

LET ME SHARE

this
LOGSY

APPLICATION

with you

Senior Project
Semester 2, 2020



Engineering Project Final Report

mHealth App integrated with Eat, Sleep, and Exercise Data Analysis

Submitted by

Natakorn Ammy Kam	6031772621
Pachara Pattarabodee	6031796721

Approved by:

Project Advisor : Dr. Kunwadee Sripanidkulchai

Project Committee Member : Asst. Prof. Sukree Sinthupinyo, Ph.D.,

Project Committee Member : Asst. Prof. Daricha Sutivong, Ph.D.,



ABSTRACT

These days, living healthy has become a lifestyle that helps prevent chronic diseases and long-term illness, leading to one feeling good about themselves and boost their self-esteem and self-image. In Thailand, many people do not know how to live healthily and the available tools, such as health tracking applications, are not answering the users' needs. Therefore, the objective of this project is to create an application for users to accomplish a healthy living lifestyle through the use of data analytics to provide insightful suggestive data. Numerous surveys and literature were reviewed to discover the problem of mHealth apps in the market. Furthermore, the functions in the application were based on the solution suggested in the literature and user survey that it would solve the existing difficulties. Logsy is a mHealth application integrated with gamification and suggestive systems that suggest personalized meals based on users' total daily energy expenditure and location. The first version of Logsy is available in iOS and its suggestive meal based on location is usable in the Faculty of Engineering, Chulalongkorn University area. Moreover, the user test was conducted with the targeted users' group and the application was accepted for its ease-of-use and contained functions according to users' demands.



TABLE OF CONTENTS

1	INTRODUCTION	1
2	BACKGROUND	2
3	DESIGN REQUIREMENTS	4
4	DESIGN DESCRIPTION	7
4.1	Overview	7
4.2	Detailed Description	7
4.3	Use	13
5	EXPERIMENTAL SETUP AND METHODS	14
5.1	Experimental Setup	14
5.2	Experimental Methods	15
6	RESULTS AND DISCUSSION	16
7	CONCLUSIONS	18
8	REFERENCES	19
9	APPENDIX A: DESIGN	21
10	APPENDIX B: USER TEST	33
11	APPENDIX C: LOGSY USER INTERFACE	34



LIST OF FIGURES

Figure 1: Overall System Diagram	7
Figure 2: Use Case Diagram of Logsy Application	21
Figure 3: Login Activity Diagram	22
Figure 4: Dashboard Activity Diagram	23
Figure 5: Recommendation Activity Diagram	24
Figure 6: Record Activity Diagram	25
Figure 7: Community Activity Diagram	26
Figure 8: Notification Activity Diagram	27
Figure 9: Lifestyle Activity Diagram	28
Figure 10: Data Retrieval Activity Diagram	29
Figure 11: Sleep Standard Table. Note the table is referenced from the National Sleep Foundation [5].	29
Figure 12: Recommend Meal based on Daily Intakes Activity Diagram	30
Figure 13: Meal Recommendation based on Favorite Food Activity Diagram	31
Figure 14: Logsy Entity-Relational Diagram	32
Figure 15: Logsy User Test Recording Sheet	33
Figure 16: Login	34
Figure 17: Sign Up	34
Figure 18: Homepage	34
Figure 19: Eat Weekly Summary	34
Figure 20: Sleep Weekly Summary	34
Figure 21: Exercise Weekly Summary	34
Figure 22: Recommendation 1	35
Figure 23: Recommendation 2	35
Figure 24: Location	35
Figure 25: Food Record	35
Figure 26: Add New Food	35
Figure 27: Food Nutrient Info	35
Figure 28: Logging Record	36
Figure 29: Log Food	36
Figure 30: Log Drink	36
Figure 31: Log Sleep	36
Figure 32: Log Exercise	36
Figure 33: Notifications	36
Figure 34: Community Feed	37
Figure 35: Friend Search	37
Figure 36: Group Search	37
Figure 37: Community Bar	37
Figure 38: Profile	37
Figure 39: Edit Profile	37
Figure 40: Create Group 1	38
Figure 41: Create Group 2	38
Figure 42: Group Feed	38
Figure 43: Create Challenge	38
Figure 44: Challenge List	38
Figure 45: Scoreboard	38



LIST OF TABLES

Table 1: Design Requirement.....	5
Table 2: Eat and Exercise Criteria.....	10
Table 3: BMR Formula. Note the table is referenced from BMR Calculator [6]	11
Table 4: TDEE. Note the table is referenced from American Heart Association Recommendations [8]	11
Table 5: Recommended Nutrition for Thais. Note the table is referenced from DIETARY REFERENCE INTAKE FOR THAIS 2020 [4].....	12
Table 6: Results and Discussion.....	16



1 INTRODUCTION

Nowadays, people are more likely to be less aware of taking care of themselves especially in the urban area. People are prone to live such a rush lifestyle, which affects their health. For example, people who work as office workers have to get up early to go to work because of the traffic, resulting in less sleep or skipping breakfast. Moreover, people began to rely on technology to help accomplish tasks in every aspect of their life as it requires less effort. With the current situation in the urban area and the technology, it makes people care less about a healthy lifestyle.

Therefore, an mHealth application named Logsy is created, which is an application that helps users to reach their health goal through the use of data analytics to provide insightful data via a suggestive system. The application could lead users to a better lifestyle as it could tell the condition of your health along with the suggestions to improve it. It can help people especially those in the urban area to track each of their lifestyle aspects which include eating, sleeping, and exercising. Moreover, the application shall reduce the ease of understanding health information.

The objective of this project is to deliver an application that is basic and attractive to use. The application offers 4 main functions which are providing personalized analysis, localized suggestive plan, community, and challenge. The scope of the work is to provide an application that can suggest the meal within the Faculty of Engineering, Chulalongkorn University area. In conclusion, the team wants to improve the quality of people's life in urban areas by providing an application that helps them to do so.



2 BACKGROUND

For decades there have been concerns about the increasing number of people living in urban areas of Thailand, especially Bangkok. Its population is approximately 13 times larger than Samut Prakan, which is the province that has the second largest population in Thailand. This number does not include those who live in Bangkok without properly immigrating themselves from their hometown. This shows that Bangkok is likely to be more overcrowded, leading to an unhealthy lifestyle of Bangkokians as everyone is living in a fast-paced environment. “According to the World Health Organization, ‘A healthy lifestyle is a way of living that lowers the risk of being seriously ill or dying early. Not all diseases are preventable, but a large proportion of deaths, particularly those from coronary heart disease and lung cancer, can be avoided.’ This shows that there is a need to promote healthy habits.” To have a healthy lifestyle, each person has to manage to have a balance of eating, sleeping, and exercising. However, Bangkok’s surroundings do not support this to happen due to the hot climate, inconvenient public transportations, and poor public footpath, leading to an unproductive lifestyle. The prevention of Bangkokians from being healthy not only includes the environment but also individual money, time, and knowledge constraints.

Countless people have a perception of a healthy lifestyle as eating only boiled chicken breast and vegetables, sleeping at 8 PM, and going to the gym 7 days a week. In reality, a balanced diet can be obtained by consuming food with calories according to “Total Energy Expenditure”, which is the number of calories burned by the human body in one day adjusted to the amount of activity. Furthermore, the food ingest shall incorporate sufficient nutrients (carbohydrates, proteins, fat, vitamins, minerals, fiber, and water) needed for body nourishment. For the sleeping aspect, the individual shall seize for rest duration as recommended by the National Sleep Foundation which is based on age. Lastly, on the exercise angle, adults are suggested to spread out a total of at least 150 minutes of moderate activity in a week which brisk walking is also included; being active for short periods throughout the day can add up to provide health benefits.

With the problems mentioned above, there should be a platform that could track or enhance the wellness of people’s lives along with educating healthy lifestyle information. Currently, there are innumerable health tracking applications for users to choose in the market. Even so, the research has pointed out that people are using the available application for a short period of time [10]. The question arises what is the motivation for one to have continuous usage of the application. From the literature reviews, the team found out that there are 2 types of motivation, which are extrinsic motivation and intrinsic motivation. Extrinsic motivation refers to the urge to perform for a reward, while intrinsic motivation refers to the urge to perform for personal rewarding. The latest research has found that intrinsic motivation is needed for users to keep using the application (Cerasoli et al., 2014, cited by Tu et al., 2020). Besides, the major reasons users tend to stop using health tracking applications are because of no motivation, non-local data support, complex information, no engagement, and lack of community [11, 12, 14]. Another issue being concerned is the privacy regulation of the application; users are fearful of data breaches as they do not know or have control of where their data would go [1].



The team investigated the popular health tracking applications, which include MyFitnessPal [8] and CalorieDiary [9]. The main issue in MyFitnessPal is that its food database is lacking the menu found in Thailand, leading to unable to log food records. CalorieDiary is an application developed by Thai people, providing a personalized meal plan joining Thai and International food. However, the daily meal plan offered by CalorieDiary cannot be refreshed to suggest a new menu, which causes difficulty as users would not be able to find the exact menu recommended all the time. The problem can lead to not following the personalized diet plan and stop tracking performance.

The team, therefore, examines the issues and finds a solution by reviewing publications and surveying. The study has stated that implementing gamification experience in health tracking applications contributes a positive impact on the users, which includes both behavior and motivation impacts [2]. According to another paper [3], the game elements in which promotes intrinsic motivation include like, leaderboard and community. While intrinsic elements boost social interaction, the extrinsic elements (level, badge, point, digital reward) enhance the enjoyment of the user. At the end of the day, the elements urging intrinsic motivation showed more impact both in users' performance on physical activities and the prolonged usage of the application.

Logsy application development aims to help people accomplish a healthy living lifestyle by using data analytics to provide insightful suggestive data. Apart from this, the application also targets to uplift the continuing usage of health tracking applications by gamifying the functions.



3 DESIGN REQUIREMENTS

The design requirement gathered in this section emerged from problem analysis, which leads to literature reviews and potential users' interviews. As the team encountered the problem of keeping a healthy lifestyle, the team began to analyze the existing solutions. However, the result was that there is no single platform that could respond to all the user's needs; for example, most platforms could not provide the appropriate activities according to the user's location. Therefore, the team started to gather the information to create a proper solution for the problem.

The literature review was conducted leading to many important factors in health application. The team first found out that the main interest for users to use the health application is motivational factor, which is the main reason that affects long term usage. By motivational factor, we mean that application should be convincing to use continuously. Moreover, the team found out that there are 2 types of motivation: intrinsic and extrinsic motivation. While intrinsic motivation means doing things to get reward, extrinsic motivation means doing things for individual's happiness. Therefore, the team would like to improve these motivations which leads us to these 3 points.

1. **Gamification:** This refers to applying competence and autonomy into the health application. It also refers to integrating the avatar, scoreboard, and likes into the application.
2. **Personalization:** This refers to providing an individual's result and suggestion as each person has different needs as well as ability to comply with application suggestions.
3. **Association:** This refers to communicating with other people. The team found out that users need to feel related to something in order to improve their intrinsic motivation.

However, the research information is important, but the opinion of potential users is as important as prior information. As a result, the user interview is conducted to collect information about what should be included in the health application. Each interviewee is selected according to their health lifestyle, ranging from fitness person to unfitness person. Each interviewee is given a set of questions, varying from broad to deep questions about health application, that are asked for an opinion by the team. The finding can be concluded into 2 main points.

1. **Incompatible:** Interviewees have problems on complying to the suggestion of other health applications. For example, users could not find the suggested food in their area, then they lose motivation to comply with the suggested plan.
2. **Engaging:** Interviewees find that other health applications lack engaging elements. Most health applications show boring informative text resulting in less engaging elements. This also affects the user's level of interest in the application.

After the team analyzed the problem thoroughly, the proper solution is to create a mobile application that could create customized suggestive lifestyles for everyone. Therefore, the team has created solutions to address each problem found in both literature research and interview.



Table 1: Design Requirement

#	Design Requirement	Source	Problem Address	Description
Functional Requirement				
1	Personalized Analysis	Literature, Interview	Personalization, Engaging	The application shall allow the user to view their result of lifestyle every week.
2	Location Awareness	Interview	Incompatible, Engaging	The application shall be aware of the user's location to present the recommendation plan according to location.
3	Community	Literature, Interview	Association, Engaging	The application shall have social-media features to allow users to communicate with other users.
4	Challenges	Literature	Gamification, Engaging	The application shall allow users to create challenges to compete with others in the community.
Non-Functional Requirement				
5	Availability	-	-	The application shall be 24-hour available online.
6	Performance	-	-	The application shall provide real-time data with at most 1-minute delay.

The main design requirement for Logsy mobile application is divided into 6 parts, which are personalized analysis, location awareness, community, challenges, availability, and performance.

For the first design requirement, the need for the personalized analysis for each user is found on both literature and interview. The analysis is about the user's lifestyle in eat, sleep, and exercise aspects, which represents through text no complex number. However, Logsy acknowledges that the numeric information is still needed, so that information is shown in other sections as well.



The location is one of the main problems stated by the interviewees. Most of the health applications in the market come from foreign countries, which makes their food database contain a lot of foreign food that is hard to find in Thailand. Therefore, the recommendation from those applications would be hard to comply for the user. On the other hand, Logsy shall provide recommendations based on the user's location.

The third design requirement is community. The community is represented by the application of social media where people could talk to each other online based on the topic they are interested in. This requirement is encouraged from both literature and interview.

The competence in the health application is also included to the main design requirements based on the literature review. To apply this to the application, the challenges feature is added to the community where users can create their own challenge to play with friends. Moreover, there are badges to comply with this design as well.

Availability means that the application is available to access by users anytime. The users could use the application as long as the internet connection is available.

Performance means that the application response time will be lowered than 1 minute. The users could use the application with delay at most a minute as long as the internet connection is available.



4 DESIGN DESCRIPTION

After the design requirement was done, the solution of the process needs to be created. The solution is decided to be presented as a mobile application, named Logsy, as it is used extensively among the target users. The main feature of the application would involve encouraging users to live a healthier life, filling the missing ability in most of the health applications.

In this section, the whole process will be described from the high-level to low-level. This section contains illustrations as well as textual descriptions.

4.1 Overview

Logsy is a mobile application that has 3 main parts in the system architecture, which are back-end, front-end, and database parts (See Figure 1). The system that Logsy used to implement the system is called client-server architecture, which means that the client side shall contact the server side directly. Users can use the application by installing the front-end part on their mobile, which can communicate with the Logsy backend on the cloud. For the database, the only connection it needs is to the backend part because the backend is the only gateway to communicate with the database. The team also provides the design of the database to elaborate the detail of the database (See Appendix A Figure 14). In this way, it can be made sure that users could not access the database directly, preventing any unusual or malicious activities in the future. This system shall be able to serve the main features in the application, which are Dashboard, Recommendation, Record, Community, and Notification.

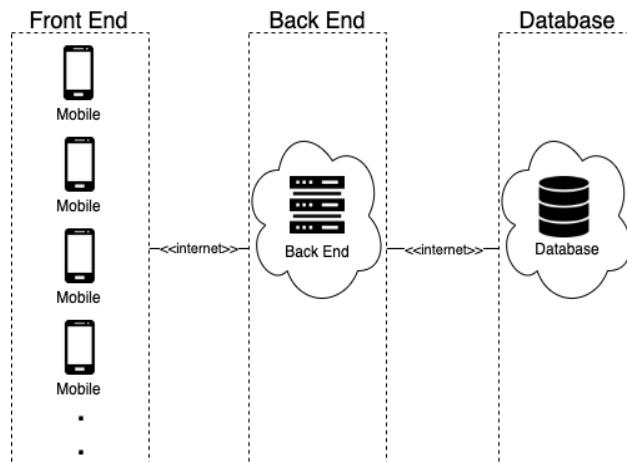


Figure 1: Overall System Diagram

4.2 Detailed Description

Even though the system architecture of the application seems to be simple, the detailed component is complex. There are many activities and features that users could access in the application, which means that each scenario should be illustrated and categorized based on those activities. Each activity includes the user-experience and some data management. Therefore, this section will be separated into 3 parts: Features Implementations, Algorithm Implementations, and Database Implementations.



4.2.1 Features Implementation

As stated, Logsy application shall have 5 main features for users; therefore, the technical description in this section will be divided according to those features. However, there is one feature that could not be missed to explain the whole implementation which is the Login feature; therefore, the login feature is discussed as well. First, the overall use-case diagram and activity diagram are provided to facilitate reader's understanding. (See Appendix A Figure 2)

4.2.1.1 Login Feature Implementation

For the additional main feature, this feature is completed before other features. The process starts when the user opens the application, then there are 2 possible ways for users to continue depending on their condition. For the user that uses the application for the first time, the user must provide their basic information about themselves and their lifestyle in order to let Logsy generate a personalized plan for them. The user that already signed up with Logsy could login using their own credential. (See Appendix A Figure 3)

The goal of the login feature is to retrieve user's information; therefore, it is not considered as one of the main features. However, it is the first process in the application, so it is mentioned. All the features mentioned after this is assumed that this process is already done.

4.2.1.2 Dashboard Feature Implementation

Dashboard is the main feature of the application as it is the main reason why the team wants to develop this application. This feature is the first feature that the user sees after entering Logsy. The content in this feature is separated into 2 parts: personalized analysis and color indicator. The first part contains informative text that analyzes the user's lifestyle, while the other part represents the condition in colors. Users can understand their lifestyle performance quickly. However, there is detailed information for users to access. The user can choose each icon below to see detailed information containing numbers, graphs, and some specific data like meal and exercise list. Moreover, the data can be changed to view in different weeks. (See Appendix A Figure 4)

The objective of the dashboard feature is to present the performance of the user's lifestyle as simply as possible. This feature is developed based on the problem of too complex information for users to interpret.

4.2.1.3 Recommendation Feature Implementation

Logsy's food recommendation system is also different from other applications in the market, as it concerns the user's location. Each time a user uses this feature, the application shall check the current location before calculating the recommendation for the user. The recommended meal shall be calculated from the nearest restaurant first. In this page, users can view 3 types of recommendation: recommend meals based on daily intakes, snacks, and recommend meals based on interest. To recommend meals based on daily intakes, it recalculates 3 times a day for breakfast, lunch, and dinner. Moreover, there are more choices in the next section, the personalized meal based on the user's interest, where users could also select to eat. Therefore, there are 2 sections where users could view their meal and select to eat. The snack section shall recommend once a day only. (See Appendix A Figure 5)



This feature purpose is to recommend the meal the user could find and eat in their area instead of finding some meal that is impossible to find like what other applications recommend them to eat, for example, avocado toast with smoked salmon.

4.2.1.4 Record Feature Implementation

This feature is an essential part of the application because the application could not produce any analysis without any recordings. There are 3 main types of record in this section: eat, sleep, and exercise. The eat section has 5 sub-type which are snacks, breakfast, lunch, dinner, and water. The first four have similar processes, starting by searching for the meal that the user wants to record. If the meal is not found, there is an option to add the user's own food (or a food that does not exist in the database). Moreover, each food can be viewed into more details before the user selects to press the eat button. For water recording, users can select the pre-selection water amount or enter any amount the user wants. For the other type of record, the user gives their information required in each page and presses the record (See Appendix A Figure 6). The main function of this feature is to record all types of lifestyle for the algorithm to calculate the analysis in the dashboard section.

4.2.1.5 Community Feature Implementation

Community feature is a feature that represents social media related to health aspects only. This is where users can come to communicate with other users, join groups, and join challenges. There are 4 types of activity in the community section: friend, group, challenge, and user management. Users can find friends in the search area; moreover, users can add, delete, accept, and cancel friend requests.

There are 2 types of groups: public and private. Moreover, users can create groups as well as join others. Being in a group, users can unlock the ability to challenge other members and earn points, racing to be on the scoreboard. Lastly, users can post in the group to express themselves or to motivate other members. For the last activities, users can view their information and manage them. (See Appendix A Figure 7)

The feature allows users to meet with other users with the same interest and also gives users an opportunity to have friends experiencing the same journey for lifestyle goals.

4.2.1.6 Notification Feature Implementation

The last feature is a miniature feature to support community features, which is a notification feature. This is where the user comes to see their friend requests and group invitations, which the user can either accept or refuse. Moreover, there is also a badge notification for users to see what badge they have just earned as well. (See Appendix A Figure 8)

4.2.2 Algorithm Implementation

Behind those simple activities in each feature, there is a place that holds a complex algorithm to calculate the result for those activities. In Logsy, there are 2 main complex algorithms that require critical analysis to create an algorithm in both mathematical and correctness in the health aspect, which are lifestyle analysis calculation and food recommendation calculation.



4.2.2.1 Lifestyle Analysis Implementation

For lifestyle analysis, there are 2 types of algorithms, which are personalized messages and color indicators. These algorithms are used with the dashboard feature, where it shows the analysis result. In total, there are 3 sub-section in each type: eat, sleep, and exercise.

In this section, the algorithm comes from the real data used in the food and nutrition field. This lifestyle analysis algorithm can be used to determine both personalized message and lifestyle analysis. (See Appendix A Figure 9) To determine the result, the information of the user is first obtained to create the nutrition plan. (See Appendix A Figure 10) For eating, the criteria to determine the result of a user is according to table 2; for example, if the user eats more than 120% of their goal daily intakes, it means that they eat too much; this criterion is derived from discussion with a nutritionist and a report paper [15]. For sleep, the user's result shall be compared with the sleep standard by age range (See Appendix A Figure 11). Lastly, the exercise shall be varied by the settings of the user. However, Logsy recommends users to exercise at least 150 minutes per week [7]. This criterion is also derived with a nutritionist.

Table 2: Eat and Exercise Criteria

Health Aspect	Color	Percentage
Eat	Red	>120% or < 80%
	Green	80%-120%
Exercise	Green	>80%
	Yellow	>=50%
	Red	<50%

4.2.2.2 Food Recommendation Implementation

In Logsy, there are 2 types of recommendations, which are based on the user's daily intakes and favorite food. By daily intakes, it means that the application shall recommend the meal based on time of the day, nearest restaurants list, and remaining ratio of daily intakes. On the other hand, favorite food means that the application shall recommend based on the user's interest.

4.2.2.2.1 Recommend Meal based on Daily Intakes

From consulting with nutritionists, the team found out that the recommended ratio for each meal in a day should be about 30% of daily intakes; for example, Emily has 1600 kcal as daily intakes, Emily has to eat about 480 calories per meal. However, Emily can eat less or more than the recommended ratio; therefore, the server shall check whether Emily had eaten any meal on that day to adjust the recommended meal properly (See Appendix A Figure 12). After that, if the calculated ratio results in less than 300 kcal or more than 700 kcal. The recommended meal shall be searched based on those thresholds instead. Then, the algorithm shall find the suitable meal until the number of meals is more than 10. Lastly, one meal shall be random to send to the user.



To elaborate more, this section will walk through a day of Jessica with Logsy. Starting from looking at Jessica's daily intakes, which is calculated since Jessica signed up with the application. The results needed to calculate each person's daily intakes are BMR (Basal Metabolic Rate) and TDEE (Total Daily Energy Expenditure).

Table 3: BMR Formula. Note the table is referenced from BMR Calculator [6]

Gender	BMR Formula
Female	(10*weight in kg) + (6.25*height in cm) - (5*age) - 161
Male	(10*weight in kg) + (6.25*height in cm) - (5*age) + 5

Table 4: TDEE. Note the table is referenced from American Heart Association Recommendations [8]

Level	Physical Activity Description	TDEE Formula
1	Little or no exercise	BMR * 1.2
2	Exercise 1-3 times/ week	BMR * 1.375
3	Exercise 4-5 times/ week	BMR * 1.465
4	Daily exercise or intense exercise 3-4 times/ week	BMR * 1.55
5	Intense exercise 6-7 times/ week	BMR * 1.725
6	Very intense exercise daily, or physical job	BMR * 1.9

Jessica is a 22 years-old female with the weight of 55 kg and 162 cm in height, resulting in a BMR of 1292 kcal. She has level 1 in exercise resulting in 1550 kcal for TDEE, which is the daily intakes for Jessica. However, finding the meal based on one value could result in a small amount of meal to fit the criteria. To widen the search area, the team discussed with nutritionists, leading to allowing the number of daily intakes to be lower by 20%; therefore, Jessica can eat between 1240-1550 kcal per day.

After Jessica opens the recommendation feature in the app, the server shall check for their daily intakes before suggesting any meal. Assuming that Jessica opens this feature in the morning and Jessica opens it while Jessica is near iCanteen, Chulalongkorn University, the server shall request for the nearest restaurants that are near Jessica to query breakfast. First, the current location of the user is retrieved, then the server shall send the restaurant information to sort it in the user side. Then, the sorted restaurant shall be sent back to the server for meal retrieval. As stated above, each meal should be about 30% of the daily intakes; therefore, this meal should be about 372-465 kcal. However, Logsy does not recommend meals based on calories only because Logsy also concerns carbohydrate, protein, and fat intakes.



In this case, Jessica shall have daily intake of carbohydrate between 175-250g, protein between 39-58g, and fat between 34-60g. In conclusion, the server has 4 meal criterions to find breakfast which are the calories, carbohydrates, protein, and fat should be between 372-465 kcal, 52.5-75 g, 11.7-17.4 g and 10.2-18g, respectively. (See Table 5)

Then, the meal shall be filtered by the meal calories and nutrition value from top 5 nearest restaurants to Jessica. If the result is less than 10 meals, then the algorithm would widen its search to top 10 nearest restaurants. If it is still less than 10 meals, the algorithm would change by filtering only meal calories from top 10 nearest restaurants. This is because the team wants to make sure that the meal is varied enough to be random. Lastly, one meal is random and sent to Jessica to view.

Table 5: Recommended Nutrition for Thais. Note the table is referenced from DIETARY REFERENCE INTAKE FOR THAIS 2020 [4]

Nutrition	Calories Comparison	Age Range	Daily Intakes Percentage
Carbohydrates	1 g/ 4 kcal	all	45-65%
Protein	1 g/ 4 kcal	all	10-15%
Fat	1 g/ 9 kcal	9-18 years	25-35%
		More than 18 year	20-35%

4.2.2.2 Recommend Meal based on Favorite Food

This recommendation is based on the user's interest. The algorithm works similarly to the prior one; however, there are some differences. The information required to generate results are the user's interest and nearest restaurants list. (See Appendix A Figure 13)

4.2.3 Database Implementations

4.2.3.1 Food Table Implementation

The data store in the food table can be added by either the admin or users. The food inserted by the admin is considered as a verified food and the one added by users is regarded as unverified; however, it can be verified later by the admin.

4.2.3.2 Restaurant Table Implementation

The restaurant table contains all the restaurants in iCanteen, Faculty of Engineering, Chulalongkorn University. Moreover, those restaurants can have multiple branches, such as Khao Nheaw Kai restaurant (at iCanteen and faculty of arts canteen). Therefore, RestaurantBranch table is created to store the information of each branches, for example, latitude and longitude. The relationship between Restaurant and RestaurantBranch table is many-to-one.



4.2.3.3 HasMenu Table Implementation

The HasMenu table in the database contains foreign keys from 2 tables, which are the Food table and Restaurant table. The table stores the list of menus that each restaurant has. For the implementation, the team first obtained the menu list of each restaurant by visiting iCanteen and taking pictures of the menu. Then, add the relationship of food and restaurant according to the menu into HasMenu table.

4.3 Use

Logsy application is available for download on the app store of iOS platform. After installing it on mobile, users can open Logsy to sign up on the platform as the information of the user is needed to create a nutrition plan. Then, users can use all of the features provided by Logsy.

- **Dashboard**

If a user wants to view their analysis, the user can view on the dashboard. This section includes their analysis as personalized message and color indicators. However, this can be viewed when there is at least 1 week of record.

- **Meal Recommendation**

If the user wants to see the meal recommended, the user can view the recommendation page. This section provides a meal that is recommended 3 times a day (breakfast, lunch, dinner). There is also a snack recommendation which is recommended once a day. Lastly, there is a favorite meal section that recommends the food based on the user's interest.

- **Record**

If the user wants to record, the user can do it here. There are meal, sleep, and exercise records. Users can also add a new meal if it does not exist on the food database.

- **Community**

If a user wants to communicate with others, the user can access this page. Community has friends, groups, and challenges. Users can find friends and groups to join. After joining a group, users can communicate with others in the group and join challenges.

- **Notification**

Users can check their friend request and group request on this page. These requests can either be accepted or deleted.



5 EXPERIMENTAL SETUP AND METHODS

5.1 Experimental Setup

The purpose of this user test is to evaluate the usability and performance of Logsy from the perspective of the target user group. It would allow the team to find out errors and defects of the application as well as check the completeness of the application against the requirement.

Scope: To test the 6 main design requirements of the application.

Goal: To be able to identify the usability problems, collect qualitative and quantitative data and determine the user's satisfaction with the application.

Sample Size: 3 users

The following is the setup for user testing of Logsy:

1. Recruit testers

Contact the target tester group to join the user test. The tester shall be the target and potential user of Logsy.

2. Make an appointment with each tester

The team shall make an appointment with the testers about the exact time, test duration and location.

3. Explain the testing process

On the test day, the team shall inform the tester about the goal and objectives of the test as well as the number of tasks to complete. Each task will have a specific goal, and the team wants the tester to explore the application and complete each task.

4. Test the application

While the tester uses the application, the team will be observing the tester to track the tester interaction with the application as well as the time to complete each task.

5. Collect feedback

Ask the tester about the feedback which the topic includes bug reports, feature requests, user interface design, user experience. The team shall respond quickly when the tester encounters a problem while doing the test.



5.2 Experimental Methods

To examine the performance of the 6 main functions of Logsy, the team uses black-box testing technique which is also known as behavioral testing. The test focuses on the functional requirements of the application. Black-box testing attempts to find errors in the following categories: incorrect or missing functions, interface errors, errors in data structures or external database access, behavior or performance errors, and initialization and termination errors. The user test consisted of 10 scenario and 9 system usability scale questions (See Appendix B Figure 15)

1. **Personalized Analysis** - On Sunday, the personalized dashboard showing the analysis of the eating, sleeping and exercising aspect on the homepage was updated. The system processed the dashboard's information according to what the user logged in the past week. The wording analysis in the dashboards was talking about how well the user performed on 3 points, which the message was integrated with two parts: motivating and educating messages. Moreover, the outcomes were categorized into colors (red, yellow, and green) to allow the user to quickly see the conclusion of last week's performance.
2. **Location Awareness** - The system obtained the current location of the user and sorted the restaurant list according to the distance from the user. The application recommended a meal that is from the top 10 nearest restaurants.
3. **Community** - User posted a post with text and image in the group he/she has joined. The other members in the group saw the posted post in their home feed or the group feed. If the post was posted in a private group, non-members could not see the post.
4. **Challenges** - A group member created a challenge in the group and filled in the challenge information (name, category, level, start date, end date, and description). The member who created the challenge joined the challenge and other members in the group clicked to join the challenge. Once the user completed the tasks and clicked complete, the system automatically increases the user's total score according to the challenge reward. Moreover, the group members can see the list of people who joined and completed the challenge.
5. **Availability** - The user entered the application (at any time of the day) and then the system showed the data of the user in the application. All the functions, such as logging breakfast, logging water, posting a post, and adding a friend was ready for the user to use.
6. **Performance** - The user opened Logsy and the system displayed the information and function within 1 minute. All the actions taken by the user were showing their result in less than 1 minute.



6 RESULTS AND DISCUSSION

After the experimental setup and method are clearly stated, the user testing process is conducted. There are a total of 3 users that took part in this test. In this section, the results from the test are shown along with the discussion. There are 2 parts, which are the test scenario result and usability system scale result.

In this part, the scenarios are separated into 4 parts, which are the same as the functional requirements in the design requirement section. These four parts include personalized analysis, location awareness, community, and challenge. The results and discussion are explained separately in the table.

Table 6: Results and Discussion

Scenarios	Results	Discussion
Personalized Analysis		
You want to read your weekly analysis in each aspect. You want to see your performance in textual description and know what you can improve.	All of the users did not spot the 3 dashboards in the home page as they said it is just a text explaining how to use the application.	The team and users agree that if they were to use the application for the first time, there should be a message that tells them about the purpose of this part. Then, users will notice that the text on the dashboard is their personalized analysis of their performance.
You have been logging food, sleep and exercise records in Logsy for a week. You want to see your performance in numerical data.	The users were able to do the task right away.	Most of the users click this part as a mistake from the first task; therefore, it makes them know about this part quickly. Moreover, users could understand the meaning of the most data in the application right away. Some users suggest that the color legend should be added for more clarification.
Location Awareness		
You want to have breakfast, so you open Logsy to see what is the recommended menu for your breakfast in the restaurant nearby. You also want to know how to go to that restaurant.	The users were able to find the recommended meal but did not notice that the map is clickable.	The team shall redesign the location button to make users regard it as clickable.



You want to have breakfast, but you don't like the recommended menu. Then, you look at the personalized meal instead.	The users were able to do the task right away.	The team and users agree that the section shall change the name to "Your favorite menu" to make users understand the rationale behind the section.
Community		
You don't have the same interest anymore, so you want to change that in your profile.	The users were able to do the task right away.	The function is straight forward; therefore, users were able to do the task without any hesitation.
You want to find Group "Boba Lover", and you want to join this group as well.	The users were able to do the task right away.	The function is straight forward; therefore, users were able to do the task without any hesitation.
You want to create a community space where people who love avocado can discuss it with each other.	The users were able to do the task right away.	The function is straight forward; therefore, users were able to do the task without any hesitation.
You have just finished a workout and want to write a post in your group to let your friend know.	The users were able to do the task right away.	The function is straight forward; therefore, users were able to do the task without any hesitation.
Challenge		
You decided to not eat sweet for a week and you want friends to join in, so you decided to create a challenge in the group.	The users were able to spot the page they were supposed to create the challenge but did not notice the location of the create button right away.	Users are not able to spot the create button as it is in the group page. All of the users decide to go into the challenge page, which they think that the create button is located there; therefore, the challenge button shall be moved into the challenge page.
You want to join a challenge.	The users were able to do the task right away.	The function is straight forward; therefore, users were able to do the task without any hesitation.

The second part of the test is usability system scale, which is the general question for the application. The outcome is that most of the users said that the application is interesting to use; moreover, they said that it is not too complex. There is no need to learn new things to be able to use this application. (See Appendix B Figure 15)



7 CONCLUSIONS

To conclude the project, the team is able to deliver an application that is simple to use and able to comply with the user's needs stated in the design requirement. In this section, the result work shall be assessed, and the future work shall be discussed.

7.1 Assessment

The first version of the application meets nearly all of the requirements stated. The core functionality remains unchanged; however, the avatar function did not meet up to the standard mentioned in the pre-project proposal as it did not allow users to customize it but give a set of 50 pre-design avatars for users to choose from. Nonetheless, after users tried the application, most of them are satisfied with the current version and provide suggestions for further improvements. Users were impressed with the ability of the application to recommend meals according to their location and also allow them to refresh for new recommended meals as it solves the problem of not being able to find the menu. Moreover, the application also contains multiple functions that other mHealth apps in the market do not have, such as challenge and textual analysis of user performance. With all the functionality in the application, it would allow Logsy to stand out in the competitive mHealth application market.

7.2 Next Steps

To improve the usability of the application, there are many features that could be implemented for users; for example, messaging, like, or comment can be added in the community feature to make this feature more similar towards a social media application.

Logsy main focus is on the eat aspects rather than sleep and exercise. The next step should be about focusing on those two aspects; for example, how could we detect the sleep state better without the help of an additional gadget or how could we suggest the exercise activity to be more realistic. For the current state of the food database, there is only data in the Faculty of Engineering, Chulalongkorn University area. The future work for Logsy is to make it usable in different areas and provide the API for fetching food data along with posting data to enlarge the food database. Moreover, this API could be used for other projects like analyzing the nutrition that Chulalongkorn University students are likely to take in a year.

8 REFERENCES

- [1] Woldaregay, Ashenafi & Issom, David-Zacharie & Henriksen, André & Marttila, Henna & Mikalsen, Martin & Pfuhl, Gerit & Sato, Keiichi & Lovis, Christian & Hartvigsen, Gunnar. (2018) Motivational Factors for User Engagement with mHealth Apps. *Studies in Health Technology and Informatics* 249: 151-157.
 - [2] Kari, Tuomas & Pippo, Jenni & Frank, Lauri & Makkonen, Markus & Moilanen, Panu. (2016) To Gamify or Not to Gamify? Gamification in Exercise Applications and Its Role in Impacting Exercise Motivation. *BLED 2016: Proceedings of the 29th Bled eConference “Digital Economy”*: 393-405.
 - [3] Tu, Rungting & Hsieh, Peishan & Feng, Wenting. (2018) Walking for fun or for “likes”? The impacts of different gamification orientations of fitness apps on consumers’ physical activities. *Sport Management Review* 22(5): 682-693.
 - [4] สำนักโภชนาการ กรมอนามัย กระทรวงสาธารณสุข. (2020). *DIETARY REFERENCE INTAKE FOR THAI* 2020 (1st ed., p. 4).
 - [5] *How Much Sleep Do We Really Need?* | Sleep Foundation. Sleepfoundation.org. (2021). Retrieved 1 February 2021, from <https://www.sleepfoundation.org/how-sleep-works/how-much-sleep-do-we-really-need>
 - [6] *BMR Calculator*. Calculator.net. (2008). Retrieved 19 February 2021, from <https://www.calculator.net/bmr-calculator.html>.
 - [7] *American Heart Association Recommendations for Physical Activity in Adults and Kids*. www.heart.org. (2018). Retrieved 17 February 2021, from <https://www.heart.org/en/healthy-living/fitness/fitness-basics/aha-recs-for-physical-activity-in-adults>.
 - [8] Under Armour Inc. (2020) MyFitnessPal (Version 20.22.0) [mobile app]. Available from: <https://apps.apple.com/us/app/myfitnesspal/id341232718> (Accessed November 9th 2020).
 - [9] Dimo Co.,Ltd. (2020) CalorieDiary (Version 2.1.64) [mobile app]. Available from: <https://apps.apple.com/us/app/แคลอรี่-ไดร์ดี้/id892040449> (Accessed November 9th 2020).
 - [10] Behne, A. & Arlinghaus, T. & Kotte, N. & Teuteberg, F. (2020) Towards Functionalities of Self-Tracking Wearables, their Effects on Humans and their Application Areas: Where can We Improve?. *AMCIS 2020 Proceedings* 14.
 - [11] Mathieu Winand , Alicia Ng & Terri Byers (2020): Pokémon “Go” but for how long?: a qualitative analysis of motivation to play and sustainability of physical activity behaviour in young adults using mobile augmented reality. *Managing Sport and Leisure*.
 - [12] Fenton, A., Cooper-Ryan, A. M., & Vasilica, C. M. Smartphone fitness apps and football fans. *Football as Medicine*: 201.
 - [13] Lin, C. W., Mao, T. Y., Huang, Y. C., Sia, W. Y., & Yang, C. C. (2020) Exploring the Adoption of Nike+ Run Club App: An Application of the Theory of Reasoned Action.
 - [14] Yang, Xiaotian, et al. (2020) Factors influencing user’s adherence to physical activity applications: A scoping literature review and future directions. *International Journal of Medical Informatics* 134: 104039.



- [15] Joint FAO/WHO/UNU Expert Consultation. (2001). *Human energy requirements* (pp. 5-6). Rome: Food and Agriculture Organization. Retrieved from <http://www.fao.org/3/y5686e/y5686e.pdf>

9 APPENDIX A: DESIGN

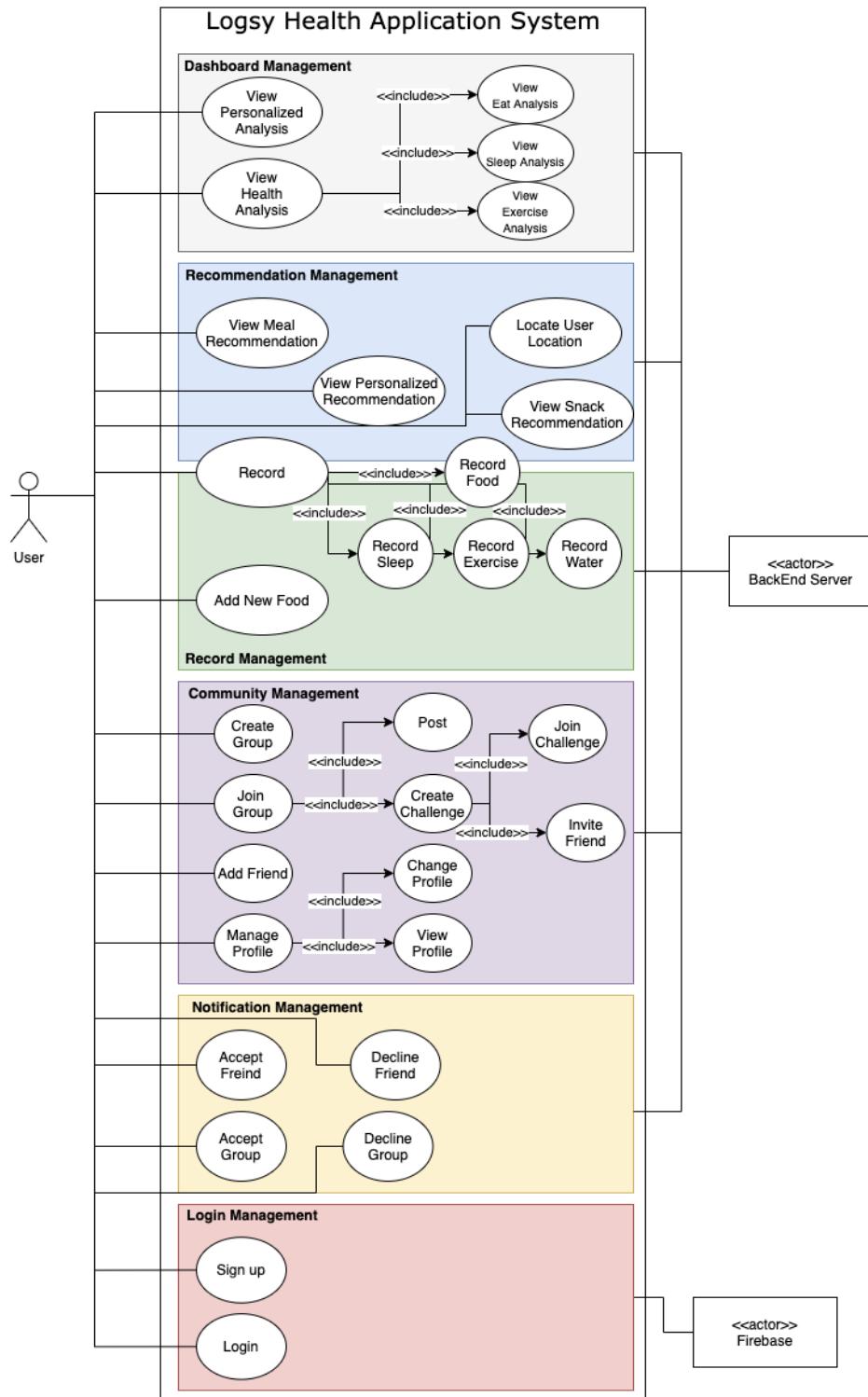


Figure 2: Use Case Diagram of Logsy Application

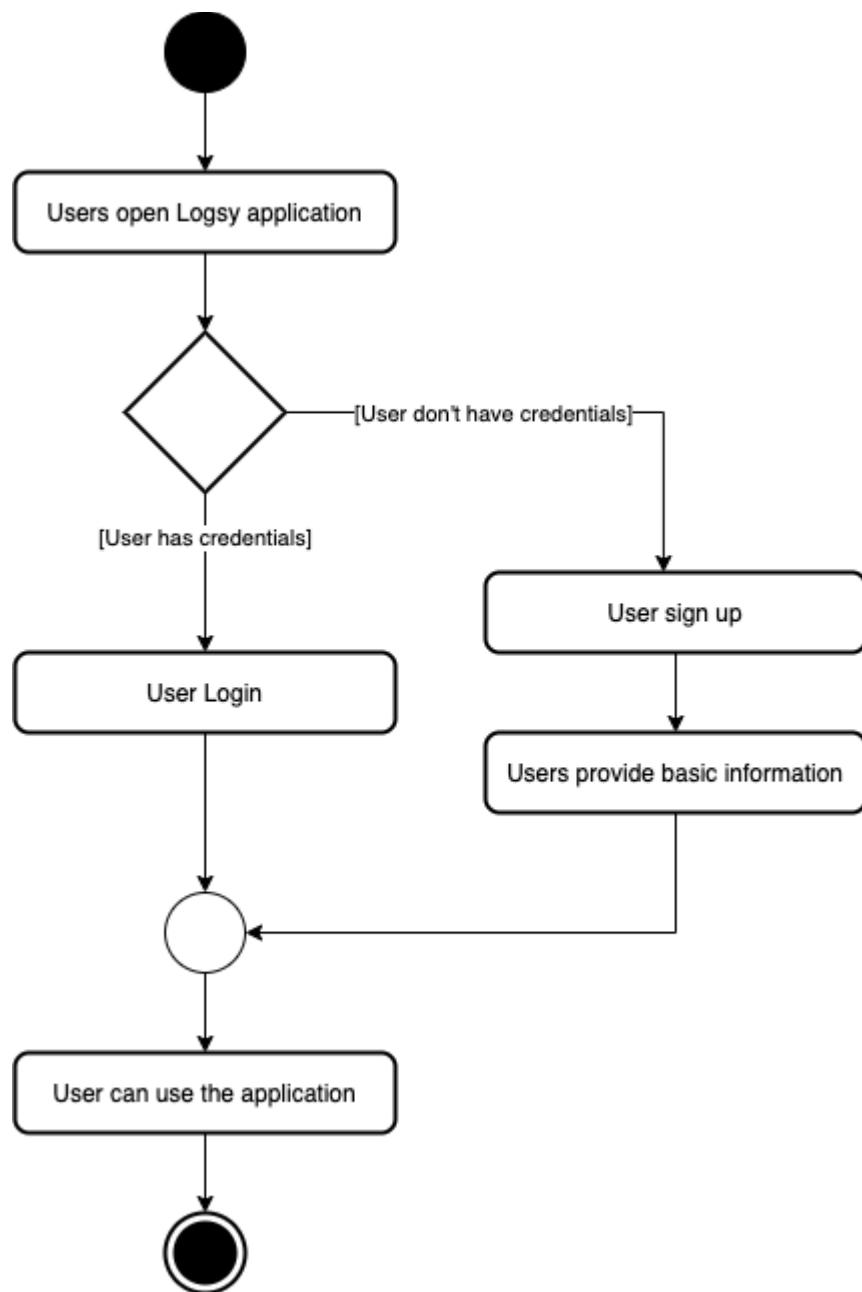


Figure 3: Login Activity Diagram

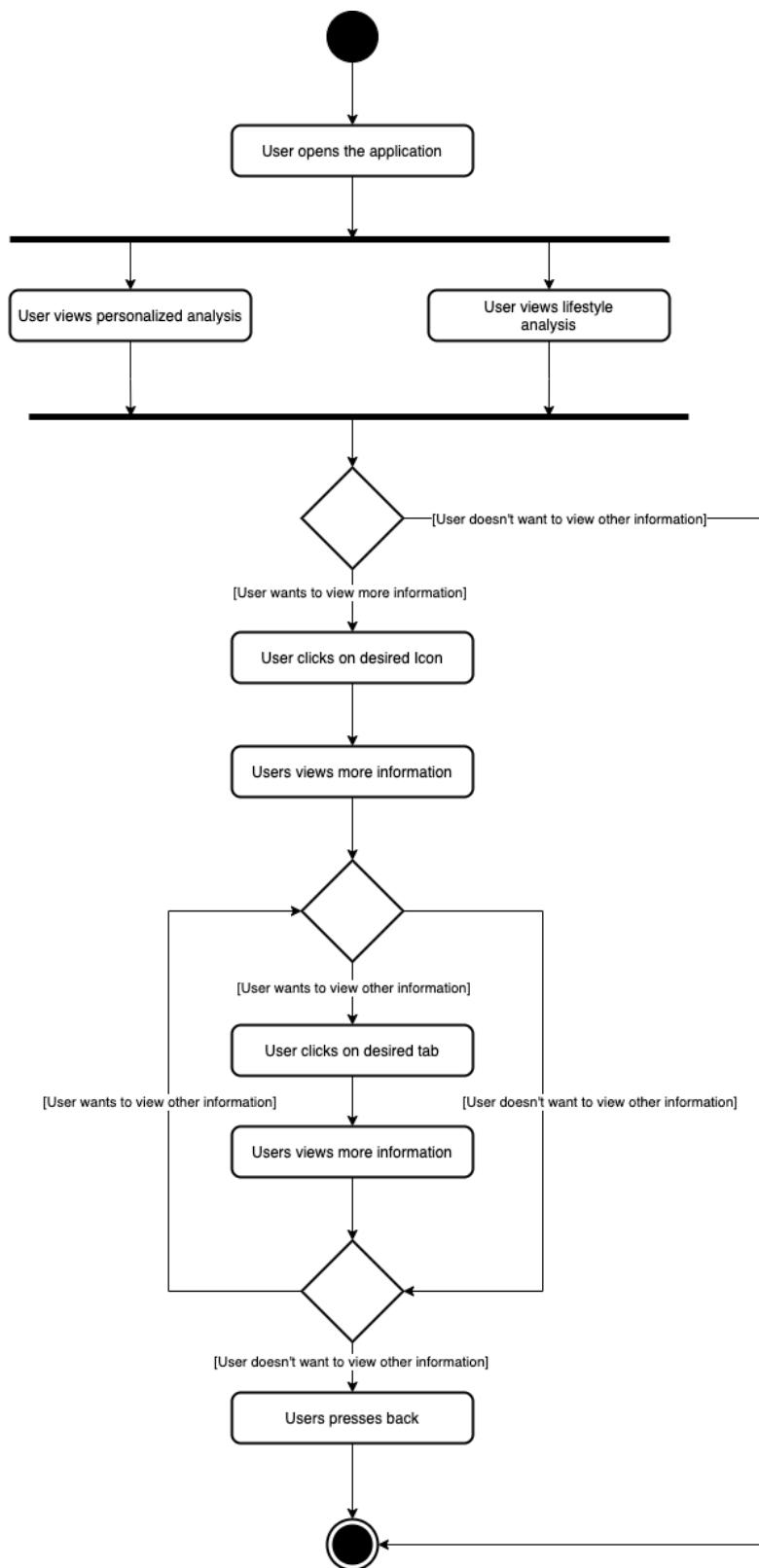


Figure 4: Dashboard Activity Diagram

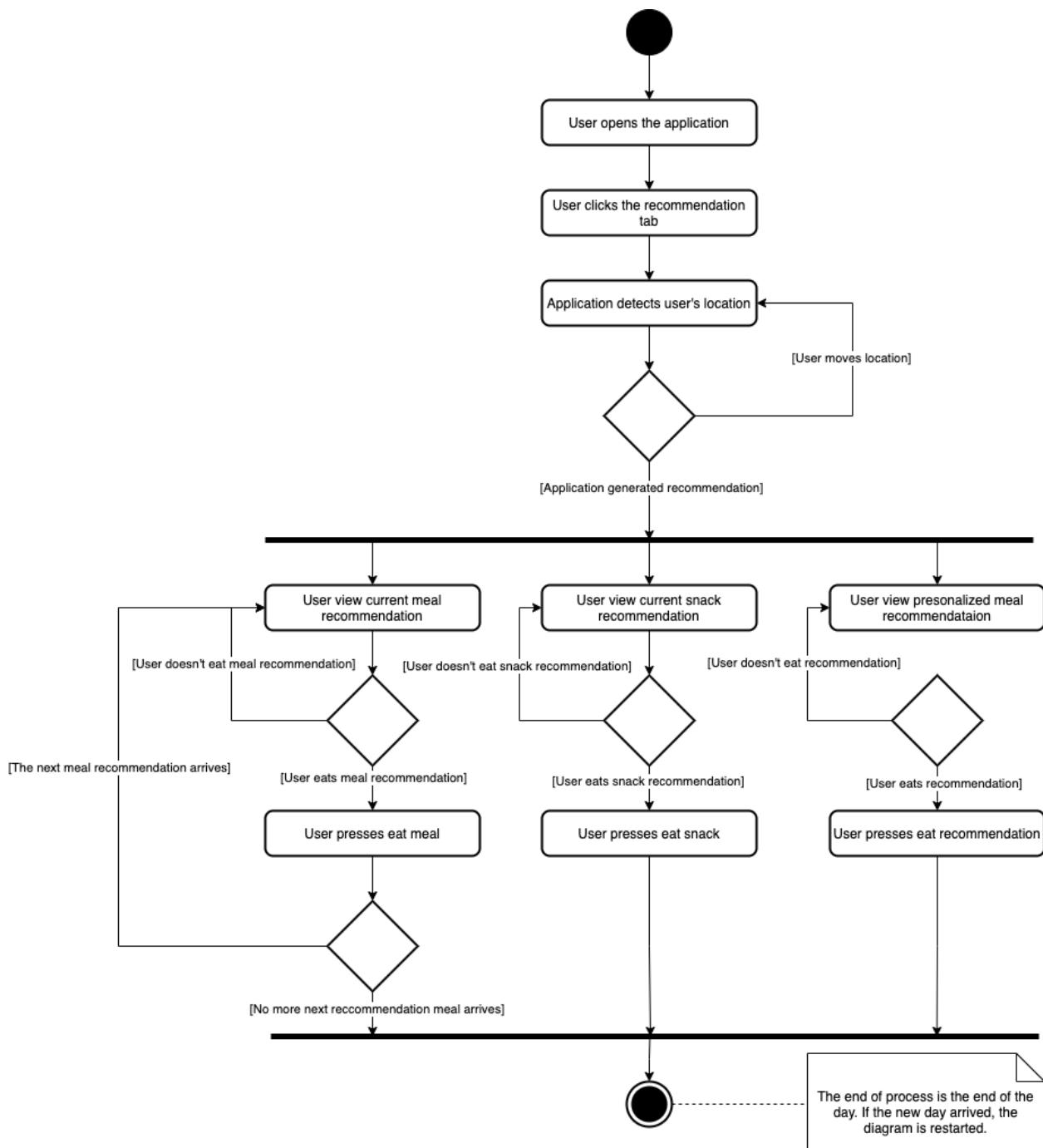


Figure 5: Recommendation Activity Diagram

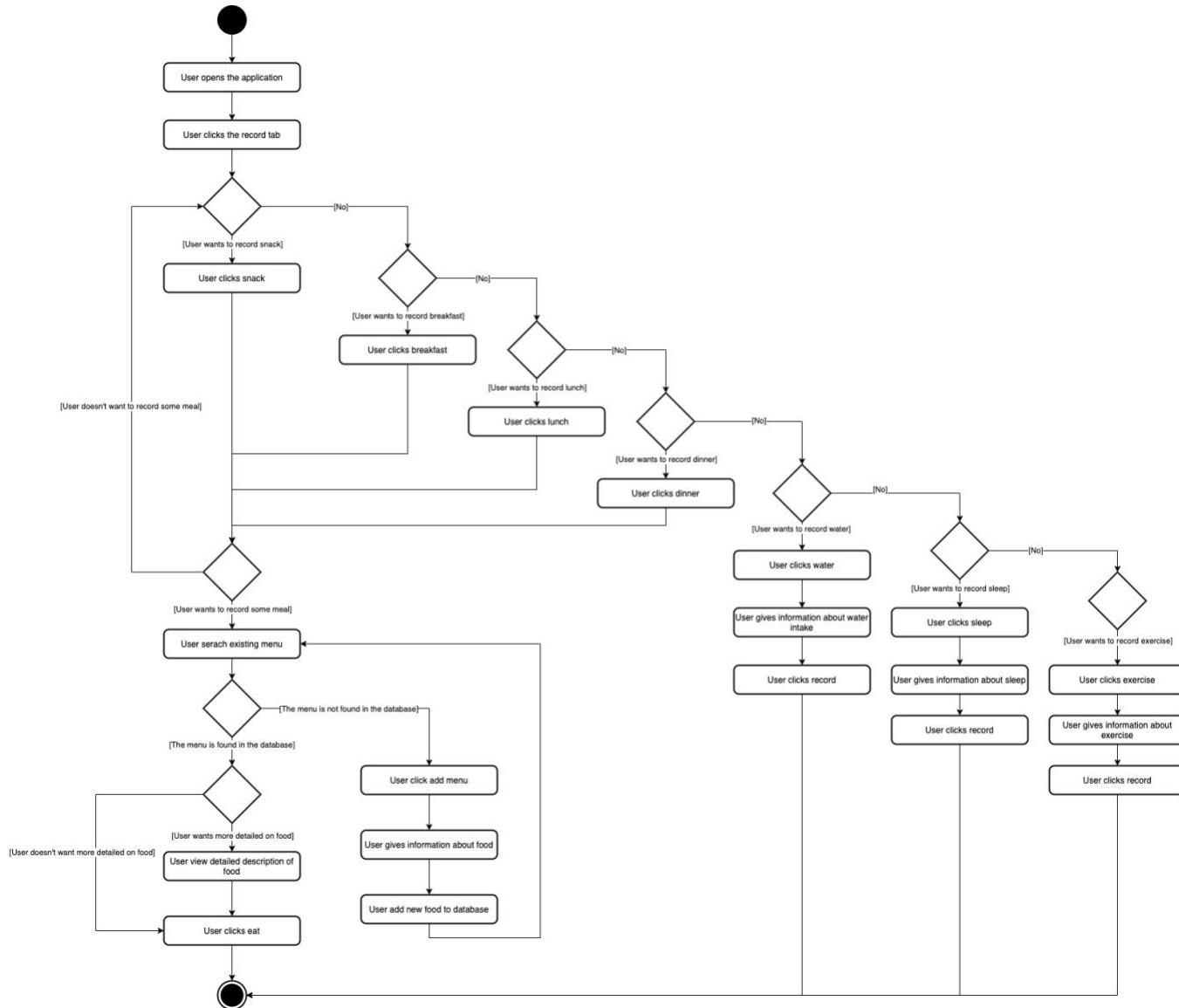


Figure 6: Record Activity Diagram

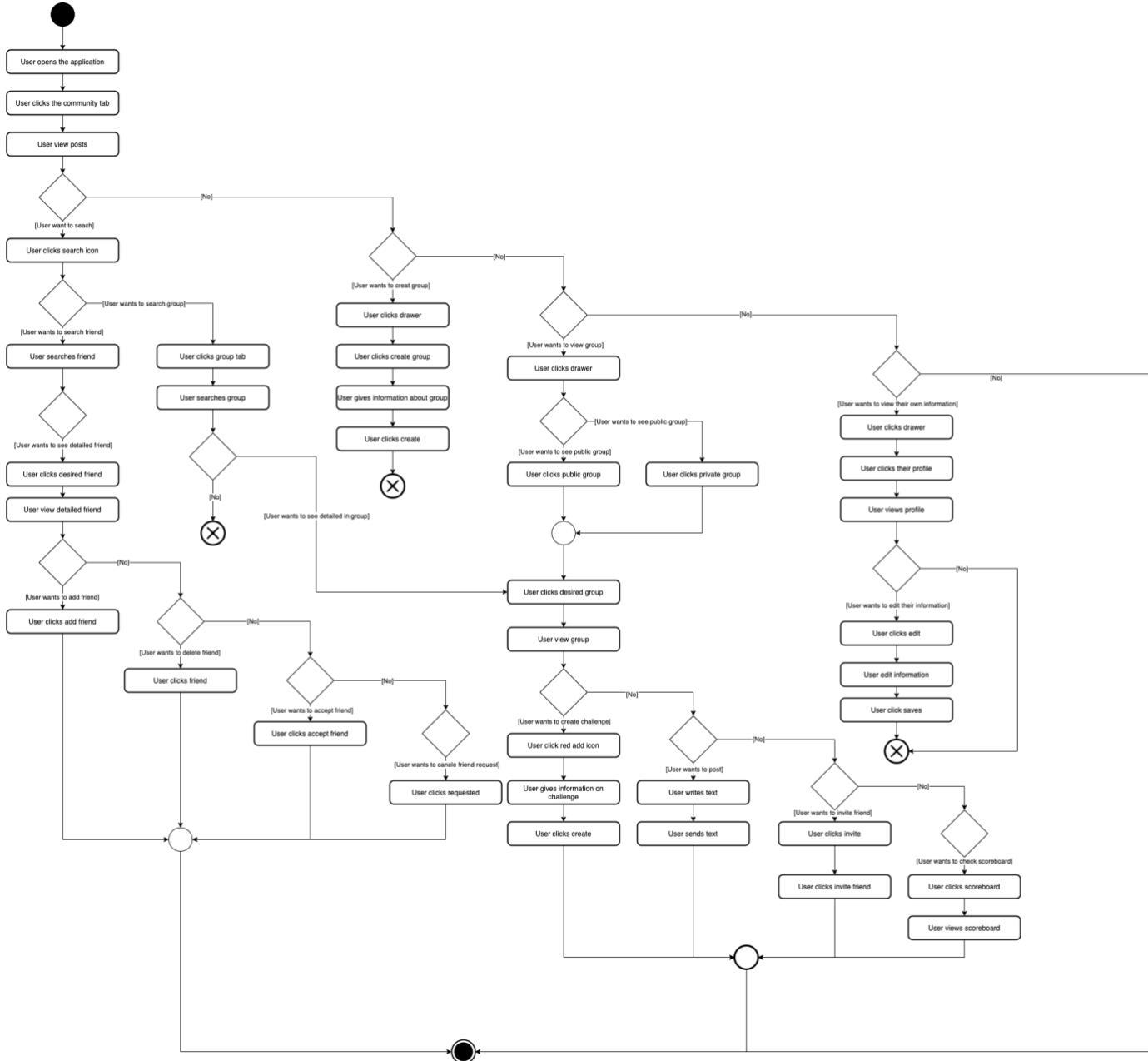


Figure 7: Community Activity Diagram

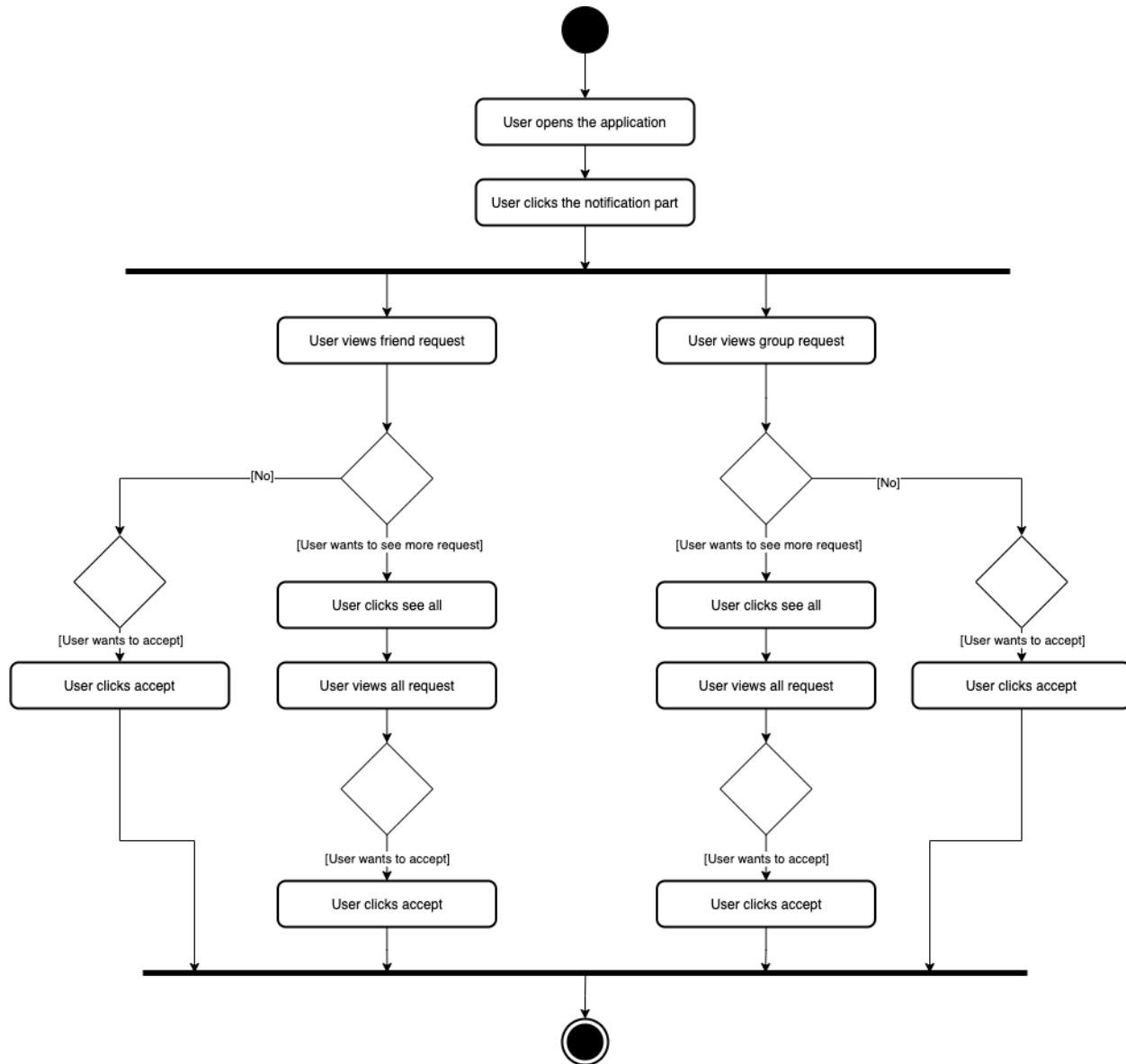


Figure 8: Notification Activity Diagram

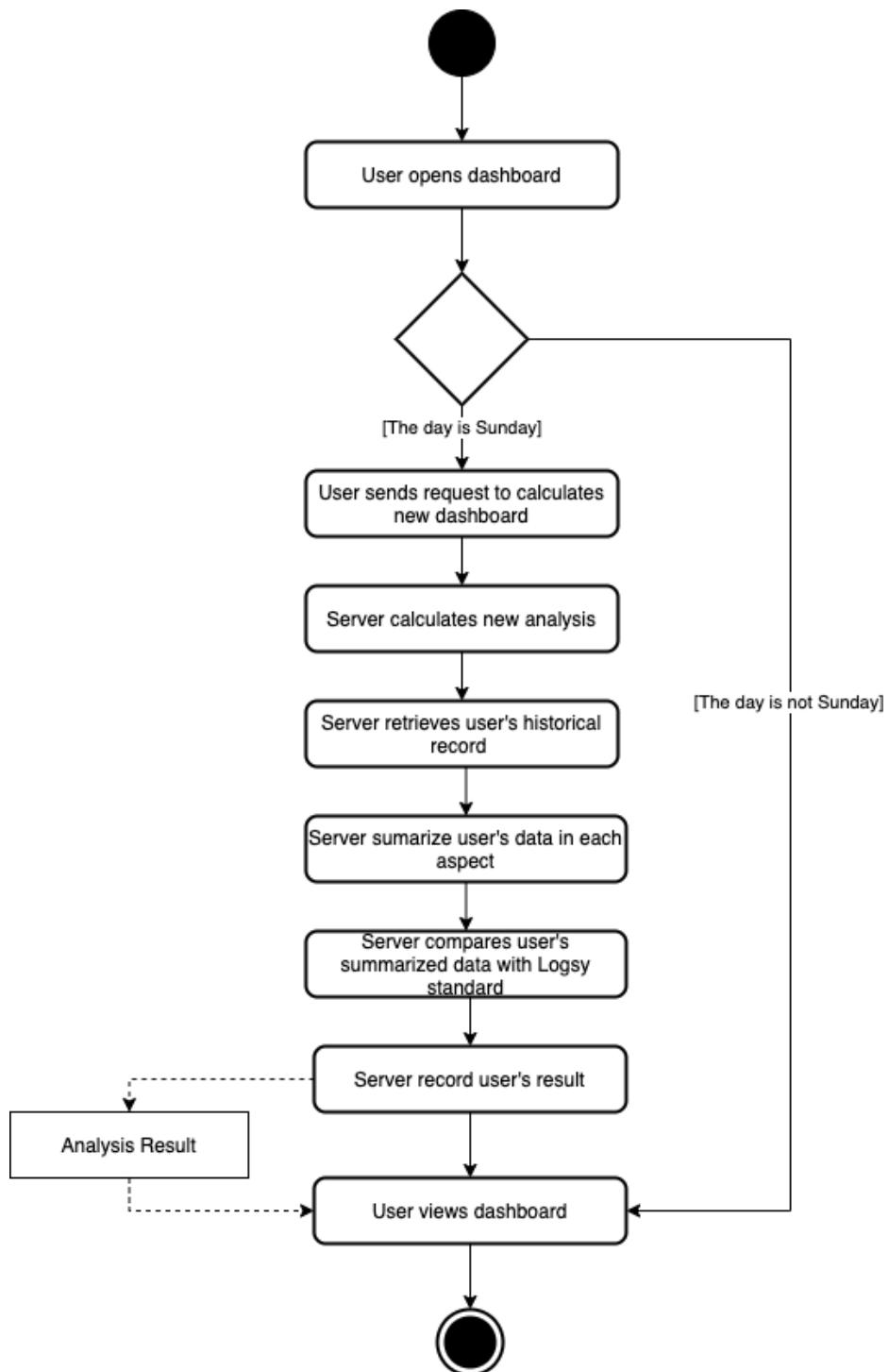


Figure 9: Lifestyle Activity Diagram

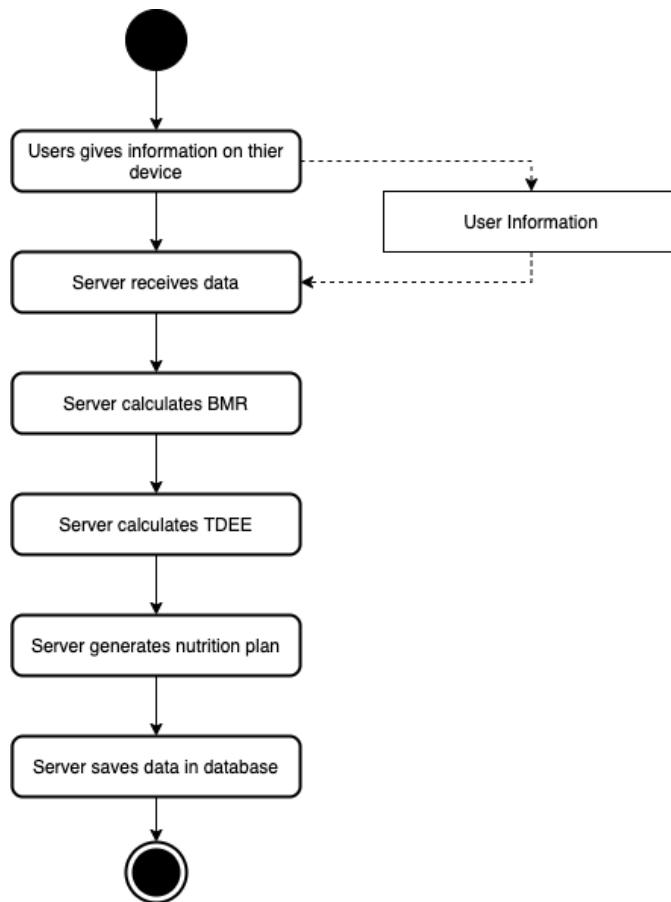


Figure 10: Data Retrieval Activity Diagram

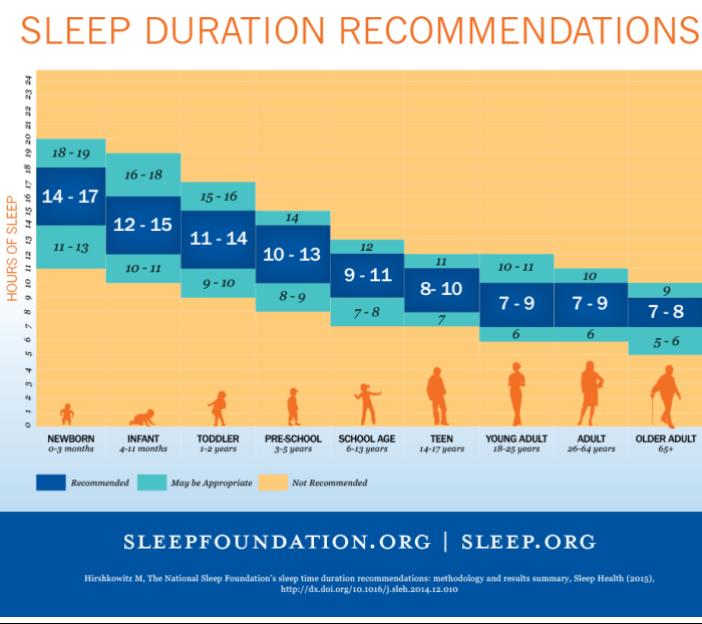


Figure 11: Sleep Standard Table. Note the table is referenced from the National Sleep Foundation [5].

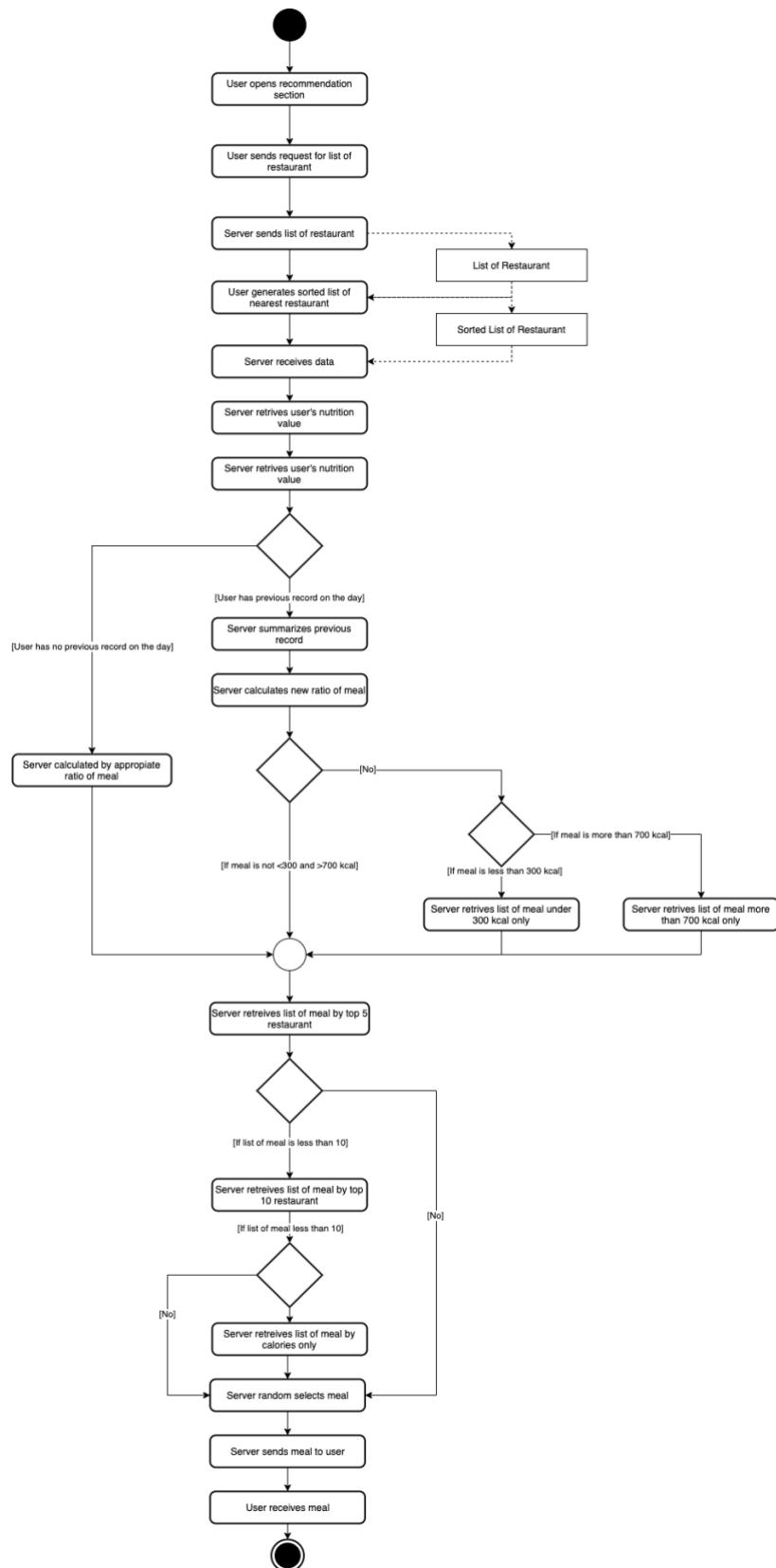


Figure 12: Recommend Meal based on Daily Intakes Activity Diagram

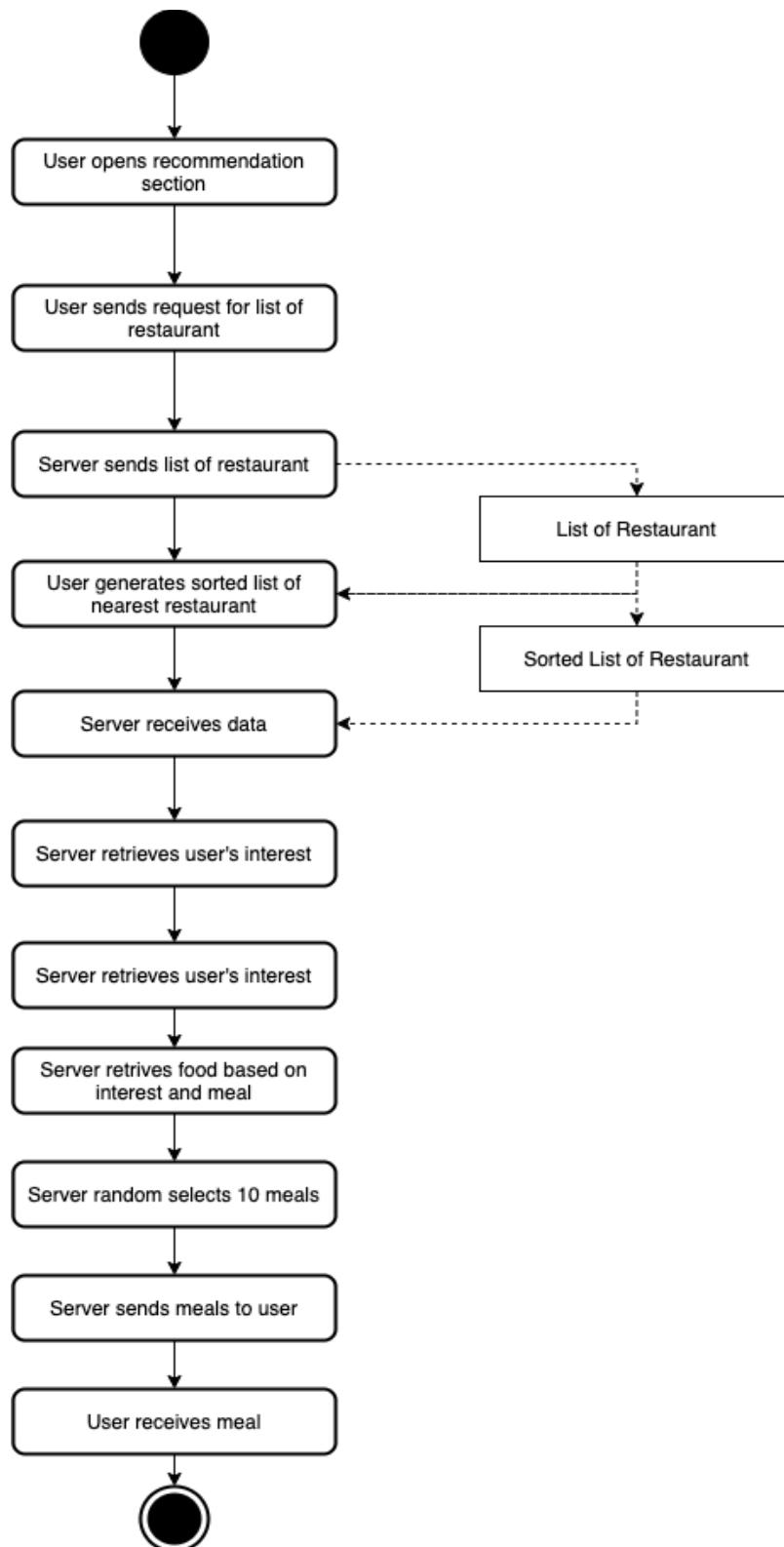


Figure 13: Meal Recommendation based on Favorite Food Activity Diagram

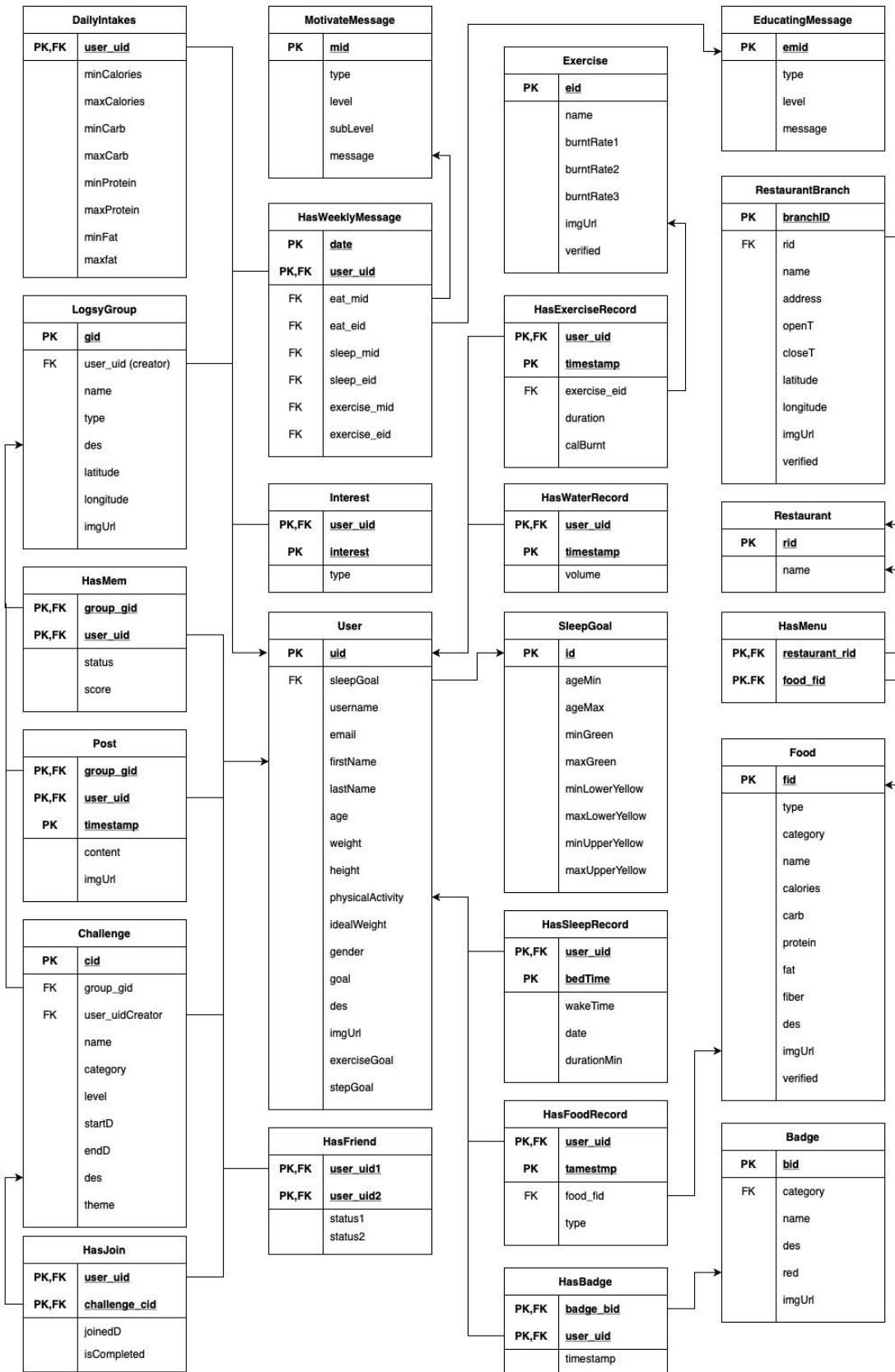


Figure 14: Logsy Entity-Relational Diagram



10 APPENDIX B: USER TEST

Evaluation of Logsy User Testing

The following scenarios are designed to evaluate the Logsy application relative to the test objectives. The scenarios were reviewed and adjusted to best fit the objectives.

Preferred Scenario	Tasks	Estimated Time	Observation Detail	Scoring	User Feedback
Personalized Analysis					
You want to read your weekly analysis in each aspect. You want to see your performance in textual description and know what you can improve.	Read the data analysis text	2 minutes			
Assume you have been logging food, sleep and exercise records in Logsy for a week. You want to see your performance in numerical data.	Review food dashboard Review sleep dashboard Review exercise dashboard	3 minutes			
Location Awareness (assume you are at Faculty of Engineering, Chulalongkorn University)					
You want to have breakfast, so you open Logsy to see what is the recommended menu for your breakfast in your area. You also want to know how far to that restaurant.	Review the menu recommended Record the breakfast eaten Find the map to the restaurant	2 minutes			
You want to have breakfast, but you don't like the recommended menu. Then, you decided to look at the personalized meal instead.	Review the personalized menu Record the breakfast eaten	2 minutes			
Community (think like you are using a social media application)					
You want to find Group "Boba Lover", and you want to join this group as well.	Find group Join group	2 minutes			
You want to create a community space where people who love avocado can discuss it with each other. You also want to invite one of your friends to the group.	Create group Invite friend	3 minutes			
You have just finished a workout and want to write a post in your group to let your friend know.	Find the group you want to post Write a post	4 minutes			
You don't have the same interest anymore, so you want to change that in your profile.	Edit profile	2 minutes			
Challenges					
You decided to not eat sweet for a week and you want friends to join in, so you decided to create a challenge in the group.	Find the group you want to challenge with Create the challenge	5 minutes			
You want to join a challenge in the group.	Search for challenges in the group Join the challenge	2 minutes			

Additional Tasks	Pass
Availability	
Does the application respond with no lost connection?	
Performance	
Does the application provide a response with 1-minute at most delay?	

Remark: Scoring

- 1 - Very difficult
- 2 - Somewhat difficult
- 3 - Neither difficult nor easy
- 4 - Somewhat easy
- 5 - Very easy

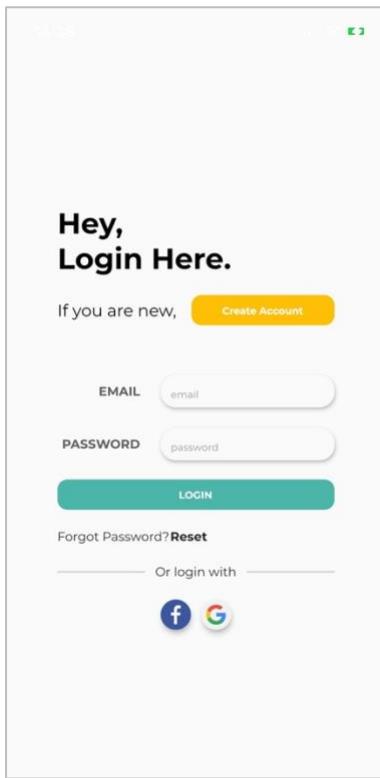
System Usability Scale

	Strongly Disagree					Strongly Agree				
	1	2	3	4	5					
I think that I would like to use this application frequently										
I found application unnecessarily complex										
I thought the application was easy to use										
I think that I would need the support of a technical person to be able to use the application										
I found the various functions in this application were well integrated										
I thought there was too much inconsistency in this application										
I would imagine that most people would learn to use this application very quickly										
I felt very confident using the application										
I needed to learn a lot of things before I could get going with this application										

Figure 15: Logsy User Test Recording Sheet



11 APPENDIX C: LOGSY USER INTERFACE



Hey,
Login Here.

If you are new, [Create Account](#)

EMAIL

email

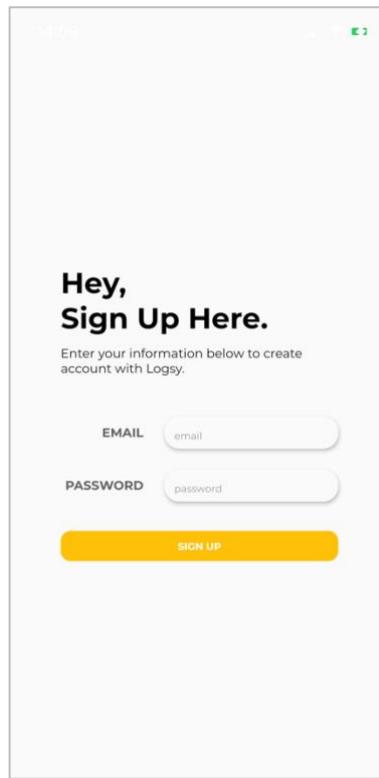
PASSWORD

password

LOGIN

Forgot Password? [Reset](#)

Or login with



Hey,
Sign Up Here.

Enter your information below to create account with Logsy.

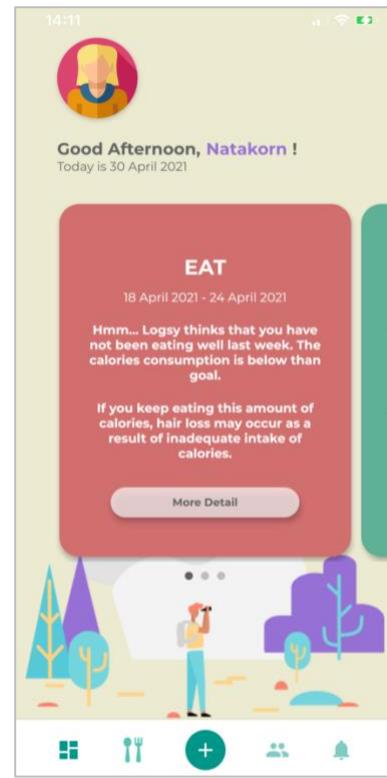
EMAIL

email

PASSWORD

password

SIGN UP



Good Afternoon, Natakorn !
Today is 30 April 2021

EAT

18 April 2021 - 24 April 2021

Hmm... Logsy thinks that you have not been eating well last week. The calories consumption is below than goal.

If you keep eating this amount of calories, hair loss may occur as a result of inadequate intake of calories.

More Detail

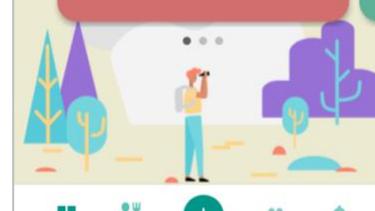


Figure 16: Login

Figure 17: Sign Up

Figure 18: Homepage

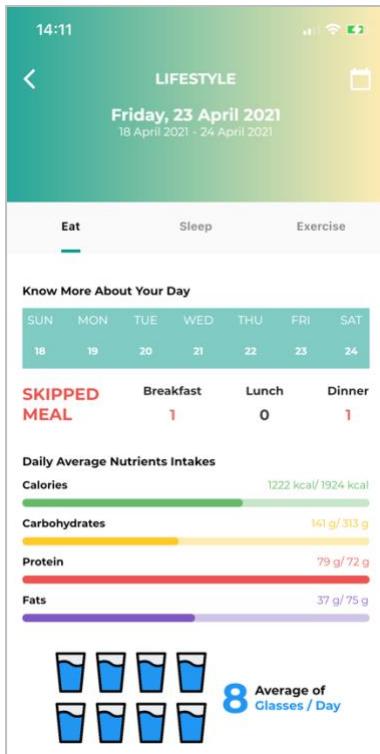


Figure 19: Eat Weekly Summary

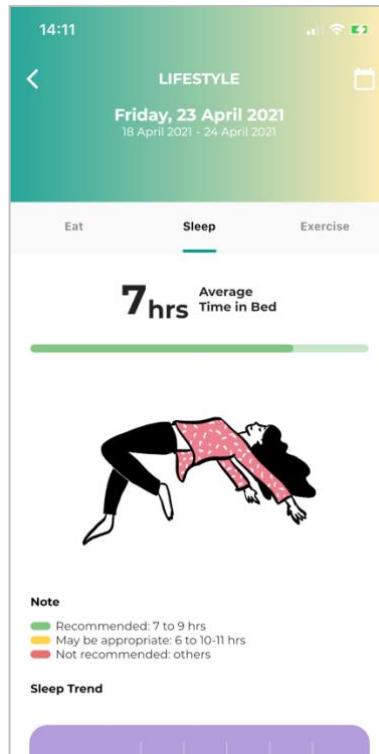


Figure 20: Sleep Weekly Summary

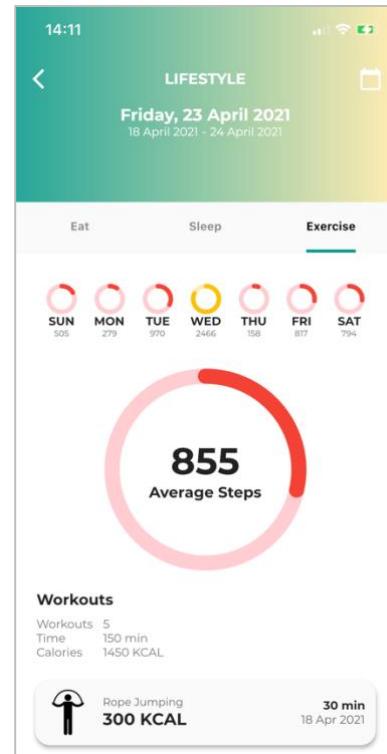


Figure 21: Exercise Weekly Summary

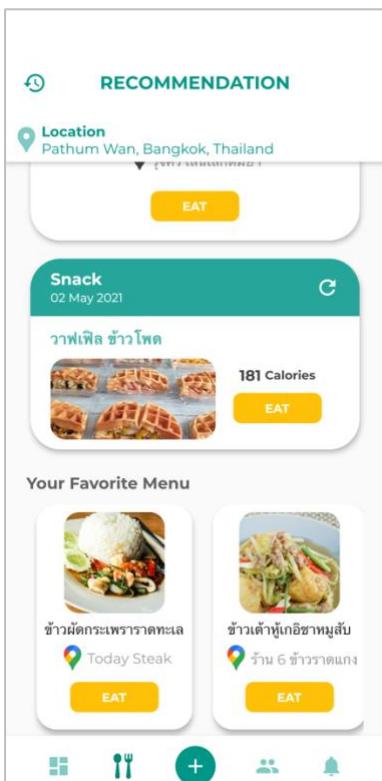


Figure 22: Recommendation 1

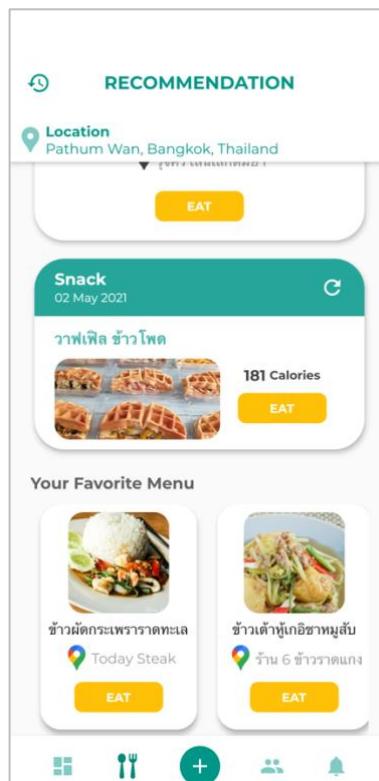


Figure 23: Recommendation 2



Figure 24: Location

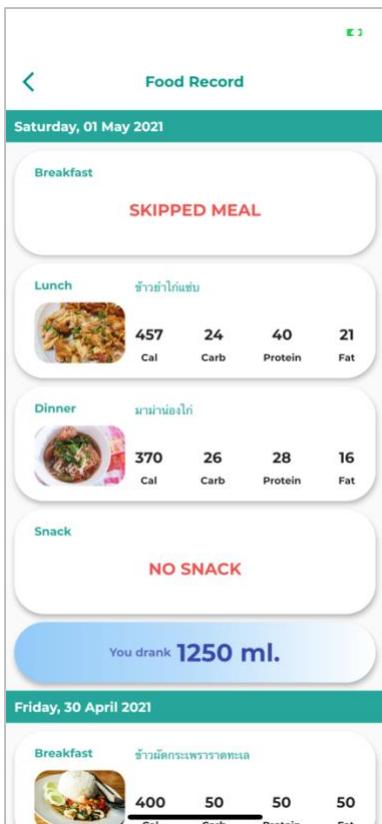


Figure 25: Food Record

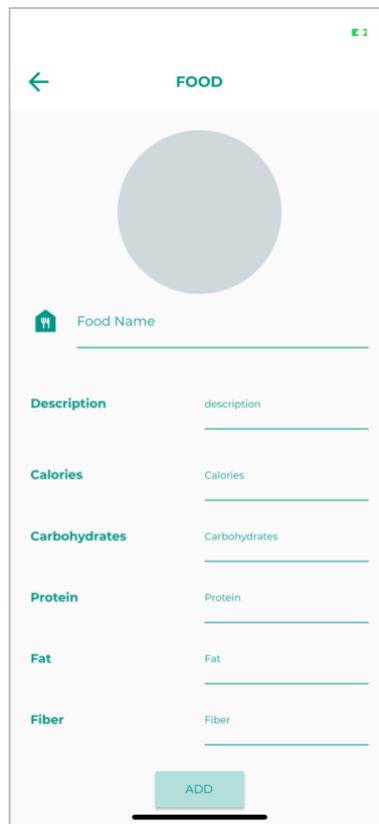


Figure 26: Add New Food

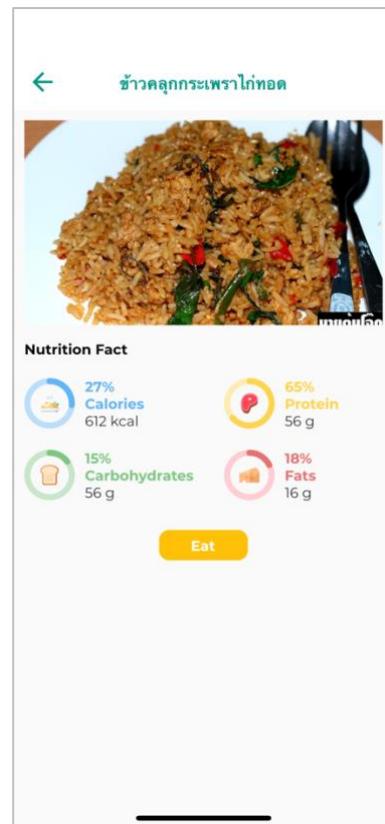


Figure 27: Food Nutrient Info

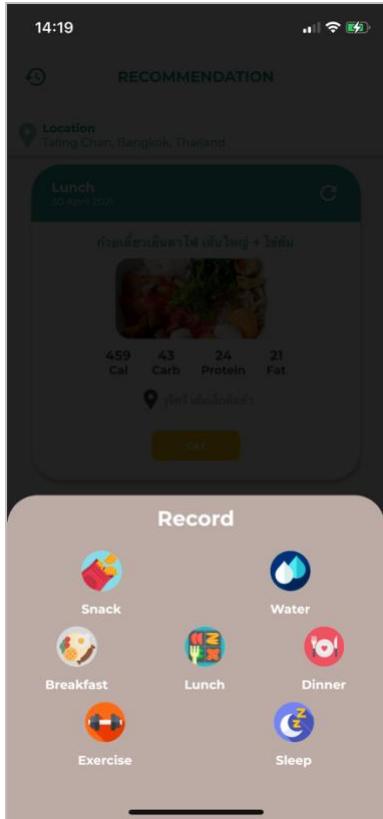


Figure 28: Logging Record

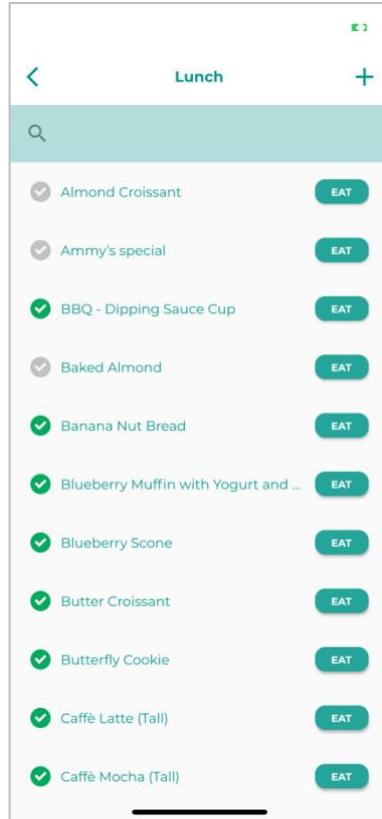


Figure 29: Log Food

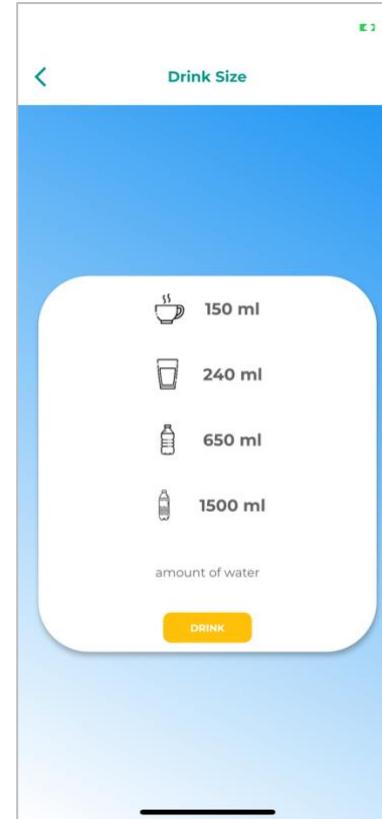


Figure 30: Log Drink

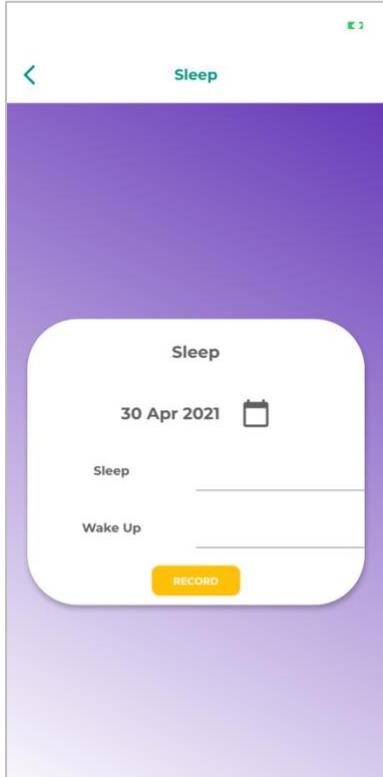


Figure 31: Log Sleep

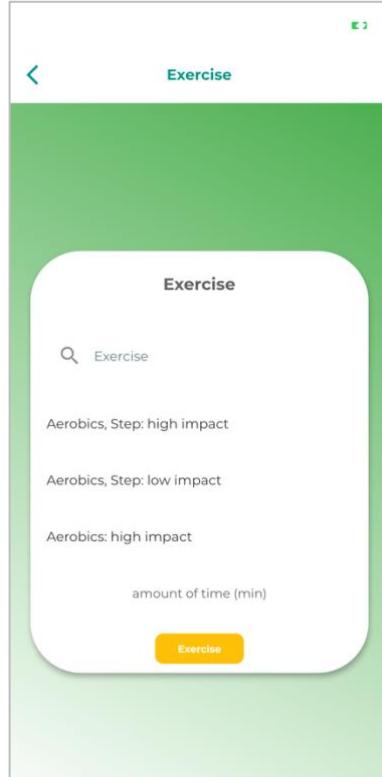


Figure 32: Log Exercise

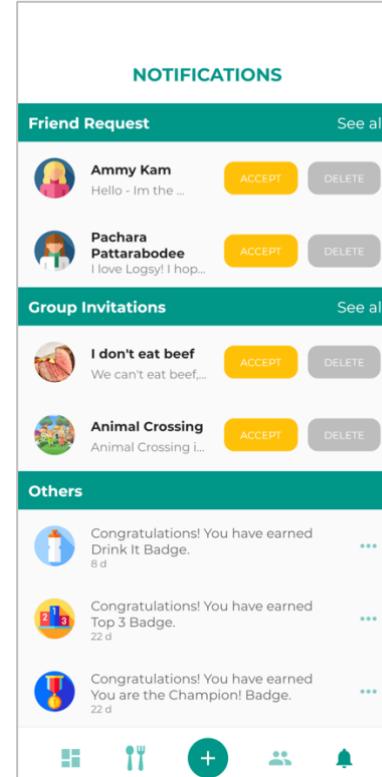


Figure 33: Notifications

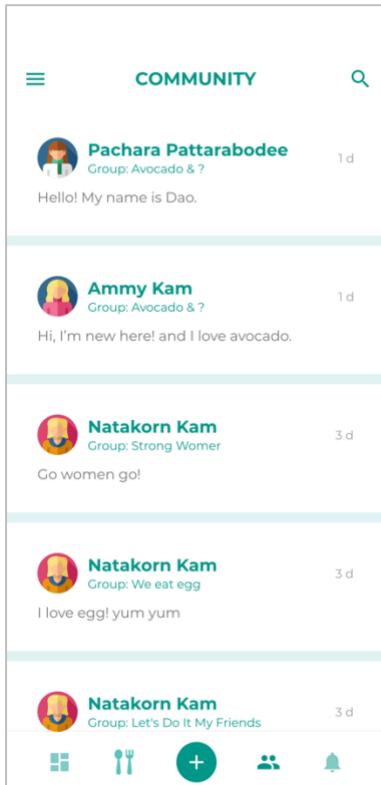


Figure 34: Community Feed

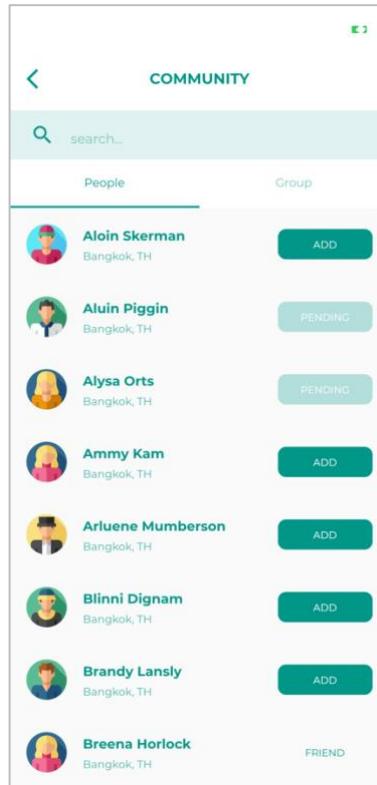


Figure 35: Friend Search

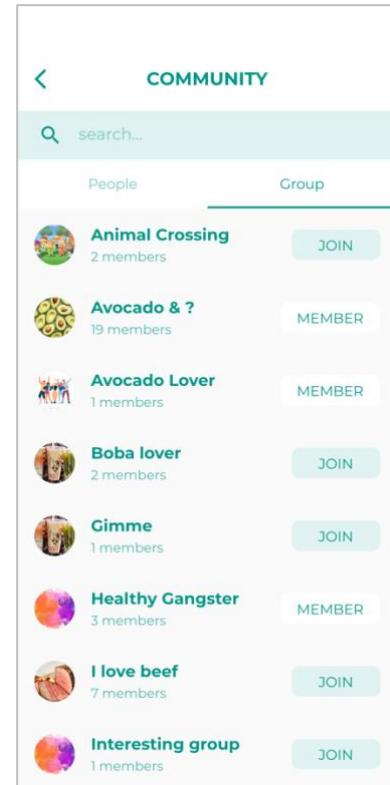


Figure 36: Group Search

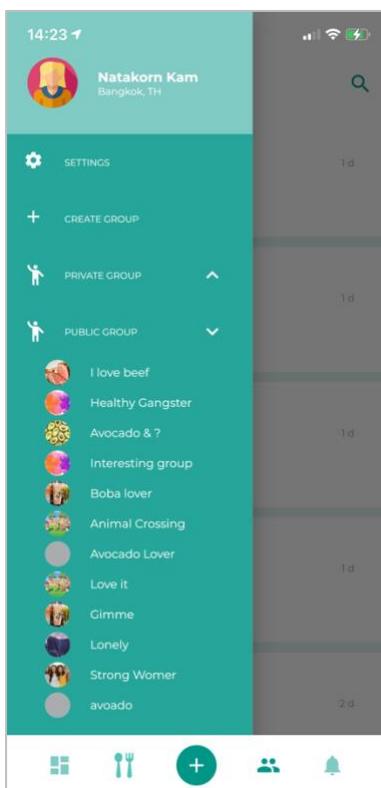


Figure 37: Community Bar

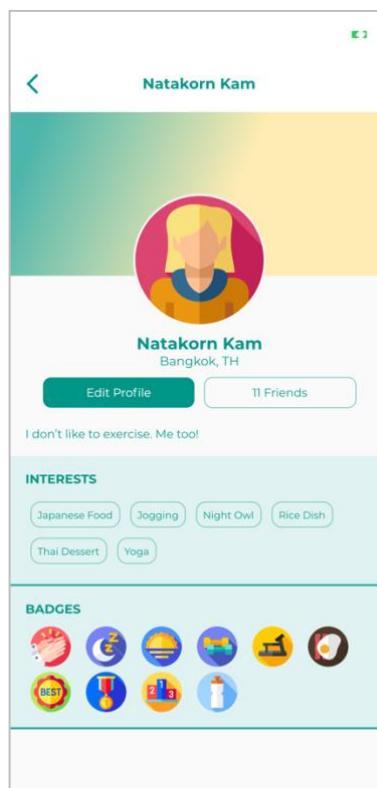


Figure 38: Profile

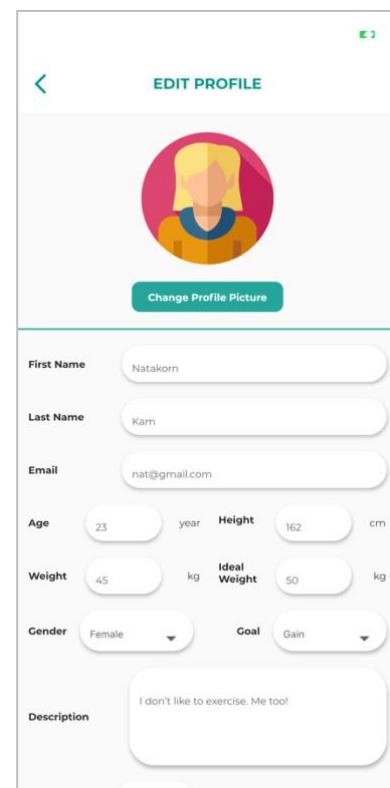


Figure 39: Edit Profile



Figure 40: Create Group 1

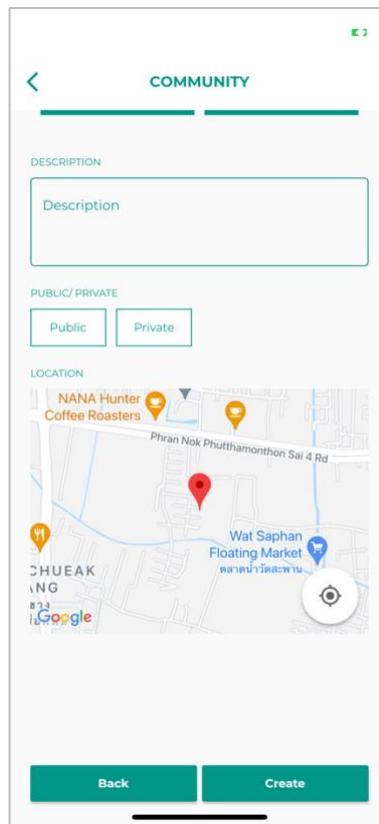


Figure 41: Create Group 2

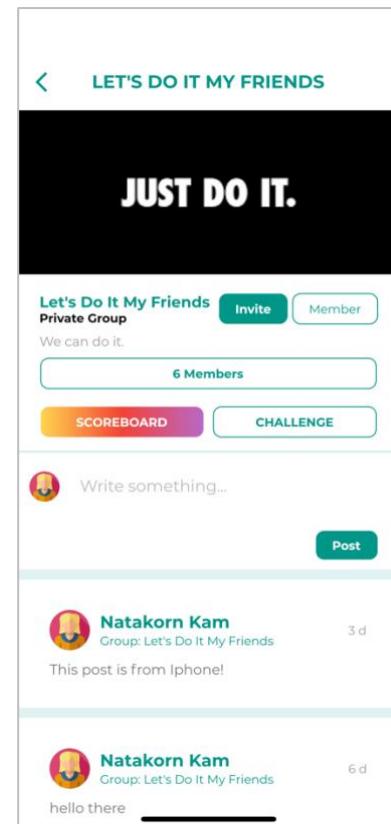


Figure 42: Group Feed

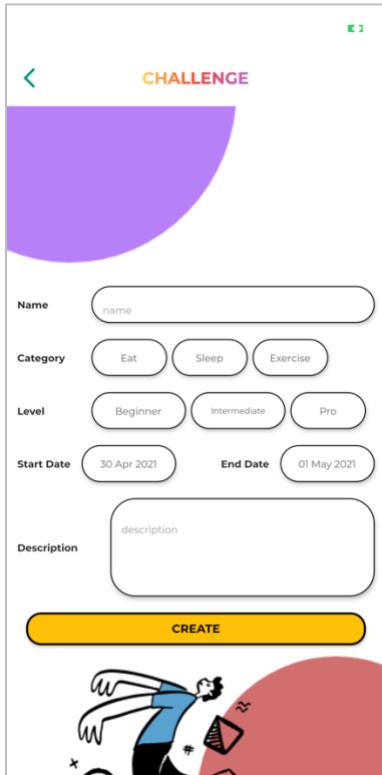


Figure 43: Create Challenge

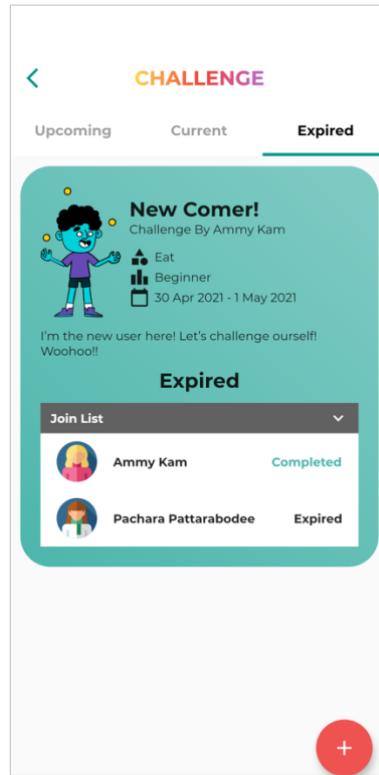


Figure 44: Challenge List



Figure 45: Scoreboard

mHealth App integrated with Eat, Sleep, and Exercise Data Analysis

ORIGINALITY REPORT



PRIMARY SOURCES

1	ukcatalogue.oup.com Internet Source	1 %
2	Submitted to Higher Education Commission Pakistan Student Paper	1 %
3	Submitted to St. Joseph's Teachers' College - Jamaica Student Paper	1 %
4	Submitted to Galgotias University, Greater Noida Student Paper	<1 %
5	Submitted to United International College Student Paper	<1 %
6	www.gamasutra.com Internet Source	<1 %
7	Submitted to University of Greenwich Student Paper	<1 %
8	www.coursehero.com Internet Source	<1 %

9	Submitted to University of Maryland, University College Student Paper	<1 %
10	www.jmir.org Internet Source	<1 %
11	Submitted to University of Lincoln Student Paper	<1 %
12	policy.usq.edu.au Internet Source	<1 %
13	Submitted to The Robert Gordon University Student Paper	<1 %
14	mafiadoc.com Internet Source	<1 %
15	Submitted to CECOS College London Student Paper	<1 %
16	Laurie C. Dolan, Susan M. Potter, George A. Burdock. "Evidence-Based Review on the Effect of Normal Dietary Consumption of Fructose on Development of Hyperlipidemia and Obesity in Healthy, Normal Weight Individuals", Critical Reviews in Food Science and Nutrition, 2009 Publication	<1 %
17	documents.mx Internet Source	<1 %

18	www.dtic.mil Internet Source	<1 %
19	Submitted to Colorado Technical University Online Student Paper	<1 %
20	idoc.pub Internet Source	<1 %
21	"Human Aspects of IT for the Aged Population. Healthy and Active Aging", Springer Science and Business Media LLC, 2020 Publication	<1 %

Exclude quotes Off

Exclude bibliography On

Exclude matches Off