**UNIVERSITI TEKNOLOGI MARA**

# PERSONALIZED FITNESS RECOMMENDATION: MOBILE APPLICATION

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**BACHELOR OF COMPUTER SCIENCE (HONS.)**
**MULTIMEDIA COMPUTING**

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# SUPERVISOR APPROVAL

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By

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This thesis was prepared under the supervision of the project supervisor, Dr. Norzilah Binti Musa. It was submitted to the Faculty of Computer and Mathematical Sciences and was accepted in partial fulfilment of the requirements for the degree of Bachelor of Computer Science (Hons.) Multimedia Computing.

Approved By

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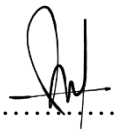
Dr. Norzilah Binti Musa
Project Supervisor

JULY 1, 2023

## STUDENT DECLARATION

I certify that any ideas or quotations from other people's work, whether published or not, are fully acknowledged in accordance with the accepted referencing practises of the discipline. This thesis and the project it refers to are the results of my own effort.



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# CHAPTER 1

# INTRODUCTION

In this chapter, it will define the background of study, elaborate the problem statement, state the objectives of this project, state the research questions, explain the scope of this project and describe the significance that will benefit to the community.

## 1.1 Introduction

Waking up freshly and having a good period of time from sleep make someone's day feel better and vigorous. Not to forget about the rest of the day that will lead to smoothly of any activities. That is one of examples of how healthy lifestyle take the action in someone life if it has been take care properly.

According to research from National Health and Morbidity Studies (NHMS) on 2019, Due to unhealthy lifestyle choices, Malaysians are experiencing an increase in health risks and the burden of disease. In addition, one in four Malaysians aged 15 and older are inactive, 4.8 million smokes, one in two are overweight or obese and only one in twenty Malaysians consume the recommended amounts of fruits and vegetables (Online, 2022). By November 11, 2021, Health Minister Khairy Jamaluddin said that health awareness among the Malaysian was low and Malaysia is considered as an unhealthy country as the number of people suffering from heart disease and obesity is high (Bernama, 2021). As an additional statistic, Malaysians are the most obese citizens in Southeast Asia, in which 48% of the population is experiencing obesity (Chong et al., 2019).

This can be related how Malaysian take this problem in seriousness or not. So how the Malaysian can ignore their healthy and stay in it without take any better step to change it? Malaysian need to realized that ignore healthy lifestyle will lead to serious illness. Those can be the main reason why it is important to take care and maintain the healthy lifestyle as it will give a lot of benefits either for themself and their generation.

## 1.2 Project background

Fitness is crucial for overall health and wellbeing because it linked to a lower risk of chronic diseases like heart disease, stroke, diabetes and some types of cancer. Fitness is the ability to carry out daily tasks without experiencing excessive exhaustion or stress and to be in good physical and mental health. Next, something that is adapted or changed to a person's particular needs or preferences is referred to as being personalize. It entails providing an individual with a good, service or experience that is tailored to their particular requirements while taking into account their preferences, goals and interests.

With combination of two important keywords – personalize and fitness, it comes with an idea to create an app related to healthy. However, the idea is not only supported by those two definitions. The others such as lifestyle, people with busy life, unhealthy food, student and worker with unbalanced schedule had been a supportive term to carry out the idea. Additionally, lack awareness of health is increasing in a community, making it a more significant issue that has to be prioritized as well as steps to make people aware of it in order to prevent them from suffering (Lai & Tang, 2020).

Furthermore, nowadays there are a lot of technologies that use machine learning (ML) to assist user to gain their goals. By using ML in the app, it can improve the accuracy and the relevancy of the recommendation for the user by analysing the user’s input such as their height, weight, calorie intake, meal history and so on. Using this analysis, the app can make personalized suggestions for behavior change, social support and goal-setting techniques that are catered to each user's unique requirements and preferences.

## 1.3 Problem Statement

The increase of people who ignore their healthy lifestyle that will lead to serious illness is a serious issue. It does not specific for adult but also included youngster as the illness does not make exception of age (Arfa Yunus & Nor Ain Mohamed Radhi, 2019).

A recent meta-review emphasised the significance of focusing on lifestyle factors in the prevention. Healthy lifestyle behaviours have been linked to increased

psychological well-being, decreased psychological distress and healthy body (Kleppang et al., 2021). For example, the affection of lack of physical activity and sedentary behaviour high levels lead to someone have a bipolar disorder (Ercan Doğu & Gündoğmuş, 2022).People that ignore their food intake due to cost of food also can be one of the reasons why they take unhealthy food which can lead to poor healthy lifestyle. Not to forget the wave of Covid-19 occurring back a few years ago, making the people who had low income to having a good food intake are difficult. They tried their best to survive and struggle to have income (Wong Li Za & Ming Teoh, 2022).

Technologies nowadays is widely use in most environment and situation. One of the examples is mobile devices. Using this technology to encourage people to have healthy lifestyle by creating the mobile application that can monitor their health is a good idea. Hence, the mobile application can be tool to promote healthy lifestyle among user. Additionally, with advancement technique in machine learning (ML), the mobile app can analyse datasets and construct decision-making systems where an algorithmic solution is not possible due to the problem's complexity (Verbraeken et al., 2020). With this type of assistance, people will be able to self-assess their health as their busy pace of social work and life causes them to have less time to enjoy the pleasures of life brought by their healthy physical and psychological state (Zhai et al., 2022).

## 1.4 Research question

1. What suitable algorithm should be used to recommend a personalised fitness mobile application?
2. What is the platform that need to be develop to deploy the idea of personalize recommended?
3. How to measure the functionality of the application?

## 1.5 Research objectives

1. To study suitable algorithm for personalize recommended.
2. To design and develop personalized fitness recommendation on mobile application.
3. To test functionality of the mobile application.

## 1.6 Scope

The importance of having healthy lifestyle in daily life is such a must to have it. The youngsters and adult people who have range 15 – 30 years old who are be the target to conduct this research will be used in order to limit the research scope. Healthy lifestyle among them will be on focus and be analysed to gain the objectives of this research. The personalized fitness recommendation app will have capabilities like helping users discover their preferred forms of exercise by having features such as step tracking, body mass index (BMI) calculator and motivation recommendation. Android devices running operating systems version 5 and above will be able to use the app.

## 1.7 Significant

This research aims to fill a gap in the current knowledge on the personalize fitness based on having the healthy lifestyle. This research is about a help for people to have a healthy lifestyle in their life. Given to them an 'obligation' of activities in daily life that need to be done, it will come with a lot of consequence either in a good or bad and they will give their best for those activities to finish successfully. However, they need to realized that having healthy lifestyle will help them to get it. That is why this research is very important to identify the effective of having the knowledge on the personalize fitness based on the healthy lifestyle. The result of this study has the potential to inform the importance of having a good care of lifestyle, build an inner confidence that acknowledge healthy lifestyle is a must to have and reduce the amount of people who have the illness due lack of care of lifestyle. The research is important because it addresses a pressing issue in the field of healthy living and has the potential to enhance health outcomes and people's overall wellbeing including both adults and children.

## 1.8 Conclusion

In summary of this chapter, the personalized fitness recommendation application needs to be developed as it is an alternative to give to the people and they can use it daily life. However, they cannot use it as main solution for their lifestyle because they still need to refer expert to give them specific advance and better

treatments. With this app, the user can use it to make their life to be healthier and easier as they carry their smartphone everywhere and then they can check instantly.

# CHAPTER 2

# LITERATURE REVIEW

This chapter will be discussing on subjects that are related to this project. It will be describing and summarizing the topics starting from definition of healthy lifestyle, healthy food, the importance of exercise, definition of fitness and physical, mobile device and its general component to track health, machine learning and methods for recommendation and lastly is reviewing and comparison the existing of health mobile application. Citations from various authors and articles will support the statements stated in this chapter.

## 2.1 Healthy Lifestyle

Waist circumference, smoking status, alcohol intake, physical activity and diet are the five lifestyle factors that comprise a healthy lifestyle (Lu et al., 2023). This definition is similar to one found in an article by (Tan, 2022) which states as follows:

1. A never smoker is someone who has never smoked in their life or has abstained from smoking for at least a year.
2. Non-drinkers are people who did not consume alcohol in the previous year.
3. Ideal body mass index (BMI) was deemed to be between 18.5 - 24.9kg.
4. According to the World Health Organization's global recommendations, a physically active person is someone who engages in at least 150 minutes of moderate physical activity or at least 75 minutes of vigorous physical activity per week.
5. At least 500g of fresh vegetables and fruits per day were deemed adequate.

Based on the information presented above, it is possible to conclude that if someone desires a healthy lifestyle, they must meet certain criteria. That information is not specific and necessary for people who want to live a healthy lifestyle because it also depends on people's lives such as what they do every day and what status they have.

### 2.1.1 Healthy food

Food consumption has evolved significantly over time and health has gradually been recognized as one of the primary motivators of food choices (Hopwood et al., 2020; Sorić et al., 2021). It is up to the individual to determine how much and how well they consume food (Powell et al., 2019). A number of health problems such as obesity, diabetes, arthritis, musculoskeletal disorders, some cancers, mental illness, stroke and heart disease are all linked to food intake (Powell et al., 2019). This demonstrates how important it is for someone to consume healthy foods on a daily basis in order to prevent those disease from occurring. Healthy food comes with a lot of benefits such as having more energy, living longer and reducing or maintaining weight.

However, not all people are aware of this matter. By proving a report by The Global Nutrition Report (GNR), currently, 48% of people eat excessively or insufficiently which causes them to be overweight, obese or underweight (Toper, 2021). They need to realize the importance of consuming healthy food and what the consequence of it.

One of the methods that the people can use as a guide is using Mediterranean diet. In contrast to Western dietary mode which priorities the consumption of meat and animal fats, less sustainable and less healthy foods, this method involves a high consumption of cereals, fruit, vegetables and legumes while also being a sustainable diet model because these foods are produced with less intensive use of natural resources (soil and water) and greenhouse gas emissions (Lisa Clodoveo et al., 2022) The Mediterranean Diet is regarded as one of the healthiest eating patterns, lowering the risk of non-communicable diseases (metabolic syndrome, type 2 diabetes, cardiovascular disease, some neurodegenerative diseases and cancers) (Lisa Clodoveo et al., 2022). Below is the figure 2.1 - The Mediterranean Diet pyramid:

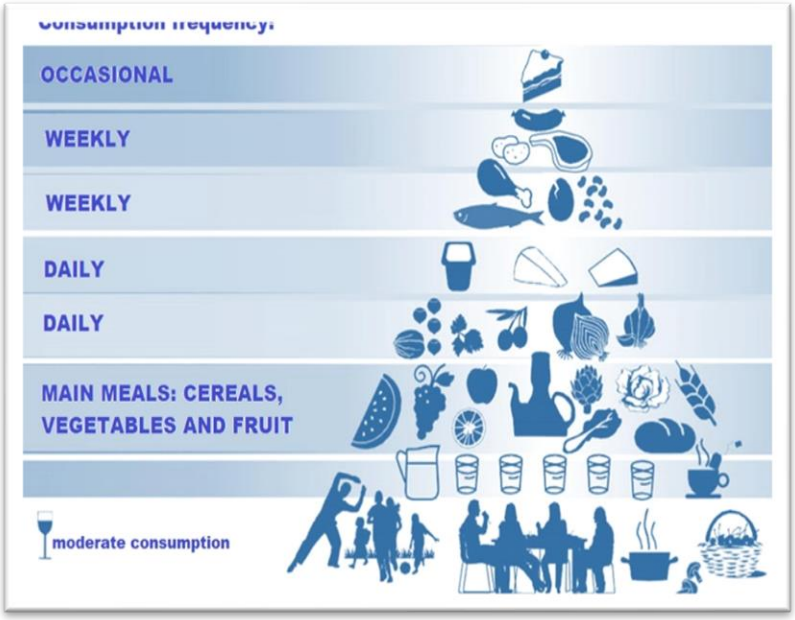



**Figure 2.1** Mediterranean Diet pyramid

(Source: (Lisa Clodoveo et al., 2022))

It is also the most well-known dietary pattern in the world because it is supported by the studies of Ancel Keys, who in 1945 measured and disseminated its health effects, theorizing its principles (Tracy, 2019).

### 2.1.2 The importance of exercise

Exercise is equally important as eating healthy to live in healthy lifestyle. There have been numerous studies that show that someone with a healthy body, they exercise on their own time. For example, they exercise every day or only on weekends. Time management is critical in this situation because it influences what activities people can participate in. If they manage it poorly, they will not improve their ability to manage anything on time.

Furthermore, the World Health Organization recommends that adults engage in at least 150-300 minutes of moderate-intensity aerobic physical activity or 75-150 minutes of vigorous-intensity aerobic physical activity per week or an equivalent combination of moderate-intensity and vigorous-intensity aerobic physical activity (WHO Guidelines on Physical Activity and Sedentary Behaviour, 2020).

Unhealthy exercise is necessary to avoid as it can be an obstacle to people gain healthy life. It can be categorized into three types (Cantu, 2020). The first one is excessive exercise. The characteristics of excessive exercise are typically high frequency, prolonged duration, and high intensity physical activity. Excessive exercise, on the other hand, clearly has a number of negative physical consequences. Excessive exercise has been linked to negative changes in cardiovascular structure and function. Excessive endurance exercise causes enlargement of the heart and arteries, resulting in an overload of the atria and right ventricle. This repetitive damage can lead to a variety of cardiac arrhythmias over time. Second type is compulsive exercise. Compulsive exercise is a multifaceted domain of unhealthy exercise that includes exercising to avoid or reduce distress as well as preoccupation with exercise. The last type is compensatory exercise. Compensatory exercise is exercise done to compensate for the effects of food consumption on one's weight or shape. A person can suffer psychological and physical harm as a result of compensatory exercise. Individuals who engage in compensatory exercise have more disordered eating behaviours and attitudes (Davis et al., 2014).

Last but not least, it can be concluded that a good exercise come from the good techniques, excellent management of time and guide from expert as the health matter is not something that can handle easily and need specific information of it in order to get the benefit of exercise.

## 2.2 Fitness

The state of being physically and mentally healthy, fit and capable of performing physical activities effectively is referred to as fitness. Fitness is an important component of overall health and well-being. Regular physical activity, exercise and a healthy lifestyle all contribute to better fitness. Participating in fitness activities improves not only physical strength, endurance and flexibility but also cardiovascular health, weight management, the risk of chronic diseases, mood and cognitive function.

### 2.2.1 Physical

The physical of body is important to maintain it in healthy condition. As it is used to complete activities in daily life. Physical inactivity can increase the possibility of cardiovascular disease (Huang & Chen, 2021) and it can have a negative impact on one's future life (Huang & Chen, 2021). A steadily increasing amount of research in the field of physical education has revealed that improved physical fitness is positively related to superior academic performance (Górska et al., 2018). The element of flexibility of fitness (muscle strength, muscular endurance, flexibility and cardiorespiratory fitness) is related to academic performance and founded a positive correlation but when it comes to gender in order to classify what the suitable exercise for each of them is not found yet (Górska et al., 2018). Considering the health benefits of physical fitness for students, the role of physical education and extracurricular sport activities should not be overlooked. It must be done with consistency of measurement and quantity in order to be included in a school's or university's curriculum.

## 2.3 Mobile device

In this modern era, the mobile device become one of the technologies that have the variety of functions. Not only use it as to communicate but to track people healthy also become the reality today. It is really shock how fast that technology can become so advance. For example, a smartphone that have thermometer feature which can monitors people skin's temperature to help determine if they are unwell and be used to measure the heat of other objects (Górska et al., 2018). However, it is not a good idea to use this technology to measure people's health accurately because in the end, they still need to see a doctor or other expert to draw a conclusion about their health.

### 2.3.1 Component for health tracking

There is a lot of components in mobile device that have been used to track and calculate health-related data. They each have unique function to make the device can perform as mention previously. Not all mobile device has the component as mention in table 2.1 as it depends on the technology itself and their developer or company. However, they still considered as advanced technology nowadays as the features they

have not only focus on health matter but others such as camera and performance of chipset. The table below is the example of the components and its description:

**Table 2.1** Component in mobile device and its description

| Component | Description |
|---|---|
| Accelerometer | Measures constant (gravity), time varying (vibrations) and quasi static (tilt) acceleration forces, which affect the device on the three axes (x, y and z) in meter per second squared (m/s2) (Mohammed et al., 2018) |
| Global Positioning System (GPS) sensor | Assists in the collection of data in a remote location (Virginia Anikwe et al., 2022). |
| Pedometer sensor | Detects the hand movement or the pedestrian's hips to count the necessary steps a person takes (Virginia Anikwe et al., 2022). |
| Thermometer | Checks the temperature of a person's skin to see if they are ill (Will Sattelberg, 2023) |

These components in conjunction with specialized health tracking applications and algorithms enable mobile devices to monitor and calculate a variety of health-related data. However, there are more parts used to monitor and collect data to assess someone's level of health.

## 2.4 Machine learning

Machine learning is a subfield of artificial intelligence. It's effectiveness and adaptability have been advancing quickly and are essential to many facets of social life (Komuro et al., 2023). This is also included in medical field. Machine learning can assist in obtaining a medical result with greater accuracy by using its algorithm (Arain et al., 2023). One of the examples that machine learning has been used in medical field is prediction of diseases in obstetrics. It helps to predict the gestational diabetes and pre-eclampsia (Arain et al., 2023).

### 2.4.1 Method for recommendation

A method is required by the recommendation technology in order to make a prediction or provide the best answer to any issues. One of the issues is for personalization. Understanding the user's preferences and behaviors is a good idea. With access to the user's data, the algorithm in the method can deliver accurate and pertinent information to the user.

#### 2.4.1.1 User collaborative filtering

One of the most popular algorithms is the collaborative filtering recommendation algorithm (Konstan et al., 1997). The idea is to use the user's large historical behavior data, calculate the similarity and target user neighbor sets, predict the score and make recommendations (Wang et al., 2019). Figure 2.2 below is the example of demonstration to understand the concept of how collaborative filtering algorithm work.

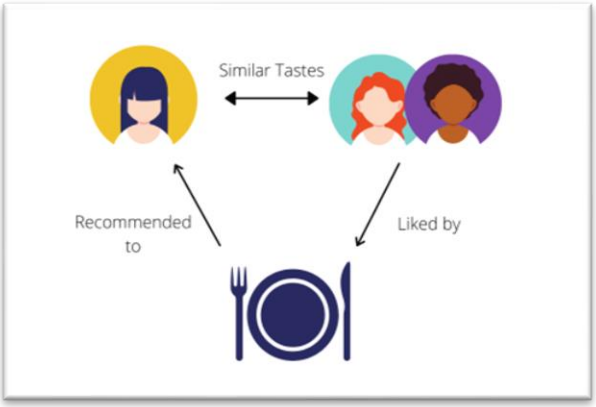



**Figure 2.2** The concept of collaborative filtering algorithm based on the nutritional problem (Source: (Amaro, 2021))

There are two types of collaborative recommendation algorithms: memory-based (or user-based) and model-based. The user's previously rated items are studied for memory-based predictions. This data is used to locate users who share the most similarities. This is accomplished through the use of the nearest neighbor's method. The nearest neighbors search assumes that observations with similar characteristics will provide similar results (Amaro, 2021).

#### 2.4.1.2 Reinforcement learning

Reinforcement learning (RL) is a subfield of machine learning concerned with learning how to make decision sequences in order to optimize long-term effects (Gottesman et al., 2018). RL can handle sequential, dynamic user-system interaction while also considering long-term user engagement (Afsar et al., 2023). Even though RL has been used a long time ago but still it faces same problem. The problems described as below (DiploDoc, 2023):

1. Health information is not stationary. Symptoms of patients are frequently recorded at irregular intervals and some patients' vital signs are recorded more frequently than others (condition).
2. RL algorithms require a lot of data. Researchers cannot simulate a patient's treatment in the same way that they can simulate a chess game for Alphazero (this is unethical). Health data is still scarce and difficult to come by.
3. It is difficult to determine the reward function. In the case of sepsis, periodic improvements in blood pressure may have no effect on the final patient's condition. When interpreting the effects of a treatment, it is necessary to consider causality.

However, reinforcement learning has three unique which make it suitable to solve any recommendation problem. The first one is RL can deal with the dynamics of sequential user-system interaction by adjusting actions in response to continuous feedback from the environment. Second, it is capable of accounting for long-term user engagement with the system. Finally, it does not require user ratings and optimizes its policy by interacting with the environment sequentially. Those can be the reasons why this type of algorithm can be used to find the recommendation in healthy matter.

#### 2.4.1.3 Content-Based filtering

Content-based filtering is a recommended method based on item descriptions and user preference profiles. This method is appropriate for complete data items like name, location, description and so on but not for users (Devi et al., 2022). There are some strengths about this method which is simple to construct, can make recommendations based on a small number of preference expressions and use the same data that users have used to make their decisions (Neve, 2021).

However, this method has limitations or disadvantages compared to another method. The limitations described as below (Neve, 2021):

1. The content-based filtering is overspecialization. This happens when a user gets caught in a filter bubble where they only express preferences for things that are similar to each other, which increases the likelihood that those things will appear in recommendations in the future.
2. Features used for content-based filtering are selected by 'feature engineering'. Representative features can be difficult to extract from unstructured data and while recommender systems are frequently trained to weight features based on effectiveness, the original feature selection is done by the algorithm designers is dependent on the designers' domain knowledge and is sometimes arbitrary (Bobadilla et al., 2013). This can limit the effectiveness of even a very well-designed algorithm.

#### 2.4.1.4 The comparison between algorithms

The information provided above concerning three recommendation approaches demonstrates that each has advantages and downsides for recommended purposes. They donated based on the benefits they provide and the developer who uses them adjusts them in order to apply them in the project that they want to build. Below is the table of comparison in order to summarize the details each of them.

**Table 2.2** The comparison between algorithms

| **Algorithm** | User-collaborative filtering | Reinforcement learning | Content-Based filtering |
|---|---|---|---|
| **Strength** | works well for products that have numerous ratings | Can be extremely accurate, particularly for items with few ratings. | make recommendations based on a small number of preference expressions |
| **Weakness** | inaccurate for items with few ratings | require a lot of data | overspecialization |
| **Data required** | User ratings | User ratings, item features | Item features, user interests |
| **Accuracy** | Exercises with many ratings score highly while those with few ratings score poorly | Exercises with few ratings are rated highly but learning is slow | Exercises with explicit features score well while exercises with implicit features score poorly |
| **Flexibility** | Flexible | Inflexible | Flexible |
| **Similarity measure** | Cosine similarity | Reward function | Euclidean distance |

Based on the research and comparison of three of them, the content-based filtering method will be used for the personalized fitness recommendation application as its technique has the potential to be employed because of its algorithm can search for what the user wants and is in line with the objectives of this final-year project. The flexibility of this algorithm means it can be used in a variety of domains including exercise. Furthermore, the data required is based on the user's interests, so the user can customize the data and have the option to choose which of it to use.

## 2.5 Reviewing of health mobile application

There are a few existing applications developed by various organizations that make use of the recommendation feature. This existing application is available in the app store and can be used by anyone. Each one has a unique set of contents and presentation style for the application.

### 2.5.1 MyFitnessPal

MyFitnessPal is a fitness and nutrition app for iOS and Android devices. It was introduced in 2005 by popular fitness brand Under Armour and now has millions of users worldwide (Zlatopolsky, 2023). It has recommendation feature which is give to the user how many net calories they will have.

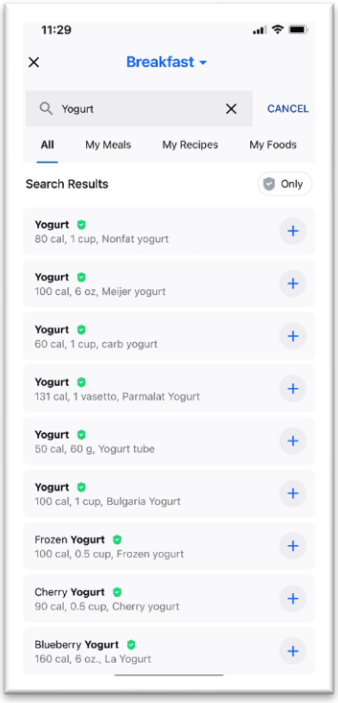



**Figure 2.3** Search feature

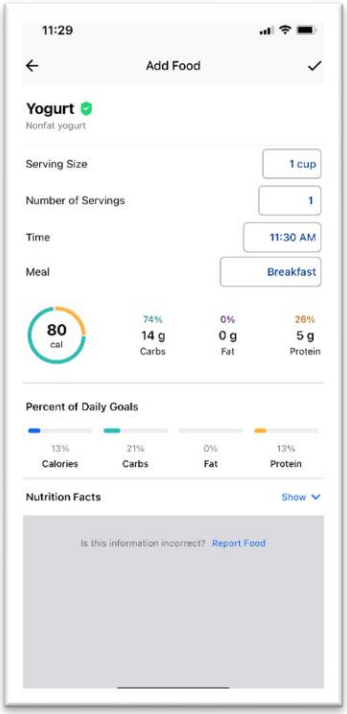



**Figure 2.4** Customize your information in the boxes. It will generate cal, carbs, fat and protein information

(Source: https://support.myfitnesspal.com/hc/en-us/articles/360032274592-How-do-I-add-a-food-to-my-food-diary- )

The search feature is depicted in Figure 2.3. The user can first select a meal and then enter a keyword for the food that they want. Following that, they can customize the serving cup, number of servings, time, and meal to generate daily goal information (Figure 2.4). The user can add it as a goal using the process outlined above. Thus, the user can use it as a guide. Net calories will be calculated by subtracting calories consumed (food) from calories burned (exercise). There are many features in this app included nutrition tracking, scanning bar codes, community and social features and integration with fitness trackers and apps. This app also contains a few of algorithm related to recommendation which is it will give to the user a satisfaction. Those algorithms are an algorithm for food searching from its database and an algorithm to calculate and track calorie and nutrient intake. The goal of this app is to assist individuals in achieving their specific health goals whether they are weight management, overall fitness improvement, adopting healthier eating habits or making positive lifestyle changes.

### 2.5.2 Fitbod

Fitbod is a fitness app that gives a personalized exercise plan that will push to user's limit. Fitbod will help become stronger and faster. Fitbod's advanced technology is designed to plan user's workouts based on a variety of factors, ensuring that no muscle group is overlooked. This app contains recommendation feature where the user has the access of recommendation manually. User can turn on or off the recommendation toggle to look more or less about the exercise based on what they choose (Figure 2.6).

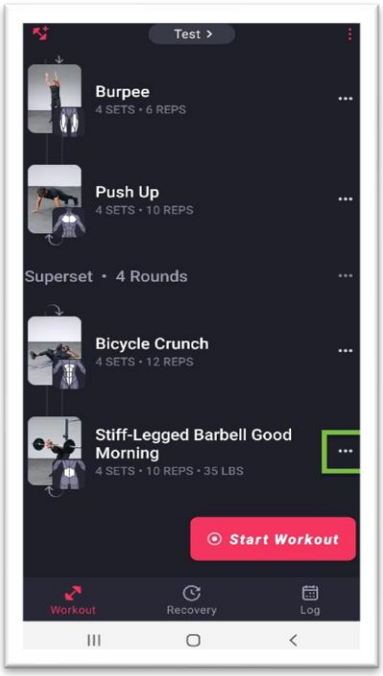



**Figure 2.5** List of exercise. Each of them has the ellipsis to modify

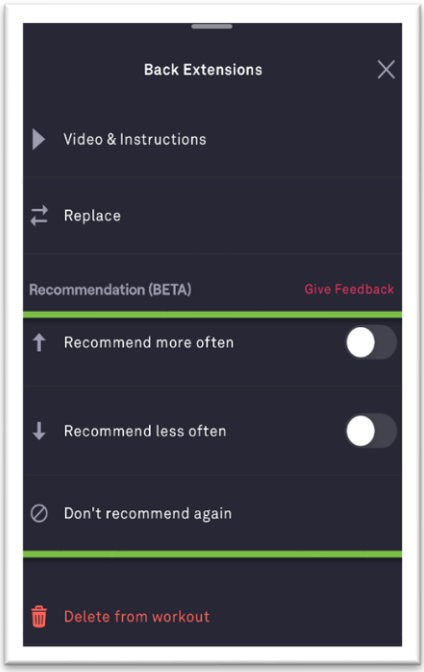



**Figure 2. 6** User can turn the recommendation off or on

(Source: https://fitbod.zendesk.com/hc/en-us/articles/9093233634711-Recommend-More-Less-or-Exclude)

This app has a lot of advance features such as tracking and analysis workouts, exercise demonstrations and guidance, progress and achievement tracking and lastly is exercise variety and customization. In order to understand how those features works, there is a few of algorithm that make it happen such as an algorithm generates personalized workout plans and an algorithm designed to provide a diverse range of exercises. Both of feature and algorithm have same effect which is it will lead to

achieve the goal of this app - assist individuals in optimizing their strength training workouts and achieving their fitness objectives.

### 2.5.3 Strava

Strava is an American internet service that tracks physical activity and includes social networking features. It is mostly used for cycling and running and it makes use of Global Positioning System (GPS) data (Wikipedia contributors, 2023). User can enter their search criteria to find the best route and then the app will generate it as a recommendation.

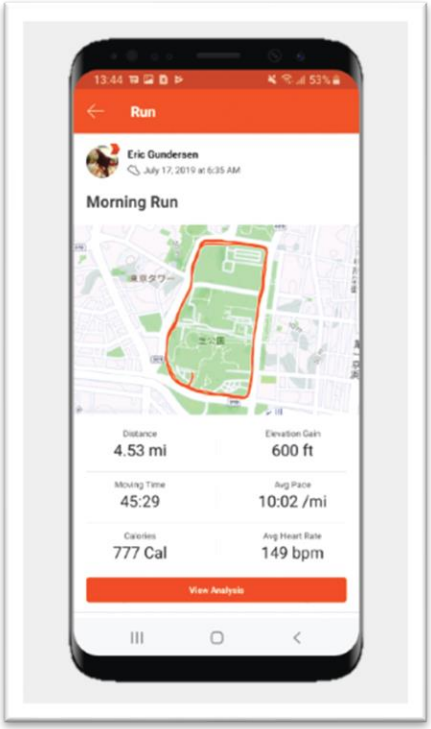



**Figure 2.7** The interface of route in Strava app

(Source: https://www.mapbox.com/showcase/strava )

Features that come from this app is insane which is it can access to custom route building tools, access to map segment and having tools to make report about suspicious activities. Also, there are algorithm that has been used in this app such as an algorithm that analyses user's activity data in order to identify popular activities (e.g., running and cycling) routes and give to the user. This app wants give users a

running and cycling-specific platform where they can track, analyse and share their fitness-related activities.

### 2.5.4 Comparison between the existing application

Table below show comparison between MyFitnessPal, Fitbod, Strava app and Personalized Fitness Recommendation app. Each of them has different algorithm and unique features provided by the company.

**Table 2.3** The description of comparison between MyFitnessPal, Fitbod, Strava and Personalized Fitness Recommendation app (proposed system)

| | Application | MyFitnessPal | Fitbod | Strava | Proposed system |
|---|---|---|---|---|---|
| **Features** | Nutrition tracking | ✓ | × | × | × |
| | Progress and Achievement Tracking | ✓ | ✓ | × | × |
| | BMI calculator | ✓ | × | × | ✓ |
| | Access to map segment leaderboards | × | × | ✓ | × |
| | Step Tracker | × | × | × | ✓ |
| **Algorithm** | An algorithm generates personalized workout plans | × | ✓ | × | ✓ |
| | An algorithm analyzes user activity data to identify popular running, cycling and other activity routes and to suggest new routes | × | × | ✓ | × |
| | An algorithm to calculate and track calorie and nutrient intake | ✓ | × | × | × |
| **Accessibility** | Online | × | × | × | × |
| | Offline | ✓ | ✓ | ✓ | ✓ |
| **Multi-Language** | English | ✓ | ✓ | ✓ | ✓ |
| | Malay | × | × | × | × |
| | German | ✓ | × | ✓ | × |
| | Italian | ✓ | × | ✓ | × |

## 2.6 Conclusion

In conclusion of this chapter, the domain of this final year project has been introduced – healthy lifestyle. The summarize of it is to tell the benefits awareness of healthy food and the importance of having exercise. The definition of fitness also included as it is a part of the domain and acknowledge it is crucial in order to know and synchronize the objective of this chapter with chapter one. The mobile part also been introduced as it is the platform that will be used. Acknowledge the component of mobile that have the function related to health matter will give a visual of this project clearly. Then, there are three description of method that can be used in recommendation technology also included in order to know how the method's process and its function to this project. Last but not least, the comparisons of current apps are required in order to understand the differences between them and uncover similarities in qualities in personalized fitness recommendation app.

# CHAPTER 3

# METHODOLOGY

This chapter presents and develops a technique for the project of Personalized Fitness Recommendation. The Waterfall model is chosen as the research approach for this project to ensure that development proceeds smoothly and that the project's objectives are met. There are five stages to it: analysis, design, development, testing and implementation. Because the process of this model is a linear flow with a specified sequence, it will aid the developer's knowledge of the project's flow.

## 3.1 Research method

This project required a model to make the process of it to be smooth and have better understanding. Waterfall model is the suit model to use. A short brief of this model is this model employs a logical progression of The Software Development Life Cycle (SDLC) processes for a project, analogous to how water pours over a cliff's edge. It establishes different endpoints or objectives for each stage of growth. After they have been completed, the endpoints or goals cannot be revisited (Lutkevich & Lewis, 2022).

This section is intended to discuss on every phase that are related to the Waterfall model. It contains five important phases which is analysis, design, development, testing and implementation. All of them have different role and description to describe how each of them help in this project. Each phase will help the developer understand and take action properly. Figure 3.1 shows the sequential steps in Waterfall model.

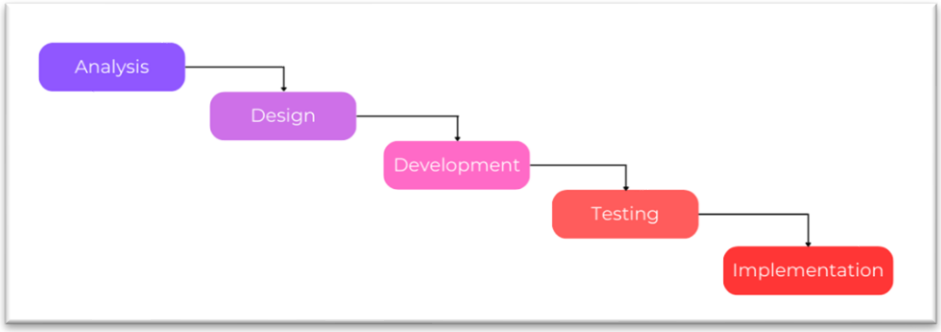



**Figure 3.1** Phases in Waterfall Model

## 3.2 Project Modelling Approach

The Waterfall model consists of five major phases: analysis, design, development, testing and implementation. These phases will be elaborated one by one in order to provide a clear picture of the project's procedure. This model has a simple structure that makes it easy to grasp and can be mapped on the time axis. This model also has a linear flow which makes it suited for small, straightforward and well-structured software projects. Figure 3.2 is the conceptual of the development phases. It will show with short brief about the process of the app was built until complete.

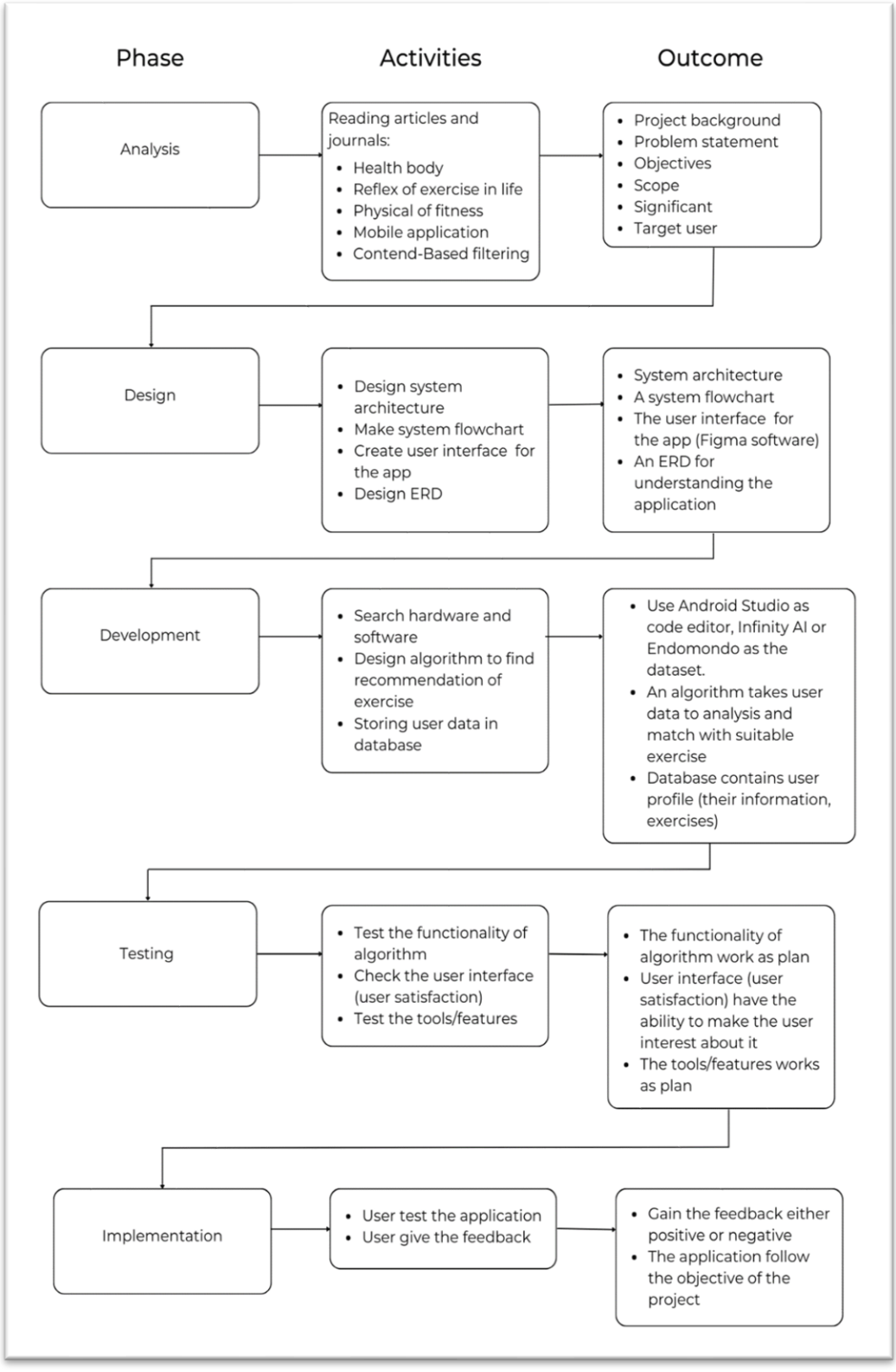



**Figure 3.2** The conceptual of development phase

This conceptual is important to be developed first as to increase the likelihood of a viable end result. As an outcome, a conceptual design should be carried out in sufficient detail to allow for time and overall dimension estimations.

### 3.2.1 Analysis

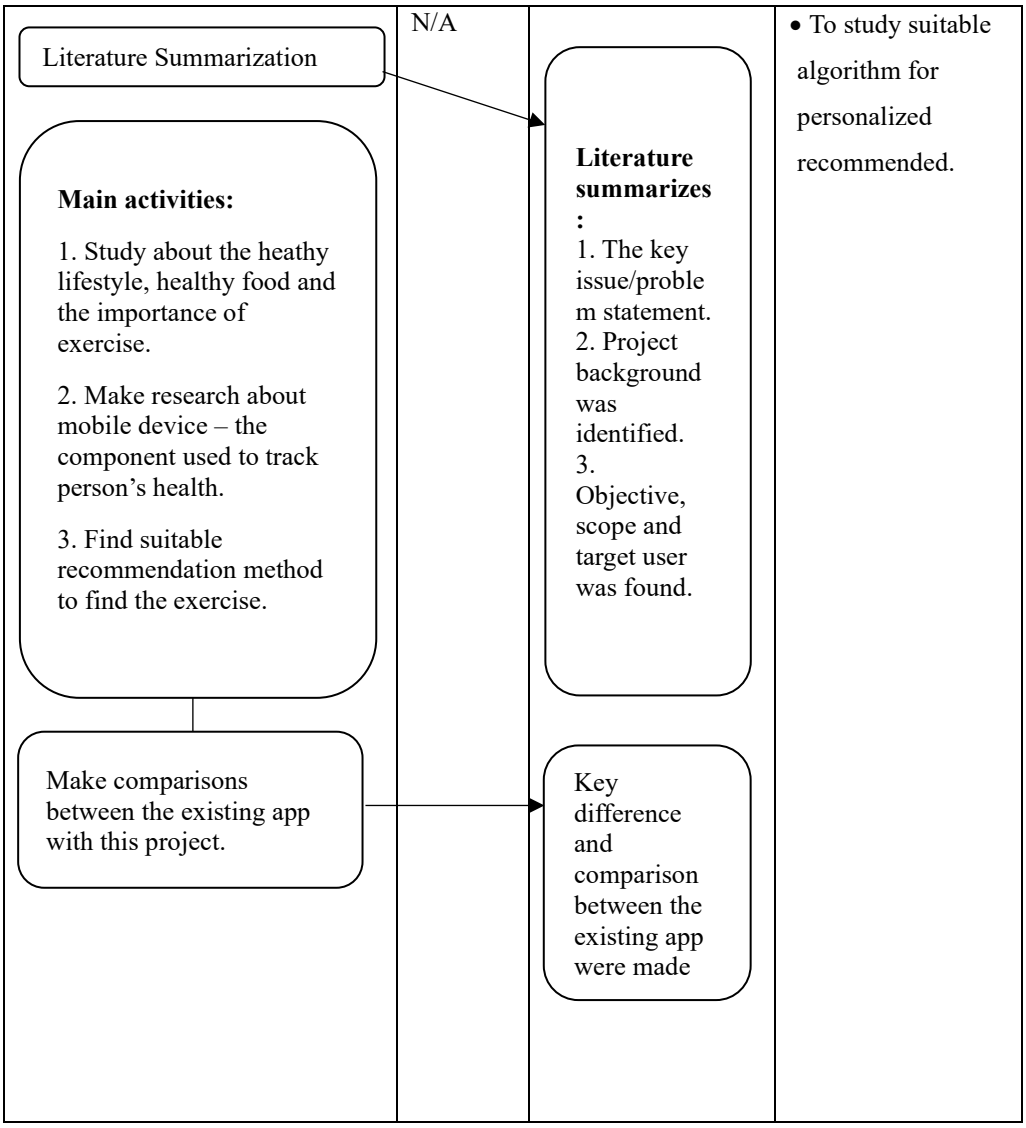
The first phase of Waterfall model is analysis. This phase is meant to discuss and explain the Waterfall model's analysis phase. During this phase, all information pertaining to the project background and literature review is acquired from a variety of sources. All material is typically derived from reliable sources such as journals, articles, books and many more. This vital information is required for improved project planning and execution. This phase concludes when the developer agrees on the primary issues and obtains potential problem solutions to proceed. Based on the resources, the concepts and definitions of health, fitness, and mobile applications are extensively researched.

Multiple methods and software can be utilized in order to create and develop the personalized fitness recommendation on mobile application. Based on the resources and study of this project, the importance of fitness is portraited as one of the solutions to give to the people who want healthy lifestyle. Thus, this project aims term of fitness to drive in this project rather than take term of healthy food.

In order to match the requirements and standards of recommendation system development, there are several software and tools that will be used in developing this mobile application. The software and tool consist of Figma, Infinity AI and Android Studio. The existing of app that have similar function and structure has been included in order to find the key differences and the lacking functionality and delivery. Not to forget, the variety of method of recommendation also studied because it important to find which method can be used in this project. Table 3.1 displays the process of analysis phase in Waterfall model.

**Table 3.1** Table summarization of analysis phase

| Activities | Method/ Software | Deliverables | Objective |
|---|---|---|---|

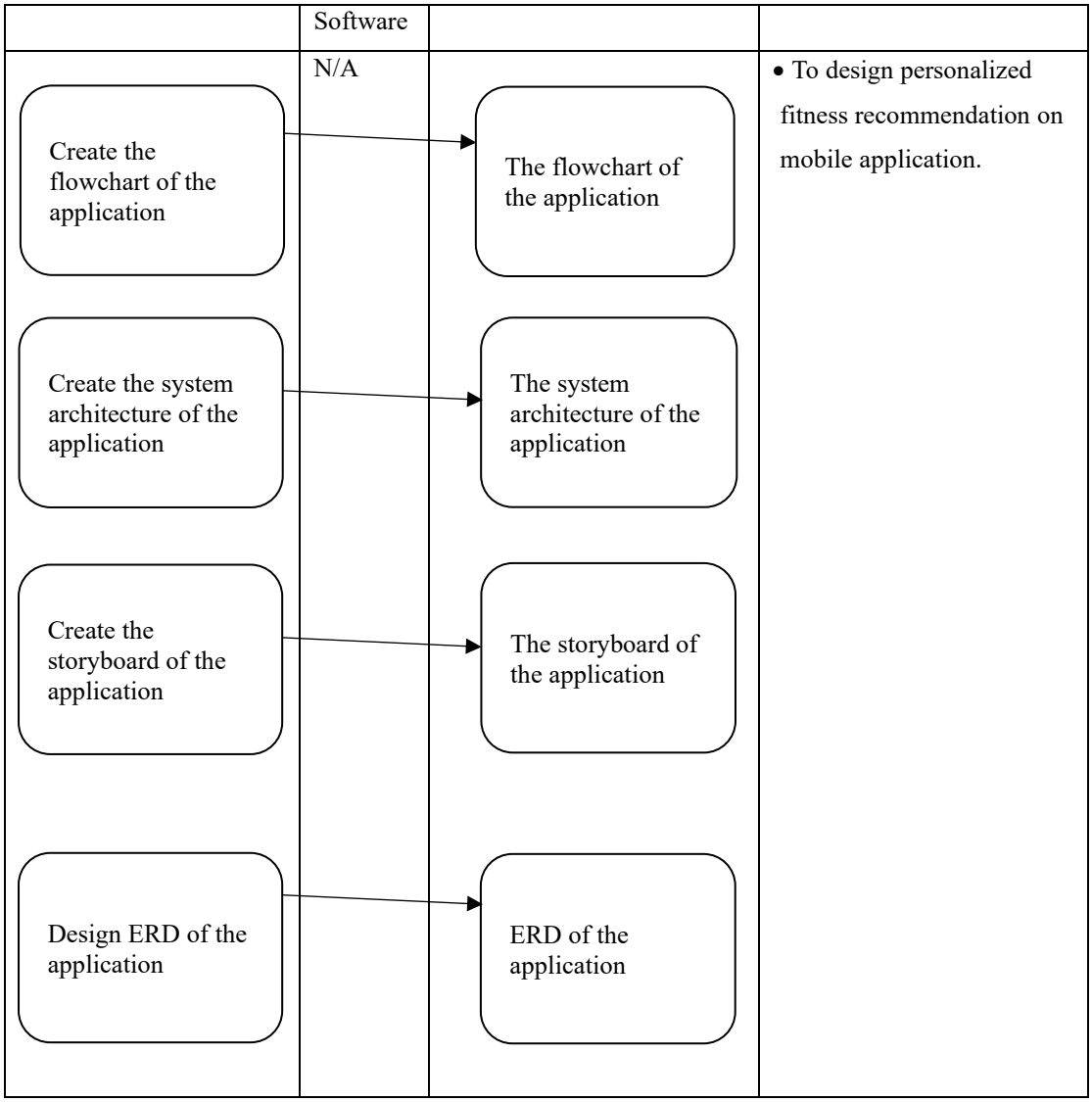



### 3.2.2 Design

The second phase is design. The system flowchart, system architecture, storyboard and entity relationship diagram (ERD) are all discussed during this phase. The developer will be familiar with and understand how the application operates and flows. The importance of this phase is to clearly show the physical and conceptual aspects of the project. Because it is simple to spot errors, particularly in the structure of this application which must be in sync with the purpose and literature review in chapter 2 of this project. The process in this phase will be concluded in table 3.2 below.

**Table 3.2** Table summarization of design phase

| Activities | Method/ | Deliverables | Objective |
|---|---|---|---|




### 3.2.2.1 Flowchart

Flowcharts are visual diagrams that employ symbols to outline the sequential steps of a process. They are a tool on which the developer can rely for a variety of functions. As mention previously, the flowchart consists a few of symbols to display the process of application and each of them have their function. For flowchart in this project, it is important to draw first before go to the next phase which is development. Each function has its own flow and is linked to the others. This flowchart will be separated to a few of sub-module and each of them will be explained.

**Sub-Module of User Registration**

This flowchart begins with the sub-module of user registration. Before logging into the application, user must first create an account. User need to put their name and

password. If they successful, they will be directed to login page. Otherwise, they will go back to register page.

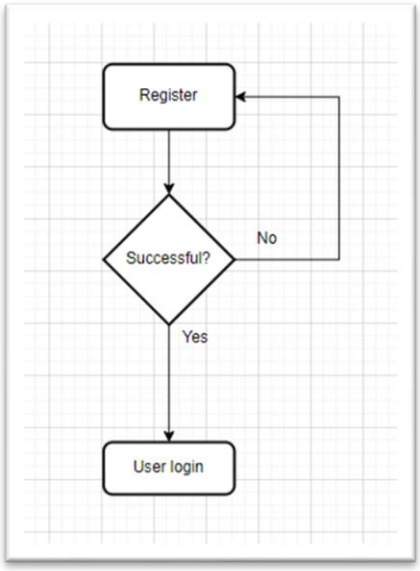



**Figure 3.3** The sub-module of user registration

**Sub-Module of Data's Flow**

For second module – sub-module of data's flow. After successfully logging into the program, the user will be taken to the dashboard page where they can view their exercise recommendations. However, for the first-time user, they will be sent to a page where they will be required to complete a few questions since the answers will be the data that can then be analyzed. On the dashboard page, users will see an icon whose job is to locate another exercise recommendation but they must respond to the questions again because it is critical for the system to gather new data in order to process the new recommendation.

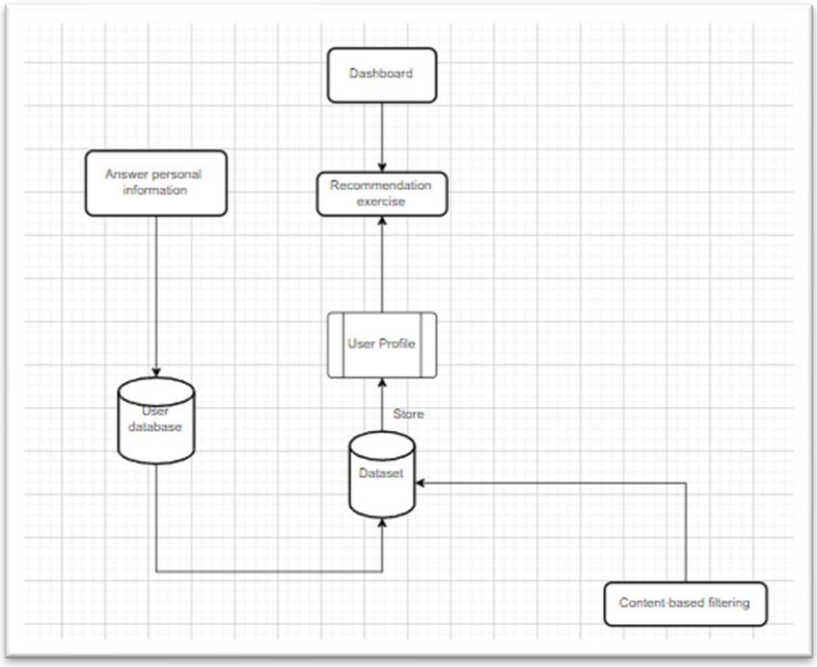



**Figure 3.4** The sub-module of data's flow

There is a database where it keeps the user information such as name, password, userID, and information that come from questions and tools. Also, there is dataset which it will be the source of recommendation. Not to forget, the method of content-based filtering where its function to analyze the user data and dataset. After analyzing, it will store the new data in the user profile and it will be used to display in dashboard page

**Sub-Module of User Tool**

Furthermore, the sub-module of tool. In this module, there are two tools that will be explained: a step tracker and a body mass index (BMI) calculator. These tools are useful in assisting the user in obtaining more precise exercise recommendations. All the data that get from the tools, will be inserted in user database.

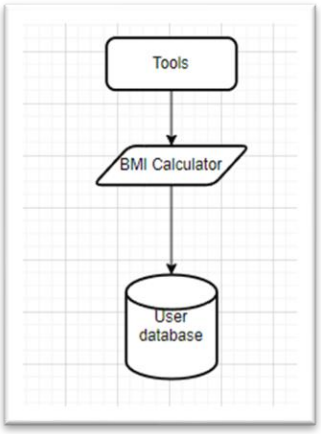



**Figure 3.5** The sub-module of tools - BMI

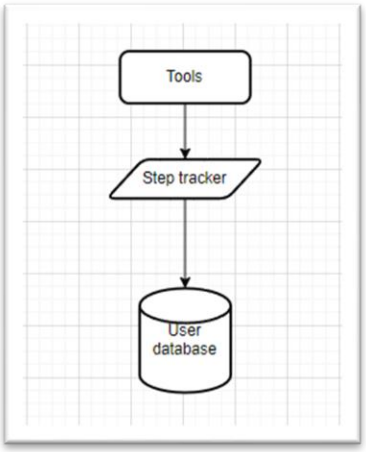



**Figure 3.6** The sub-module of tools – Step tracker

## Sub-Module of Log out

Lastly, the sub-module of log out. There is a log out icon for the user to exit the application. After clicking on it, the user will not be directly exited, but instead will get a pop out notice asking for confirmation. As a result, if the user wants to continue using the application, they can click on no button. Otherwise, the user can click on yes button to log out from the application.

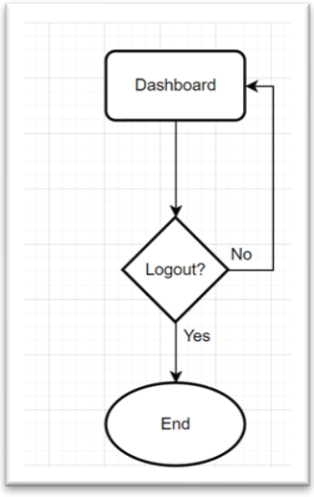



**Figure 3.7** The sub-module of log out

### 3.2.2.2 System architecture

A system's architecture reflects how it is utilized and how it interacts with other systems and the outside environment. It describes the interconnectedness of all system components as well as the data link that connects them. A well-defined system architecture allows to focus on software development while avoiding long-term concerns with integration and operational issues. Figure 3.8 below show the system architecture of the project.

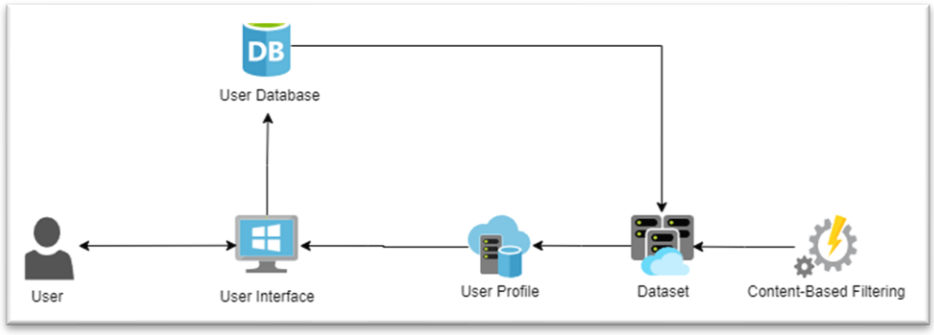



**Figure 3.8** The system architecture of personalized fitness recommendation

The user will have interaction with user interface in order to use the system. Another component like dataset is crucial because it will be the main source to get the recommendation of exercise. Then, user can see through user interface back after all the process complete.

The data is the key component of any machine learning project (Khan Rafiuddin, 2022). The accuracy and relevance of the system's recommendations are directly affected by the dataset's quality and comprehensiveness. The importance of dataset to this project can be defined as follow:

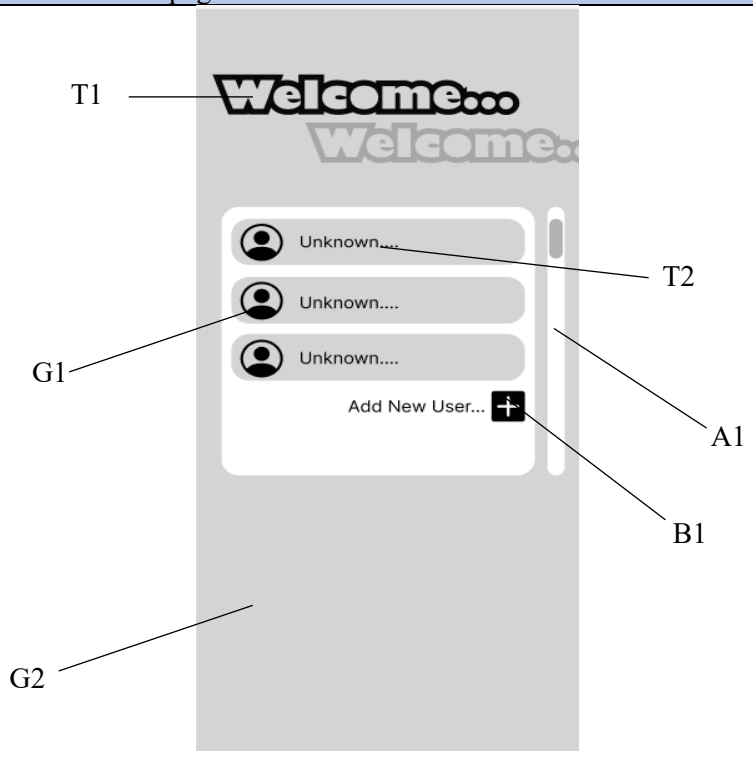
1. For training the recommendation system. Machine learning will handle it by utilizing an algorithm to do any process such as filtering, displaying and learning the system's pattern. As a result, the system can learn to understand what the user's recommend exercise.
2. For recommend exercise to the user. In order to do it, the system require the user data (user profile). As a result, based on the dataset, the system can show the user the optimal exercise recommendation.

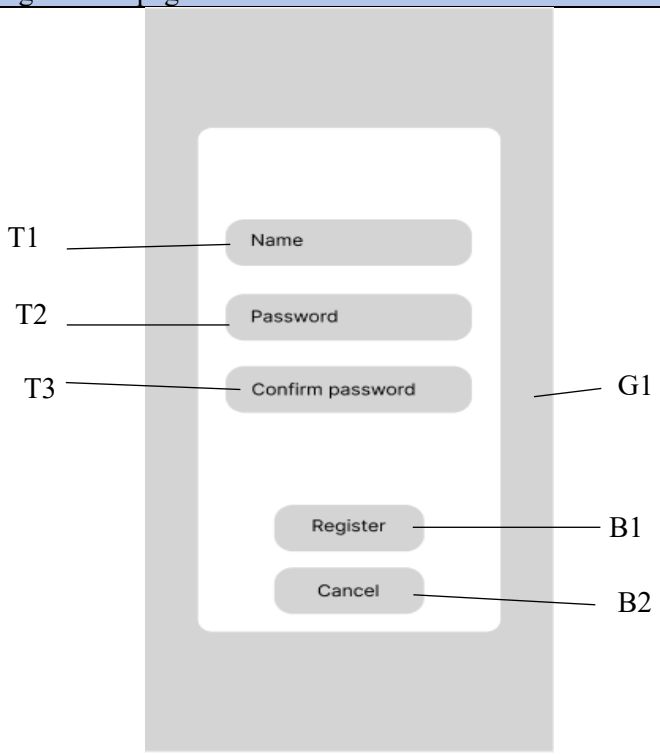
The dataset in this project is necessary as to recommend to the user the exercise that they can do. The dataset from endomondo.com such as gender, timestamps, sport and distance are good data to produce the recommendation exercise (Ni et al., 2019). Additionally, the Endomondo dataset have 167373 workout records from 965 users. The sequential data (such as distance, timestamps and heart rate) for each workout record contains 500 data points with sampling periods ranging from seconds to minutes. The dataset produced positive results making it promising for examining long-term temporal variance among users (Ni et al., 2019).

### 3.2.2.3 Storyboard

The storyboard is essential for making the process easy to comprehend without having to produce a bunch of documentation to describe it. The form that will be utilized is in the application's visual - scratch. It will aid the developer in reducing app development time by preventing the developer from writing needless code. Table 3.3 below will show the details of application and user interface from the registration until log out the app.

**Table 3.3** The storyboard of the application

| Scene 1: Main Menu page |
| --- |
|  <br>**Figure 3.9** The interface of main menu page |
| Description: |

| |
|---|
| This is the first page that the user will see after they open the application. As shown in the figure above, there is a list of existing users and there is a button to add new user. |
| Multimedia Element:<br>text (T), button (B), graphic (G), action (A) |
| T1: A simple text that set as to display only.<br>T2: User name.<br>B1: Button to add new user. It is in form of icon.<br>G1: An icon for existing user. Each of user's account will have it.<br>G2: The background of main menu page.<br>A1: a tool for scrolling. |
| Scene 2: Registration page |
|  <br>**Figure 3.10** The interface of registration page |
| Description: |
| In this page, it is for new user. They need to fill the registration first before logging into the app. User need to put the name, password and confirmation password. The data that will be in the database only name and password. |
| Multimedia Element:<br>text (T), button (B), graphic (G) |
| T1: User put their name.<br>T2: User put their password.<br>T3: User put their confirm password.<br>B1: A button to register. After user put all the information, they need to click this button to register.<br>B2: Cancel button which if user do not want register as new user, they can click it.<br>G1: The background of registration page. |
| Scene 3: Login page |

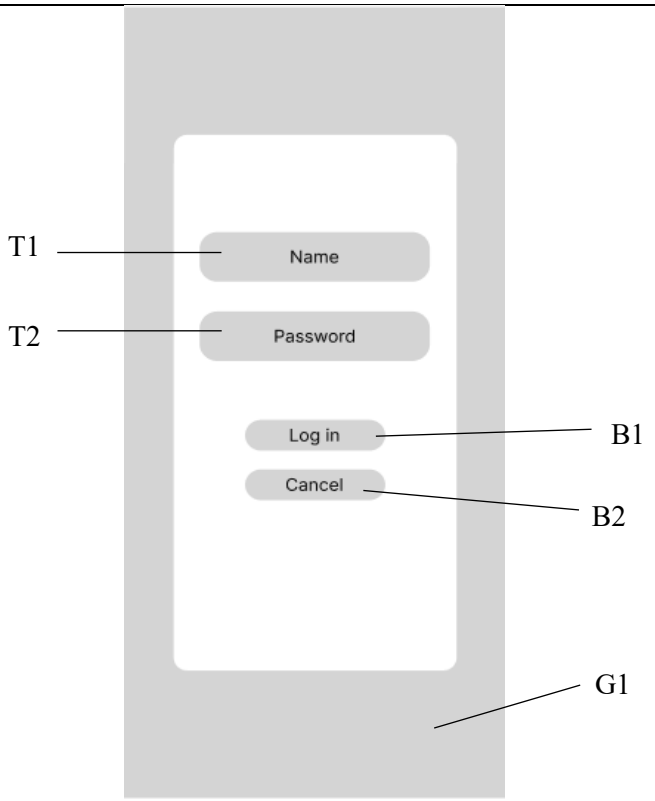



**Figure 3.11** The interface of login page

| Description: |
| --- |
| A page where user can log in into the application. The user must use the same name and password that they created on the registration page. Otherwise, they will be unable to access the app. |
| Multimedia Element:<br>text (T), button (B), graphic (G) |
| T1: User put their name.<br>T2: User put their password.<br>B1: A button to log in. After user put all the information, they need to click this button to log in.<br>B2: Cancel button which if user do not want log in, they can click it.<br>G1: The background of login page. |
| Scene 4: Question page |

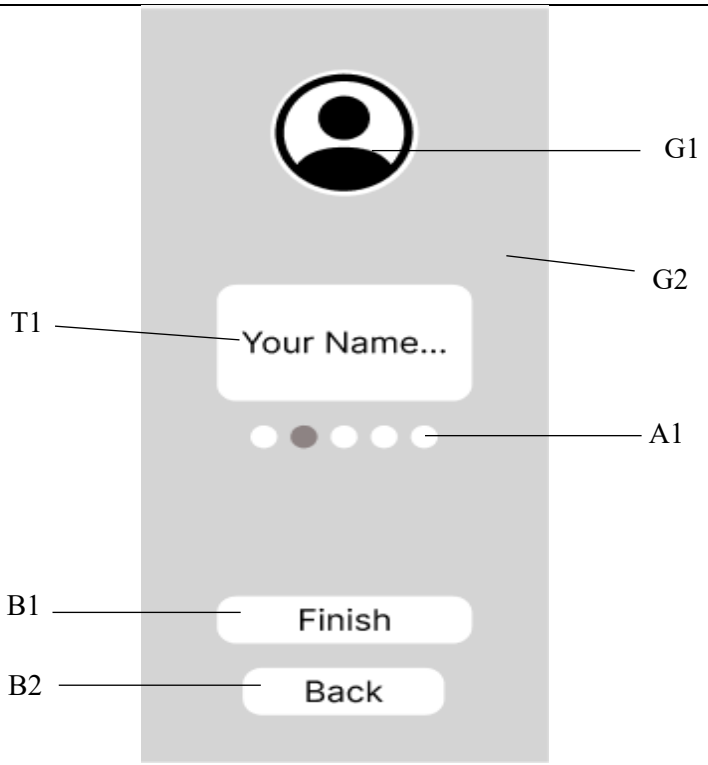



**Figure 3.12** The interface of question page

| Description: |
| --- |
| In this page, user will be asked about their information such as:<br>• Name<br>• Weight<br>• Height<br>• How much their time of sleep?<br>• How many exercises they do?<br>• Their goal and many more<br><br>This page will be showed for the first-time user as soon as after they login. For the user that have already answer the questions will be directed to dashboard page. |
| Multimedia Element:<br>text (T), button (B), graphic (G), action (A) |
| T1: User put their information (refer description).<br>G1: An icon of user.<br>G2: The background of question page.<br>B1: The button will able to click once the user put all the information.<br>B2: User can go back to the previous question if they want to change it.<br>A1: Slider tool. |
| Scene 5: Dashboard page |

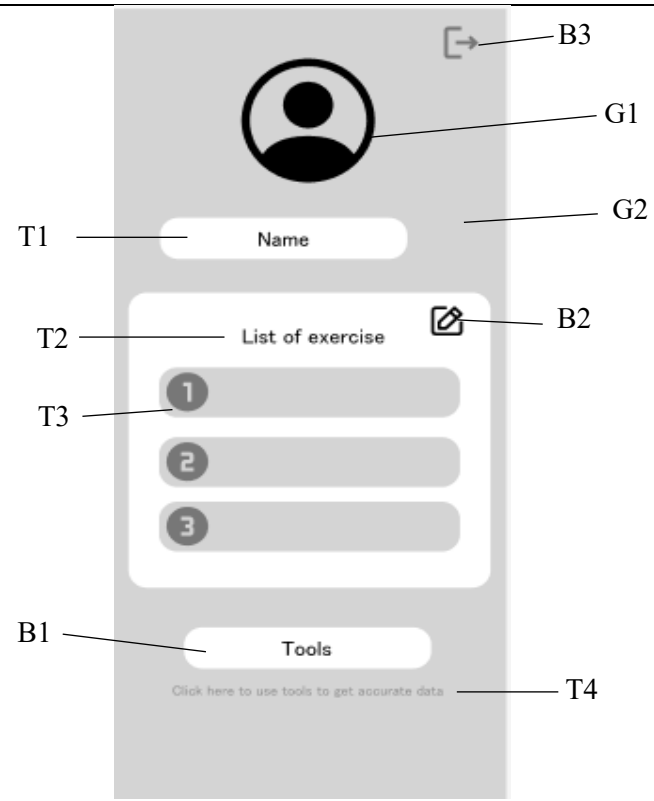



**Figure 3.13** The interface of dashboard page

| Description: |
| --- |
| In this page, user can see their list of recommendation exercise and they can get another exercise by answer back the questions if they put different input. There is a button of tool where the user can click it and then will be directed to tools page. |
| Multimedia Element:<br>text (T), button (B), graphic (G) |
| T1: Name of user. Same as in the question page.<br>T2: A text of list of exercise.<br>T3: List of exercise and numbering.<br>T4: The description of the tools.<br>B1: Button to go to the tools page.<br>B2: Button to edit and go to the question page back.<br>B3: Log out button.<br>G1: An icon of user.<br>G2: The background of dashboard page. |
| Scene 6: The detail of exercise page. |

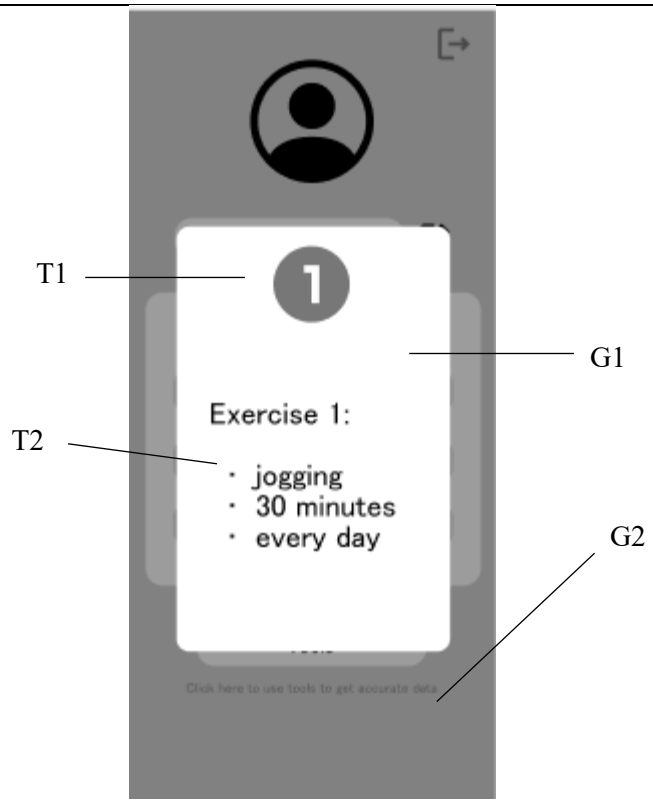



**Figure 3.14** The interface of the detail of exercise page

| Description: |
| --- |
| If the user clicks at one of the exercises, it will pop up the detail of exercise. User can use it as guide to achieve their goal. |
| Multimedia Element:<br>text (T), button (B), graphic (G) |
| T1: Numbering of exercise.<br>T2: The details of exercise.<br>G1: The background of pop up.<br>G2: The background of dashboard page. |
| Scene 7: Tools page |

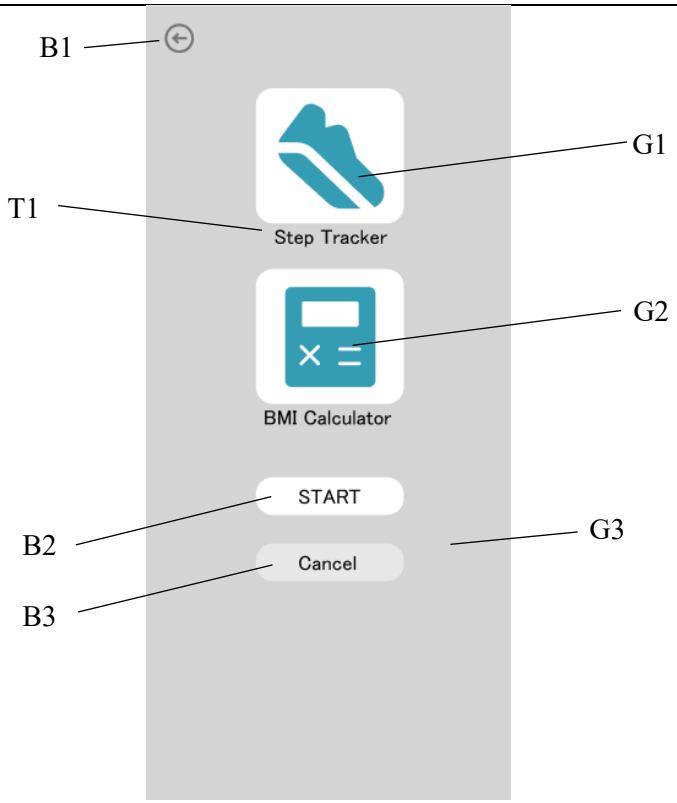



**Figure 3.15** The interface of tools page

| Description: |
| --- |
| There are two tools that user can use – step tracker and BMI calculator. |
| Multimedia Element:<br>text (T), button (B), graphic (G) |
| T1: The name of tool.<br>B1: Back button.<br>B2: Button to start to use the tool.<br>B3: Button to cancel use the tool/back to the previous page.<br>G1: An shoes icon.<br>G2: A calculator icon.<br>G3: The background of tool page. |
| Scene 8: Step Tracker page |

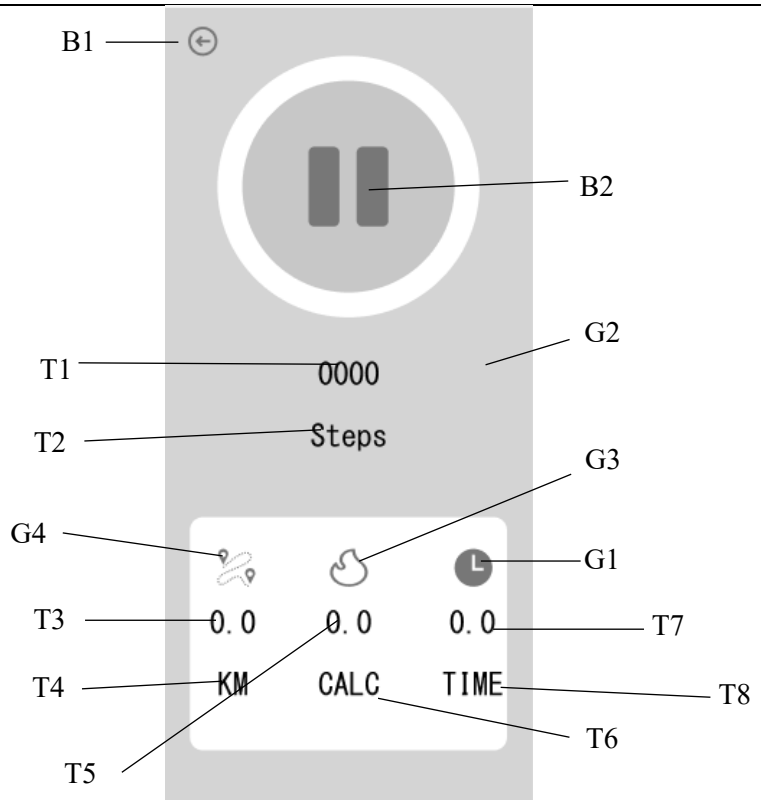



**Figure 3.16** The interface of step tracker page

| Description: |
| --- |
| This page contains a tool of step tracker. The output of this tool is<br>• the distance of the user walks or run<br>• Calories that have burn<br>• Time the user spent on using this tool<br><br>Once the user clicks on the pause interface, the tool will start operate |
| Multimedia Element:<br>text (T), button (B), graphic (G) |
| T1: The total of steps.<br>T2: Unit of steps.<br>T3: The total of distance.<br>T4: The unit of distance in kilometre.<br>T5: The total of calories.<br>T6: The unit of calories.<br>T7: The total of time.<br>T8: The unit of time in hour.<br>B1: Button back to previous page (tool page).<br>B2: Button to start the step tracker.<br>G1: Clock icon.<br>G2: The background of step tracker page.<br>G3: Fire icon.<br>G4: Map icon. |
| Scene 9: BMI Calculator page |

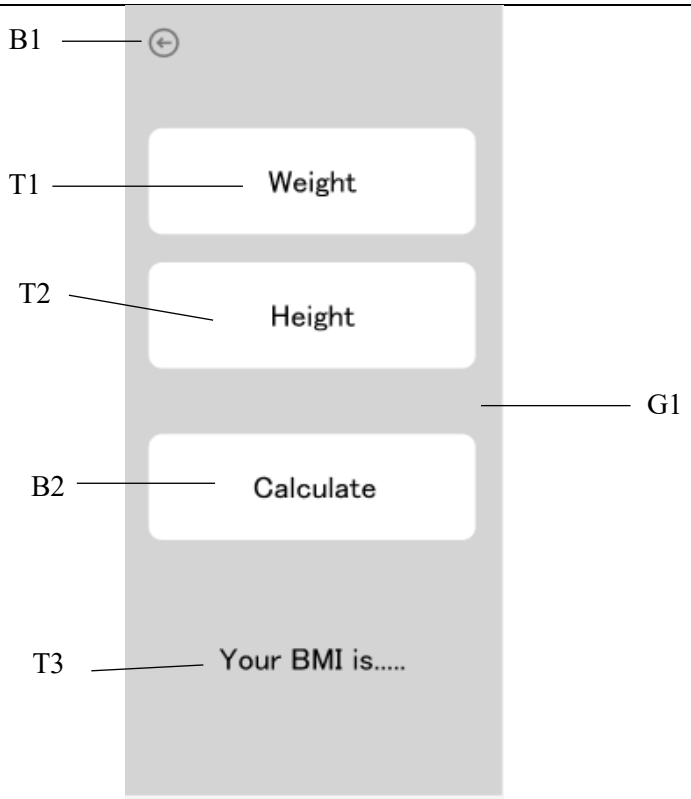



**Figure 3.17** The interface of BMI calculator page

| Description: |
| --- |
| User need to put their height and weight. Once they put the information, they can press the calculate button to see the result. |
| Multimedia Element:<br>text (T), button (B), graphic (G) |
| T1: User's weight.<br>T2: User's height.<br>T3: Result of BMI calculator.<br>B1: Back button to previous page (tools page).<br>B2: Button to calculate the BMI.<br>G1: The background of BMI Calculator page. |
| Scene 10: Log Out page |

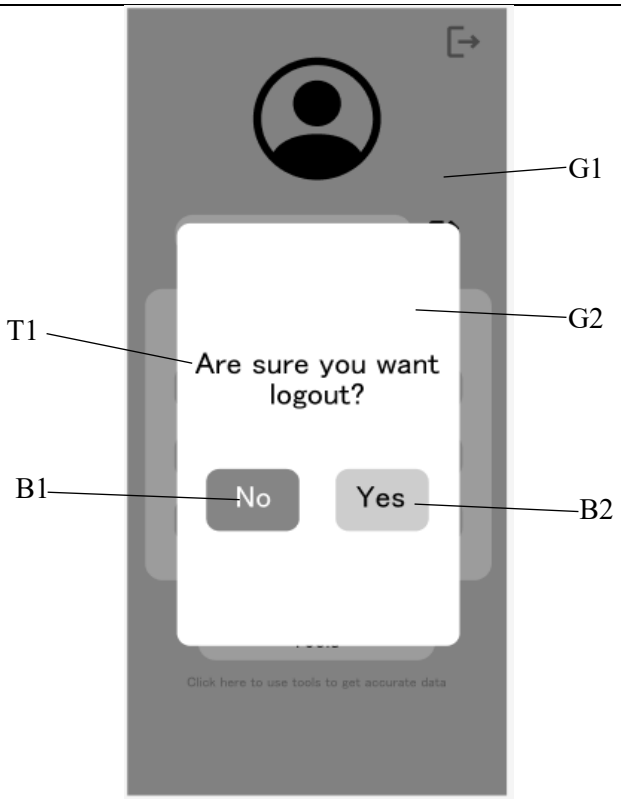



**Figure 3.18** The interface of logout page

| Description: |
| --- |
| After the user click on logout icon, a message will be pop out. If the user clicks yes, they will exit from the app. If the user clicks no, they will stay in the app |
| Multimedia Element:<br>text (T), button (B), graphic (G) |
| T1: Confirmation question before user want to log out.<br>B1: Button to cancel from logging out.<br>B2: Button to proceed of user to log out from the application.<br>G1: The background of pop up.<br>G2: The background of dashboard page. |

### 3.2.2.4 Entity Relationship diagram (ERD)

The Entity Relationship Diagram (ERD) also known as the ER Diagram or the ER model is a sort of structural diagram used in database architecture. An ERD contains several symbols and connectors that depict two crucial pieces of information: the major entities inside the system scope and their interrelationships. Additionally, the ERD is important to know what the capability of the system with the user either the system can accept only one user or more. The figure 3.19 below is the figure of ERD of this project. User also can have more recommendation of exercises and it is based on the data user provide.

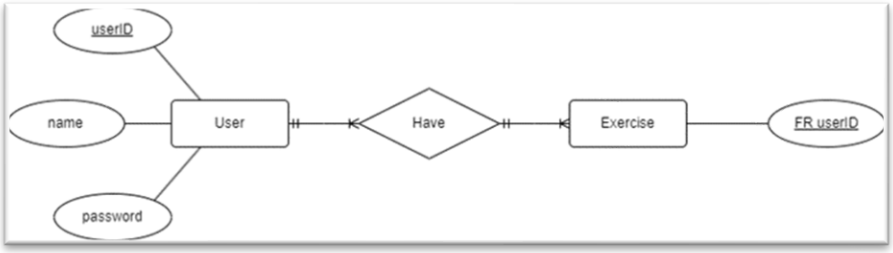


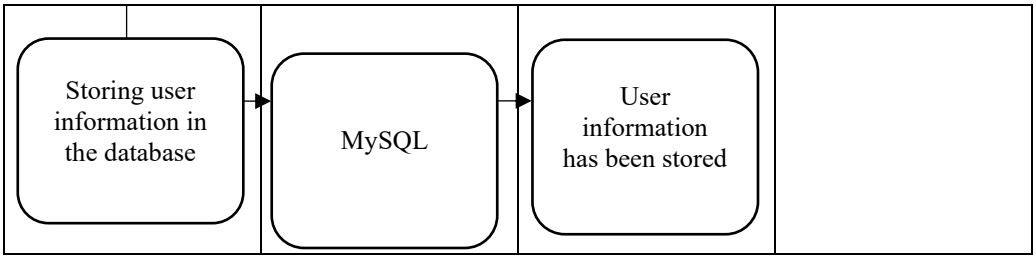

**Figure 3.19** The Entity Relationship Diagram (ERD) of the application

### 3.2.3 Development

This is often referred to as the Construction Phase. It is the process of converting what was created during the design phase into a product. This step produces a product that will be tested. All detailed interface, technical design, script and coding will be created at this period. Table 3.4 depicts the development phase in terms of activities and deliverables for each activity.

**Table 3.4** The summarization of development phase

| Activities | Method/Software | Deliverables | Objective |
|---|---|---|---|
| Development | Install code editor | Android Studio | • To develop personalized fitness recommendation on mobile application. |
| Design the user interface | Design the user interface | The user interface has complete made | |
| Design the algorithm for recommendation | Android Studio | An algorithm to recommend exercise were create | |




### 3.2.4 Testing

This phase is important for developer to do as it will be the challenge to recognize either the app is kept on track based on the objective or not. While testing, the developer can detect the mistake that have been done and can fix immediately. The summarization of this process will be concluded in table 3.5.

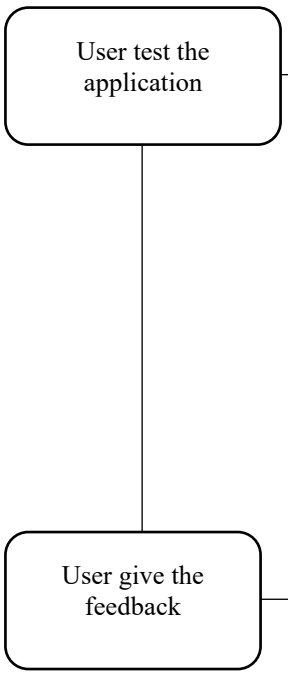
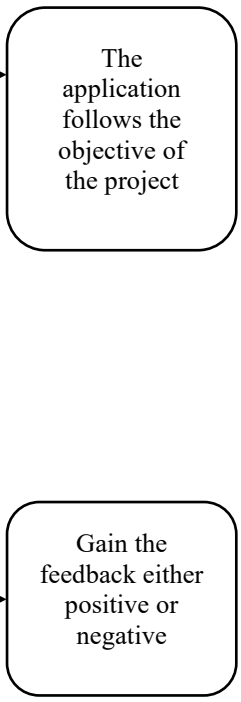
**Table 3.5** The summarization of testing phase

| Activities | Method/Software | Deliverables | Objective |
|---|---|---|---|
| Test the functionality of algorithm | N/A | An algorithm works as plan | • To test functionality of the mobile application. |
| Check the user interface | | User like about the interface of application | |
| Test the tools in the application | | Test the functionality of algorithm | |

### 3.2.5 Implementation

The last of phase of Waterfall model is implementation phase. This phase will focus on the user feedback and test from user. Additionally, the target user is important here as to maintain the scope of this project. The table 3.6 below show the process of this phase.

**Table 3.6** The summarization of implementation phase

| Activities | Method/ Software | Deliverables | Objective |
|---|---|---|---|
|  | N/A |  | • To gain the feedback about the personalized fitness recommendation mobile apllication. |

## 3.3 Conclusion

For the conclusion of this chapter, The Waterfall model was chosen for this proposed project to achieve a satisfactory project outcome within the time limit specified. The waterfall model is a technique that can meet all of the project's needs and primary goals. To avoid errors and development issues, each phase of the Waterfall model must be meticulously carried out. Then, there are crucial software and methods that have been implemented in this phase that will aid in the completion of the project. That software are the greatest tools for designing mobile applications - personalise

fitness recommendation since they have their own unique features and advantages over other software.

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