

# JomImageProcessing: Machine Learning Weight Control with SnapFudo

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**Abstract**—Tracking the calorie of food consumed is becoming harder when eating outside. With many fast food choices available almost everywhere, the consumption of fast food is high among Malaysian. While numerous calorie-tracking apps are available in the market, these apps require manual inputs that are frustrating yet demotivating. With the application of machine learning, this study will involve image recognition of food to ease the food input for the user. From the survey data collected, most respondents are aware of Body Mass Index (BMI) but find it difficult to track their calorie intake, especially when eating out. Respondents also have difficulties identifying each ingredient and how much the quantity in their meals. As a result, the implemented apps can guide the user on losing weight healthily and motivating them to achieve their weight goals.

**Index Terms**—Food; Calorie; Healthy; Weight Loss; Obesity; Overweight; Image Recognition; Food Recognition.

## I. INTRODUCTION

For people with full outdoor activities, it is hard to eat healthily and track their calorie intake. When eating outside, people tend to choose food available nearby. On the other side, fast food restaurants are available almost everywhere at a cheaper price offered. As the impact, it could promote high consumption of fast food. The consumption of fast food is high, especially for young Malays in Malaysia [1]-[3]. Lack of exercise also could make them have a fat body shape.

Currently, more than 70% population over the world are categorized as overweight or obese [2]. Moreover, the WHO (World Health Organization) claims that the frequency of overweight and obese people is cumulative worldwide [5]. In 2014, WHO reported that “*Malaysia is the fattest country in South East Asia*” [4]. Based on the Malaysian National Health and Morbidity Survey (2012), in range of age 18 and above of Malaysia’s population, 33.3% of people are pre-obese, and 27.2% are categorized obese [1]. Due to overweight and obesity disease, 2.8 million population are dying per year [6]. People with obesity have a higher probability of having various diseases such as high cholesterol, high blood pressure, hypertension, high lipids, cardiovascular disease, and type-2 diabetes [2][6].

Meanwhile, the book written by Butland et al. stated that obesity could be controlled and treated with defined four determinants such as [6]:

- a) Primary appetite control’s level,
- b) The potency of dietary habits,
- c) Physical activity level, and
- d) Psychological ambivalence level

Based on these determinants, self-control, habits, exercise and stress level could result in controlling obesity and losing

weight. The appetite level could be reflected by how humans eat and how much they consume. Moreover, a high-fat mass could make the hormone that controls appetite to appear [7]. As the impact, it will lead people to overeat and gain more weight in their body. Too much food consumed also means a more significant amount of calorie is consumed. To overcome this problem, Naughton, McCarthy and McCarthy (2015) state that a dietary plan with user’s self-control will facilitate them to contribute to their diets and achieve weight goals and prevent them from overeating. A balanced calorie and nutrition level could affect people to maintain and lose weight.

On the other hand, the habits of consuming junk food and other unhealthy food might be hard to resist. “Once the habit is ingrained, it becomes very difficult to change” [8]. Research has shown that obese people consume less healthy food than others with a normal weight [9]. It might be difficult to encourage those people who eat unhealthy food daily. However, it is possible to encourage them by alternating their unhealthy food preferences to a healthier option. For example, swapping fried chicken with grilled chicken to reduce oil intake or swap white bread with whole wheat bread, which has more nutrients. These alternatives of choices might help people to reduce their calorie intake and support the balance of nutrients.

Not only inhabit and appetite, controlling the calorie intake and serving size is very important to maintain or achieve the weight goal. Usually, the approximation of calorie intake for male adults is around 2500 calories while 2000 calories for female adults [6]. However, tracking all records of food intake might be troublesome, especially for busy people. As an impact, some of them might find a fast platform to lose weight easily. Besides, Ipjian and Johnston (2017) state that mobile apps can impact people’s healthy eating and diet habits. By tracking all records and the number of calories consumed could help people to control their food intake. Because of their convenience, mobile apps are useful for the user to update their food intake daily. Furthermore, most people own a smartphone these days.

Smartphone now becomes a must-have item in people’s lifestyle. Approximately there are 72% of everyday smartphone users in Malaysia [10]. Using a smartphone as a technology to improve working people’s healthy lifestyle might be effective through the mobile application. My Fitness Pal (MFP) is the most popular mobile application from America to help people on tracking their food and calorie intake [11][12][14][15][16]. Moreover, many dietitians recommended this application. Because this application records the food intake and calories, it is not just for achieving weight goals. This application can also be used for an eating

disorder or food intake control. Levinson, Fewel & Brosf (2017) surveyed 78 people with an eating disorder who have used the My Fitness Pal application before. It is said that only 14 people mentioned that these apps did not help at contributing to their eating disorder at all. However, the other said it was either somewhat contribute, moderately contribute, or very much contribute to their eating disorder.

Other smartphone applications also offered the same functions, such as Lifesum and Fat Secret, apart from My Fitness Pal. Just like My Fitness Pal, the design of these two apps also is USA based. However, those companies have different features offered in their application, although they have similar purposes and approaches.

Table 1  
SWOT of Applications for Calorie Tracker

My Fitness Pal		Lifesum		Fat Secret	
<b>Strength</b> -Many features included in the free plan -The database is quite complete	<b>Weakness</b> -No diet plan has given -UI & UX not attractive -Just show the total calories. Protein etc shown in the hidden page. -Not user friendly -No food suggestion -The database comes with American brand first -Requires a lot of user input -Not suitable for long-term use -Not support menus offered in the restaurant	<b>Strength</b> -Good User Interface -Show the total calories as well as nutrition intake in total -Paid diet plan included for paid users	<b>Weakness</b> -A lot of paid subscription plan -No custom serving size -No food suggestion -Requires a lot of user input -Not suitable for long-term use -Not support menus offered in the restaurant	<b>Strength</b> -Easier to search product by category -User Friendly -UI is very simple. Every food is divided by their category	<b>Weakness</b> -Bad Branding -No water tracking -No diet plan provided -No Food suggestion -Requires a lot of user input -Not suitable for long-term use -Not support menus offered in the restaurant
<b>Opportunities</b> -Many people are aware to eat healthily -Recommended by dietitians in a Western country	<b>Threat</b> -Many people use it for short-term only -Many people are looking for the alternative of this app -Most people will not be able to use the apps efficiently -User does not know how to start -The non-American user might have difficulty finding their local brand -User not willing to input data (the food they ate) to record their progress	<b>Opportunities</b> -Popular in social media (influenced by many fitness influencers)	<b>Threat</b> -Users need to subscribe to a paid plan to use these apps efficiently -User unable to custom serving size -User not willing to input data (the food they ate) to record their progress	<b>Opportunities</b> -Most people go to this app for an alternative of MyFitnessPal	<b>Threat</b> -User is not able to track their water intake -User does not know how to start -User cannot track their water intake -User not willing to input data (the food they ate) to record their progress

Because three of those apps have their speciality and deliverables, some strengths and weaknesses could affect their performance in society. Table 1 shows that My Fitness Pal has many features included in their apps compared to the others. However, the complexity of these apps makes it hard for the user to use their features efficiently. On the other side, Lifesum and Fat Secret impress their user with their simple and friendly UI, which attract many bodybuilders to these apps as the alternative of My Fitness Pal apps. However, those alternative apps do not support the Malaysian local product as they prioritize American brand first. Further, they force the user to know all the ingredients of each meal they consumed which is not convenient. Therefore, this project will develop a mobile application that could recommend the users to eat healthy food even when they eat outside.

The comparison of feature in Table 2 included similar products that will help visualize what feature included in the new mobile apps. My Fitness Pal has the most features among the others. Three of these applications has food input and calorie counter as their main features. However, those applications require users to input their meals by searching the food from the database and approximate the serving size. It is a burden to the users [2]. Sorbrig et al. (2017) did their survey and concluded that many people dislike using a calorie counter to promote weight loss as it requires many input and measurement. Hence, those applications will not sustain a user's long-term usage due to the consistent input required. As the impact, the user will be demotivated as they need to update their apps whenever they are having a meal. However, the application still needs information to process data output from the program to the user. User input with just-in-time food recording might help to reduce the problem of food logging [2]. Therefore, image recognition will be applied to

the apps to retrieve data from the food's image taken by the user and give the possible result after identifying it. Besides, most participants suggested a simple design with a function that enables the users to set and review goals to be included in the apps [17].

Table 2  
Comparison of Features in Current Mobile Applications

Features	MFP	Lifesum	Fat Secret
Food input (Breakfast, Lunch, Dinner, Snack)	/	/	/
Scan Barcode	/	/	/
Calorie Goals	/	/	/
Food Diary	/	/	/
Location (Search restaurant nearby)	/	X	X
Recipes	/	/	/
Water intake	/	/	X
Nutrition chart	/	X	/
Diet Progression	/	/	/
Meal recommendation	X	X	X

On the other hand, most weight-loss applications are designed for people interested in physical training and exercise [18]. Therefore, most of these apps include an exercise logger, although it might not be applicable. As a result, obese and overweight people will not be able to get the motivation to achieve weight loss. Therefore, people need to be aware of their meals consumed per day. Obese and overweight could lead to many diseases and even death. With a balanced diet and self-control guided by a smartphone application, the weight loss target can be accomplished. The obligation of the current application that demand users' input will be replaced with an image retrieval module in the new application. The application is specially designed for people who are not physically fit and lack exercise to get motivation and encouragement to cut back on calories and meals. A minimal input should be enough to support the application efficiently.

Besides health problems, overweight and obesity could affect job performance. Based on this study, obese people can have a higher score of productivity loss than those who have a normal BMI [19]. If the percentage of obese and overweight people increased as time goes, it might impact the overall productivity. Hence, a healthy diet and the control of food intake should be applied and made aware to everyone. However, most people who are obese tend to eat unhealthy food such as fast food [9]. It would be difficult to change the habit once it is engrained. Consequently, controlling the appetite to eat unhealthy food might be hard to resist due to unhealthy eating habits.

When appetite cannot be resisted, people might feel guilty after eating the bad and unhealthy food afterwards. Eventually, they will not lose any weight and see no difference. Furthermore, it may affect their psychology level, leading to stress as they do not see any progress in their weight loss. The option of food swap might help control people who have difficulty controlling their appetite and change their eating habits. With this mobile application feature, it is possible for users to eat their favourite food but in a healthy version. Furthermore, they will get more motivated to lose weight without the miserable feeling of eating salad every day.

These days, some companies have come out with a software application that could track the users' calorie intake. Those applications might lead to weight loss, especially for those who are obese or overweight. However, those applications that count calories require user input regularly. Moreover, there are many data that the user needs to enter. The process might be demanding for the user and lead to resentment on those applications with short-term usage [17]. Users also will lose motivation to lose weight and eat healthily.

Furthermore, those applications are designed for fit people to track their exercise routine and food intake to keep their body in shape [18]. People who are not in a fitness background might not find the applications that could promote weight loss, especially in their busy lifestyle. Therefore, the mobile application which is developed should meet the requirement that most employees would prefer.

## II. LITERATURE REVIEW

Lately, awareness of obesity and overweight is spread all over the internet and social media. There is a lot of meal plan, and a healthy food recipe shared over the internet. However, according to Choi & Zhao (2012), only 35% nationwide really do their meal plan carefully to be healthy and nutritious. It will not affect that much, and there are still many people who approximately reach 70% of the world population that are categorized as obese and overweight [2]. Choi & Zhao (2012) mentioned that the high consumption of restaurant food could affect the obesity level to be increased. This is because we could not know how many calories it contained in each meal they served.

Although most restaurants tend to serve tasty rather than healthy meals, many restaurants still serve healthy food and are friendly for those on a diet. However, based on Croverto et al. (2018); Chan (2019), obese students consume less healthy food. Most students are likely to choose to eat unhealthy food such as fast food while eating out with friends [12]. The consumption of fast food also is high among young Malays in Malaysia [1]. Moreover, the price of fast food tends to be cheaper than healthy food that uses organic ingredients.

Many mobile apps help people lose weight and track the user's calorie intake. The use of calorie-tracking apps has been proven to result in significant weight loss [13]. As people nowadays cannot live without a smartphone, the mobile application has a high opportunity to bring technology to human. It would be more impactful if the developer could bring technology to the human's lifestyle to ease their lives. Ipjian & Johnston (2017) mentioned that mobile apps could improve diet habits and encourage people to eat more healthy food. Not only for regular people who want to achieve a good body, but it could be also beneficial for people who have an eating disorder and health disease that require them to eat clean. Levinson, Fewell and Brosos (2017) stated that calorie-tracking apps could contribute to eating disorder symptoms. On the other side, Rose, Petrut, L'Hevender and Sabata (2019) stated that mobile app usage also prevents diabetes and its complications. Thus, using technology, it is possible to encourage people to eat healthier and achieve weight loss. Moreover, it could help to prevent diseases such as diabetes, obesity, even an eating disorder.

Calorie tracking apps can be used as guidance or personal nutritionists for everyone to track their diet and not overeat. In diabetes, mobile apps can help ease the burden by using

smartphones as their medical device [20]. Thus, this is how mobile apps work to approach people. However, not every app could successfully deliver its aims to the users. Some of the features might not have met the requirements that their user need. User preferences change from user interface design, usability, flexibility, and many more. For calorie-tracking apps, user inputs are essential to make the system works efficiently. What food is consumed, how many serving size, how many grams or cups in one serving size? These are primarily found in all calorie-tracking apps when entering food data. However, most people disliked these apps due to the many user inputs required [17]. Some apps have complicated steps and interface that are not intuitive and comprehensive.

Machine learning is a subset of artificial intelligence that automatically deploys a system to learn from experience and enhance its performance without any explicit programming required [20]. Nowadays, many machine learning applications, such as image recognition, voice recognition, fingerprint scanner, and many more, could be found. Training is essential to make machine learning perform as optimum as possible. Training is the process of machine learning when the system learns and correct itself whenever new data are given [20]. With training, the system can learn new things as much as possible. For instance, to perform image recognition of food, the system will be given hundreds of images to learn. However, there are many types of food, and some of them might look similar. For example, blueberry and grapes are looks similar in terms of their shape. If the system is given a hundred images of blueberry and a hundred images of grapes, after much training, it could differentiate which one is blueberry and which one is grapes in just a look. The system can be considered reliable if it can give the correct and accurate result to the user.

There are many ways to implement machine learning into the system. To choose the best training for the system, some comparisons of the algorithm used for machine learning training are analyzed. Based on Kamavisdar, Saluja & Agrawal (2013), there are four types of machine learning algorithms: supervised learning, unsupervised learning, semi-supervised learning, and reinforcement learning.

Supervised learning is a learning algorithm that map a function (F) to some labelled input data (X) into output data (Y). the goal of this learning is to find the correct function to predict the outcome of the input given. The term "Supervised" is associated with a teacher who constantly monitors and supervise the learning process. The algorithm can be thought of as a student who predicts the output constantly. Whenever the student made a wrong prediction, it will be corrected by the teacher. In the end, the algorithm will stop the learning process when it has achieved its best performance.

Unsupervised learning is a learning algorithm that does not provide any label for the input data. The algorithm itself has to find a pattern for those inputs by observing or discover by itself. One of the examples usually used in the machine learning field is *clustering*.

Semi-Supervised learning is a learning algorithm with two types of input data: labelled input data and non-labelled input data. The concept is similar to supervised learning but with some expectation. The learning process will also classify and predict the non-labelled data and correct mistakes if necessary.

Reinforcement learning is a learning algorithm that emphasizes how ideal agents can find the best way to earn the most reward. The agent will perform some actions and get rewards from its surroundings or environments. For every action completed, the agent's behaviour or state will change, thus improving its behaviour.

Image recognition enables the system to identify an object from image-based with the process of machine learning. Taking pictures of food before eating has become a common habit people adapted to these days [21]. Hence, image recognition of food embedded in the mobile apps will be easier to adopt. There are many ways to implement image recognition. Scale Invariant Feature Transform (SIFT) is one of the most well-known techniques for image recognition [21]. It has many advantages in orientation, variety of scale, affine distortion and biased invariance to illumination changes [21].

On the other hand, Convolutional Neural Networks (CNNs) have been more powerful and sensitive than hand-crafted techniques [9]. CNN's have been successfully used in various computer vision tasks, including object detection, pattern recognition, and the understanding of images [9]. Although many techniques can be used for image recognition for food, the efficiency of the structures learned depends on the domain-representativeness of training examples. Therefore, the well-trained model must undergo the training process to make the system recognize the image faster and more accurately.

From the reviewed system, many of them required a paid subscription to use their app more efficiently. Besides, the free plans they offered do not support features like micronutrients and meal plans for the user. Thus, the app developed will provide free and open features for the user to use it. This app will provide image recognition as the food input for the user, which is far more effective than manually input by type. With this feature, the user does not need to type all the food ingredients they will consume one by one. Thus, it will be less troublesome and more sustainable usage.

Moreover, the recommendation of healthy food available will motivate the user to eat healthier, which have not been implemented before from the other systems that have been reviewed. Mobile app brings convenience and simplicity to the user because it is with the user everywhere and every time. Therefore, this app should perform as simple as possible to be more sustainable and used in the long term. Moreover, the image recognition feature should reduce and simplify user input.

This study will focus on the following research questions and elaborate on these three value creations deeper.

**RQ1:** What effect could mobile apps approach on the staff and students' healthy food intake in university?

**RQ2:** What type of food should people eat to lose weight when they dine out in the university area?

**RQ3:** How to encourage people to use mobile apps to track calorie intake without many user inputs required?

**RQ4:** How could the technology encourage people in the university to eat healthy food and keep them motivated to achieve their weight loss?

There are four research questions determined to examine the value creations. To reduce the scope area, the investigation will be conducted in UCSI university only. Each

research question will be answered by each research objective as listed below:

**RO1:** To encourage people to achieve their weight goal and healthy body among staff and student at UCSI University with a mobile application.

**RO2:** To recommend healthy food available within all restaurant around UCSI University.

**RO3:** To reduce user input requirement by adding image recognition in the program for inputting data.

**RO4:** To develop a mobile application that encourages people in UCSI University to eat healthily.

The study is aimed to develop a mobile application that could encourage people to lose weight and achieve a healthy lifestyle even though with food served in the restaurant. A simple interface design will motivate people to use this app; thus, it is more user-friendly and learnable for first-time users. Healthy food recommendation available at UCSI University also could let the user try out new menus. Thus, they will not be bored with the same food. On the other hand, image recognition reduces the user input and ease the burden of typing one by one of the ingredients in the food they eat to count its calorie. From the objectives defined, there are hypotheses for each point and summarized in Figure 1.

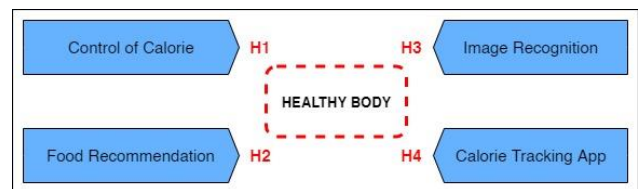


Figure 1: Research Model.

**H1:** The control of calorie will bring people's BMI level to normal.

Calorie has the most important roles in achieving a healthy weight. Deficit calorie is important in weight loss, while surplus calorie is important in weight gain. For instance, to lose weight, the calorie consumed within a day must not exceed the TDEE number. No matter how healthy the food is eaten, it will gain weight if it exceeds the recommended calorie intake much more than the body needed. Having a normal BMI level could promote a healthy body. Moreover, it will prevent many diseases as obesity and overweight could.

**H2:** Food Recommendation will improve the consumption of healthy food at UCSI University.

The recommendation of healthy food available could give the option for the user. By recommending healthy food and the calories provided, the user will choose the healthy food recommended by the system rather than following their tastier instinct, which is mostly unhealthy for diet.

**H3:** Image recognition will help to reduce the data input required for the apps.

By taking a picture of the food consumed, the user could input the food without typing one by one of the ingredients.

This would be more efficient and save time which impact user to be more motivated on their diet. Moreover, there is no reason to postpone their diet plan because of the calorie tracking app’s troublesome data input.

**H4:** Calorie tracking apps will help people to achieve their weight goals.

With all features provided in the app, the user could track what food they have consumed. On the other hand, with the convenience of a smartphone, the user can use the app whenever they go with only one click. Thus, the awareness of taking care of their body could be stimulated to achieve their weight goals and a healthy body.

Introducing a calorie tracking app to the user will motivate them to control their calorie intake and keep their body weight on track to achieve a healthy body and lifestyle. On the other hand, a healthy food recommendation can suggest what food they should consume to lose weight and impact their healthy habit. Moreover, there will be no reasons for the user to procrastinate on their diet. Besides, image recognition can give a different experience of inputting food data and simplifying food input steps. The user will feel more motivated to use the app because they can log the food consumed by only one photo snap. Finally, developing a calorie tracking app could bring technology to humans and motivation to achieve their weight goal and healthy lifestyle.

### III. METHODOLOGY

This study will apply the mixed method to answer how and why questions from the target audience more effectively. Survey and interview will have occurred during the data collection. Table 3 shows the three parts of the research methodology that is going to be conducted.

Table 3  
Research Methodology [22]-[25]

Research Dimension	Explanatory Sequential Design
Research Methodology	Mixed Mode
Primary Data Collection	Mass Survey & Interview

Based on Table 3, the research dimension will be explained in the sequential design, explaining each step on data collection. Mixed-mode or mixed-method is applied by doing a random survey and interview as its primary data collection. To elaborate on the steps of data collection, the sequential design is shown in Figure 2.

Surveying the quantitative data collection, generalized information is gathered. The survey is done by randomly choose people at UCSI University. After the generalized explanatory analysis is identified, it is followed with the qualitative data collection, which is the interview. The interview is done by questioning people who are on a diet and make eating healthily as part of their habit. From the interview, the depth analysis and reasoning behind the quantitative research is accumulated. Finally, all the information is characterized and concluded together to form a single conclusion. Table 4 shows the metrics of the questionnaire.

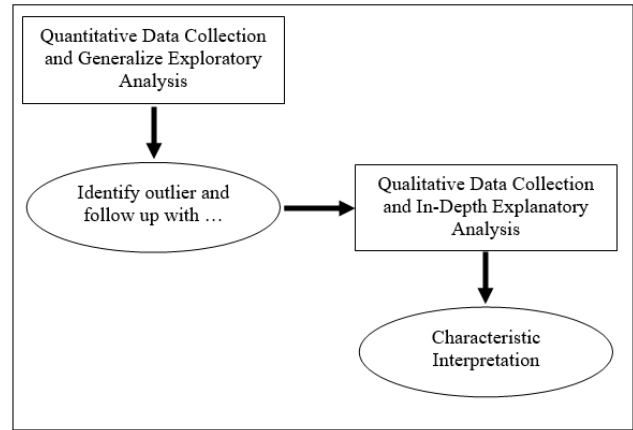


Figure 2: Sequential Design [22]-[25]

Table 4  
Research Question Objective with Primary Data Collection Mapping

RQ	RO	Survey Questions	Interview Questions
What effect mobile apps approach on healthy food intake of students and staffs in university?	To encourage people to achieve their weight goal and healthy body among staff and student at UCSI University with a mobile application.	1. What is your age? 2. Do you aware of your weight and BMI? 3. Do you control your food intake? 4. What causes do you think could affect obesity? 5. Have you used mobile apps (e.g. MyFitnessPal) for tracking your calorie intake before?	1. Do you think weight and food control is important? Why? 2. Why it is difficult to track your calorie intake when eating at the restaurant?
What type of food that people should eat to lose weight when they dine out in university area?	To recommend healthy food available within all restaurant around UCSI University.	6. Do you find difficulty in tracking your food while you eat out? 7. How often do you eat in UCSI University restaurant? 8. What type of food you usually eat at UCSI University? 9. What is the most important thing that you concern when eating in a restaurant?	3. Do you think food recommendation could promote people to eat healthier? Why?
How to encourage people to use mobile apps to track calorie intake without many user inputs required?	To reduce user input requirement by adding image recognition in the program for inputting data.	10. Do you find it difficult to input food you have eaten using mobile apps? 11. Which type of input for calorie-tracking apps do you prefer? 12. How accurate are the apps in calculating the calorie of your food?	4. How many steps of data input you would prefer and why?
How could technology encourage people in the university environment to eat healthy food and keep them motivated to achieve their weight loss?	To develop a mobile application that encourages people in UCSI University to eat healthily.	13. What is your smartphone's OS? 14. What has the most important thing come first when you using calorie-tracking apps? 15. How convenient do you think is mobile apps to encourage people losing/maintaining weight? 16. Do you think using mobile apps could encourage you to improve healthy eating habits?	5. Why the mobile app is more convenient to update user's food records? 6. Why mobile apps could encourage people losing weight and eat healthier?

The data collection questionnaires are divided into four parts, which determines each research question and research objective. There will be 20 questions for the survey, including demographic questions and six questions for an interview. Preliminary data collection is conducted first beforehand to test if the questionnaires are understandable for the respondents. There are five respondents for the survey and three respondents for the interview. Small changes in survey and interview questions occurred because there were some irrelevant answers from the respondents. There are 31 respondents in the actual data collection, and seven people asked in the interview. For the survey, random people are selected around UCSI University to fill in the questionnaire. Besides, people on a diet and trying to achieve a healthy lifestyle are asked in the interview about their personal opinion of calorie intake and how mobile apps could play a role in losing weight. From the data collection gathered, the result information is discussed in the next chapter.

#### IV. RESULTS AND DISCUSSION

From the primary survey that has been done, there are 31 respondents involved to answer the questionnaire given. In general, most respondents are aware of the Body Mass Index (BMI), which is illustrated in Figure 3.

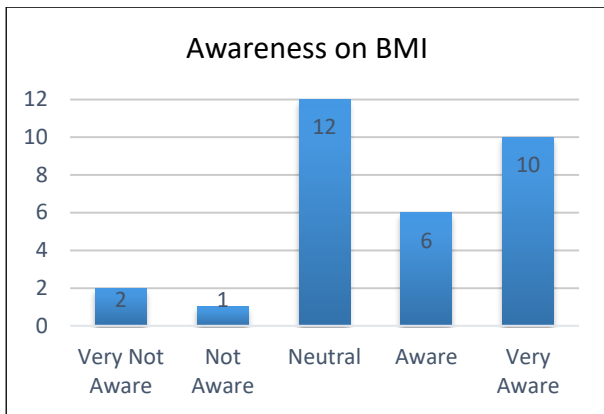


Figure 3: Survey Results of Awareness of BMI

As illustrated in Figure 3, most respondents are aware of BMI and their weight which could support the first objective of this study, which is encouraging people to achieve their weight goal and healthy body with the application of mobile app. Moreover, 68% of people (21 out of 31 people) sometimes control their calorie intake. However, 55% of people (15 out of 31 people) have difficulty controlling their calorie intake while eating out at a restaurant. To ask more details about the impact of mobile apps in preventing obesity and supporting diet and weight loss, the respondents are questioned about their perspective on the causes of obesity.

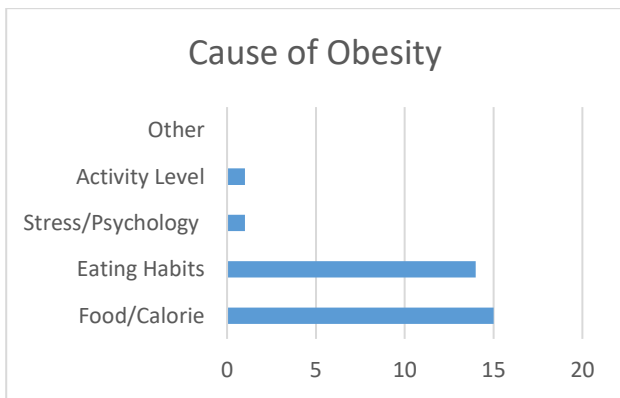


Figure 4: Survey Result of the cause of obesity

As shown in Figure 4, there is a quite challenging answer between eating habits and food or calorie intake as the cause of obesity. However, 15 out of 31 people vote for food or calorie as the most impactful cause for obesity. Based on the interview, all respondents agreed that calorie plays the most important role in the diet because it could determine how much the energy used and consumed from the food eaten. However, it is not easy to track the calorie of food served in most restaurant since the consumers will not know what ingredients and seasoning the chef used in the meals they served. Moreover, most restaurants are focus more on taste than the healthiness of their food.

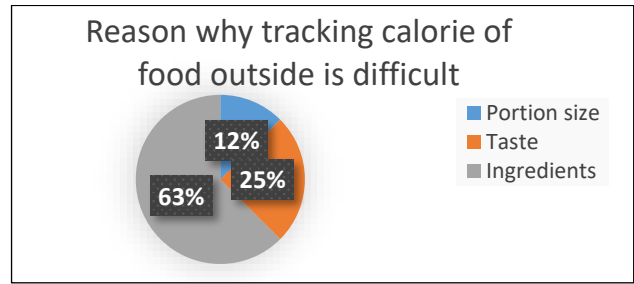


Figure 5: Interview Result difficulty tracking food calorie

In Figure 5, several reasons can be concluded from the respondents on why tracking food calorie outside is difficult. All respondents interviewed agreed that healthy food recommendation could promote people to eat healthier and lose weight if the nutritional information of food is provided and gives many food choices recommended for the user. Thus, the user can compare each food's calorie and nutrients and decide what they should eat.

The application of image recognition in the mobile app for food logging has positive feedback from the respondents. There are 40% (12 out of 31) of respondents prefer images, and 57% (17 out of 31) prefer image and text-based for food logging embedded in the calorie tracking app. On the other hand, 65% (20 out of 31) of respondents are android users. Thus, the app that will be implemented could approach more users and give them positive feedback.

The respondents also have positive feedback on the mobile app as a calorie tracker because of its convenience. With the app is accessed through a smartphone, users can get the notification as to the reminder and no reason for them not to track their food since they have the phone and the app with them. Also, the app could give knowledge to the people who are new in diet and lead them to achieve their goals.

#### V. PROJECT SOLUTION

From the feedback and data collected, the product solution has been implemented with three types of users: admin, shop owner, and the general user. The app has been implemented and recognizes the food captured on camera. Figure 6 illustrates the app's home screen.

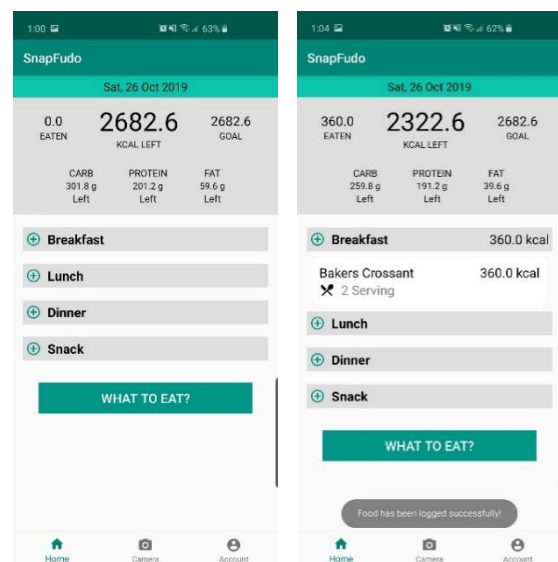


Figure 6: Home screen of the app



Figure 6 displays the home screen where the user can log their food and track the calorie. This home screen is displayed for the first time when the user successfully logged in to the app. Figure 6 (right) shows the food has been successfully logged when the user logs their food. The app automatically calculates the calorie that the user has eaten within a day.

There are three menus for the user to select at the bottom navigation menu: home, camera, and account. The camera menu will show new activity where the user can access the camera to log their food. The image recognition is working in this activity which is shown in Figure 7.

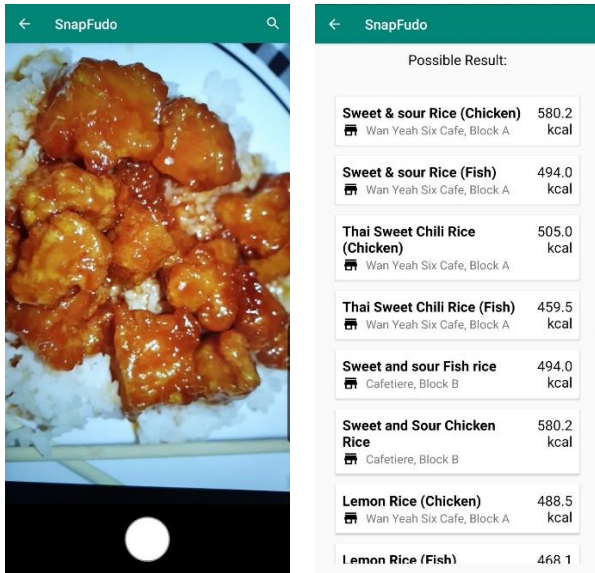


Figure 7: Real-time image recognition

Figure 7 shows that the app recognized the image captured as sweet and sour and results from it in the new screen and its calorie and shop in which the food is sold. As this dish commonly found in many shops in the UCSI, the result has many foods listed. After the user clicks on one of the items listed, they will be brought to the food details. The user can input how many servings of food they have eaten from the food details screen and let them log into their food diary. Afterwards, the system will perform the calculation and bring the user back to the home screen.

Besides image recognition, another main feature of the app is food recommendation. Figure 8 shows the function of the developed app. The food recommendation is based on the meal category include breakfast, lunch, dinner, snack and drink. This app will calculate the suggested calorie for the user in each meal. There is 25% of total calories for breakfast, 30% for lunch, 35% for dinner, and 10% for snack and drink. This percentage is the basic and recommended amount of calorie for each meal per day. The illustrated result is the food recommendation for breakfast. The food listed is sorted from the lowest to the highest calorie with the information details displayed in each item. Therefore, the user will tend to choose lower-calorie food for their meal.

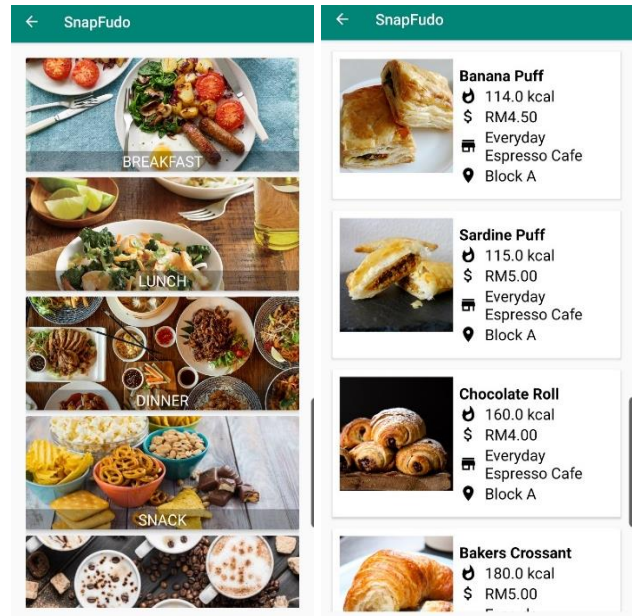


Figure 8: Food recommendation of the app

Another menu, the account page, allows users to personalize their data, such as weight, height, or name. This activity also allows them to see weight loss progression and BMI indicator. With the chart and indicator displayed, the user will be more aware of their weight and keen to achieve the target weight they have indicated. In Figure 9, the progress bar shows how far the target weight users want to achieve from their starting point. Below the chart, there are two buttons to update their weight and height. The system also shows the BMI value and in which category is the user.

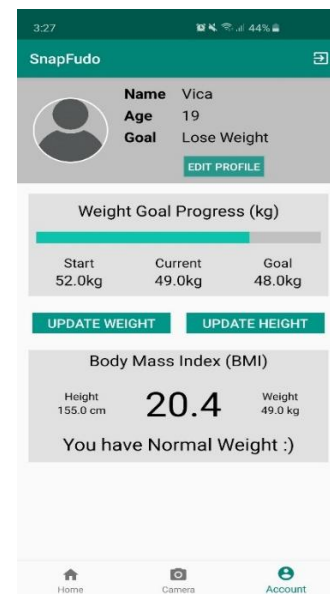


Figure 9: Account page of the app

After a few users tested the app, with these features included in the calorie tracking app developed, tracking calorie is more enjoyable and motivates the user to keep tracking their calorie intake. The calorie tracker works well like another calorie tracking app in the market. All features developed successfully without error occurred.

## VI. CONCLUSION

In conclusion, the process conducted throughout the project development has led to creating the system and successfully achieving this study's objective. Firstly, the app that provides calorie tracker and weight goal progress encourages people to achieve the weight goal and healthy body of the user [26][27]. The app successfully motivates the user with its simplicity and learnability offered to the user.

Secondly, the food recommendation of healthy food available in UCSI University is achieved from the feature included in the mobile app implemented. The feature is achieved by determining the calorie intake recommended by the user and showing the resulted food based on its calorie and macronutrient value [28].

Third, image recognition as another way of logging food has successfully been implemented to reduce the user input requirement. Using TensorFlow as the API for image recognition, the app support reuse and save more time on the implementation [29]. Moreover, the food detected is more accurate rather than a manually-trained system.

The final objective is to develop a mobile application by presenting the app physically [30]. Although this app judge itself could motivate the user to achieve their weight goals and a healthy body, the impact could be seen from the user's action and consistency. If many users use this app and successfully achieve a healthy body, Malaysia can be better and healthier. Moreover, it could boost the performance of each individual because of the healthy habit and lifestyle they are going to develop.

However, it might take time to result in the significant difference of each person since every person has a different metabolism. Further, healthy food recommendation is based on UCSI Restaurant only. The future study might be enlarged the scope for the food recommendation. Moreover, adding vegetarian and halal food options can be an option in the future project.

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