MOBILE GEOBASED BUDGET PLANNER AND CALCULATOR

BY

LO JOON HOE

A REPORT

SUBMITTED TO

Universiti Tunku Abdul Rahman

in partial fulfillment of the requirements

for the degree of

BACHELOR OF COMPUTER SCIENCE (HONS)

Faculty of Information and Communication Technology
(Kampar Campus)

MAY 2020

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Date: 05 SEPTEMBER 2020

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I would like to express my sincere thanks and appreciation to my supervisors, Ts Tan Teik Boon who has given me this bright opportunity to engage in a mobile application development project. It is my first step to establish a career in mobile development field. A million thanks to him.

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ABSTRACT

The project is named 'Mobile Geo Based Budget Planner and Calculator' while the deliverable of this project is called 'GeoBudget'. This project focus on developing an advance budgeting mobile application. Budgeting application provides good solution for the user to manage their financial resources. The user can categorize their spending and get a brief picture on how the money gone. These are the basic functions for a budgeting application. In this project, the improvement that will be carried out is an innovative way to perform budgeting with the assist from geo location services and image recognition. It is a new function that does not exist in any existing budgeting application. With these two modules, GeoBudget had overcome the problem of forgetting the amount of budget expenditure. Besides that, it can reduce the tedious input by the user. The user is able to track the context and information of the items in any stores. If the user is having difficulty in recalling the name of the store, they can take a photo of nearby landmark and solve the problem. At the same time, if the user is having difficulty in recalling the name of the product, text and logo image services will help them in resolving those problems. Next, it allows the user to track the situation of borrowing money or returning money with their friends or family. User always found it difficult to track the situation of borrowing and lending money. It is not considered as a budget expenditure but it may influence the overall budgeting process. Thus, GeoBudget will provide this module to solve the problem mentioned above. Last but not least, user often finds it troublesome when deciding a product to buy or where to buy the products. So, GeoBudget will provide suggestions of products to user based on their targeted budget so that they can meet their financial goals easily.

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LIST OF ABBREVIATIONS

API	Application Programming Interface
GUI	Graphical User Interface
SDK	Software Development Kit
GCP	Google Cloud Platform
ROI	Return on Investment
IDE	Integrated development environment
AVD	Android Virtual Devices
CLI	Command line Interface

Chapter 1-Introduction

1.1 Background and Motivation

The ultimate goal of this project is to develop an interactive budgeting mobile application. This mobile application which is named Mobile Geo Based Budget Planner and Calculator has provided an innovative solution with some advanced functionalities that does not exist in any other existing budgeting application. These functionalities include geo location services, image recognition services, social interaction tracking system, etc. The application is also named as 'GeoBudget' as geo location services have been fully utilized in assisting the overall budgeting process.

In this age of advanced science and technology, the majority of local citizens are still worrying about their financial situation. There have to live from pay check to pay check and some of them will be running out of money at the end of the month. If they are being asked whether they have used budgeting application to manage their income and expenses. Most of them will probably answer 'No'. Although there are many freemium versions of budgeting application that can be downloaded from the App Stores or Play Stores, most of the user will have no interest in using budgeting application to manage their financial resources. As a result, they may not know the cash flow situation and where the money has gone. This is one of the main reasons why some of the people will have problems in their financial situation as they are not able to perform right budget spending based on the past history or records. This situation motivates us to develop an informative and interactive budgeting application to improve their interest in using this kind of application.

1.2 Problem statement

i) Budget Expenditure is lack of related important details

Although all the related functionalities are provided by the existing budgeting app, the user still face some issues when they are planning for budget. Firstly, when planning for budget, the user is not able to remember and record the context and location they spent the money. When the user intends to do budgeting, they have to recall back some of the problems. For instances, what item that they have purchased? What is the price of the items? Where do they buy the products?

In such situation, the user may accidentally input the wrong information into the system. As a result, these unstoppable human errors may affect the result of budgeting and the users may not meet their financial goals. In fact, the root cause of this problem is that the budget expenditure in budgeting application is lack of related important details. When the user is planning for budget, they have to input the budget, budget type and other related information. However, the user may forget where and how they spend the money since there are no geo location information and price of the product. Therefore, a potential solution would be applying geo location services to track the user location and shows the nearby stores. Besides, GeoBudget enables the user or vendors to provides the price and other related information so that the user can view the price details. Consequently, the user will not forget the context and location that they spend the money and make an accurate budgeting planning.

ii) Most expenditure needs repetition and tedious input of data

When the user is inserting the expenses information into the application, they need to insert the bill one by one. What if the user had purchased a lot of items from a store or supermarket? If there are 100 items in the receipt, they have to insert 100 times to the system. It may waste the user time in conducting other daily activities as they are busy inputting the information manually and one by one. In short, the user is facing some difficulties to input the expenditure or items they pay for as it involved a lot of entering data. To solve the problem mentioned above, GeoBudget will apply the product information inserted by the user and vendors and display a customized menu of the particular store. Instead of manually key in the information one by one, they can select

the items they had bought, similar like the situation where the user is ordering a pizza online or purchase an item via e-commerce website.

iii) Not able to track payment that involve sharing or split of bills

In the existing budget planning application, the user is not able to track properly in situation whereby payment for services or items involved sharing or split of bills. The existing app record the expenses categories such as grocery, restaurant, transport but there is no category which record how much money the user lent someone or the situation where someone lent the user money. In consequence, it may affect the result of budget planning and the user may forget this kind of social based situation. Hence, GeoBudget is designed with a section where the user can record payment that involved sharing or split of bills.

iv) Not able to provide recommendation on how to spend the money

The user often faces a situation where they are having difficulty in deciding what product to select and where to buy the product. For example, when they are looking for a product, they may be wasting their time choosing certain product that they preferred in some stores. Eventually, the user may end up with performing an incorrect budget spending because they may not know their overall financial situation. Therefore, a function should be designed to assist the user in selecting the right product based on the expected and targeted budget. This feature should suggest the most appropriate products which the user is afford to buy so the user may meet their financial goals easily.

1.3 Project Scope

At the end of this project, a piece of software named GeoBudget has designed with the following functions and modules:

i) Budget Management Module

The total income, total expenses, total assets will be displayed in the main page of GeoBudget. User can view the financial status in a quick manner. Besides that, income is categorized into 4 types which is card, cash, ewallet, saving, and other while expenses are categorized into 9 types which is grocery, restaurant, leisure, transport, health, gift, family, shopping and other. The user can insert or edit the information to the respective categories in a smooth and simple way. Lastly, user can do budget allocation process in this module. They can insert their expected budget on different categories so that the system can get their targeted budget and assist in the budget planning.

ii) Chart Module

GeoBudget will generate two charts which is bar chart and doughnut chart for the user to perform visualisation and analytics. For bar chart, x-axis is the 9 types of expenses that mentioned before while y-axis is the amount that the user spent. For doughnut chart, different colour represents different types of expenses types. After inserting the amount, it will allocate a space for the amount. The more the expenses, the larger the spaces that will be allocated.

iii) Calendar Module

User can select particular date to input the expenses. Calendar is coordinated with the database which retrieve data from database and post data into database. In addition, the calendar assists in calculating the monthly expenses as it is able retrieve every expenses of every single day in a month.

iv) Calculator Module

Calculator is designed for the user to calculate and insert their expenses, especially the situation when the user purchase multiples items in the store.

v) Suggestive Module

This module is designed for suggesting a product to the user based on their correct targeted budget. The user can view what the product they afford to buy and make a decision wisely.

vi) Menu Registration Module

User, shops and vendors can register their menu in this module. They must provide some information like place name, product name, price, image, place type, etc. Then, GeoBudget will create a menu for the user to insert the budget easily. If the place name is already existed in the user menu list. It will automatically add or update the product details.

vii) Split Bills Module

User is able to record the split of bills by visiting this module. They can choose a transaction type and insert information (name and amount). After inserting the required information, a friend list will be showed and the user can click 'settle up' button when the user or their friend has returned the money.

viii) Geo Location Module

User can either choose auto locate themselves or pick a location on the map when they want to use this module. When the location is selected, nearby stores will be iteratively displayed as yellow marker. If the menu is provided by the user or vendors, user can view the menu when they select the yellow marker and they can simply record the expenses by selecting the items they buy.

ix) Image Recognition Module

There are three detection methods offered by this module. These methods are landmark detection, text detection and logo detection. User choose a detection method and provide an image of the product that they buy. This module will analyse the image and display a menu for the user to record their expenses.

1.4 Project Objectives

The main objective of this projects is to build a brand-new budgeting application which contains some advance functions. The functions include Geo location services, Image Recognition Services, Split Bill Services, etc. These advance functions can provide assistance throughout the budgeting process and improve the interest of the user. The objectives can be broken down into several subobjectives:

- aims to utilise and provide geo location information to assist user on where and how they spend the money.
- aims to provide an interactive system that allow the user to enter inputs with reducing lengthy efforts of entering data by providing pre-prepared list of items based different types of expenditure.
- enable sharing of expenditure/cost among related parties based on their identification.

1.5 Impact, Significance and Contributions

In this digital driven era of globalization, some business owner realizes that it is not possible to create a successful action plan without a well thought out budget. Budgeting is an essential process that provides an estimate of expenditures and anticipates incoming revenue. If no budget planning, there will be difficult for the organization to achieve the business objectives. Therefore, budget planner application causes a great impact to the organization or company.

According to the Global Financial App Market Research Report, it is stated that the global financial app is expected to earn approximately USD 114.28 billion by 2023. Therefore, this forecast report has greatly explained the importance of budgeting app in the industry. If the advanced features are installed into the financial app, it will strengthen the budgeting process and cause a greater impact in the market. The data that is stored in GeoBudget can be sold to the stores and companies. This data is a valuable resource as it consists of some useful information such as the location that the user spend money, the affordable price when buying certain products and others, preferred brand, preferred promotional price and the others. The companies can utilize this valuable data to plan their business strategies and grow the business. Thus, it will increase the economic benefits and performance of a country and also increase the life quality of certain targeted places.

1.6 Background Information

i) Mobile Application

Mobile application is a type of application which provides quality services and experiences in the small devices such as smartphone, tablets, etc. The user can download and install mobile application from different sources such as App Stores, Play Stores, etc. The mobile applications consist of several types such as gaming apps, business or productivity apps, educational, lifestyle, travel and each type serve different purpose. According to the research, a smartphone user will check their phone 63 times a day and 87 % of the users will check their phone before sleeping. Thus, mobile application plays an important role in current industry.

ii) Budgeting Application

Budget Application is a tool for managing the income and expense. Budget planner can be utilised by an individual or an organization. It helps us to evaluate the financial resources, assist in control of the spending, and monitor the progress so that the personnel or organization can successfully achieve the financial goals with less effort. In the past, there is no mobile application for budget planning, most of the individuals or the organizations are using lots of documentation or use the excel to manage their financial resources. Documentation is a primitive and manual way to record the cash flow daily or weekly so some of the human errors cannot be avoided. Microsoft excel, which is more advance software, is also considered as a famous software for analysing the cashflow but the user still has to insert the result and compute it manually. Thus, employees that are not familiar with this technology will troubles the budget planning.

iii) Image Recognition

Image recognition can be defined as a technology which analyse the image and it is able to recognize objects, animals, words, etc. The methodology and tools in the image recognition process are machine learning and some image processing techniques. However, in this project, we have applied Cloud Vision API which is a sort of artificial intelligence which is able to recognize text, detects faces and detect landmarks in the image itself.

iv) Geo Location Services

A service which utilize network routing address and internal GPS services to track the user location. API that is provided by Google includes Geo Coding API, Places API, Maps JavaScript's API and the others. Nowadays, geo location services are widely used in different kind of application. A popular application called 'Waze' have fully utilized this service to get the driving directions, tracking real time traffic situation, road alerts features, etc.

1.7 Report Organization

Chapter 1: Introduction	• Provides an introduction on GeoBudget. • Subsections included background and motivation, problem statement, project scope, project objectives, impact significance and contributions, and background information.
Chapter 2: Literature Review	• Review of the mobile development and development tools, Android, Google Cloud Vision API, Google Maps Platform, personal expenditure categories and some of the existing budgeting application. • Provides comparison after reviewing the existing budgeting app.
Chapter 3: System Design	• Provides a design overview to GeoBudget • System designs such as flow chart, use case diagram, use case description, activity diagram • Timeline, Gannt Chat, Milestone
Chapter 4	• Provides an overview of system architecture • Methodologies and tools involved, system performance definition, verification plan • Provide system architecture design such as component diagram, database diagram and UI design
Chapter 5	• Implementation, testing and deployment issues
Chapter 6: Conclusion	• Project Overview, Constraints, future work

Table 1.7 Report Organization

Chapter 2-Literature Review

2.1 Mobile App Development and Development Tools

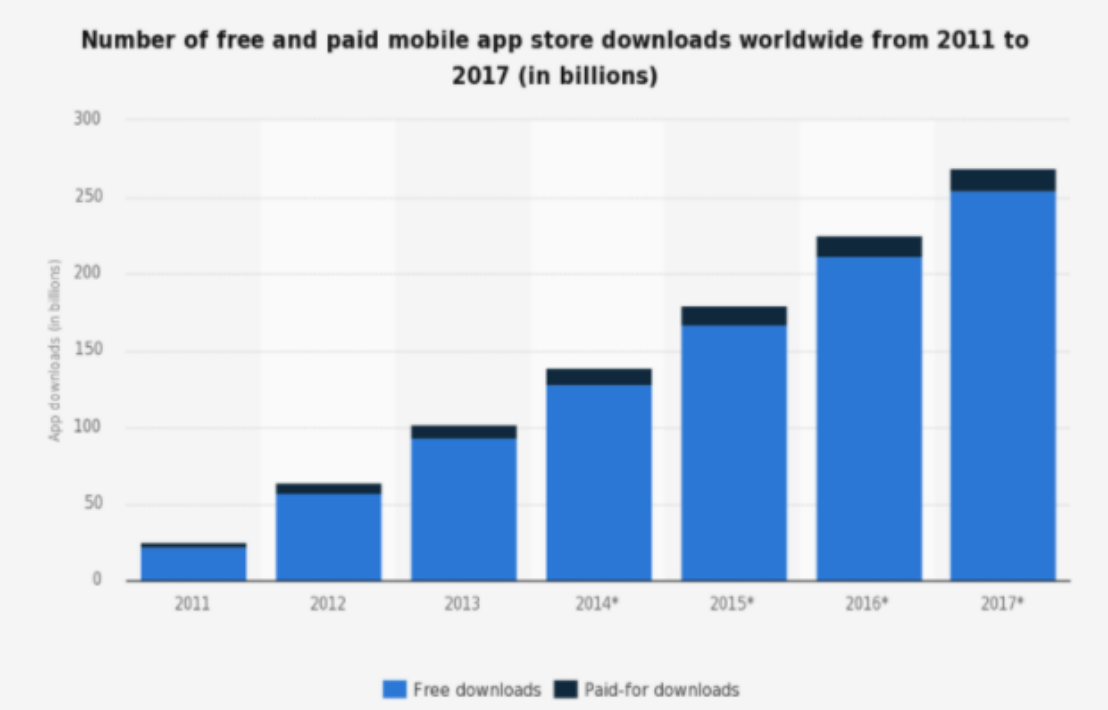

Figure 2.1.1 Number of free and paid mobile app

From Figure 2.1.1, number of free and paid mobile app which is available in app store is rising every year. Nowadays, the organization which develop mobile devices such as smartphone, tablet have monopolised the market. Some of the popular organizations are Xiao MI, Huawei, Samsung. They can even generate ROI in billions annually. With the growth of mobile industry, mobile app development is getting more and more important as mobile app is the only main method to provide different services to solve real world problems. Mobile app is similar like the app on PC, but it is developed for mobile devices and it is mobile responsive. In this century, mobile app has provided assistance to accomplish some of the daily task such as ordering a food delivery, planning for budget or online banking transactions etc. Hence, mobile app has become an essential component in our daily life as it provides effective solution and conveniences from different aspects.

Throughout the development process of GeoBudget, there is another problem arising. How do we develop a mobile app? How do we avoid paying too much when implementing a mobile app?

In order to answer those questions, an open source mobile app development tools are needed during the development process. As the development tools are open source, so we do not need to bother or worry about the development cost. The following is some of the popular mobile app development tools in recent years:

i) Ionic

Figure 2.1.2 Ionic Framework

Ionic is an opensource web and mobile development toolkit which is released by Max Lynch, Ben Sperry and Adam Bradley in 2013. It offers a good development experience for the user as it is supports high quality, cross platform functionalities. Ionic has a detailed Ionic documentation which provides installation and configuration guides, UI components guide and the others. At first, it is developed on top of the Angular JS and Cordova. In recent years, it allows the user to choose from different frameworks such as Angular, React, JavaScript and Vue.Js. It is supports web application and mobile application. It is convenience to maintain the whole system as all the codes is in one place. User can develop using web technologies such as HTML5, CSS and TypeScript. HTML5 and CSS is a common and well-known language which is applied in website development. Typescript, however, is the superset of JavaScript or jQuery. Thus, developers can use JavaScript or jQuery if they are familiar with it. Besides, Ionic uses Capacitor or Cordova to request access from mobile device so that the mobile app is configured with camera, GPS, flashlight, and the others. In the deployment process, Capacitor and Cordova have their own deployment command and it is stated in the Ionic documentation. User can either choose to deploy to emulator or real devices based on their preferences.

Why choose Ionic:

1) Single codebase so that all the code is in one place.
2) Detailed Ionic documentation is provided.
3) Workflow from configuration to quality assurance is automated.
4) Live reload functions to assist the user to view real time result when they change the code.
5) Updated features will be displayed at the central and beautiful dashboard.
6) Easy access to storage, camera, barcode scanner, QR code scanner, etc.

ii) Framework 7

Figure 2.1.3 Framework 7

Framework 7 is another option for developing mobile, desktop and web apps. It is free, open source development tools. Initially, it is used to create native iOS applications but recent years it can support both Android and iOS applications. If the developer intends to build the application with beautiful look quickly, Framework 7 is the greatest choice as the UI components is organised and good- looking. However, since Framework 7 is focus on iOS so some of the functions may not be available to all platforms. Compared to Ionic, it does not have any other framework because it has its own DOM manipulation framework (DOM7). This framework behaves like the optimized version of jQuery. In terms of features, it offers features like view management and FastClick library. View management is a navigation method which enables the user to traverse through pages with their own navigation settings. FastClick library which reduce the delay when the user touch on the GUI and provides pre-styled components which supports Android and iOS platform.

Why choose Framework7:

1) Suitable for those who is familiar in developing web application since the language includes HTML, CSS, JavaScript and jQuery.
2) Suitable for developing mobile application in iOS platform.
3) FastClick library is configured to provide various kind of UI elements and widgets such as media lists, popups, actions sheets, etc.
4) Enable the user to customize their preferable design.
5) Good video experience as it is built with Video Intelligence (VI).

iii) Xamarin

Figure 2.1.4 Xamarin

Xamarin is one of the famous approaches when comes to mobile development. It is developed by Microsoft. Therefore, developers will feel more confidence and safe as the problems such as termination of services, security issues, and sudden technological updates will not be happened throughout the development process. Xamarin is an open source development tool which is developed based on the .Net framework. The developers have to learn C# languages as it only supports this programming languages. Since it is C# codebase, it supports the development in environment such as Android, iOS and Windows. Moreover, it has an interesting feature which allows the developer to reuse 96 percent of the code as the code is shared by engineers once it is debugged and compiled. Therefore, it can speed up the development lifecycle.

Why choose Xamarin:

1) All the native API is 100% available since it is built under MONO framework.
2) Suitable for those who are familiar with C# language.
3) Application indexing and deep linking.
4) Sense the syntax inserted by developer and provides useful suggestion.
5) High performance development tools with built-in libraries.
6) High speed in conducting the overall development life cycle.

Among these three examples, we have chosen Ionic as the development tools and Angular as the framework. Ionic Angular framework can support cross platform functionalities and it is totally 100% free. Besides that, it has provided a detailed installation, UI components guide. For example, in the action sheet UI components guide, there are some recommendation of CSS customization, the multiple usage methods that can be achieved by action sheet, the shared library, the available properties and methods, etc. It is explained thoroughly and changes to code will have quick response with just a single command 'ionic serve'. For accessing features like storage or camera, Cordova plugin has provided a command called 'ionic cordova run android' or 'ionic cordova run android -l' for deploying to emulators and mobile devices. With a '-l' at the back of the command, Ionic will have live reload functions which enable real time response between application and codes. Finally, some plugins of the components like calendar, bar code scanner is available in any website. The majority of the command is accessible even though Ionic has been upgraded to different versions.

2.2 Android

Figure 2.2.1 Android operating system

Android is a widely-adopted open-source project which is developed and maintained by Google. It is design specifically for touch screen devices such as mobile phones and tablets as it provides a platform for the manufacturers to build their software and applications. At present, some well-known manufacturers like Samsung, Huawei, Xiaomi have fully utilised this operating system to produce their hardware product. Android OS allows them to share the common features and it is easily to maintain and personalise. For an instance, as long as the user is under network environment, they should be able to upgrade their application in time. Android OS have its own 'app store' called 'Play store' which offers various kind of mobile apps. It is categorised with different categories including game, photography, articles, and others. From the different point of view, Android OS enables anyone to download the SDK (software development kit) and develop applications This features allows anyone who are intended in writing applications to apply the necessary functions which are predefined by Googles such as GPS services and account management function. Every developer also has the rights to enhance the functions to meet user requirements. In a nutshell, Android is an exciting platform for the consumers and the developers.

In this modern era, Android seems to be more advanced to meet the requirements of different target audience. In the latest update of Android (Android 10.0), Android tends to be more efficient and flexible in customizing the performance and settings of the mobile devices. Actually, Android has published some new and interesting features. These features include:

Live Caption	Generate real time subtitle when a video media or audio message is playing without the need of WIFI and mobile data.
Smart Reply	Analysing the received inbox message and provides recommendation on how to reply it. Besides, Android enables the user open the Google Maps with a single tap.
Sound Amplifier	Filter the background noise and improve the auditory experience.
Gesture Navigation	An advance navigation method which is smoother and simpler. User can get around the mobile device with swipe and pull in the screen.
Dark Theme	A popular theme which is used by Google, Messenger, Facebook. It can save the battery and provide good visual experience on the users' eyes.
Privacy & Location Controls	Decide and adjust when and how the privacy data such as app activity, user location is shared.
Focus Mode	Enable the user to choose what apps to focus and what apps to pause temporarily.
Family link	Parents can adjust the usage time and content type of the children's smartphone. It also can track the location of every family member.

Table 2.2.1 Latest features of Android

After reviewing the latest version (Android 10.0), we realize that Android is improved day by day apparently as it receives many user feedbacks from all over the world. Due to the connection with Googles, Android has some framework and middleware components which can assist in system development. However, there are still some drawbacks of Android. The problems that come into our mind is: “what is the strength and weakness of Android?”.

Strength:

1. Multitasking: In Android based products, we can access multiple mobile application at the same time. This can save time and the user can focus on another task. For an example, the user can simultaneously update the mobile app in the background and enjoy sliding the social media.
2. Alerts and notifications: Notifications is one of the important features in Android system as it notifies the user when certain task is completed. Every user has the rights to turn on and turn off the notifications.
3. Open supply applications: Android provide free packages and development tools to help anyone to develop applications. As long as the user is legitimate, he or she can apply these tools in their system development process.
4. More smartphone performing on Android: There are different kinds of manufacturer who use Android OS likes HTC, Motorola, Samsung, Huawei, etc. The user can choose their smartphone according to their preference, while IOS can only applied on Apple.
5. Widgets: Android based system have the functions of setting widgets. This enable the user to customised their home screen display.
6. Availability of Google services: Google provides some clean and popular apps for the user. Gmail, Google Drive, Docs, etc. is a part of Android gadget and it is sincerely free and reliable.
7. Customised ROM: The user can install a modified ROM and it is guaranteed not to harm the device.

Weakness:

1. Internet connection: Although Android based system is very useful, it has to be run under network environment so that all the application and services is applicable in time.
2. The performance of Android based system is not very excellent in some mobile devices, and many applications contain viruses and ads that will lead to lagging.

2.3 Cloud Vision API

Figure 2.3.1 Logo of Google Vision API

In 2nd of December 2015, a brand-new technology named Google Vision API was released. API stands for application programming interface, while 'Google vision' is a framework for finding photos and video. Google Vision API can quickly analyse the image content and classify them into thousands of categories. It works like artificial intelligence as it can detect different kinds of objects like face, landmark, logo, label and others. Since it is an open source technology, it allows the developers to build their technology in an efficient way. Every developer can take this advantage to build system and applications with this image recognition technology. Besides that, Google Vision API has a very high accuracy in analysing the image content. It continuously evolves its learning models and image processing algorithms so that it can recognise any unknown objects or something that is not described. It is easy to learn because all the required procedures before we apply this technology are listed in the "cloud.google.com". It enables the developers to take advantage of Google's latest machine learning technology quite easily.

In more detail, Google Vision API has the following features which assist in image classification:

1) Face detection can detect faces in an image based on the attributes within an image like eyes, nose, and mouth position. It also can detect the emotion of the faces such as joy, anger, surprise and sorrow.

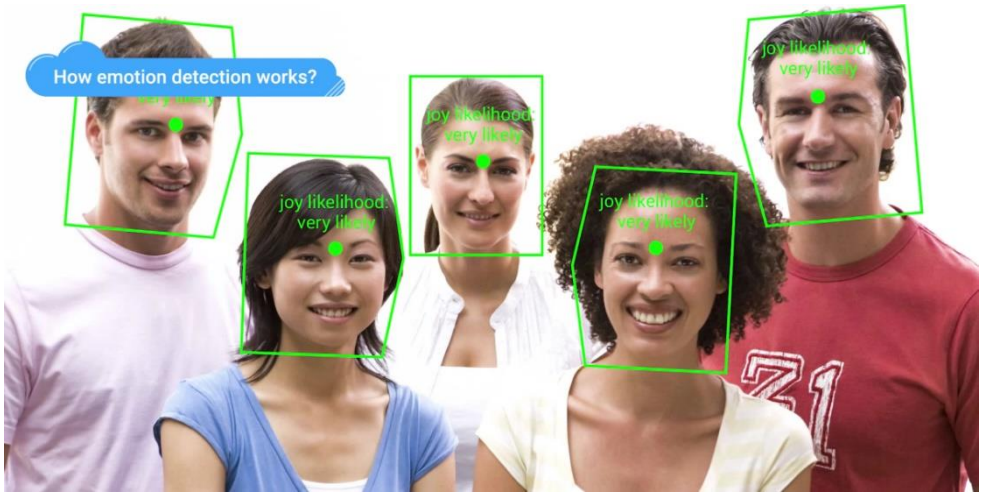

Figure 2.3.2 Face Detection Features

2) Logo detection can detect any company logo and it will provide a description after the entity is identified.
3) Label detection analyses the image content and provides relevant labels.

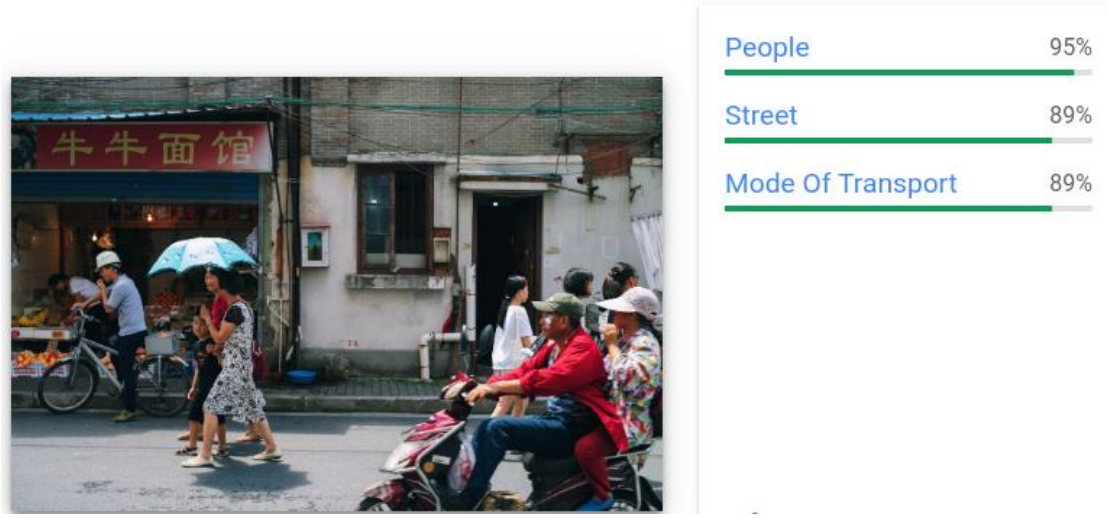

Figure 2.3.3 Label Detection Features

4) Text detection and Document text detection perform OCR (optical character recognition) and convert the text to machine coded-text. Then it will identify and provide the extracted text.
5) Safe search detection can determine any image contents that might include violence, pornographic and illegal components.
6) Image properties detection can analyse how much colours is in an image and each colour is represented using colour space.
7) Object localization detects the existence of multiple objects within an image and each of the detected objects has a brief description, confidence score and box annotations.
8) Crop hint detection which can detect the bounding polygon for the cropped image. It enables the user to discover the perfect scale to crop an image.
9) Landmark detection can detect geographical landmark so that it can know where the landmark is.
10) Web entities detection can detect and display web reference to an image together with the confident score.

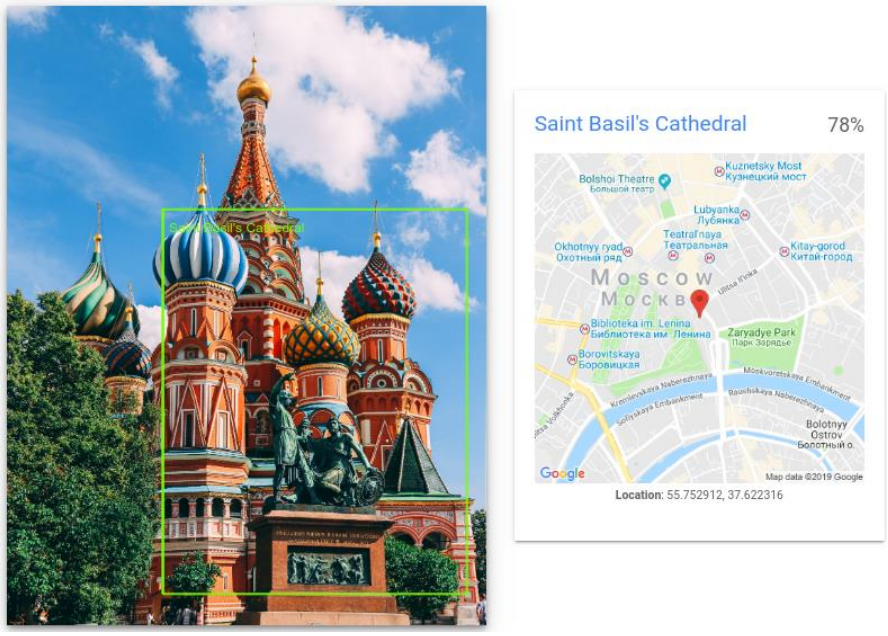

Figure 2.3.4 Landmark Detection Features

These features work by sending an image to the cloud and it returns JSON with the name, the longitude and latitude coordinates, and some metadata that described the image.


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{
  "responses": [
    {
      "landmarkAnnotations": [
        {
          "mid": "/m/014lft",
          "description": "Saint Basil's Cathedral",
          "score": 0.7840959,
          "boundingPoly": {
            "vertices": [
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                "x": 812,
                "y": 1058
              },
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                "x": 2389,
                "y": 1058
              },
              {
                "x": 2389,
                "y": 3052
              },
              {
                "x": 812,
                "y": 3052
              }
            ]
          },
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                "latitude": 55.752912,
                "longitude": 37.622315883636475
              }
            }
          ]
        }
      ]
    }
  ]
}
```


Figure 2.3.5 Output of Landmark Detection Features

Taking everything into account, Google Cloud Vision API has the following benefits:

1) Adaptive- Cloud vision allows the user to detect faces, logos, objects in an image. The more we work together with it, the higher the accuracy as it will continuously adapt to the environment.
2) Detailed detection- Vision API can be used together with the Google Image Search and it can provide a detailed description of such image.
3) Moderate Content- OCR is a very powerful tool for text recognition as it not only detects the content of the world. It also analyses the content to justify that whether it is legal and appropriate content for the consumer.
4) Multiple features application- the developer can apply multiples features in one image.
5) Discoverability- The image that is sent to the cloud can be present as any angles. Besides, it can appear at any location like walls, bottle, bag, T-shirt etc.
6) Google- As we know, Google is an experienced company which can handle huge data and provide maintenance on time. It has enough resource and manpower to enhance Vision API.

Figure 2.3.6 Discoverability- Logo detection can be conducted at any location

2.4 Google Maps Platform

Figure 2.4.1 Google Maps Platform

Few years ago, the development team of Google Cloud has invested a platform called Google Maps Platform. This platform is built with reliable and accurate geo location data and it is a specialist in managing location-based services. This platform has caused a great impact in every industry. For examples, logistic services, food delivery, hotel management system and any other services that requires geo location services. At present, if a mobile app is developed without Google Map Platform, it would be high possibility that the system is less advanced and flexible. Google Maps Platform definitely can enhance the user experience in using an application as it provides real time place data, traffic and route information. Besides providing dedicated services and support, it will provide usage data, median latency in a dashboard so that the user will have greater experience on the business. Actually, Google Maps Platform is built under GCP. Therefore, the first 300-dollar free credit can be utilized to buy more advanced functionalities and API. In fact, Google Maps Platform has delivered some products and API to the developers. Those products consist of three categories which is Maps, Routes, and Places.

For ‘Maps’ products, it enables the user to have visual experience on the static and dynamic maps, the user can even have 360-degree street views on every selected location.

For ‘Route’ products, it provides an accurate and real time traffic information when the user travels from one place to another. It highlights a route from a starting point to the destination with just one tap. In addition, it has the ability to calculate a precise distance matrix and determines how many vehicles in the road.

For ‘Places’ Products, it provides more specific location information to the user. It can discover over 100 million of places. With the features of ‘Places’, the user can easily realize the address, phone number, or other related information of a particular location.

Getting to the main point, what types of product that we can apply in GeoBudget? Firstly, GeoBudget must be designed with a map so that the user can auto locate themselves or pick on a particular location. Next, the user can click on the location and the information of the location will be showed to the user for inserting their expenses. Thus, ‘Maps’ and ‘Places’ is suitable for developing GeoBudget. Among all the API, we can apply API such as GeoCoding API, Map Static API, Map JavaScript API and Places API when developing the geo location services. The followings are the functions of these 4 API:

i) GeoCoding API- This API enables the system to convert a location to a coordinate (latitude and longitude). It also can convert a coordinate to an address, this process is called Reverse GeoCoding.

ii) Map Static API- This API will return a map image for the user who intends to show the image of current location. It works by sending the HTTP request with the URL parameters. After that, a screenshot of the location will be displayed on the application.

iii) Map JavaScript API- It enables the user to customize the map with their preferable components like roadmap, satellite, terrain, etc. Besides, it assists the developer to show particular location when the app is launched by simply adjusting the coordinates.

iv) Places API- It works by sending HTTP request and it will return the information of a place together with geographic locations or prominent points of interest.

2.5 Personal Expenditure Categories

Creating a budget in the app seems to be like very simple, but when it comes to real budgeting process, the user will think of thousands of categories to consider. For examples, categories that consumes small amount of money such as a gym membership fee, WIFI subscription fee, school fees of daughter while the categories that consumes a lot of money such as buying a car, renting a property and the others. In such circumstances, breaking down the category into different areas will help the user to get a better picture when they are managing their budget. Below are the budget categories area which is advised by some budgeting experts.

Expenditure Categories	**Example**
Housing	Property rent, taxes, house maintenance costs, etc.
Transportation	Car payments, petrol fees, parking, tolls, public transport fee, etc.
Food	Grocery purchase, having a meal in restaurant, etc.
Utilities	Water, electric, WIFI, mobile devices, etc.
Insurance	Any type of insurance
Shopping	Clothes, wallet, hobbies, etc.
Education/ Kids	School fees, tuition fee, music classes, etc.
Household item/Supplies	Laundry, dishwasher, cleaning robot, rice cooker, etc.
Medical and healthcare	Treatment, skin care, medical services, etc.
Investing and debt payments	Investment on property, stock, etc.
Personal spending	Salon, gym, haircuts, etc.
Entertainment	Watching movie, games, concerts, etc.
Gift/ Donations	Birthday present, Christmas, donation, etc.

Table 2.5.1 Expenditure categories

Summarizing all the expenditure categories, we have concluded 9 categories in GeoBudget. The following table is the expenditure categories in GeoBudget.

Expenditure Categories	**Example**
Grocery	Grocery purchase
Restaurant	Having a meal in restaurant
Leisure	Same as entertainment in the previous table
Transport	Same as transportation in the previous table, but also included car insurance
Health	Same as Medical and healthcare in the previous table, but also included health insurance
Gift	Birthday, anniversary, Christmas present
Family	Includes education, housing, utilities, kids, household item in the previous table
Shopping	Same as shopping in the previous table
Others	Includes investment, donations and other expenses

Table 2.5.2 Expenditure categories in GeoBudget

2.6 Review of existing works

The following mobile application is the examples of the existing budgeting application.

2.6.1 1Money-Expense Tracker, Money Manager, Budget

Figure2.6.1.1 1Money symbol

Figure2.6.1.2 Home screen of 1Money

1Money is developed by PixelRush and is released at February 2018. This application currently has 1 million above downloads and it is one of the top grossing apps in Play Store. It enables us to add a new transaction with a single tap. We can quickly plan our income and expenses and eventually the app will provide an informative chart for us. It helps us to achieve our financial goal efficiently. 1Money is free with no ads. It provides a permanent premium version for the users which costs below RM12.50. The fact is that we can access it without paying large amount of money and we can use all the excellent features of this application. Besides, this application has a very simple and understandable interface for the user to record their daily transactions. Some common expenses such as restaurants, transport, groceries, shopping, etc are grouped well with the symbol. User also have the rights to add new categories and rename the categories. What the user has to enter is just the amount that they spend. 1Money offers users to visualise their spending in a bar graph. User consequently able to plan their financial goals or control the amount they consume per day. Looking to the left-hand side of the main screen, there exist a drop-down list for the user to set the language, theme, currency format and manage the account. Most importantly, 1Money has the ability set a daily reminder to add transactions. This features more or less can solve the problem in which the user forgets about to record their daily expenditure.

From the different point of view, 1Money have a 'transaction' icon below the main screen. Its function is to ease the modification of every transaction. For an instance, when one friend of the user refunds the money, the user can simply delete the transaction which the user lent money to them. In addition, 1Money have a unique functionality which it prompts out a calculator for the user to compute their expenditure when the bills involve multiple items.

Nevertheless, 1Money have some limitations. Firstly, 1Money is an Android only application. It is only available for some major platform such as Window, Android. In our opinion, PixelRush may have to develop this application in app store for the convenience of IOS user. Another weakness of this application is that all data must be manually inputted and the user cannot include the location data of each transaction. This problem can be solved through geo-location services. The application can track the location of the user and show a list of items for them to choose. Next, it seems like a bit lacking of budget reports. It is not suitable for the user who need a detailed documentation of their transaction. This problem can be resolved by showing an option for outputting a detailed report rather than just giving a graphical visualization on main screen.

Key features:

1. Do budgeting with a single tap on provided categories.
2. Informative chart for visualization purpose. User can view the overall transactions status at a glance.
3. Income and expenses section are categorized well and user can easily add or edit the categories they preferred.
4. Able to track the debts and saving so that the user can achieve their financial goals.
5. Enable the user to have a quick setting on theme, currency format.
6. Synchronize the budget data in all devices with cloud-based data synchronization.

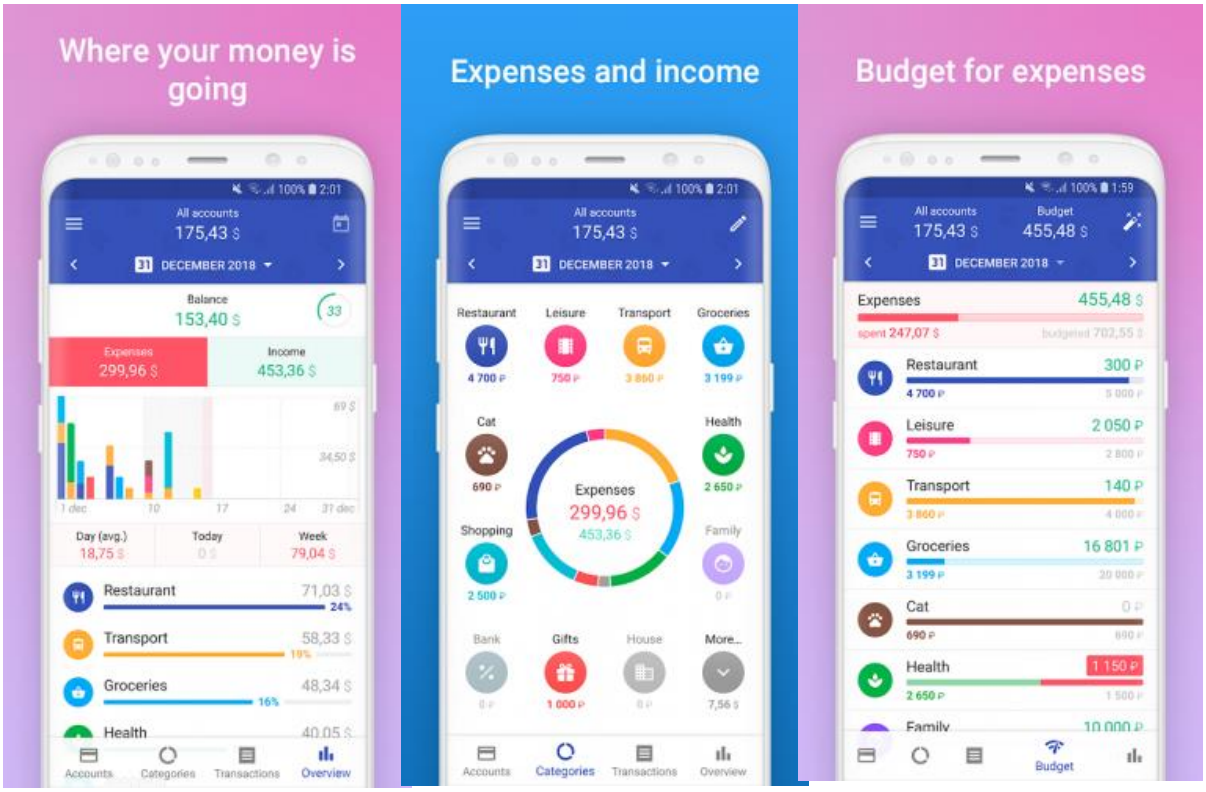

Figure2.6.1.3 GUI of 1Money

Strength:

1) Free with no ads.
2) Cheap subscription fee.
3) Beautiful and user-friendly interface.
4) Well-designed bar chart and doughnut chart.
5) Dynamic setting when user do budgeting.
6) Daily reminder and notification.

Weakness:

1) Android only application.
2) Manual insertion.
3) Not able to generate budgeting report.

2.6.2 Fast Budget- Expense Manager and Money Tracker

Figure 2.6.2.1 Fast Budget

Fast budget is a free personal financial application which is offered by FerApps- Mobile solutions. At present, Fast Budget has 1 million above users. This application is designed with a fully customizable overview page which enables the user to visualise the flow of their money at a glance. Fast Budget only supports Android and iOS platform. It allows the user to see a lot of information about their financial status. However, it is very difficult to process since large amount of data will make it a bit cluttered. Moreover, Fast Budget offers a short tutorial upon opening the new screen for the first time. It explains what features can be deployed when encountering on certain situation. As the same as 1Money, the users are able to schedule the reminder to input the purchase at a specified time. This is quite useful features for the user to get into habits of consistently inputting data into such applications. Next, there are separate tabs like transactions, accounts, credit cards, debts, charts, etc. Most of them are common in other budgeting application, while the charts tab allows the user to generate charts for any categories and date range. Besides that, there exists a calendar tab to view transactions for any individual date. Users can add, edit, update and delete previous transaction if they mistakenly insert the wrong input.

Despite Fast Budget has lots of strength, there is still some flaws in this application. Some users also respond some negative reviews towards such application. First of all, as the same as 1Money, users have to manually inputting data. Secondly, there are too many information on one single screen. Therefore, adding or deleting a transaction will seems like intimidating and cluttered. Although this application has the feature of customizing the layout of the screen, it is not mentioned in the tutorial and is hidden away in the settings. From the other perspective, the chart is not generated automatically. The most crucial part of this feature is that the chart cannot be saved as reference. Consequently, the user may not have the ability to refer to the chart and plan for further financial goals.

During the research of this application, we also find some negative reviews from the play store. For an example, a user named Adam Carling used to say that he cannot find out how to log that someone owes him money. This is exactly what the problem we encountered during the process of researching this title. Thus, this problem can be resolved by adding a section for calculating the split of bills. Fast Budget may need to have a tab to record the social interaction of the users.

Key features:

1. User is able to synchronize their transactions with their bank account, which means the deduction of money in the bank will directly record as expenses.
2. Daily, weekly, monthly informative chart for visualization and analytics.
3. Support 90 currencies.
4. Create own categories in the expenses section.
5. User can easily manage and schedule the transactions.
6. Calendar to keep an eye on daily and monthly transactions.
7. Report generation system.

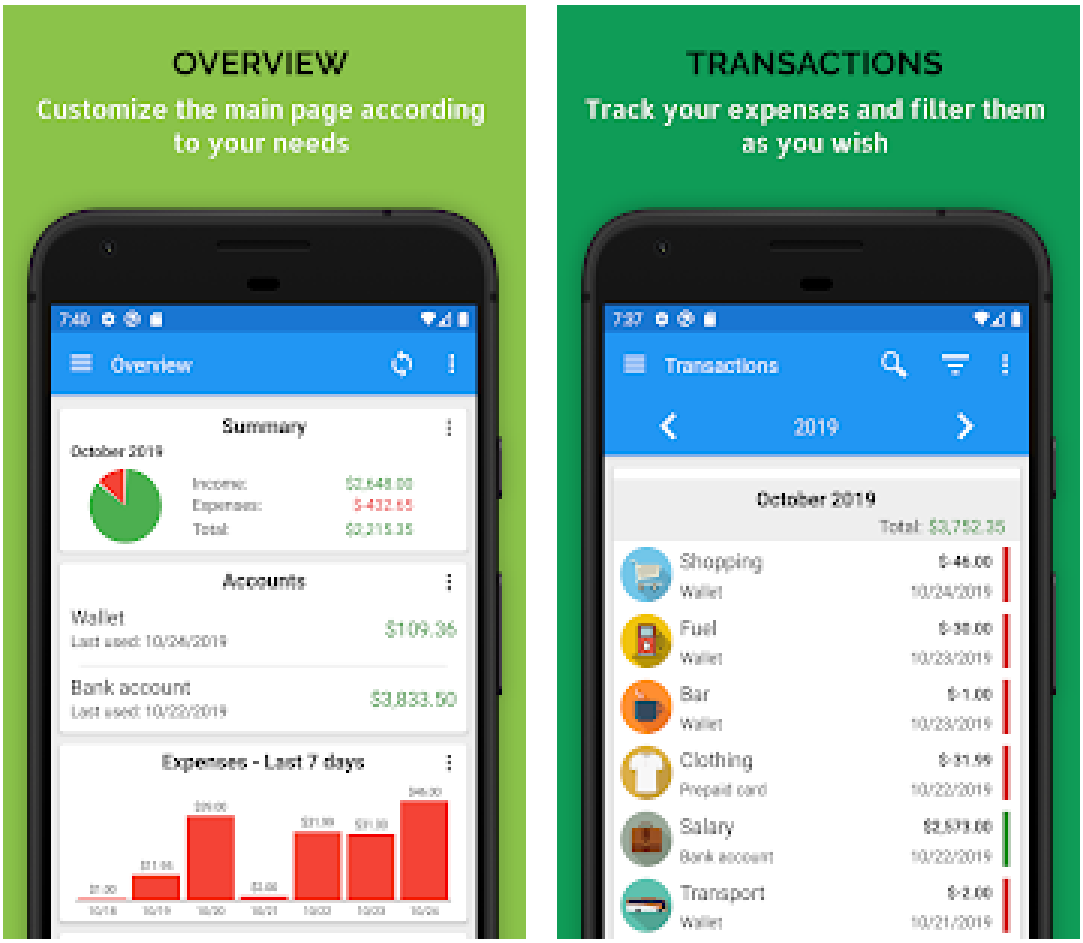

Figure 2.6.2.2 GUI of Fast Budget

Strength:

1. Support both Android and iOS platform.
2. Different type of chart which serve respective purposes.
3. Free tutorial before entering the GUI.
4. Bank synchronization.
5. Generate Report.

Weakness:

1. Manual insertion.
2. Too many information in one single screen.
3. No section for managing split of bills.

2.6.3 HomeBudget

Figure2.6.3.1 HomeBudget

Home Budget is one of the free budgeting applications which is offered by Anishu. It supports all major platforms such as Window, Mac, IOS, Android and Amazon. We have found two versions on Play Store, which respectively provide integrated set of features to help us manage our cash flow. One of them is lite version, which is free of charge. Another version is named "Home Budget with Sync", which is available as a paid application. Home Budget has 'Family Sync' function which is an advanced feature that allows multiple devices within the family to exchange financial information. This feature can be setup under 3G, 4G or WIFI environment.

The first time we launched Home Budget, we are presented with the summary of the expenses, bills, income, and budget for the current month. Instead of using the actual amount of income and expenses, it uses the percentage to represent on homepage. Payee, reports and search functionality also included at the bottom on the main screen. Overall, all the components are arranged properly and neatly.

Home Budget has an extraordinary feature which is decent report functionality. It enables the user to export the reports to their PC and Mac for further planning and analysis. It also has real time balance awareness which is to make the user to alert on their balance of account to avoid overspending.

As a matter of fact, Home Budget has some negative implications towards the users. First and foremost, Family Sync feature does not work as well as it expected because there are still some problems like data transfer between devices. Secondly, the ability to create additional categories will result in vast amount of data. This issue will directly ruin the report because it will become more difficult for the user to detect pattern of expenditure. Therefore, this budgeting application should limit the number of categories that the user can create to ensure that the report is clear and less confused.

Key features:

1. User can attach an image of receipt and resize it to update the expenses.
2. Functions for searching expense entries.
3. Bill reminders.
4. User can generate the report via email and under WIFI environment.
5. Family Sync which synchronize mobile devices of every family member.
6. Bank synchronization which link the expenses and income entries with the bank account balance.

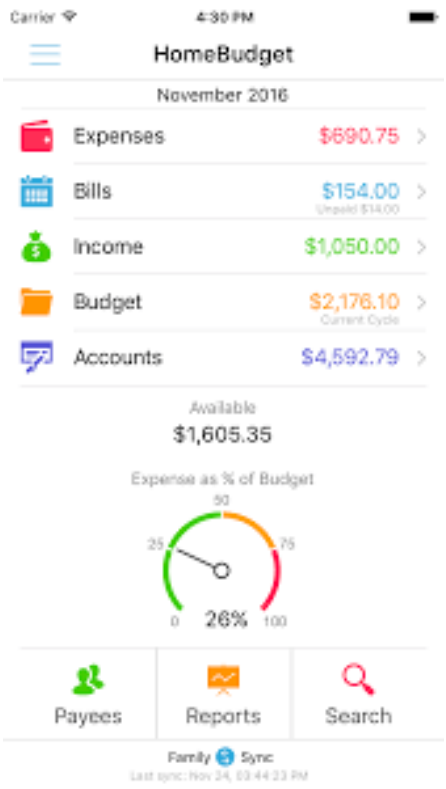

Figure2.6.3.2 Home screen

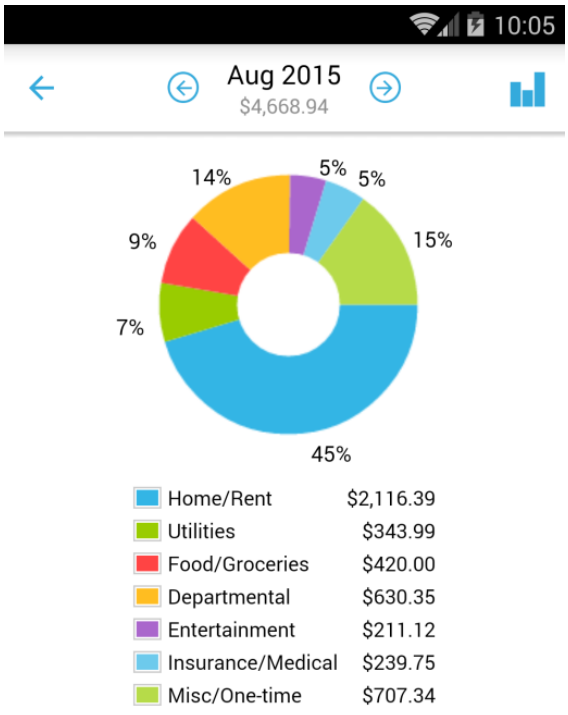

Figure2.6.3.3 Pie Chart

Strength:

1. Supports all major platforms.
2. Exchange budgeting information with family members.
3. Well-designed summary in the home screen.
4. Generated report can be supported in different format. (csv, pdf)
5. Easy to manage all the transactions.

Weakness

1. User still encounter some problem when using ‘Family Sync’.
2. No update and maintenance constantly.
3. Creating a category will result in prompting out a lot of data.
4. Not suitable for businessman who has hundreds or thousands transaction per day.
5. Manual insertion.

2.6.4 Comparison of Key features

Key features	1Money	Fast Budget	HomeBudget	Proposed system (GeoBudget)
Bank Synchronization		√	√	
Theme selection				
Currency selection	√	√	√	
Generate and Export report		√	√	
Geo location services				√
Context Scanner				√
Chart Module	√	√	√	√
Calendar Module	√	√	√	√
Manage Split of Bills				√
Android	√	√	√	√
iOS		√	√	
Windows			√	√
Family Sync			√	
Set target budget				√
Suggestive system				√
Image module			√	√
Budget management	√	√	√	√
Split bills management				√
Scan receipt			√	

Table2.6.4.1 Comparison between existing budgeting app with GeoBudget

Chapter 3- Proposed Method Approach

3.1 Design Overview

GeoBudget is designed with 4 tabs and each of them carries out different functionalities. The following table shows the features of every tabs:

Tab1- Accounts	Features in this tab includes: 1. View the overall financial detail. 2. Add income. 3. Edit income
Tab2- Categories	Features in this tab includes: 1. View the entered budget before and after changing the dates. 2. Input expenses after changing the dates. 3. Set target budget for each category. 4. Suggest product based on targeted budget. 5. View the bar chart and doughnut chart.
Tab3- Transactions	Features in this tab includes: 1. View the list of split bill transactions. 2. Create new split bill transactions. 3. Mark the transactions as completed after get the refund.
Tab4- Discover	Features in this tab includes: 1. Show current location image. 2. Show nearby stores when selecting a location. 3. Show menu of the selected stores. 4. Input budget with geo location services. 5. Image recognition. 6. Input budget with context scanner.

Table 3.1.1 System Design Overview

3.2 System Design

3.2.1 System Flow Chart

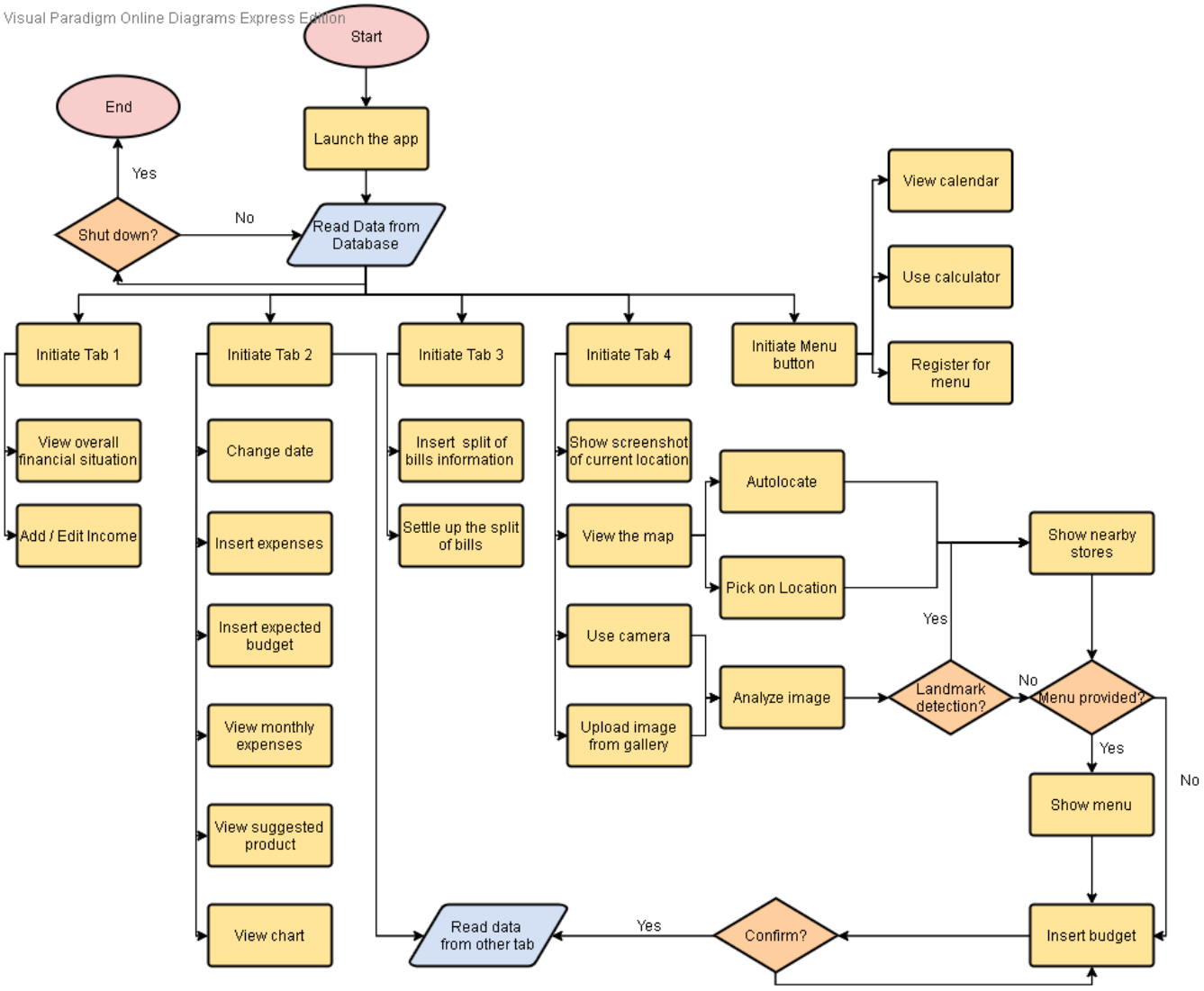

Figure 3.2.1.1 System Flow Chart

3.2.2 Use case diagram

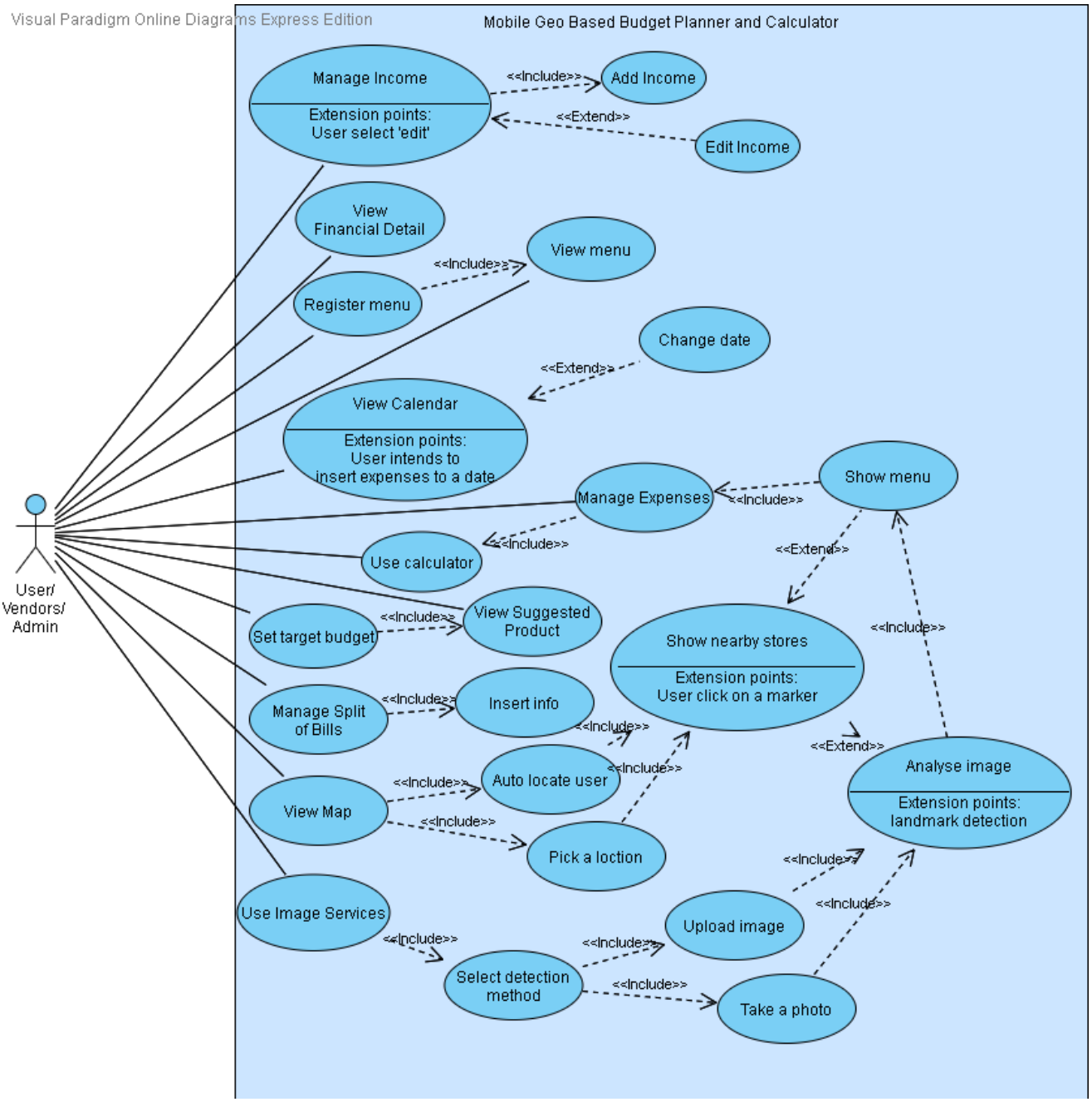

Figure 3.2.2.1 Use Case Diagram

3.2.3 Use Cases Description

Manage Income

Use Case ID	UC001	
Feature	Manage Income	
Purpose	To allow the user to add or edit the income amount.	
Actor	User/ Vendors/ Admin	
Trigger	User press the 'create' icon besides the 'Card', 'Cash', 'Ewallet' and 'Saving'.	
Precondition	User is navigated to first tab- Accounts.	
Main Flow	Step	Action
	1	User press the icon besides the income type.
	2	User will be redirected to a page to insert the income amount.
	3	User press 'Submit' after entering the amount.
	4	An alert message will prompt out.
	5	User select 'Add'.
	6	The amount will be added and displayed to the user.
Alternative Flow 5a. The user wants to edit the amount of income	Step	Action
	5a	User select 'Edit'.
	6	The amount will be edited and displayed to the user.

Table 3.2.3.1: Use case description of Manage Income use case

View Financial Detail

Use Case ID	UC002	
Feature	View Financial Detail	
Purpose	To allow the user to view financial detail such as income, expenses and assets amount.	
Actor	User/ Vendors/ Admin	
Trigger	User enter first tab-Accounts or second tab-Categories.	
Precondition	User launched the system.	
Main Flow	Step	Action
	1	System displays the financial detail to every respective category and display the total assets, total income and total expenses on top of first tab-Accounts.

Table 3.2.3.2: Use case description of View Financial Detail use case

View Calendar

Use Case ID	UC003	
Feature	View Calendar	
Purpose	To allow the user to view calendar.	
Actor	User/ Vendors/ Admin	
Trigger	User press the ‘calendar’ in the drop side menu list or press the date button at second tab- categories.	
Precondition	User launched the system.	
Main Flow	Step	Action
	1	System displays the calendar.

Table 3.2.3.3: Use case description of View Calendar use case

View Menu

Use Case ID	UC004	
Feature	View Menu	
Purpose	To allow the user to view registered menu.	
Actor	User/ Vendors/ Admin	
Trigger	User select and press on a store in the menu list.	
Precondition	User press the menu button at the top left side of every tabs and select ‘Menu Registration’.	
Main Flow	Step	Action
	1	System shows a list of stores.
	2	User selects on a store.
	3	System displays the product items sold by the store.

Table 3.2.3.4: Use case description of View Menu use case

Register Menu

Use Case ID	UC005	
Feature	Register Menu	
Purpose	To allow the user to register and create a new menu.	
Actor	User/ Vendors/ Admin	
Trigger	User press the menu button at the top left side of every tabs and select ‘Menu Registration’.	
Precondition	User launched the system.	
Main Flow	Step	Action
	1	User insert the place details.
	2	User insert the product details.
	3	User select the expenses type.

	4	User press ‘submit’ button.

Table 3.2.3.5: Use case description of Register Menu use case

Manage Expenses

Use Case ID	UC006	
Feature	Manage Expenses	
Purpose	To allow the user to manage expenses amount.	
Actor	User/ Vendors/ Admin	
Trigger	User select a category type.	
Precondition	User is navigated to second-tab-Categories.	
Main Flow	Step	Action
	1	User press any of the category.
	2	User will be redirected to calculator module to calculate their expenses.
	3	User press ‘Confirm’ after calculating the amount.
	4	System displayed the inserted amount on respective categories.
Alternative Flow 3a. User cancel the process	Step	Action
	3a	User press ‘Cancel’.
	4	The amount will be not be inserted and the user is redirected to previous webpage.

Table 3.2.3.6: Use case description of Manage Expenses use case

Set Target Budget

Use Case ID	UC007	
Feature	Set Target Budget	
Purpose	To allow the user to allocate and set their targeted budget.	
Actor	User/ Vendors/ Admin	
Trigger	User select 'Budget Allocation' at second tab- Categories.	
Precondition	User launched the system.	
Main Flow	Step	Action
	1	User select 'Budget Allocation' at second tab- Categories.
	2	User enter the targeted budget to every category.
	3	User press the checkmark icon on the top right side.
	4	User select 'Yes' in the alert message box.
	5	System display the total targeted budget.
Alternative Flow 4a. User don't want to input the target budget.	Step	Action
	4a	User select 'No in the alert message box.
	5	The amount will be not be inserted and the user is redirected to previous page.

Table 3.2.3.7: Use case description of Set Target Budget use case

View Suggested Product

Use Case ID	UC008	
Feature	View Suggested Product	
Purpose	To allow the user to view the suggested product which is based on their targeted budget.	
Actor	User/ Vendors/ Admin	
Trigger	User press ‘Suggestive System’ button at second tab- Categories.	
Precondition	User launched the system and is at second tab- Categories.	
Main Flow	Step	Action
	1	User press ‘Suggestive System’ at second tab- Categories.
	2	User select any of the category.
	3	System display the suggested products in a list form.

Table 3.2.3.8: Use case description of View Suggested Product use case

Manage Split of Bills

Use Case ID	UC009	
Feature	Manage Split of Bills	
Purpose	To allow the user to track the split of bills.	
Actor	User/ Vendors/ Admin	
Trigger	User is at the third tab- Transactions.	
Precondition	User launched the system.	
Main Flow	Step	Action
	1	User select the ‘you owed’ type.
	2	User enter the name and amount.
	3	User press the ‘submit’ button
	4	System displays the list of inserted information.
Alternative Flow 1a. User choose different type	Step	Action
	1a	User select the ‘you are owed’ type.
	2	User enter the name and amount.
	3	User press the ‘submit’ button
	4	System displays the list of inserted information.

Table 3.2.3.9: Use case description of Manage Split of Bills use case

View Map

Use Case ID	UC010	
Feature	View Map	
Purpose	To allow the user to use geo location services to do budgeting.	
Actor	User/ Vendors/ Admin	
Trigger	User press the map image in Tab4 and select 'View Map' in the action sheet.	
Precondition	User launched the system and is at the fourth tab- Discover.	
Main Flow	Step	Action
	1	User press the map image.
	2	An action sheet will be displayed, and user select 'View Map' in the action sheet.
	3	User pick a place on the map.
	4	System displays the nearby stores.
	5	User select the stores that they visited
	6	System displayed the menu.
	7	User select the product that they had purchased
	8	User click the checkmark icon in the toolbar.
	9	User press 'Confirm' in the action sheet.
	10	The user is redirected to second tab- Categories and system will displayed the inserted amount.
Alternative Flow 2a. User wants to see where they at	Step	Action
	2a	An action sheet will be displayed, and user select 'Show current location image' in the action sheet.
	3	System displayed the current location image of the user.
Alternative Flow	Step	Action

3a. User wants to locate themselves on the map	3a	User press the 'locate' icon in the toolbar and auto locate themselves on the map.
	4	System displays the nearby stores.
	5	User select the stores that they visited
	6	System displayed the menu.
	7	User select the product that they had purchased
	8	User click the checkmark icon in the toolbar.
	9	User press 'Confirm' in the action sheet.
	10	The user is redirected to second tab- Categories and system will displayed the inserted amount.
Alternative Flow 6a. No menu is provided in this location	6a	System displayed a page for the user to insert amount.
	7	User select the expenses type and insert the amount.
	8	User press 'Confirm' in the action and redirected to Tab2.
	9	System will display the inserted amount
Alternative Flow 9a. User cancel the process	Step	Action
	9a	User press 'Cancel in the action sheet.
	10	User is redirected to the map to repeat the process again.

Table 3.2.3.10: Use case description of View Map use case

Use Image Services

Use Case ID	UC011	
Feature	Use Image Services	
Purpose	To allow the user to use image services.	
Actor	User/ Vendors/ Admin	
Trigger	User provided image in the fourth tab- Discover.	
Precondition	User launched the system and is at the fourth tab- Discover.	
Main Flow	Step	Action
	1	User select a detection method (text and logo detection) in tab4.
	2	User press the camera icon at the bottom.
	3	User select 'use camera' option in the action sheet.
	4	User use camera to take a photo of the product.
	5	System will analyse the product image and displayed the result in a page.
	6	User press 'show menu' in the result page.
	7	System displayed the menu.
	8	User select the product that they had purchased
	9	User click the checkmark icon in the toolbar.
	10	User press 'Confirm' in the action sheet.
	11	The user is redirected to second tab- Categories and system will displayed the inputted amount.
Alternative Flow	Step	Action
1a. User choose landmark detection	1a	User select landmark detection method.
	2	User press the camera icon at the bottom.

	3	User select ‘use camera’ option in the action sheet.
	4	User use camera to take a photo of the landmark.
	5	System will analyse the landmark image and displayed the result in a page.
	6	User press ‘show nearby stores’ in the result page.
	7	System displayed the map.
	8	User press the refresh icon in the toolbar.
	9	System displayed the location of the landmark with the nearby stores.
	10	User select the stores that they visited
	11	System displayed the menu.
	12	User select the product that they had purchased
	13	User click the checkmark icon in the toolbar.
	14	User press ‘Confirm’ in the action sheet.
	15	The user is redirected to second tab- Categories and system will displayed the inserted amount.
Alternative Flow 3a. User want to upload a product image	Step	Action
	3a	User select ‘Take from gallery’ option in the action sheet
	4	User select and upload an image of the product.
	5	System will analyse the product image and displayed the result in a page.
	6	User press ‘show menu’ in the result page.
	7	System displayed the menu.
	8	User select the product that they had purchased

	9	User click the checkmark icon in the toolbar.
	10	User press ‘Confirm’ in the action sheet.
	11	The user is redirected to second tab- Categories and system will displayed the inserted amount.
Alternative Flow 10a. User cancel the process	Step	Action
	10a	User press ‘Cancel in the action sheet.
	11	User is redirected to previous page.

Table 3.2.3.11: Use case description of Use Image Services use case

3.2.4 Activity Diagrams

3.2.4.1 Manage income

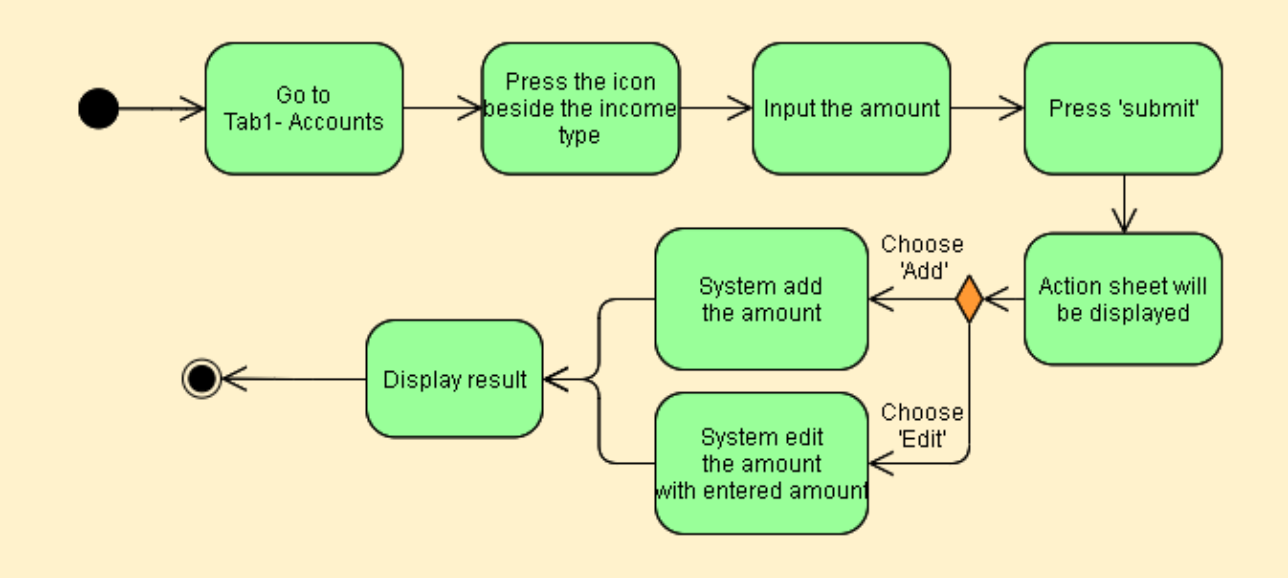

Figure 3.2.4.1 Activity diagram of Manage Income

3.2.4.2 View financial detail (Total assets, total income)

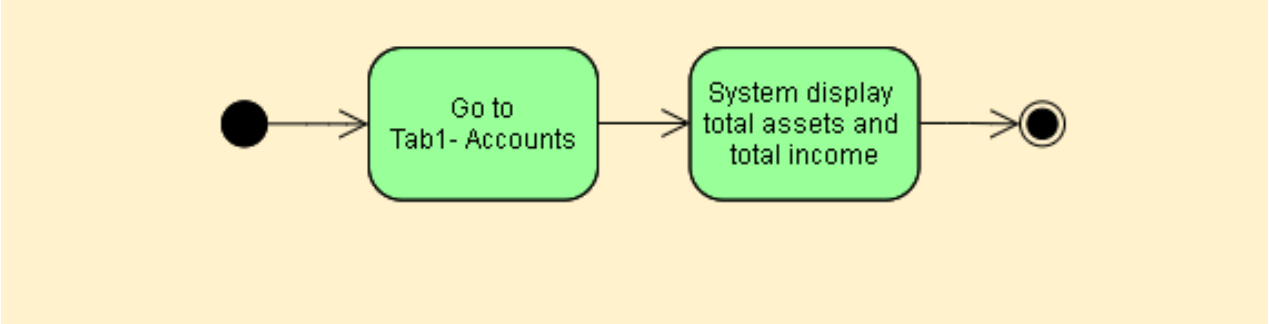

Figure 3.2.4.2 Activity diagram of View Financial Detail

3.2.4.3 View expenses of particular date

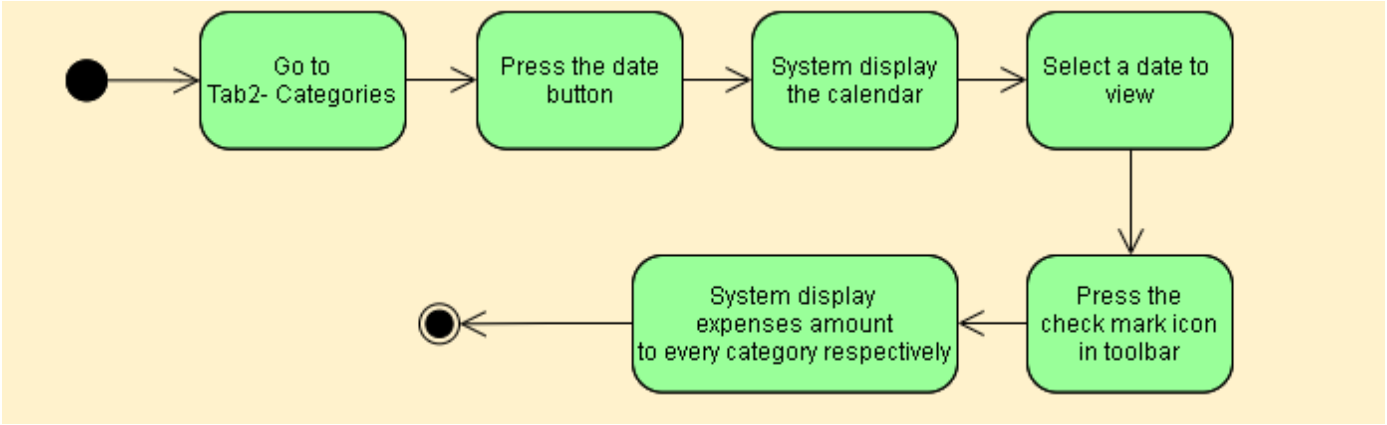

Figure 3.2.4.3 Activity diagram of View Expenses of particular detail

3.2.4.4 Add expenses

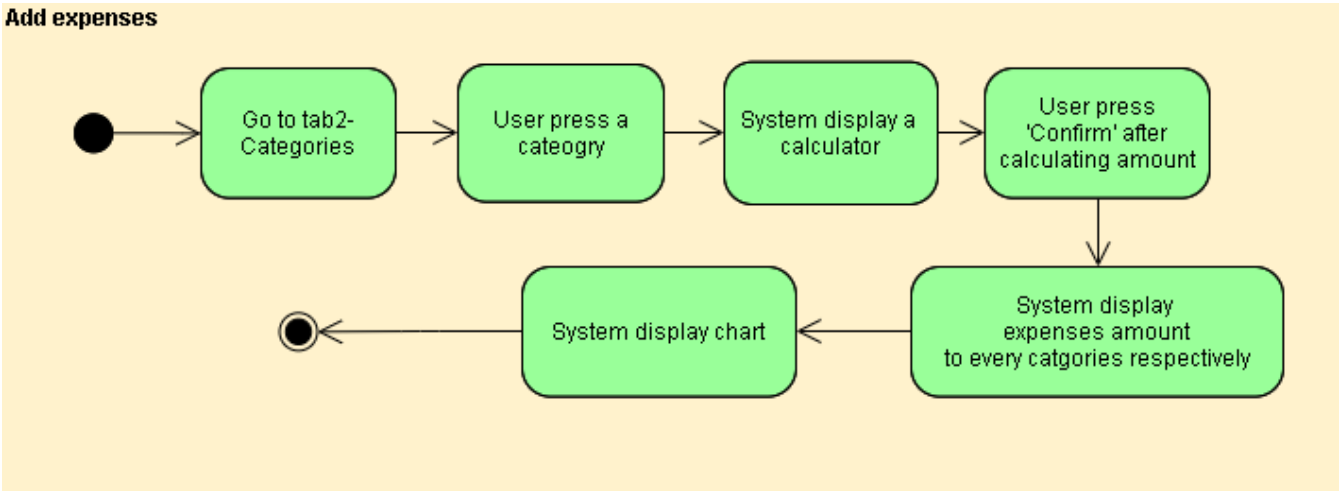

Figure 3.2.4.4 Activity diagram of Add Expenses

3.2.4.5 Set targeted budget

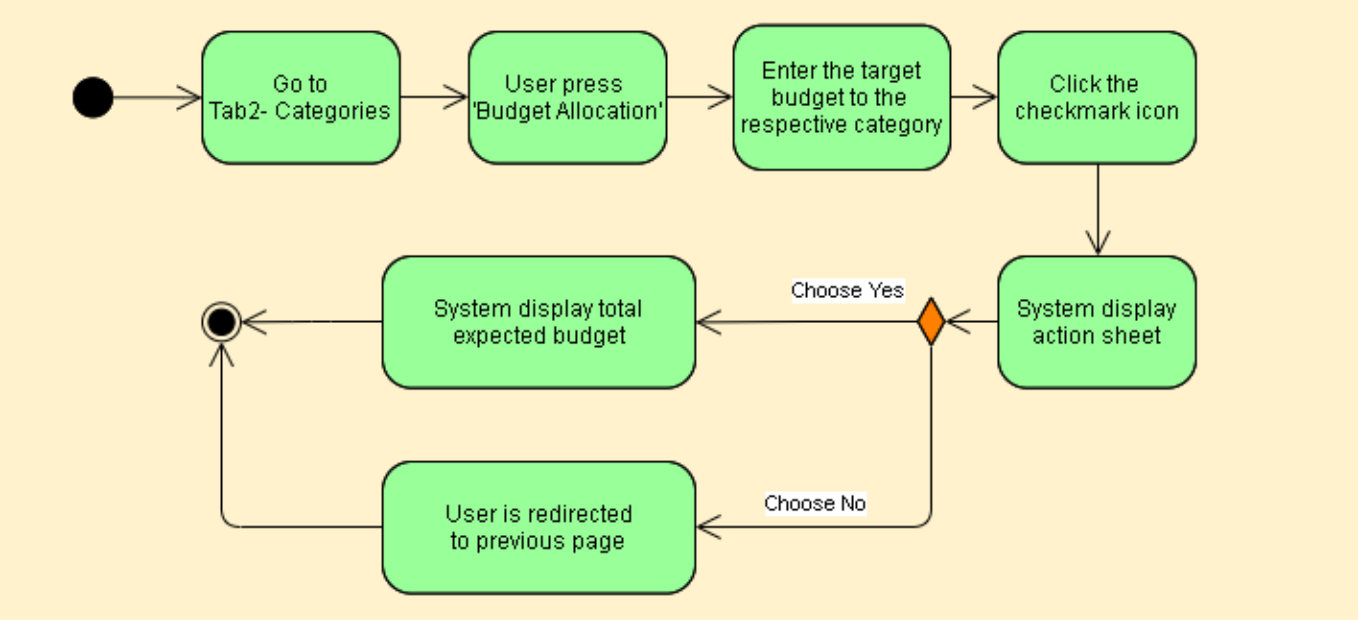

Figure 3.2.4.5 Activity diagram of Set targeted

3.2.4.6 View suggested product

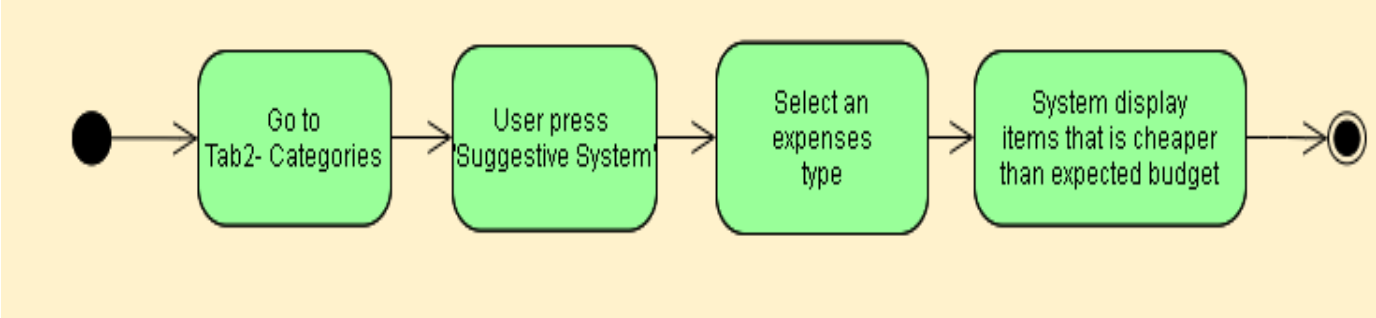

Figure 3.2.4.6 Activity diagram of View Suggested Product

3.2.4.7 Register menu

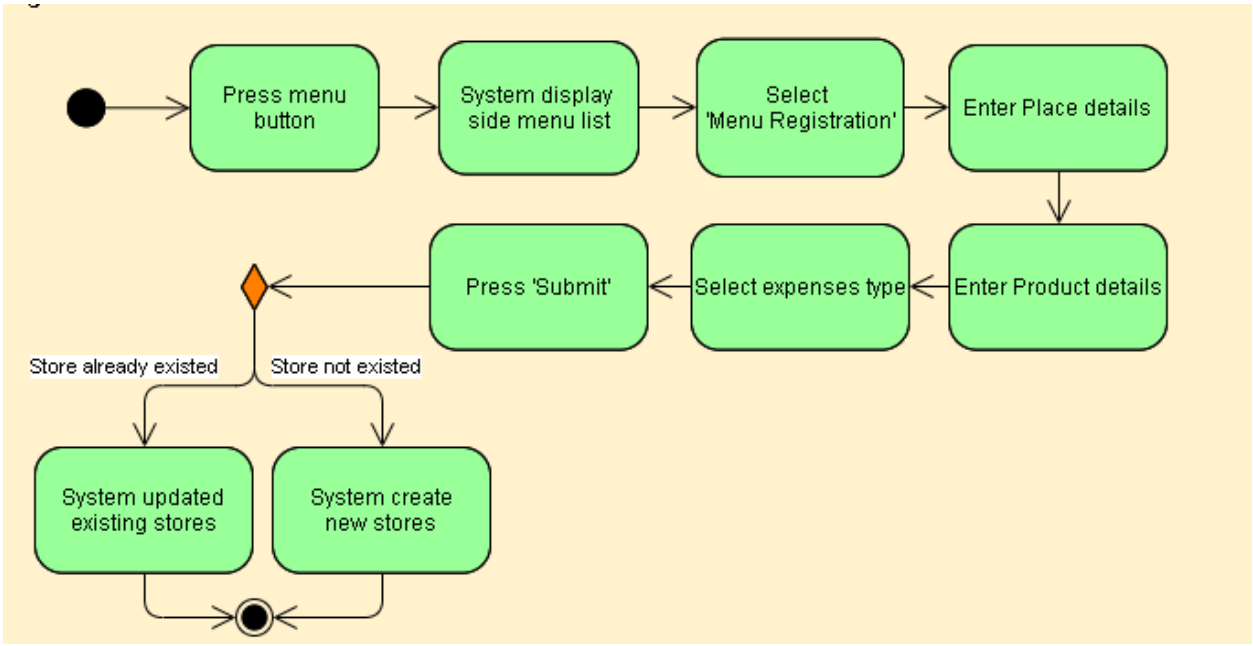

Figure 3.2.4.7 Activity diagram of Register Menu

3.2.4.8 View menu

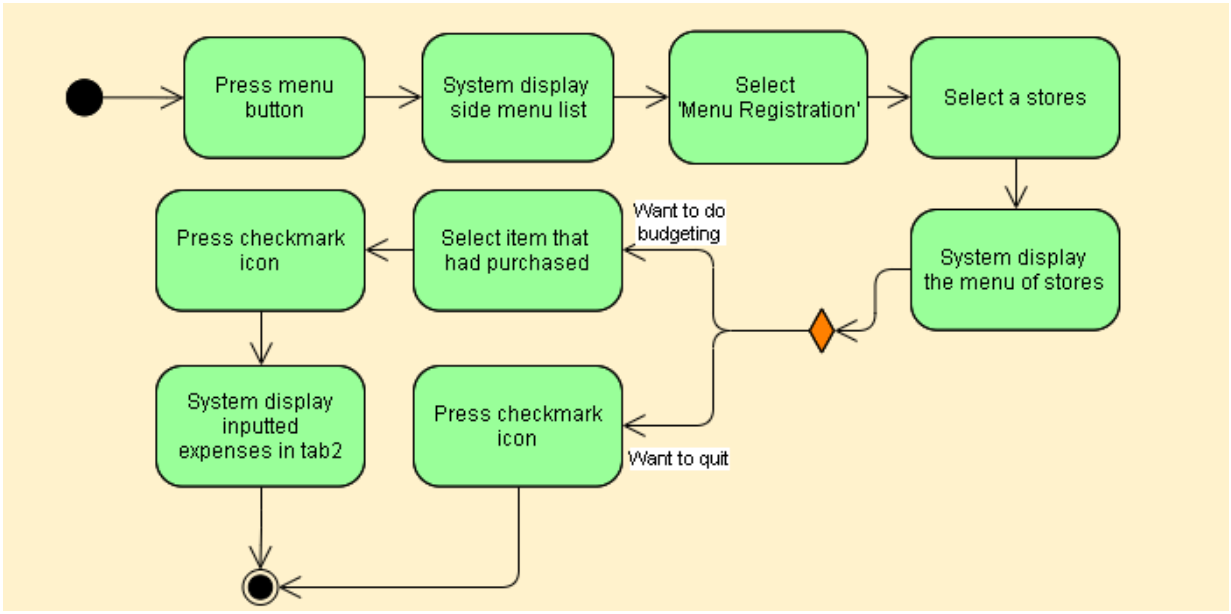

Figure 3.2.4.8 Activity diagram of View Menu

3.2.4.9 Manage split of bills

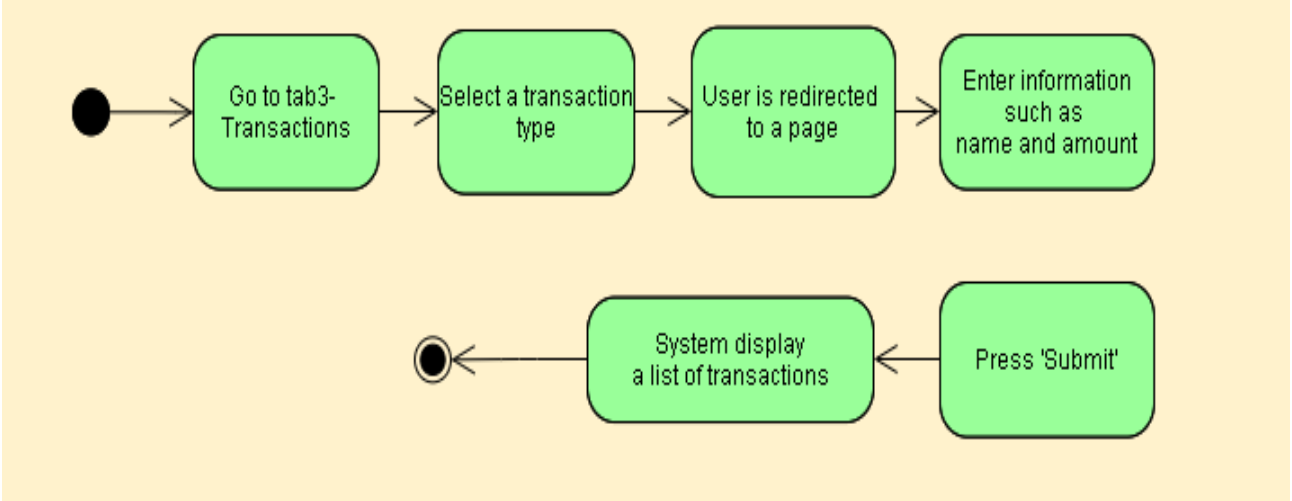

Figure 3.2.4.9 Activity diagram of Manage Split of Bills

3.2.4.10 Show current location image

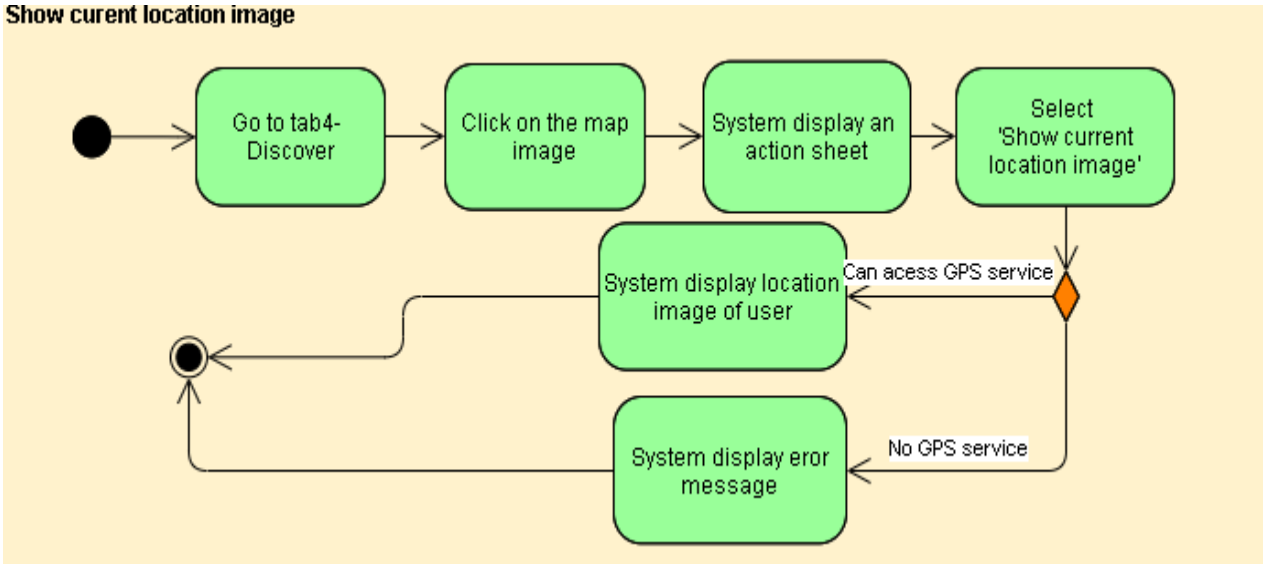

Figure 3.2.4.10 Activity diagram of Show Current Location Image

3.2.4.11Auto locate

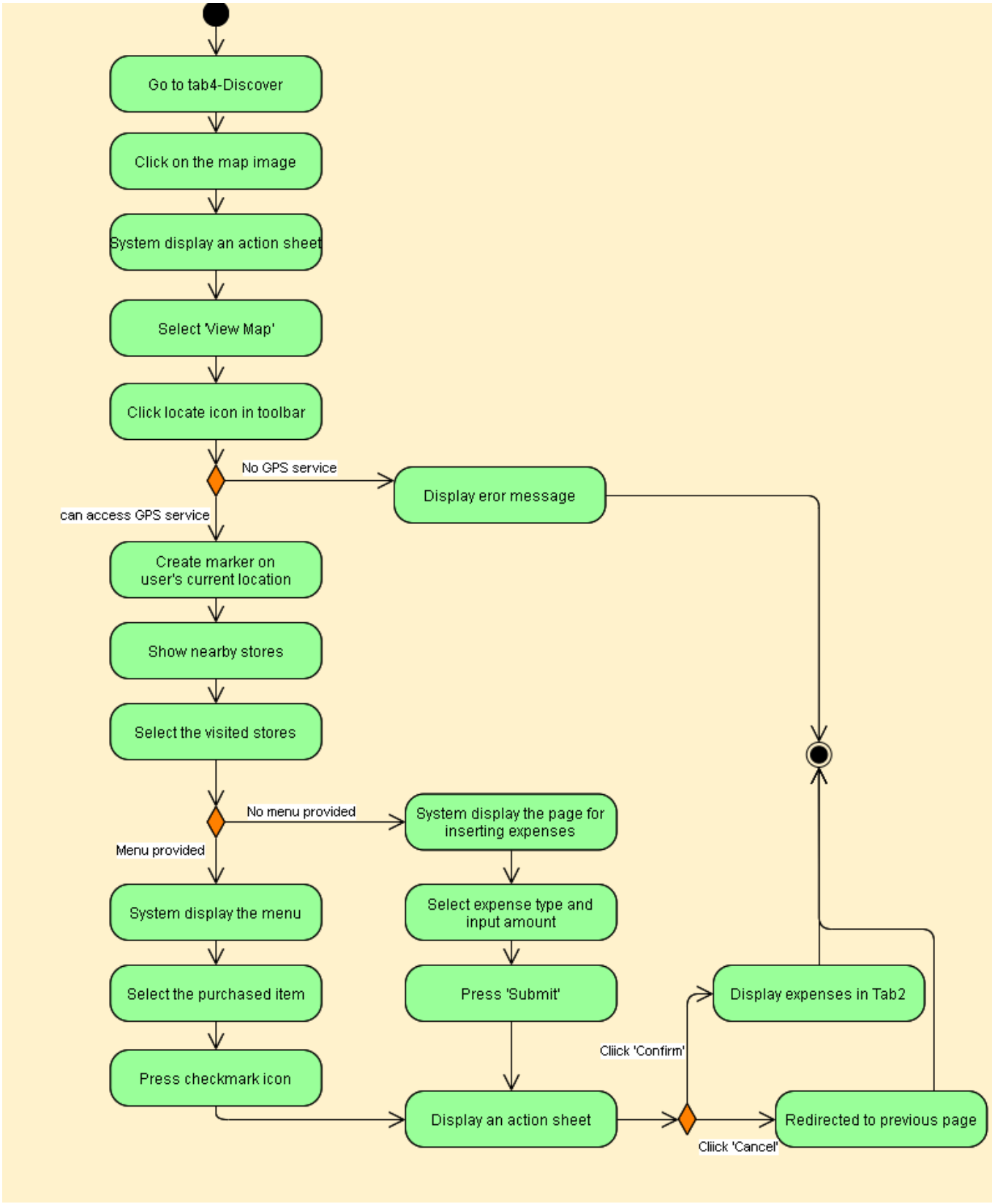

Figure 3.2.4.11 Activity diagram of Auto Locate

3.2.4.12 Pick on location

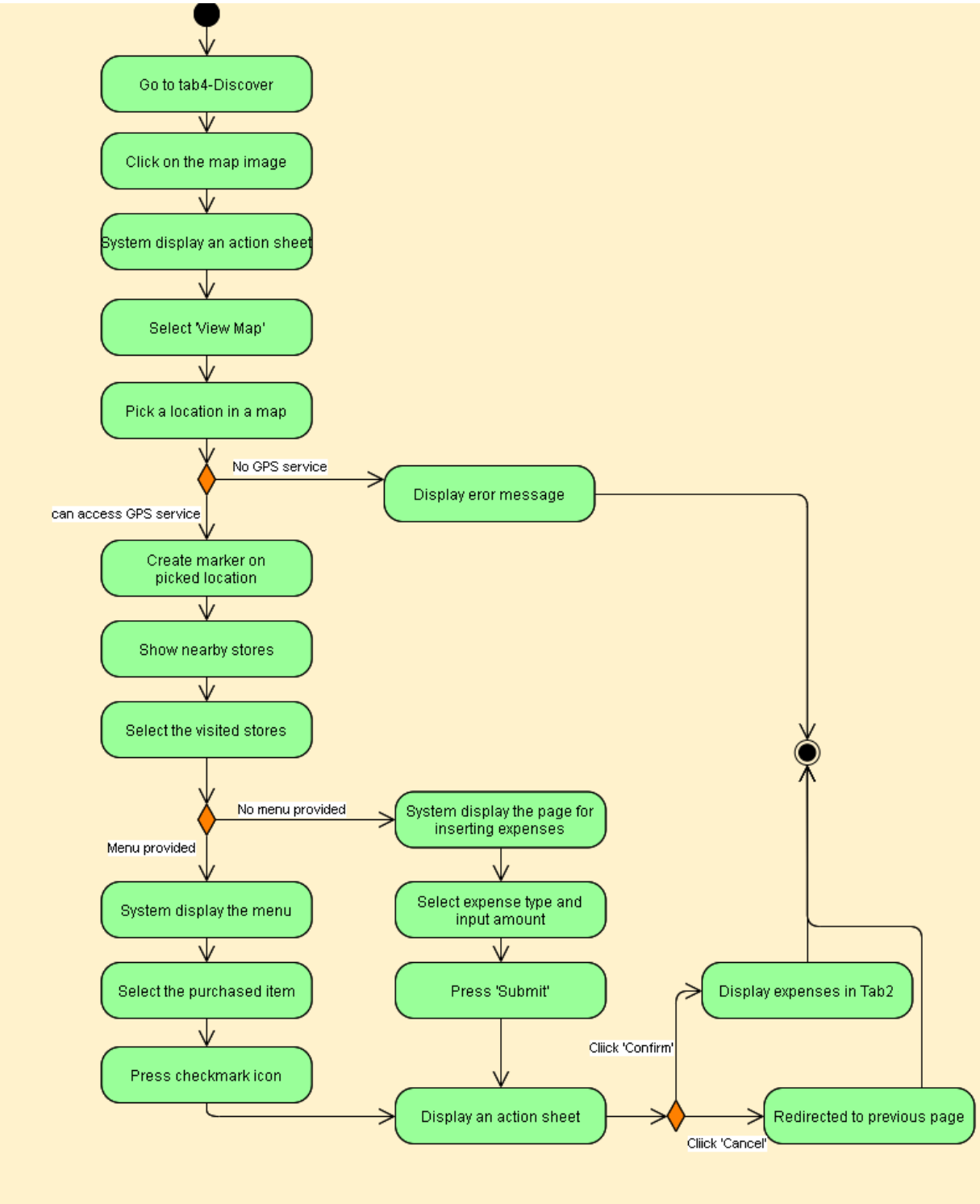

Figure 3.2.4.12 Activity diagram of Pick on Location

3.2.4.13 Landmark Detection

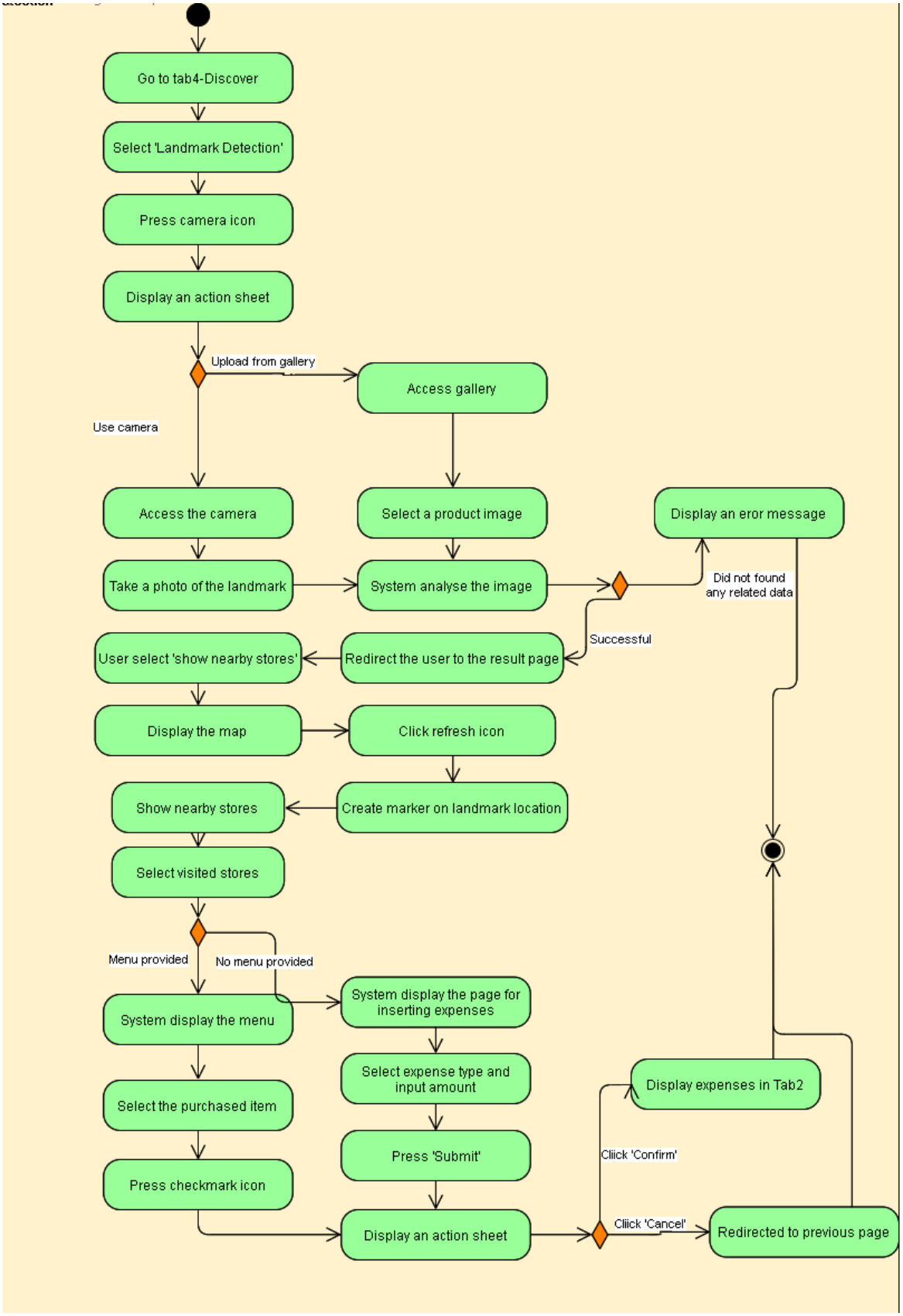

Figure 3.2.4.13 Activity diagram of Landmark Detection

3.2.4.14 Text/ Logo Detection

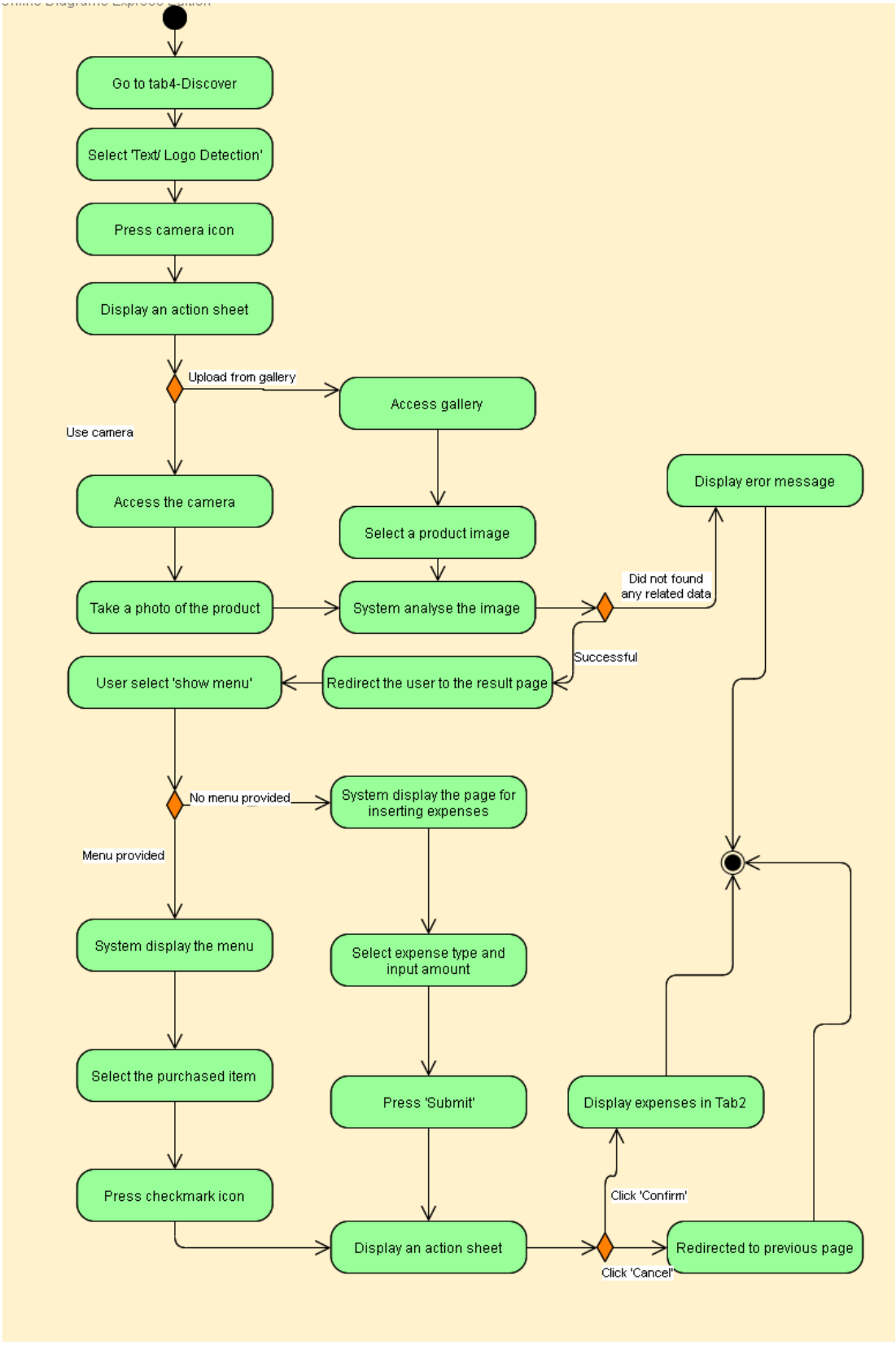

Figure 3.2.4.14 Activity diagram of Text/ Logo Detection

3.2.5 Timeline

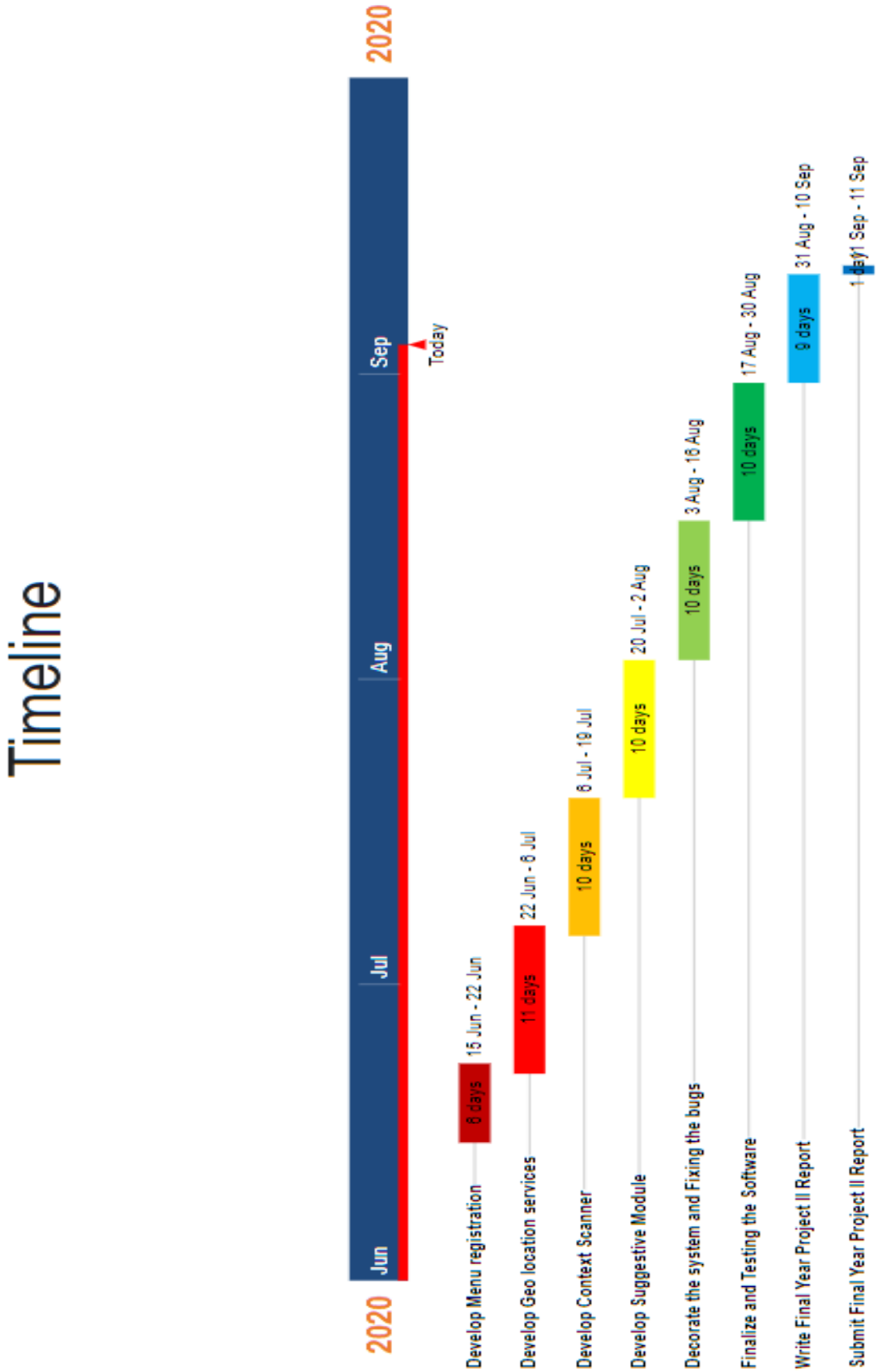

Figure 3.2.5.1 Gantt Chart

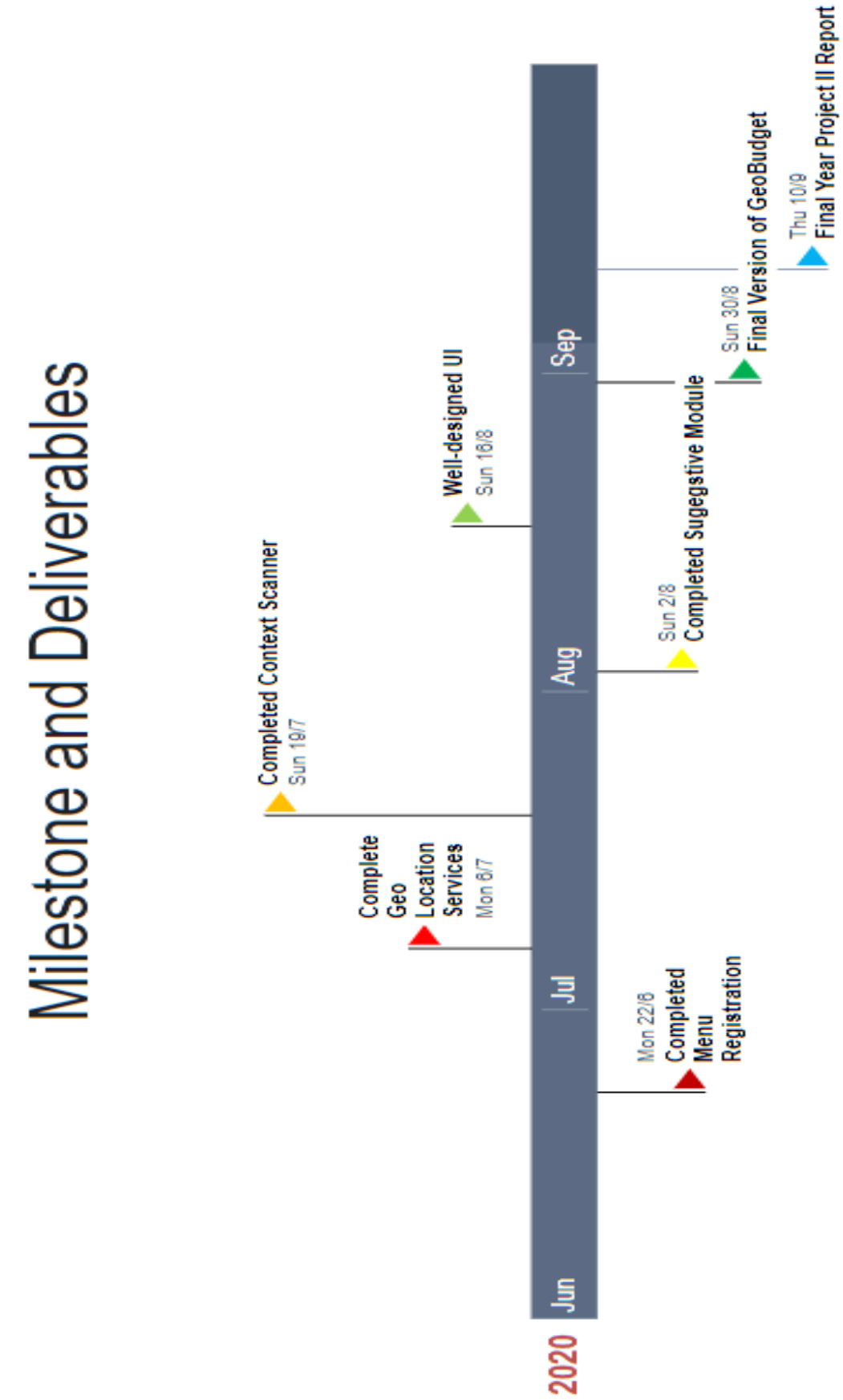

Figure 3.2.5.2 Milestone

Chapter4- System Architecture

4.1 Methodologies

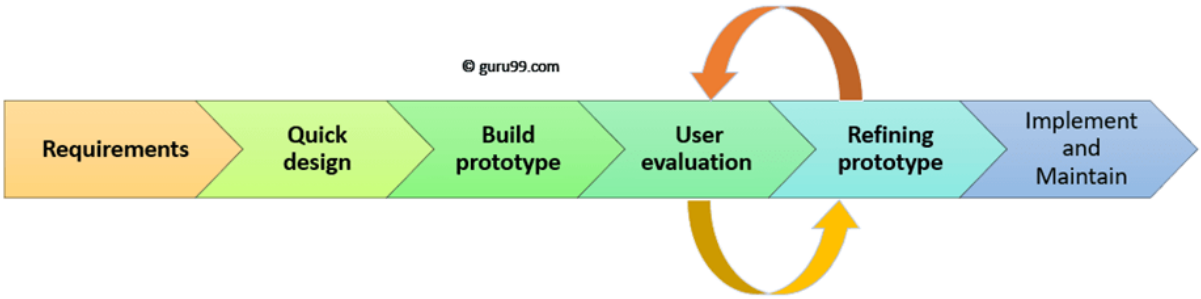

Figure 4.1.1 Prototyping model

In order to solve the problem that are mentioned in problem statement, prototyping model is applied throughout the development process. Prototyping is an adaptive approach as it emphasise on working software and user feedbacks. Unlike waterfall approach, we can easily change the core functions when the prototype is built. We can develop multiple versions of prototype. Each version of prototype can be reworked, refined and evaluated by the user until all the user requirements and objectives had been achieved.

4.2 General Work Procedures

1. Requirements

   In this stage, we have to gather user requirements and system requirements in order to build GeoBudget. We can research on the existing budgeting application and realize what is the common features involved in a budgeting application. Moreover, we can make an appointment with the user to get their opinions on the expected result of the system. After that, we will study and analyse all the provided requirements.

2. Quick design

   A simple design of the system will be conducted. The design will provide a brief picture on how the system will behave. This design can be modified if there is extra feature which need to add into the system or any instant feedbacks is provided by the user. These designs can be UML diagrams such as use case diagrams, activity diagram, database diagram, block diagram, UI design, etc.

3. Build prototype

   This phase focus on developing a prototype based on the design which is provided by the previous phases. It behaves like the small working model of the final system.

4. User evaluation

   This prototype is shown to the user for evaluation purpose. The user will provide instant feedbacks on the improvement of the logics, UI design and system workflows. These feedbacks will be used for refining all the requirements.

5. Refining prototype

   Refine the prototype based on the collected feedbacks. After that, submit the refined system to the user to evaluate again. User evaluation and refining prototype is being performed iteratively until the user is satisfied with the refined prototype.

6. Implement and maintain

   Finally, the final prototype will be implemented and maintained. We have to ensure that the software is runnable and stable before deploying to the clients. With this approach, the project will be delivered in time and the software will be less errors and reliable.

4.3 Technologies and Tools involved

1. Hardware
    - Laptop

Hardware	Specification
Operating System	Windows 10
Processor	Intel ® Core ™ i5-7200U CPU @2.50Hz
Installed memory (RAM)	8GB
System type	64-bit operating system

Table 4.3.1: Laptop specifications

- Mobile phone

Hardware	Specification
Operating System	Android 9.0
CPU	Hisilicon Kirin 710
Installed memory (RAM)	4GB

Table 4.3.2: Mobile phone specifications

2. Software
    - MongoDB

MongoDB is a modern document-oriented database which is designed specifically for mobile application developers. It is developed by MongoDB Inc. and have a Server-Side Public License. At this moment in time, MongoDB Inc. has published a community version of MongoDB. It can be downloaded with the link: https://www.mongodb.com/try/download/community

- Loopback API

  Loopback framework is a popular tool to build REST API quickly. It has built an API so that the user can implement the get, post and delete method in the API. Besides, it has a detailed documentation on how to connect the database with the mobile app. In this project, loopback API is a connector between MongoDB and GeoBudget. We can access the loopback API explorer with URL generated by loopback. The URL can also be used for access certain functions in loopback API explorer. Its documentation link is: https://loopback.io/doc/en/lb3/Getting-started-with-LoopBack.html

- Node.js

  Node JS is an integrated JavaScript runtime environment. We can execute JavaScript code outside the web browser because it uses JavaScript code at server. For an instance, Node.js enables the mobile application to be deployed to emulator or real device. In addition, Node.js can be used for manipulating files on the server and database. It can be downloaded with the link: https://nodejs.org/en/

- Ionic Angular Framework

  Ionic framework is a mobile development tools which apply web technologies in mobile app development while Angular is the application design framework that cooperate with Ionic.

- Visual Studio Code

  Vs code is a popular code editor in this century. It supports lots of programming language. Developers can use this tool to do data analysis, mobile application, web-based application, website and the others. It can be downloaded with the link: https://code.visualstudio.com/

- Android Studio

  Android Studio is an official IDE for system that built on top of Android Operating System. It also considers as code editor. However, we use it for downloading some important tools for Android application. Besides, we can use AVD manager in Android Studio to launch an emulator for deployment purpose. It can be downloaded with the link: https://developer.android.com/studio

- Apache Cordova

  Apache Cordova is a mobile application framework which enable the developer to build hybrid mobile application using HTML, CSS and JavaScript.

- Google Cloud Platform and API keys

  GCP offers various kind of cloud computing services to assist in the process of data analytics, machine learning, big data, artificial intelligence, etc. In this project, API platform of GCP is fully utilized for accessing geo location services and image recognition services. APIs that are applied in GeoBudget includes Geo Coding API, Map Static API, Map JavaScript API, Places API and Cloud Vision API. In order to use those API, we must have a Google email account to create a new project in GCP. In the created project, search for API and click on 'Enable API and services. After enabling, create credentials and stored API key in the safe place. Finally, HTTP request is required to access the URL with the given API key.

4.4 System Performance Definition

The system performance can be defined from five perspective:

1. Budget Management-
   i) Ensure that the user can view overall financial situation after they insert the budget or income.
   ii) Ensure that the user can insert expenses to respective dates.
2. Geo location services
   i) Ensure that the user is able to auto locate themselves or pick on a location.
   ii) Ensure that nearby stores are showed in the map after tracking or selected a location.
   iii) Ensure that the menu is displayed after clicking on the marker of nearby stores.
3. Image recognition Services
   i) User shall able to open camera or upload image from gallery.
   ii) Ensure that the image uploaded is analysed successfully according to the selected detection method and the menu will be showed.
4. Split Bills Management System
   i) User shall be able to insert information of the related parties which involve in sharing or split of bills.
5. Suggestive Module
   i) System shall list out the recommendation result after the user select the expenses types.
   ii) Ensure that the price of the result does not exceed the user's targeted budget.

4.5 Verification Plan

There are three verification methods to verify the result of GeoBudget. Since GeoBudget is developed using Ionic, it can be deployed to web browser at the first stage. Any errors or bugs will be displayed at the console. The command used to deploy to web browser is 'ionic serve'. It has a local host URL address which hosted the code in the server. With such situation, when the code is being changed, it will automatically be updated in the browser. Therefore, we can have real time verification process during the development process.

Next, we will verify the software by performing testing process. We will apply some dynamic testing techniques such as white box and black box testing in the verification process. We will test the input with some invalid values or the value with long decimal places. For image recognition services, we will upload different kind of images into the system to test its accuracy. For geo location services, we may travel to different places to test the accuracy of GPS services. For suggestive module, we will test the recommendation result of GeoBudget by constantly changing the targeted budget.

Lastly, the prototype of GeoBudget will be evaluated by the user iteratively. We can collect user feedbacks and comments so that we may improve it afterwards.

4.6 System Architecture Design

4.6.1 Component Architecture

In this section, all the components and module will be described in Table 4.6.1. In addition, the component diagram will describe the relationship among different components.

Component	Functions/ Tasks
Input	1. Read user's input
Output	1. Display total assets, total income and total expenses 2. Display income to respective categories 3. Display total expected budget 4. Display expense to respective categories 5. Display calendar 6. Display chart 7. Display list of split bills information 8. Display list of suggested products 9. Display map 10. Display stores and its menu 11. Display result of image recognition 12. Display nearby stores.
Tabs	1. Display 4 tabs which named Accounts, Categories, Transactions, and Discover 2. Display side menu list
Income & Expenses	1. Allow the user to add or edit the income 2. Send income data to database 3. Allow to view overall financial detail 4. Allow to input expense with calculator 5. Send expense data to database 6. Allow to allocate their budget 7. Send allocated budget to database 8. Retrieve the income and expense data from database after the app is launched
Database	1. Receive income details. 2. Receive expenses details.

	3. Receive allocated budget details. 4. Receive split bill details. 5. Store income and expense details. 6. Store allocated budget details. 7. Store split bills details. 8. Retrieve income and expense details. 9. Retrieve allocated budget details. 10. Retrieve split bill details.
Calculator	1. Allow the user to perform calculation 2. Allow the user to input expense. 3. Send the calculated data to database
Calendar	1. Allow the user to view the date from different months and different years 2. Allow the user to change the current displayed date. 3. Allow the user to view the monthly expenses.
Chart	1. Allow the user to view the bar chart and doughnut chart after entering expenses.
Suggestive System	1. Allow the user select an expenses type. 2. Allow the user to view the list of suggested products.
Split Bills System	1. Allow the user to choose from different transaction types. 2. Allow the user to enter information of split bills. 3. Send the inputted information to database. 4. Allow the user to remove the information.
Stores/ Menu	1. Allow the user to create new stores. 2. Allow the user to update store's products. 3. Allow the user to view registered menu. 4. Allow the user to perform budgeting after viewing the menu. 5. Send the expenses data to database. 6. Send stores and menu data to database
Geolocation System	1. Allow the user to show location image of current location. 2. Allow the user to auto locate themselves.

	3. Allow the user to pick on any location. 4. Allow the user to search a location. 5. Allow the user to view nearby stores. 6. Allow the user to view store's menu after clicking a nearby stores. 7. Allow the user to perform budgeting. 8. Send the expense data to database.
Context Scanner	1. Allow the user to select detection method. 2. Allow the user to use camera. 3. Allow the user to upload image from gallery. 4. Allow the user to view the result of image recognition. 5. Allow the user to view nearby stores (landmark detection). 6. Allow the user to view store's menu after clicking a nearby stores. 7. Allow the user to perform budgeting. 8. Send expense data to database. 9. Allow the user to view store's menu after click 'show menu'.

Table 4.6.1 GeoBudget Subsystems

4.6.1.1 Income & Expenses

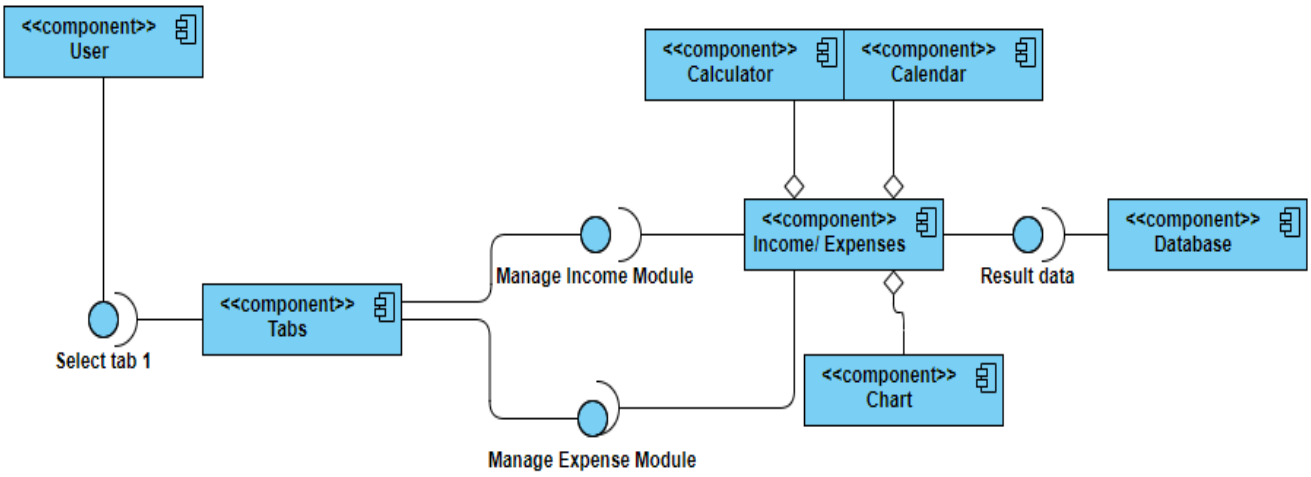

Figure 4.6.1.1 Income & Expense

4.6.1.2 Suggestive System

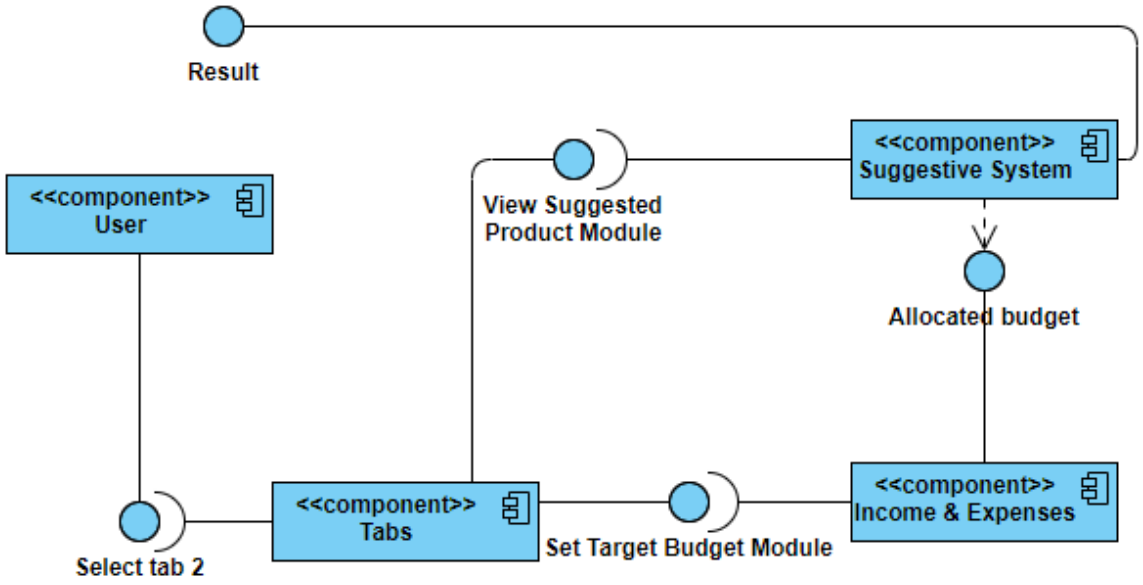

Figure 4.6.1.2 Suggestive System

4.6.1.3 Manage Split of Bills

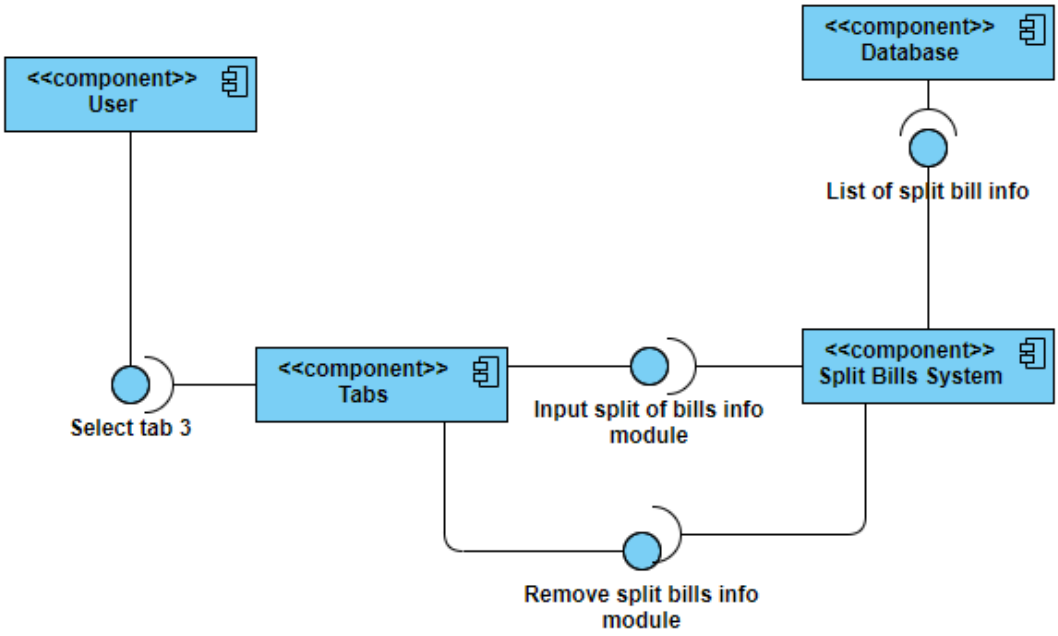

Figure 4.6.1.3 Manage Split of Bills

4.6.1.4 Register Stores and View Menu

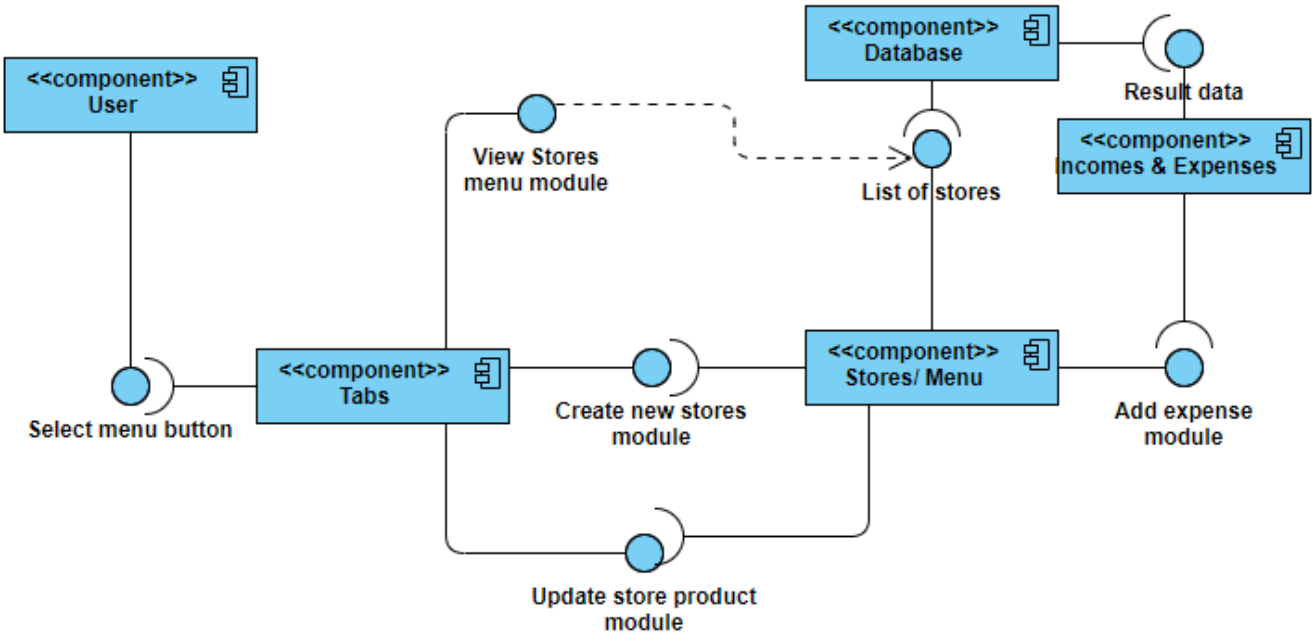

Figure 4.6.1.4 Register Stores and View Menu

4.6.1.5 Geolocation System

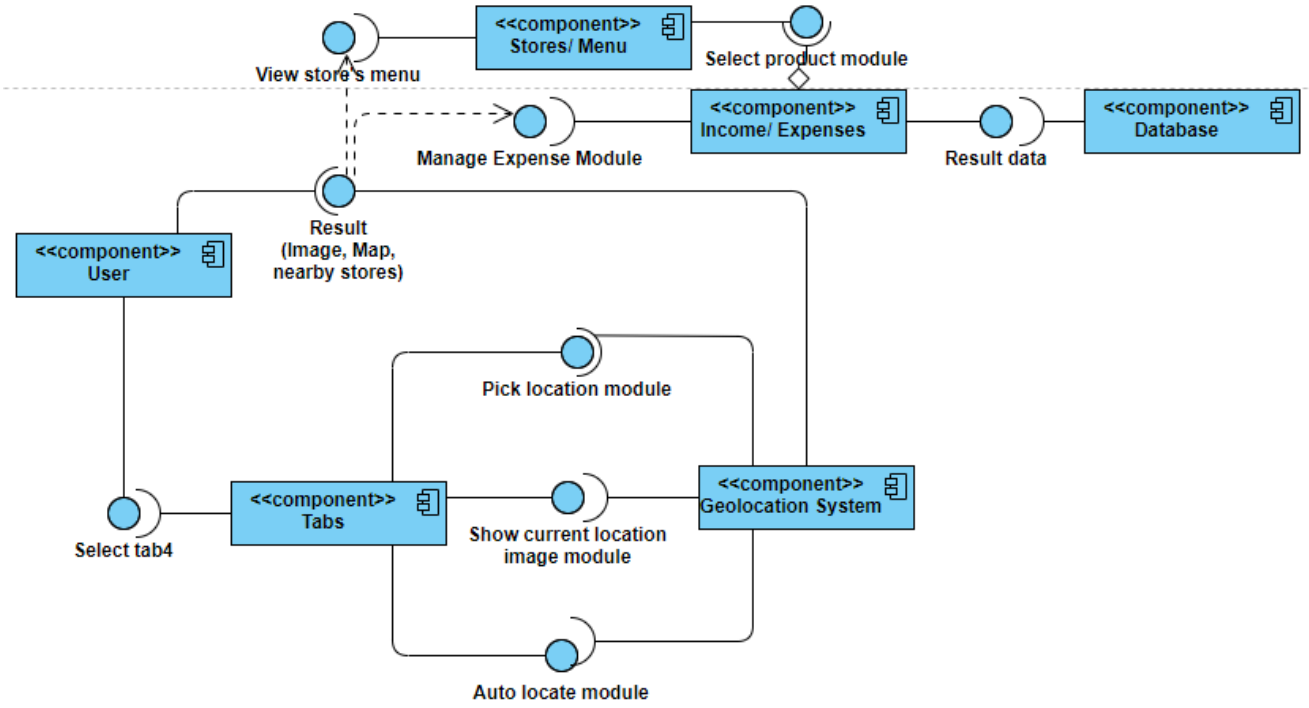

Figure 4.6.1.5 Geolocation System

4.6.1.6 Context Scanner

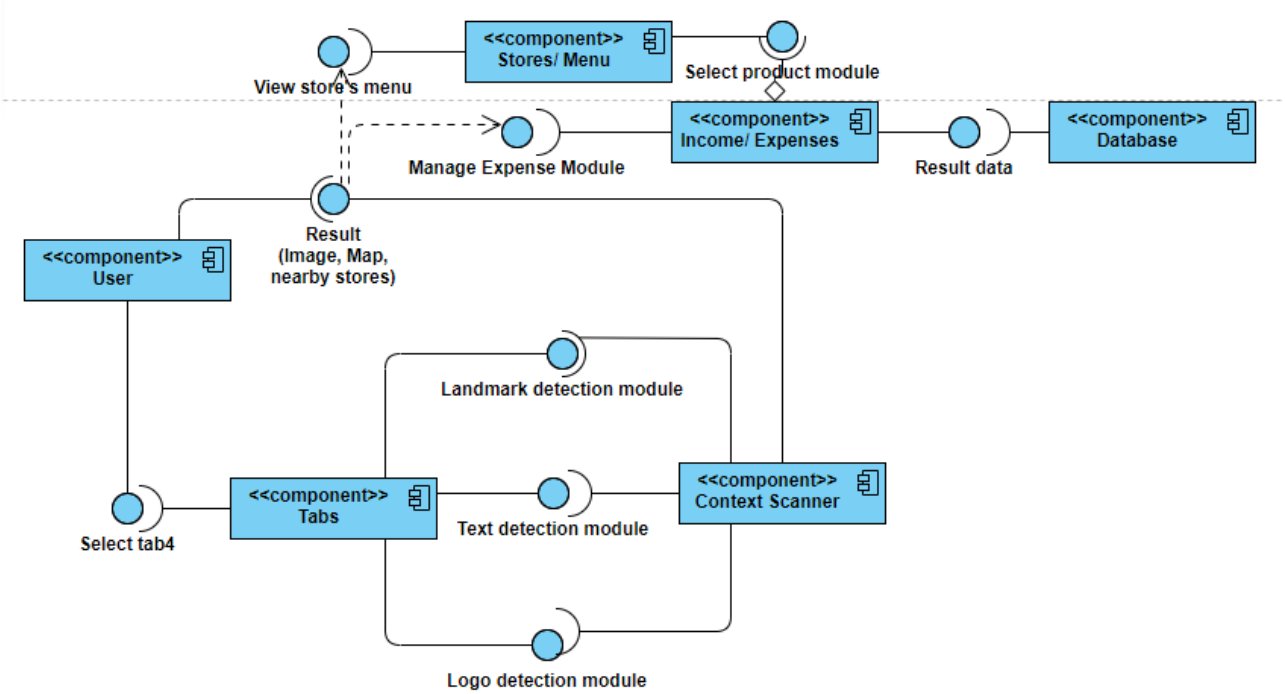

Figure 4.6.1.6 Context Scanner

4.6.2 Data Design

i. Database setup

In this project, MongoDB is applied to perform database operation on every component and modules. MongoDB is an open source NoSQL database. It works by creating a document which is similar as JavaScript Object Notation (JSON), but use a variant named Binary JSON (BSON). The benefits of creating this document is to support various kind of data structure. Therefore, it is very flexible to create any number of fields in a document.

The problem that we faced during this project is how to perform coordination and communication between GeoBudget and MongoDB. For this issue, we have introduced Loopback API. Firstly, a command is required to build the loopback CLI. Type the command 'npm install -g loopback-cli' in the terminal to install the CLI. Next, we have to create a loopback server using the CLI. Create a file in the project folder and use the command 'npm install -save loopback-connector-mongodb' to install the plugin. After that, create a data source by typing 'lb datasource' and filled in the information. Every time when we want to create a table field, we have to create a model in Loopback using the command 'lb model' and filled in the field description. Finally, start the MongoDB service in administrator command prompt by typing 'net start MongoDB' and run 'node .' in the terminal. A web server will be created and the user can browse Loopback API Explorer with the given link.

After configure all the requirements, the database is ready to serve different purposes. We can build a service provider in project folder and use HTTP request to call the API URL. Besides that, all the operations such as get, post, delete can be utilized for further database operation.

ii. Structure of documents and Loopback API explorer

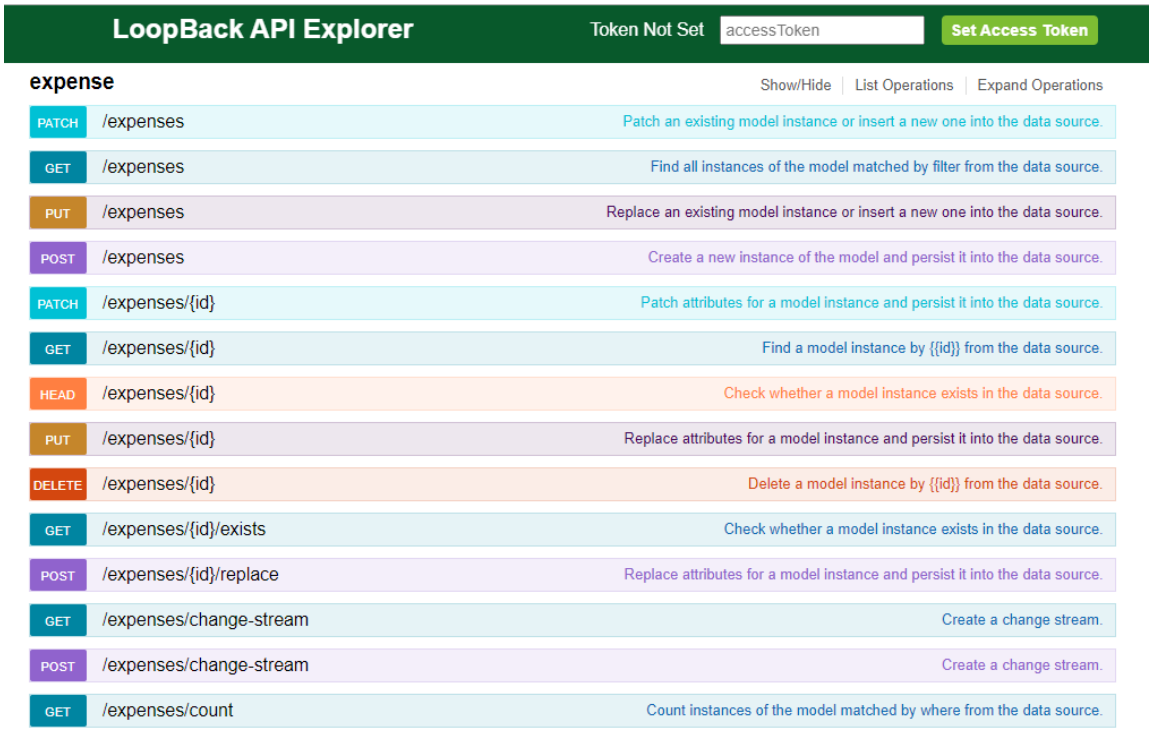

Figure 4.6.2.1 Loopback API explorer


```
{
  "id": "5f4efb5c3122b918e0263512",
  "groceryExpenses": 1,
  "restaurantExpenses": 0,
  "leisureExpenses": 0,
  "transportExpenses": 0,
  "healthExpenses": 0,
  "giftExpenses": 0,
  "familyExpenses": 0,
  "shoppingExpenses": 0,
  "otherExpensess": 0,
  "totalExpenses": 1,
  "dateinserted": "2020-09-02",
  "day": "02",
  "month": "09"
}
```


Figure 4.6.2.2 Structure of stored documents

iii. Description for Table

a) User Table

Field	Type	Description
User_ID	VARCHAR	Primary key
Income_ID	VARCHAR	Foreign Key
Expense_ID	VARCHAR	Foreign Key
Allocate_ID	VARCHAR	Foreign Key
SplitBills_ID	VARCHAR	Foreign Key

Table 4.6.2 Database- User Table

b) Income Table

Field	Type	Description
Income_ID	VARCHAR	Primary key, income id for every entered income
Card	INT	Amount of money in the card
Cash	INT	Amount of cash
Ewallet	INT	Amount of money in ewallet
Saving	INT	Amount of money in the saving
Other	INT	Amount of money in other categories
Total_Income	INT	Total amount of money

Table 4.6.3 Database- Income Table

c) Expense Table

Field	Type	Description
Expense_ID	VARCHAR	Primary key, expense id for every entered expense
Grocery_exp	INT	Spending amount in grocery
Restaurant_exp	INT	Spending amount in restaurant
Leisure_exp	INT	Spending amount in leisure
Transport_exp	INT	Spending amount in transport
Health_exp	INT	Spending amount in health
Gift_exp	INT	Spending amount in gift
Family_exp	INT	Spending amount in family
Shopping_exp	INT	Spending amount in shopping
Other_exp	INT	Spending amount in other category
Total_exp	INT	Total spending amount
Date_Inserted	VARCHAR	Date which entered the data

Table 4.6.4 Database- Expense Table

d) Split Bills Table

Field	Type	Description
SplitBills_ID	VARCHAR	Primary key, split bills id for every entered info
Owed	INT	Total money that the user owed someone.
Are_owed	INT	Total money that the user is owed by someone.
Form	VARCHAR	Information of split bills (name, money, type)

Table 4.6.5 Database- Split Bills Table

e) Allocated Budget Table

Field	Type	Description
Allocate_ID	VARCHAR	Primary key, allocate id for every targeted budget
Expect_gro	INT	Targeted money to spend in grocery
Expected_res	INT	Targeted money to spend in restaurant
Expected_lei	INT	Targeted money to spend in leisure
Expected_trns	INT	Targeted money to spend in transport
Expected_hea	INT	Targeted money to spend in health
Expected_gif	INT	Targeted money to spend in gift
Expected_fam	INT	Targeted money to spend in family
Expected_sho	INT	Targeted money to spend in shopping
Expected_total	INT	Targeted money to spend in total

Table 4.6.6 Database- Allocated Budget Table

iv. Database Diagram

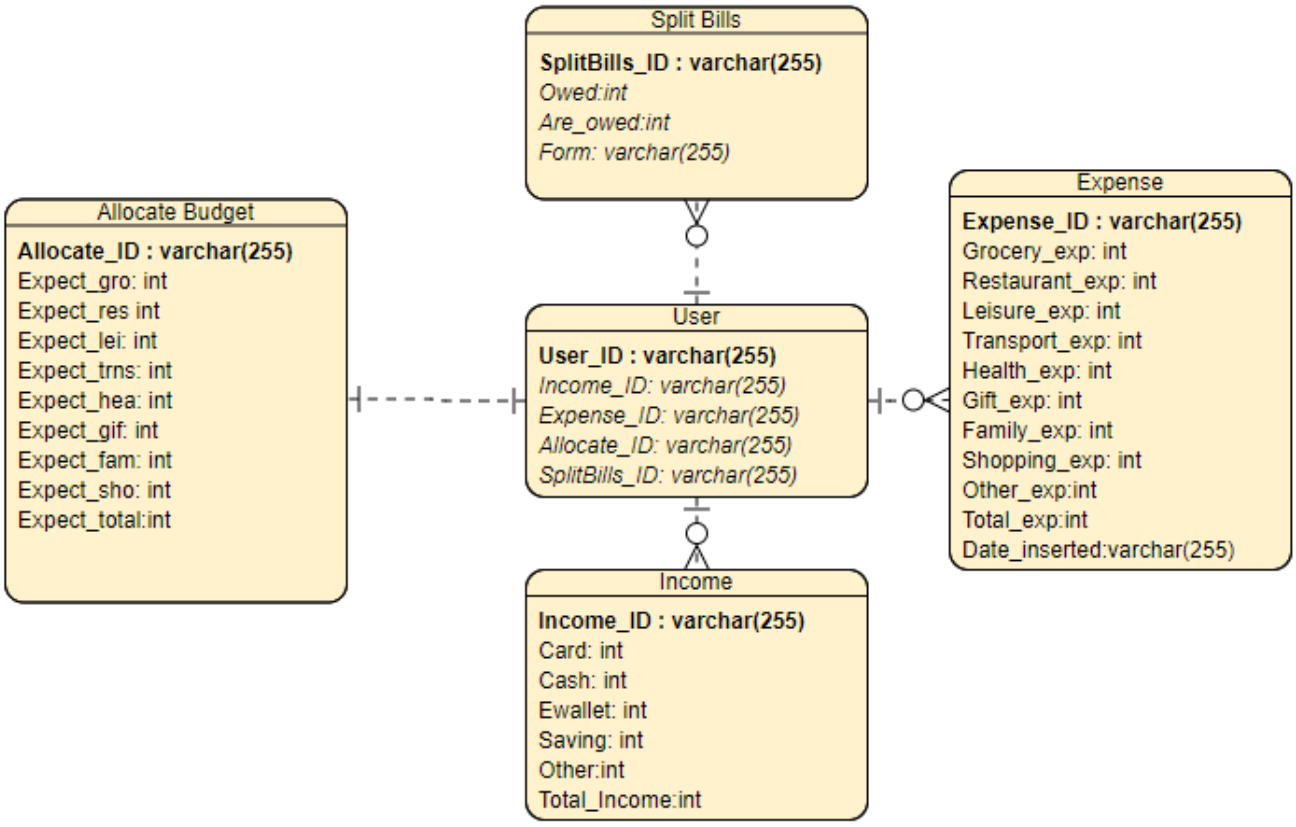

Figure 4.6.2 Entity Relationship Diagram

4.6.3 UI Design

Tab 1- Accounts

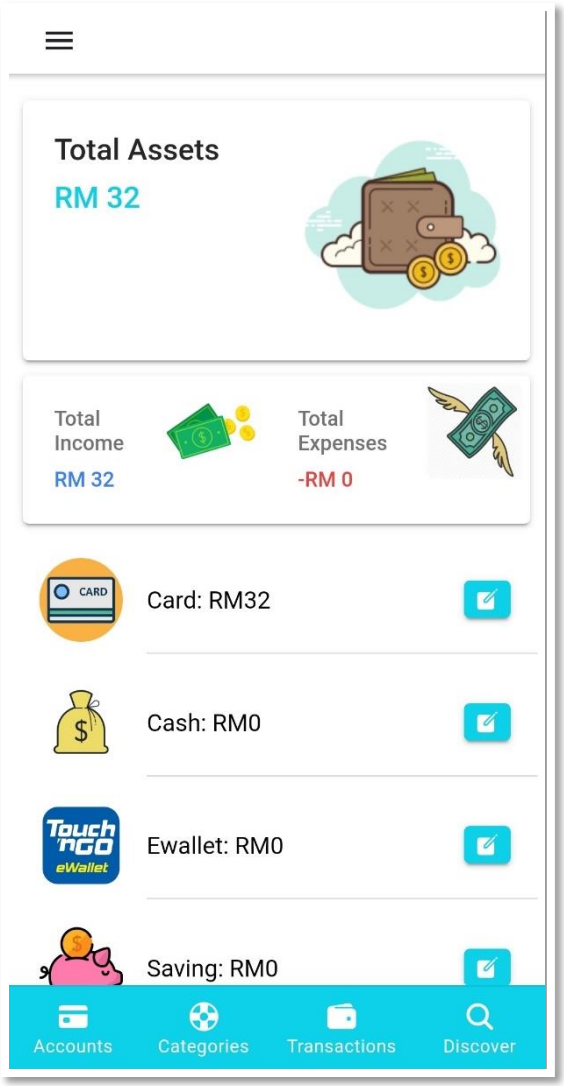

Figure 4.6.3.1 Tab1- Accounts

Tab1- Accounts allows the user to have an overview of financial situation. It displays total assets, total income and total expenses. The total assets are the subtraction of total income and total expenses. Total income is the addition of every categories in this tab. Total expenses is passed from Tab2- Categories after they have inserted the expenses.

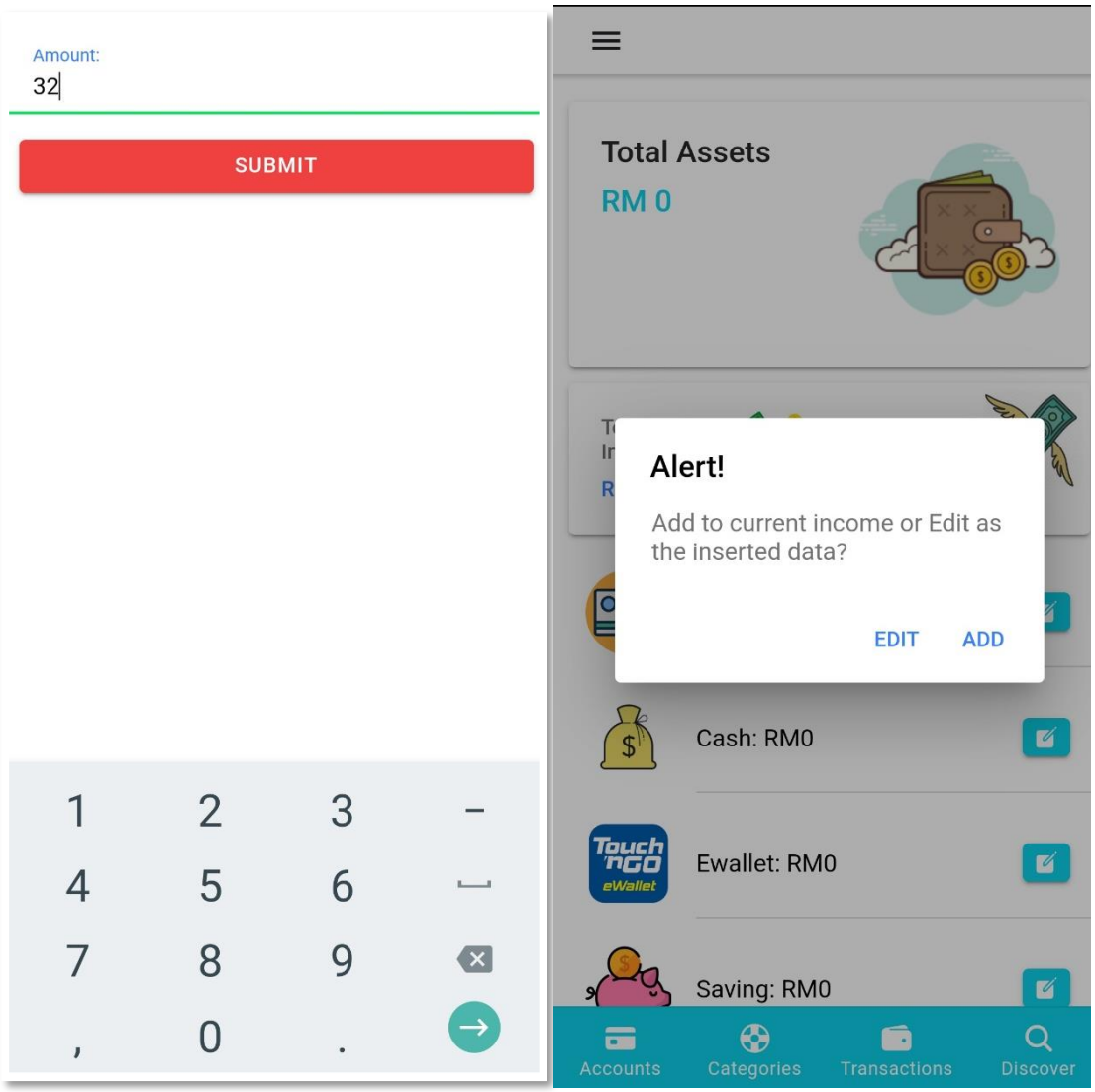

Figure 4.6.3.1 Tab1- Accounts

Next, the user can input the money they own into different categories (card, cash, Ewallet, saving and other). The steps included pressing the icon besides each category. A page that same as the left-side image will be displayed. The user key in the amount then select ‘add’ or ‘edit’. Finally, the result will be displayed.

Tab 2- Categories

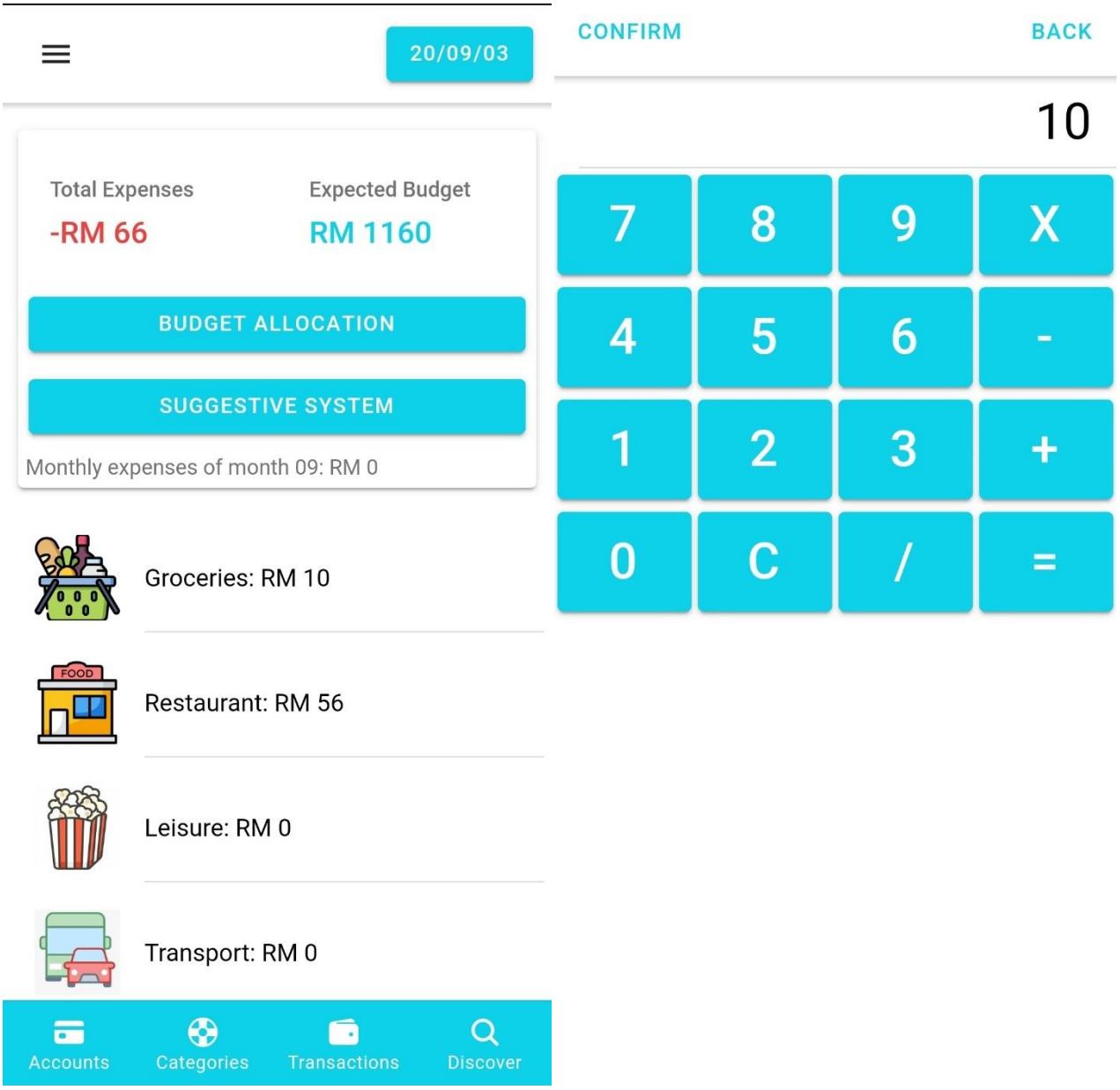

Figure 4.6.3.2 Tab 2- Categories

There are many components and modules included in Tab2 such as calendar, chart, budget allocation, suggestive system. It allows the user to insert the budget with calculator module. At first, the user clicks on a category and a calculator will be displayed. User can perform calculation and press 'confirm'. Lastly, the budget will be displayed to respective categories and the total budget will be sum up as 'Total Expenses'.

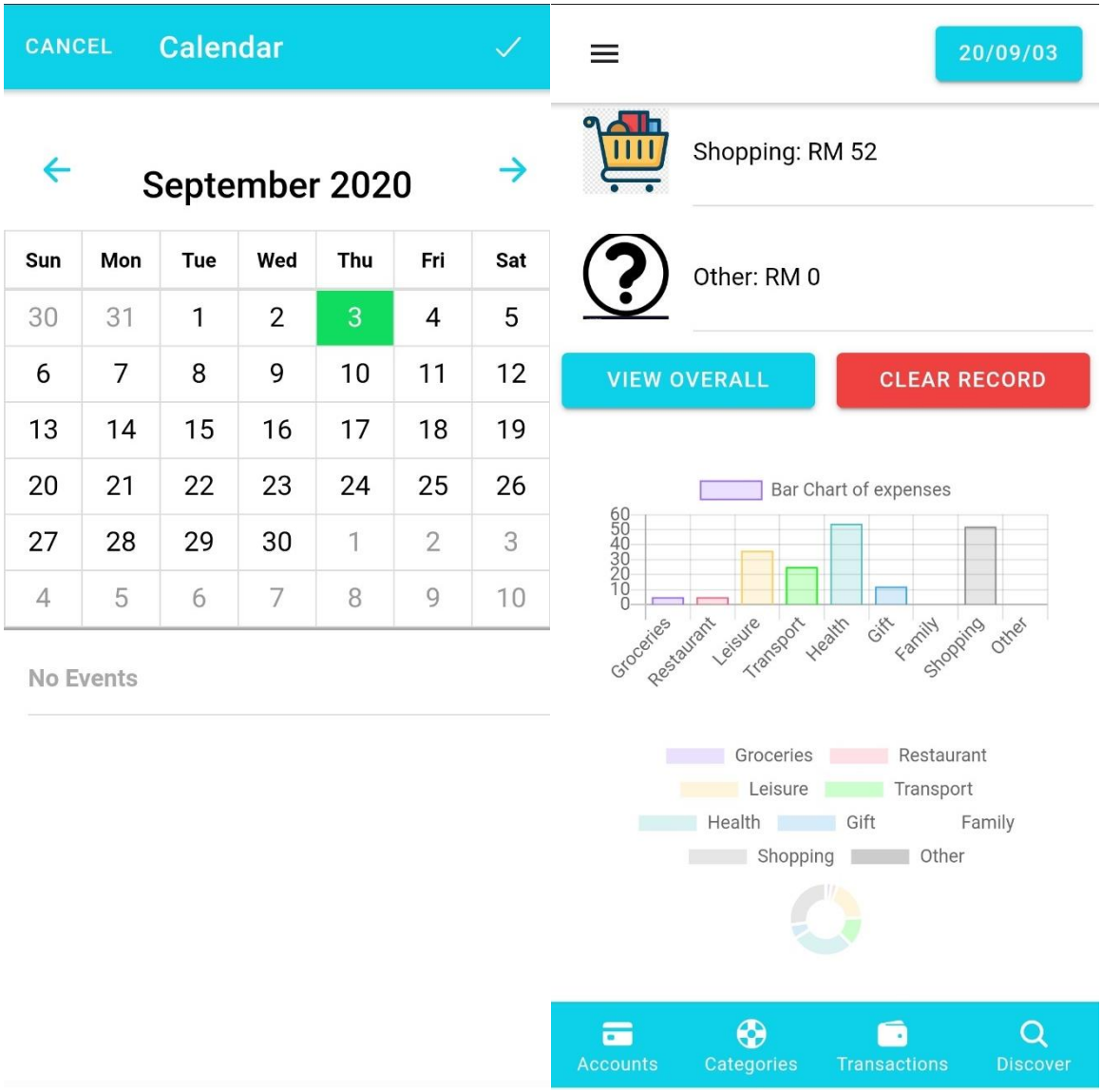

Figure 4.6.3.3 Calendar and Chart Module

User often find it difficult to track back the expenses that they have inputted. Therefore, calendar module allows them to view the past record and perform budgeting in the past.

For chart module, user can get a better picture on where their money gone. The chart provided includes bar chart and doughnut chart. Each category has their own colour so that the user can differentiate it easily.

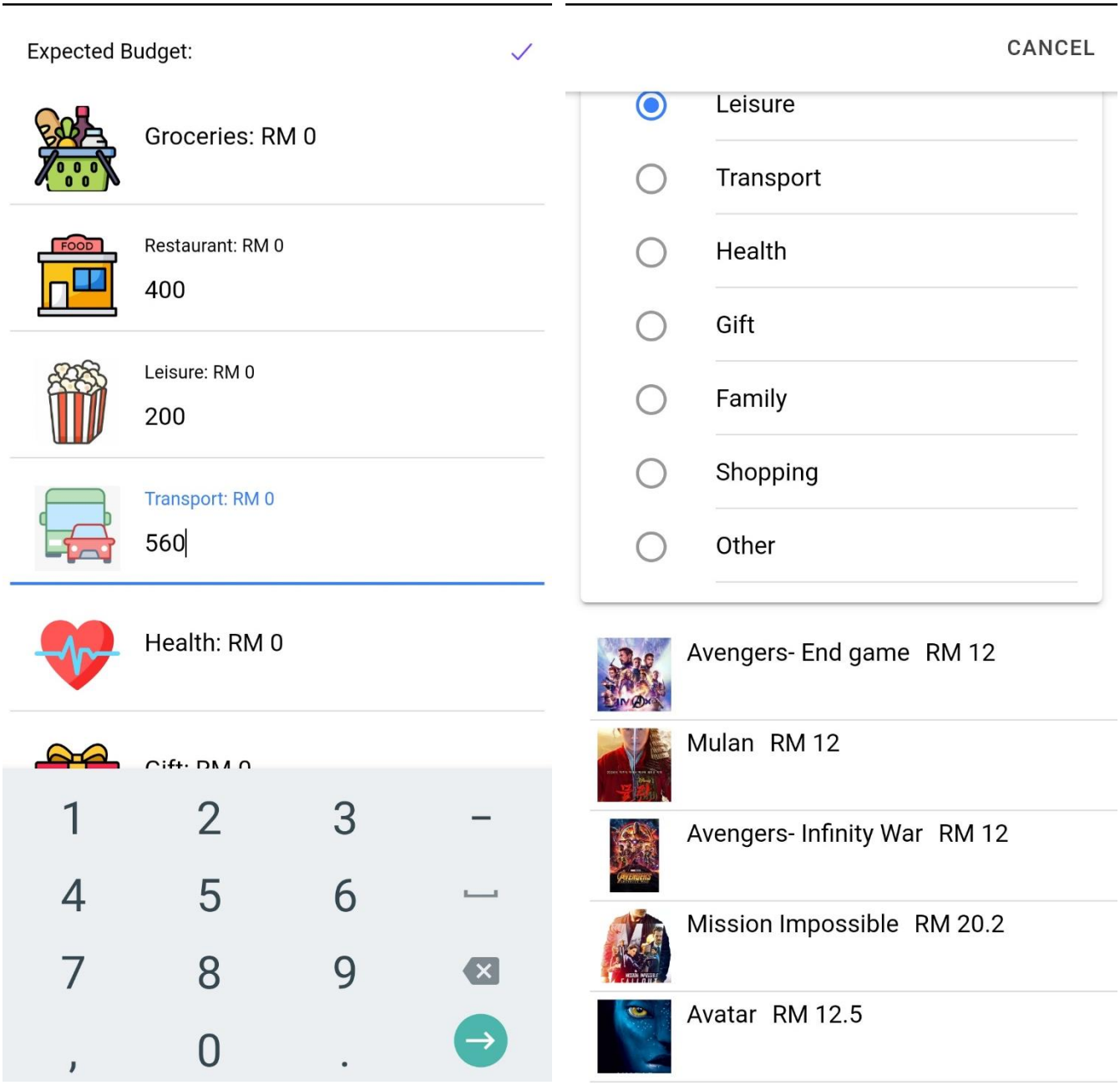

Figure 4.6.3.4 Budget allocation and Suggestive system

'Budget Allocation' is designed for the user to set their targeted budget. Same as the insertion of expense, select a category and enter the amount. Then, if the user has spent a money which exceed s the amount of targeted budget, GeoBudget will prompt out an alert message.

For the suggestive system, user can simply choose a category and the suggested product will be showed at the bottom.

Tab 3- Transactions

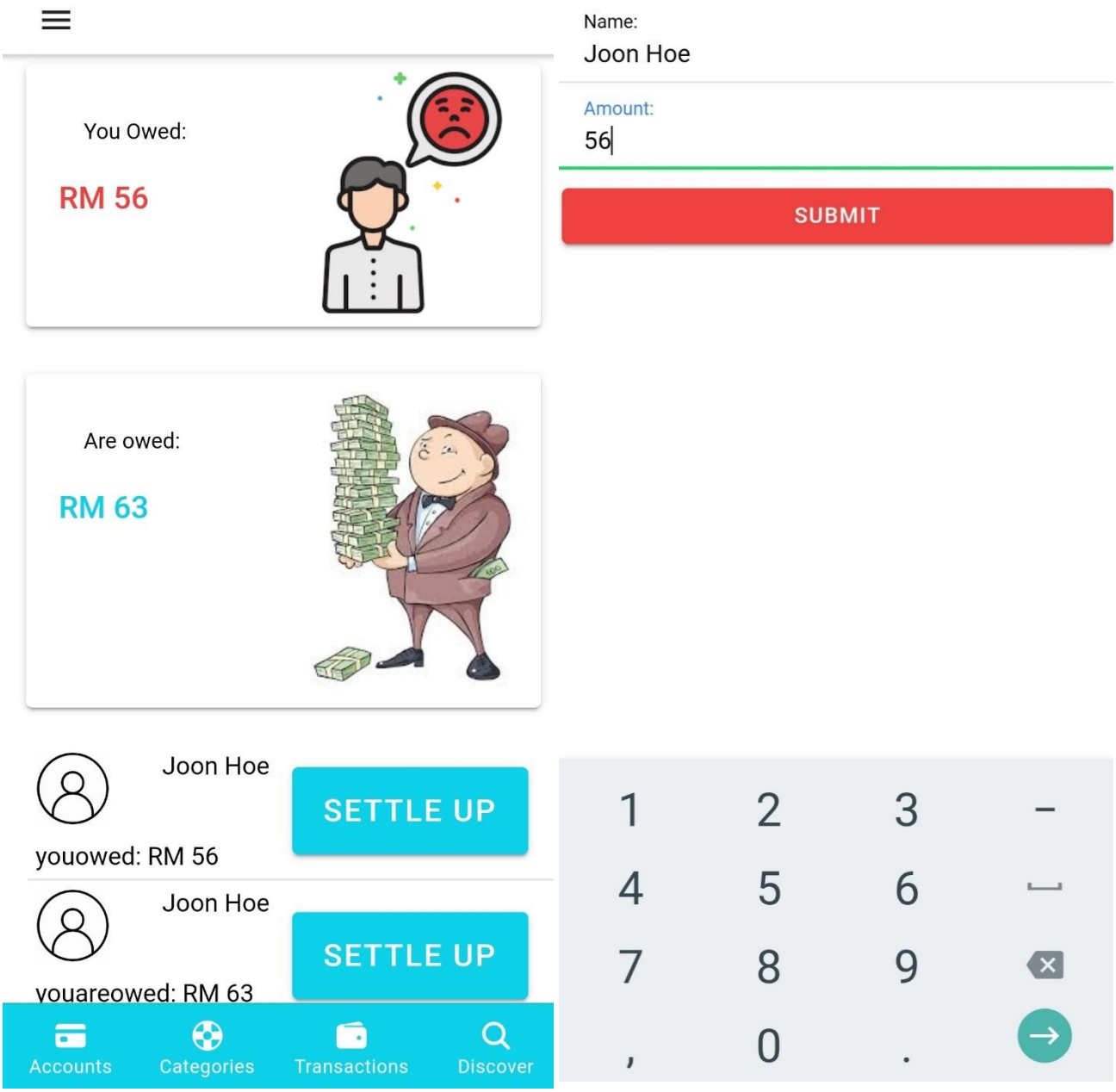

Figure 4.6.3.5 Split Bills

Tab3- Transactions manage the payment or service that involve sharing or split of bills.

The steps included:

1. Choosing ‘you owed’ or ‘you are owed’.
2. A form will be displayed.
3. Enter the name and amount.
4. Press ‘Submit’.
5. A list of split bills will be displayed.

Side Menu list

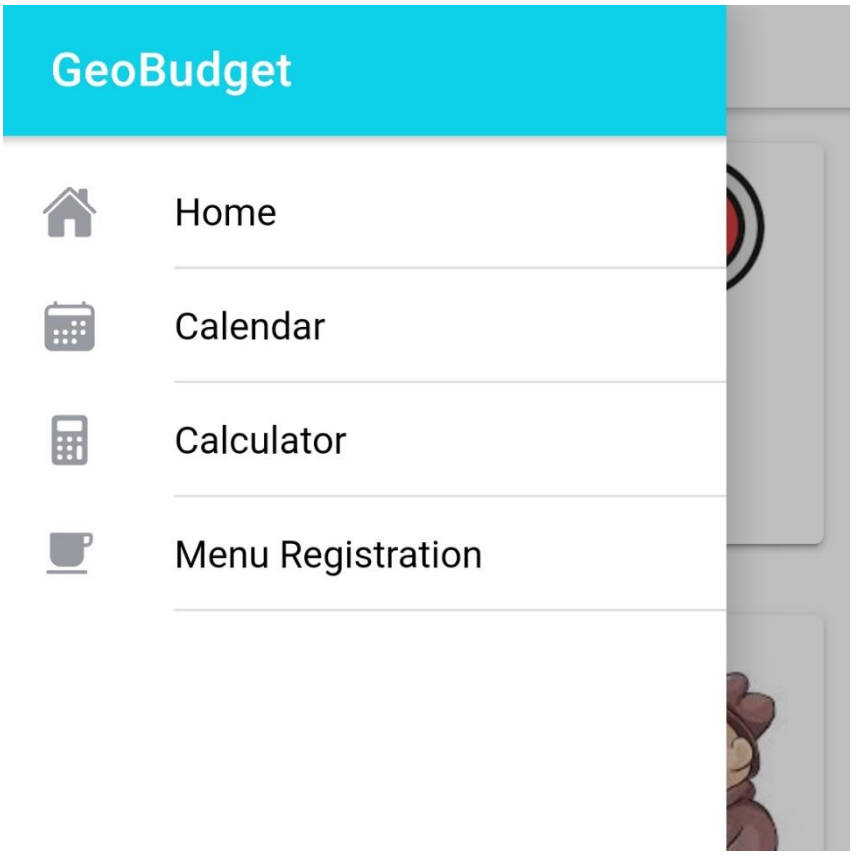

Figure 4.6.3.6 Side Menu List

Side menu list includes:

1. Home- Redirect the user to home page which is Tab1- Accounts
2. Calendar- A calendar for viewing purpose.
3. Calculator- A calculator for calculation purpose but it is not able to insert expense.
4. Menu Registration- Create or update the stores and menu.

For the calendar and calculator, it is shown in figure 4.6.3.2, the function inside this module is almost the same. One important component in this side menu list is called menu registration. This component is designed for user or vendors to provide the store and products information. In short, all the stores that will be explained at Tab4 is created and provided by this component.

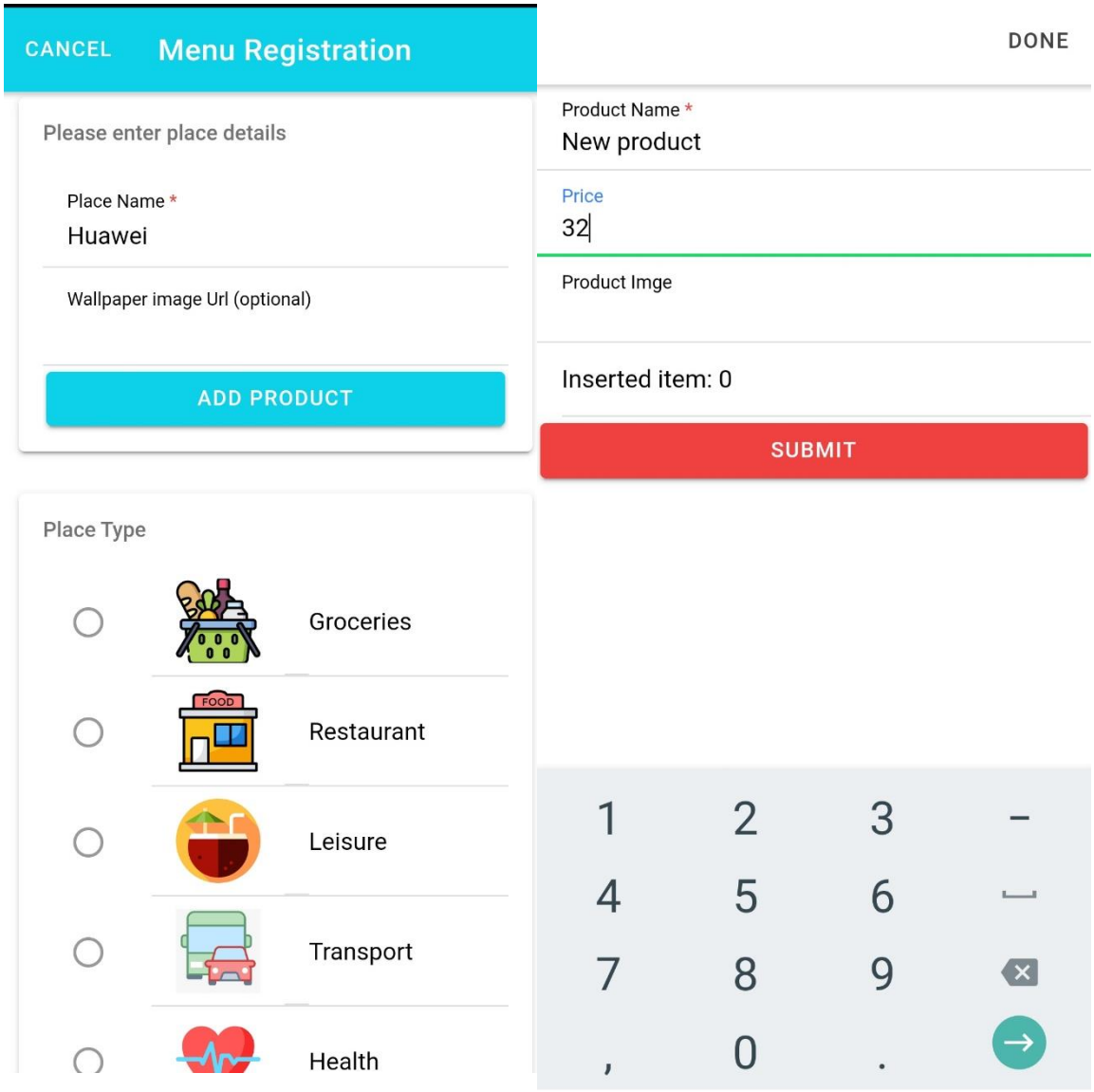

Figure 4.6.3.7 Menu registration

In the menu registration module, user have to enter the place name, wallpaper image URL. Pressing ‘add product’ will redirect the user to the page which same as right-side image. The last step is selecting a place type and press submit. The result will be a created store which is same as the figure 4.6.3.8.

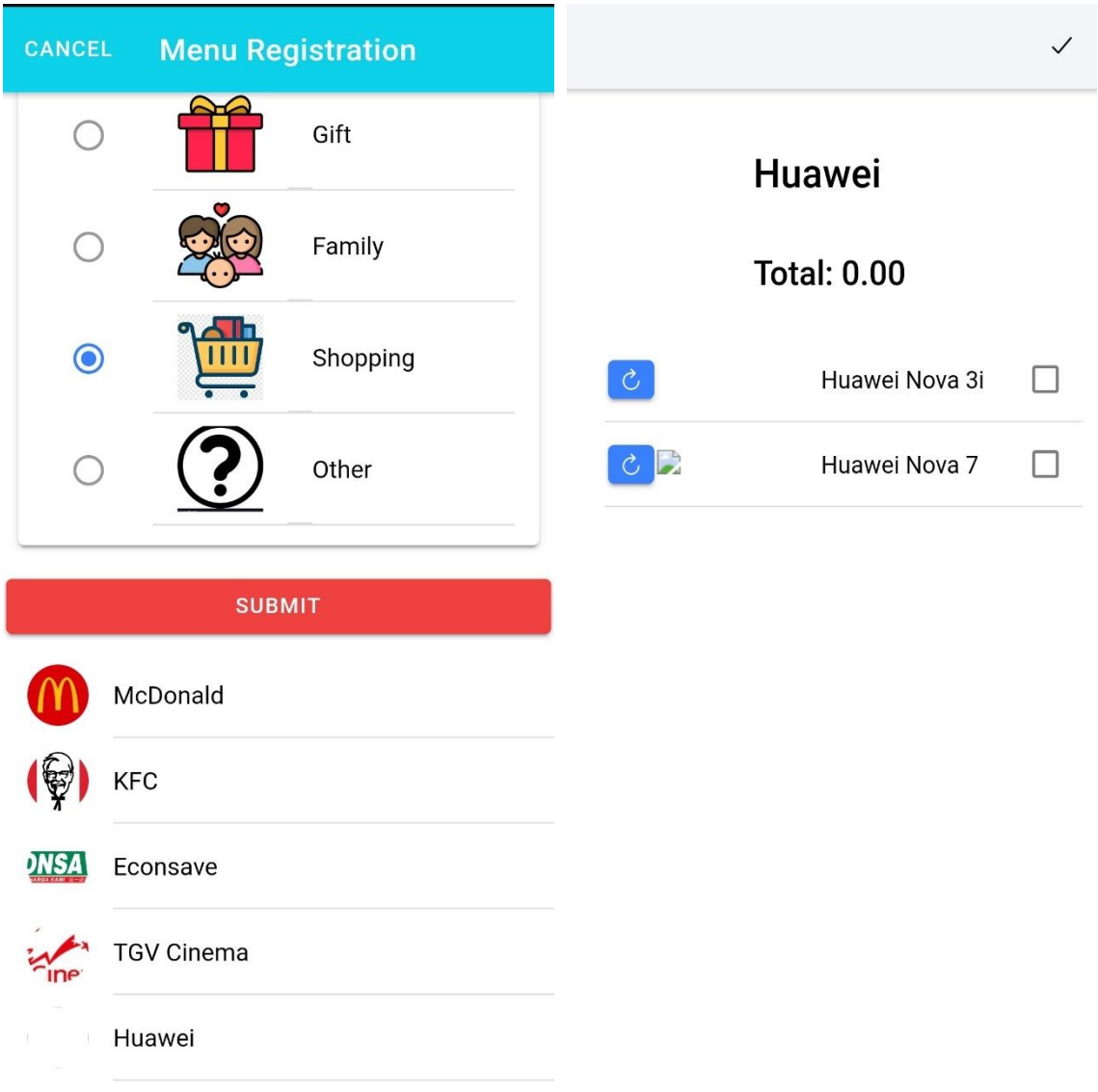

Figure 4.6.3.8 Result of Menu registration

As shown in the figure 4.6.3.8, the left-side image is the list of stores while the right-side image is the created menu. Since there is no image added to the product menu, so the menu will look like very simple and plain. If the image is added to menu, the result will be shown as the same as figure 4.6.3.9.

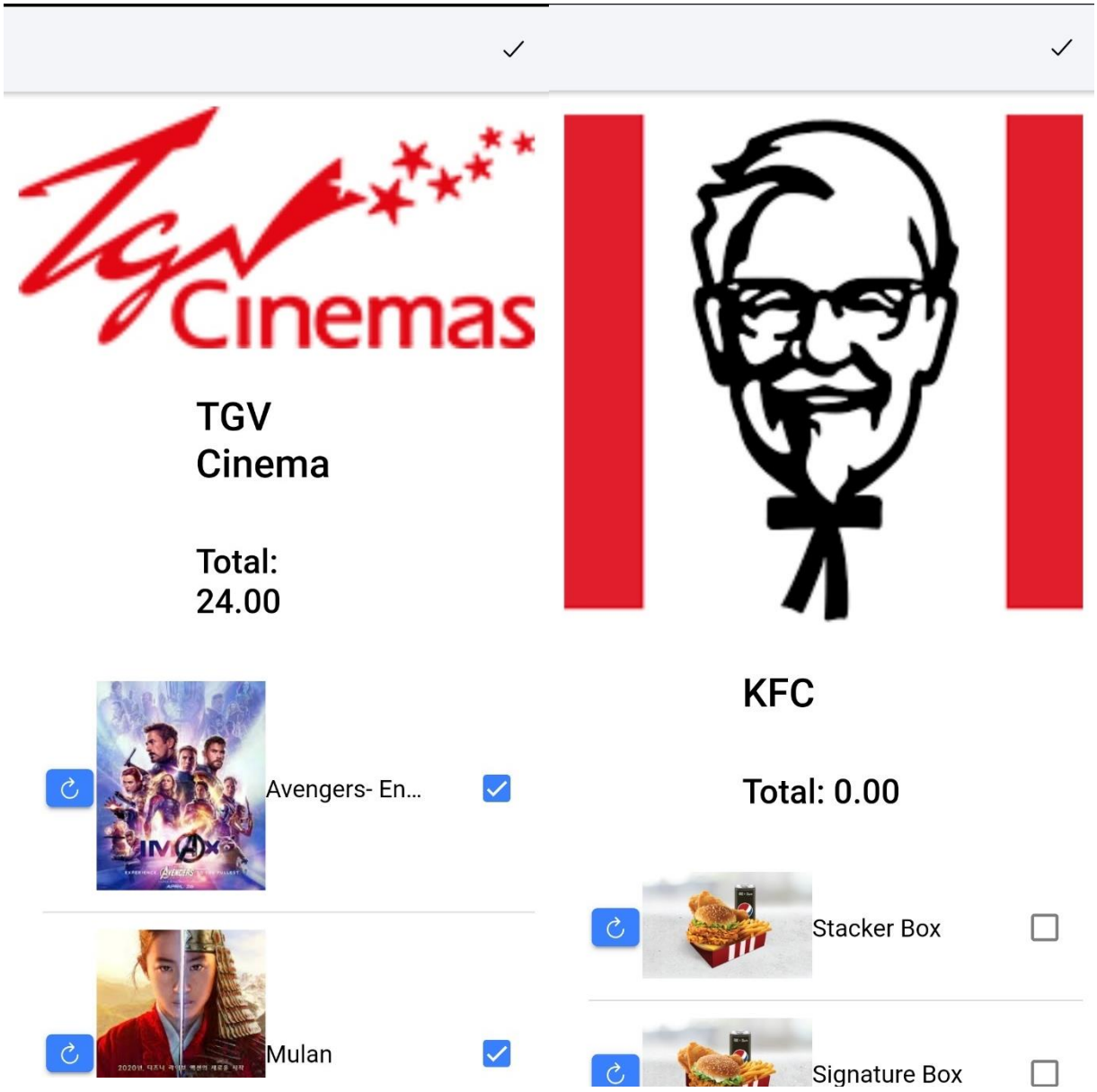

Figure 4.6.3.9 Result of Menu registration (with image)

Tab 4- Discover

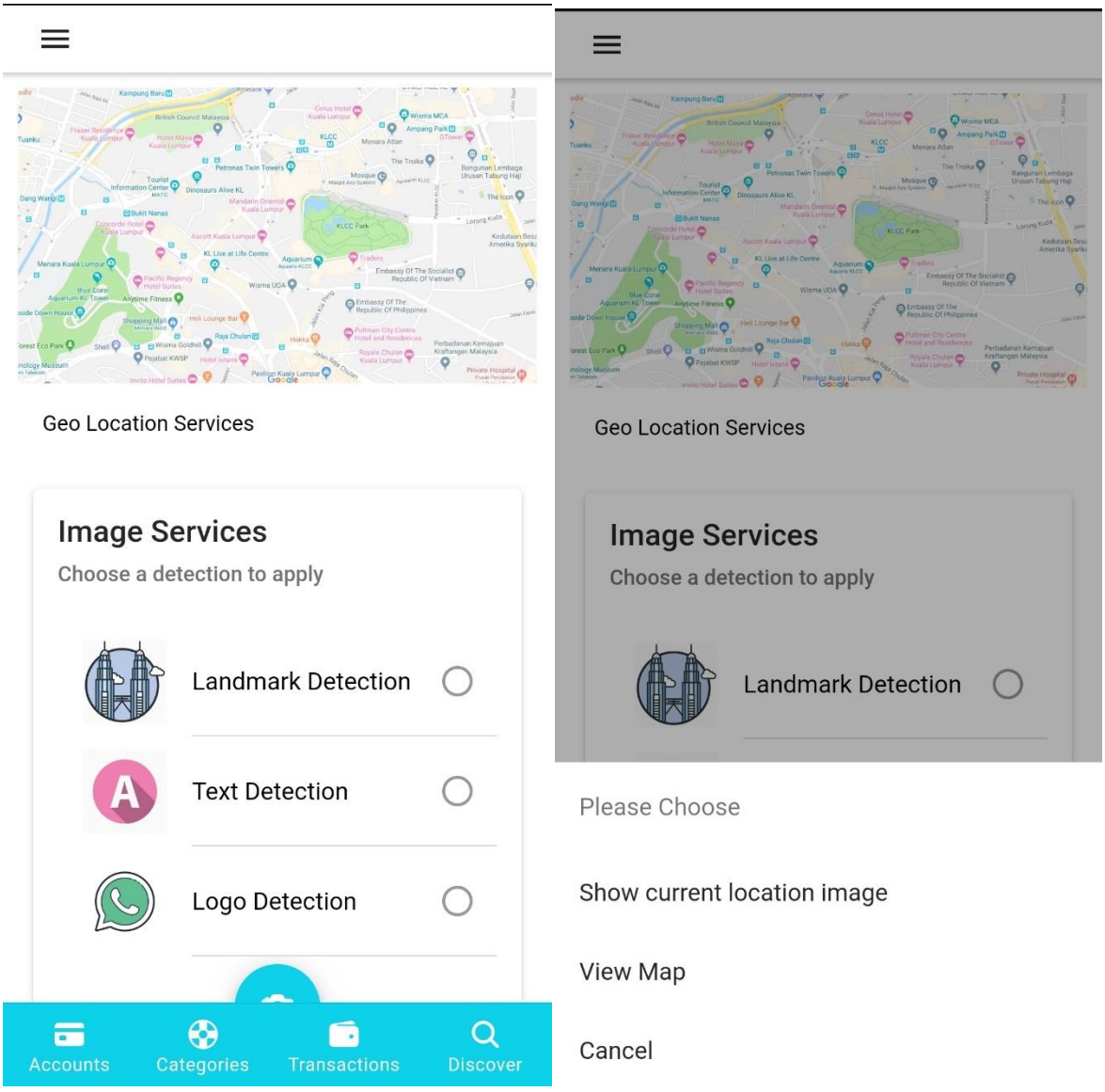

Figure 4.6.3.10 Tab4- Discover

Tab4- Discover manage geo location system and context scanner. Geo location system is the component which provides geo location information to assist user on where and how they spend their money. Firstly, user can choose on 'show current location image' or 'view map'. The first option provides a brief picture on where the user is. The second option will provide a map for further operation. The user can either auto locate or pick a place on the location. Then, GeoBudget will display the nearby stores. By clicking the nearby stores, it will redirect the user to the menu. The user can then insert budget with reducing lengthy efforts. The process is shown in the following figures.

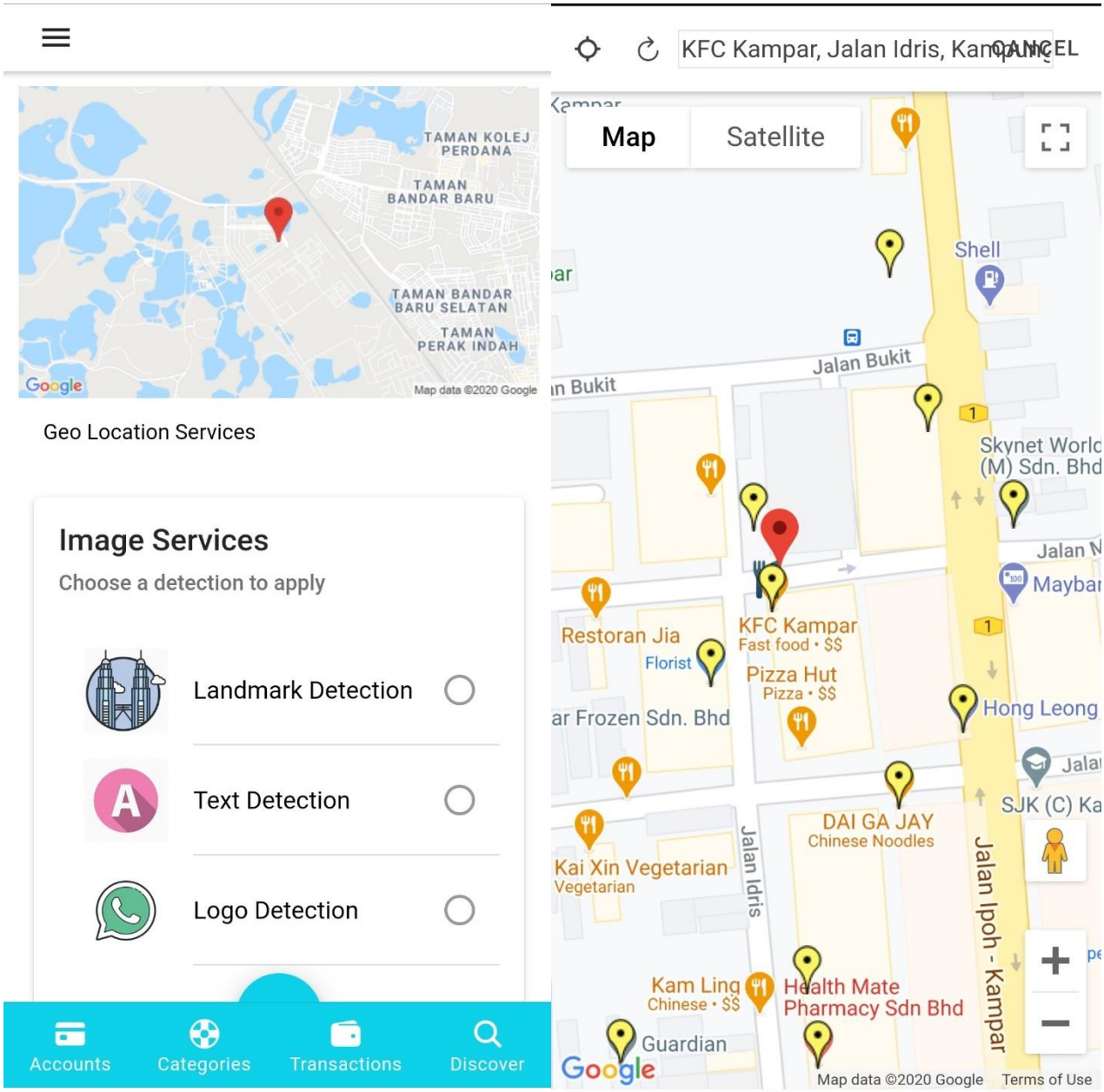

Figure 4.6.3.11 Geo location system

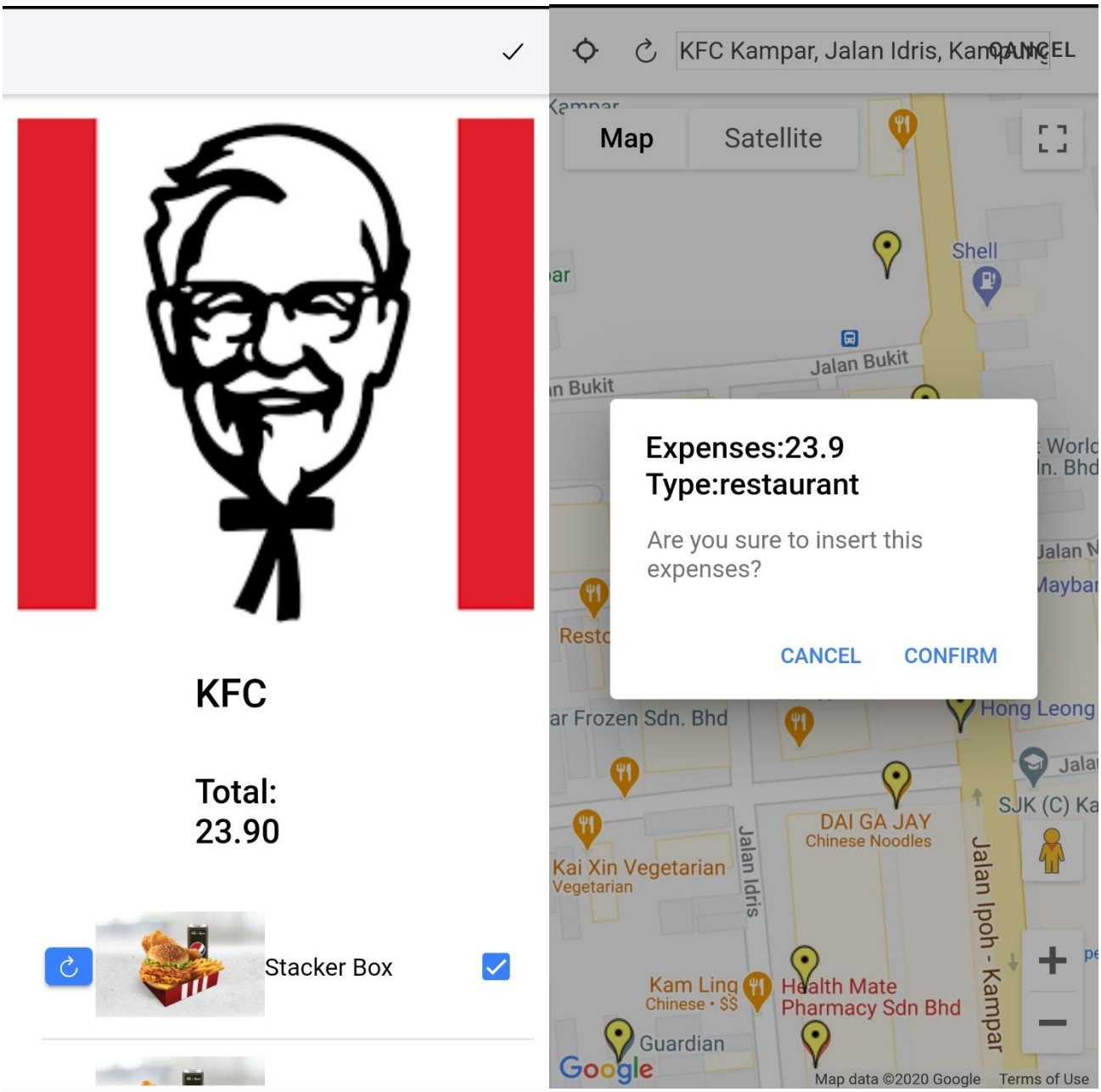

Figure 4.6.3.11 Geo location system

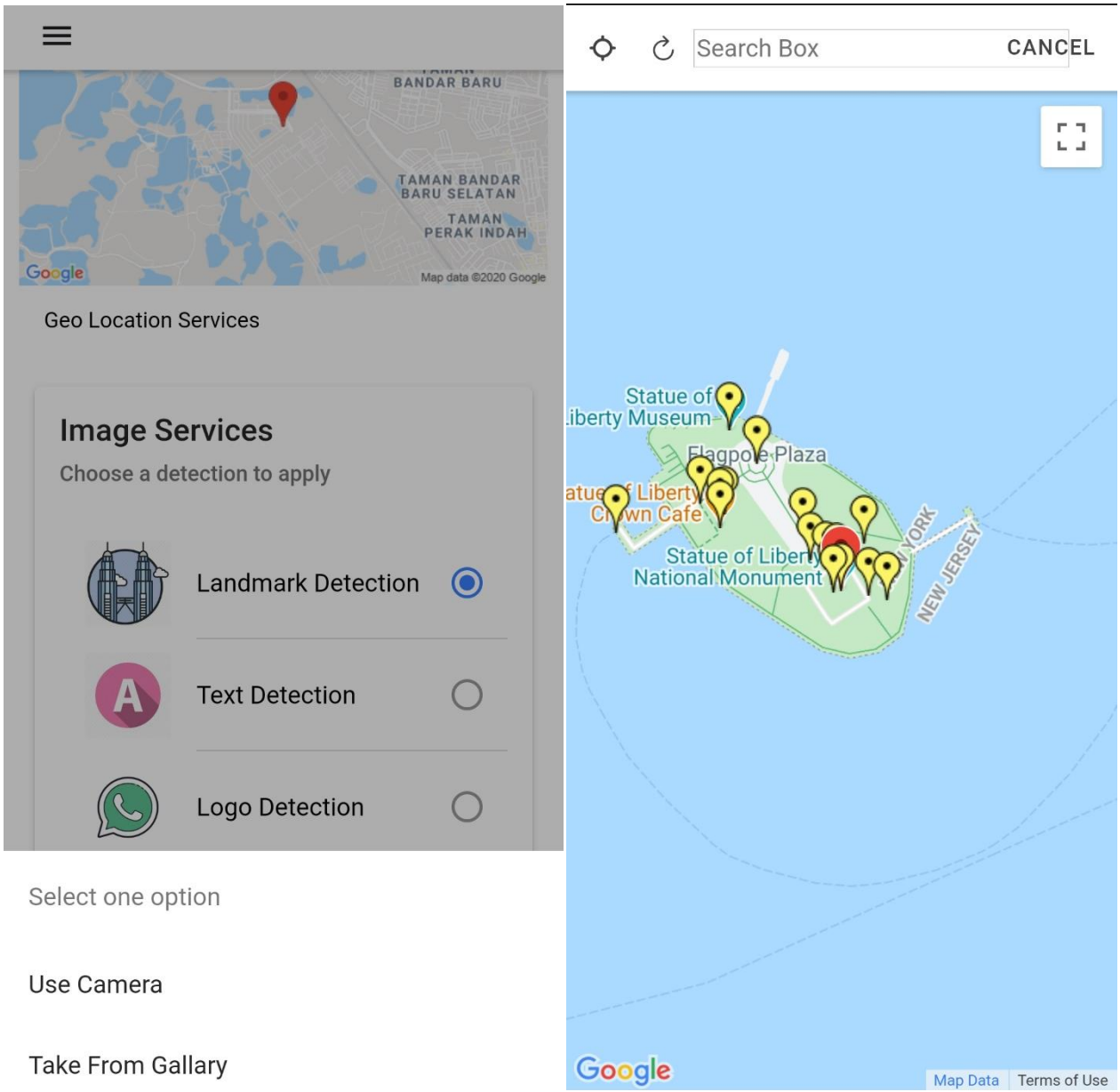

Figure 4.6.3.12 Context Scanner

In this section, the user will choose a detection method. For landmark detection, GeoBudget will redirect the user to the landmark location and the budgeting process is similar to Geo location system.

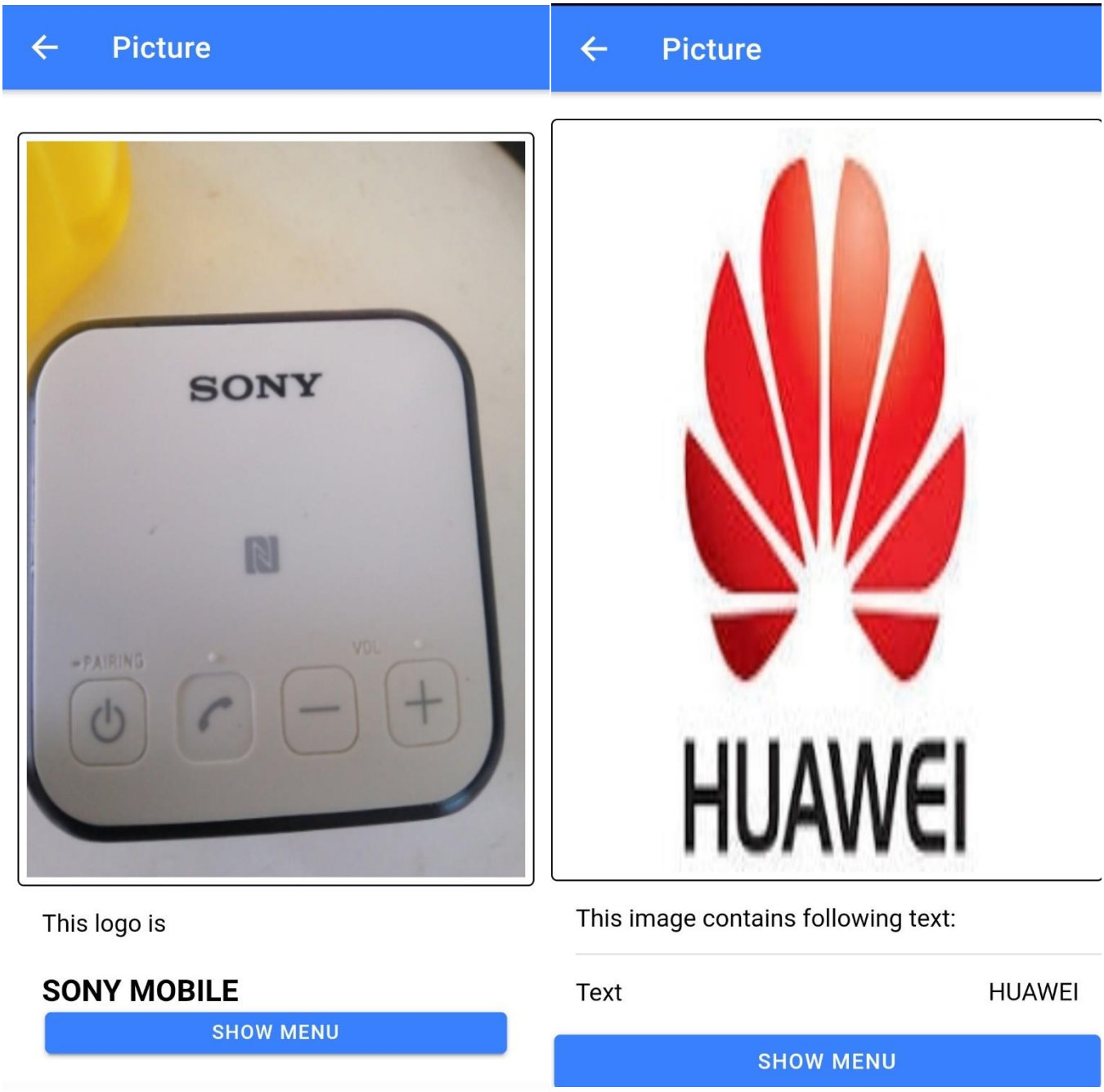

Figure 4.6.3.12 Context Scanner

If the user chooses text or logo detection, the image will be analysed and the user can do budgeting by viewing the pressing ‘show menu’.

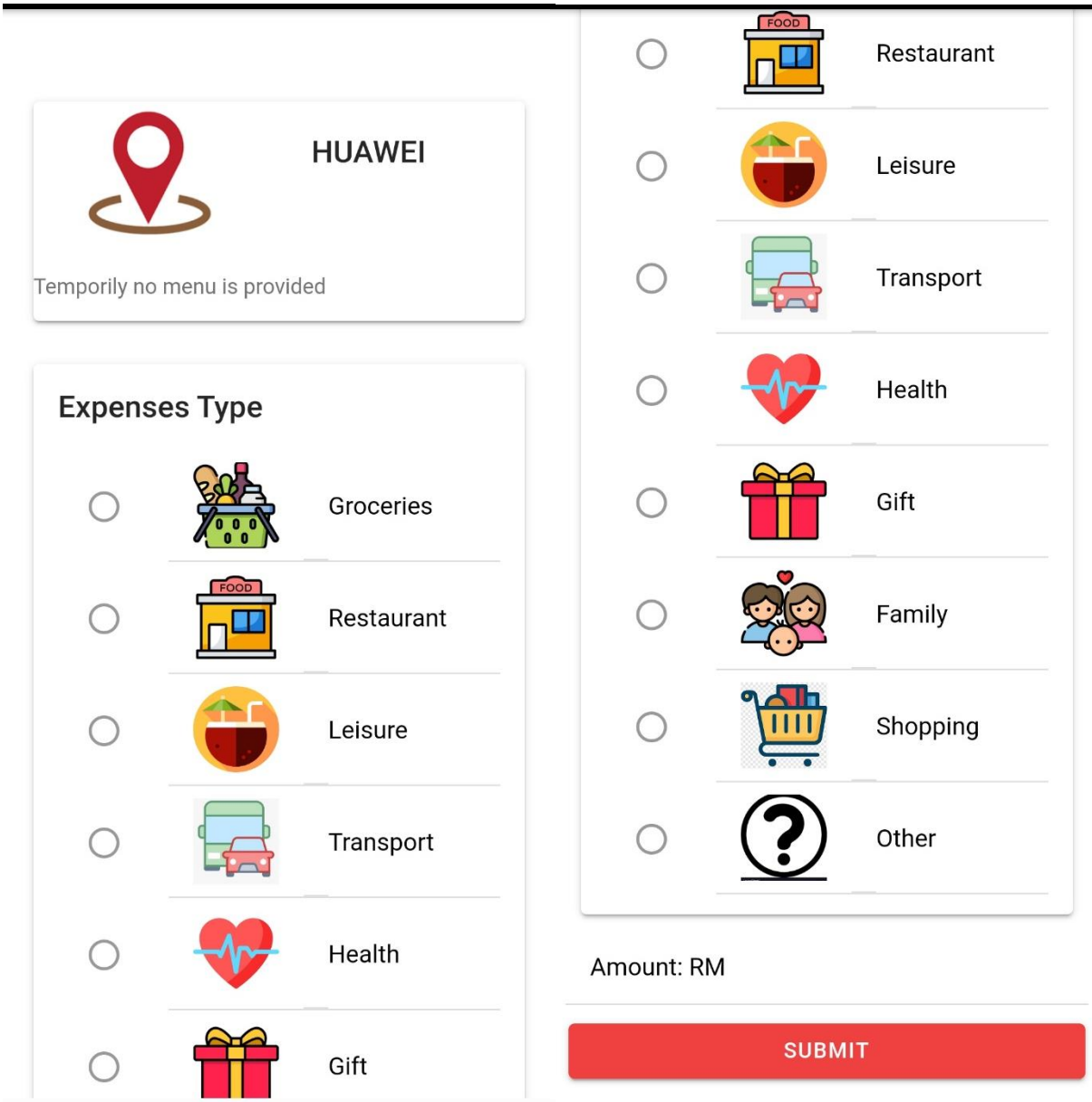

Figure 4.6.3.13 Budget insertion (no menu)

If there is no menu provided to the stores or product, the user will insert the expense by this method.

Chapter 5- Implementation and Testing

5.1 Implementation of main features

i. Manage financial resources

This feature is the basic and the core function in every budgeting application. Different budgeting application will have their own way to insert budget. In GeoBudget, an Ionic UI component called ion-modal is being used for redirecting the user to a webpage. After completing the budgeting process, the modal will be dismissed and certain data will be used for the next operations. The problem is how to ensure the created modal is correct modal. For example, if the user selects 'grocery', calculator modal will be presented. If the user selects another category, calculator modal will also be presented. The difficulties encountered is how to distinguish between the calculator modal. Therefore, an identification method called 'NavParams' is introduced. It gets the primary identity of every category and display the correct calculator modal. Hence, user can be navigated to the correct modal component to insert their information. User can perform further operations with the information after the modal is dismissed.

ii. Manage split of bills

This feature is almost the same because it presents a modal for the user to input their information. The differences are the method of entering the information. We have used ngModel to collect user information. 'ngModel' is used with ion-input in HTML element. It is a quite simple element to handle input from user. The next problem is how to display a list of information to the user. This can be done by declaring an array to store the information in JSON format. With the array, apply 'ngFor' in HTML to display specific JSON information in the array. For removing a chunk of data in the list, we can use 'pop' operation to do so.

iii. Provide guidance on how to spend money

GeoBudget allows the user to set their targeted budget. The ultimate aim of the targeted budget is to assist the user to meet their financial goals easily. For instance, the targeted budget can be utilized in suggestive system to filter the products that is lesser than the targeted budget.

iv. Advanced budgeting method

The method involves applying geo location service and image recognition services to do budgeting. The pre-requisite for this feature is the menu provided by vendors and user. If there are no menu provided, user have to manually insert the information in a modal.

In order to utilize geo location service, Capacitor plugin and google maps API key is required. Capacitor can be downloaded using the command 'npm install @capacitor/core @capcitor/cli' while google maps API key need to have an account in google cloud platform. After creating a new project in google cloud platform, press 'create credentials' to generate API keys. Lastly, enable the Geocoding API, Places API, Map Static API, Map JavaScript API. With all these tools and some configuration, a google map will be displayed. When the user selects a location, nearby stores will be displayed. Choosing a nearby store will bring the user to the budgeting process.

For image recognition services, an API which named Cloud Vision API key is also needed during the implementation process. By enabling the Cloud Vison API, the credentials key that is created in the geo location services can be reused. Another required tool is the plugin named 'CameraOptions'. It allows the user to have access on the camera and gallery. With the image provided by user, different annotation method will accommodate the respective detection method. Finally, it will bring the user to budgeting process.

5.2 Use Case Testing

Use Case	Input	Expected Output	Actual Output	Result
UC001 Manage Income	User press the icon beside income category	User is redirected to a page to enter the income information.	User is redirected to a page to enter the income information.	Passed
	User enter valid income information	User is able to see the valid information they entered.	User is able to see the valid information they entered.	Passed
	User enter invalid income information	User unable to see the invalid information they entered.	User unable to see the invalid information they entered.	Passed
	User press 'Submit' button	An alert message will be prompt out	An alert message will be prompt out	Passed
	User press 'Add' in the alert message	The amount of income is added to existing amount	The amount of income is added to existing amount and update in database.	Passed
	User press 'Edit' in the alert message	The amount of income is edited and replaced as the entered amount	The amount of income is edited and replaced as the entered amount and update in database	Passed

Use Case	Input	Expected Output	Actual Output	Result
UC002 View Financial Detail	User had entered income or expense information	System display the total assets, total income, total expense and chart.	System display the total assets, total income, total expense and chart.	Passed

Use Case	Input	Expected Output	Actual Output	Result
UC003 View Calendar	User press the 'calendar' in the side menu list or press the date button at the second tab-categories.	System display a calendar.	System display a calendar.	Passed

Use Case	Input	Expected Output	Actual Output	Result
UC004 View Menu	User press the menu button and select 'Menu Registration'.	System displays a list of stores.	System displays a list of stores.	Passed
	User select a store.	System display the registered menu.	System display the registered menu.	Passed

Use Case	Input	Expected Output	Actual Output	Result
UC005 Register Menu	User enter valid information and press submit.	System created the new stores in a store list.	System created the new stores in a store list.	Passed
	User select the expense type.	The radio button is selected.	The radio button is selected.	Passed
	User enter invalid information or do not select expense type.	An alert message will be prompt out and the stores will not be created.	An alert message will be prompt out and the stores will not be created.	Passed

Use Case	Input	Expected Output	Actual Output	Result
UC006 Manage Expense	User select a category	User is redirected to calculator modal to insert their expenses.	User is redirected to calculator modal to insert their expenses.	Passed
	User calculated the amount and press 'Confirm'	System display the amount they inserted to respective category and update in database.	System display the amount they inserted to respective category and update in database.	Passed
	User calculated the amount and press 'Cancel'	System do not display the amount they inserted.	System do not display the amount they inserted.	Passed
	User do not calculate the amount and press 'Confirm'	No changes to the expenses amount.	No changes to the expenses amount.	Passed
	User do not calculate the amount and press 'Cancel'	No changes to the expenses amount.	No changes to the expenses amount.	Passed

Use Case	Input	Expected Output	Actual Output	Result
UC007 Set Target Budget	User enter valid information.	User is able to see the valid information they entered.	User is able to see the valid information they entered.	Passed
	User enter invalid information.	User unable to see the invalid information they entered.	User unable to see the invalid information they entered.	Passed
	User press the checkmark icon on the top right side.	System displayed an alert message.	System displayed an alert message.	Passed
	User press 'yes' in the alert message.	System display the total expected budget by sum up all the information entered.	System display the total expected budget by sum up all the information entered.	Passed
	User press 'no' in the alert message.	System do not display the entered information.	System do not display the entered information.	Passed

Use Case	Input	Expected Output	Actual Output	Result
UC008 View Suggested Product	User press 'Suggestive System'	User is redirected to a suggestive module page.	User is redirected to a suggestive module page.	Passed
	User select a category	System display a list of products which price is less than the targeted budget.	System display a list of products which price is less than the targeted budget.	Passed

Use Case	Input	Expected Output	Actual Output	Result
UC009 Manage Split of Bills	User select a bills type.	User is redirected to a page to input the info.	User is redirected to a page to input the info.	Passed
	User enter valid information.	User is able to see the valid information they entered.	User is able to see the valid information they entered.	Passed
	User enter invalid information.	User unable to see the invalid information they entered.	User unable to see the invalid information they entered.	Passed
	User press the 'submit' button	System displays the list of inserted information.	System displays the list of inserted information.	Passed
	User press 'Settle up'	System remove the item from the list.	System remove the item from the list.	Passed

Use Case	Input	Expected Output	Actual Output	Result
UC010 View Map	User press the map image.	System displays an action sheet.	System displays an action sheet.	Passed
	User select 'Show current location image' in the action sheet.	System displayed the current location image of the user.	System displayed the current location image of the user.	Passed
	User select 'View Map' in the action sheet.	System displays google map.	System displays google map.	Passed
	User pick a location on the map.	System displays the nearby stores.	System displays the nearby stores.	Passed

	User press the locate icon in toolbar	System displays the nearby stores.	System displays the nearby stores.	Passed
	User select a nearby store	System displayed the menu. If no menu is provided for the store, system will display a page to perform manual insertion.	System displayed the menu. If no menu is provided for the store, system will display a page to perform manual insertion.	Passed
	User press ‘cancel’	User is redirected to previous page.	User is redirected to previous page.	Passed
	User select the product that they had purchased	System displayed the total at the top.	System displayed the total at the top.	Passed
	User enter valid information.	System will display the information in Tab2 after press ‘confirm’.	System will display the information in Tab2 after press ‘confirm’.	Passed
	User enter invalid information.	User unable to see the invalid information they entered.	User unable to see the invalid information they entered.	Passed
	User click the checkmark icon.	System display an alert message.	System display an alert message.	Passed
	User press ‘yes’ in the alert message.	The user is redirected to second tab- Categories and system will displayed the inserted amount.	The user is redirected to second tab- Categories and system will displayed the inserted amount.	Passed
	User press ‘no’ in the alert message.	System do not display the inserted amount.	System do not display the inserted amount.	Passed

Use Case	Input	Expected Output	Actual Output	Result
UC011 Use Image Services	User select detection method.	The radio button is selected.	The radio button is selected.	Passed
	User press the camera icon.	System displays the action sheet	System displays the action sheet	Passed
	User select 'Use camera' option in the action sheet.	System access the camera of mobile devices.	System access the camera of mobile devices.	Passed
	User select 'Take from gallery' option in the action sheet	System access the storage of mobile devices.	System access the storage of mobile devices.	Passed
	User press checkmark icon.	System will analyse the product image and displayed the result in a page.	System will analyse the product image and displayed the result in a page.	Passed
	User select an image from the gallery	System will analyse the product image and displayed the result in a page.	System will analyse the product image and displayed the result in a page.	Passed
	User press 'Show menu'	System displays the menu of the store. If no menu is provided, system will display a page to perform manual insertion.	System display the menu of the store. If no menu is provided, system will display a page to perform manual insertion.	Passed
	User press 'Show nearby stores'	System displays google map with the nearby stores around the landmark.	System displays google map with the nearby stores around the landmark.	Passed

User select a nearby store	System displayed the menu. If no menu is provided for the store, system will display a page to perform manual insertion.	System displayed the menu. If no menu is provided for the store, system will display a page to perform manual insertion.	Passed
User press 'cancel'	User is redirected to previous page.	User is redirected to previous page.	Passed
User select the product that they had purchased	System displayed the total at the top.	System displayed the total at the top.	Passed
User enter valid information.	System will display the information in Tab2 after press 'confirm'.	System will display the information in Tab2 after press 'confirm'.	Passed
User enter invalid information.	User unable to see the invalid information they entered.	User unable to see the invalid information they entered.	Passed
User click the checkmark icon.	System display an alert message.	System display an alert message.	Passed
User press 'yes' in the alert message.	The user is redirected to second tab- Categories and system will	The user is redirected to second tab- Categories and system will	Passed

		displayed the inserted amount.	displayed the inserted amount.	
	User press ‘no’ in the alert message.	System do not display the inserted amount.	System do not display the inserted amount.	Passed

5.3 Deployment

Throughout the development process, the user interface of GeoBudget can be viewed at the web browser. We can use ‘ionic serve’ to launch a development server on local host. The result will be displayed and we can change the layout with chrome developer tools. Another benefit of this command is the live reload function. When we make changes in the code, it will automatically update the result in browser.

There is another command to perform deployment process. The command is ‘ionic cordova run android’. This command can assist in deploying the code to emulator or real mobile devices. In addition, it can assist in accessing the camera and storage of mobile devices. Since GeoBudget has image recognition service, it is necessary to deploy to mobile devices to test the result. For geo location system, this deployment method also can assist in testing the accuracy and performance.

5.4 Implementation issues and challenges

During the deployment process, we found that there was an error called 'appmergeDebugresource' when we try to run the ionic cordova prepare android. After few weeks looking for the solution, we noted that our project folder is located at this file path: C:\Windows\System32. This situation occurs when we try to run the NodeJS in administrator mode. This file path is the default file path so we stored the entire folder in this file path. However, this file path is a very secure path. Although we have run the visual studio code in administrator mode, it still cannot work as expected. Therefore, we have changed the file path to the desktop and it successfully solve this problem.

Another main problem that we encountered is the bug fixing issues in some tabs. Previously, we run 'ionic serve' in the terminal and it can display all the errors in the console. We will refer to the console and provide an efficient solution. The process is quite fast and reliable. During the implementation process, we found that some features like camera need to be run in a stimulator or real devices so that it can access to the camera features. However, when it run on stimulator and real devices, we may not see some of the hidden error of the code. Therefore, we may not know what error is happening in the background and we cannot figure out any solution. After searching for information in Internet, we finally know that we can actually click 'f12' in google chrome. Next, we click 'ctrl+shift+p' and search for 'show remote devices'. Then, click on the 'chrome://inspect/#devices' and we will be able to see our stimulator or real devices. Select the remote target and the error will be displayed in the console as well.

Chapter 6- Conclusion

Nowadays, budgeting application plays a vital role in our life. Although all the related functionalities are installed in it, the users still encountered problems from different aspects. For this reason, GeoBudget is designed to enhance the existing budgeting application. GeoBudget is an advanced budgeting mobile application. It provides many features that does not exist in the any existing budgeting app. The following table has explained the problem faced by the user and solution provided by GeoBudget.

Problems	Solution
Budget Expenditure is lack of related important details	utilise and provide geo location information to assist user on where and how they spend the money.
Most expenditure needs repetition and tedious input of data	provide an interactive system that allow the user to enter inputs with reducing lengthy efforts of entering data by providing pre-prepared list of items based different types of expenditure.
Not able to track payment that involve sharing or split of bills	enable sharing of expenditure/cost among related parties based on their identification.
Face difficulties in deciding what product to select and where to buy it.	Provide suggestion and assistance to the user based on correct targeted budget

Table 6.1 Problems and Solutions

After reviewing all the existing budgeting application, we believe that GeoBudget will have the potential to monopolise the market. Although some of the functions like scanning the receipt and Family Sync are not included in this app, GeoBudget still have its unique features to attract the customers. If this mobile application is published in the market, it will become the most advance budgeting application in the app store. In fact, some monetization strategies can be used in selling GeoBudget.

Firstly, an in-app subscription package can be provided to the user who intends to upgrade to premium version. Premium version of GeoBudget will be advertisement free and more menu will be included in Menu/ Stores module. Besides, we can recruit some busines partners and get the sponsorship from them because GeoBudget is able to promote the product to the user. Moreover, GeoBudget should have in app advertisement which generate a large amount of site-ad revenue in the market. Finally, the most interesting is the user behaviour analysis. We can sell the user data to different companies and shops. For instances, if a company is looking for a user who can afford to buy expensive stuff, GeoBudget is able to answer the questions since it records the user expenditure daily. If a company wants to do promotional event, GeoBudget can assist in providing the most attractive price range for the company to sell their products. In short, studying user data will improve the business and provide competitive advantage in the market.

Indeed, there are some constraints and future enhancement in GeoBudget.

i) Constraints

The limitation of GeoBudget is the lack of login function. Login process can be defined as a process which provides authorization access to the user using username and password. This process is used by many mobile applications, web application and website in current industry. Unfortunately, GeoBudget does not include the login modules.

ii) Future enhancement

In the future, GeoBudget can be developed with a module called 'Product information System'. Before the user enters the shop, they can view the information of the products. For example, information such as the quantity of the stock, the price of the product, the size of the product can be reviewed by the user. This function can save the user time and assist in promoting the product of the stores. However, the shop and vendors must be willing to share their price and sign the invasion of privacy contract. Another future work that can be done is the coordination between e- commerce application and GeoBudget. When the user is having purchase in the e-commerce application or website, the amount they purchase will be automatically record as expenses. Nevertheless, developers have to request access from the e-commerce app so that developers can gather and manipulate the payment data.

Throughout the development of GeoBudget, we have learnt the application development with Ionic, Angular, Android, etc. Although we face problems when some critical bugs take place, we enjoy the process of fixing the bugs and implement the modules. We have learnt to manage our time so that the project can be completed in time. We have learnt to conduct root cause analysis when an error occurred. Finally, the most important ethics value we have learnt is never give up, no matter how hard the situation is. We always believe that the project is going to be successfully launched one day.

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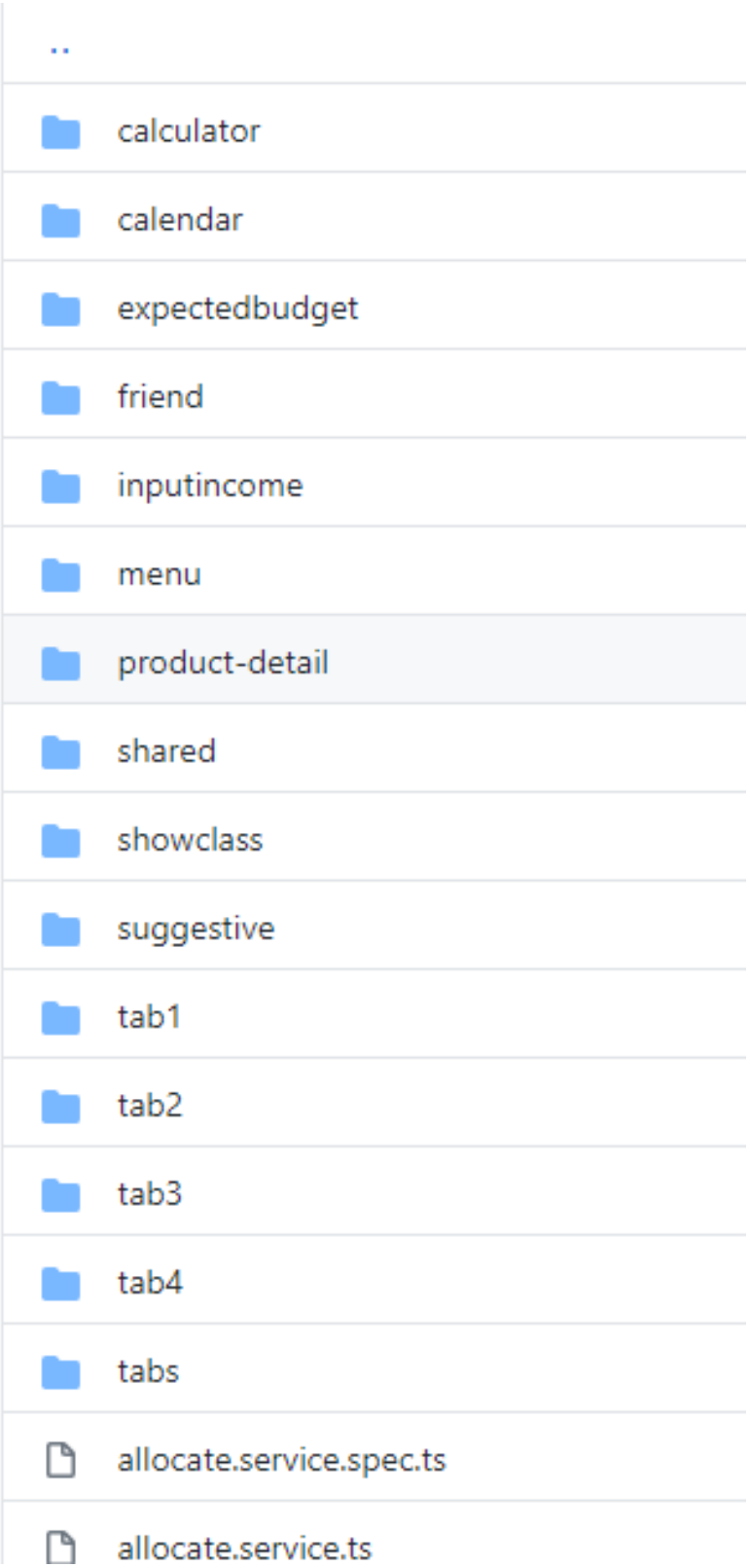
Appendices

APPENDIX A: Final Year Project Source Code (GitHub)

GitHub Link: https://github.com/JoonHoe1998/FYP2



APPENDIX B: Poster

UNIVERSITY TUNKU ABDUL RAHMAN

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

MOBILE GEOBASED BUDGET PLANNER AND CALCULATOR

An Interactive and Advanced Budgeting Application

INTRODUCTION

Mobile Goe Based Budget Planner is an interactive and advanced budgeting mobile application. It is built with some advanced features that does not exist before.
The project aims to enhance the existing budgeting application so that the user will have more interest in using such application.

PROJECT OBJECTIVES

· aims to utilise and provide geo location information to assist user on where and how they spend the money.
· aims to provide an interactive system that allow the user to enter inputs with reducing lengthy efforts of entering data by providing pre-prepared list of items based different types of expenditure.
· enable sharing of expenditure/cost among related parties based on their identification.

Methods and Features

- Geolocation System
- Context Scanner
- Split Biils Management System
- Suggestive System

RESULTS

- User will not forget where and how they spend their money
- User will have better decision making in selecting what product to buy and where to buy it
- User can do budgeting with reducing effort.

DISCUSSION

Geolocation System provides geo location services. Context Scanner provides imgae recognition services. Both of these functions can cooperate with the menu provided by the user and vendors to make the budgeting smoother and simpler.

CONCLUSION

Budgeting application is very important in providing assistance to manage our financial resources. Therefore, Mobile Geo Based Budget Planner and Calculator is designed to solve the problems encountered by the user. This project is successfully launched and has met the objectives.

APPENDIX C: Final Year Project Biweekly Report

FINAL YEAR PROJECT WEEKLY REPORT

(Project I / Project II)

Trimester, Year: Y3S3	**Study week no.:2**
Student Name & ID: Lo Joon Hoe 17ACB05596	
Supervisor: Ts. Tan Teik Boon	
Project Title: Mobile Geobased Budget Planner and Calculator	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

1. Install and configure all the plugin.
2. Having a consultation with supervisor.

2. WORK TO BE DONE

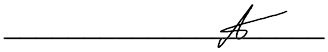
1. Develop Calendar and database
2. Develop Split Bills Management system

3. PROBLEMS ENCOUNTERED

Face difficulties in using loopback and MongoDB.

4. SELF EVALUATION OF THE PROGRESS

Self assigned tasks are completed within expected timeframe.



Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project I / Project II)

Trimester, Year: Y3S3	**Study week no.:4**
Student Name & ID: Lo Joon Hoe 17ACB05596	
Supervisor: Ts. Tan Teik Boon	
Project Title: Mobile Geobased Budget Planner and Calculator	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Developed Split Bills management system, calendar and database.

2. WORK TO BE DONE

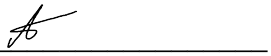
3. Develop Geo location system
4. Develop Context Scanner

3. PROBLEMS ENCOUNTERED

Face difficulties in coordinate the geolocation system with the menu.

4. SELF EVALUATION OF THE PROGRESS

Self assigned tasks are completed within expected timeframe.



Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project I / Project II)

Trimester, Year: Y3S3	**Study week no.:6**
Student Name & ID: Lo Joon Hoe 17ACB05596	
Supervisor: Ts. Tan Teik Boon	
Project Title: Mobile Geobased Budget Planner and Calculator	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Developed Geo location system and Context scanner.

2. WORK TO BE DONE

1. Decorate GeoBudget.
2. Develop function of calculating monthly expenses.
3. Fixing the bugs of menu registration.

3. PROBLEMS ENCOUNTERED

No problems encountered for this week.

4. SELF EVALUATION OF THE PROGRESS

Self assigned tasks are completed within expected timeframe.

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project I / Project II)

Trimester, Year: Y3S3	**Study week no.:8**
Student Name & ID: Lo Joon Hoe 17ACB05596	
Supervisor: Ts. Tan Teik Boon	
Project Title: Mobile Geobased Budget Planner and Calculator	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Complete the design of GeoBudget.

2. WORK TO BE DONE

1. Fixing all the bugs in GeoBudget.
2. Develop suggestive system.

3. PROBLEMS ENCOUNTERED

There are many bugs in GeoBudget.

4. SELF EVALUATION OF THE PROGRESS

Self assigned tasks are completed within expected timeframe.

Supervisor's signature **Student's signature**

FINAL YEAR PROJECT WEEKLY REPORT

(Project I / Project II)

Trimester, Year: Y3S3	**Study week no.:10**
Student Name & ID: Lo Joon Hoe 17ACB05596	
Supervisor: Ts. Tan Teik Boon	
Project Title: Mobile Geobased Budget Planner and Calculator	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Conduct a research on Chapter1,2 and 3.

2. WORK TO BE DONE

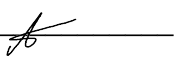
Write Chapter 1,2,3 of FYP 2 report.

3. PROBLEMS ENCOUNTERED

No problems encountered for this week.

4. SELF EVALUATION OF THE PROGRESS

Self assigned tasks are completed within expected timeframe.



Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project I / Project II)

Trimester, Year: Y3S3	**Study week no.:12**
Student Name & ID: Lo Joon Hoe 17ACB05596	
Supervisor: Ts. Tan Teik Boon	
Project Title: Mobile Geobased Budget Planner and Calculator	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Finalize and Check the draft of Chapter 1,2 and 3.

2. WORK TO BE DONE

Write Chapter 4,5,6 of FYP 2 report.

3. PROBLEMS ENCOUNTERED

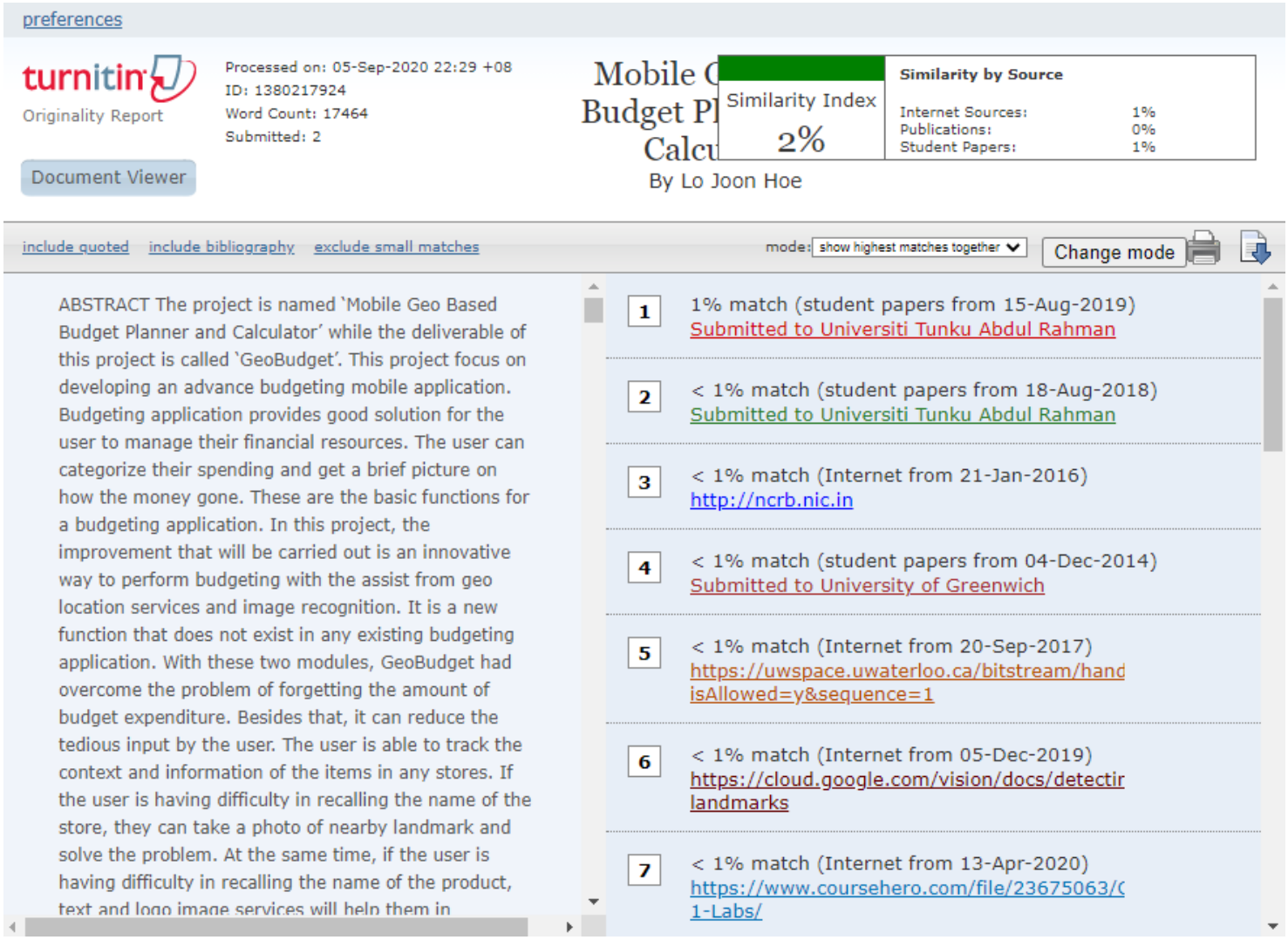
Do not know what content should be placed under Chapter4,5 and 6.

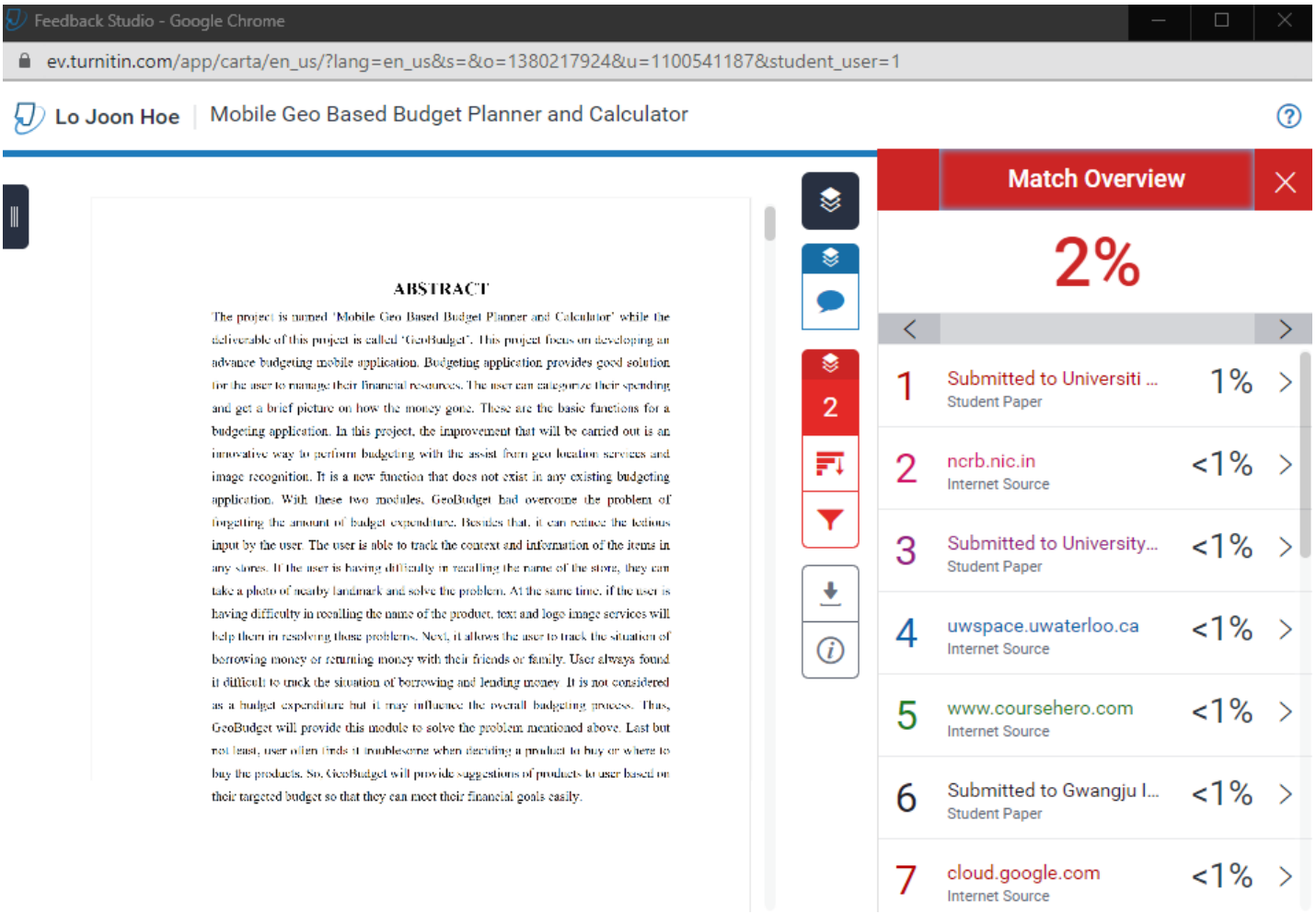
4. SELF EVALUATION OF THE PROGRESS

Self assigned tasks are completed within expected timeframe.

Supervisor's signature **Student's signature**

APPENDIX D: Plagiarism Check Result




Feedback Studio - Google Chrome
ev.turnitin.com/app/carta/en_us/?lang=en_us&s=&o=1380217924&u=1100541187&student_user=1
Lo Joon Hoe | Mobile Geo Based Budget Planner and Calculator
ABSTRACT
The project is named 'Mobile Geo Based Budget Planner and Calculator' while the deliverable of this project is called 'GeoBudget'. This project focus on developing an advance budgeting mobile application. Budgeting application provides good solution for the user to manage their financial resources. The user can categorize their spending and get a brief picture on how the money gone. These are the basic functions for a budgeting application. In this project, the improvement that will be carried out is an innovative way to perform budgeting with the assist from geo location services and image recognition. It is a new function that does not exist in any existing budgeting application. With these two modules, GeoBudget had overcome the problem of forgetting the amount of budget expenditure. Besides that, it can reduce the tedious input by the user. The user is able to track the context and information of the items in any stores. If the user is having difficulty in recalling the name of the store, they can take a photo of nearby landmark and solve the problem. At the same time, if the user is having difficulty in recalling the name of the product, text and logo image services will help them in resolving those problems. Next, it allows the user to track the situation of borrowing money or returning money with their friends or family. User always found it difficult to track the situation of borrowing and lending money. It is not considered as a budget expenditure but it may influence the overall budgeting process. Thus, GeoBudget will provide this module to solve the problem mentioned above. Last but not least, user often finds it troublesome when deciding a product to buy or where to buy the products. So, GeoBudget will provide suggestions of products to user based on their targeted budget so that they can meet their financial goals easily.
Match Overview
2%
1 Submitted to Universiti ... 1%
Student Paper
2 ncrb.nic.in <1%
Internet Source
3 Submitted to University... <1%
Student Paper
4 uwspace.uwaterloo.ca <1%
Internet Source
5 www.coursehero.com <1%
Internet Source
6 Submitted to Gwangju I... <1%
Student Paper
7 cloud.google.com <1%
Internet Source

APPENDIX E: Checklist for FYP2 Thesis Submission

Universiti Tunku Abdul Rahman			
Form Title : Supervisor's Comments on Originality Report Generated by Turnitin for Submission of Final Year Project Report (for Undergraduate Programmes)			
Form Number: FM-IAD-005	Rev No.: 0	Effective Date: 01/10/2013	Page No.: 1of 1

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

Full Name(s) of Candidate(s)	Lo Joon Hoe
ID Number(s)	17ACB05596
Programme / Course	CS
Title of Final Year Project	Mobile Geo Based Budget Planner and Calculator

Similarity	**Supervisor's Comments (Compulsory if parameters of originality exceeds the limits approved by UTAR)**
Overall similarity index: 2 **%** **Similarity by source** Internet Sources: 1 % Publications: 0 % Student Papers: 1 %	
Number of individual sources listed of more than 3% similarity: 0	

Parameters of originality required and limits approved by UTAR are as Follows:
- **(i) Overall similarity index is 20% and below, and**
- **(ii) Matching of individual sources listed must be less than 3% each, and**
- **(iii) Matching texts in continuous block must not exceed 8 words**

Note: Parameters (i) – (ii) shall exclude quotes, bibliography and text matches which are less than 8 words.

Note Supervisor/Candidate(s) is/are required to provide softcopy of full set of the originality report to Faculty/Institute

Based on the above results, I hereby declare that I am satisfied with the originality of the Final Year Project Report submitted by my student(s) as named above.

Signature of Supervisor

Name: Tan Teik Boon

Date: 9 September 2020

Signature of Co-Supervisor

Name: _____

Date: _____

UNIVERSITI TUNKU ABDUL RAHMAN

FACULTY OF INFORMATION & COMMUNICATION TECHNOLOGY (KAMPAR CAMPUS)

CHECKLIST FOR FYP2 THESIS SUBMISSION

Student Id	17ACB05596
Student Name	Lo Joon Hoe
Supervisor Name	Ts. Tan Teik Boon

TICK (√)	DOCUMENT ITEMS Your report must include all the items below. Put a tick on the left column after you have checked your report with respect to the corresponding item.
√	Front Cover
√	Signed Report Status Declaration Form
√	Title Page
√	Signed form of the Declaration of Originality
√	Acknowledgement
√	Abstract
√	Table of Contents
√	List of Figures (if applicable)
√	List of Tables (if applicable)
	List of Symbols (if applicable)
√	List of Abbreviations (if applicable)
√	Chapters / Content
√	Bibliography (or References)
√	All references in bibliography are cited in the thesis, especially in the chapter of literature review
√	Appendices (if applicable)
√	Poster
√	Signed Turnitin Report (Plagiarism Check Result - Form Number: FM-IAD-005)

*Include this form (checklist) in the thesis (Bind together as the last page)

I, the author, have checked and confirmed all the items listed in the table are included in my report. _____ (Signature of Student) Date:5-9-2020	Supervisor verification. Report with incorrect format can get 5 mark (1 grade) reduction. _____ (Signature of Supervisor) Date: 9 September 2020