citta, 2017)

##### Advantages

* Adapts to shifting teams
* Forces a structured organisation
* Allows for early design changes
* Suited for milestone development

##### Disadvantages

* Nonadaptive design constraints
* Lack of user/client feedback mid-process
* Delayed Testing Period

#### Modified Waterfall.

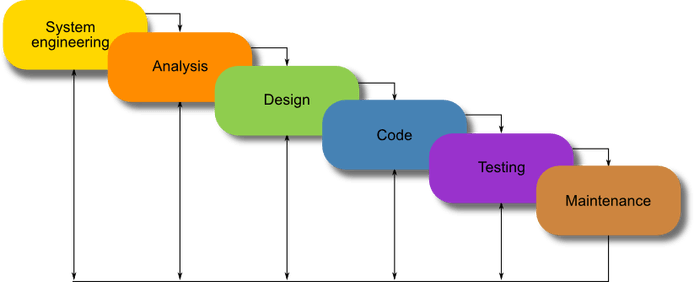
The modified waterfall model is almost identical to the waterfall model which it is based off. The modified waterfall model allows a developer to go back to an earlier task and update it if they release that something needs to be changed instead of going back starting all over again from the start.

Figure 2.2.5 Modified Waterfall Model (Powell-Morse, 2016)

##### Advantages

* Adapts to shifting teams
* Forces a structured organisation
* Allows for early design changes
* Suited for milestone development
* Adaptive to Design Constraints

##### Disadvantages

* Lack of user/client feedback mid-process
* Delayed Testing Period

#### Scrum Model

The Scrum model is an agile methodology that suggests that work should be carried out in series of sprints with each sprint lasting for an agreed upon period of time. In the Scrum model at the start of each sprint the team members will determine the number of items they can commit to. The team members will then create a sprint backlog which is a list of all of the tasks that are to be performed during the sprint.

As a part of the Scrum model that are two key roles which support the scrum teams, these the ScrumMaster, who could be thought of as the coach or captain of the team. It is the ScrumMasters’ role to help the team members involved in a sprint to use, the Scrum process, to allow them to perform at the highest level. (Mountain Goat Software, 2018)

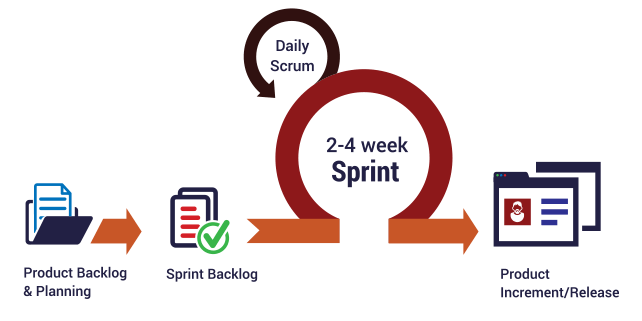


Figure 2.2.6 Scrum Model (Intelegain Technologies, 2017)

##### Advantages

* Ensures effective use of time and money
* Projects are divided into easily managed sprints
* Development work is tested in-sprint
* Feedback from customers and stakeholders
* Adaptive to Design Constraints

##### Disadvantages

* Scope creep, due to lack of a definite end-date
* Requires experienced team members
* Team member can become frustrated due to daily team meetings
* Difficult to adopt in large teams

(Chandana, 2018)

#### Spiral Model

The Spiral model is an incremental Software Development Life Cycle which focuses on risk analysis. The Spiral model was first described by Barry Boehm in his 1986 paper "A Spiral Model of Software Development and Enhancement". The spiral model combines combination of iterative development process model and sequential linear development model i.e. the waterfall model with a very high emphasis on risk analysis. This allows for the incremental release of the product or incremental refinement through each iteration around the spiral. In the spiral model the risk determines the amount effort required for each task as well as the amount of details required for a task to completed. (PAL, 2018)

##### Advantages

* Risk handling
* Good for large projects
* Flexibility in requirements
* Client/user feedback
* Adaptive to Design Constraints

##### Disadvantages

* Difficult to implement
* Expensive
* Highly dependent on Risk Analysis
* Difficult to manage time

#### Conclusion

Having reviewed the advantages and disadvantages of each of the four software development life cycles that are detailed in this report, I decided that the best approach for my project would be to follow the modified waterfall model.

The reason that I chose the modified waterfall model is that like I like the logical process that it follows when completing tasks. The reason I did not chose either the Scrum or Spiral models is due to my belief that they are better suited to projects that are being developed by a team and not as a solo project.

During the project it is important that I fellow the project plan that will be created and watch out for slipping into the habit continuously going back and forth between the various stages in the plan to make small incremental changes which could result in a delay in the project’s planned completion date.

## Technical Background

### iPhone Operating System

Originally called the iPhone Operating System due to the release of the first iPhone in 2007 and later renamed to IOS with introduction of the Apple iPad. Nowadays iOS is used on the iPhone, iPad and the iPod Touch. Apple requires all of their devices. Apps can be installed onto a device that runs on iOS via Apples’ AppStore which currently has approximately 2,000,000 apps available for download. In order to publish an app to the AppStore an Apple Developer account and Apple XCode are both required. It is important to note that Apple XCode can only be run on an Apple device running MacOS (i.e. Mac or MacBook). An Apple Developer Account has yearly fee for £79. From the period of November 2017 to November 2018 around 20.31% of all devices where running on iOS. (Nations, 2019)

### Android

Android is the mobile operating system that is most commonly found installed on most mobile devices. It was first released in 2009 by Google. To install an app on a device which utilises Android as its mobile operating system via the Google Play store. The Google Play store has approximately 2,600,000 apps available for download. In order to publish an app to Google Play a Google Developer account is required. This developer account has a one of fee of $25. From the period of November 2017 to November 2018 around 75.08% of all devices were running on Android.

### Chosen Platform

The solution developed for this project should work on both iOS and Android. The reason for this is that these two platforms have the largest market share with them having a total market share of over 95%, from November 2017 to November 2018.

A screenshot of a cell phone

Description automatically generated

Figure 2.2.7 Mobile Operating Market Share (StatCounter, 2018)

### Development Tools and Languages

#### Xamarin

Xamarin is a cross-platform framework for mobile app development which brings .NET and C# to both the Android and the iOS platforms. It is an optional add-on feature which is offered for free as part of Microsoft Visual Studio. Xamarin allows the developer to create applications that have a native look and feel to them.

By using Xamarin a developer can access native APIs and SDKs that are constantly kept up to date by Microsoft to ensure that the application being developed will work on the latest target platform version.

Xamarin also allows the developer to shar large parts of their code across different target platforms (usually around 70-80%). This means that the developer does not have to waste time rewriting code to meet certain platform needs.

##### Requirements

* Visual Studio
* Xamarin add-on feature

#### Ionic

The Ionic Framework is an open source UI toolkit which can be used to develop and build high-quality mobile and desktop apps using existing web technologies such as HTML, CSS, and JavaScript. The Ionic Framework is currently integrated with Angular, and it focuses primarily on the frontend user experience or UI interaction of an app with aim being for an application which has been developed in the Ionic Framework to have the look and feel of a native application.

The Ionic Framework offers the advantage of being able develop native looking applications for multiple platforms simultaneously without needing to write parts of code for specific platforms.

The current version of the Ionic Framework in ‘Ionic 3’ and whilst ‘Ionic 4’ is also available for use it is currently in beta testing and is therefore not being considered as development option.

##### Requirements

* Node.js
* Git/Github Desktop
* Cordova
* Ionic CLI
* NPM

#### Chosen Development Tool and Language

After reviewing the possible development tools out there, it was decided that this project shall make use of the Ionic Framework and more specifically Ionic 3. The main reasoning behind this choice was that Ionic 3 is currently used by my current employer. This therefore means that I have access to the company’s documentation and best practices which are currently used when creating an application for any of our clients.

#### Data Storage Options

After a deciding upon the development tool that would be used for this project, it was important to determine which database option would be best suited for use in this project. Three options were considered.

##### SQLite

This is the default database option for both the Android and IOS platforms. SQLite has the advantage of being a lightweight, transitional database which requires very little storage space. SQLite databases can only be accessed by the device that it is currently installed on. This means that there is little risk to its use when it comes to storing personal information about a user.

##### Firebase

Firebase provides users with a real-time database and backend as a service. The service allows for developers to access an API which allows for application data to synchronised across multiple devices and also shared with multiple users. All data stored on Firebase is stored on Firebase’s cloud. It was first developed in 2011 by Firebase Inc. but it was later acquired by Google in 2014. Firebase also allows a develop to view analytics regarding app usage and user engagement. Firebase has a developer community of than more than 450,000 developers.

##### Local Storage

Local Storage differs from SQLite and Firebase in that you do not tell the application to use a specific database type. Instead Local Storage will use the default data storage option for the device in which the application is being ran on. This means that this option is perfectly suited to cross-platform development as there is no need to worry about if the device that the application is being run on, has the chosen data storage option available. The one drawback with Local Storage is that you not able to create a record that has multiple fields to each record, but this can be resolved by simply saving all the required data as JSON. An advantage using Local Storage is that it can only be accessed by the device it was stored on meaning there is a reduced risk of a security or data breach occurring.

##### Chosen Data Storage Option

This project shall use Local Storage for all the data storage needs for the application that will created as part of this project. The reason Local Storage was chosen was because the data that is to be stored via the application does not need to be shared with any other devices or users, and due to it defaulting to the preferred data storage method of the device the application is being run on.

### Resources Required

In order to publish my application to both Google Play and the AppStore the following resources are required:

* Apple Developer Account
* Google Developer Account
* XCode
* Android SDK Manager
* Adobe Experience Design (XD) – UI design
* RapidAPi – API Hub (intending to use the Nutrionix api)
* Git/Github Desktop (Document Control)
* Visual Studio Code

# Chapter 3: Requirement Analysis

## Requirement Gathering

As part of any project or project management it is essential that requirements gathering is carried out as part of it. This allows for stakeholders to develop a full understanding of what it will deliver that is critical to its success. It is important that this stage of a project is not overlooked, so that further down the line it is not realised that the customers’ needs have not been adequately met due to the customers’ requirements not being fully understood.

To give this project a greater chance at success the following rules will be applied to help ensure successful requirement gathering is carried out:

1. Don't assume you know what the customer wants - always ask.
2. Involve the users from the start.
3. Define and agree on the scope of the project.
4. Make sure requirements are SMART - specific, measurable, agreed upon, realistic and time-based.
5. Gain clarity if there is any doubt.
6. Create a clear, concise and thorough requirements document and share it with the customer.
7. Confirm your understanding of the requirements alongside the customer (play them back).
8. Avoid talking technology or solutions until the requirements are fully understood.
9. Get the requirements agreed with the stakeholders before the project starts.
10. Create a prototype, if necessary, to confirm or refine the customer's requirements.

(Haughey, 2014)

During the requirements gathering process, there some commonly found mistakes that should be avoided. These mistakes are:

* Basing a solution on complex or cutting-edge technology and then discovering that it cannot easily be rolled out in the 'real world'.
* Not prioritising the requirements, for example, 'must have', 'should have', 'could have' and 'would have' - known as the MoSCoW principle.
* Insufficient consultation with real users and practitioners.
* Solving the 'problem' before you know what the problem is.
* Lacking a clear understanding and making assumptions rather than asking.

(Haughey, 2014)

Two different methods where utilised when it came to requirements gathering for this project to help ensure that no requirements were missed. The two methods employed for this project was a Focus Group and Observation. Both techniques were carried out over a period of time.

The collated requirements where then separated out into Functional and Non-Functional Requirements.

### Focus Group

Focus Groups are used to help provide a large variety of possible requirements, by getting a group of people together to discuss the problem and think of possible solutions and desirable functionality. This technique is useful in that it allows people to bounce ideas of each other and therefore creating broader range of ideas.

In this case I gathered four people together who had an interest in keeping fit and tracking their diet and briefed them on the project background and my aims for the completed solution. Upon being briefed I then asked them about how they currently keep track of this information and what they would like to see in the proposed solution.

### Observations

Observations is another useful technique for requirement gathering. Observations work by a person observing the environment that the solution will used in or by observing solutions that are already on the market.

Due to the fact my proposed solution is something that I personally would use and have prior experience when it comes to solutions already on the market, this meant that I had a unique perspective when it came to gathering requirements. As part of this requirement gather technique, I looked at apps that I have already used previously, which are already on the market and I have used in the past. These apps are:

* Apple Health
* Nike Run Club
* MyFitnessPal & MapMyRun

#### Apple Health

Apple health is an app that becomes pre-installed on all iPhones. It was first released in 2014 upon the release of iOS 8.0. Upon review I found that Apple Health was the most basic in terms of overall design with the app simply keeping track of the user sleep patter, total, steps, total distance and weight. However, it is useful for storing medical data and if linked to an Apple iWatch it is even able to tell if there are any irregularities with a wearer’s heartbeat, which the user should see a medical professional about. The data that the app stores is viewable on daily basis and can also be viewed in a graph that allowed the user to keep track of changes in their daily life. Apple Health can also be integrated with a large number of third-party apps that are available for download on the Apple Appstore.

#### Nike Run Club

Nike Run Club is an activity tracking app that is produced by Nike. The app is available for free on both the Google Play store and the Apple AppStore. Nike Run Club had what I feel to be the best user interface out of all the existing solutions that where reviewed, with the app being very easy to use and understand. The app offers guided runs and exercise by professional athletes that was a nice feature as well as an interactive map which your route was tracked on. Also included is the ability to set yourself challenges create training plans to reach a certain distance on your runs. Also included in any training plans that are created, are links to exercises in the Nike Training Club which can guides you through a large number of exercise routines. However, despite these positive features there was one big drawback in that it was not able to keep track of your daily diet.

#### MyFitnessPal & MapMyRun

MyFitnessPal and MapMyRun are both owned by the same company, in this case ‘Under Armour’, upon being purchased in 2015. A free version of both apps is available for download on the Google Play and Apple AppStore however, to get access to all of the features available on both of the apps, a yearly subscription fee of £39.99 is required, making it one of the more expensive Mobile Health applications on the market. Due to them being owed by the same company a user is allowed to like the account they use on the apps together, this allows a user to view the combined data from the two apps however, I felt that this was a complicated process and the apps contain almost too much information, which made them quite complex to use and understand. Another downfall for these apps was the number adverts and restricted features which aren’t included unless they are bought by the user.

## Requirements

### Functional Requirements

A functional requirement is basically a requirement that specifies what a system ‘should’ do. A functional requirement will usually identify the behaviour or function of a feature which the end user will require the system to do. Table 1 lists all of the functional requirements defined for this project:

|  |  |
| --- | --- |
| Number | Functional Requirement |
| FR-01 | The application shall work on both iOS and Android platforms |
| FR-02 | A new user shall be asked to set up an account |
| FR-03 | The app shall remember a user after first-time set up |
| FR-04 | The user shall be able to navigate the app via a Navigation menu pane |
| FR-05 | The app shall allow a user to be able to search for meals. |
| FR-06 | A user shall be able to log a meal for breakfast |
| FR-07 | A user shall be able to log a meal for lunch |
| FR-08 | A user shall be able to log a meal for dinner |
| FR-09 | A user shall be able to log a snack |
| FR-10 | A user shall be able to view all the food they have logged in the last 7 days |
| FR-11 | A user shall be able to view a calorie break down for all the food they have eaten for the current day. |
| FR-12 | The app shall allow the user to start a run |
| FR-13 | The app shall allow the user to end a run |
| FR-14 | The app shall record the time ran by a user |
| FR-15 | The app shall record the distance covered during a run |
| FR-16 | The app shall record the calories burned during a run |
| FR-17 | Upon a run ending the app shall show the route a user ran on a map |
| FR-18 | Upon a run ending the app shall show the distance a user ran |
| FR-19 | Upon a run ending the app shall show the calories burned by a user |
| FR-20 | Upon a run ending the app shall show the average pace of the user |
| FR-21 | The app shall show statistics on all the runs a user has completed |
| FR-22 | The app shall display the total distance walked/ran in a day |
| FR-23 | The app shall show the average distance walked/ran since the user started using the app |
| FR-24 | The app shall ask the user to select a gender upon initial set up |
| FR-25 | The app shall ask the user to enter their weight upon initial set up |
| FR-26 | The app shall be able to randomly suggest a meal for breakfast |
| FR-27 | The app shall be able to randomly suggest a meal for lunch |
| FR-28 | The app shall be able to randomly suggest a meal for dinner |
| FR-29 | The app shall display the recipe upon selecting a meal |
| FR-30 | The app shall provide a nutritional breakdown of any meals/snacks it suggests |
| FR-31 | The app shall allow the user to compare their information against other app users |
| FR-32 | The app shall provide the user with a monthly summary of their workouts |
| FR-33 | The app shall allow display information on their weekly diet in a graph |

Table 1 Functional Requirements

### Non-Functional Requirements

A non-functional requirement simply describes ‘how’ are system should work upon completion. They help to determine the quality of the software and how it should be behave once developed. Table 2 list all of the non-functional requirements that my completed projects shall meet.

|  |  |
| --- | --- |
| Number | Non-Functional Requirement |
| NFR-01 | The app shall have a consistent theme throughout the application |
| NFR-02 | The app shall be simple to understand and use |
| NFR-03 | The app shall work on devices of different screen sizes |
| NFR-04 | The app shall not crash |
| NFR-05 | The app shall be capable of running in the background |
| NFR-06 | The app shall react appropriately to changes orientation |
| NFR-07 | The app shall be easy to navigate |
| NFR-08 | The app shall conform to best practice and design principles for the chosen platforms |

Table 2 Non-Functional Requirements

### Requirement Prioritisation Strategy

To ensure that this project is successful a requirement prioritisation strategy will be used. A requirement prioritisation strategy is used to determine which requirements should be implemented first and which ones can be delayed until later in the project’s development lifecycle. For this project the MOSCOW technique was employed.

The MOSCOW technique categorises, requirements into the following 4 categories:

* Must Do
* Should Do
* Could Do
* Won’t Do

The following tables show the MOSCOW rating for each of the non-functional and functional requirements.

|  |  |  |
| --- | --- | --- |
| Number | Functional Requirement | MosCOW |
| FR-01 | The application shall work on both iOS and Android platforms | Must |
| FR-02 | A new user shall be asked to set up an account | Must |
| FR-03 | The app shall remember a user after first-time set up | Must |
| FR-04 | The user shall be able to navigate the app via a Navigation menu pane | Must |
| FR-05 | The app shall allow a user to be able to search for meals. | Should |
| FR-06 | A user shall be able to log a meal for breakfast | Must |
| FR-07 | A user shall be able to log a meal for lunch | Must |
| FR-08 | A user shall be able to log a meal for dinner | Must |
| FR-09 | A user shall be able to log a snack | Should |
| FR-10 | A user shall be able to view all the food they have logged in the last 7 days | Should |
| FR-11 | A user shall be able to view a calorie break down for all the food they have eaten for the current day. | Must |
| FR-12 | The app shall allow the user to start a run | Must |
| FR-13 | The app shall allow the user to end a run | Must |
| FR-14 | The app shall record the time ran by a user | Must |
| FR-15 | The app shall record the distance covered during a run | Must |
| FR-16 | The app shall record the calories burned during a run | Should |
| FR-17 | Upon a run ending the app shall show the route a user ran on a map | Should |
| FR-18 | Upon a run ending the app shall show the distance a user ran | Should |
| FR-19 | Upon a run ending the app shall show the calories burned by a user | Should |
| FR-20 | Upon a run ending the app shall show the average pace of the user | Should |
| FR-21 | The app shall show statistics on all the runs a user has completed | Should |
| FR-22 | The app shall display the total distance walked/ran in a day | Should |
| FR-23 | The app shall show the average distance walked/ran since the user started using the app | Won’t |
| FR-24 | The app shall ask the user to select a gender upon initial set up | Must |
| FR-25 | The app shall ask the user to enter their weight upon initial set up | Must |
| FR-26 | The app shall be able to randomly suggest a meal for breakfast | Could |
| FR-27 | The app shall be able to randomly suggest a meal for lunch | Could |
| FR-28 | The app shall be able to randomly suggest a meal for dinner | Could |
| FR-29 | The app shall display the recipe upon selecting a meal | Could |
| FR-30 | The app shall provide a nutritional breakdown of any meals/snacks it suggests | Could |
| FR-31 | The app shall allow the user to compare their information against other app users | Won’t |
| FR-32 | The app shall provide the user with a monthly summary of their workouts | Won’t |
| FR-33 | The app shall allow display information on their weekly diet in a graph | Won’t |
| NFR-01 | The app shall have a consistent theme throughout the application | Must |
| NFR-02 | The app shall be simple to understand and use | Must |
| NFR-03 | The app shall work on devices of different screen sizes | Must |
| NFR-04 | The app shall not crash | Must |
| NFR-05 | The app shall be capable of running in the background | Must |
| NFR-06 | The app shall react appropriately to changes orientation | Must |
| NFR-07 | The app shall be easy to navigate | Must |
| NFR-08 | The app shall conform to best practice and design principles for the chosen platforms | Must |

Table 3 MOSCOW Rating for Functional and Non-Functional Requirements

## Risk Analysis

For any project to achieve a successful it is important that all project risks are identified early and managed appropriately to avoid time slippage, increased costs, corruption or even the total loss of the project. A risk can be thought as anything that may be a potential problem that may occur during the software development life cycle.

Table 4 below contains all of the risks identified for this project.

|  |  |  |  |
| --- | --- | --- | --- |
| No. | RISK | IMPACT | RESOLUTION |
| 1 | Developer illness | Reduced productivity. Project falls behind schedule. | Task buffers and trying to work ahead of schedule. |
| 2 | Lack of productivity | Project will fall behind schedule | Creation and following of a project plan will help ensure productivity. |
| 3 | Compromising on Design | Finished software may not follow the same theme and be complex to user. May lead to further coding being needed in later stages. | Designs for all screens will produced before any development commences. 2 weeks has been dedicated to this. |
| 4 | Data Loss | Project may need to be restarted or falls behind schedule due to having redo work. | Multiple copies of all work carried out will be kept. i.e. Cloud, USB, hard drive |
| 5 | Unidentified resources | Time wasted getting the unidentified resources. Fall behind schedule | All required resources will be identified early in the projects planning stage. |
| 6 | Unavailable resources | Resources may be identified which you may need to pay for or are unable to access. Workarounds could compromise project quality. Project falls behind schedule | All resources will be gathered in advance and checked that they are working correctly. |
| 7 | Unforeseen Circumstances | Both technical and personal issues which may result in work not being completed to schedule. Or having to change project direction. | Buffers are included in the project plan to account for unforeseen circumstances. |
| 8 | Requirement Creep | Constant updating/adding of requirements will result in work not being accounted for in the project plan | Requirements will be finalised and can only be changed should a review carried to determine the feasibility and impact on the projects planned completion date. |

Table 4 Project Risk Analysis

### Risk Mitigation Strategy

Upon all project risks being identified and controls being implemented. All risks where put through a Probability-Impact Matrix to ensure that the risks were within acceptable tolerances.

Figures 3.1 and 3.2 show probability-impact matrices for before and after controls were implemented for al risks identified.

#### Pre-Controls



Figure 3.3.1 Probability-Impact Matrix before controls were implemented

#### Post Controls

Figure 3.3.2 Probability-Impact Matrix after controls were implemented

## Requirements Gathered During Development

During the development stage of the project there was the introduction of some new requirements as well as changes to the MOSCOW prioritisation of some of the existing requirements. In a SDLC these changes to the requirements are called ‘scope creep’, it is called this because the new requirements where not originally scoped and were therefore not planned for. Table 5 below shows this scope creep and their MOSCOW prioritisation (note: all scope creep changes are shown in red).

|  |  |  |
| --- | --- | --- |
| Number | Functional Requirement | MosCOW |
| FR-28 | The app shall be able to randomly suggest a meal for breakfast | Won’t |
| FR-29 | The app shall be able to randomly suggest a meal for lunch | Won’t |
| FR-30 | The app shall be able to randomly suggest a meal for dinner | Won’t |
| FR-31 | The app shall display the recipe upon selecting a meal | Won’t |
| FR-33 | The app shall be integrated with the Apple Health application | Could |
| FR-34 | The app shall be able to save data to the Apple Health application | Could |
| FR-35 | The app shall be able to retrieve data from the Apple Health application | Could |
| FR-36 | The app shall be integrated with the Google Fit api | Could |
| FR-37 | The app shall be able to save data to the Google Fit api | Could |
| FR-38 | The app shall be able to retrieve data from the Google Fit api | Could |

Table 5 Scope Creep

# Chapter 4: Design

## Design Principles

When designing a new application, it is important to adhere to common design principles which the user will already be familiar with from other apps and websites. By employing common design principles, it means that the applications end user should be able to quickly understand the app by using their knowledge of existing applications. The common design patterns that will be followed in this project will be the use of the ‘Hamburger’ icon for applications menu pane. All app icons will be taken from [ionicons.com/](https://ionicons.com/) which, contains icons that were designed and created by the Ionic Framework team. By using these icons, it will ensure the final application feels like it is native app and is therefore familiar to the end user. It is also important for the application to be internally consistent. This means that the apps colour scheme, components and layout shall be consistent throughout the application to help ensure that the end user has a smooth experience when navigating through and using the application whilst avoiding inconsistencies which could result in the user to stop using the application.

To help ensure that application created as part of this project offers users a smooth user experience and is consistent throughout, Schneiderman’s 8 golden rules will be followed during its design phase. These 8 rules are:

1. Strive for consistency.
2. Enable frequent users to use shortcuts.
3. Offer informative feedback.
4. Design dialog to yield closure.
5. Offer simple error handling.
6. Permit easy reversal of actions.
7. Support internal locus of control.
8. Reduce short-term memory load.

## Flow Map

Flow maps are a technique which are employed by user interface and user experience designers to help them try and understand how the end user is likely going to interact with the application and what their decision-making processes will be based on. Figure 4.1 as seen below shows the flow map of how user may wish to interact with application for this project.

A picture containing text, whiteboard

Description automatically generated

Figure 4.0.1 FFT User Flow

## Prototyping

The User Interface (UI) Design is the link between users and an application/website. A good UI design will include the basic design elements that need to be present so that someone can successfully navigate an application and make the appropriate decisions.

During the UI design stage, it is important to consider the User Experience (UX). The UX design is important due to the objective of UX design being to create a frictionless and enjoyable experience for the end user. By considering UX Design during he prototyping stage means that customer satisfaction should be boosted by providing better usability, accessibility and pleasure in the interaction they have with the application.

Using Adobe XD, a simple prototype design was created for this project, to help visualise what the application may look like upon completion of this project (Note the final application may differ in design). The following prototype design have developed on an iPhone X template.

### Colour Palette

One of the easiest and best ways to achieve consistency in any application or web site is to ensure that the application or website follows a set colour scheme. Table 6 below shows the colour scheme that was used throughout the application that was created as part of this project.

|  |  |  |  |
| --- | --- | --- | --- |
| Colour | Hex | RGB | Usage |
|  | #4A41C5 | 74, 65, 197 | Primary: used for the header bar and buttons |
|  | #32db64 | 50, 219, 100 | Secondary: used if for some reason the primary colour is not suitable |
|  | #f53d3d | 245, 61, 61 | Danger: used to show any errors that occur |
|  | #f4f4f4 | 244, 244, 244 | Light colour: used as the screen background colour and for the text colour if it is inside an object with the ‘Primary’ colour. |
|  | #222 | 34, 34, 34 | Dark: Used to show normal text which is shown on top of the ‘Light’ colour |

Table 6 Colour scheme of project application

### App Badge



Figure 4.0.2 App Badge

This is the app badge that will be displayed on a devices home screen for the application. This app badge will be the same for both iOS and Android platforms.

### Details Page

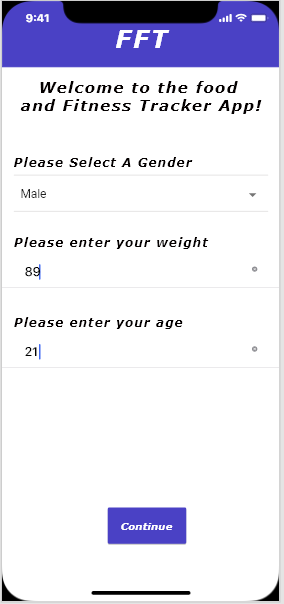


Figure 4.0.3 Details Page

The Details page is where the user enters their personal details such as gender, age and weight. This data is then stored in an SQLite database upon pressing the continue button. At the top of the application is the app header bar. The header bar will always contain the text ‘FFT’, however the Details page will not contain the ‘Hamburger’ icon because the Details page will be displayed upon the app being opened for the very first time. The ‘Continue’ button will be disabled until each of the three fields on the Details page are populated with valid data. Upon data being populated into all three fields and the ‘Continue’ button will become enabled, which, upon being pressed will redirect the user to the ‘Diet Home’ page. This page can also be accessed via the ‘Personal Details’ menu option found in the ‘Main Menu’ pane.

### Diet Home Page

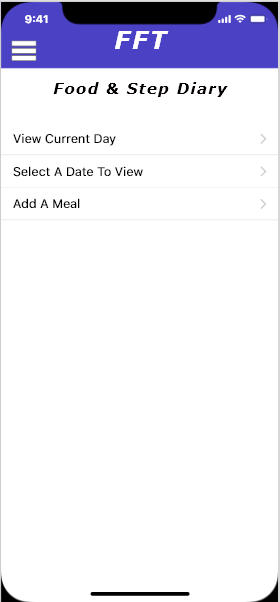


Figure 4.0.4 Diet Home Page

The ‘Diet Home’ page is the main home page for the app. As such it will be the 1st page that will appear to the user if they have already set their personal details. From this page that a user can add a meal, view the food eaten for a date in the past or view their food diary for the current day. In the header bar the ‘Hamburger’ icon will be displayed. Which upon being pressed will open the main menu pane for the application.

### Main Menu Pane

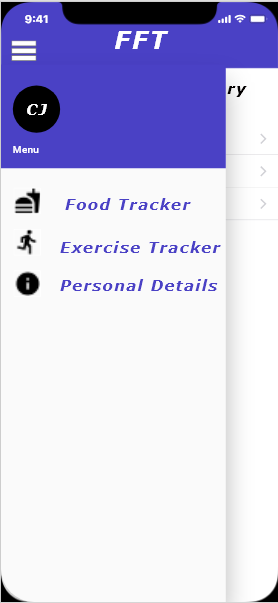


Figure 4.0.5 Main Menu Pane

This is the Main Menu pane it can be accessed by the ‘Hamburger’ icon found in the header of the application. The Main Menu pane will display the following options ‘Food Tracker’ which will redirect you to the Diet Home page, the option ‘Exercise Tracker’ which will direct you to the Exercise Home page and the option ‘Personal Details’ which will direct the user to the Details page.

### Select Date Page

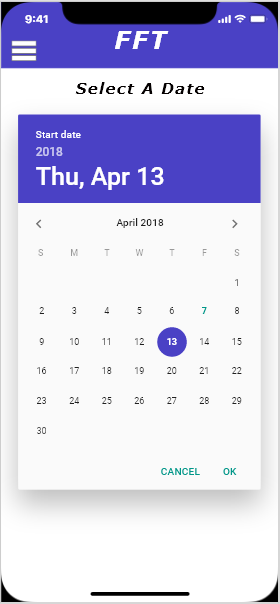


Figure 4.0.6 Select Date Page

This is the ‘Select Date’ page, it is displayed upon the user pressing the option “Select Date to View” found on the ‘Diet Home’ page. This page will display the native date picker field for devices platform. Upon selecting a date and pressing the ‘Ok’ button will then redirect the user to the Food Diary page.

### Food Diary Page

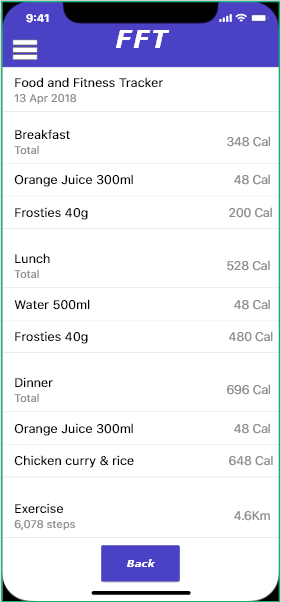


Figure 4.0.7 Food Diary Page

This is the ‘Food Diary’ page, which will be displayed upon the user selecting a date on the ‘Select Date’ page or by the user pressing the ‘View current Day’ option found on the ‘Diet Home’ page. Tis page will display to the user information on what they have eaten for the selected date/current day as well as the total number of steps completed for the day. The ‘Back’ button will redirect the user to the ‘Diet Home’ page.

### Add Meal Page

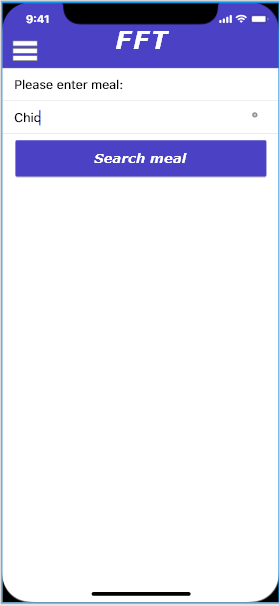
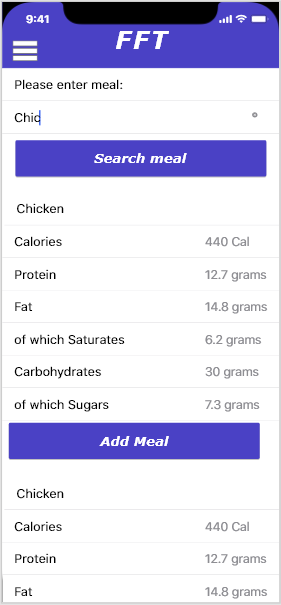


Figure 4.0.8 Add Meal Page

This is the ‘Add Meal’ page, the image on the left shows the screen that will be displayed when the user navigates to this page via the ‘Add A Meal’ button located on the ‘Diet Home’ page. The ‘Add Meal’ page will contain a text input field and a search button that get all of the matching results for the inputted text from the Nutritionix API and then display the returned results as seen in the second image. Each of the returned results will display some basic food macro data and an add meal button so that the user can add a meal to their food diary. Upon the page displaying the returned result the text input field and search bar will still be shown at the top of the screen. Should the user not find meal that they wish to add the user can opt to enter greater detail into the text input field and then press the search button again to update the results.

### Exercise Home Page

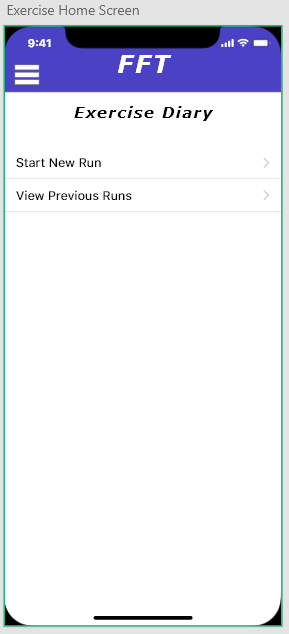


Figure 4.0.9 Exercise Home Page

This is the ‘Exercise Home’ screen, from this page a user can navigate to either the ‘New Run’ page or the ‘Previous Runs’ page. This page is accessed via the option ‘Exercise Tracker’ found on the Main Menu pane. The ‘Hamburger’ icon is present in the left-hand corner of the header bar should the use wish to open the navigation pane.

### New Run Page

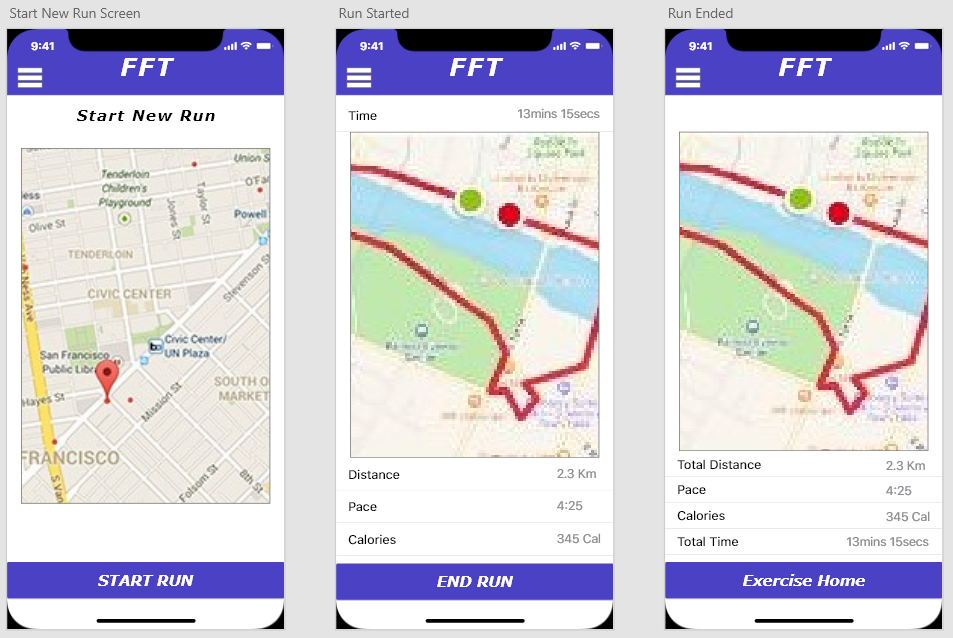


Figure 4.0.10 New Run Page

These are the screens that will display for the ‘New Run’ page. This page can be accessed via the ‘Start New Run’ option found on the ‘Exercise Home’ page. When a user first navigates to this page they will see screen “Start New Run”. This screen will display a map showing their current location and a ‘Start Run’ button located at the bottom of page.

Upon pressing the ‘Start Run’ button the “Run Started” screen will be displayed; this screen will display map showing their current location as well as the route they have currently travelled. Below the map will be some basic information about their run such as the distance travelled, pace and calories burned. Finally, there will be an ‘End Run’ button at the bottom of the screen.

Upon the user pressing the “End Run” button the “Run Ended” screen will be displayed. This screen will display the route they travelled during their workout and some information about their run such total time, total distance, pace and calories. At the bottom of the page will be a button to the ‘Exercise Home’ page.

### Previous Runs Page

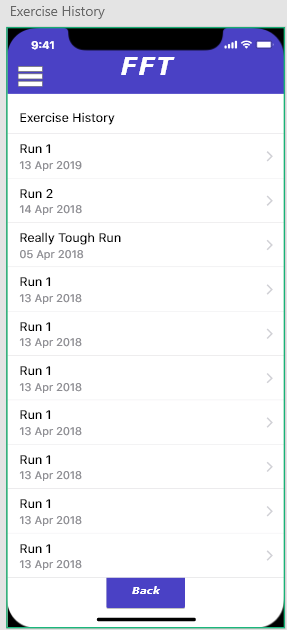


Figure 4.0.11 Previous Runs Page

This is the ‘Previous Runs’ page which can be accessed via the option ‘View Previous Runs’ found on the ‘Exercise Home’ page. This page will display all the runs that a user has previously completed. Upon pressing on one of the previous runs listed that the user has completed, they will be directed to the Run Details page for that run. Upon pressing the ‘Back’ button they will be redirected back to the ‘Exercise Home’ page.

### Run Details Page

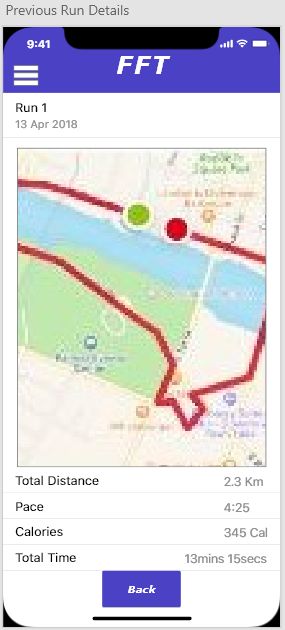


Figure 4.0.12 Run Details page

The “Run Details” page as seen above is accessed by selecting a run listed on the ‘Previous Runs’ page. This page displays information about the selected run. The information that is displayed is the date the run was completed on, the route of the run as displayed on a map, the total distance, pace, calories and the total time the run took to complete.

## Data Storage

Due to the final application using Local Storage and not a set database type (i.e. SQLite or Firebase) means that all data that will saved by the application will be stored in either the ‘Details’, ‘Meals’ or ‘Routes’ table as a single field using JSON. Figure 4.1 shows what the database models would be shown as if SQLite or Firebase was used and what data will be present in the JSON for each table.

The Details table will be used to store the personal information about the applications user. The data that will be stored in the is table is their age, gender and weight. The Details table will only ever contain a single record for a user because the app should only ever be used by one user. Du to this presumption there is no need for any foreign keys in this table.

The Meals table will contain records containing information about all the meals that an app user has eaten and recorded during their time using the application. Each record in the table will contain the following information ‘meal description’, ‘date’, ‘calories’, ‘protein’ and as what meal type it belongs too (i.e. Breakfast, Lunch, Dinner or Snack). Each record will also contain a unique identifier number which will autoincrement upon a new record being added to the table. Due to the Meals table not being linked in any other table a foreign key is not necessary.

The Routes table will contain records containing information about all the workouts that an app user has completed using the application. Each record in the table will contain the following information ‘path route, ‘start date/time, ‘end date/time’, ‘speed’ and the ‘distance’ of each workout. Each record will also contain a unique identifier number which will autoincrement upon a new record being added to the table. Due to the Routes table not being linked in any other table a foreign key is not necessary.

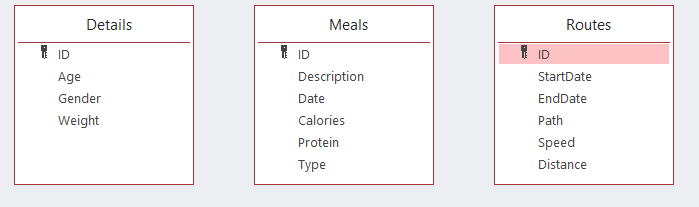


Figure 4.0.13 Database Models

# Chapter 5: Implementation

The following section provides an overview of both the Applications System Architecture as well as a code overview which provides a breakdown of code snippets and its purpose in the application created as part of this project.

## System Architecture

Due to the code being written using the Ionic Framework, the application created by this project can be thought off as following the MVC (Mode-View-Controller) pattern. This is because most ionic apps can be broken down into 5 major areas: Views, Controllers, Data, App Configuration, and Directives. In an ionic app the MVC is made up of the Views, Controllers and the Data.

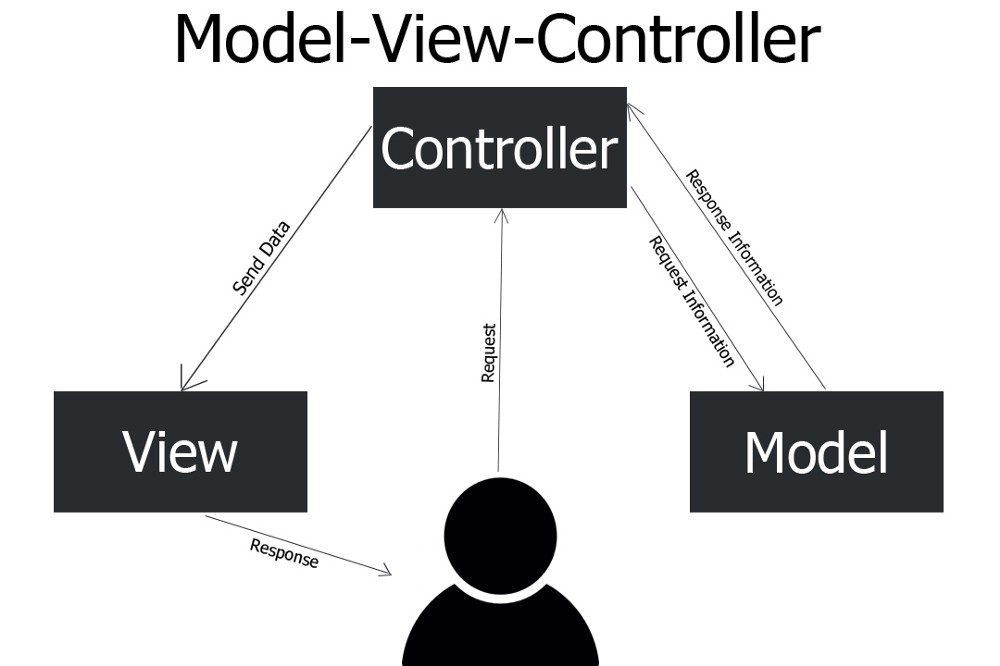


Figure 5.0.1 Model-View-Controller (Margam, 2018)

### Views

In an Ionic App ‘Views’ are often be referred to as templates due to them being referred to as such by Angular controllers. As a result of this, in ionic ‘Views’ are often stored in a ‘/templates’ folder where each ‘View’ is in a separate .html file. It is also possible to include data bindings in an ionic ‘View’. (McGivery, 2014) An example of a ‘View’ with data bindings in ionic can be seen in the code snippet below:

<ion-view title="About">

<ion-content>

This is a view in Ionic! My Name is {{name}}

</ion-content>

</ion-view>

Figure 5.0.2 Ionic ‘View’ example (McGivery, 2014)

In an ionic app the ‘Views’ should be found within the .html file of a page.

### Controllers

Controllers meanwhile can be thought of as the brains behind an application, where the flow of logic and data is being controlled. In Angular when you navigate to a page you are actually calling the ‘controller’. The controller will then, use a view as a template for the mark-up it will show to the user and, then make calls to the data layer classes (factories/services) so that the actual data is bound to the template. (McGivery, 2014)

### Model

Finally, the model can be thought of as the data (factories/services) as this provides the data to controller, normally through an external backend or web service. For this project the data layers are the mobile devices local storage and the Nutritionix Library in which API calls are made too.

## Code Overview

# Chapter 6: Testing

Testing is final stage of my Software Development Life Cycle (SDLC) before the application created as part of this project can be released to the wider public for download on the relevant app stores. As part of this project testing was carried out during two separate occasions. The first occasion was during the actual development stage of the SDLC and the second occasion being upon the completion of the development stage of the SDLC.

## What is Testing?

Testing can be used to fulfil several purposes such as:

* Confidence Building
* Finding Defects
* Ensuring requirements are met
* A risk management exercise
* Measuring and improving quality
* Preventing defects

However, this is not a definition of what testing is; the International Software Testing Quality Board define test as:

“The process consisting of all lifecycle activities, both static and dynamic, concerned with planning, preparation and evaluation of software products and related work products to determine that they satisfy specified requirements, to demonstrate that they are fit for purpose and to detect defects.”

(International Software Testing Quality Board, 2019)

The primary purpose of testing is to force failures (negative testing; i.e. break the software) however, the absence of defects is not a consolation should the software not meet its stated requirements (positive testing; i.e. requirement testing). It is therefore important to carry out both positive and negative testing to ensure that the software is working as expected. Software that does not work correctly can often lead to many problems, including the loss of money, time or even the businesses reputation, and in the worst cases even injury or death.

## Software Defects

Software defects are often the result of a human being making an error (mistake) in a programs code or in the documentation, which in turn will produce a defect. In a programs code, if a defect is present in a programs code this may result in the system failing to do what it is expected to do. It is important to note though, that whilst defects in software, systems or documents may result in failures, but not all defects do so. Figure 6.1 below shows the common causes of software defects.

* Humans are fallible
* Working under pressure
* Working with extreme complexity

A Defect/Fault/Bug

“the result of an error”

An Error

“a mistake by a human”

A Failure

“System does not perform as expected”

causes

causes

causes

Figure 6.0.1 Causes of Software Defects

## Software Testing

The two main processes involved in Software Testing are Verification and Validation. These processes are used to check whether a system meets the specification and that it fulfils its intended purpose.

### Verification

Under the ISO 9000 standard ‘Verification’ can be defined as:

“Confirmation by examination and through the provision of objective evidence that specified requirements have been fulfilled”

(International Software Testing Quality Board, 2019)

Or as suggested by in 1979 by Barry Boehm by asking the question ‘Are we building the product right?’ (i.e. Are we building what is specified?). The main objective of verification is to ensure that a product is built according to the stated requirements and design specifications.

Throughout the implementation of this project, verification was frequently carried out. The projects’ Gantt chart was reviewed frequently to ensure that the projects timeline was being adhered too. The developer also consulted the projects requirements and designs to ensure that they were being followed and met sufficiently after every element was created.

### Validation

Under the ISO 9000 standard ‘Validation’ can be defined as:

“Confirmation by examination and through provision of objective evidence that the requirements for a specific intended use or application have been fulfilled”

(International Software Testing Quality Board, 2019)

Or as suggested by in 1979 by Barry Boehm by asking the question ‘Are we building the right product?’ (i.e. Is that which is specified really what is required?). The main objective of validation is to ensure that the finished product meets the needs of the intended user’s and that initial specifications were correct.

Validation was incorporated throughout the development stage as seen in the project Gantt chart for this project, through the form of development testing. Black Box (manual) testing was also carried out on both iOS and Android platform before the project’s application was released to UAT for the stakeholders to test.

### Development Testing

Development Testing is a testing technique that is used by developers during the development phase of a project to check if the code they have just written is working as expected.

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