School of Electronic Engineering and Computer Science

Final Report

Programme of study:
BSc Computer Science with Industrial Experience

Project title:

StepMyHealth – Maintaining a Healthy Lifestyle using Mobile Sensing

Supervisor:
Dr. Usman Naeem

Student Name:
Shivani Bhimji Patel

Final Year
Undergraduate Project 2019/20

Queen Mary University of London

Date: 10th May 2020

Abstract

The exponential rise in obesity and its related diseases has emphasised the necessity for all to remain health conscious. This, coupled with the increasing use of smartphones, has resulted in a surge of popularity amongst health applications, in particular, calorie-tracking mobile applications. Many applications currently available look to dramatically change user behaviour rather than enabling the maintenance of healthy lifestyles. Furthermore, such applications provide various functionalities to allow for the tracking of calorific consumption but go no further in providing suggestions to help users remain within their calorie allowance.

StepMyHealth is an iOS application that enables users to track their daily steps, calories burned and food consumption. StepMyHealth uses the device’s built-in accelerometer to calculate the remaining calorie allowance at a given time automatically. Based on the users’ consumption, StepMyHealth periodically provides suggestions such as food intake ideas and a further number of steps to be taken. StepMyHealth implements motivational gamification elements, the main of which is a leaderboard. The interface design is simplistic to enhance the usability of the application.

The user feedback and evaluation of StepMyHealth has shown that the application does enable users to easily track their calorie consumption, while also increasing motivation through its gamification elements.

Keywords - Mobile Application, iOS, Healthy lifestyle, Calorie Tracking, Suggestions

Acknowledgements

A special thank you to my supervisor Dr Usman Naeem, for his guidance, expertise and encouragement throughout the project. Thank you to my family for their unconditional support, to my sister for always believing in me, for putting up my coding outbursts and for never letting me give up.

Contents

Table of Tables

Table of Figures

Chapter 1: **Introduction**

1.1 Background

The leading cause of obesity is calorie overconsumption: the intake of more calories than are burned off through physical activity (Global Food Security, 2016). As of September 2019, nearly 40% of adults in America are medically obese – the highest rate documented by the National Health and Nutrition Examination Survey (NHANES) (Robert Wood Johnson Foundation, 2019). Between 2014-2015 the NHS spent £6.1 billion on obesity and its related diseases (Public Health England, 2017). Obesity is one of the significant underlying risk factors to several non-communicable diseases (NCDs), including premature heart disease, diabetes and stroke (Public Health England, 2017). Thus, highlighting that the global obesity epidemic is posing both a substantial economic cost and a health risk to the world population.

There are several existing calorie tracking applications available to users who aim to sustain healthy lifestyles. Apps such as Lose It! and MyFitnessPal focus on user input of exercise and food intake. However, such applications go no further in analysing the resulting calorie balances, providing no suggestions to help users to meet their daily goals (FitNow, 2009) (MyFitnessPal, 2014). Thus, meaning users often become disengaged in using the applications once the novelty wears off. In addition, existing applications have downfalls in usability, leading to reduced motivation and hindrance in adoption (Lee, et al., 2006).

1.2 Problem Statement

There is an evident problem with the motivation levels amongst users who are looking to track their calorie consumption (Saboia , et al., 2018). Individuals tend to have different calorie related goals. Some are looking to lose weight while others are looking to maintain consistency in their lifestyles. Individuals should first be motivated to achieve these goals and secondly focus their time in actioning changes. However, individuals often lack motivation due to the usage of excessively time-consuming, monotonous and non-user-friendly tracking techniques (Lee, et al., 2006). This absence of motivation means users are less inclined to achieve their desired calorie goals.

1.3 Aim

This project aimed to build an iOS application that helped users track their calorie consumption efficiently. There are several calorie tracking applications currently available on the App store, but such applications have downfalls. The applications that exist do not provide users with intake recommendations. Also, many of the applications have usability issues, the main problem of which relates to the cluttered design of user interfaces. Such design issues have led to a lack of user engagement. Furthermore, existing applications implement limited uses of gamification elements. Thus, do not fully utilise the motivational potential of gamification within calorie tracking.

StepMyHealth aimed to implement features and design elements to solve these issues within a single application.

StepMyHealth aimed to provide regular intake recommendations to users based on their current calorie balance. The automated calculation, using the accelerometer data collected from the device intended to reduce the overheads associated with the manual input of distance metrics.

In addition, StepMyHealth aimed to implement gamification features to motivate users in reaching their calorie goals. The main element of gamification used was a leaderboard, allowing users to compare their calorie progress to others. The leaderboard aimed to encourage users to remain within their daily calorie balance.

StepMyHealth also aimed to provide a simple, easy to use interface for tracking, ensuring users were not overwhelmed by information. The aim was to attract users not only in the short term but for prolonged durations, such that the simplicity of the application would lead the integration of calorie tracking into users' lifestyles.

The combination of these features aimed to provide users with an engaging, easy to use, effective calorie-tracking mobile application - StepMyHealth.

1.4 Objectives

- To investigate the existing calorie tracking applications available to users
- To identify the challenges related to self-reporting systems
- To use the current research available to understand the impact of different functionalities on the effectiveness of calorie tracking applications
- To develop an iOS application to allow users to track their calorie consumption calories burned easily
- To implement an algorithm that can determine how many calories the user has over/under-consumed and provide suggestions based off of this outcome
- To perform user testing to conclude the effectiveness of the application
- To utilise the results from user testing to evaluate the application's effectiveness against existing applications

1.5 Research Questions

The following research questions were explored through the implementation, validation and evaluation of StepMyHealth.

1. What are the effects of using gamification elements in the achievement of calorie related goals?
2. What impact does the usability of features have on a user's retention of calorie tracking applications?
3. What are the effects of consumption recommendations among individuals seeking to track their calorific intake?

1.6 Report Structure

Chapter two explored the research conducted in the area of mobile health tracking. Three significant themes were studied: Electronic Applications Integrating with Health Tracking, The Effects of Gamification in Mobile Health Tracking Applications and The Impact of Interface Design on Usability within Calorie Tracking Applications. Current calorie tracking applications were analysed, with details of their benefits and drawbacks.

Chapter three detailed the resulting functional and non-functional requirements for the system alongside several design diagrams.

Chapter four specified the implementation of StepMyHealth, including the technologies and methodologies used. Each of the main features within the application was explained.

Chapter five discussed how StepMyHealth was tested including both the development tests and user tests carried out.

Chapter six looked at the overall outcome of the project. The aims, objectives and research questions initially set out at the beginning of the project were evaluated against the final implementation. The limitations of the project were also discussed.

Chapter seven explored the legal, social and ethical issues that were considered during implementation. Retrospective issues highlighted by the evaluation have also been discussed.

Chapter eight detailed a personal reflection of the challenges and achievements throughout the project. Ideas for future work on the project have been presented.

Chapter nine consisted of the bibliography. The full references for sources mentioned throughout the report can be found here.

Chapter 2: **Background Research**

There has been a vast amount of academic research and studies within the domain of health tracking and the various functionalities that affect their efficacy. Several researchers and developers have analysed the concepts and their impact on user engagement.

2.1 Literature Review

2.1.1 Electronic Applications Integrating with Health Tracking

Users of self-monitoring health applications are often looking to better track their calorie consumption through the convenience of their devices. An internet-based computerised tracking system (CTS) was developed by a team of dietitians, health psychologists, and software developers. The effects of using the CTS to track calorific intake over two years was evaluated on a sample size of 811 healthy and overweight men and women (Anton, et al., 2012). The study found that participants who actively used the CTS to track their calories lost on average 3.2% more weight within 32 weeks than those who did not (Anton, et al., 2012). Thus, showing that computer-based systems and mobile applications which provide direct feedback to users can be useful in achieving health-related goals. In particular, a research study conducted by Tirasirichai, et al., 2018 implemented a prototype calorie tracking application- BloomBalance with feedback in the form of notifications. The results found that users paid more attention to their health due to the prompts received. A large amount of further research has also been conducted, which concludes a positive correlation between the utilisation of mobile health applications and visible results (Zhao, et al., 2016).

However, there were limitations associated with the study, which should be highlighted. In addition to calorie consumption logging, users were solely responsible for manually inputting their daily exercise, meaning figures were subject to bias. Furthermore, long term evaluations from greater than 32 weeks could not be accurately drawn due to the decline in CTS usage (Anton, et al., 2012). Nonetheless, the main conclusion from the study was that the use of computer/mobile-based tracking systems that provide direct feedback could cause users to 'modify their dietary intake in line with dietary goals' (Anton, et al., 2012).

A comparable study carried out by Turner-McGrievy et al. (2013) produced similar results. The study carried out a direct comparison between 2 groups of participants. One group used a physical activity (PA) mobile application for six months, while the other did not (non-PA application users). At the end of the study, those using the application showed to not only self-monitor more frequently but also showed a significantly lower BMI (Turner-McGrievy, et al., 2013). However, participants were allowed to select which group they wanted to be a part of beforehand. Therefore, it is likely that they were pre-inclined to use their prefered chosen methods. The impact of such decisions was not factored into the results(Turner-McGrievy, et al., 2013). The sample size of the trial participants was also significantly smaller than that of Jing et al. (2016) with only 96 men and women.

Overall, both studies have validated the ability of mobile tracking applications in aiding users to achieve their health-related goals, specifically those centred around calorie intake. There is a clear indication that regular feedback urges users to make better consumption decisions (Anton, et al., 2012).

2.1.2 The Effects of Gamification in Mobile Health Tracking Applications

Gamification is defined as “the use of video game elements in non-gaming systems to improve user experience (UX) and user engagement” (Deterding, et al., 2011). Gamification can result from different forms such as points, levels and progress bars (Tóth & Tóvölgyi, 2016). Though there have been discussions regarding the correct use of gamification within self-health monitoring applications, when used correctly, there is strong evidence to suggest a positive increase in user engagement (Lister, et al., 2014).

A research study carried out by Goldhill, et al. (2018) analysed the impact of mobile application gamification on health-related behavioural changes. The studies’ findings were based on survey questions completed by students from the University of Cape Town. At the time of the study, each of the students used or did not use a mobile health application. The research survey, which was modelled around closed, quantitative data questions drew several significant conclusions. The most substantial of which was concerning the question: ‘how does the inclusion of gamification elements in m-health applications affect their adoption by students?’ (Goldhill & Roodt, 2018). Out of the 35 respondents, 25 implied that they were more likely to use a mobile health application which integrated features of gamification (Goldhill & Roodt, 2018).

Though the research has shown gamification within mobile applications can have a significant impact on user engagement, there were limitations concerning the accuracy of the data collated. All statistical analysis was performed on the basis that the responses were honest; there was no method of checking the legitimacy of participants claims. Also, the small sample size meant the results were not representative of the population, thus questioning if the trends identified can be extrapolated (Goldhill & Roodt, 2018).

Despite the limitations, this study is one of many that concludes the positive impact of gamification in health tracking applications and the importance of considering gamification during development (Saboia , et al., 2018). An implementation study by Masitoh et al. (2015) provides further evidence in support of gamification and its impact on user motivation. This particular study looked at the implementation of a mobile step tracking application, Steppy. The study found that elements which promoted user engagement were those centred around competition such as levels and leaderboards (Masitoh, et al., 2015). Gamification can be further justified from looking at features within existing applications. MyFitnessPal already utilises gamification elements such as calorie progress bars as a means of motivating users (MyFitnessPal, 2014).

2.1.3 The Impact of Interface Design on Usability within Calorie Tracking Applications

Usability is arguably one of the most important elements in mobile application development. The ISO (the International Organization for Standardization) defines usability as the extent to which an application can be used by target users to achieve goals based on the variables of effectiveness, efficiency and satisfaction (International Organization for Standardization, 2014). However, the concept of usability also encompasses further variables including, aesthetics, data accuracy and functionality (Feroz, et al., 2019). According to the interaction design foundation, the primary measure of an application’s usability is the ease of use, from initial user interaction through to repeated usage (Interaction Design Foundation, 2019). In the case of calorie tracking applications that are used daily, usability is even more of a critical factor. Many such applications tend to short lifecycle due to the lack of focus on usability during design and development (Feroz, et al., 2019).

There have been several studies in relation to usability within health tracking applications. A one-month feasibility study was carried out amongst a sample of 15 participants. The participants were asked to use a mobile application – PmEB to track their diet and physical activity for one month. Upon completion, participants were asked a series of questions relating to rate the usability of the application on a Likert scale from 1-5 (Lee, et al., 2006). The results showed that users valued the convenience and the simplicity of the user interface as the top factors (Lee, et al., 2006). Though the sample size was minimal, this study has shown that interface design is an essential factor to be considered within usability. There has also been further support to this conclusion from research that considers aesthetics to be one of the five major classes in usability (Feroz, et al., 2019)

In 2014 Kascak et al. (2014) carried a study which involved the redesign of a remote patient monitoring (RPM) mobile application. The interface design was centred around the universal design (UD) principles. UD looks at designing products and interfaces usable by all individuals, with all ranges of abilities. Examples of UD features that were implemented were buttons of altering sizes and colour coding to differentiate elements. The findings from the study showed that UD principles improved the usability and adoption of the application (Kascak, et al., 2014). Though this application was explicitly targeted at older adults, the conclusions about the importance of user interface design are still valid across mobile health application developments for varying users.

Though the importance of considering design with usability is evident, there have been several issues highlighted with current measures of usability. At present, the most commonly used measure is star ratings (Feroz, et al., 2019). There have been attempts to produce a more stringent standard. For example, Feroz, et al., 2019 put forward a structured usability questionnaire based on five major classes of usability. Other techniques, such as comparative usability evaluations have also shown potential in collecting more accurate data (Veldsman & van Greunen, 2017). However, since usability is a subjective concept, often dependent on an individual, it is difficult to find a consistent measuring method. Such limitations should be considered when concluding the usability studies discussed.

2.2 Existing Application Reviews

At present, there are a plethora of mobile applications available that track health statistics. These range from simple calorie tracking applications to fully-fledged health and fitness diaries.

The applications in *Table 1* are available on the mentioned platforms as of October 2019. The applications were selected on the grounds of their effectiveness as specified by qualified nutritionists (Bjarnadottir, 2018) (Chen, 2016). In addition, the applications selected for review are among the highest-rated applications when searching for ‘calorie tracking’ on the Apple App Store (Apple, 2019). All of the applications have star ratings of 4.5 or above.

Application Name	**Main Features**	**Primary Objective**	**App Store Rating** (out of 5)	**Drawbacks identified from a personal review**
Lose It!	• Weight loss community • Goal list • Historical trend views	Help individuals to lose weight	4.8	No intake recommendations so challenging to identify which consumptions would be within the calorific balance
MyFittnessPal	• Discussion forums • Links to external applications • Extensive food database	Help individuals track their exercise	4.7	No intake recommendations and several calorific values are returned for the same search item
SparkPeople	• Calorie progress • Virtual coach	Help individuals track and visualise their calorie consumption	4.8	Cluttered layout making navigation difficult
Cronometer	• In-depth consumption analysis	Help individuals identify the micronutrients within their consumption choices	4.6	Inconvenience in viewing historic graphs due to the linkage to an external website
Fooducate	• Food Scanner • High calorie • warnings	Help individuals identify highly calorific consumption choices	4.5	No intake recommendations provided

Table 1 - Summary of current mobile health tracking applications. Ratings and customer reviews from the Apple app store (Apple, 2019)

2.2.1 Lose It!

Lose it! is an Android/iOS application focused on personalised goal setting (FitNow, 2009). Lose it! provides a clear interface when visualising historical data through a single trend view of calorie consumption.

Lose it! has a variety of personalised account features including customisable reminders, profile-based statistics and the optional addition of external device connections. The ease of food consumption logging is improved through the convenience of the built-in barcode scanner. Lose it! further motivates users through the weight loss community where goal achievements can be shared.

However, Lose It! does not provide any additional recommendations based on a user's current calorie consumption. Users can continue to consume any number of calories without an indication that they are over their daily limit, making it difficult for users to plan their calorie intake (Anton, et al., 2012).

While Lose It! provides an appealing interface; it does not give users regular updates on their current calorie balance.

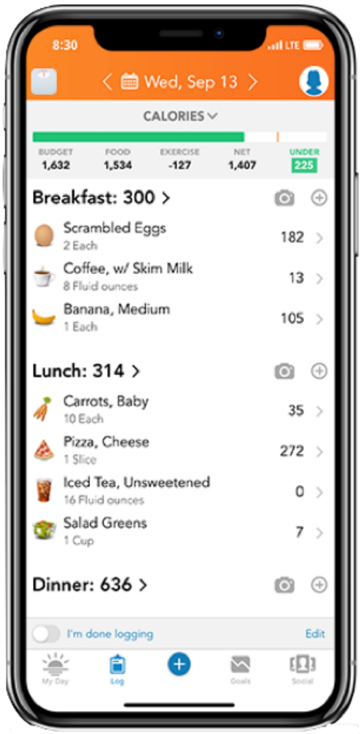


Figure 1 - Screenshot of Lose It! (FitNow, 2009)

2.2.2 MyFittnessPal

MyFitnessPal is an android/ iOS health tracking application that aids individuals whose primary motivation is weight loss (MyFitnessPal, 2014). MyFitnessPal provides the best searchability amongst applications alike through its extensive food database of over 300,000,000 items (MyFitnessPal, 2014). MyFitnessPal has the ability to link data from other applications such as Samsung Health and the Apple HealthKit to provide users with collated statics. Similar to other applications, MyFitnessPal uses discussion forums as a means of motivation among users. MyFittnessPal also implements elements of gamification as motivation, for example, progress bars (Goldhill & Roodt, 2018).

MyFitnessPal has an additional feature allowing users to add meals/items that cannot be found in the database. However, this leads to questionability surrounding the accuracy of the given calorie count. Such doubt is furthered as there are often multiple entries for the same item with differing calorific values.

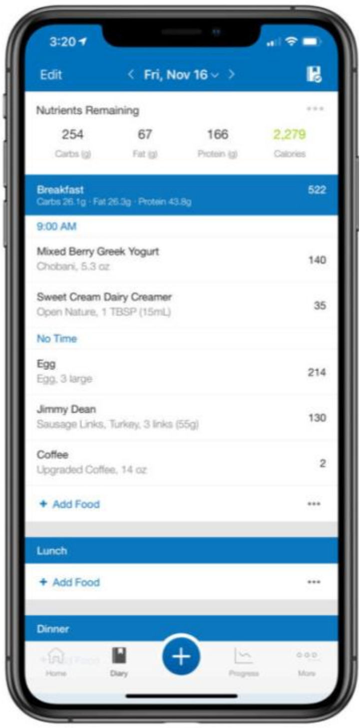


Figure 2 - Screenshot of MyFitnessPal (MyFitnessPal, 2014)

2.2.3 SparkPeople Calorie Tracker

SparkPeople Calorie Tracker is an Android/iOS mobile application. Spark People provides logging of both food and exercise (SparkPeople, 2013). In addition, several features aim to act as motivators to users — for example, the ‘SparkCoach,’ a virtual coach that provides useful feedback and guidance.

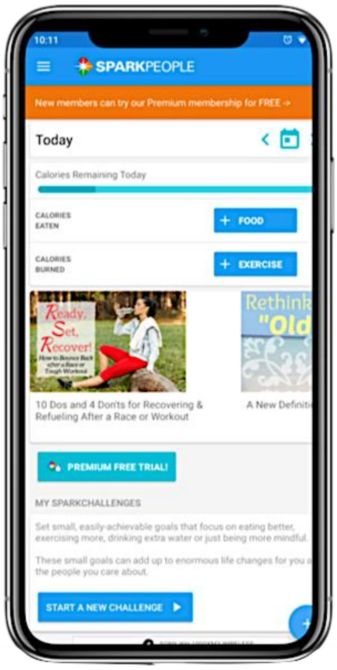


Figure 3 - Screenshot of SparkPeople Calorie Tracker (SparkPeople, 2013)

Despite the various motivational functionalities, SparkPeople Calorie Tracker has the most cluttered user interface amongst the applications reviewed. The ‘Top Stories’ section is placed closely beside the users’ calorie tracker despite the features have no relation. Thus, the interface was overwhelming and could cause users to be deferred from using the application (Lee, et al., 2006).

Though SparkPeople Calorie Tracker provides many motivational functionalities, the confusing layout raises usability issues.

2.2.4 Cronometer

Cronometer has the most precise visuals for viewing current balances. There are three separate progress circles for consumed, burned and remaining calories. Cronometer also provides users with information, not just on the calorific content of food but also on other micronutrients (Cronometer, 2011). This is especially useful for users who are looking for an in-depth analysis.

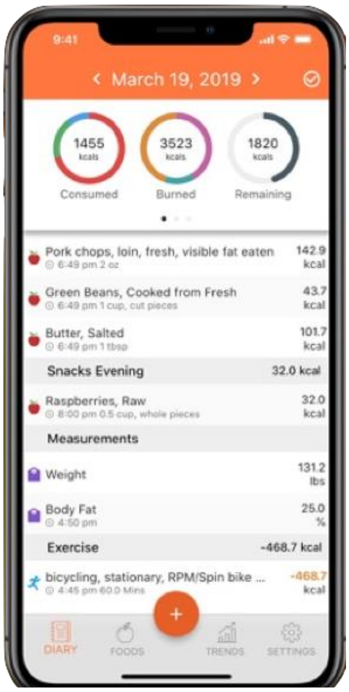


Figure 4 - Screenshot of Cronometer (Cronometer, 2011)

The Cronometer application is linked to the Cronometer website. Users can only access the full visual graphs of their calories through the website, which questions the convenience of the mobile application. Another feature that is not available on the mobile application is logging personal recipe meals.

Despite the clear visuals, the lack of convenience on Cronometer’s mobile application is likely to defer users from fully utilising the application.

2.2.5 Fooducate

Fooducate is an iOS/ mobile application whose primary function is to enable users to easily view the nutrients and calorific values of foods they want to consume (Fooducate, 2018). The barcode scanner allows users to scan items on the go before purchasing. The addition of warning messages based on scanned items aims to be a deterrent away from highly calorific items. Fooducate provides clear and concise progress bars for the calories consumed and steps taken.

Though Fooducate provides a level of convenience, it still lacks in giving users suggestions. For example, if an item is over the users' calorie budget, the app does not provide users with alternatives within the range. Though users can save items to compare later, this is not automatic.

Fooducate's barcode scanner, coupled with the warning messages, makes the application engaging. However, due to the lack of automated suggestions, the usefulness is limited.

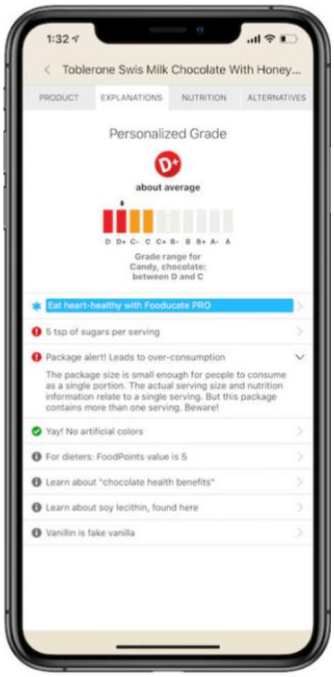


Figure 5 - Screenshot of Fooducate (Fooducate, 2018)

2.3 Requirements Research

For this project, the most efficient method of gaining insights from a wide range of individuals was through using an online questionnaire. This allowed for the collection of user's behaviours, opinions and attitudes towards mobile calorie tracking applications. To ensure data privacy, the questionnaire was conducted anonymously using Microsoft Forms using Queen Mary University of London's Microsoft office 365 service. The questions can be found in *Appendix A* and a full breakdown of the 112 responses in *Appendix B*. The questions included were closed questions to allow for statistical analysis of the results.

2.3.1 Results from Requirements Research

From the questionnaire, a range of conclusions can be drawn. It is evident from the responses gathered that the majority of respondents, 93% do currently use mobile calorie tracking applications. Also, the majority of respondents used Apple devices.

Interestingly, despite the high usage levels, when asked how effective existing applications were, the resulting score was low with 2.34/5 (*Figure 6*). Therefore, highlighting further that there are downfalls in current applications as previously discussed. When asked about the importance of particular elements such as usability and intake suggestions, the resulting scores were high with 4.35/5 and 4.53/5, respectively *(Figure 6*).

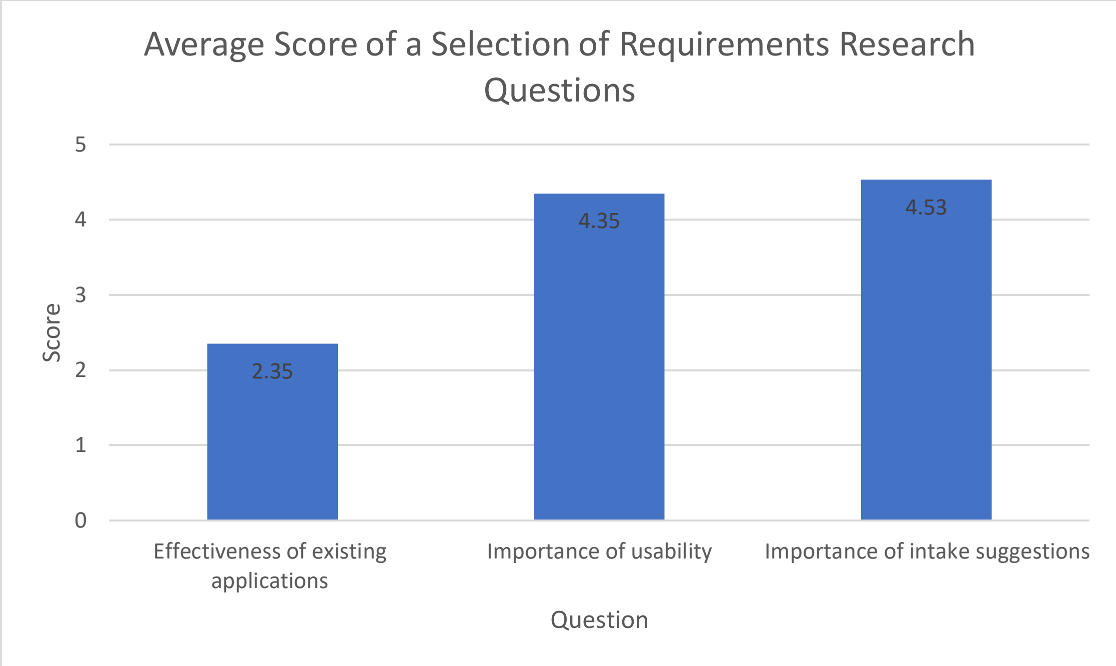


Figure 6 - Average score responses for three selected requirements research questions

An interesting result showed that the majority of respondents would be more inclined to use mobile tracking applications with leaderboards. This coincides with the findings from other research papers (Saboia , et al., 2018), showing competition-based gamification features would be utilised in mobile calorie tracking applications.

2.4 Summary

There is ample evidence supporting the use of mobile applications to track calorie consumption. More specifically, there is adequate proof to suggest that feedback functionalities motivate users to engage with such applications. However, current applications are lacking regular feedback and intake recommendations. StepMyHealth implemented feedback functionalities such as personalised push notifications, which aimed to increase the likelihood of calorific goal achievement.

Gamification proves to improve user retention. Furthermore, as concluded from various research, competition-based gamification elements provide excellent motivation to users within goal-based applications, further supported by the results from the questionnaire. However, at present, there is limited use of gamification elements within calorie tracking applications. StepMyHealth had a significant use of gamification through the implementation of a leaderboard.

Usability has also had a significant impact on user engagement levels. Though usability can be difficult to measure due to its subjective nature, the simplicity of interface design has proven to impact user satisfaction. Many of the existing applications available are heavily cluttered. Due to this, the interface design for StepMyHealth took into account simplicity as one of its primary requirements.

Chapter 3: **Analysis and Design**

The requirements specification was a vital aspect of this project. The requirements form the basis of a software development project and therefore need to be clearly defined. The defined requirements for StepMyHealth informed the design and implementation.

3.1 Requirements Analysis

Below are the functional and non-functional requirements collated from the literature review, exiting application review and the outcomes of the online questionnaire.

3.1.1 Functional Requirements

1. The system should allow users to input their food consumption – The system should contain a log intake screen, easily identified via a tab view controller. A search functionality on this screen should allow users to input the foods they have consumed via the use of an API. The results should be clearly displayed to the user, who can then select the entries to be stored. The stored values should be used to calculate the users progress.

2. The system should allow users to view their daily calorie balance – There should be a user dashboard, whereby users can view their calorie balance and remaining allowance. These values should be reset daily.

3. The system should provide users with intake recommendations based on their current calorie balance – Users should be sent recommendations in the form of local notifications which should be personalised by into consideration the users previous consumption history and their remaining allowance. Recommendations should be sent three times during the day as not to overuse the functionality.

4. The system should allow users to compare their calorie balance with other users of the application – The system should provide a view of a leaderboard amongst users. The points displayed should indicate the users progress.

5. The system should allow users to view a historic graph of their points over a period of time – The system should provide a screen whereby users can visualise the progression of their points. Since points will be an abstraction of the users calorie balance, the points graph will also incidentally visualise goal progression.

6. The system should automatically calculate the remaining calorie balance based on the user's intake inputs and the devices accelerometer data – There should be an algorithm in place that is able to calculate the remaining balance. This calculated balance should be visualised via the progress meter on the dashboard.

3.1.2 Non-functional Requirements

1. The system should respond to user input within a reasonable about of time without a noticeable delay – The system should be able to display results from API and database calls in adequate time. If there is a delay/error during retrieval, the system should indicate this.

2. All of the data in the system should be available even if the application is closed and reopened – Users data should be stored using the Firebase Cloud Firestore database. When the user closes the application, they should be logged out. When they log back into the application, their account data should be displayed as stored on the database.

3. The system should provide a simple, easy to use interface – The system should have segregated screens for each logical functionality. The systems' design should lead to intuitive use that requires minimal explanation.

4. The system should validate all user input data to ensure it meets the specified requirements – The system should check all user input. If invalid, the system should display an error message accordingly. The system should restrict the type of user input allowed for certain fields such as numbers only to help users identify valid inputs.

3.2 Design

3.2.1 Use Cases

StepMyHealth has several use cases, as shown in *Figure 7*. The use cases were kept simplistic to ensure there was minimal user input required. Examples of use cases within StepMyHealth are Register, Log Food and View Dashboard.

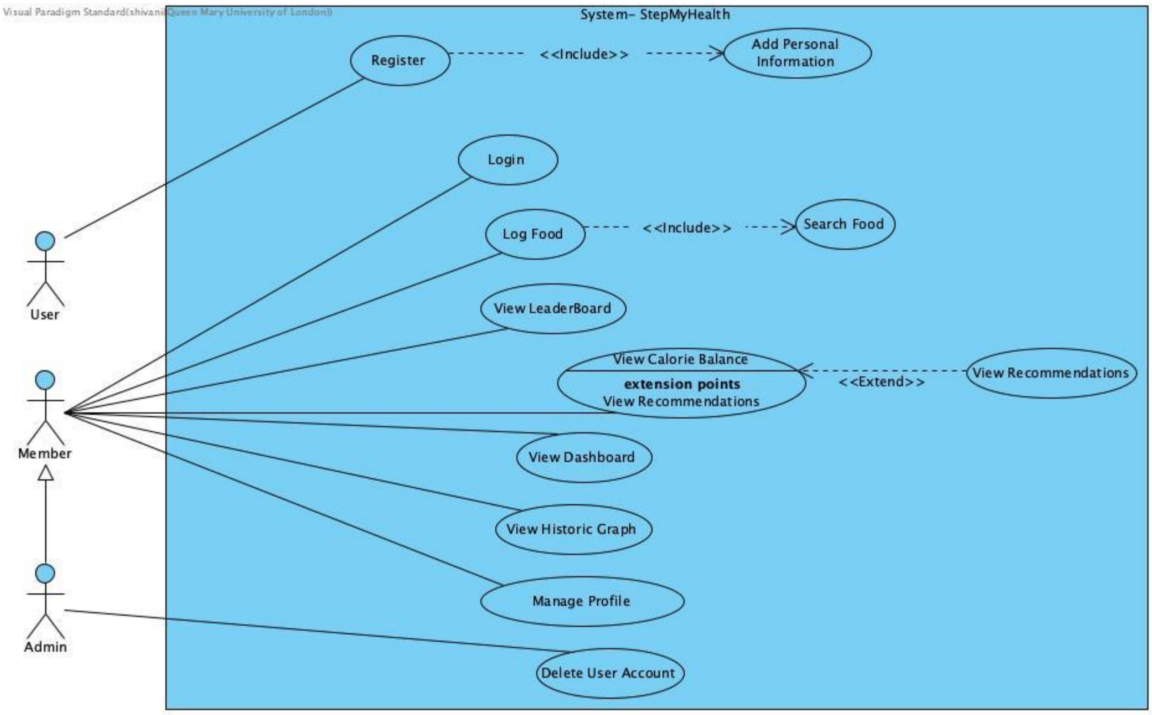


Figure 7 - StepMyHealth Use Case diagram

Table 2 and Table 3 provide the details for two integral use cases within StepMyHealth: View Leaderboard and Log Food. The remaining use cases are detailed in *Appendix C*.

Use case	View Leaderboard
Actor/s	Member
Pre-condition	Member must be logged into their account
Post-condition	Member has viewed their progress on the points graph
Basic path	1. Member clicks on the 'Leaderboard' icon displayed in the tab bar 2. The system displays the points graph for the member
Alternative path	At step 2, there may be an error in retrieving the data from the database. The system will display an error message accordingly.

Table 3 - StepMyHealth View Leaderboard use case

Use case	Log Food
Actor/s	Member
Pre-condition	Member must be logged into their account
Post-condition	Member's calorie balance will be altered
Basic path	1. Member clicks on the 'Log Food' icon displayed in the tab bar 2. Member clicks the search field 3. The system prompts the user with keyboard input to enter their search criteria 4. The system displays the results of the search, showing the calorific intake of each of the results 5. The user selects the result to be logged 6. The system records the member's input and adjusts their balance accordingly 7. The system displays the altered calorie balance on the users Dashboard
Alternative path	At step 4 the system may have no results that match the search criteria. In which case, the system will display a message stating there were no results yielded.

Table 2 - StepMyHealth Log Food use case

3.3 SDLC

3.3.1 Development environment

iOS application development is based on the Swift programming language. Developed by Apple, Swift is a compiled programming language designed to work with existing Objective-c code and Cocoa frameworks (Apple Inc, 2020). The implementation of StepMyHealth uses Swift 5, coded in Xcode – Apple's official integrated development environment (IDE) (Apple Inc, 2020). Xcode provides several features centred around simplifying the development process, including a simulator tool for different Apple devices and a Storyboard feature allowing for the rapid construction of application screens. Such features allowed for timesaving during the development of StepMyHealth.

3.3.2 System Architecture

StepMyHealth is an iOS mobile application, therefore it was important to follow a standard design pattern to ensure solidity in its structure during development. The design pattern chosen was Model-View-Controller (MVC) design pattern (*Figure 8*). MVC separates the codes functionality into three distinct roles: the model, the view and the controller (Dragos-Paul & Altar, 2014).

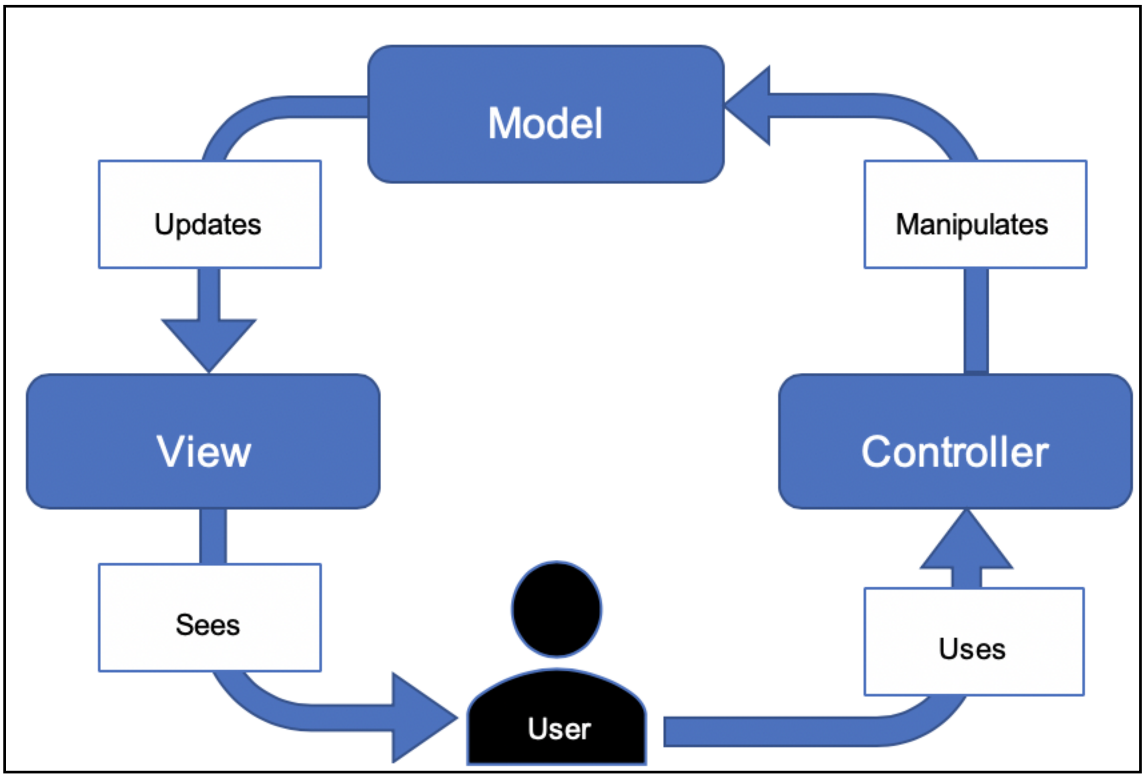


Figure 8 - MVC Design Pattern flow (Miessler, 2019)

In practical iOS development these three roles can overlap, with some code performing more than one of the roles. However, when correctly implemented, the roles should still be distinguishable. The model manages the data related tasks. Most often, the model within mobile applications is the database backend. StepMyHealth's model is the Firebase back-end and its related data structures.

The view handles the presentation of the graphical user interface, defining how the data from the model will be displayed. In iOS development, a view should be reusable, i.e. a `UITableViewCell` should be written such that it can be used in all cells in a `UITableView`. Each of the screens within StepMyHealth are views.

The controller is required for event handling and updates the models, for example from user input. The updates are in turn processed by the models and passed to the view, which displays the updated interface. In the case of StepMyHealth, each of the screens within the storyboard is linked to a collection view controller subclass. For example, the Log intake screen is controlled by the `LogIntakeViewController`. Therefore, the controller is tightly coupled with view, hence the "View Controller" naming convention.

3.4 View

Combing together the requirements and findings from research, the initial wireframes for StepMyHealth were created (*Figures 9 & 10)*. *Figures 11 - 15* detail the wireframes for each screen. The annotations describe how usability, clarity and simplicity were key factors in designing of StepMyHealth and the influences behind the design decisions.

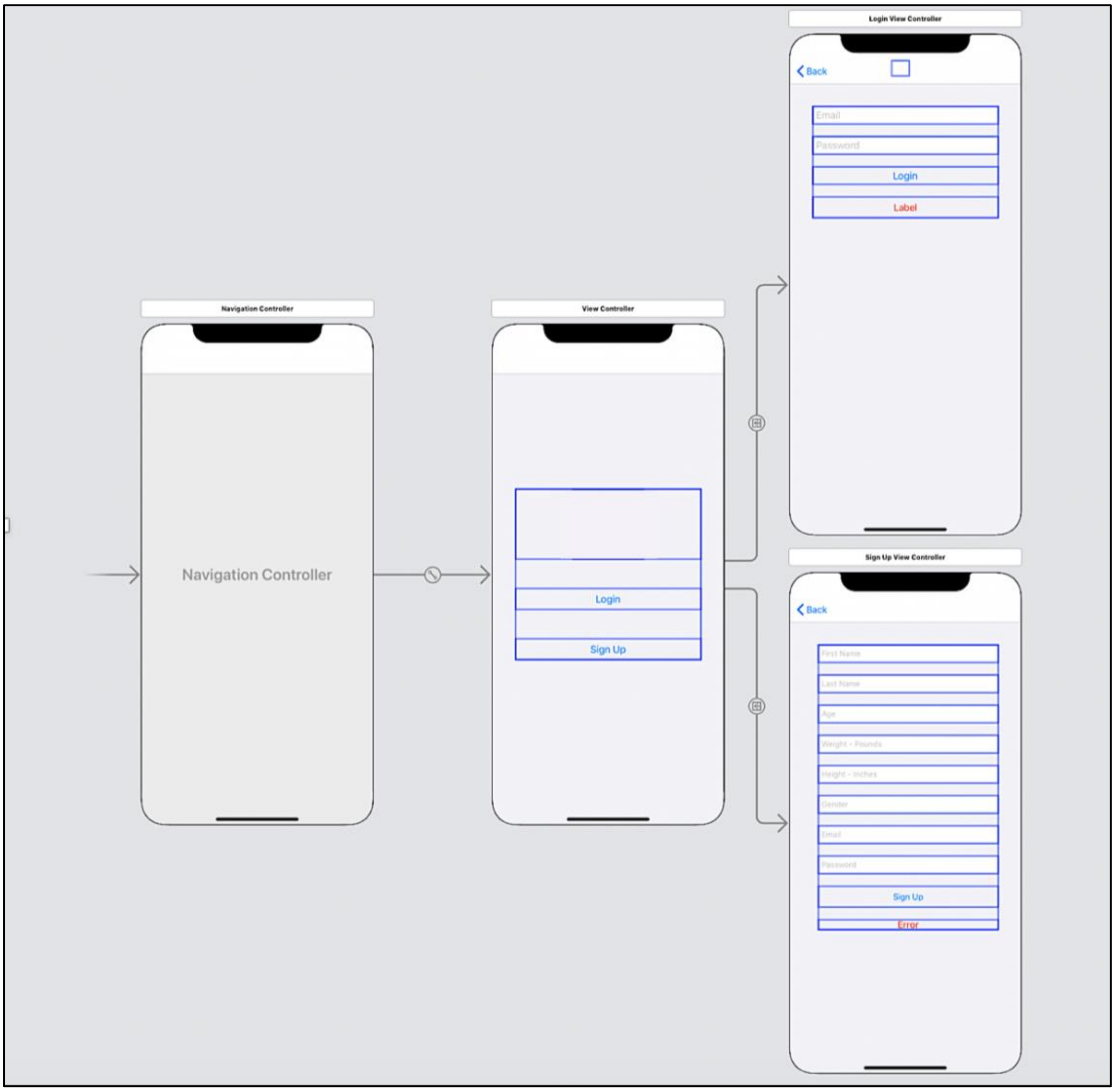


Figure 9 - StepMyHealth Initial Wireframes

Figure 10 - StepMyHealth main screen wireframe structure

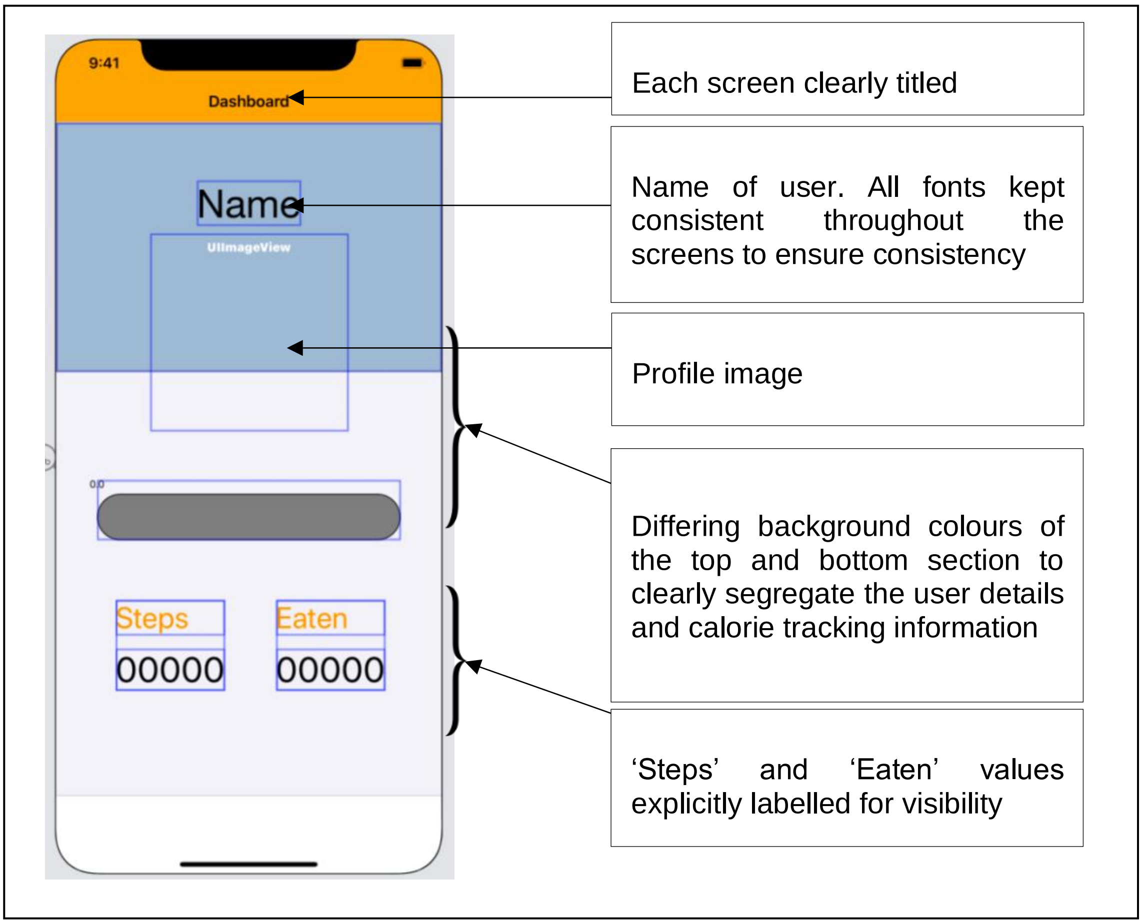


Figure 11 - Dashboard Wireframe

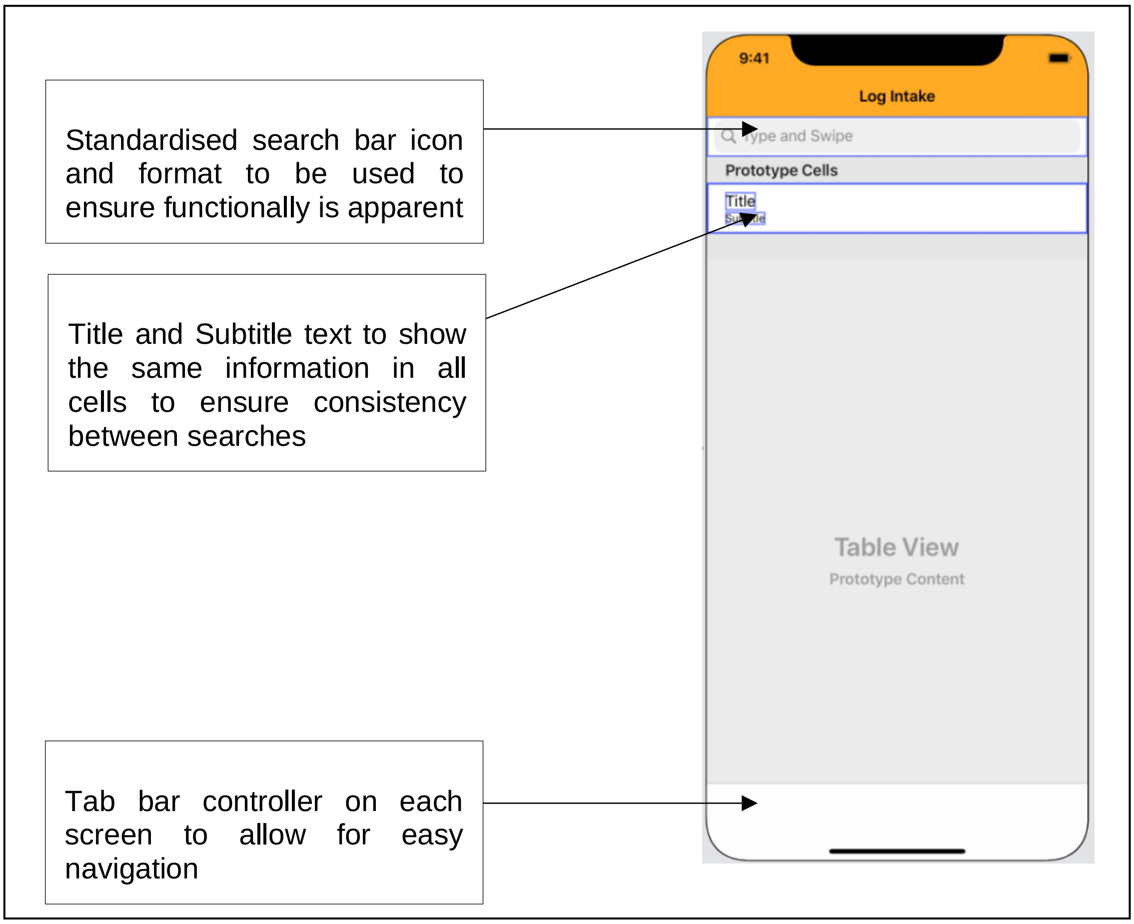


Figure 12 - Log Intake Wireframe

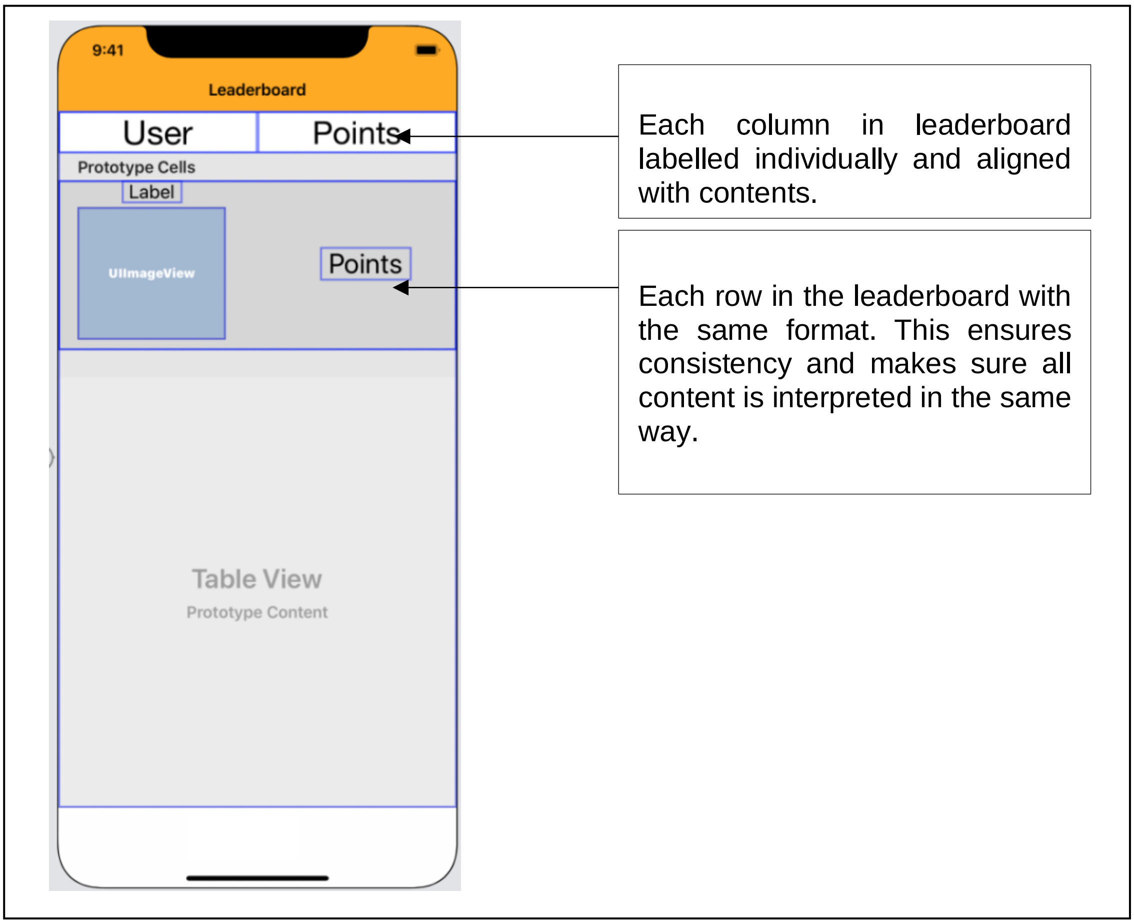


Figure 13 - Leaderboard Wireframe

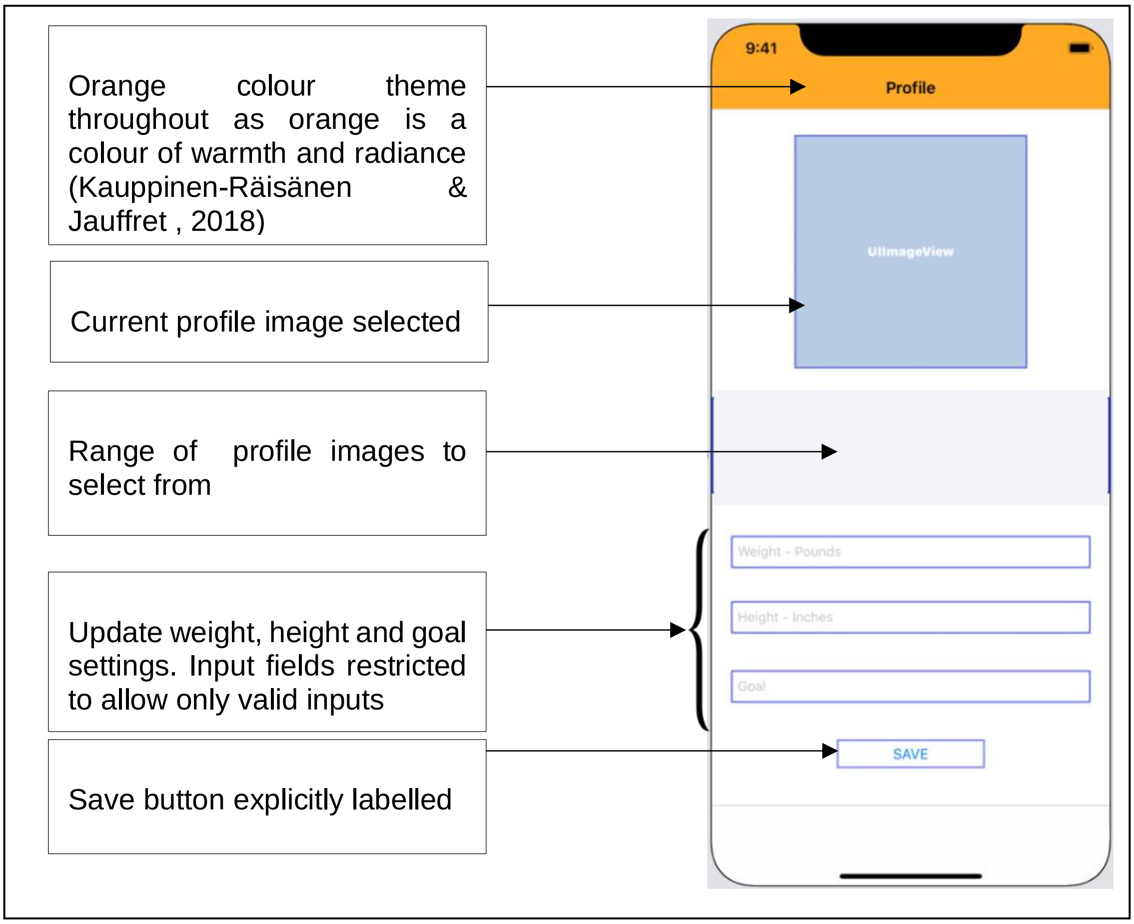


Figure 14 -Profile Wireframe

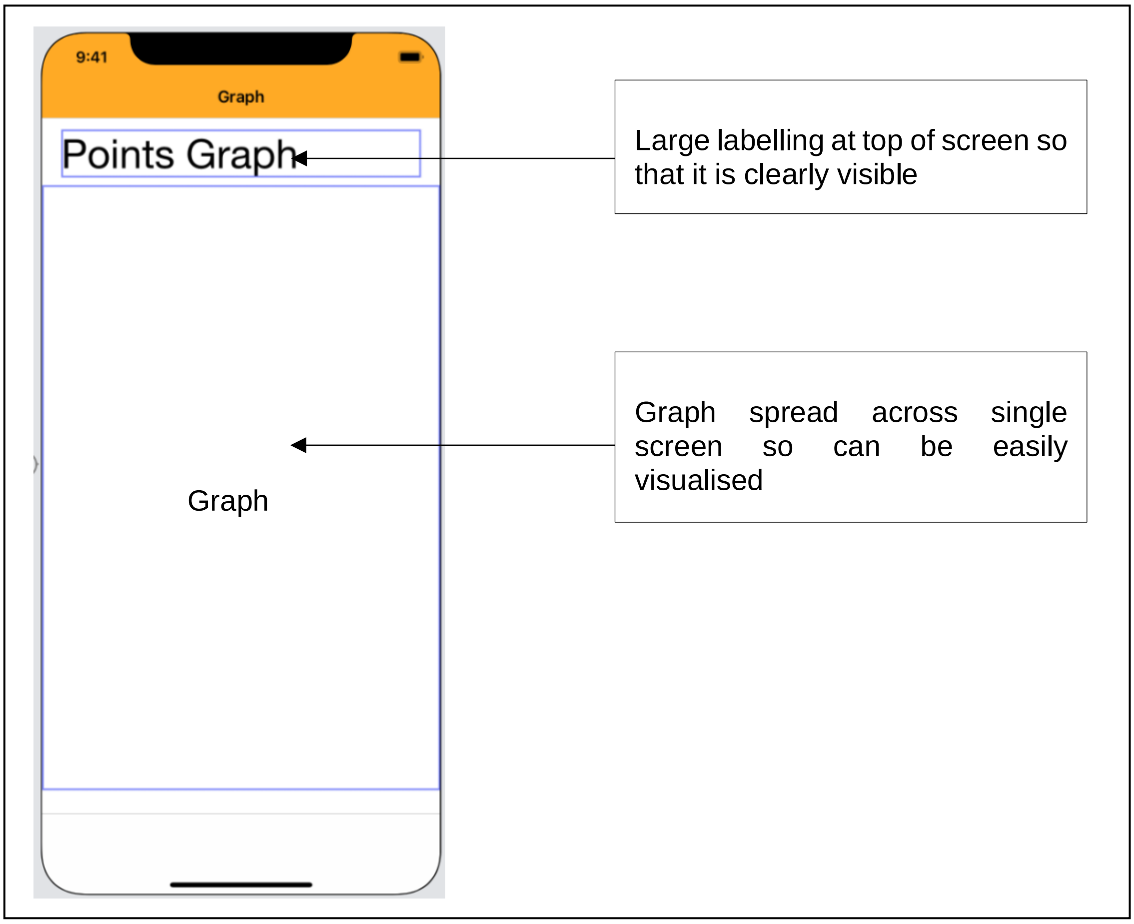


Figure 15 - Points Graph Wireframe

3.5 Database Model

A NoSQL database was used for StepMyHealth due to its flexible nature. *Figure 16* shows the database model for StepMyHealth. The model was built using a class diagram visualisation. The model was arranged in a hierarchical structure. The documents (Member, Food, Graph Point) are nested within their superior collections.

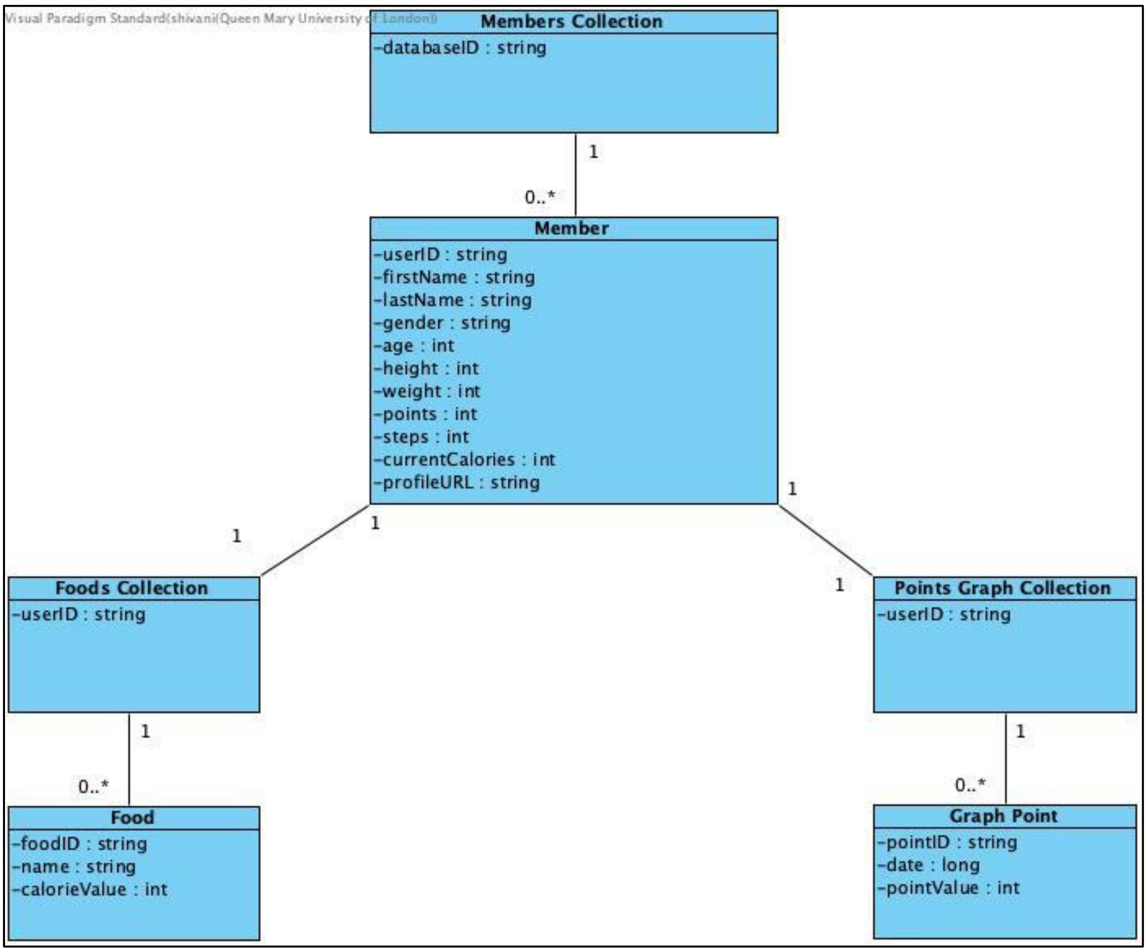


Figure 16 - StepMyHealth NoSQL Database Schema

3.6 Summary

The functional and non-functional requirements for StepMyHealth were defined using the knowledge gathered from primary and secondary research. These requirements provided the fundamental building blocks for the implementation of StepMyHealth. This coupled with the MVC model outlined ensured structure and clarity during implementation.

Chapter 4: **Implementation**

There are often several different methods to implement any one feature. Regardless of the chosen algorithms and technologies, it is important as a developer to be able to provide rationale for these.

4.1 Rationale for Platform and Technologies

4.1.1 iOS

StepMyHealth is an iOS mobile application. A mobile application was chosen over a web application due to the app's nature of needing to track steps taken automatically. A mobile application also allowed for tracking on the go. Furthermore, as revealed from the online questionnaire conducted during requirements gathering (*Appendix B*), the majority of participants were iOS users. This would likely be the same pool of users from which participants for testing would be selected, providing further support for using the iOS platform.

4.1.2 Firebase

Firebase is a Google platform which aids in the development of web and mobile applications. Firebase provides an array of nineteen products that provide varying functionalities (Google, 2020). The database selected needed to be flexible, to allow the storage of user details. Firebase's cloud Firestore database offered this through its storage structure of documents within collections in a hierarchical NoSQL data structure. The database also needed to allow for advanced querying. Again, this was available through the expressive querying in Cloud Firestore. Most importantly the database needed to be scalable to allow for multiple users generating daily data. Cloud Firebase is designed to scale, with its multi-region data replication it was able to offer the scalability required for StepMyHealth. In addition, Firebase also offer Firebase Authentication which can be used cohesively with Firestore to create user accounts. It is for these reasons that Cloud Firestore was selected as the database of choice for StepMyHealth.

4.1.3 Edamam API

As discussed, several existing applications showed more than one result for a food item. The API selected needed to avoid this problem. For this project, there we also restrictions of funding so the API selected needed to be free for use. Several APIs were explored and the best suited for StepMyHealth was the natural language processing (NLP) Edamam Food and Grocery Database API (Edamam, 2020). The Edamam API's NLP feature meant that only one calorific value would be returned per item searched. Edamam also offered a free developer account, which enabled 10 calls per minute. This would be sufficient for the development and testing of StepMyHealth.

4.2 System Architecture

The system architecture for StepMyHealth is visualised if *Figure 17*. It can be seen how the platforms and technologies discussed were integrated together.

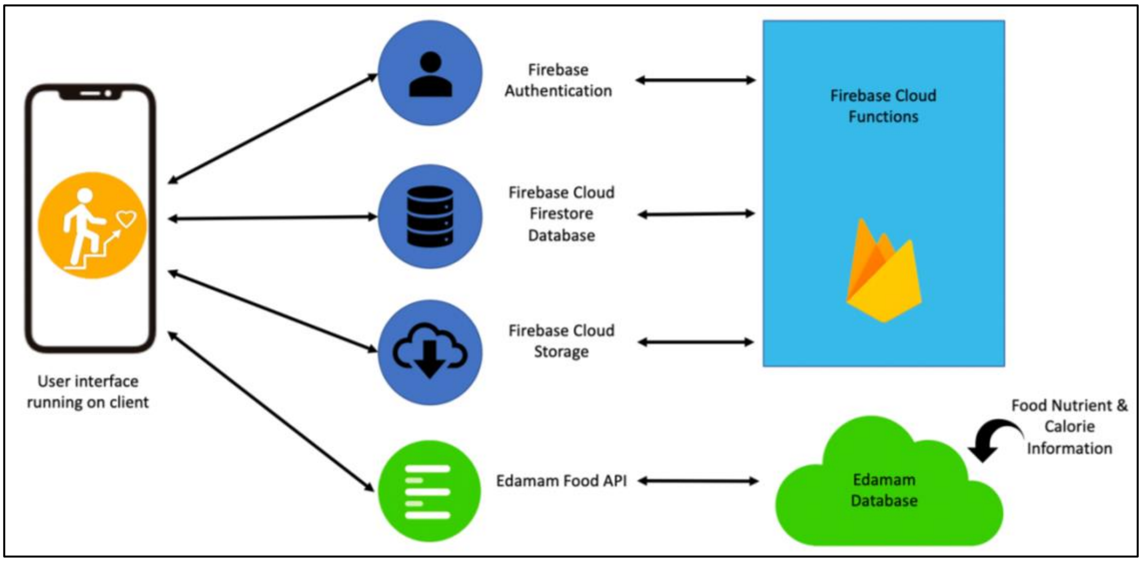


Figure 17 - StepMyHealth System Architecture Diagram

4.3 Implementation details

4.3.1 Application Model and Screen Flow

StepMyHealth consists of eight main screens. The outline of the screen flow can be seen in *Figure 18*. Once the Dashboard screen is reached, the remaining screens can be reached via the root Tab View Controller.

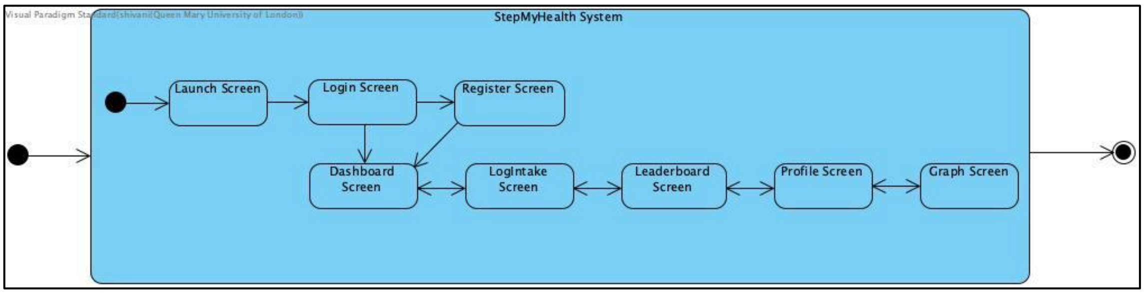


Figure 18 - StepMyHealth Screen Flow

4.3.2 Workspace setup

Before any implementation could take place, it was necessary to set up the workspace. CocoPods was used as the application-level dependency manager to manage the external libraries used in the project. The following `Podfile` was created:

```
target 'StepMyHealth' do
  use_frameworks!

  # Pods for StepMyHealth
  pod ‘Firebase/Analytics’
```

```
  pod ‘Firebase/Auth’
  pod ‘Firebase/Core’
  pod ‘Firebase/Firestore’
  pod 'Firebase/Storage'
  pod 'ProgressMeter'
  pod ‘Charts’
end
```

To pull the dependencies into the project, `Pod install` was run from the project folder within terminal. The successful installation of the pods indicated the workspace had been built.

As mentioned in the Risk Assessment (*Appendix D*), it was necessary to have an external code repository to prevent loss of work. The QMUL instance of GitHub was used for this purpose. The workspace was then pushed to the repository to allow all proceeding changes to be stored.

4.3.3 Dashboard

Prior to creating the Dashboard for StepMyHealth, a `RootTabBarController` was created using XCode’s interface builder. The controller was used to link all of the views together.

The Dashboard was a `UICollectionView` with a collection of UI elements (*Figure 19*). Groups of elements were placed inside a `UIStackView` so that auto layout constraints were triggered.

The dashboard aimed to visualise to the user their current calorific progress. The dashboard displayed the username and profile image of the logged-in user. Upon requesting access, the steps were taken from the accelerometer of the device. The calories eaten were accumulated via the food logged by the user.

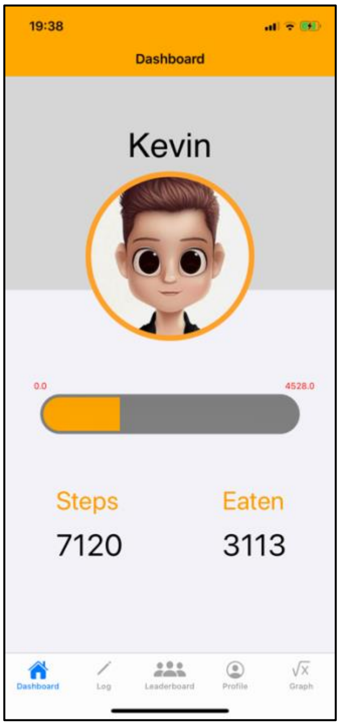


Figure 19 - StepMyHealth Dashboard Screen

The progress meter was built from the PogressMeter pod. It showed the maximum calorie intake value for the user. The automatic calculation of this value was based on the user's height, weight, gender and age and thus adjusted for each user based on their BMI (Benton & Young, 2017). The progress meter level changed according to the ‘Steps’ and ‘Eaten’ values for that day. To enable better visualisation, the progress meter changed colour according to the current balance (*Figures 20 & 21*) . The colours acted a strong visual prompt each time the user visited their dashboard. The calculation for the number of calories burnt per step and the colour changing meter can be seen below (Yusof, et al., 2018).

```
calorieBalance = (data["currentCalories"] as! Double) - ((data["Steps"] as! Double) * 0.4)
progress.progress = Float(calorieBalance)/Float(Double(temp))

if progress.progress > 1 {
      barcolor = UIColor.init(red: 255/255, green: 0/255, blue: 0/255, alpha: 1)
}
else if progress.progress > 0.5{
```

```
        barcolor = UIColor.init(red: 0/255, green: 255/255, blue: 0/255,
alpha: 1)
}
else{
        barcolor = UIColor.init(red: 255/255, green: 165/255, blue:
0/255, alpha: 1)
}
```

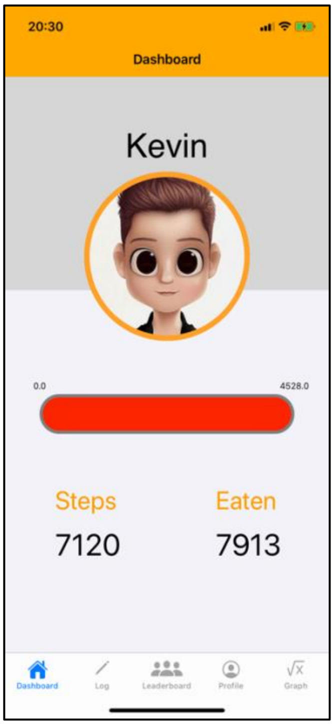


Figure 21 - StepMyHealth Progress Meter Red

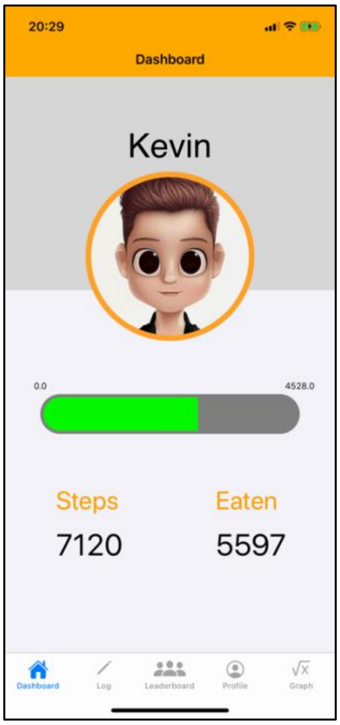


Figure 20 - StepMyHealth Progress Meter Green

4.3.4 Automated Personalised Intake Recommendations

The LogIntake screen was implemented using the view controller subclass `UITableViewController`. A `UISearchBar` was placed at the top of the screen. An API call was then performed to retrieve the most relevant food item and the calorific content of that item. In order to perform the call, a struct needed to be created to decode the required data from the JSON object returned. The structs created were within the 'Food' class:

```
struct ListFoods:Decodable{
    var parsed:[Foods]
}

struct Foods:Decodable{
    var food:FoodDetail
}

struct FoodDetail:Decodable{
    var label:String?
    var nutrients:CalorieInfo?

}
struct CalorieInfo:Decodable {
    var ENERC_KCAL:Double?
}
```

In order to display the resulting `Food` object, a prototype `UITableViewCell` was created. The `Title` text held the food item name and the `Subtitle` text held the number of calories. To implement the add functionality, an `addItem` function was created. Within this function, each cell was attached to a destructive swipe action, triggering the item details to be stored in the database and removed from the view. The `addItem` function also incremented the user's eaten balance. A similar `deleteItem` function was also implemented though this function only removed the item from the view, with no storage effects.

As the user logged food, a history of their composition was accumulated. It was from this history that the personalised intake recommendations were devised. Local notifications were chosen as the means of displaying the recommendations to the user. Notifications allowed the recommendations to be sent to the user even when they were not actively using the application.

So as to not overwhelm the user, but also to ensure the notifications provided a slight nudge leading to a change in user behaviour, it was decided that notifications would be sent three times a day, at the same time each day. A `UNUserNotificationCenter` object was created. Three triggers in the form of `UNNotificationRequest` objects were added.

There were three situations that needed to be accounted for when generating the notification text. These were as follows:

1. The user had not yet started tracking
2. The user was over their calorie allowance for the day
3. The user had a calorie balance which indicated the

The following code was implemented to deal with the cases.

```
if currentBalance > allocatedBalance{
  let over = String(Int(currentBalance - allocatedBalance))
  self.notification = ("You are " + over + " over balance! Step some
more")
  content.title = "woah"
}
else if currentBalance < 0 {
  self.notification = "Don't forget to start tracking"
  content.title = "Hey..."
}
else{
  content.title = "You have room for more... "
  let query =
Firestore.firestore().collection("users").document(Auth.auth().current
User?.uid ?? "").collection("Foods")

query.getDocuments() { (querySnapshot, err) in
      if let err = err {
        print("Error getting documents: \(err)")
      }
      else {
        for document in querySnapshot!.documents {
          let dataDescription = document.data()
          let food = (dataDescription["Food"] ?? "") as! String
```

```
        let value = (dataDescription["Value"] ?? "") as! Double

        if value < (allocatedBalance - currentBalance){
           DispatchQueue.main.async {
           content.title = "You have room for more... "
           self.notification = "Maybe have more " + food
           }
        break

    }
```

If the user had room for more calories, their Foods collection was retrieved from firebase, which contained their intake history. Each of the documents in the collection were then iterated through - if the calorific value of the food was lower than their current calorific balance, then the food was recommended (*Figure 22*). Therefore, the notifications are personalised based on the users eating habits. If the user was over balance or had not begun tracking, the notification message changed accordingly (*Figure 23*) .

Figure 22 - StepMyHealth Personalised Intake Recommendation

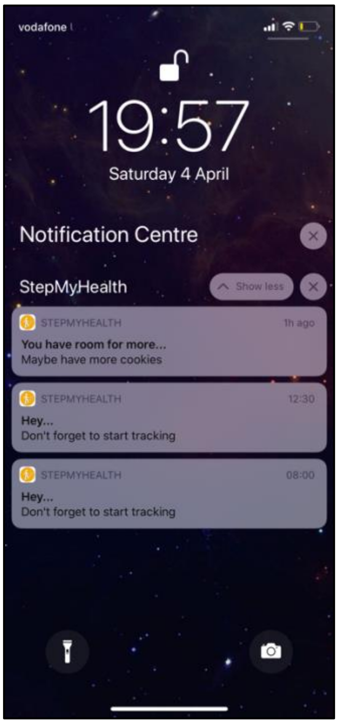


Figure 23 - StepMyHealth Notification to begin tracking

4.3.5 Goal Setting

StepMyHealth enabled users to set their weight goal. There were three options provided on the profile screen: maintain, loose and gain (*Figure 25*). The setting of the users goal, affected their daily caloric allowance as visualised on the progress bar of the Dashboard. The `updateGoal` function contained the calculations that aimed to help users gradually reach their goals, rather than forcing a sudden change of diet which may not have been sustainable in the long-term (NHS , 2020) (Benton & Young, 2017).

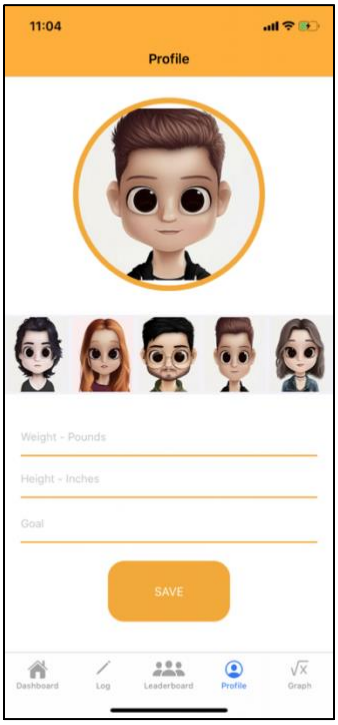


Figure 25 - StepMyHealth Profile Screen

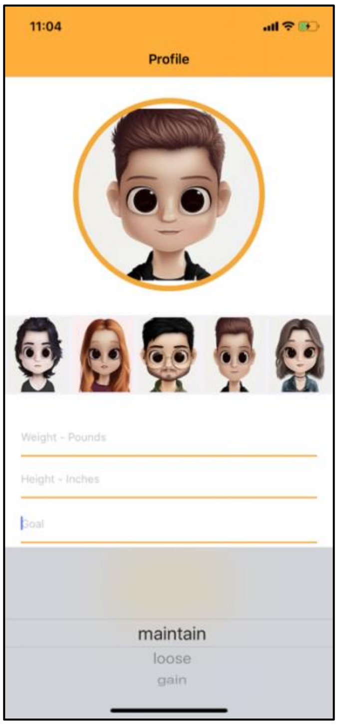


Figure 24 - Goal Setting StepMyHealth

4.3.6 Leaderboard and Historic Points Graph

As found from the research conducted, gamification can prove to be a major goal motivator. A leaderboard was the gamification element introduced in StepMyHealth (*Figure 26*). To build the leaderboard screen, a `tableView` was added to the `LeaderBoardViewController`. The `tableView` was populated using the `LeaderBoardCell` class. As defined in the `LeaderBoardCell` class, each cell contained a profile image, name and points fields. The points were calculated using the algorithm within the `calculatePoints` function. Calculating points using percentage progress, rather than the user's actual calorific balance allowed for animonity.

```
points = ((currentBalance as! Double)/(allocation as! Double))*100
```

The data for each cell was retrieved from firebase using an ordered query.

```
let query = db.collection("users").order(by: "Points", descending: true)
```

The points for each user were stored in the database daily. This data was then used to draw the points graph (*Figure 27*). Tracking points also abstracted away from the calories, moving more towards the gamified element of the leaderboard. The graph was implemented using the `LineChartView` within the Charts pod. The `DateValueFormatter` class was used to format the dates.

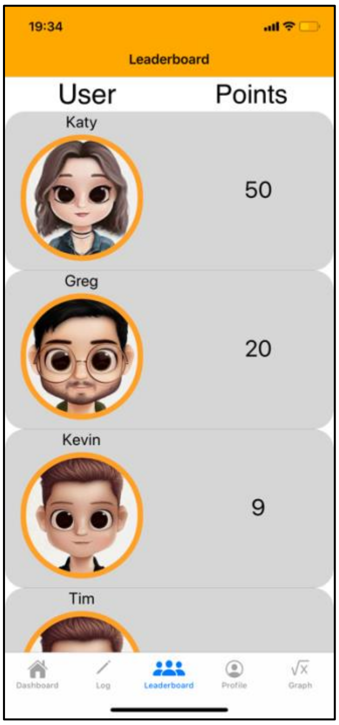


Figure 26 -Leaderboard Screen StepMyHealth

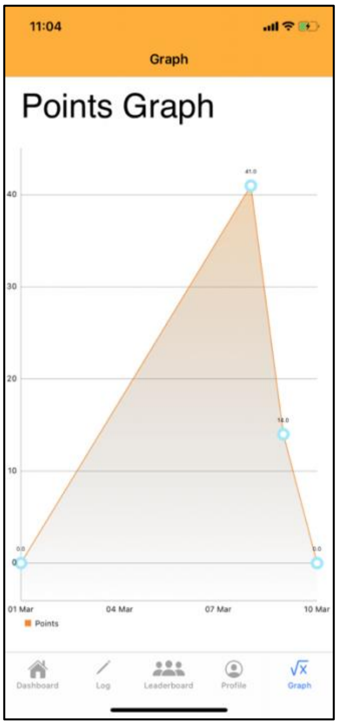


Figure 27 - Points Graph Screen StepMyHealth

4.4 Summary

The final implementation of StepMyHealth has aimed to cover all of the functional and non-functional requirements mentioned in chapter three. A variety of different algorithms were implemented, in combination with existing libraries to achieve the final implementation. Overall, the resulting product is a fully functional calorie-tracking mobile application.

Chapter 5: **Validation**

To test the implementation of StepMyHealth, it was necessary to conduct user testing. The methods of user testing used were user trials, demos and questionnaires, which allowed for direct feedback from users.

5.1 Software Testing

5.1.1 Unit Testing

Within software development, unit testing is the testing of components. In the case of software implementations such as iOS mobile applications, these components are functions. The functions are tested individually or in combination with related functions.

For StepMyHealth, unit tests were written and executed for each major function within the application. The code was only committed to the repository upon the successful execution of the tests. By doing so, it was ensured that a stable copy of the code was kept on the repository at all times.

Appendix E summarises the test cases for each of the screens within StepMyHealth.

5.2 User Testing

5.2.1 User Trials Scenario

The first form of user testing performed was user trials. A group of five Apple iPhone users were asked to use StepMyHealth for a period of five days. Participants were selected randomly from the pool of respondents who initially completed the requirements gathering survey. The participant's devices ranged from an iPhone 8 to an iPhone 11.

To allow the participants to install the application on their own devices, Apples TestFlight service was used. TestFlight enables iOS developers to perform beta testing on their applications without having to make applications live on the Apple App Store (Apple, 2020). Participants were sent an invitation email which enabled the installation of StepMyHealth via TestFlight.

Upon successful installation, the participants were briefed about the trial. They were asked to use the application in place of any existing calorie tracking applications currently installed on their devices.

5.2.2 User trials findings

The data collected during the duration of the trial showed some interesting patterns. Firstly, it was clear that as the trial progressed, participants became more engaged in using the application. This can be seen in *Figure 28* which shows a day on day increase in the rate of opening of StepMyHealth. By day 5 there were 154 more openings than at day 1.

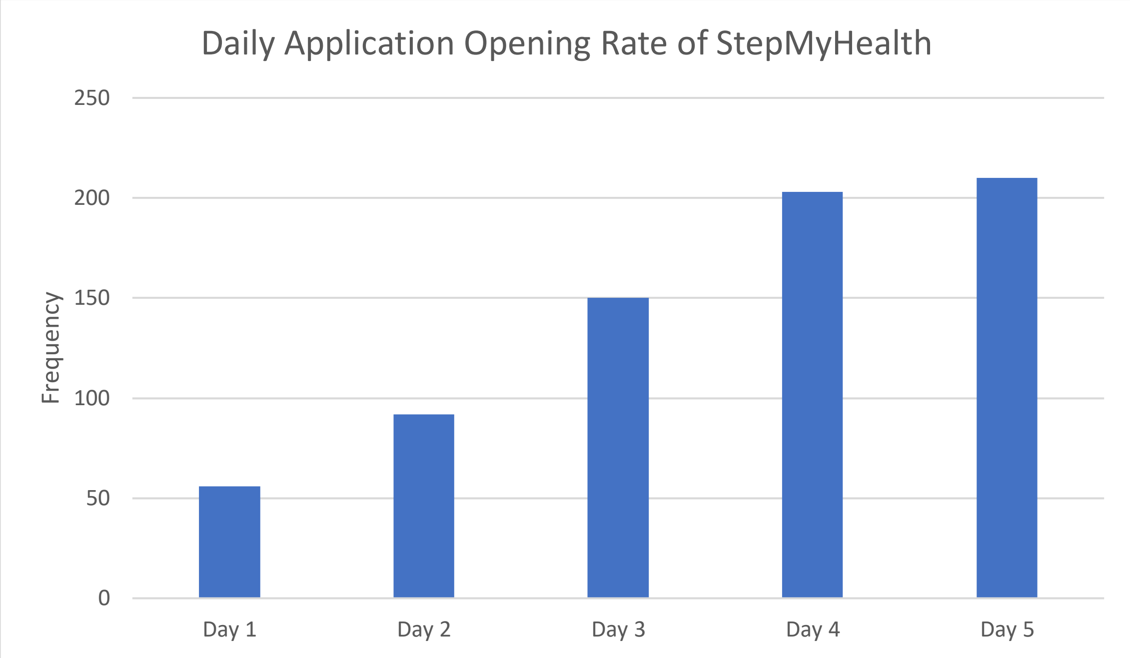


Figure 28 - StepMyHealth Daily application opening rate

Another trend was that participants logged more of their intake as the trial progressed. A similar trend to the rate of opening was revealed. As can be seen in *Figure 29*, on average, the participants began logging more frequently.

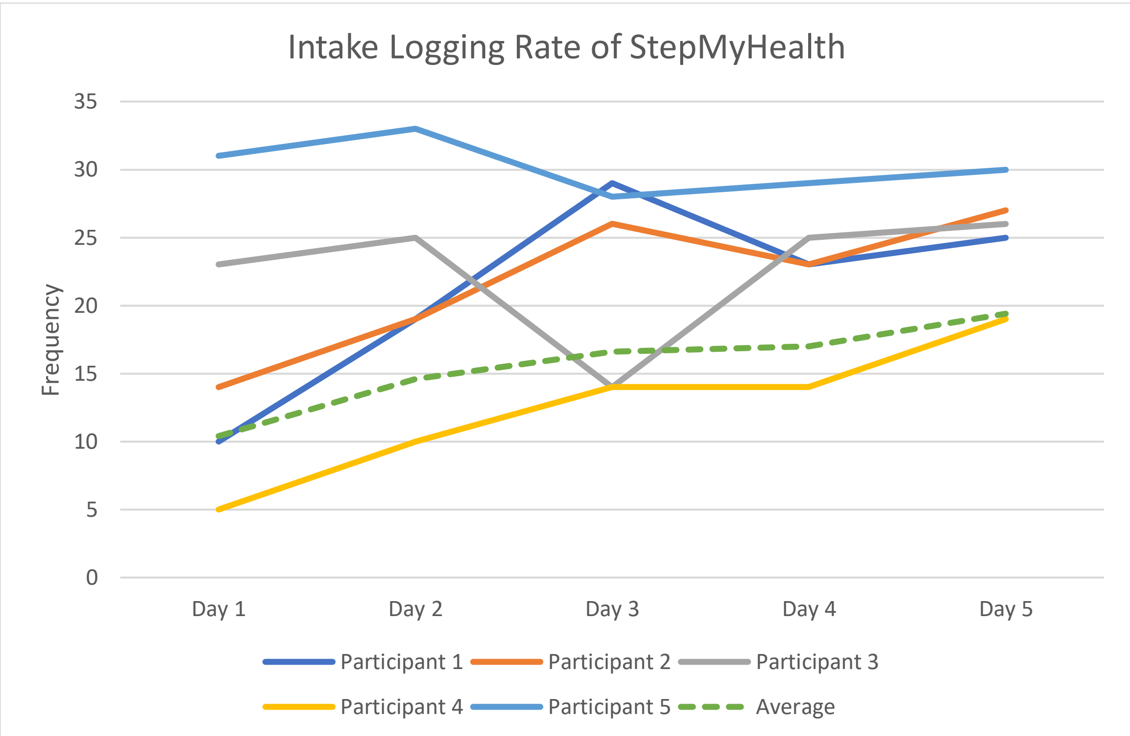


Figure 29 - StepMyHealth Intake logging frequency

Once the trial was complete, participants were asked to give their personal feedback. It was prominent that the trends identified in the data were not by chance when marrying them up with the feedback provided. The majority of the participants said they initially had to get used to tracking their intake regularly, but once they did this, they were motivated to carry on that behaviour because of the interface.

"StepMyHealth was easy to use, initially it took me time to get used to tracking everything I ate. As time went on and I saw I was reaching my goals, I was motivated to keep tracking and stepping" – Participant 3

4 out of the 5 participants also claimed that the gamification provided through the leader board was a key motivator for them to use the app. This would likely have resulted in the increased opening frequency rate shown. As the trial progressed, the participants became increasingly competitive.

"I really like the way the app looks. Personally, I need to be motivated to use apps like these. The leaderboard is what did this for me. I found myself getting surprisingly competitive. It would be great if I could have leaderboards just with a group though" – Participant 5

5.3 Demo and Questionnaire

5.3.1 Demo and Questionnaire Scenario

It would have been ideal to move forward with testing with an additional user trial of a longer length, with additional participants. This was set out in the original plan (*Appendix F)*. Unfortunately, due to the COVID-19 outbreak, this was no longer possible. A solution to continue with testing StepMyHealth was sought. The resulting timelines in *Appendixes G & H*.

The second phase of testing was a demo questionnaire-based scenario. A video of StepMyHealth was created : https://drive.google.com/open?id=1Am5REFmHOIxw5sHy5tndNx7GHGEY337O . The video presented a walkthrough of the application. All participants were asked to watch the demo video and then complete a questionnaire. The majority were closed questions to allow for statistical analysis. There was however, a section where participants were able to give any additional written feedback or improvements for StepMyHealth. The full questionnaire completed by each participant can be found in *Appendix I*.

As per the user trials, the participants were selected from the pool of original questionnaire respondents. In total, 25 participants completed were involved in this stage of testing.

5.3.2 Demo and Questionnaire Findings

The full results for the questionnaire can be found in *Appendix J*. Overall, the results show that the majority of feedback provided for StepMyHealth was positive. They also show that the main features of the application were received well by participants.

23 out of the 25 participants said they both liked the user interface of StepMyHealth and agreed the features were easy to understand. These are encouraging statistics which indicate StepMyHealth does provide a simple user interface. 96% of participants also thought that the application helped to reduce the time they spent calculating their calorie balance. This shows that StepMyHealth's automated pedometer and calculations are time-reducing features. The gamification feature of the leaderboard also faired strongly, as it did in the user trials. 76% of participants said that the leaderboard was motivational.

Most participants were positive towards the design of StepMyHealth. They thought the interface presented was clear and concise. The most mentioned feature in the open text feedback was the changing colour of the progress meter followed closely by the leaderboard.

5.4 Summary

The validation in the form of unit tests and user testing for StepMyHealth have shown that the main functionalities of the application work correctly. Overall, the results show that StepMyHealth does enable users to achieve their calorific goals better.

Chapter 6: **Evaluation**

To reflect on the outcome of a project, it was important to carry out a thorough evaluation. The resulting application has its strengths but also limitations.

6.1 Outcome

During the development of StepMyHealth, there were great successes. All major milestones were met (*Appendix F & G*) even though some testing plans had to be adapted because of the limitations that arose from the Covid-19 outbreak. In addition, as concluded from the software and user testing, the requirements were met within the final implementation. By doing so, the original aim to build a mobile application to aid users to track their calorie consumption efficiently was achieved.

When comparing StepMyHealth with the downfalls found in existing applications, it is evident that StepMyHealth improved on the current implementations. The original research questions have been answered, though there are still areas for improvement.

6.1.1 What are the effects of using gamification elements in the achievement of calorie related goals?

The gamification elements of the leaderboard and points graph combined with the automated step tracking via mobile sensing allowed for users to easily track their calorie consumption. As found from user testing, the leaderboard increased the levels of motivation in users, urging them to want to achieve their goals. The positive impact of the leaderboard coincides with the research explored by Saboia et al. (2018). Since StepMyHealth implemented a limited range of gamification, it cannot be said that all gamification elements would have a positive impact.

6.1.2 What impact does the usability of features have on a user's retention of calorie tracking applications?

The user interface design was kept simple, which allowed for users to focus on reaching their calorific goals. From the results gathered, the design fared well, many users said the simplicity would be one of the main reasons that they would continue to use StepMyHealth. This supports previous research such as by Feroz, et al (2019). However, the user trails were conducted over a short duration. To further enhance the findings for this question, it would be best to perform a more extended trial to measure retention.

6.1.3 What are the effects of consumption recommendations among individuals seeking to track their calorific intake?

The personalised intake recommendations gained positive feedback both from the user trials and questionnaire. Participants said that they made them motivated and urged them to track more often as well as encouraged them to eat the foods specified. These were lacking in applications such as MyFitnessPal and Fooducate.

6.2 Empirical Evaluation

As usability was one of the core requirements for StepMyHealth, a heuristic evaluation was carried out to help identify any problems with the user interface.

A heuristic evaluation involves placing severity ratings on each of the usability principles also known as heuristics. The ten heuristics analysed for StepMyHealth can be seen in Appendix K. The severity ratings applied were as follows (Nielsen, 1994).

0 = Not a usability problem at all
1 = Cosmetic problem only: need not be fixed unless extra time is available on project
2 = Minor usability problem: fixing this should be given low priority
3 = Major usability problem: important to fix, so should be given high priority
4 = Usability catastrophe: imperative to fix this before product can be released

Appendix K details the full empirical evaluation carried out.

6.3 Limitations

Though overall StepMyHealth did prove to be successful in achieving the requirements defined at the beginning of the project, it does still have its limitations.

There were some limitations that occurred due to the technologies. Though the API used for logging intake was well researched, it did need to be free. This came with restrictions. The API did not recognise many frequently known foods. This would have likely caused discrepancies when users logged their intake as they were forced to search for alternatives with a differing calorific value. If funding were available, a more stringent API could have been used to improve the inaccuracy.

At present, StepMyHealth relies on users inputting the correct intake information themselves. Users could be tempted not to log certain intake to ensure they meet their goals; therefore, the lack of checking the validity of user-entered data is a limitation. A validation method for logging such as using image recognition to automatically calculate calories based off images would a potential solution.

Though the user testing conducted for StepMyHealth does show promising results, it must be noted that a major limitation was the sample size of the testing group. Active testing using the application was conducted amongst only 5 participants, with the video demo and questionnaire completed by an additional 25. Together 30 participants partook in the overall testing phase of StepMyHealth. This does mean that the results should be interpreted with caution as the trends cannot be extrapolated across the user population.

6.4 Summary

The aim of building an iOS mobile application to help users track their calorie balance has been achieved successfully. As revealed by the heuristic evaluation, there are some downfalls in the amount of help provided when using StepMyHealth. There are also some limitations with the resulting implementation such as API restrictions and the level of trust given to the user.

Chapter 7: **Legal, Social & Ethical Issues**

The nature of StepMyHealth raises legal, social and ethical issues. During the development of StepMyHealth, some of these issues were considered and upon evaluation of the final application, further issues have also been identified.

7.1 Legal Issues

Several laws and regulations surround the storage and distribution of personal data. The most prominent of which is the General Data Protection Act (EU GDPR) which sets out 7 principles concerning personal data (European Commission, 2018). As StepMyHealth handles data such as name, age weight etc., it was important that the data remained secure. During development, only essential data was stored. All computation that could take place on the device itself was done so. As more users begin to use StepMyHealth, it must be ensured that their data is used only for the purposes intended and not unknowingly distributed to third parties. According to Firebases terms and conditions, all data ownership is given to the application developer (Google, 2020). This way, developers have control over data but must also themselves abide by GDPR regulations.

7.2 Social Issues

As StepMyHealth looks to change the lifestyles of users positively, there are social issues that arise. Different groups within society envision ‘healthy’ in different ways. Unfortunately, eating disorders have become common with between 1.25 and 3.4 million people in the UK affected (Priory Group, 2020). Questions arise as to how to detect users that are using StepMyHealth for unhealthy reasons, how should this activity be flagged and to whom? Linking back to data protection, is it legal to flag such suspected activity? These social issues have not currently been considered within the prototype developed though have been highlighted for future.

7.3 Ethical issues

When considering what is morally right a wrong, StepMyHealth has considered this. One of the significant ways this was done was in the implementation of the leaderboard. Calorie tracking is personal, so it would have been wrong to display such information publicly across the leaderboard. Instead, the scores for each user were calculated based on their balance instead of displaying calorific values as scores.

7.4 Sustainability

By using the MVC model discussed, the implementation of StepMyHealth could be used for the basis of another health tracking application. The separation functionalities across each of the screens means that they can be tailored. For example, using a different API or tracking more exercise methods beyond steps. The firebase database used could also easily be changed to refer to a new instance for a new application. Furthermore, the overall structure via the tab bar controller means additional screens could easily be added.

7.5 Summary

Overall, StepMyHealth has considered and highlighted legal, ethical and social issues. Some such issues such as the ethical issue regarding eating disorders would need to be worked on in future iterations.

Chapter 8: **Conclusions**

This chapter details my personal achievements throughout this project. Whilst undertaking this project, I have identified both accomplishments and areas of improvement.

8.1 Learnings and Achievements

Overall, I am proud of my achievements in this project. Developing a functional mobile application has been an ambition of mine since I was exposed to the area during my industrial placement. I have progressed from having no experience of iOS development to learning an entirely new programming language and using it to create a purposeful application. My personal aim for my final year project was to push myself, which I definitely think I have achieved.

I have gained an insight into the various stages of application development. I have been able to experience how the different stages of the software development lifecycle are dependent on each other, the theory of which I had studied in my Software Engineering module. I have also been able to apply the UI design concepts learnt during my Graphical User Interfaces module to create a sleek and clean interface design.

Though there are still areas of improvement, the final application is most certainly my greatest academic achievement to date. It has been an extraordinary journey to the final application presented in this report from which I have developed greatly.

8.2 Challenges faced

The first major hurdle I faced was the technical limitations of my skills. I had never developed a mobile application or used Swift. Whilst completing the first phase of the project, I spent a significant amount of time learning the fundamentals of Swift. I also created a few basic, single interface applications using online resources to familiarise myself with the best practices and the Xcode IDE. It was from here that I was able to develop StepMyHealth.

As I progressed through the project, I began to realise the vast size of the health tracking field. There has been extensive research into the number of calories required per individual, however much of this research has found it challenging to come to a single consensus calculation. As the calorie calculation algorithm I implemented was one of the fundamental aspects of my application, I had to ensure the best research fuelled my algorithm. Initially, I found it difficult to navigate the scale of research available. To overcome this and ensure my algorithm's validity in the short time period, I selected resources only from academic sources and those that had been peer-reviewed. I read around the topic of health tracking to understand the terminology used so that I could ensure my implementation was correct.

8.3 Future work

From the feedback received and from the evaluation conducted, there are areas of improvement for StepMyHealth. Though some of the aspects discussed below were out of scope for the original project, they are none the less interesting areas of exploration for future work.

- **Group based leaderboard** – As discussed, the user-wide leaderboard was implemented in an anonymised form, showing only users points. However, a group based leaderboard implementation would allow for individuals to compete amongst select groups such as friends and family. This could allow for increased motivation as users would be able to compete directly with each other.

- **Selection of notification times** – The current implementation of the personalised recommendations does not allow users to set the time at which they receive the notifications. It would be an improvement if users could select these times to allow the application to be used across time zones and better fit individuals varying lifestyles.

- **Enhancement of recommendations** – StepMyHealth used users intake history to generate personalised recommendations. An improvement to these recommendations would be for the recommendation algorithm to delve further into the types of food logged, inducing consumption patterns. That way the recommendations could recommend healthier, alternative or even new intake suggestions.

8.4 Summary

This project has been a major academic accomplishment and a great way for me to apply the knowledge I have gained throughout my undergraduate studies. I have acquired new skills which I will use to continue developing this project and in my future career ventures.

Chapter 9: **Bibliography**

Anton, S. D. et al., 2012. Use of a Computerized Tracking System to Monitor and Provide Feedback on Dietary Goals for Calorie-Restricted Diets: The POUNDS LOST Study. *Journal of Diabetes Science and Technology,* September, 6(5), pp. 1216-1225.

Apple Inc, 2020. *Swift. A powerful open language that lets everyone build amazing apps..* [Online]
[Accessed 19 March 2010].

Apple Inc, 2020. *Xcode 11.* [Online]
Available at: https://developer.apple.com/xcode/
[Accessed 19 March 2020].

Apple, 2019. *App Store.* [Online]
Available at: https://www.apple.com/uk/ios/app-store/
[Accessed 16 October 2019].

Apple, 2020. *Testing Apps with TestFlight.* [Online]
Available at: https://testflight.apple.com/
[Accessed 31 March 2020].

Benton, D. & Young, H. A., 2017. Reducing Calorie Intake May Not Help You Lose Body Weight. *PubMed,* June 28, 12(2017), pp. 703-714.

Bjarnadottir, . A., 2018. *The 5 Best Calorie Counter Websites and Apps.* [Online]
Available at: https://www.healthline.com/nutrition/5-best-calorie-counters
[Accessed October 2019].

Chen, M., 2016. *The 5 Best Nutrition Apps, According to RDs.* [Online]
Available at: https://www.health.com/nutrition/best-nutrition-apps
[Accessed 22 October 2019].

Cronometer, 2011. *Track Your Nutrition, Fitness, & Health Data.* [Online]
Available at: https://cronometer.com/
[Accessed 27 October 2019].

Deterding, S. et al., 2011. *Gamification: Using Game Design Elements in Non-Gaming Contexts.* Vancouver, s.n., pp. 2425-2428.

Dragos-Paul, P. & Altar, A., 2014. Designing an MVC Model for Rapid Web Application Development. *Procedia Engineering,* 69(2014), pp. 1172-1179.

Edamam, 2020. *Nutrition Analysis API Demo.* [Online]
Available at: https://developer.edamam.com/edamam-nutrition-api-demo
[Accessed 27 March 2020].

Eriksson, U., 2015. *The difference between functional and non-functional requirements.* [Online]
Available at: https://reqtest.com/requirements-blog/understanding-the-difference-between-functional-and-non-functional-requirements/
[Accessed 24 November 2019].

European Commission, 2018. *2018 reform of EU data protection rules.* [Online] Available at: https://gdpr-info.eu/ [Accessed 28 April 2020].

Feroz, I., Ahmad , N. & Iqbal , M. W., 2019. *Usability Based Rating Scale for Mobile Health Applications.* Lahore, Pakistan, s.n., pp. 1-7.

FitNow, 2009. *Lose It!.* [Online] Available at: https://www.loseit.com/ [Accessed 17 November 2019].

Fooducate, 2018. *Eat better. Lose weight. Get healthy..* [Online] Available at: http://www.fooducate.com/ [Accessed 25 October 2019].

Global Food Security, 2016. *Overconsumption and Influences on Diet.* [Online] Available at: https://www.foodsecurity.ac.uk/publications/ [Accessed 24 November 2019].

Goldhill, J. & Roodt, S., 2018. *Gamification in m-Health Applications and its Effects on Health Behavioural Changes in Net Generation Students.* Plaine Magnien, Mauritius, s.n., pp. 1-7.

Google, 2020. *Firebase helps mobile and web app teams succeed.* [Online] Available at: https://firebase.google.com/?gclid=CjwKCAjw3-bzBRBhEiwAgnnLCsx1JLYICuPqdR-IazHiygXDicfTiRezO64S0SfqUxSX2NBByYrP5RoCiDMQAvD_BwE [Accessed 24 March 2020].

Google, 2020. *Terms of Service for Firebase Services.* [Online] Available at: https://firebase.google.com/terms [Accessed 28 April 2020].

IGIGlobal, 2020. *What is Empirical Evaluation.* [Online] Available at: https://www.igi-global.com/dictionary/evaluating-context-aware-mobile-interfaces/9741 [Accessed 07 April 2020].

Interaction Design Foundation, 2019. *Usability: A part of the User Experience.* [Online] Available at: interaction-design.org/literature/article/usability-a-part-of-the-user-experience [Accessed 17 November 2019].

International Organization for Standardization, 2014. *ISO 9241-11:2018(en) Ergonomics of human-system interaction — Part 11: Usability: Definitions and concepts.* [Online] Available at: https://www.iso.org/obp/ui/#iso:std:iso:9241:-11:ed-2:v1:en [Accessed 17 November 2019].

Kascak, R. L., Rébola, C. B. & Sanford, J. A., 2014. *Integrating Universal Design (UD) Principles and Mobile Design Guidelines to Improve Design of Mobile Health Applications for Older Adults.* Verona, s.n.

Kauppinen-Räisänen, H. & Jauffret , M.-N., 2018. Using colour semiotics to explore colour meanings. *Qualitative Market Research ,* 08 January, 21(1), pp. 101-117.

Kumari, N. & Pillai , A., 2013. *A study on the software requirements elicitation issues Its causes and effects ,* Chennai: Third World Congress on Information and Communication Technologies (WICT) .

Lee, G. et al., 2006. *Usability and Feasibility of PmEB: A Mobile Phone Application for Monitoring Real Time Caloric Balance.* Innsbruck, s.n., pp. 1-10.

Lister, C. et al., 2014. Just a Fad? Gamification in Health and Fitness Apps. *JMIR Serious Games,* 2(2), p. e9.

Masitoh, Y., Wuryandari, A. I. & Mardiono, T., 2015. *Gamification on Steppy Application in the Development of the Electronic Health Record as Health Service Users of SHESOP.* Bandung, Indonesia, IEEE.

michigan.gov, 2012. *The Pros and Cons of Data Collection Methods.* [Online] Available at: https://www.michigan.gov/documents/mentormichigan/Data_Collection_Methods--pros_and_cons_2_403346_7.pdf
[Accessed 24 November 2019].

Miessler, D., 2019. *An MVC Primer.* [Online] Available at: https://danielmiessler.com/study/mvc/
[Accessed 25 April 2020].

MyFitnessPal, 2014. *Lose Weight with MyFitnessPal.com — for FREE!.* [Online] Available at: https://www.myfitnesspal.com/welcome/learn_more
[Accessed 14 October 2019].

NHS , 2020. *Cut down on your calories.* [Online] Available at: https://www.nhs.uk/live-well/eat-well/cut-down-on-your-calories/
[Accessed 29 March 2020].

Nielsen, J., 1994. *Severity Ratings for Usability Problems.* [Online] Available at: https://www.nngroup.com/articles/how-to-rate-the-severity-of-usability-problems/
[Accessed 07 April 2020].

Priory Group, 2020. *Eating Disorder Statistics.* [Online] Available at: https://www.priorygroup.com/eating-disorders/eating-disorder-statistics
[Accessed 28 April 2020].

Public Health England, 2017. *Health matters: obesity and the food environment.* [Online] Available at: ttps://www.gov.uk/government/publications/health-matters-obesity-and-thefoodenvironment/health-matters-obesity-and-the-food-environment--2
[Accessed 03 October 2019].

Robert Wood Johnson Foundation, 2019. *National Obesity Rates & Trends.* [Online] Available at: https://www.stateofobesity.org/obesity-rates-trends-overview/
[Accessed 03 October 2019].

Saboia , I. F., Pernencar , C., Almeida , A. M. & Veloso , A. I., 2018. *Gamification Strategies in Weight Control Applications, where "losing (weight) is winning".* Vienna, s.n., pp. 1-8.

SparkPeople, 2013. *Free Calorie Counter By SparkPeople.com.* [Online] Available at: https://www.sparkpeople.com/calorie-counter.asp
[Accessed 27 October 2019].

Tirasirichai, B. et al., 2018. *Bloom Balance: Calorie Balancing Application With Scientific Validation.* Nakhonpathom, Thailand, IEEE.

Turner-McGrievy, G. M. et al., 2013. Comparison of traditional versus mobile app self-monitoring of physical activity and dietary intake among overweight adults participating in an mHealth weight loss program. *Journal of the American Medical Informatics Association,* 20(3), pp. 513-518.

Tóth , Á. & Tóvölgyi, S., 2016. *The introduction of gamification: A review paper about the applied gamification in the smartphone applications.* Wroclaw, IEEE, pp. 213-218.

Veldsman, A. & van Greunen, D., 2017. *Comparative usability evaluation of a mobile health app.* Port Elizabeth, South Africa, s.n.

Yusof, M. S., Ahmad, J. I. & Abdul, T. H., 2018. *Mobile Calorie Burned Estimation Based on Pedometer Steps.* Springer, Singapore, Regional Conference on Science, Technology and Social Sciences.

Zhao, J., Freeman, B. & Li, M., 2016. Can Mobile Phone Apps Influence People's Health Behavior Change? An Evidence Review. *Journal of Medical Internet Research,* 31 October, 18(11), p. e287.

Appendix A - Usage of Calorie Tracking Mobile Applications Questionnaire

1.What is your age?

- 18 to 24
- 25 to 34
- 35 to 44
- 45 to 54
- 55 to 64
- 65 to 74
- 75 or older

2.Which of the following devices do you use to run your mobile apps?

- Apple iPhone
- Smartphone running Android operating system (Examples: Motorola Moto, Samsung Galaxy S, Google Pixel, etc.)
- Smartphone running Microsoft Windows operating system (Examples: Microsoft Lumia, HP Elite, etc.)
- Smartphone running another operating system

3.Have you used /do you use a mobile calorie tracking application?

- Yes
- No

4.Which of the following features would make you more inclined to use a mobile calorie tracking mobile application?

- Progress bars
- Levels
- Leader boards
- Badges / Achievements

5.How important is ease of use when choosing a calorie tracking mobile application?

- 1
- 2
- 3
- 4
- 5

6.How useful would intake suggestions be in reaching calorie related goals?

- 1
- 2
- 3
- 4
- 5

7.In general, how effective would you say current calorie tracking apps are in helping you manage your calorie intake?

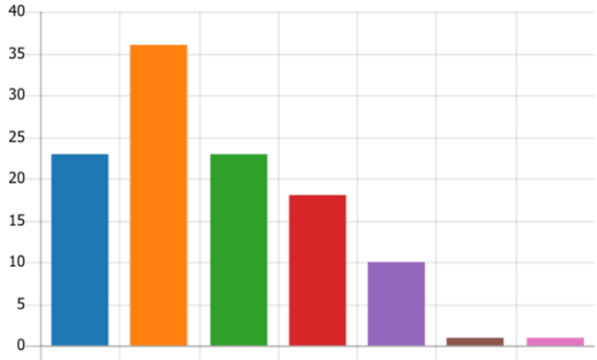
- 1
- 2
- 3
- 4
- 5

Appendix B - Online Questionnaire Results

1. What is your age?

More Details

18 to 24	23
25 to 34	36
35 to 44	23
45 to 54	18
55 to 64	10
65 to 74	1
75 or older	1



2. Which of the following devices do you use to run your mobile apps?

More Details

Apple iPhone	84
Smartphone running Android ...	19
Smartphone running Microsof...	5
Smartphone running other op...	4

3. Have you used /do you use a mobile calorie tracking application?

More Details

Yes	104
No	8

4. Which of the following features would make you more inclined to use a mobile calorie tracking mobile application?

More Details

Progress bars	32
Levels	8
Leaderboards	68
Badges / Achievements	4

5. How important is ease of use when choosing a calorie tracking mobile application?

More Details

112	4.35
Responses	Average Number

6. How useful would intake suggestions be in reaching calorie related goals?

More Details

112	4.53
Responses	Average Number

7. In general, how effective would you say current calorie tracking apps are in helping you manage your calorie intake?

More Details

112	2.34
Responses	Average Number

Appendix C - StepMyHealth Use Cases

Use case	Register
Actor/s	User
Pre-condition	User must have StepMyHealth installed on their mobile device
Post-condition	User will be registered with an account, therefore will be a member who can log into their account
Basic path	1. User opens the StepMyHealth Application 2. User sees the login page, prompting them to log in or register for an account 3. User clicks the register button 4. The user inputs the required fields including Username, password and Date of Birth 5. User clicks the register button 6. The system creates a member account
Alternative path	At step 4 the user may input an invalid entry into one of the fields. The system will respond with an error message detailing the requirements for a valid entry.

Use case	Login
Actor/s	Member
Pre-condition	Member must know their login details
Post-condition	Member has logged into the system
Basic path	1. Member opens the system 2. Member is presented with the login screen 3. Member enters their login details 4. Member successfully logs in and the system displays the dashboard
Alternative path	At step 3 the member may enter the incorrect login details. The system will present an error message accordingly. At step 4 there may be an error in retrieve the data required to display the dashboard. The system will present an error message.

Use case	Manage Profile
Actor/s	Member
Pre-condition	Member must know their login details
Post-condition	Member has updated their profile
Basic path	1. Member clicks on the 'Profile' icon displayed in the tab bar 2. Member is presented with the profile screen 3. Member updates the fields desired – weight, height, goal and/or profile picture 4. Member presses the save button 5. The system stores the updated details on the database
Alternative path	At step 5 there may be an error in saving the update/s to the database. The system will present an error message.

Use case	View Recommendations
Actor/s	Member
Pre-condition	Member must have previously logged intake in order to have generate recommendation
Post-condition	Member has received an intake recommendation, or a recommendation based on their balance
Basic path	1. Member looks at their phone 2. Member views the recommendation via the notification presented 3. Member clicks on the notification which prompts the system to open
Alternative path	At step 2 there may be no recommendations displayed to the member as the member is looking too early in the day. At step 2 the member may decide not to proceed to step 3 in which case the use case will terminate early.

Use case	View Dashboard
Actor/s	Member
Pre-condition	Member must be logged in
Post-condition	Member views dashboard
Basic path	1. Member clicks on the dashboard icon displayed in the tab bar 2. Member successfully logs in and the system displays the dashboard
Alternative path	At step 2 there may be an error in retrieve the data required to display the dashboard. The system will present an error message.

Use case	View Graph
Actor/s	Member
Pre-condition	Member must be logged into their account Member must have previously logged intake in order to have generated historical points data
Post-condition	Member has viewed their progress on the points graph
Basic path	1. Member clicks on the 'Graph' icon displayed in the tab bar 2. The system displays the points graph for the member
Alternative path	At step 2 the system may have no data for the user or there may be an error in retrieving the data from the database. The system will display an empty graph/ error message accordingly.

Appendix D - Risk Assessment

Description of risk	**Description of impact**	**Likelihood rating**	**Impact rating**	**Preventative actions**
Corruption/ loss of work files	No project to submit or leading to the restart of the entire project	Medium	High	Ensure that there is always more than one copy of the documents and code related to the project being stored. This can be achieved through storing various synchronised backups. For documentation this includes Google Drive, OneDrive and iCloud. For code a version control repository will be used i.e. GitHub
Loss of user testing participants	Insufficient data to draw project conclusions	Low	High	Ensure that all participants are made aware of the level of testing that will be carried out and the expectation of their participation in this. There should also be a large enough sample so that if there are dropouts, there is still sufficient data to draw conclusions from.
Personal illness/unforeseen events	Delay in project timelines	Medium	Medium	Make sure that timelines are adhered to. Ensure all major milestones for the project factor in a degree of contingency time in case there is a delay due to an unforeseen event. For the maintenance of personal health be sure to take regular breaks when working.
Neglecting time for project to work on other assignments	Inability to meet deadlines	High	Medium	Manage time effectively. Deadlines will be known in advance both for this project and other assignments. Plan time accordingly making sure there is an even distribution amongst all

				tasks that need to be completed.
Unable to install the application on the participants device	Unable to collect data for the participant	Low	Low	Ensure that once the participant has agreed to take part in the research, it is checked that the app can be installed on their device. The app should also be designed so that it is compatible with multiple apple device screen sizes.
Exceeding the free data storage capacity on the server database	Data stored will not be accurate	Low	Medium	Only store data that is necessary on the server i.e. username, password. Restrict computation and user persistent data to the user's device.
Update in iOS / Xcode	Implemented features may no longer function correctly	Medium	Low	The major iOS/ Xcode releases occur on an annual basis. Ensure that the Xcode is kept updated at all unit tests are regularly executed to maintain correct functionality within the app.
Incorrect implementation of new concepts	Development delay due having to correct incorrect implementations	Medium	Medium	Ensure that all new concepts have been thoroughly researched and learnt prior to implementation. Spend time learning the concepts through using online resources, library resources and individuals with first-hand experience.
Storage of user information	Infringing the user's data storage rights	Low	High	Ensure that all users are made aware of exactly what data that will be stored. Users should consent to the storage of such information. All data stored on the database should be stored anonymously.

Appendix E - StepMyHealth Unit Tests

Screen	***Test Case***	***Unit Test/s***	***Expected Output***	***Success***
Login	User enters incorrect login details	testLoginIncorrect()	User presented with an error message prompting them to try again.	*Yes*
	User enters correct login details	testLoginCorrect()	User is taken to the Dashboard screen	*Yes*
Register	User enters invalid inputs into register form	testRegisterIncorrect()	User presented with an error message specifying the field/s that need to be changed	*Yes*
	User enters valid inputs into all fields of the register form	testRegisterCorrect()	User account is created, and user is taken to the Dashboard Screen	*Yes*
Dashboard	User has allowed for the steps to be taken from their device	testStepAccess()	The device's accelerometer data is displayed besides the 'Steps' label	*Yes*
	Application calculates points according to the users goal and statistics	testCalculatePoints()	The correct points value is stored in the database	*Yes*
Log Intake	User searches for an item/s which the API has a result for	testCall()	The calorific value of the item/s is presented to the user	*Yes*
	User adds the searched item	testCall() testAdd()	The users current calorie intake balance increases and the resulting	*Yes*

	result to their intake		value is presented on the users Dashboard besides the 'Eaten' label	
	User deleted the resulting search item	testCall() testDelete()	The item does not get added to the users balance and is removed from the view	*Yes*
	The user searches for an item/s which the API does not have a result for	testInvalidCall()	The user is presented with an error message	*Yes*
Profile	User enters a valid input for one or more than one of the update profile fields	testUpdateProfile()	The users details are updated on the database	*Yes*
	User changes their weight goal (maintain, loose, gain)	testUpdateGoal()	The users daily allowance is updated and reflected in the progress meter display on the home screen	*Yes*
Leaderboard	The user selects the leaderboard screen	testLeaderBoard()	Each user on the leaderboard has their profile picture, name and current points displayed	*Yes*
Graph	The user zooms into the graph view	testGraphZoom()	The graph is zoomed into and the axis	*Yes*

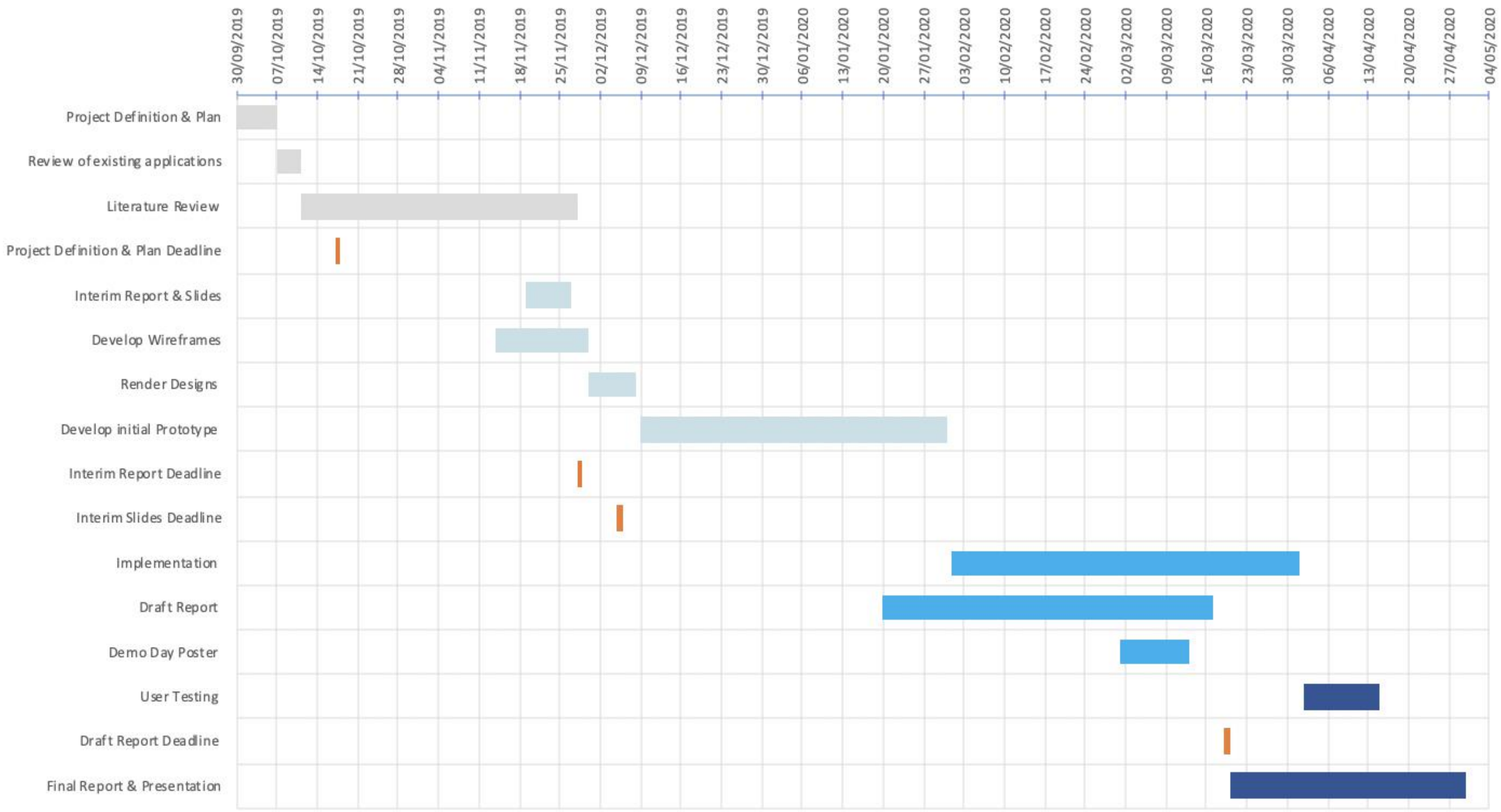
Appendix F – Original Project Time Plan

TASK NAME	START DATE	DUE DATE	DURATION	DESCRIPTION	SPRINT/MILESTONE
Project Definition & Plan	30/09/2019	07/10/2019	7	Define the problem description and overall plan for the project	Background
Review of existing applications	07/10/2019	11/10/2019	4	Review 5 existing applications available on the market	Background
Literature Review	11/10/2019	28/11/2019	48	Review 2 pieces of published literature related to the project	Background
Project Definition & Plan Deadline	17/10/2019	18/10/2019	1		Hard Deadline
Interim Report & Slides	19/11/2019	27/11/2019	8	Including risk assessment & progress report	Phase 1
Develop Wireframes	14/11/2019	30/11/2019	16	Outline of app screens and features	Phase 1
Render Designs	30/11/2019	08/12/2019	8	Details of how each of the screens will appear	Phase 1
Develop initial prototype	09/12/2019	31/01/2020	53	Basic working prototype	Phase 1
Interim Report Deadline	28/11/2019	29/11/2019	1		Hard Deadline
Interim Slides Deadline	05/12/2019	06/12/2019	1		Hard Deadline
Implementation	01/02/2020	01/04/2020	60	Full implementation of the application	Phase 2
Draft Report	20/01/2020	17/03/2020	57	Draft write up of full report	Phase 2
Demo Day Poster	01/03/2020	13/03/2020	12	Create demo day Poster	Phase 2
Demo Day Poster Submission	15/03/2020	16/03/2020	1		Hard Deadline
Draft Report Deadline	19/03/2020	20/03/2020	1		Hard Deadline
Demo Day	07/04/2020	08/04/2020	1		Hard Deadline
User Testing	02/04/2020	15/04/2020	13	Application testing	Phase 3
Final Report & Presentation	20/03/2020	30/04/2020	41	Final write up	Phase 3
Final Report Deadline	04/05/2020	05/05/2020	1		Hard Deadline

Appendix G - Revised Project Time Plan Post Covid-19

TASK NAME	START DATE	DUE DATE	DURATION	DESCRIPTION	SPRINT/MILESTONE
Project Definition & Plan	30/09/2019	07/10/2019	7	Define the problem description and overall plan for the project	Background
Review of existing applications	07/10/2019	11/10/2019	4	Review 5 existing applications available on the market	Background
Literature Review	11/10/2019	28/11/2019	48	Review 2 pieces of published literature related to the project	Background
Project Definition & Plan Deadline	17/10/2019	18/10/2019	1		Hard Deadline
Interim Report & Slides	19/11/2019	27/11/2019	8	Including risk assessment & progress report	Phase 1
Develop Wireframes	14/11/2019	30/11/2019	16	Outline of app screens and features	Phase 1
Render Designs	30/11/2019	08/12/2019	8	Details of how each of the screens will appear	Phase 1
Develop initial prototype	09/12/2019	31/01/2020	53	Basic working prototype	Phase 1
Interim Report Deadline	28/11/2019	29/11/2019	1		Hard Deadline
Interim Slides Deadline	05/12/2019	06/12/2019	1		Hard Deadline
Implementation	01/02/2020	01/04/2020	60	Full implementation of the application	Phase 2
Draft Report	20/01/2020	17/03/2020	57	Draft write up of full report	Phase 2
Demo Day Poster	01/03/2020	13/03/2020	12	Create demo day Poster	Phase 2
User Testing	02/04/2020	15/04/2020	13	Application testing	Phase 3
Draft Report Deadline	19/03/2020	20/03/2020	1		Hard Deadline
Final Report & Presentation	20/03/2020	30/04/2020	41	Final write up	Phase 3
Final Report & Poster Deadline	10/05/2020	11/05/2020	1		Hard Deadline

Appendix H - Project Time Plan Gantt Chart Post Covid-19



- End of November 2019
    - Completion of Literature Review
    - Completion of review of 5 existing applications
    - Rendering of wireframes
    - Documentation for Interim report
    - Completion of Interim slides
- End of January 2019
    - Development of working prototype
- End of March 2019
    - Creation of Demo Day poster
    - Completion of final application
- End of April 2019
    - Completion of user testing
    - Completion of final report
    - Completion of viva slides

Appendix I – Demo Video Questionnaire

1.Do you like the overall user interface of StepMyHealth?

-Yes
-No

2.Would you use StepMyHealth in place of your existing calorie tracking application?

-Yes
-No

3.Would the personalised intake recommendation notifications urge you to keep to your calorie target?

-Yes
-No

4.Are the features easy to understand/use?

-Yes
-No

5.Does the progress meter changing colour make the current calorie balance easier to visualise?

-Yes
-No

6.Would you use the goal setting feature?

-Yes
-No

7.Do you think the app overall reduced the time you have to spend tracking your calorie balance compared with other applications?

-Yes
-No

8.Which of the following features from the demo would you say would provide you with motivation to reach your daily calorie target?

-Leader Board
-Points Graph
-Changing Progress Meter
-None of the features

9.Is it useful that the steps are automatically collected for you from the device?

-Yes
-No

10.Please provide any other feedback and/or improvements you have for StepMyHealth

Appendix J - Demo Video Questionnaire Results

1. Do you like the overall user interface of StepMyHealth?

More Details

Yes	23
No	2

2. Would you use StepMyHealth in place of your existing calorie tracking application?

More Details

Yes	23
No	2

3. Would the personalised intake recommendation notifications urge you to keep to your calorie target?

More Details

Yes	21
No	4

4. Are the features easy to understand/use?

More Details

Yes	22
No	3

5. Does the progress meter changing colour make the current calorie balance easier to visualise?

More Details

Yes	19
No	6

6. Would you use the goal setting feature?

More Details

Yes	19
No	6

7. Do you think the app overall reduced the time you have to spend tracking your calorie balance compared with other applications?

More Details

Yes	24
No	1

8. Which of the following features from the demo would you say would provide you with motivation to reach your daily calorie target?

More Details

Leader Board	18
Points Graph	5
Changing Progress Meter	0
None of the features	2

9. Is it useful that the steps are automatically collected for you from the device?

More Details

Yes	25
No	0

10. Please provide any other feedback and/or improvements you have for StepMyHealth

*Not all participants responded to this question, hence there is a total of 18 responses recorded

ID	**Responses**
1	I think the user interface is really nice, I like the colours and emoji like profile pics. It would be nice if you could select when you wanted to get notifications because i don't have meals at the same time every day.
2	The progress meter changing colour seems really useful, it goes well with the overall interface of the app too. I like how each screen has it's distinct function, it seems easy to navigate.
3	The changing colours of the meter on the dashboard and leaderboard are the features that stand out to me the most
4	It would be useful to be able to select when to have notifications appear
5	I'm not sure if this is what the app should do but it would be useful to track more exercise than just my steps, i do a lot of other exercise that would affect my intake. I do like the look of the app though, it's clean and not cluttered, a lot of apps i'm using now have this problem.
6	I like it all
7	I think it would be good if i could have a leaderboard amongst my friends, I'm a naturally competitive person but i wouldn't be too keen having my score out in public.
8	I liked the the look of StepMyHealth. From what i saw in the video everything seems to be really well planned and looks good. The progress meter changing colour is a cool addition. Would definitely use!!
9	It's a good app
10	I think the points graph is really nice, it's better than having a generic history tab and adds the competition element which I love. The app looks nice too which is also a plus
11	I like the look and I like the progress meter colour change
12	It would have been nice to be able to set when notifications occurred
13	I really like the look of the application, but maybe instead of the progress bar changing colour, it would have been useful to have notifications instead like the recommendations since i'm not constantly on my phone so might miss that colour change
14	That graph transition is really cool.
15	Wow! It really is a great looking app. I like the colour choice and everything is clear, unlike most of the cluttered apps out there
16	It looks nice and i like the leaderboard and progress meters
17	I really like the overall look of the application, the dashboard is simple and for someone older like me it's really clear what everything does
18	I think the application looks quite childlike for myself but the features still seem good. Just not the aesthetic for me personally.

Appendix K - Heuristic Evaluation

Heuristic	**Severity**	**Justification**
Visibility of system status	0	The tab bar allowed for the user to clearly identify which screen was being displayed along with the screen title in the navigation bar at the top of the screen. The system either displays the result or an error message in reasonable time.
Match between system and real world	0	They system was designed to use standardised user inputs that users were familiar with. No system specific actions were implemented.
User control and freedom	2	Users were mostly presented with confirmation dialog boxes, for example when updating their profile. However, when logging their food intake, there was no option to remove any food that had accidently been added due to a swipe action in the wrong direction. However, enable such a functionality could allow for users to fluctuate their points.
Consistency and standards	0	The system follows the iOS platform conventions. The user actions were kept the same as per applications already built on the platform so that familiar users could intuitively use the application. Each distinct action resulted in a distinct output.
Error prevention	2	There were some error prevention methods put in place. For example, on the sign up and log in pages. However, there were still areas of the system were errors were not prevented. Such a case was when making an invalid API call.
Recognition rather than recall	0	All information presented on the screens was automatically refreshed on each screen load, so the user did was not required to use the
Flexibility and efficiency of use	1	All of the functionalities of the application were labelled for use by either experienced or in experienced users. There were not options to tailor actions for each user.
Aesthetic and minimalist design	0	Each of the screens within the application were kept simplistic. Only the required information was presented on each screen so as to not clutter the interface. The design theme across the screens was kept consistent to provide a flow through the application.
Help users recognise and recover from errors	0	The user was notified if there was an error in retrieving their data. They were also instructed on a possible solution to the problem if it occurred.
Help and documentation	3	Though the user actions required were kept to standard, when initially opening the system there was no walkthrough tutorial provided.