Mobile Application Development of an Alternative Credit Scoring System at A Fintech Company to Improve Personal Financial Planning.

BY

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A REPORT

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Date: ____19 April 2022_____   **Date**: ____19 April 2022____

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ABSTRACT

In recent years, the size of populations using smartphones are increasing rapidly. It is because technology brings convenience and ease to the lifestyle. This brings more convenience to people's lives, which in turn increases the customer experience of the services provided by smartphones, especially credit scoring systems that are related to financial services. Credit scoring is a statistical analysis performed by financial institutions and lending institutions to assess a person's creditworthiness to decide whether to extend or deny credit. There are still several groups of population that do not access to essential banking services due to them not having a savings or checking account. Thus, alternative credit scoring comes to them as a solution to this problem. Alternative credit scoring refers to use of alternative or non-traditional financial data to determine credit worthiness such as mobile money usage, utility payment, e-commerce platform usage and so on.

This project aims to develop an alternative credit scoring system that could help the country's unbanked and underbanked populations improve their financial conditions. The project aims to solve the problems to let people have credit history with financial institutions to obtain loans and to solve the problems of lenders who do not have the information to effectively identify and determine the borrower's character and credit worthiness. The project also encourages and enable unbanked and underbanked Malaysians to use alternative credit scoring systems, and solve the loan approval process in an easy way for SMEs. Using an alternative credit scoring mobile application will let Malaysians to receive better financial services as compared to the physical bank branch. Using mobile apps will be more convenient, cheaper and save time because there will be no need to spending time to queue up, to fill out forms and wait for banks to approve financial products. Besides, alternative data has the potential to help expand the responsibilities of credit access for those people who lack traditional credit scores. Alternative data such as rental payments, mobile phone payments, cable TV payments, banks account information such as withdrawals, deposits, transfers and so on, can be used to determine credit worthiness. Therefore, unbanked and underbanked people can have access to the loans they need to improve their lives, without facing many difficulties with the rules and barriers from the banks, especially in this COVID-19.

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Lastly, the project is expected to help unbanked and underbanked populations to improve their financial conditions, and let everyone has opportunity to be involved and contribute to their pursuit for a better live for themselves and their families.

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LIST OF SYMBOLS

$\%$ Percentages

$\hat{y}$ Y hat

df   Degrees of freedom

F   Significance F

MS   Mean Squared Errors

SS   Sum of Square

t-Stat   t-statistic

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LIST OF ABBREVIATIONS

FinTech	Financial Technology
ANOVA	Analysis of Variance
AOT	Ahead of time
ARM	Advanced Risk Machines
GPIO	General Purpose Input Output
IC	Identity Number
JIT	Just-in-Time
MAE	Mean Absolute Error
MAPE	Mean Absolute Percentage Error
MSPE	Mean Squared Prediction Error
PDF	Portable Document Format
RAM	Random Access Memory
RM	Ringgit Malaysia
SDK	Software Development Kit
SOP	Standard Operating Procedure
UI	User Interface
VIF	Variance Inflation Factor
VS Code	Visual Studio Code

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CHAPTER 1: INTRODUCTION

1.1 Problem Statement and Motivation

Figure 1.1.1 Percentage of the unbanked adult population in Malaysia

(Source:https://www.bnm.gov.my/documents/20124/1073866/Malaysia+Experience+in+Financial+Inclusion.pdf)
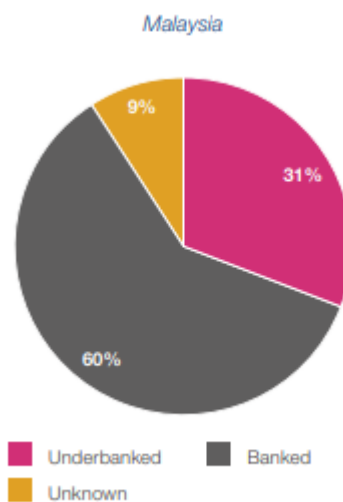
Figure 1.1.2 Percentage of the underbanked population in Malaysia

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(Source: https://cdn.crowdfundinsider.com/wp-content/uploads/2019/09/2019-ccaf-asean-fintech-ecosystem-benchmarking-study.pdf)

According to Bank Negara Malaysia [2], the Bank expects Malaysia to remain about 8% of the unbanked population and the underbanked population is at 31%. Bank has explored the demographics such as gender, age, location, and income to understand the Malaysian unbanked reason. There is still a problem in traditional credit scoring, such as each agency uses a different kind of max score. Various lenders subscribe to the additional bureau as known as agencies. Hence, there is not a standard operation process to determine a person's credit scoring. Stated below are some main problems in traditional credit scoring, that alternative credit scoring is able to provide solution to, by using alternative credit scoring with alternative data.

- **No able to obtain the loans from banks due to no history with financial institutions**

First, unbanked and underbanked people's problem is that they do not have a bank's financial transaction history, so it is hard to evaluate these individual's creditworthiness. Bank, credit card companies, and financial institutions will determine credit reliability based on the repayment histories and other financial benchmarks held by the credit institutions or bureaus, as well as their internal databases. Therefore, the unbanked people never develop a credit score, for some banks of the good credits risk but cannot prove it to the lenders. Hence, people who do not have a good credit history will directly impact their credit scores and not allowing them to apply for a loan. To solve this problem, alternative credit scoring using alternative data can help identify the credit scores. A person who has not taken out a loan in the past and has no credit payment history may have paid off utilities, monthly bills, telecom payments, and so on. Alternative credit scoring is more focused on current parameters than historical data, and it is useful to a person who does not have a history with financial institutions. Alternative credit scoring provides benefits to new consumers with access to credit and loan systems that can still benefit them with their personal financial planning, business and their personal life. However, they lack credit score data from traditional channels.

- **Credit assessment data and credit scores of individuals are not available or not made known to a lender**

  The unbanked and underbanked do not have the relevant and strong financial data for credit scoring purposes. Lenders find it challenging to correctly identify their characters. The credit score is key to measure and determine if individuals or an organization can repay a loan. By analysing their existing credit histories and repayment histories, lenders can avoid or minimize the borrower's risks. Without the data of an individual's credit scoring, it is hard to judge their creditworthiness, including collateral, capacity, and character. Besides that, lenders may require to visit and interview the applicant because of the individual's new credit assessment. This visit and interviews are time-consuming, causing inconvenience and are expensive. The solution is alternative credit scoring data will be based on the analysed data such as payment pattern as shown in monthly bills, rental fee, insurance fee, and so on to determine who is less likely to have trouble in payments. As the report will generate the amounts, lenders can base their current financial and discipline to identify their ability, stability, and intent to repay a loan. Therefore, compared with the traditional credit scoring methods, alternative credit score significantly in terms of accuracy.

- **High number of unbanked and underbanked population in Malaysia**

  Different customer segments or groups bring a different kind of unbanked and underbanked reasons. The banks often are unwilling to lend money to an unbanked person. The percentage of women who unemployed is more than men. The age group from 15-24 years' old which represents the youth of the country are very much less likely to have a formal account and hence, less likely to qualify for loans. The income level of about 86% of people is either no income and low income, and 33% of adults who live in East Malaysia is living in the rural and remote location. There is less likely to be a bank branch near them [2]. Apart from that, traditional bank institutions have been reluctant and struggled to expand into remote areas. This is because establishing and maintaining the bank branches in a small, remote town to serve low-impact customers is expensive and needs a longer time. It is also not a convenient process to apply to banks for loans in small towns. The same problem also applies to the new customers, such as fresh university graduates, who lack credit scoring data to satisfy

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the requirements of a traditional bank. They do not have sufficient data available, but that does not mean other good, credible data cannot be made available for credit scoring purposes. The solution is by using the alternative credit score will help and support them in loan applications. They can pay household expenses, fees, educations and bills on time and are more likely to get a loan even if they have a low credit score. Also, by using alternative credit scoring, which is based on alternative data, customers can easily access the financial planning products without going to the bank, queuing up, and filling many forms that they live in the rural and remote location.

1.2 Project Objectives

- **To calculate alternative credit scoring by using mobile application**

The application will provide financial service for the financial planning product to the users. The users can use this application to perform the credit score so they no need to go to a local bank wait for a long time. Because many people are unbanked and do not have histories from the financial banking institution, they can use the application we developed. This application is using alternative data to get the financial information of the users. Using this, the users can know their credit scoring anytime and anywhere and efficiently manage and settle their financial problems. This application will also provide the tips to improve credit score to let them know and can use the financial planning service like avail loans even though they lack proof or do not have enough credit scores. For example, alternative data such as mobile usage payment, rental payment, and so on, will provide the additional financial payment information of the users. This information can prove if the user can be trusted to have the will and ability to pay the loan.

- **To solve the problem of people who do not have a financial institution history to obtain the loans by using an algorithm**

For the young individuals such as fresh graduate's students with no credit score history or adults with the thin or stale traditional credit scores, the alternative credit scoring system can help them qualify for the loans with the better terms. The algorithm is used multiple linear regression to calculate, which is from different fields and categories such as traditional bank data, debt data, utilities data, mobile data, and shopping data. Unbanked credit lines will become faster, cheaper, and more creditworthy as a result of alternative credit scoring and prediction models. While credit history is the traditional

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and most common way to analyse an individual's credit, those without a bank account do not have access to it. Because some of the individuals, they rely on cash and have no previous financial history; their credit files are thin, whereas banks prefer thick files. As a result, the several behavioural characteristics of an individual that may be used to establish credit scores. The system is based on characteristics and factors that are widely available and easy to track such as social media, mobile data or utilities data, as well as monthly utilities bills, all contribute to this data. This strategy will convert these clients from thin to the thick over time, and they will become regular bank customers with the history credit score data. Hence, without traditional credit score history data, the borrowers still able to show their alternative credit score history to the lenders or bank institutions.

- **To identify and determine the borrower's creditworthiness by using analyst tool**

Alternative credit scoring mobile application can enhance the creditworthiness assessment of the borrowers. People with poor credit scores may have their loan applications rejected. The formula for calculating the borrower's credit is done using Excel's analytical tools. Through the formula with the borrower's alternative data, the system can calculate the alternative credit score to define the borrower's creditworthiness. Therefore, lenders can obtain a better understanding of an applicant's credit position by substituting credit scores. They were able to identify those who were less likely to have payback issues by examining other data, such as monthly bill payments, mobile monthly bills, and rental. Hence, this makes it a better option for borrowers who do not have credit score because their reports may provide a more accurate view of their current financial habits and discipline, as well as their ability, stability, and purpose to repay borrowed money based on their social interactions. As a result, alternative credit scoring approaches outperform standard credit scoring methods in terms of accuracy.

1.3 Project Scope

The overall project aims to develop and build an alternative credit scoring, which is a mobile-based application to provide better financial planning for the user through the smartphone. Furthermore, people nowadays carry smart devices which including smartphones with them wherever they go. Therefore, developing on mobile-

based application will have advantages over web-based platform. The primary outcome of this project is an alternative credit scoring based on the Android platform. The application can let users have a financial service such as financial planning products, view credit scores, credit reports, use alternative data to calculate the credit scores and giving users tips to improve the credit scoring. Using this application will bring a lot of convenience such as faster than a local bank, cheap and save time, check credit scores any time, and no need to wait for the bank's complicated formalities. The application will able to view credit scores using alternative data such as rentals, utilities bills, usage on social media and so on.

- The application will able to view credit report for easy understanding.
- The application will able to view graphic pinpoints or dashboard of the credit score.
- The application will able to view debt payment percentage of the user.
- The application will able to view total debt balance percentage by monthly.
- The application will provide detailed advice to help improve credit scores.

1.4 Impact, Significance and Contribution

This application can provide the financial services. By using this alternative credit scoring mobile application, it will let Malaysian to have the better financial service compared to the physical branch. It will more convenient, cheaper, save time as no need queue up to fill out the form, wait for bank approve to get the financial product services. As now in the technology trending era, it is easy to get an internet access in anytime and anywhere. Therefore, the lenders can evaluate a user's creditworthiness by using alternative credit data to refer to information and evaluate creditworthiness that isn't often provided on a traditional credit score report. This information allows the lenders to have a better knowledge of full file and thin file users, allowing them to enhance inquiry and payment visibility and transparency. Some users might get better credit access by combining information from alternative credit sources. The alternative credit scoring examples are rental payments, cable TV payments, mobile phone payments, banks account information such as transfers, withdrawals, deposits, and so on. Hence, traditional loan company data frequently does not represent a person's recent activity. Alternative data can provide real-time information which is more up-to-date.

For the unbanked and underbanked people, they can get the loan by only using alternative credit scoring data mobile application because it can help people who are incapable of entering the credit scoring system in traditional way and let them credit accessible. By using the alternative data, it has the potential to help expand the responsible of the credit access for those people who lack the traditional credit scores. For example, people who do not have the history of loan payments on their credit report may regularly pay other bills or duplicate charges. These bill payment histories can prove to the lender that the person will pay the debt as agreed. In other cases, alternative credit data can help lenders hedge risks and curb consumers who might disclose delinquent payments.

Other than that, alternative credit scoring can show a person ability and willingness because some of the unbanked or underbanked person is still paying monthly bills or services which can shows their ability and willingness instead of poor. Alternative credit scoring is better description of a person's credit worthiness compared to the traditional credit report. Some lenders may not lend to people with credit scores below 620, which mean the range is lower than the average of credit scores. But if these lenders can identify people who are less likely to default through other data sources, they may be willing to do so.

Therefore, unbanked and underbanked people can have access to the loans they need to improve their lives, without facing much difficulties with the rules and barriers from the banks, especially in this COVID-19 pandemic. Some types of alternative data, such as online bank account information, may allow lenders to automate tasks that were done manually during the loan approval process. Such automation could speed up the application process or avoid subjective interpretations that could lead to differential treatment or false discrimination. It also provides the opportunity to unbanked and underbanked people who may be unable to get financial services since traditional banks do not appear to be interested in providing them with any affordable financial services. More individuals will be able to establish businesses and improving their lives and as a result, positively affecting the country's economic growth. Hence, the financial service is able to let everyone has an equal opportunity to be involve and contribute to it.

1.5 Report Organization

The report is divided into 7 chapters that discuss the project's different details and concepts. Chapter 1 discuss about the problem statement and motivation, project objectives, project scope, the impact, significance and contribution to give an overall explanation of this project.

Chapter 2 is Literature Review, to review and compare similar existing credit scoring systems and applications developed by other developers. Each system's strengths and drawbacks are examined to see which is the suitable to apply for the project.

Next, system method and approach is discussed in Chapter 3. The system design equation is the equation used in the project to calculate an individual alternative credit score. Apart from that, the use case diagram and activity diagram with explanations is used to describe the functionality and flow of the project.

Chapter 4 is discussed about the system design in the project. The process of developing and functionality of the system is described in the system block diagram. Therefore, the information of the system is can be view in an easy way.

Chapter 5 will show how the system implement with system methodology. Other than that, the technologies and tool involved in the project such as hardware, software, database is discussed. The system implementation such as hardware and software setup also show how the project is configuring and operate. The system operation is screenshot is to show the system works.

The topic of system evaluation and discussion is discussed in Chapter 6. The purpose of system testing and performance metrics such as use case testing is to guarantee that the application runs smoothly. It also serves to show the software's ability to respond to user scenarios and handle user flows in real-time. This chapter also examines the objectives in order to determine if they were achieved.

Lastly, chapter 7 is conclusion and recommendation. The project review and discussion, novelties and contribution is covered in this chapter. Before concluding the project, this chapter discusses future work to indicate improvements or advances that can be made to the system in the future.

CHAPTER 2: LITERATURE REVIEW

2.1 Review of the Existing Systems/ Applications

2.1.1 Credit Karma
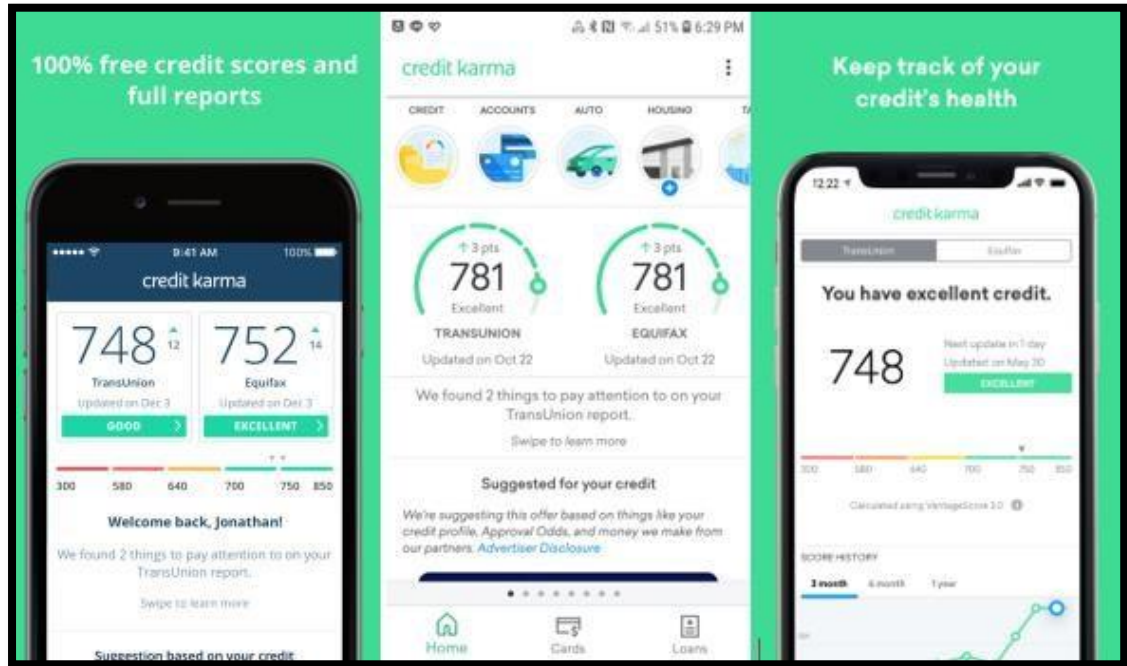
Figure 2.1.1 Credit Karma Mobile Application

Credit Karma is an application and website that provides users with free credit scores, credit report data [11]. It will keep the user up to date on the critical credit score, tell the user about the potential credit defaults and provide the tools to let the user find and secure better credit, loan, and auto insurance deals. Other than that, it will also let the user know the details about what factors are affecting their credit score, and also will give the suggestion to improve the credit score. It will also provide credit products recommendations, helping the user save money [6].

The primary feature is easy to sign up for as provide the user name, address, a few financial accounts, personal details, which is social security number. It can verify the user's account by using two-factor authentication because it holds sensitive information, and the user can choose to request and perform it. It also provided free ID monitoring, which can keep personal information more securely. Users can receive email notifications for the special promotion and can turn credit and identifying tracking on or off.

CHAPTER 2: LITERATURE REVIEW

Strengths of the Credit Karma

The user can view their credit score, as reported by two of the three bureaus, which are TransUnion and Equifax. Other than that, Credit Karma will show the graphic pinpoints to let the user know their scale of the possible number and the arrows which can illustrate the current credit score is increase or decrease from the last report. Users can get free credit monitoring. The user will receive the credit alerts if the system found the essential changes to a user's Equifax or TransUnion credit report. Credit Karma can also help check free credit scores and let the users learn what will affect and take control of the credit scores. [4].

Weakness of the Credit Karma

The weakness is Karma Credit is didn't provide the FICO scores. Credit Karma uses VintageScore 3.0 credit scoring model to provide the data and credit scores from Equifax and TransUnion. Although it can give a lot of insight, most lenders will check that your FICO score may differ. However, VintageScore 3.0 will follow the same trend lines as the FICO scores.

2.1.2 Credit Sesame
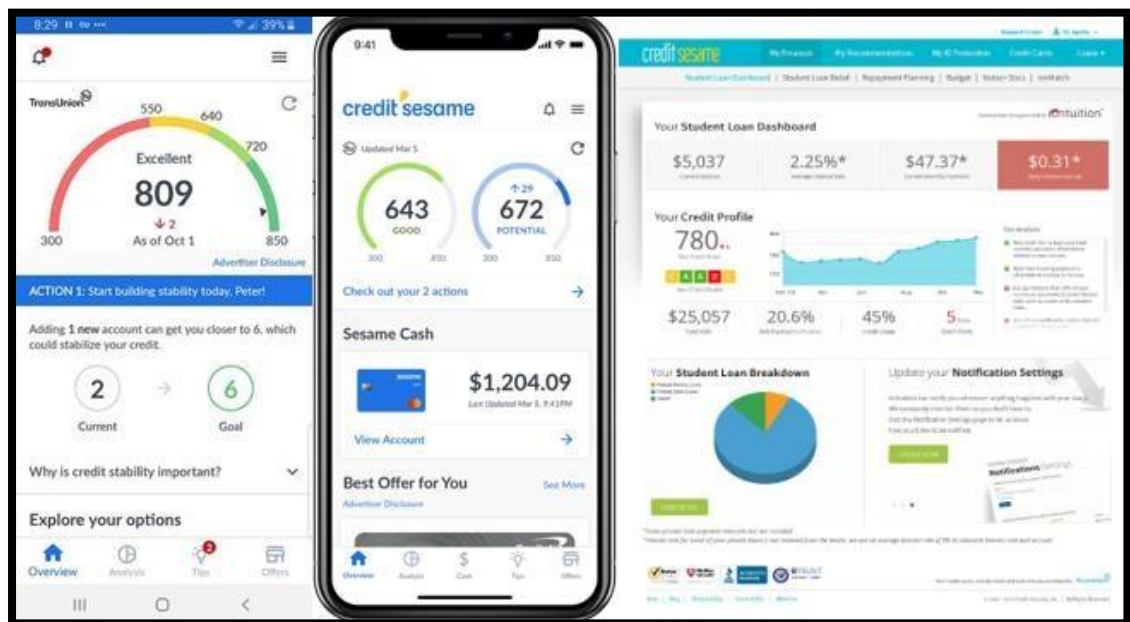
Figure 2.1.2 Credit Sesame Mobile Application

Credit Sesame is a credit reporting and monitoring platform. It was founded in 2010 and is currently headquartered in Mountain View, California. It provides a

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monthly credit score and credit monitoring, summarizes the monthly debt payments, and lists the total debt balance through TransUnion, one of the three credit reporting bureaus. It can also help users understand how to calculate the credit score.

Other than that, the users will receive credit score reports, financial advice, and anti-identity theft protection. Credit Sesame offers four memberships: free membership, advanced credit, pro credit, and platinum protection, so users can choose to upgrade the services depending on their needs. The essential feature is to sign in and create an account using the email address. Next is the users need to provide name, current address, date of birth and the last four digit of the user's social security number.

Strengths of the Credit Sesame

Credit Sesame provides monthly credit score reports, which will grade the credit standing to the Vantage scale. It will give the users a useful breakdown of how much a person owes, how many moneys need to pay, and how to maintain a healthy financial position in what percentage of the income. Credit Sesame also offers tips about how to improve credit scores base on the unique situation. Besides, it also provides free services to help users track, improve, and learn about their credit scores. They also offer free identity theft protection and monthly credit monitoring to all the customers.

Weakness of the Credit Sesame

Credit Sesame's features and functionality are limited when it is using the free membership service. The premium users can access the reports from TransUnion, Equifax, and Experian. But for the free subscription, the user can only receive from TransUnion. Here is one of the weaknesses of Credit Sesame. The TransUnion report alone does not adequately represent the user's ranking in the FICO score model, which is most often drawn by borrowers.

2.1.3 WalletHub

Figure 2.1.3 WalletHub Mobile Application

WalletHub is a personal financial service that can know the credit score, monitor the credit report, and learn more about personal finance. It focuses on credit cards, loans, and also financial accounts. WalletHub offers monitoring and alerts, which are more proactive now, provide detailed advice to help improve the credit score, and when the credit score changed will provide an in-depth explanation. It is easy to sign up as. First, the users need to give the address, date of birth, and the last four digits of the social security number. Next, WalletHub will pull a credit report from TransUnion by using the users' personal information. The credit report includes a user's finances, which are loans and credit card in a user's name, the account balances, and the user's late payment.

Strengths of the WalletHub

WalletHub provided the advertisement which is related to the user's need. Users can review car loans, mortgage, saving accounts, prepare sending cards, and so on. Users can also search for professional services such as car insurance, credit unions, and attorneys in their geographical area. It will also help calculate and show to the users such as the new payment date, interest of the specific extra payments in each month. It is also providing tips for getting out of debt, and this will help and give a lot of helpful education on reducing the deficit. Next, it will help update the credit score daily depending on the user's need and wants, such as customizing, to receive SMS alerts

other than the email alerts. Besides, it offers personalized services for credit cards, personal loans, and also car insurance. They have included links to the credit tools such as alerts, analysis, and suggestions to improve the score and simulator for improvement.

Weakness of the WalletHub

WalletHub does not have budget or tools to monitor personal accounts and transactions which bring out the inconvenient and lack of efficiently to the users.

2.1.4 Mint: Personal Finance & Money
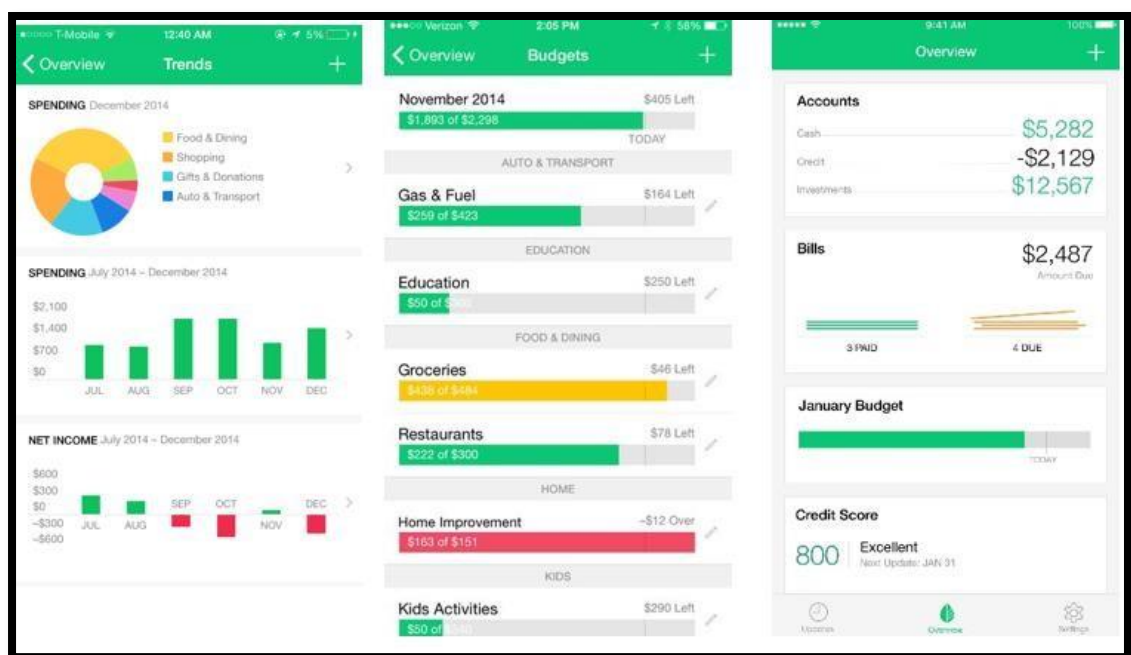
Figure 2.1.4 Mint: Personal Finance & Money Mobile Application

Mints launched in 2007. Mints mobile application can help users to monitor their spending habits and can keep track the account balances. It can also keep track of the bills and credit score. The users can easily link their bank and other financial accounts, create a dashboard to see the entire economic and financial life. Mints can let the user check the real-time account balances by pulling the app, so this is convenient to have a view. For the login feature is by using two factor-authentication before logging in either by email message or cell phone SMS message.

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Strengths of Mint: Personal Finance & Money

It provides the bill tracker, which can check the due and when the bill payment. After users set the due date of the costs, Mints will automatically alert them when the due date is close to the user. It can also perform the daily budget planner, which can analyze the daily spending habits and suggest a customized budget to the user. This will let the user more understand how much they are spending in a day. Next, it can keep track of the credit score, and the users can choose to receive automated credit alerts. Other than that, there provide free credit scoring monitoring from one of the bureaus, which is TransUnion [3].

Weakness Mint: Personal Finance & Money

The weakness is there is no real investment or savings functionality, so the users cannot move the money but can only track it. Other than that, Mints does not provide internal direct pay bill services. The users still have to pay bills by using the external application.

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2.1.5 Summary of the Existing Systems

Table 2.1.5.1 Comparison with Existing System

Features/ Application	Credit Karma	Credit Sesame	WalletHub	Mint: Personal Finance & Money	Proposal System
Able to view credit scores	√	√	√	√	√
Able to download credit report data	√	√	√	✗	√
Able to view graphic pinpoints/ dashboard	√	√	√	✗	√
Able to view total debt balance in percentages	✗	√	√	√	√
Provide advices to help improve credit scores	√	√	√	✗	√
Able to view statistic graph of each data in percentages	√	✗	✗	√	√

CHAPTER 3: SYSTEM METHOD/ APPROACH

3.1 System Design Diagram/Equation

The final formula to calculate the alternative credit scoring of an individual

1. The estimated multiple linear regression equation for Traditional Bank data:

To calculate a person's credit score with the ability to pay (= $\widehat{y1}$),

IncomePerMonth (= x_1),

Deposits (= x_2),

Insurance (= x_3),

CreditDebitCardsTransaction (= x_4),

NumDebitCards (= x_5),

$$\widehat{y1} = 70.2657 + 0.0058x_1 - 2.1553x_2 - 3.1449x_3 - 1.3840x_4 - 3.3681x_5$$

2. The estimated multiple linear regression equation for Utilities data:

To calculate a person's credit score with the ability to pay (= $\hat{y2}$),

IncomePerMonth (= x_1),

WaterBill (= x_2),

ElectricityBill (= x_3),

Wi-Fi_Bills (= x_4),

MobilePhoneBillPayments (= x_5),

$$\widehat{y2} = 56.0311 + 0.0036x_1 + 9.0094x_2 - 9.1627x_3 + 3.6289x_4 - 3.4194x_5$$

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3. The estimated multiple linear regression equation for Debt data:

To calculate a person's credit score with the ability to pay (= $\hat{y}3$),

IncomePerMonth (= x_1),

CarLoan (= x_2),

HouseLoan (= x_3),

StudentLoan (= x_4),

OutstandingBills (= x_5),

Rental (= x_6),

$\widehat{y3} = 45.5813 + 0.0036x_1 - 12.2428x_2 + 6.8032x_3 + 9.5314x_4 + 5.8109x_5 + 4.2801x_6$

4. The estimated multiple linear regression equation for Mobile data:

To calculate a person's credit score with the ability to pay (= $\widehat{y4}$),

IncomePerMonth (= x_1),

SocialMediaPlatforms (negative) (= x_2),

DataUsage (= x_3),

SubscriptionFees (= x_4),

Top-upHistory (= x_5),

E-Wallet (= x_6),

SocialMediaPlatforms (positive) (= x_7),

$\widehat{y4} = 43.1315 + 0.0054x_1 - 3.2592x_2 - 4.5039x_3 - 3.2918x_4 + 2.2952x_5 + 3.4418x_6 + 1.1119x_7$

5. The estimated multiple linear regression equation for Shopping Data:

To calculate a person's credit score with the ability to pay ($= \widehat{y5}$),

IncomePerMonth ($= x_1$),

EcommerceTransaction ($= x_2$),

EcommerceBuyingHabits ($= x_3$),

FoodDeliveryPlatforms ($= x_4$),

$$\widehat{y5} = 43.8939 + 0.0031x_1 + 2.7182x_2 + 2.2731x_3 + 2.5934x_4$$

The final calculation for alternative credit scoring of an individual:

$$\hat{y} = y1 + y2 + y3 + y4 + y5$$

3.2 System Architecture Diagram

3.2.1 System Architecture
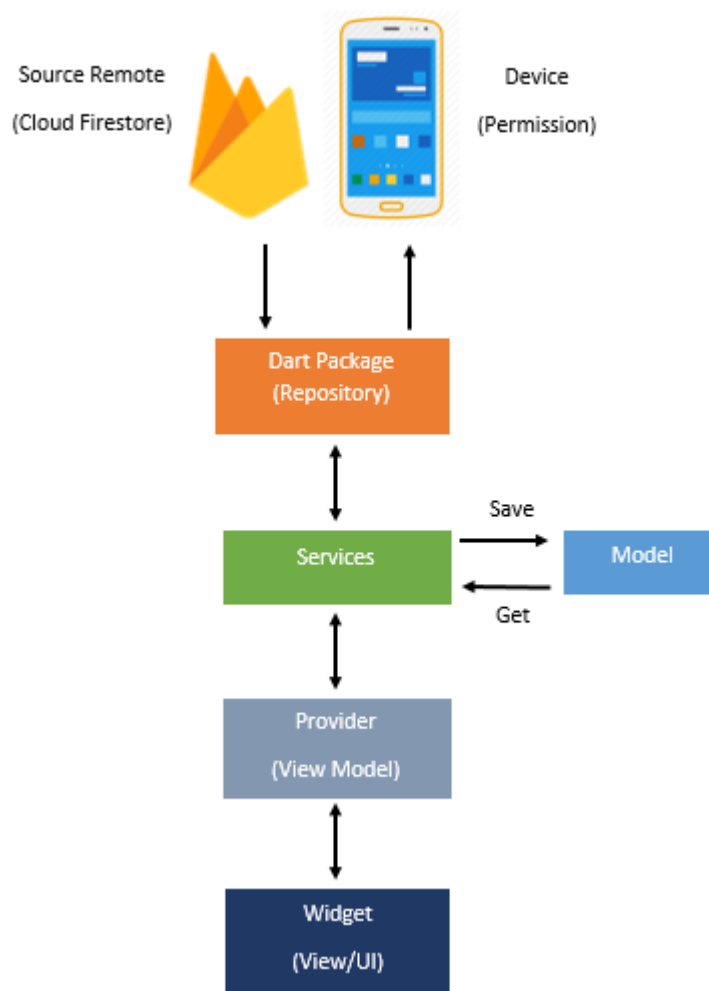
Figure 3.2.1.1 System Architecture Diagram

Figure xx is Flutter Provider Architecture which was applied to build this application. There is a widget named provider in the Flutter environment. Firstly, the Dart Package will make a request for the particular data from Cloud Firestore, and wait for it response. Besides, Dart Package will also ask for the permission for the device. After the Dart Package receives the response from the Cloud Firestore and permission, it will process it and send it to the services. Then, the services will pass the function to the provider, which will retrieve the raw data and plugin from the Dart Package. The model class will be able to save the raw data. the provider can provide the dependencies on which the widget or user interface page is dependent. The dependency injection was performed for each pair of the widgets and providers. As a result, the UI design on the UI page may be easily managed and updated.

3.3 Use Case Diagram
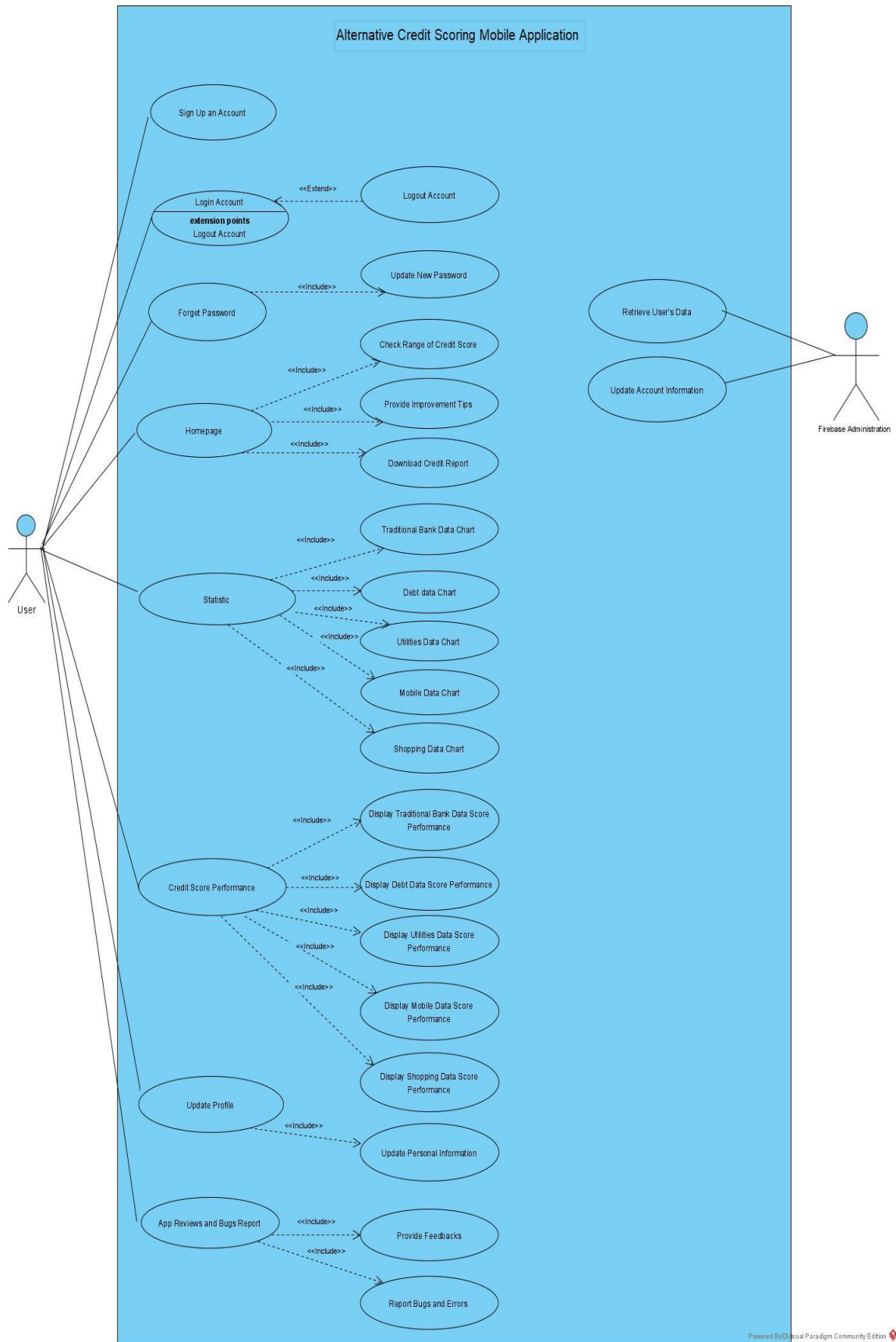
Figure 3.3.1 Use Case Diagram

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Use Case Description

3.3.1 Sign Up

Table 3.3.1.1 Use Case Description for Sign Up Account

Use Case Name: Sign Up	ID: 1	Importance Level: High
Actor: User	**Use Case Type:** Detail, Essential	
Stakeholders and Interests: Users want to sign up account in the system		
Brief Description: Process of the user sign up an account from the system.		
Trigger: User sign up an account in the system		
Relationship: Association: User Include: - Extend: - Generalization: -		
Normal Flow of Events: 1. Users fill in all the information correctly. 2. The users press the Sign Up Button 3. The information entered by the user will store to the Cloud Firestore. 4. If the user successfully creates an account, the system will direct to the login page.		
SubFlows: -		
Alternate/Exceptional Flows: If the users click Login button 1a The input details are valid, system will prompt to login and sign up page to allow user to login to their account. 1b. The input details are invalid; user needs to fill up the form again.		

3.3.2 Login

Table 3.3.2.1 Use Case Description for Login Account

Use Case Name: Login	ID: 2	Importance Level: High
Actor: User	Use Case Type: Detail, Essential	
Stakeholders and Interests: User wants to login their account in the system		
Brief Description: Process of the user login to their account in the system.		
Trigger: User sign in and starts the application		
Relationship: Association: User Include: - Extend: - Logout Account Generalization: -		
Normal Flow of Events: 1. User inputs valid email address and password. 2. User presses Login button. 3. System check the validity of entered email address and password. 4. The system will direct go to user's homepage.		
SubFlows: - 1. User inputs invalid email address and password. 2. User presses Login button. 3. System check the validity of entered email address and password. 4. System will display the errors message to the user.		
Alternate/Exceptional Flows: -		

3.3.3 Logout

Table 3.3.3.1 Use Case Description for Logout Account

Use Case Name: Logout	ID: 3	Importance Level: High
Actor: User	Use Case Type: Detail, Essential	
Stakeholders and Interests: User wants to logout their account in the system		
Brief Description: This use case describes the process of the user logout from the system.		
Trigger: User presses Logout button		
Relationship: Association: User Include: - Extend: - Generalization: -		

Normal Flow of Events:
     1. User presses the Logout button
     2. The system will logout the user from the application
     3. The system redirect to the Login Page		

SubFlows: -		
Alternate/Exceptional Flows: -		

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3.3.4 Reset Password

Table 3.3.4.1 Use Case Description for Reset Password

Use Case Name: Reset Password	ID: 4	Importance Level: High
Actor: User	**Use Case Type:** Detail, Essential	
Stakeholders and Interests: User forget the previous password and wants to reset their new password in the system		
Brief Description: This use case describes the process of the user forget their previous password and wants to reset their new passwords in the system.		
Trigger: User reset their new passwords in the system		
Relationship: Association: User Include: - Update new password Extend: - Generalization: -		

Normal Flow of Events:
 	
    1.   User presses "Forget Password"
    2.   A forgot password page will display to user, the users need enter the email address.
    3.   After the user enters the email address, the system will send the verification code to the user's email.
    4.   After the user enters verification code, the reset password page will let the users key in the new password.
    5. User enters their new password and login to the system.		

SubFlows: -		
Alternate/Exceptional Flows: -		

3.3.5 Home Page

Table 3.3.5.1 Use Case Description for Homepage

Use Case Name: Home Page	ID: 5	Importance Level: High
Actor: User	**Use Case Type:** Detail, Essential	
Stakeholders and Interests: User can check their alternative credit scores, views the tips to improve the alternative credit score, and downloads credit report in the system		
Brief Description: This use case describes the process of the user check their alternative credit scores, views the tips to improve the alternative credit score, and downloads credit report in the system		
Trigger: User check their alternative credit scores, views the tips to improve the alternative credit score, and downloads credit report in the system		
Relationship: Association: User Include: 1. Check range of credit score 2. Provide improvement tips 3. Download credit report Extend: - Generalization: -		

Normal Flow of Events:
    1.   System will retrieve the user's personal information and data, and show the total of the credit score of the user.
    2.   User can check their credit score by using the range of credit score.
    3.   The system will provide improvement tips to the user according their credit score range.
    4. User can download their credit score report.		

SubFlows: -		
Alternate/Exceptional Flows: -		

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3.3.6 Statistic Chart

Table 3.3.6.1 Use Case Description for Statistic

Use Case Name: Statistic Chart	ID: 6	Importance Level: High
Actor: User	**Use Case Type:** Detail, Essential	
Stakeholders and Interests: User wants to view their overall alternative data scores chart in current month in the system		
Brief Description: Process of the user can view their overall alternative data scores chart in current month in the system		
Trigger: User can view their overall alternative data scores graph in current month in the system		
Relationship: Association: User Include: 1. Traditional Bank Data Chart 2. Debt data Chart 3. Utilities Data Chart 4. Mobile Data Chart 5. Shopping Data Chart Extend: - Generalization: -		
Normal Flow of Events: 1. System will show the chart of overall alternative data scores. 2. User can view the chart of traditional bank data scores in the system. 3. User can view the chart of debt data scores in the system. 4. User can view the chart of utilities data scores in the system. 5. User can view the chart of mobile data scores in the system. 6. User can view the chart of shopping data scores in the system.		
SubFlows: -		
Alternate/Exceptional Flows: -		

3.3.7 Credit Score Performance

Table 3.3.7.1 Use Case Description for Credit Score Performance

Use Case Name: Credit Score Performance	ID: 7	Importance Level: High
Actor: User	Use Case Type: Detail, Essential	

Stakeholders and Interests:
User wants to check their the percentage of alternative data categories in the system
Brief Description: Process of the user wants to check their the percentage of alternative data categories in the system
Trigger: User check their the percentage of alternative data categories in the system
Relationship: Association: User Include: 1. Display Traditional Bank Data Score Performance 2. Display Debt Data Score Performance 3. Display Utilities Data Score Performance 4. Display Mobile Data Score Performance 5. Display Shopping Data Score Performance Extend: - Generalization: -

Normal Flow of Events:
 	
  1. System display the information that chosen by the user.
 	
  2. When user clicks on the "Traditional Bank"
 	
  3. System will display the traditional bank categories to the user.
 	
  4. Users can view the traditional bank performance percentage for the current month
 	
  5. When user clicks on the "Debt"
 	
  6. System will display the debt categories to the user.
 	
  7. Users can view the debt performance percentage for the current month
 	
  8. When user clicks on the "Utilities"
 	
  9. System will display the utilities categories to the user.
 	
  10. Users can view the utilities performance percentage for the current month
 	
  11. When user clicks on the "Mobile"
 	
  12. System will display the mobile data categories to the user.
 	
  13. Users can view the mobile data performance percentage for the current month

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14. When user clicks on the "Shopping"
15. System will display the shopping data categories to the user.
16. Users can view the shopping data performance percentage for the current month

SubFlows: -

Alternate/Exceptional Flows: -

3.3.8 Update Profile

Table 3.3.8.1 Use Case Description for Update Profile

Use Case Name: Update Profile	ID: 8	Importance Level: High
Actor: User	**Use Case Type:** Detail, Essential	
Stakeholders and Interests: User wants to sign up account in the system		
Brief Description: Process of the user updates their personal information in the system		
Trigger: User updates their personal information in the system		
Relationship: Association: User Include: - Update personal information Extend: - Generalization: -		

Normal Flow of Events:
    1. User updates the personal information in Profile page
    2. The user presses Update button
    3. The information entered by the user will store to Firebase Cloud Firestore.
    4. The system will display the updated personal information		

SubFlows: -		
Alternate/Exceptional Flows: -		

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3.3.9 App Reviews and Bugs Report

Table 3.3.9.1 Use Case Description for App Reviews and Bugs Report

Use Case Name: App Reviews and Bugs Report	ID: 9	Importance Level: High
Actor: User	Use Case Type: Detail, Essential	
Stakeholders and Interests: User wants to review the application and report the bugs		
Brief Description: Process of the user gives feedback application and reports errors in the system		
Trigger: User reviews application and reports errors in the system		
Relationship: Association: User Include: 1. Provide feedbacks 2. Report bugs and errors Extend: - Generalization: -		
Normal Flow of Events: 1. The user presses App Review button 2. System redirects to App Review Google form 3. User can give the feedbacks in Google form 4. The user presses Error and Bugs Report button 5. System redirects to Error and Bugs Report Google form 6. User can report the error and bugs in Google form		
SubFlows: -		
Alternate/Exceptional Flows: -		

3.4 Activity Diagram

3.4.1 Sign in
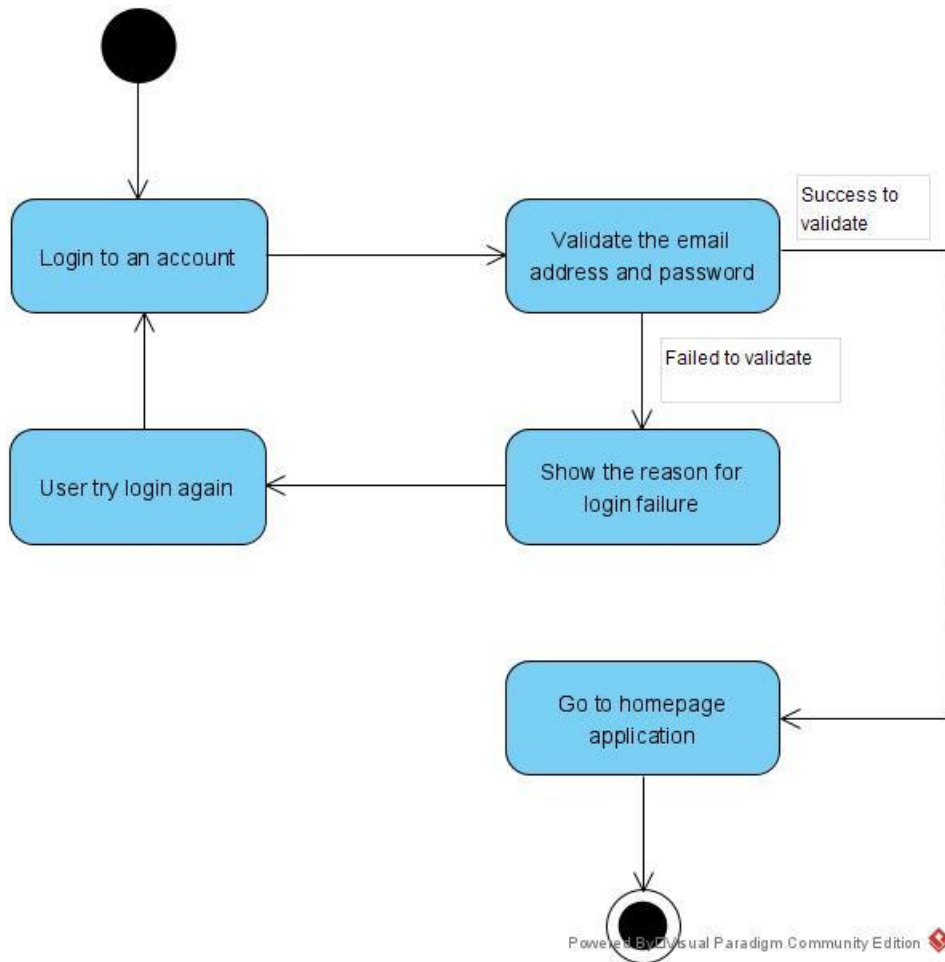
Figure 3.4.1.1 Activity Diagram for Login

When the user first time enter the application, the application will show the login and sign up page for the user. After user choose to login to an account, and need to enter their email address and password to login, the system will validate their identity. If user enter the wrong input, the system will show the reason for login failure. If the user enters the correct email address and password, the system will prompt to home page of the application.

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3.4.2 Sign Up
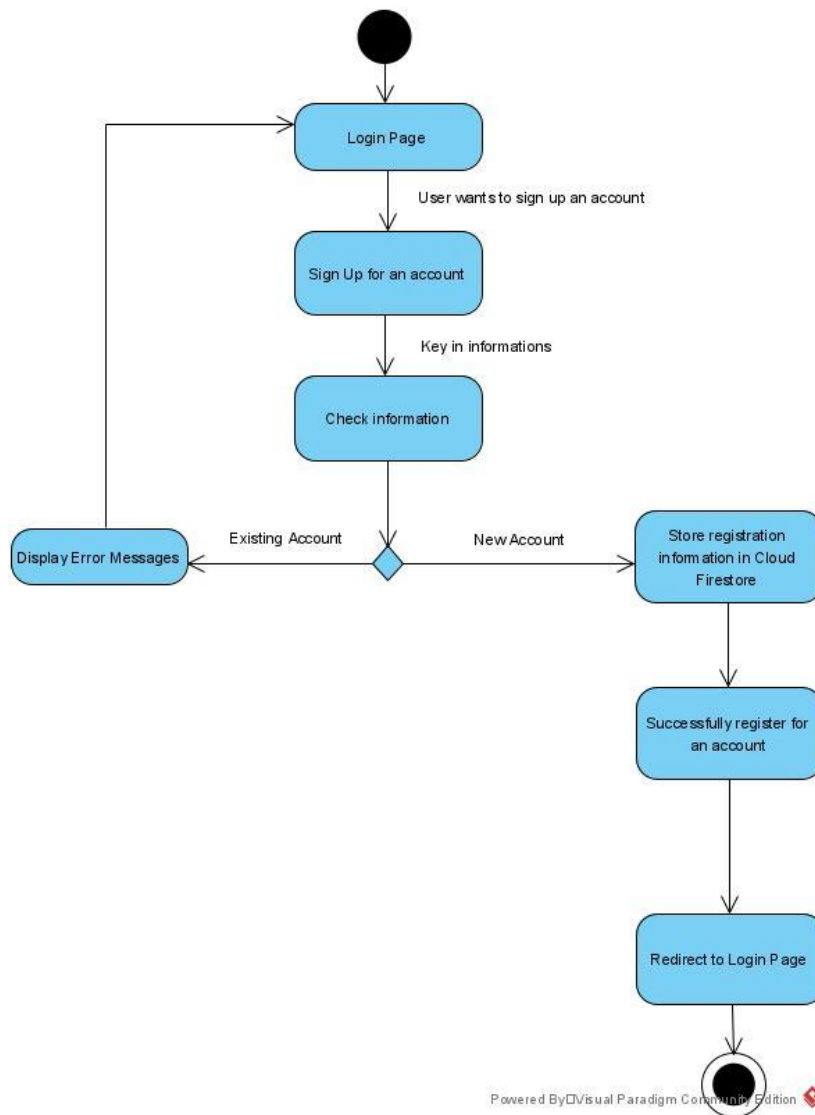
Figure 3.4.2.1 Activity diagram for Sign Up

When user sign up for an account, user need to key in their information correctly such as name, email, password and other details to verify their identity. If the email exists in the database, the system will display the error message. If the email is new to the database, then user can successfully sign up for an account. After successful sign up for an account, the system will store the information of the user in the Firebase Cloud System. Then, the user will be redirected to the Login page.

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3.4.3 Logout
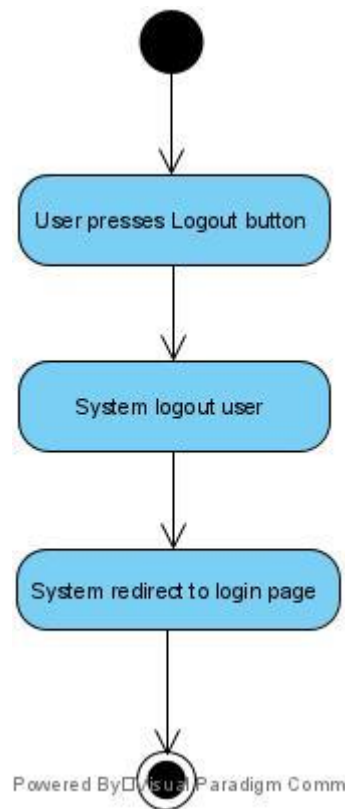
Figure 3.4.3.1 Activity diagram for Logout

When the user presses the Logout button and logout, the system will logout the user and will redirect to the Login page.

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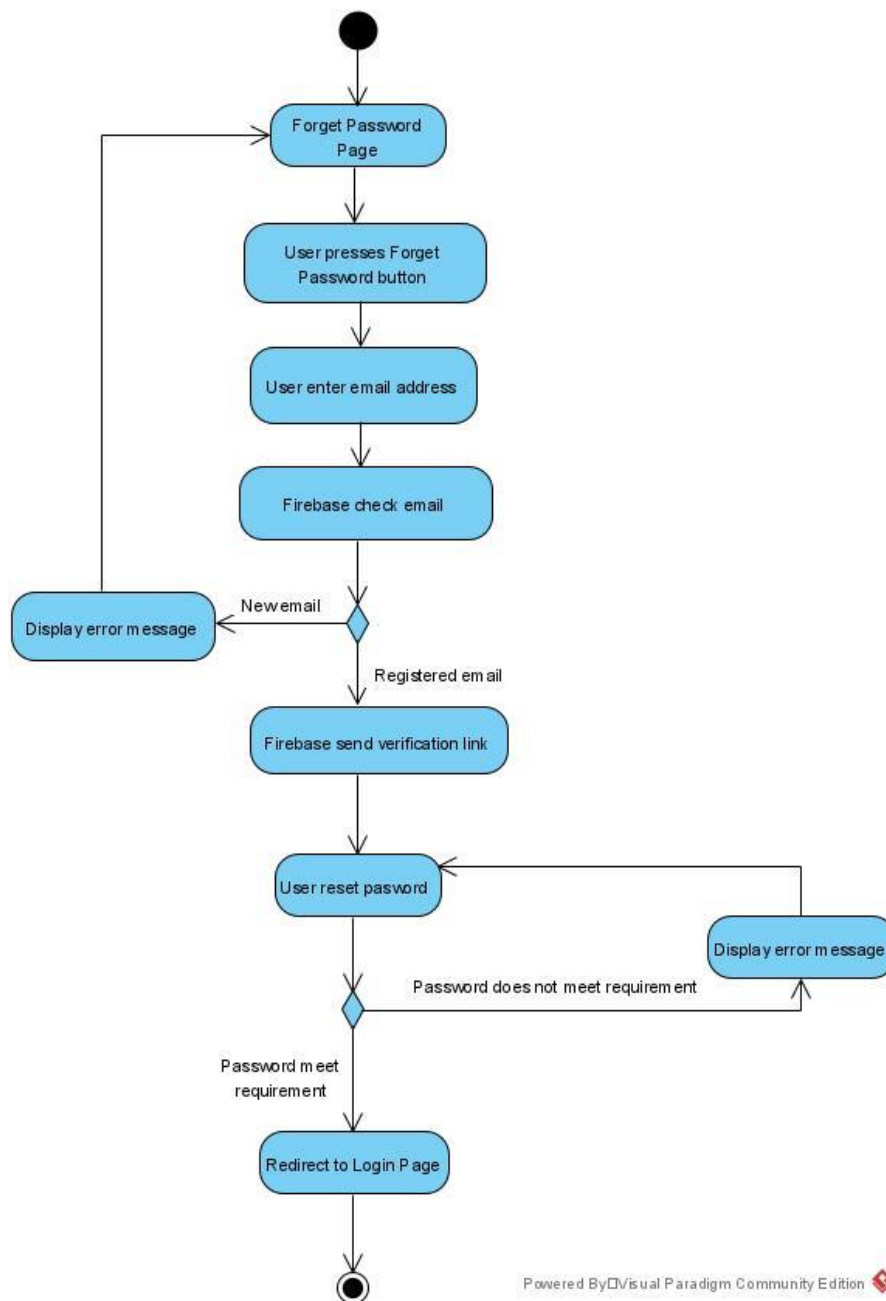
3.4.4 Reset Password

Figure 3.4.4.1 Activity diagram for Reset Password

The user can press on Reset Password button in the Login page if they forget the password. System will navigate the user to Reset Password page. Then, user needs to enter their email to get the email verification link from the Firebase. If the email is registered email, then the system will send the verification link. If the email is new to the Firebase, then the system will display error message. Next, user can click on the verification link to reset the password. If the password is meet requirement, then user

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successfully reset their password. If the password does not meet requirement, then the system will display error message.

3.4.5 Home Page
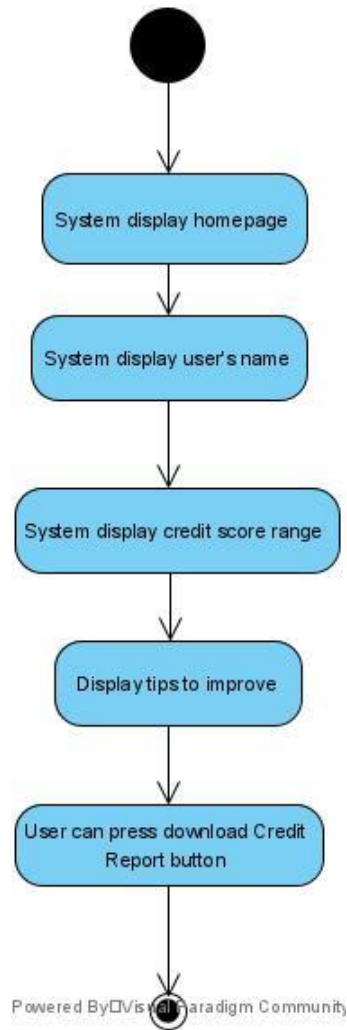
Figure 3.4.5.1 Activity diagram for Home Page

After login, the system will redirect user to the Homepage. The system will display the credit score range of the user and user can view their score range. The system will also display the improvement tips follow the range of credit score to let the user understand and what they need to improve to get a higher credit score. In addition, user can download their alternative credit score report which the report is in PDF format.

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3.4.6 Statistic Chart
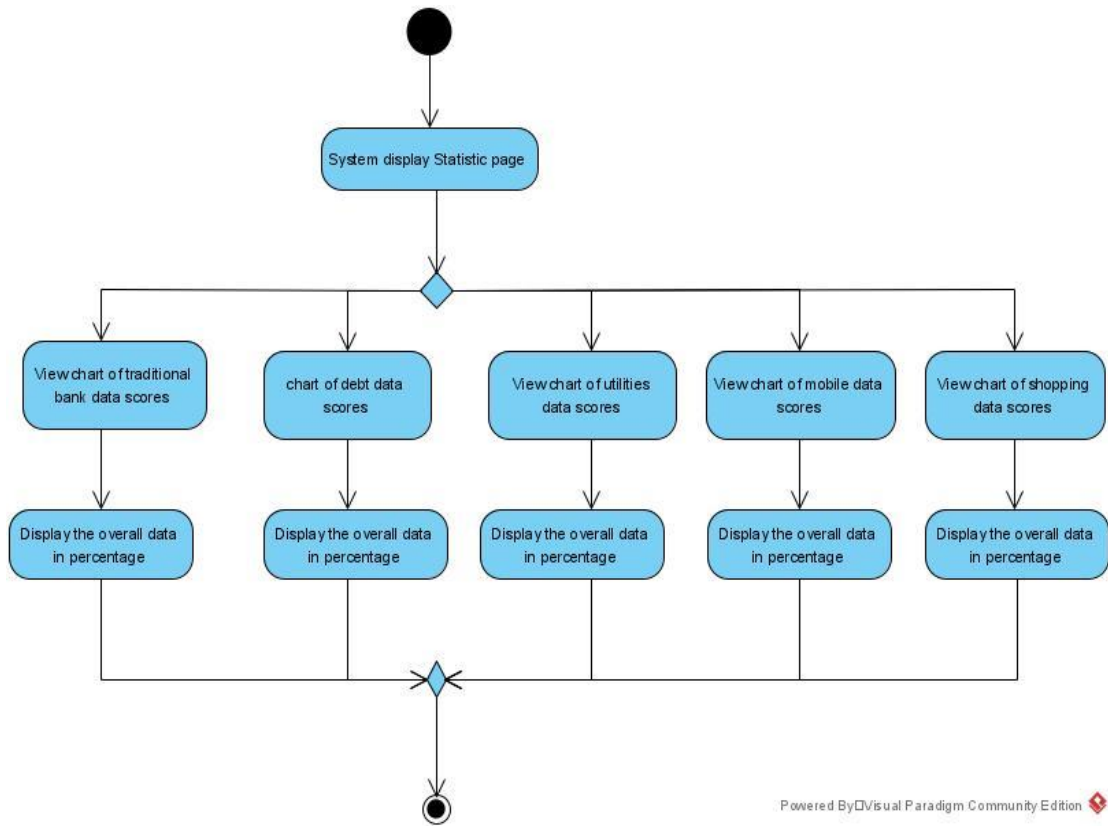
Figure 3.4.6.1 Activity diagram for Statistic

When user presses Statistic logo, the system will redirect user to Statistic page. User can click on what categories data to have a look of the statistic, for example Traditional Bank Data, the system will display the overall score and graph. For instance, user can have a better understand view of what their data overall score looks like in different categories such as Bank, Debt, Utilities, Mobile, and Shopping data.

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3.4.7 Credit Score Performance
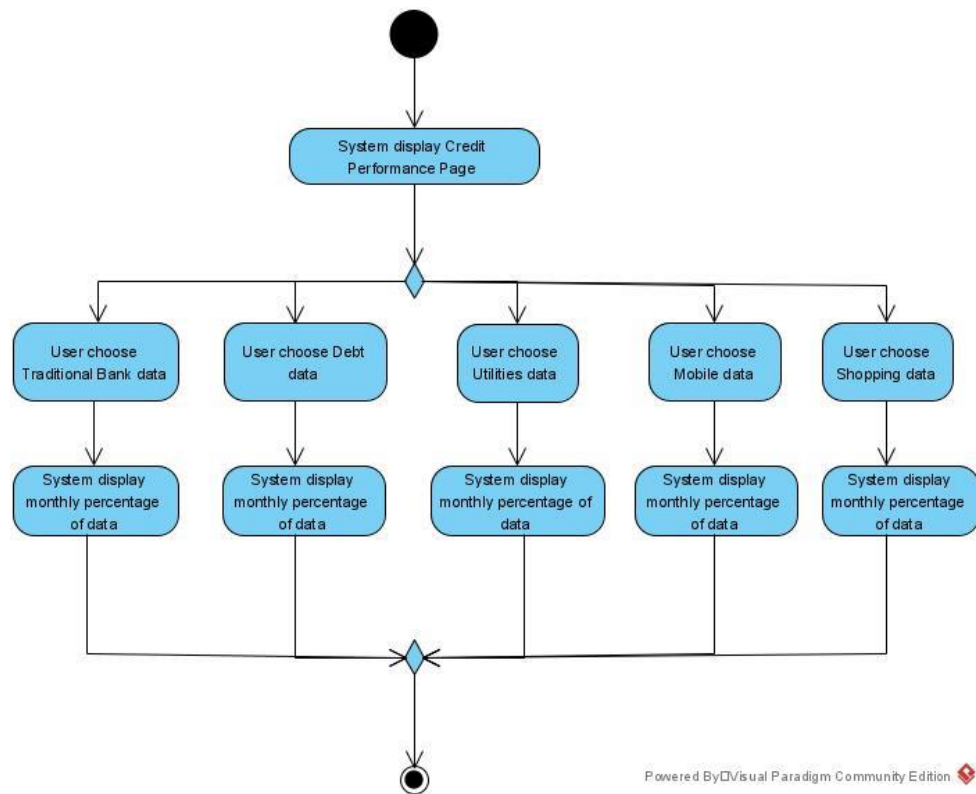
Figure 3.4.7.1 Activity diagram for Credit Score Performance

When user presses credit score performance logo, the system will display different types of categories, such as Traditional Bank data, Debt data, Utilities data, Mobile data, and Shopping data. When the user clicks one of the categories, the system will display the particular information to the user. User can view the details of data categories in a month.

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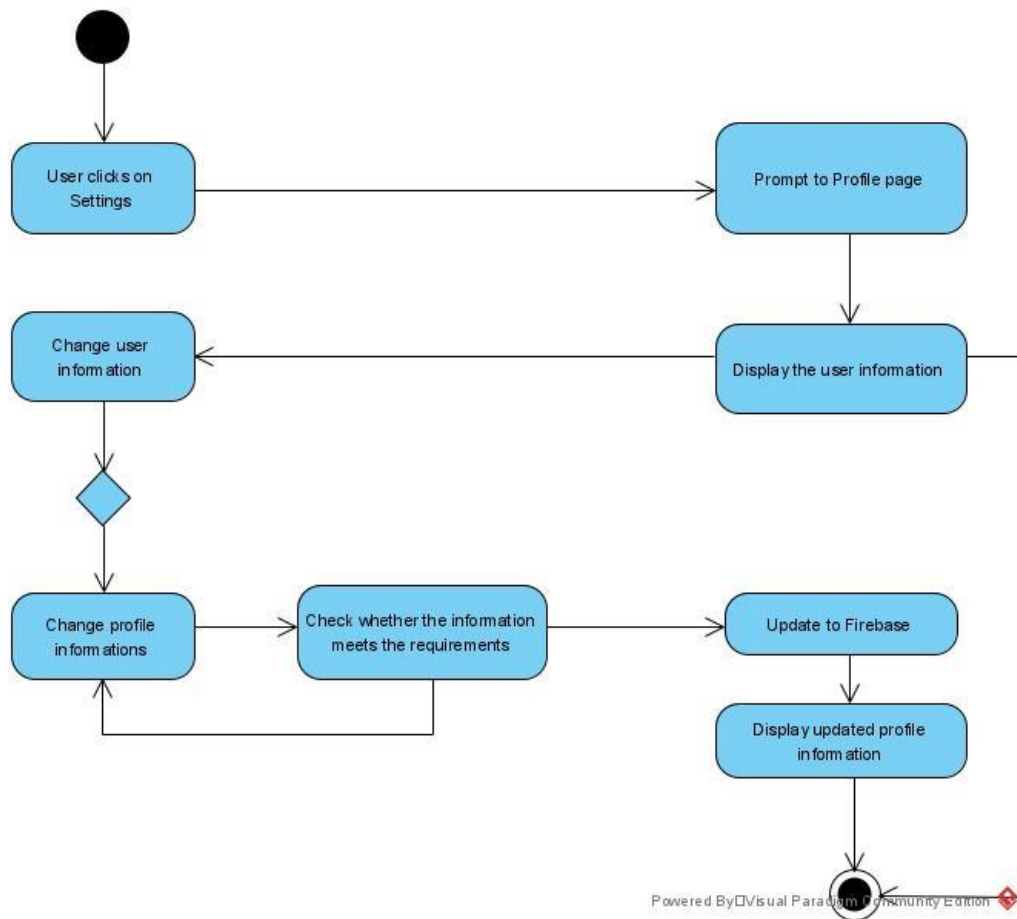
3.4.8 Update Profile

Figure 3.4.8.1 Activity diagram for Update Profile

When user clicks on Profile in Setting page, the system will display the user's information, and users can choose to change and update their personal information. If the users choose to change their profile information and click the "Update" button, the system will check whether the information meets the requirements, and the information will be updated to the Cloud Firestore Database.

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3.4.9 App Reviews and Bugs Report
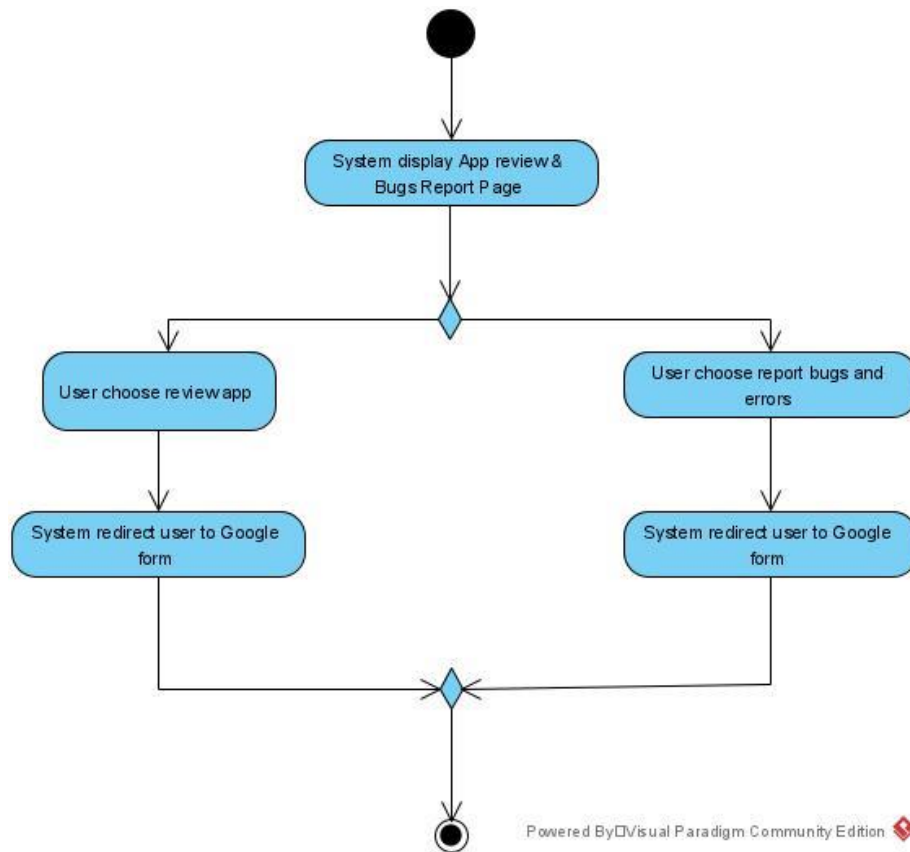
Figure 3.4.9.1 Activity diagram for App Reviews and Bugs Report

User can review the app and report bugs in Setting page. If user choose to review app, then the system will redirect the user to Google form to give feedbacks. If user choose to report bugs and errors, the system will redirect the user to Google form to report the issues.

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CHAPTER 4: SYSTEM DESIGN

4.1 System Block Diagram
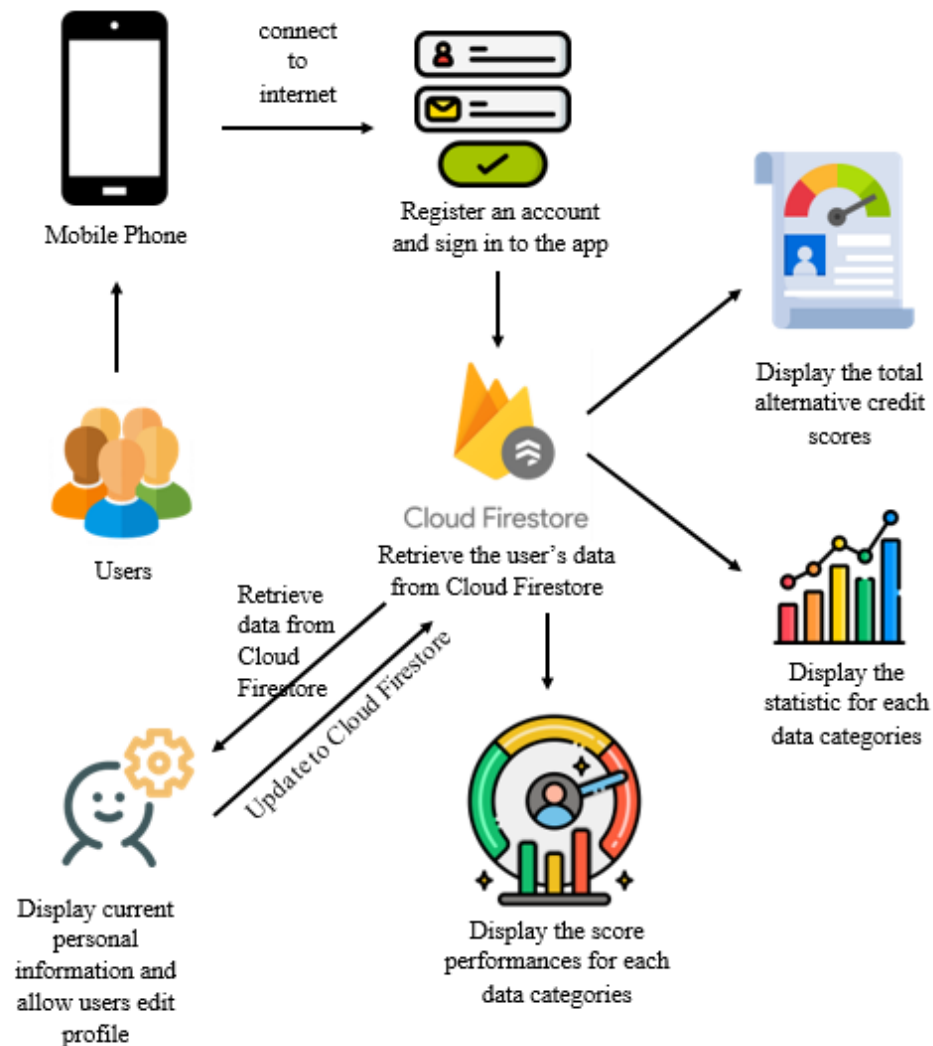
Figure 4.1.1 System Block Diagram

First, users need to register an account to sign in to the app. After sign in, the Cloud Firestore will retrieve the user's data and information and will display to the user. Next, users able to view the range of alternative credit score and also improvement tips, also able to download the credit report. The user's alternative credit score is calculated by using formula, and user's data from database is fit into the equations. Then, the app will display the chart for all the data categories. All the percentage is calculate using equation which also implement in the code. Users able to choose to view the chart for each of the data categories such as debt data. In performance page, users can view the score performance for each of the data categories. For example, the app will display the

overall percentage of debt data categories, and details for the debt data such as car loan and student loan. In settings page, users able to update their personal details such as email address and password. Besides that, the app permission page is to display to the users and let them know this app has access to storage, media and so on. For the app reviews and bugs report page, users can fill in the review form to provide the feedback and experiences. Moreover, users can also fill in the report form to report the bugs and error while using this app.

4.2 System Overview
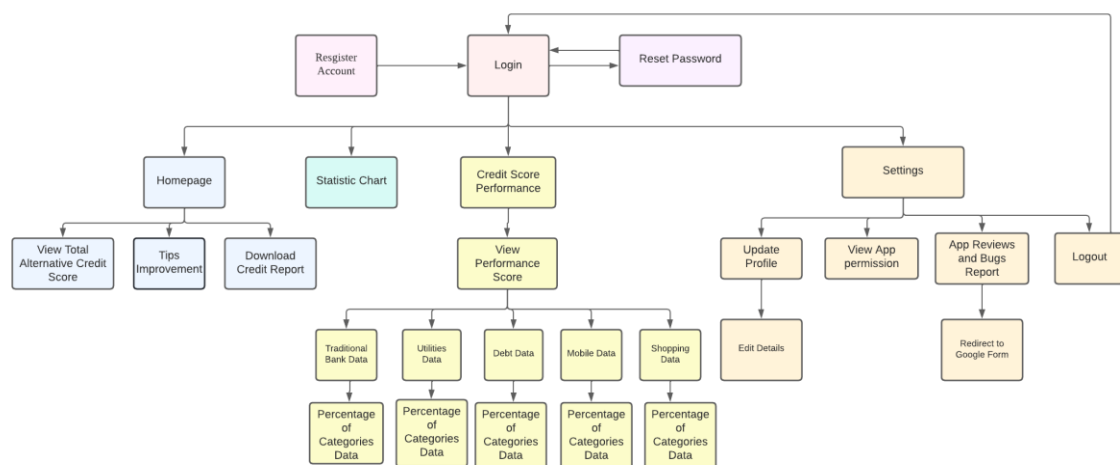
Figure 4.2.1 System Flowchart

Figure 3.1 is the system flowchart of the application in this project. First, the user needs to register an account to use this application. If a registered user forgets their password and is unable to login, they can click the forget password button to reset their password, and login using the new password. After login, the user will prompt to the home page. The home page will display the total alternative credit scores of the user, the tips to improve the user's credit score, and the user also can download their credit report. Next is the Statistic Chart page. The user can view the overall percentage of the alternative credit score such as a traditional bank, utilities, debt, mobile, and shopping. For the score performance page, the user can view more details of the alternative credit score data categories. For example, after the user clicks on utility data, the system will display the detailed percentage in the utility data such as their car loan, house loan and so on. Last but not least, there are 4 modules on the setting page. If the user wants to edit their

personal information, they can click on Update Profile. The user can view the App permission such as what data and information will be collected for this application. The user can give feedback on the reviews of the app or report the errors and bugs page. The system will redirect the user to Google form to do the reviews or report issues found. When the user logout from the system, the system will redirect the user to the Login Page.

CHAPTER 5: SYSTEM IMPLEMENTATION

5.1 System Methodology

The proposed methodology used in this project to develop the alternative credit scoring system mobile application is the Agile Methodology. Agile methodology is a process that encourages to continual development and test throughout the project's software development lifecycle. Agile is a software development methodology that is sequential and iterative. During the software development lifecycle, agile application development helps to organise processes for designing and planning, analysis, development, and testing [13]. In Agile, each cycle is referred to as a sprint because it resembles running over a short distance. Is can test and check the functionality to determine whether it works properly and adapting to new needs. The goal of the agile development methodology is to minimize the time required to deploy operational software systems. Moreover, by allowing iterations and modifications, Agile methodology helps to reduce the amount of common mistakes or errors.
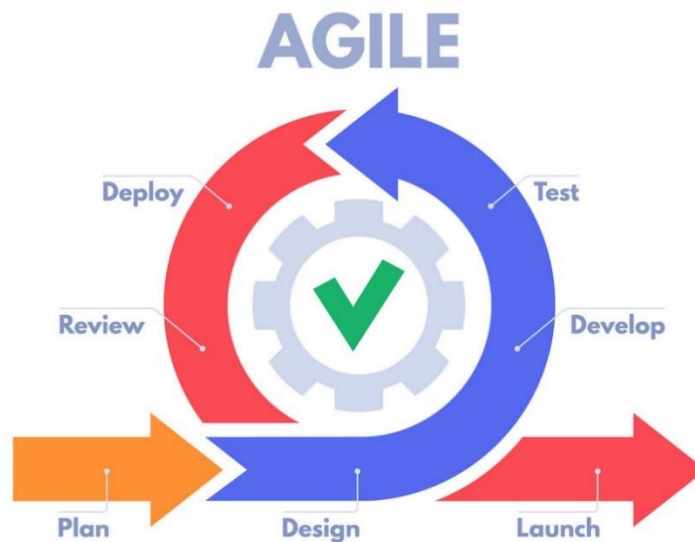
Figure 5.1.1 Agile development Methodology

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Planning

First of all, the idea of implementing alternative credit scoring system was suggested by supervisor. After read some study and articles about alternative credit scoring system in Fintech field and found out it was an interesting topic. Then, the project idea was proposed to supervisor, and begin the discussion. The introduction, project objectives, problem statements and project scope of the system were identified based on the study and articles that had done proceeding before.

Analysis

All the information related to the alternative credit scoring is collected from internet resource to understand what is the problem and expectation of public. Next, the literature review is done to review and understand the functions, strengths, and weaknesses of the existing similar system. Apart from that, after reviewing existing similar systems, the features, components, and technological tools were enabled to be defined.

Design

The phase of building a prototype is an actual and simple prototype that will be designed based on the information gathered from the literature review and studied to reach the requirement. Then, the system diagram such as block diagram, use-case diagrams, and activity diagrams was designed to identify the features and functionalities of the application. Other than that, the equation to calculate an individual alternative credit scoring is design in this phase.

Implementation

 In this phase, all the fundamental design of the application will be converted into the source code, and this phase also known as the coding phase. The development tools will be used in this phase such as Visual Studio Code for Android application development, Flutter SDK, and Firebase for manage the data on the cloud. All of the functionality, features, algorithm and application interface that were built and designed throughout the design phase will be followed by the code implementation. The system is tested before delivered to the users. The system will be maintaining in the routine time to reduce the downtime and prevent the large-scale failures to have a better improvement of the application system.

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5.2 Project Timeline

Activity	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
CHAPTER 1: INTRODUCTION														
1.1 Problem Statement and Motivation	▓	▓												
1.2 Project Objectives	▓	▓												
1.3 Project Scope	▓	▓												
1.4 Impact, Significance and Contribution	▓	▓												
1.5 Report Organization	▓	▓												
CHAPTER 2: LITERATURE REVIEW														
2.2. Review of the Existing Systems/ Applications		▓												
CHAPTER 3: SYSTEM METHOD/ APPROACH														
3.1 System Design Diagram/Equation			▓	▓	▓	▓	▓	▓	▓	▓	▓			
3.2 System Architecture Diagram														
3.3 Use Case Diagram														
3.4 Activity Diagram			▓	▓										
CHAPTER 4: SYSTEM DESIGN														
4.1 System Block Diagram				▓										
4.2 System Components Specifications				▓	▓									
CHAPTER 5: SYSTEM IMPLEMENTATION														
5.1 System Methodology						▓								
5.2 Project Timeline						▓								
5.3 Technologies and Tools Involved								▓	▓	▓	▓	▓		
5.4. Hardware Setup														
5.5 Software Setup														
5.6 Implementation Issues and Challenges						▓	▓							
5.7 System Testing								▓	▓	▓	▓	▓		
5.8 System Operation														
CHAPTER 6: SYSTEM EVALUATION AND DISCUSSION														
6.1 Project Challenges												▓	▓	
6.2 Objectives Evaluation												▓	▓	
CHAPTER 7: CONCLUSION AND RECOMMENDATION														
7.1 Conclusion													▓	
7.2 Future Work													▓	

Figure 5.2.1 Gantt Chart I

Title	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
Planning														
Define Problem Statement and Motivation	▓	▓												
Define Project Objectives	▓	▓												
Define Project Scope	▓	▓												
Define Impact, Significance and Contribution	▓	▓												
Analysis														
Review existing system		▓												
Existing system comparison		▓												
Design														
Design system design equation			▓	▓	▓	▓	▓	▓	▓	▓	▓			
Design system architecture diagram			▓	▓										
Design use case diagram			▓	▓										
Design activity diagram			▓	▓										
Design user interface										▓				
Implementation														
Develop user interface					▓	▓	▓	▓	▓	▓	▓	▓		
implement Cloud Firestore					▓	▓	▓	▓	▓	▓	▓	▓		
Develop functions					▓	▓	▓	▓	▓	▓	▓	▓		
Testing														
Verification and testing					▓	▓	▓	▓	▓	▓	▓	▓		
Usability testing					▓	▓	▓	▓	▓	▓	▓	▓		
Fix errors				▓	▓	▓	▓	▓	▓	▓	▓	▓		
Deliver the final product													▓	
Complete Report													▓	

Figure 5.2.2 Gantt Chart II

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5.3 Technologies and Tools Involved

5.3.1 Hardware

Table 5.3.1.1 Specification of laptop

Description	Specifications
Model	Asus X441U series
Processor	Intel(R) Core(TM) i3-6006U CPU @ 2.00GHz 1.99 GHz
Operating System	Windows 10
System Type	64-bit operating system, x64-based processor
Installed RAM	12.0 GB
Storage	223 GB

5.3.2 Software

Visual Studio Code

The alternative credit score mobile application is developed by using Visual Studio Code. It supports macOS, Linux, and Windows operating system. There are some of the features which made it become one of the popular development tools. When VS Code will automatically detect the programming language that will be used and which features that should utilise when download and install it. The developer can explore or search for coding problems to discover and fix them. The extension option allows for major modification, while source control allows for use of the Git repository.

Besides that, VS Code is a fast source code editor. For example, the box-selection, auto-detection, syntax highlighting, and more are available in VS Code. The developer can navigate the code simply with simple modification, intuitive keyboard shortcuts, and community-contributed keyboard shortcut mappings. Other than that, VS Code's Intelli-Sense can identify whether any code snippets are missing. Function parameter, variable declarations and standard variable syntaxes are also automatically generated. For example, if a variable is utilised in a programme but the developer forgets to declare it, intelli-sense will display it to the developer. It can also detect code error and make recommendations for how to solve them. Moreover, VS Code having thousands of extensions in the VS Code marketplace. Developers can download and use an extension if they want to use a programming language or UI (User Interface) themes.

Flutter

Developer can create a Flutter project in VS Code. The alternative credit score mobile application is developed by using **Flutter**. The reason to choose Flutter because it is a cross-platform software development framework, and it is quickly becoming one of the most popular application development platforms that were initially introduced by Google in 2017. Flutter has provided the capabilities and possibilities not only for Android and iOS mobile development, but also for web and desktop applications. Flutter can develop in mobile, web, and desktop applications, and it will assist in simultaneously developing an application for six different platforms which are iOS, Android, Windows, Linux, macOS, and the web. Developers can create cross-platform applications seamlessly because it provides many features and productive UI framework. Flutter is also a user interface toolkit that includes widgets and tools. Developers can use a platform to quickly design and develop natively built, appealing applications for a variety of platforms.

First advantage is hot reloading. Flutter's Hot Reload functionality is a useful addition to the app architecture since it allows developers to see real-time outcomes on the screen. They benefit from faster code reloading using Flutter. For example, when working with other programming languages, developers should need to wait a long time for any coding-related changes to be reflected on the screen. As a result, developers can add the features and solve the bugs or errors without worrying about running out of memory. Next is widget library. Flutter comes with a large number of build-in widget, and widgets are Google-based which means they have higher code quality and better performance than other open-source frameworks.

Apart from that, Flutter can access to native functionality and minimal code. Flutter allows developers to use Dart, which is compiled straight into the ARM (Advanced Risk Machines) code of mobile devices and helps application not only run faster but also launch faster. Flutter's third-party connectors and native codebase make life easier for developers. Flutter allows developers to use native functionality, which enables the developer to create and develop applications with the customized designs on both iOS and Android devices. It is comparable to a native application in terms of performance. Besides, it also fast and easy to develop an application a variety of platforms. Dart language is an object-oriented programming language that is easy to create and design into the native code. In addition, Flutter is a Google open-source

programming toolkit. It allows developers to ask questions and have access to a variety of resources through open development forums. Developers can learn a lot of new skills with Flutter and grow with the platform's ever-changing developer community. It improves the efficiency and productivity of coders in terms of project cost and time [9].

Android

The alternative credit score mobile application is used Android operating system. The Android version used as emulator to develop and test the applications is Android 8.0. Android was developed in collaboration with the Open Handset Alliance, which was led by Google. Android also has a unified approach to mobile app development, which means that developers just need to build for Android, and their apps should work on a range of Android devices. It is easy to learn for developers. Android is easier for mobile app development services than any other platform. Android is written in Java, which is a programming language that most programmers are familiar with [15]. An android emulator is designed exclusively for Android applications developed by developers. Emulators are used by developers to test the functionality of their apps. Emulators for Android work in the same way as real Android devices do. It is for this reason that developers utilise it, since it allows them to deploy the software they have created. They won't need to install the app on an actual device for this, making it simple to test its functionality [8]. Apart from that, it is easy to integrate. The Android platform is unrivalled when it comes to advanced technical modification or integrating an existing app. Because the platform is totally customizable, Android app developers may seamlessly integrate and change mobile apps to match the demands of their business. Many developers feel that Android is the best mobile platform, from application to processing architecture, because of its open-ended flexibility for integration. Moreover, Android is an open source platform to the developer. This offers royalty-free licence and the most up-to-date technical framework accessible. Because Android's Software Development Kit (SDK) is open-source, developers can keep up with the newest advancements in Android mobile app development. In addition, the open-source nature of the Android platform's features also makes it simple for app developers to update and improve their apps. The developer may improve the app after it has been released on the Google Play store or any other Android mobile app marketplace by listening to customer feedback and reviews.

Cloud Firestore

The alternative credit score mobile application is using **Cloud Firestore** to store the data information. Cloud Firestore is a scalable, flexible database for mobile, server, and web development. It makes use of real-time listeners to keep data synchronised across various client apps, as well as offline compatibility for mobile and web. Therefore, developer is allowing to design responsive apps that operate independent of network delay or Internet availability [7].

In Firestore, the data that stored as documents which are logically organized into collections. The collections are used to organize the data and create the queries. Multiple file types, strings, numbers, and nested objects are all supported by the Firestore document. Besides that, it can build hierarchical data structures that expand as the database develops by creating the sub-collections within documents. It is dependable and reliable and it integrates well with Firebase and the Google Cloud Platform. For example, the collections and documents is created in the Cloud Firestore database. The data field is under the collection and displayed the user's signup information.

There are many features and capabilities of using the Cloud Firestore. Firstly, it is **scalable architecture and serverless development**. Firestore is highly scalable because of its integration with Google Cloud. Developer can opt to scale the applications horizontally, and allowing them to scale on per-workload basis. As a result, vast and complicated data stores in documents and sub-collections may be efficiently maintained. For serverless functions, it makes programming tasks easier for programmers by eliminating the requirement to set up servers and manage data access. For example, prototyping, offline support, iteration, and sophisticated sync are all possible with Firebase and Google Cloud connectivity. Apart from that, Cloud Firestore can **real-time updates**. Data synchronisation is used by Cloud Firestore to keep data up to current on any connected device.

Dart

The alternative credit score mobile application is developed by using **Dart programming language**. Dart language is an object-oriented programming language that is platform-independent, open-source object-oriented programming language with a lot of useful features for software developers. Dart is optimised for the client

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development, and focusing on both developments which are high-quality production experiences and sub-second stateful hot reload across a wide range of compilation targets such as mobile, web, and desktop. Besides, Dart also helps developers to format, analyse, and test code.

The reason to use dart language to develop the project it is because Dart language is a type-safe programming language, which means that developers may use it for both runtime and static type checking to ensure that a variable's value always matches its static type [Dart overview]. Aside from that, Dart's typing system is very flexible, allowing for the usage of a dynamic type mixed with runtime checks, which can be beneficial for experimentation or for code that requires a lot of dynamic behaviour. Moreover, Dart provides the resiliency to build programmes at a rapidly speed. For mobile and desktop devices, it supports two types of compilation processes which are JIT (just-in-time) and AOT (Ahead of time) to produce the machine code. In addition, using Dart language can take a step toward improving the application performance. Dart applications run faster than those written in other programming languages. JIT and AOT are two elements of Dart that improve the language's performance. With JIT, developers can make use of the Hot Reload functionality, while AOT helps with programme start-up and execution.

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5.3.3 Algorithm
The Methods of Calculate the Credit Scores and Alternative Credit Scores

The data is referred from survey form and GitHub. Only the personal details were created randomly as we need to protect the other's privacy.

Personal Data

Email	PhoneNo	AccPassword	FullName	DOB	Age	Gender	HighestLevelEducation	Race	Religion	Married Status	Employed	Occupation	IncomePerMonth(RM)	IdentityNumber(I.C)	Bank	BankAccount	TimeOnJob
ateniese@live.com	017-839 3673	123456	Aamina	10/12/1999	23	Female	Diploma	Malay	Islam	No	No	Student	0	991210-12-5768	Maybank	3590834902	0
carroll@aol.com	010-565 1122	123456	Aaqifa	22/8/2000	22	Female	Diploma	Malay	Islam	No	No	Student	0	000822-01-0192	CIMB	9817897188	0
crandall@msn.com	013-389 3823	123456	Aarifa	28/7/1985	37	Female	SPM level	Malay	Islam	Yes	No	Housewife	0	850728-15-3756	Ambank	3458973489	3
s.chang1313@gmail.com	017-232 2302	123456	Chang Je See	13/11/2000	22	Female	Bachelor's Degrees	Chinese	Buddhism	No	No	Student	0	001113-01-0016	Public Bank	6457460910	0
wojciech@yahoo.com	018-373 2723	123456	Emily Ye	22/7/2000	22	Female	Bachelor's Degrees	Chinese	Christianity	No	No	Student	0	000722-10-5522	CIMB	4895729822	0
henkp@mac.com	018-002 3474	123456	Eza	10/7/2000	22	Female	Bachelor's Degrees	Malay	Islam	No	No	Student	0	000710-14-1008	CIMB	2590820225	0
kmself@yahoo.ca	016-293 1811	123456	Fatimah	26/5/2000	22	Female	Bachelor's Degrees	Malay	Islam	No	No	Student	0	000526-06-1338	CIMB	5902890255	0
zyghom@gmail.com	012-973 7150	123456	Jackson Chu	11/11/2003	19	Male	SPM level	Chinese	Buddhism	No	No	Student	0	031111-01-0017	Ambank	2897489456	0
staffelb@att.net	012-889 0098	123456	Luna See	16/1/1997	25	Female	Bachelor's Degrees	Chinese	Christianity	No	No	Student	0	970116-28-1034	CIMB	8259085233	0
haddawy@att.net	010-610 9399	123456	Navaratnam	24/8/2003	19	Male	SPM level	Indian	Christianity	No	No	Student	0	030824-02-4931	Ambank	8952038595	0
mrdvt@yahoo.com	014-182 3289	123456	Shaniya	3/9/2001	21	Female	Bachelor's Degrees	Indian	Hinduism	No	No	Student	0	010903-13-2846	Maybank	3658973968	0
speeves@verizon.net	014-2765251	123456	Tan Hao	9/7/2000	22	Male	Bachelor's Degrees	Chinese	Christianity	No	No	Student	0	000709-02-5463	Public Bank	8739478290	0
amimojo@me.com	016-383 2839	123456	Uma	18/5/2000	22	Female	Bachelor's Degrees	Indian	Hinduism	No	No	Student	0	000518-06-1032	Public Bank	1903890146	0
bjornk@msn.com	015-482 3754	123456	Vasudevan	23/8/2001	21	Male	Bachelor's Degrees	Indian	Hinduism	No	No	Student	0	010823-10-3833	Maybank	8957011094	0
smartfart@live.com	010-016 1559	123456	ctor Lew Ku Se	4/12/2004	18	Male	SPM level	Chinese	Buddhism	No	No	Student	0	041204-13-1907	Ambank	5908290214	0
kosact@outlook.com	018-039 2723	123456	Zoey Lai	7/4/2000	21	Female	Diploma	Chinese	Buddhism	No	No	Student	0	000407-04-2818	CIMB	3897289224	0
ryanvm@comcast.net	016-038 1733	123456	Saleha	8/2/2002	20	Female	Bachelor's Degrees	Malay	Islam	No	Yes	Student	500	020208-01-4568	Maybank	2350203294	1
alfred@yahoo.ca	019-273 2783	123456	Suraya	3/8/2001	21	Female	Bachelor's Degrees	Malay	Islam	No	Yes	Student	650	010803-02-1014	Public Bank	2589344462	1
chinthaka@gmail.com	012-060 9657	123456	Osman	4/9/1998	24	Male	Master's Degree	Malay	Islam	No	Yes	Student	900	980904-14-2927	Maybank	1987489144	1
bsikdar@gmail.com	012-364 2383	123456	Elizabeth Lim	27/3/2001	21	Female	SPM level	Chinese	Buddhism	No	Yes	Student	990	010327-05-1368	Ambank	2598792114	1
jorgb@optonline.net	016-272 2622	123456	Victoria Ng	22/11/1997	25	Female	Doctoral Degree	Chinese	Buddhism	No	Yes	Student	1000	971122-01-8726	Public Bank	2953729833	1
smeier@comcast.net	014-001 9234	123456	Ella Chang	18/6/2003	19	Female	SPM level	Chinese	Christianity	No	Yes	Student	1,200	030618-14-1046	Ambank	2582908258	1
josephw@comcast.net	018-509 2666	123456	Owen Ho	4/9/2002	20	Male	Diploma	Chinese	Buddhism	No	Yes	Student	1,200	020904-05-1947	Public Bank	2918374443	1

Figure 5.3.3.1 Personal Data Record

Personal information is any information that relates to a specific person and to identify a person. The personal information data field contains of the user's E-mail address, phone number, password, full name, date of birth, age, gender, highest level education, race, religion, married status, employed status, occupation, income per month (RM), Identity Number (I.C), bank, bank account, and time on job. An individual represents one row of the records. The number represent the relevant data to a particular individual.

Bank Data

FullName	IdentityNumber(I.C)	Age	Gender	HighestLevelEducation	Married Status	Employed	Occupation	PercentageOf AbilitytoPay	IncomePer Month	Deposits	Insurance	CreditDebitCards Transaction	NumDebit Cards	Investment	NumCredit Cards	Withdrawals
Aamina	991210-12-5768	23	Female	Diploma	No	No	Student	50	0	0	1	3	2	0	1	3
Aaqifa	000822-01-0192	22	Female	Diploma	No	No	Student	50	0	0	1	6	1	0	0	4
Aarifa	850728-15-3756	57	Female	SPM level	Yes	No	Housewife	50	0	2	1	7	1	0	1	4
Chang Je See	001113-01-0016	22	Female	Bachelor's Degrees	No	No	Student	55	0	0	1	5	1	0	1	2
Emily Ye	000722-10-5522	22	Female	Bachelor's Degrees	No	No	Student	50	0	1	1	6	1	0	1	2
Eza	000710-14-1008	22	Female	Bachelor's Degrees	No	No	Student	50	0	0	1	7	2	0	1	1
Fatimah	000526-06-1338	22	Female	Bachelor's Degrees	No	No	Student	50	0	0	1	6	1	1	1	2
Jackson Chu	031111-01-0017	19	Male	SPM level	No	No	Student	20	0	0	1	7	2	1	1	2
Luna See	970116-28-1034	25	Female	Bachelor's Degrees	No	No	Student	50	0	1	1	5	2	1	0	1
Navaratnam	030824-02-4931	19	Male	SPM level	No	No	Student	50	0	0	1	5	1	1	1	4
Shaniya	010903-13-2846	21	Female	Bachelor's Degrees	No	No	Student	50	0	0	1	3	2	0	1	1
Tan Hao	000709-02-5463	22	Male	Bachelor's Degrees	No	No	Student	55	0	0	1	4	2	1	1	3
Uma	000518-06-1032	22	Female	Bachelor's Degrees	No	No	Student	50	0	0	1	3	2	0	1	2
Vasudevan	010823-10-3833	21	Male	Bachelor's Degrees	No	No	Student	50	0	0	1	1	3	1	0	2
ctor Lew Ku Se	041204-13-1907	18	Male	SPM level	No	No	Student	40	0	0	1	2	2	0	1	1
Zoey Lai	000407-04-2818	21	Female	Diploma	No	No	Student	50	0	0	1	3	2	0	1	2
Saleha	020208-01-4568	20	Female	Bachelor's Degrees	No	Yes	Student	70	500	0	1	2	1	0	0	0
Suraya	010803-02-1014	21	Female	Bachelor's Degrees	No	Yes	Student	65	650	1	1	5	2	0	1	4
Osman	980904-14-2927	24	Male	Master's Degree	No	Yes	Student	80	900	0	1	5	2	2	1	3
Elizabeth Lim	010327-05-1368	21	Female	SPM level	No	Yes	Student	80	990	1	1	2	2	0	0	0
Victoria Ng	971122-01-8726	25	Female	Doctoral Degree	No	Yes	Student	90	1000	0	1	1	2	0	1	4
Ella Chang	030618-14-1046	19	Female	SPM level	No	Yes	Student	80	1,200	0	1	2	2	0	1	4

Figure 5.3.3.2 Traditional Bank Data Record

Traditional bank data fields included deposits, insurance, credit and debit card transaction, number of debit cards, number of credit cards, investment, and withdrawals. The reason to use the information about checking and assets is to determine whether an

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individual do have the capacity to take on more debt. Aside from that, the percentage of ability to pay the traditional bank data is to measure the capacity of an individual to make monthly payment. An individual represents one row of the records. The number represent the relevant data to a particular individual. For example, the deposits for Aamina is zero which is means do not have this payment, and have insurance payment in each of a month.

Debt data

FullName	Identity Number(I.C)	Age	Gender	HighestLevelEducation	MarriedStatus	Employed	Occupation	PercentageOfAbilitytoPay	IncomePerMonth	CarLoan	HouseLoan	StudentLoan	OutstandingBills	Rental	CreditCardLoan	Mortgages
Aamina	210-12-5	23	Female	Diploma	No	No	Student	60	0	0	0	1	1	1	0	0
Aaqifa	822-01-0	22	Female	Diploma	No	No	Student	60	0	0	0	1	1	1	0	0
Aarifa	728-15-3	57	Female	SPM level	Yes	No	Housewife	60	0	0	0	0	0	0	0	1
Chang Je See	113-01-0	22	Female	Bachelor's Degree	No	No	Student	60	0	0	0	1	1	1	0	0
Emily Ye	722-10-5	22	Female	Bachelor's Degree	No	No	Student	60	0	0	0	1	1	1	0	0
Eza	710-14-1	22	Female	Bachelor's Degree	No	No	Student	60	0	0	0	1	1	1	0	0
Fatimah	526-06-1	22	Female	Bachelor's Degree	No	No	Student	60	0	0	0	1	1	1	0	0
Jackson Chu	111-01-0	19	Male	SPM level	No	No	Student	60	0	0	0	1	0	0	0	0
Luna See	116-28-1	25	Female	Bachelor's Degree	No	No	Student	60	0	0	0	1	1	1	0	0
Navaratnam	824-02-4	19	Male	SPM level	No	No	Student	60	0	0	0	1	0	1	0	0
Shaniya	903-13-2	21	Female	Bachelor's Degree	No	No	Student	60	0	0	0	1	1	1	0	0
Tan Hao	709-02-5	22	Male	Bachelor's Degree	No	No	Student	60	0	0	0	1	1	1	0	0
Uma	518-06-1	22	Female	Bachelor's Degree	No	No	Student	60	0	0	0	1	1	1	0	0
Vasudevan	823-10-3	21	Male	Bachelor's Degree	No	No	Student	60	0	0	0	1	1	1	0	0
ctor Lew Ku Se	204-13-1	18	Male	SPM level	No	No	Student	60	0	0	0	1	0	1	0	0
Zoey Lai	407-04-2	21	Female	Diploma	No	No	Student	60	0	0	0	1	1	1	0	0
Saleha	208-01-4	20	Female	Bachelor's Degree	No	Yes	Student	70	500	0	0	1	1	1	0	0
Suraya	803-02-1	21	Female	Bachelor's Degree	No	Yes	Student	65	650	0	0	1	1	1	0	0
Osman	904-14-2	24	Male	Master's Degree	No	Yes	Student	80	900	0	0	1	1	1	0	0
Elizabeth Lim	327-05-1	21	Female	SPM level	No	Yes	Student	80	990	0	0	1	1	1	0	0
Victoria Ng	122-01-8	25	Female	Doctoral Degree	No	Yes	Student	90	1000	0	0	1	1	1	0	0
Ella Chang	618-14-1	19	Female	SPM level	No	Yes	Student	80	1,200	0	0	1	1	1	0	0
Owen Ho	904-05-1	20	Male	Diploma	No	Yes	Student	95	1,200	0	0	1	1	1	0	0

Figure 5.3.3.3 Debt Data Record

Debt data field included car loan, house loan, student loan, outstanding bills, rental, credit card loan, and mortgages. Debt data is one of the factor that will affect the credit scoring. The credit score might go down if an individual uses up the entire credit limit of the card. It will affect an individual to pay the higher interest rates on any other loan and credit cards and impact the application for rental, outstanding bills, and more. An individual represents one row of the records. The number represent the relevant data to a particular individual.

Utilities Data

FullName	IdentityNumber(I.C)	Age	Gender	HighestLevelEducation	MarriedStatus	Employed	Occupation	PercentageOfAbilitytoP	IncomePerMonth	WaterBill	ElectricityBill	Wi-Fi_B	MobilePhoneBillPayment	CableTVpayments	GasBill
Aamina	991210-12-5768	23	Female	Diploma	No	No	Student	52	0	1	0	0	2	0	0
Aaqifa	000822-01-0192	22	Female	Diploma	No	No	Student	52	0	1	0	0	1	0	0
Aarifa	850728-15-3756	57	Female	SPM level	Yes	No	Housewife	52	0	0	0	0	1	0	0
Chang Je See	001113-01-0016	22	Female	Bachelor's Degrees	No	No	Student	52	0	1	0	0	1	0	0
Emily Ye	000722-10-5522	22	Female	Bachelor's Degrees	No	No	Student	55	0	1	0	0	1	0	0
Eza	000710-14-1008	22	Female	Bachelor's Degrees	No	No	Student	52	0	1	0	0	2	0	0
Fatimah	000526-06-1338	22	Female	Bachelor's Degrees	No	No	Student	52	0	1	0	0	1	0	0
Jackson Chu	031111-01-0017	19	Male	SPM level	No	No	Student	52	0	0	0	0	2	0	0
Luna See	970116-28-1034	25	Female	Bachelor's Degrees	No	No	Student	55	0	1	0	1	2	0	0
Navaratnam	030824-02-4931	19	Male	SPM level	No	No	Student	52	0	0	0	0	1	0	0
Shaniya	010903-13-2846	21	Female	Bachelor's Degrees	No	No	Student	52	0	1	0	0	2	0	0
Tan Hao	000709-02-5463	22	Male	Bachelor's Degrees	No	No	Student	52	0	1	0	0	2	0	0
Uma	000518-06-1032	22	Female	Bachelor's Degrees	No	No	Student	50	0	1	0	0	2	0	0
Vasudevan	010823-10-3833	21	Male	Bachelor's Degrees	No	No	Student	52	0	1	0	0	3	0	0
Victor Lew Ku Seng	041204-13-1907	18	Male	SPM level	No	No	Student	52	0	0	0	0	2	0	0
Zoey Lai	000407-04-2818	21	Female	Diploma	No	No	Student	52	0	1	0	1	2	0	0
Saleha	020208-01-4568	20	Female	Bachelor's Degrees	No	Yes	Student	65	500	1	0	0	1	0	0
Suraya	010803-02-1014	21	Female	Bachelor's Degrees	No	Yes	Student	65	650	1	0	0	2	0	0
Osman	980904-14-2927	24	Male	Master's Degree	No	Yes	Student	80	900	1	0	0	2	0	0
Elizabeth Lim	010327-05-1368	21	Female	SPM level	No	Yes	Student	80	990	1	0	0	2	0	0
Victoria Ng	971122-01-8726	25	Female	Doctoral Degree	No	Yes	Student	90	1000	1	0	1	2	0	0
Ella Chang	030618-14-1046	19	Female	SPM level	No	Yes	Student	80	1,200	1	0	0	2	0	0

Figure 5.3.3.4 Utilities Data Record

Utilities data field included water bill, electricity bill, Wi-Fi bill, gas bill, mobile phone bill payment, and cable TV payment. Utility payments can help the user to score in alternative credit scoring. The users can get credit by making on-time payments to multiple organizations on a monthly basis. An individual represents one row of the records. The number represent the relevant data to a particular individual.

Mobile Data

FullName	Identity Number(I.C)	Age	Gender	HighestLevelEducation	Married Status	Employed	Occupation	PercentageOfAbilitytoPay	IncomePerMonth	SocialMediaPlatforms(negative)	DataUsage	SubscriptionFees	Top-upHistory	E-Wallet	SocialMediaPlatforms(positive)	SMS	Email	CallingBehavior	MobileGames	Geolocation
Aamina	1210-12-57	23	Female	Diploma	No	No	Student	55	0	0	3	3	5	3	8	1	5	0	2	2
Aaqifa	0822-01-01	22	Female	Diploma	No	No	Student	55	0	0	1	2	4	3	8	0	6	1	3	0
Aarifa	0728-15-37	57	Female	SPM level	Yes	No	Housewife	55	0	0	1	2	3	4	6	1	5	1	2	2
Chang Je See	1113-01-00	22	Female	Bachelor's Degree	No	No	Student	55	0	0	1	2	2	3	9	1	5	0	2	2
Emily Ye	0722-10-55	22	Female	Bachelor's Degree	No	No	Student	55	0	0	1	3	2	4	8	1	6	1	3	3
Eza	0710-14-10	22	Female	Bachelor's Degree	No	No	Student	55	0	0	2	4	2	5	8	0	6	2	3	3
Fatimah	0526-06-13	22	Female	Bachelor's Degree	No	No	Student	55	0	0	1	2	3	5	9	1	6	0	6	2
Jackson Chu	1111-01-00	19	Male	SPM level	No	No	Student	55	0	0	2	2	2	4	8	0	6	0	3	3
Luna See	0116-28-10	25	Female	Bachelor's Degree	No	No	Student	55	0	0	2	2	3	5	8	1	7	0	5	3
Navaratnam	0824-02-49	19	Male	SPM level	No	No	Student	55	0	0	1	2	2	4	9	1	7	4	7	4
Shaniya	0903-13-28	21	Female	Bachelor's Degree	No	No	Student	55	0	0	2	1	2	4	8	0	6	0	3	3
Tan Hao	0709-02-54	22	Male	Bachelor's Degree	No	No	Student	55	0	1	2	1	3	5	9	1	5	0	2	2
Uma	0518-06-10	22	Female	Bachelor's Degree	No	No	Student	55	0	0	2	1	4	4	9	1	6	0	3	3
Vasudevan	0823-10-38	21	Male	Bachelor's Degree	No	No	Student	55	0	0	3	1	4	4	8	1	7	0	4	4
ctor Lew Ku Sen	1204-13-19	18	Male	SPM level	No	No	Student	55	0	1	2	1	2	5	9	1	7	0	4	4
Zoey Lai	0407-04-28	21	Female	Diploma	No	No	Student	55	0	0	2	1	2	4	8	1	6	0	2	2
Saleha	0208-01-45	20	Female	Bachelor's Degree	No	Yes	Student	55	500	0	1	1	3	4	9	1	3	0	1	1
Suraya	0803-02-10	21	Female	Bachelor's Degree	No	Yes	Student	75	650	1	2	1	2	4	9	1	2	0	3	3
Osman	0904-14-29	24	Male	Master's Degree	No	Yes	Student	85	900	0	2	1	6	5	9	1	2	2	0	0
Elizabeth Lim	0327-05-13	21	Female	SPM level	No	Yes	Student	85	990	0	2	1	6	5	9	1	1	2	3	3
Victoria Ng	1122-01-87	25	Female	Doctoral Degree	No	Yes	Student	85	1000	0	2	1	6	4	9	0	3	2	1	1
Ella Chang	0618-14-10	19	Female	SPM level	No	Yes	Student	85	1,200	1	2	1	7	4	8	0	3	1	0	0

Figure 5.3.3.5 Mobile Data Record

Mobile data fields included social media platforms (positive and negative), data usage, subscription fees, top-up history, E-wallet, SMS, email received, calling behaviour, mobile games, geolocation. Mobile phone usage is considered as a good indicator of a user's lifestyle and economic activity. An individual represents one row of the records. The number represent the relevant data to a particular individual.

Shopping data

FullName	IdentityNumber(I.C)	Age	Gender	HighestLevelEducation	Married Status	Employed	Occupation	PercentageOfAbilitytoPay	IncomePerMonth	EcommerceTransaction	Ecommerce BuyingHabits	FoodDelivery Platform	AirlineBookings	HotelsBooking
Aamina	991210-12-5768	23	Female	Diploma	No	No	Student	60	0	2	3	2	0	0
Aaqifa	000822-01-0192	22	Female	Diploma	No	No	Student	60	0	3	3	1	0	0
Aarifa	850728-15-3756	57	Female	SPM level	Yes	No	Housewife	60	0	1	1	2	0	0
Chang Je See	001113-01-0016	22	Female	Bachelor's Degrees	No	No	Student	60	0	3	3	3	0	0
Emily Ye	000722-10-5522	22	Female	Bachelor's Degrees	No	No	Student	60	0	3	0	3	0	0
Eza	000710-14-1008	22	Female	Bachelor's Degrees	No	No	Student	60	0	0	0	3	0	0
Fatimah	000526-06-1338	22	Female	Bachelor's Degrees	No	No	Student	60	0	2	2	2	0	0
Jackson Chu	031111-01-0017	19	Male	SPM level	No	No	Student	60	0	0	2	2	0	0
Luna See	970116-28-1034	25	Female	Bachelor's Degrees	No	No	Student	60	0	0	0	4	0	0
Navaratnam	030824-02-4931	19	Male	SPM level	No	No	Student	60	0	0	3	4	0	0
Shaniya	010903-13-2846	21	Female	Bachelor's Degrees	No	No	Student	60	0	2	2	2	0	0
Tan Hao	000709-02-5463	22	Male	Bachelor's Degrees	No	No	Student	60	0	4	1	3	0	0
Uma	000518-06-1032	22	Female	Bachelor's Degrees	No	No	Student	60	0	2	1	2	0	0
Vasudevan	010823-10-3833	21	Male	Bachelor's Degrees	No	No	Student	60	0	1	1	3	1	0
Victor Lew Ku Seng	041204-13-1907	18	Male	SPM level	No	No	Student	60	0	2	1	2	0	0
Zoey Lai	000407-04-2818	21	Female	Diploma	No	No	Student	60	0	1	1	3	0	0
Saleha	020208-01-4568	20	Female	Bachelor's Degrees	No	Yes	Student	60	500	1	1	2	0	0
Suraya	010803-02-1014	21	Female	Bachelor's Degrees	No	Yes	Student	60	650	1	1	3	1	0
Osman	980904-14-2927	24	Male	Master's Degree	No	Yes	Student	60	900	3	1	2	0	0
Elizabeth Lim	010327-05-1368	21	Female	SPM level	No	Yes	Student	60	990	1	2	2	0	0
Victoria Ng	971122-01-8726	25	Female	Doctoral Degree	No	Yes	Student	60	1000	1	2	2	0	0
Ella Chang	030618-14-1046	19	Female	SPM level	No	Yes	Student	70	1,200	1	2	4	0	0

Figure 5.3.3.6 Shopping Data Record

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Shopping data fields included ecommerce transaction, ecommerce buying habits, foot delivery platforms, airline bookings, and hotel bookings. Shopping data is to define does a user make unnecessary purchases without the financial means to back them up. An individual represents one row of the records. The number represent the relevant data to a particular individual.

Above figures and the data records are the alternative credit scoring will be using in this project. In the consumer finance markets, alternative credit score refers to the information that is used to assess credit worthiness of an individual and it is usually not the part of the traditional credit report. Other data collection methods have disrupted the credit scoring industry in recent years. Alternative credit scoring companies, rather than looking at a person's credit payment history, utilize data from smartphone usage or psychometric exams to evaluate a person's chance of repaying a loan [23]. The examples of alternative credit scoring are bank data, mobile phone data, debts data, shopping data, utilities data, and also personal data. The personal data such as an individual's education level and occupation can represent that person's financial conduct. The alternative credit data above will effect an individual's credit score. It is difficult and impossible to buy a house or establish a business without credit score. For a variety of reasons, people have difficulty obtaining credit or paying more for loans. Delinquent payments, for example, are a negative mark on some institutions' credit reports. Some people have a difficult time keeping track of their earnings.

To calculate the alternative credit score of an individual, we need use **multiple regression linear method**. The terms regression analysis and linear regression are frequently used interchangeably. A collection of statistical methods known as regression analysis is used to estimate the relationship between independent and dependent variables.

The reason to use linear regression to analyse the data it is because regression analysis is more flexible and has broader range of applications. Both linear regression and neural networks are models that can utilise inputs to create predictions. However, regression analysis allows for more than just making predictions, such as determining the strength of the connections between variables. By using the R-Squared or Adjusted R-Squared, the regression analysis will show the total variability in the data model. This could determine which of the model's predictors are statistically significant and which

are not. Furthermore, regression analysis can provide the confidence interval for each calculated regression coefficient. Not only can a single coefficient of a feature be estimated, but a range of coefficients with a level of confidence, such as 95 percent or 99 percent confidence level, could also be obtained.

Other than that, the regression analysis is easy to communicate and it is less of a black box. A simplified model makes it easier to describe how the model works and to understand the model's results. For example, most of the business users are likely to understand the sum of the least square which means the best match lines is much faster than the backpropagation. Because the company is interested in how the model's underlying logic works, this is significant. There is nothing more harmful to a business than unpredictability, and black boxes are an excellent metaphor for that. Hence, it's critical to comprehend how the model's figures are calculated and how to interpret them.

Furthermore, will gain a better understanding of statistical inference by learning about regression analysis. Regression analysis will help building a simple and multiple regression models. It also conducting the residual analysis and applying the transformation like the Box-Cox. Confidence intervals for regression coefficients and residuals are calculated. Besides that, the hypothesis testing is used to determine the statistical significance of models and regression results. The evaluating models will be using by R-Squared, MSPE, MAE, MAPE and so on. Moreover, the variance inflation factor (VIF) can be identifying the multicollinearity. In addition, the partial F-test can be using to compare different of the regression models [14].

Multiple linear regression - Traditional Bank Data

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.744226509
R Square	0.553873097
Adjusted R Square	0.51465315
Standard Error	11.44145616
Observations	100

ANOVA

	df	SS	MS	F	Significance F
Regression	8	14789.58037	1848.697546	14.122229	3.58977E-13
Residual	91	11912.52963	130.9069191		
Total	99	26702.11			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	57.08824522	5.02291029	11.36557134	3.751E-19	47.11085097	67.065639	47.110851	67.06563947
IncomePerMonth	0.006061213	0.000983651	6.16195247	1.929E-08	0.00410731	0.0080151	0.00410731	0.008015115
Deposits	-2.727171414	1.012287424	-2.69406826	0.0084051	-4.737956027	-0.7163868	-4.73795603	-0.7163868
Withdrawals	0.989294693	0.916863522	1.078998858	0.2834399	-0.83194206	2.8105314	-0.83194206	2.810531446
CreditDebitCardsTransaction	-0.748090235	0.827032804	-0.90454723	0.3680938	-2.390889302	0.8947088	-2.3908893	0.894708832
Investment	0.025269935	1.163656529	0.021715974	0.9827221	-2.286190811	2.3367307	-2.28619081	2.33673068
Insurance	-2.545811482	1.648124974	-1.54467138	0.1258964	-5.819609277	0.7279863	-5.81960928	0.727986314
NumDebitCards	2.140277374	1.880905127	1.137897571	0.2581503	-1.595909599	5.8764643	-1.5959096	5.876464348
NumCreditCards	-3.442758487	1.378048801	-2.49828488	0.0142751	-6.180083144	-0.7054338	-6.18008314	-0.70543383

Figure 5.3.3.7 Multiple linear regression for Traditional Bank Data

Assume variables:

To calculate a person's credit score with the ability to pay ($= \hat{y}$),

Income per month ($= x_1$),

Deposits ($= x_2$),

Withdrawals ($= x_3$),

Credit Debit cards transaction ($= x_4$),

Investment ($= x_5$),

Insurance ($= x_6$),

Number debit cards ($= x_7$),

Number credit cards ($= x_8$),

The estimated multiple linear regression equation:

$$\hat{y} = 57.0882 + 0.0060x_1 - 2.7272x_2 + 0.9893x_3 - 0.7481x_4 + 0.0253x_5 - 2.5458x_6 + 2.1403x_7 - 3.4428x_8$$

To build a good regression model:

Figure 2.1.5.7 shows the result of regression analysis used to predict the credit score of an individual which can help them to increase their credit worthiness. Although the independent variables explain more than 52% of the average of the credit score, but for the 0.05 significance level, the p-values indicate **Withdrawals, CreditDebitCardsTransaction, investment, insurance and NumDebitCards** do not appear to be significant because it is already over than 0.05 significant level. It is because in regression, p-values less than the significant level indicate that the term is statistically significant. When a variable is not significant, it needs to be removed from the model. A good regression model should include only significant independent variables.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.758820606
R Square	0.575808711
Adjusted R Square	0.553245345
Standard Error	10.97715347
Observations	100

ANOVA

	df	SS	MS	F	Significance F
Regression	5	15375.30755	3075.06151	25.51963	3.5267E-16
Residual	94	11326.80245	120.4978984		
Total	99	26702.11			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	70.26574213	4.672714389	15.03745709	9.44E-27	60.9879582	79.54352608	60.98795817	79.54352608
IncomePerMonth	0.005775328	0.000598691	9.646593071	1.04E-15	0.00458661	0.006964042	0.004586613	0.006964042
Deposits	-2.155273841	0.931407792	-2.31399593	0.022847	-4.00460585	-0.305941836	-4.004605845	-0.30594184
Insurance	-3.144907108	1.300058197	-2.41905102	0.017486	-5.72620313	-0.563611082	-5.726203134	-0.56361108
CreditDebitCardsTransaction	-1.384007874	0.600346116	-2.30534993	0.023347	-2.57600916	-0.192006588	-2.57600916	-0.19200659
NumDebitCards	-3.368103197	1.682130032	-2.00228468	0.048135	-6.70801181	-0.028194587	-6.708011808	-0.02819459

Figure 5.3.3.8 Multiple linear regression for Traditional Bank Data

To ensure the variables may or not may be significant in new model, we should drop it one by one to look at the changing of Adjusted R square and also the other independent variables p-value. After dropped and replaced the variables in several times, here came out the final version of multiple linear regression. All of the independent variables p-value is less than 0.05 which is represent a good regression model. Other than that, the Adjusted R Square has increased to 55% compared to the *Figure 2.1.5.7*, which indicates that the model has improved. An adjusted R Square will consider the marginal improvement added by an additional term in the model. So it will increase if added the useful terms and it will decrease if added the less useful predictors. For the p-value is less than the significance level, therefore we can reject the null hypothesis that each partial regression is zero and conclude that each of them is statistically significant.
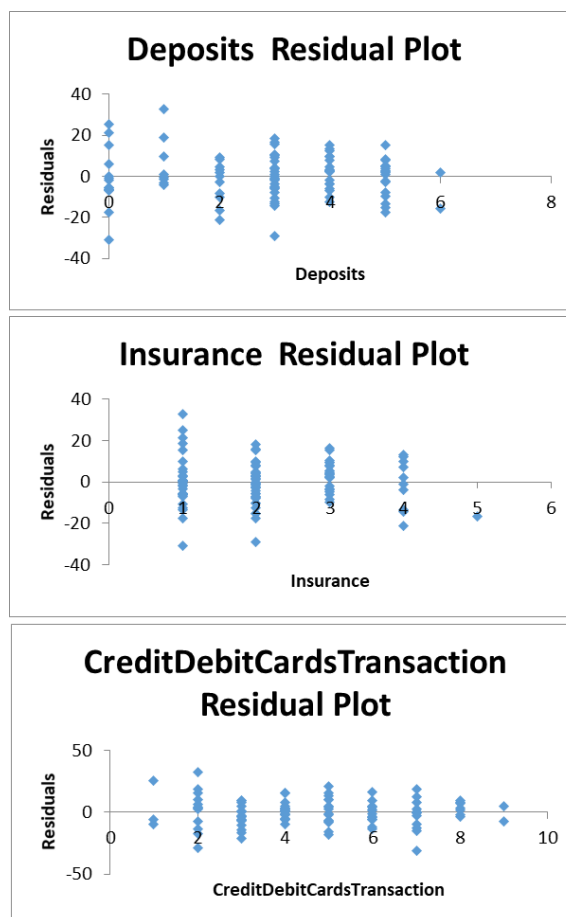
Correlation and Multicollinearity

	IncomePerMonth	Deposits	Insurance	CreditDebitCardsTransac	NumDebitCards
IncomePerMonth	1				
Deposits	0.71729366	1			
Insurance	0.52046534	0.44510178	1		
CreditDebitCardsTransaction	0.3200284	0.11049186	0.0813056	1	
NumDebitCards	0.41536524	0.35554055	0.1991643	0.16771683	1

Figure 5.3.3.9 Correlation and Multicollinearity for Traditional Bank Data

The 0.7 is bottom-line, which is still acceptable in this project. There are **not exists correlation between the independent variables.** It is better to use independent variables that are not correlated or repetitive when building multiple regression models that use two or more variables.

Residual Plot

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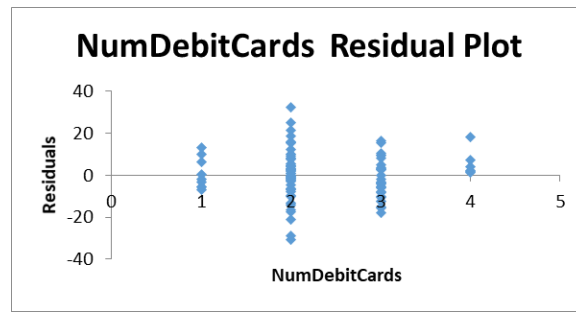Faculty of Information and Communication Technology (Kampar Campus), UTAR

Figure 5.3.3.10 Residual Plot for Traditional Bank Data

Residual plot is a scatter chart of the residuals with the value of the independent variable on the x-axis. The residuals should be at each value appear to have a mean of zero, to have similar variance, and to be concentrated around the zero. But due to the data records is not big and clear, the residual plot is not randomly and around the zero.

Here comes the better multiple linear regression model:

To calculate a person's credit score with the ability to pay ($= \hat{y}$),

IncomePerMonth ($= x_1$),

Deposits ($= x_2$),

Insurance ($= x_3$),

CreditDebitCardsTransaction ($= x_4$),

NumDebitCards ($= x_5$),

The estimated multiple linear regression equation for traditional bank data:

$$\hat{y} = 70.2657 + 0.0058x_1 - 2.1553x_2 - 3.1449x_3 - 1.3840x_4 - 3.3681x_5$$

Multiple linear regression – Utilities Data

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.74227841
R Square	0.55097724
Adjusted R Square	0.51681247
Standard Error	10.4773698
Observations	100

ANOVA

	df	SS	MS	F	Significance F
Regression	7	12392.46447	1770.352	16.12706	1.12674E-13
Residual	92	10099.32553	109.7753		
Total	99	22491.79			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%
Intercept	47.8028133	3.658297927	13.06695	1.11E-22	40.53711783	55.0685087	40.5371178
IncomePerMonth	0.00394632	0.000759998	5.192541	1.24E-06	0.002436898	0.00545574	0.0024369
WaterBill	10.3003049	3.340985725	3.083014	0.002705	3.664818915	16.935791	3.66481891
ElectricityBill	-13.784492	5.732189734	-2.40475	0.018186	-25.16911569	-2.3998685	-25.169116
GasBill	1.5309744	2.467574705	0.620437	0.536504	-3.369841962	6.43179075	-3.369842
Wi-Fi_Bills	-0.9040823	3.36704481	-0.26851	0.788909	-7.59132389	5.78315936	-7.5913239
MobilePhoneBillPayments	2.15335548	2.37012864	0.908539	0.365967	-2.553924578	6.86063554	-2.5539246
CableTVpayments	2.88925045	3.794096768	0.761512	0.448299	-4.646153223	10.4246541	-4.6461532

Figure 5.3.3.11 Multiple linear regression for Utilities Data

In regression, p-values less than the significant level (95%) indicate that the term is statistically significant. When a variable is not significant, it needs to be removed from the model. A good regression model should include only significant independent variables. The highlighted p-values shown in *Figure 2.1.5.11*which are exceed than 0.05 significant level.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.754354236
R Square	0.569050314
Adjusted R Square	0.546127458
Standard Error	10.15456602
Observations	100

ANOVA

	df	SS	MS	F	Significance F
Regression	5	12798.96015	2559.79	24.82458	7.28795E-16
Residual	94	9692.829848	103.115		
Total	99	22491.79			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	56.0310815	4.253682196	13.1724	4.55E-23	47.58529579	64.4768672	47.5852958	64.4768672
IncomePerMonth	0.003620722	0.00078219	4.62895	1.18E-05	0.002067665	0.00517378	0.00206767	0.00517378
WaterBill	9.009400797	3.093081981	2.91276	0.004475	2.868014016	15.1507876	2.86801402	15.1507876
ElectricityBill	-9.16268095	3.892241618	-2.35409	0.02065	-16.8908179	-1.434544	-16.8908179	-1.43454397
Wi-Fi_Bills	3.628873823	1.776567327	2.04263	0.043889	0.10145775	7.1562899	0.10145775	7.1562899
MobilePhoneBillPayments	-3.41943854	1.626500745	-2.10233	0.038198	-6.6488939	-0.1899832	-6.6488939	-0.18998319

Figure 5.3.3.12 Multiple linear regression for Utilities Data

To ensure the variables may or not may be significant in new model, we should drop it one by one to look at the changing of Adjusted R square and also the other independent variables p-value. After dropped and replaced the variables in several times, here came out the final version of multiple linear regression. All of the independent variables p-value is less than 0.05 which is represent a good regression model. Other than that, the Adjusted R Square has increased to 55% compared to the *Figure 2.1.5.12* (52%), which indicates that the model has improved. An adjusted R Square will consider the marginal improvement added by an additional term in the model. So it will increase if added the useful terms and it will decrease if added the less useful predictors. For the p-value is less than the significance level, therefore we can reject the null hypothesis that each partial regression is zero and conclude that each of them is statistically significant.

	IncomePerMonth	WaterBill	ElectricityBill	Wi-Fi_Bills	MobilePhoneBillPayments
IncomePerMonth	1				
WaterBill	0.388111586	1			
ElectricityBill	0.858690102	0.394227025	1		
Wi-Fi_Bills	0.841318397	0.350507112	0.785029795	1	
MobilePhoneBillPayments	0.462874469	0.195154551	0.445629564	0.367068699	1

Figure 5.3.3.13 Correlation and Multicollinearity for Utilities Data

The 0.7 is bottom-line, which is still acceptable in this project. There are **not exists correlation between the independent variables**. It is better to use independent variables that are not correlated or repetitive when building multiple regression models that use two or more variables.
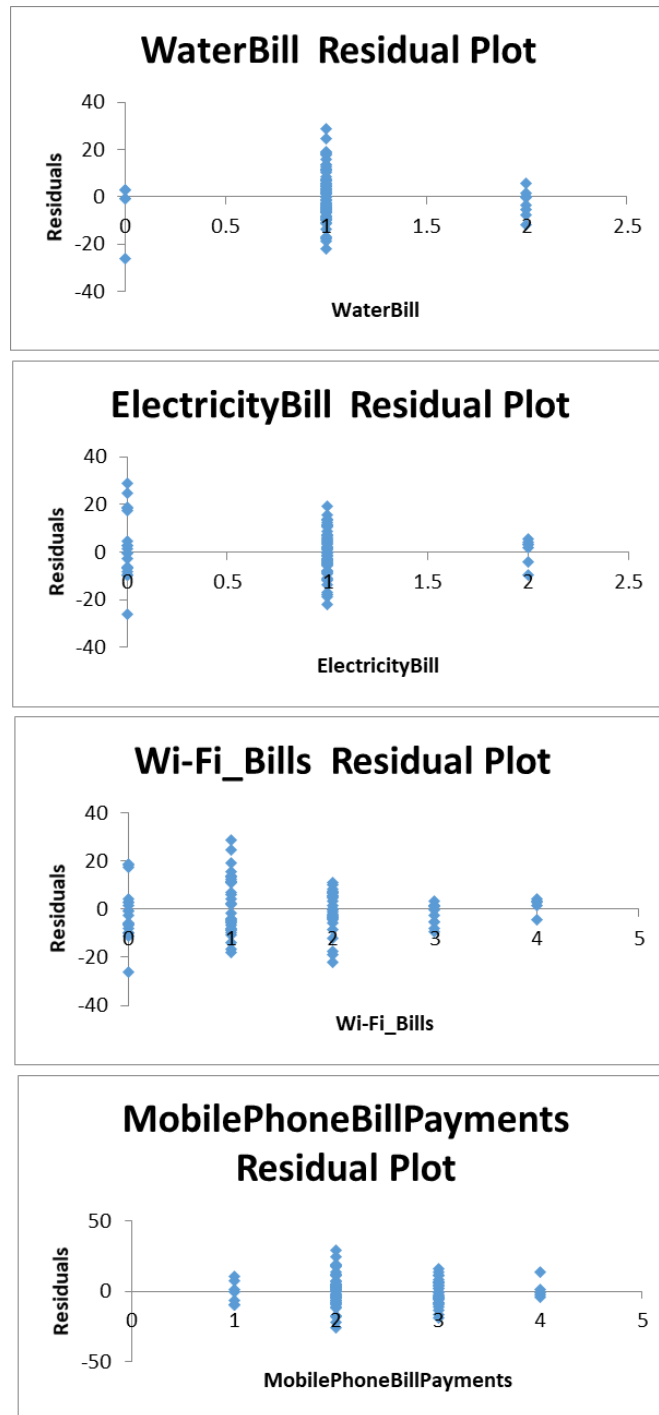
Residual Plot

Figure 5.3.3.14 Residual Plot for Utilities Data

Residual plot is a scatter chart of the residuals with the value of the independent variable on the x-axis. The residuals should be at each value appear to have a mean of zero, to have similar variance, and to be concentrated around the zero. But due to the data records is not big and clear, the residual plot is not randomly and around the zero.

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Here comes the better multiple linear regression model:

To calculate a person's credit score with the ability to pay (= $\hat{y}$),

IncomePerMonth (= x_1),

WaterBill (= x_2),

ElectricityBill (= x_3),

Wi-Fi_Bills (= x_4),

MobilePhoneBillPayments (= x_5),

The estimated multiple linear regression equation for Utilities data:

$$\hat{y} = 56.0311 + 0.0036x_1 + 9.0094x_2 - 9.1627x_3 + 3.6289x_4 - 3.4194x_5$$

Multiple linear regression – Debt Data

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.761855
R Square	0.580424
Adjusted R Square	0.543538
Standard Error	9.179762
Observations	100

ANOVA

	df	SS	MS	F	Significance F
Regression	8	10608.11923	1326.015	15.735682	2.51921E-14
Residual	91	7668.390769	84.26803		
Total	99	18276.51			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	50.70335	4.01275641	12.63554	9.881E-22	42.73249818	58.6741935	42.73249818	58.6741935
IncomePerMonth	0.003167	0.000925343	3.422569	0.0009313	0.001328971	0.00500513	0.001328971	0.00500513
CreditCardLoan	3.0367	1.970223674	1.541297	0.1267149	-0.87690757	6.95030702	-0.87690757	6.95030702
Mortgages	-0.18048	2.037585309	-0.08858	0.9296128	-4.22789604	3.86692978	-4.22789604	3.86692978
CarLoan	-9.73473	4.754945426	-2.04729	0.0435133	-19.1798444	-0.2896144	-19.1798444	-0.28961443
HouseLoan	7.50191	3.147936456	2.38312	0.0192457	1.248920517	13.7548986	1.248920517	13.7548986
StudentLoan	8.40419	2.425549374	3.464861	0.0008111	3.586134631	13.2222464	3.586134631	13.2222464
OutstandingBills	0.602571	1.468054092	0.410456	0.6824365	-2.31353791	3.5186803	-2.31353791	3.5186803
Rental	4.230062	2.764662044	1.530047	0.1294741	-1.26159907	9.72172398	-1.26159907	9.72172398

Figure 5.3.3.15 Multiple linear regression for Debt Data

In regression, p-values less than the significant level (95%) indicate that the term is statistically significant. When a variable is not significant, it needs to be removed from the model. A good regression model should include only significant independent variables. The highlighted p-values shown in *Figure 2.1.5.13* which are exceed than 0.05 significant level.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.776456
R Square	0.602884
Adjusted R Square	0.577263
Standard Error	8.834135
Observations	100

ANOVA

	df	SS	MS	F	ignificance F
Regression	6	11018.61	1836.435	23.53138	9.63E-17
Residual	93	7257.901	78.04194		
Total	99	18276.51			

	Coefficients	andard Err	t Stat	P-value	Lower 95%	Upper 95%	ower 95.0%	Jpper 95.0%
Intercept	45.58133	3.796996	12.00458	1.32E-20	38.04125	53.12141	38.04125	53.12141
IncomePerMonth	0.00361	0.000763	4.730059	7.98E-06	0.002094	0.005125	0.002094	0.005125
CarLoan	-12.2428	3.903597	-3.13628	0.002291	-19.9945	-4.49099	-19.9945	-4.49099
HouseLoan	6.803223	3.028312	2.24654	0.027036	0.789596	12.81685	0.789596	12.81685
StudentLoan	9.531415	2.158073	4.416633	2.7E-05	5.245911	13.81692	5.245911	13.81692
OutstandingBills	5.810996	2.717846	2.138089	0.035131	0.413892	11.2081	0.413892	11.2081
Rental	4.280102	2.077444	2.060273	0.042166	0.154711	8.405494	0.154711	8.405494

Figure 5.3.3.16 Multiple linear regression for Debt Data

To ensure the variables may or not may be significant in new model, we should drop it one by one to look at the changing of Adjusted R square and also the other independent variables p-value. After dropped and replaced the variables in several times, here came out the final version of multiple linear regression. All of the independent variables p-value is less than 0.05 which is represent a good regression model. Other than that, the Adjusted R Square has increased to 57% compared to the *Figure 2.1.5.13* (54%), which indicates that the model has improved. An adjusted R Square will consider the marginal improvement added by an additional term in the model. So it will increase if added the useful terms and it will decrease if added the less useful predictors. For the p-value is less than the significance level, therefore we can reject the null hypothesis that each partial regression is zero and conclude that each of them is statistically significant.

	PercentageOfAbilitytoPay	IncomePerMonth	CarLoan	HouseLoan	StudentLoan	OutstandingBills	Rental
PercentageOfAbilitytoPay	1						
IncomePerMonth	0.612847793	1					
CarLoan	0.43051249	0.859587385	1				
HouseLoan	0.645357718	0.801282094	0.68703	1			
StudentLoan	0.224602171	-0.163057037	-0.1308	-0.00364842	1		
OutstandingBills	0.399982226	0.388111586	0.364225	0.339342699	-0.018246623	1	
Rental	-0.113952978	-0.454467831	-0.38053	-0.246983863	0.045100673	-0.034622049	1

Figure 5.3.3.17 Correlation and Multicollinearity for Debt Data

The 0.7 is bottom-line, which is still acceptable in this project. There should be exists correlation between the independent variables. It is better to use independent variables that are not correlated or repetitive when building multiple regression models that use two or more variables. But due to the data records is not big and clear, the correlation is out of expectation.
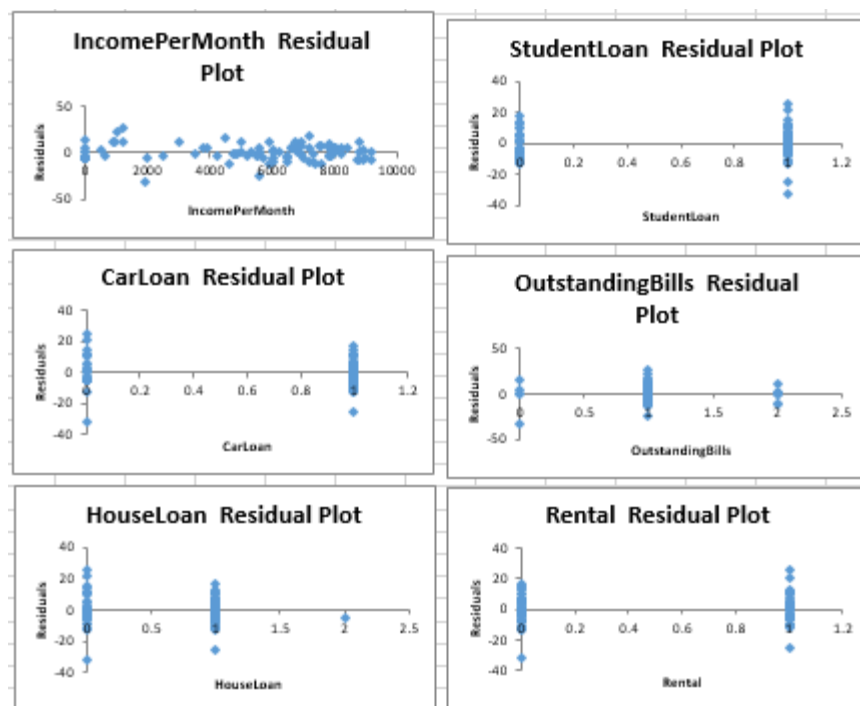
Residual Plot

Figure 5.3.3.18 Residual Plot for Debt Data

Residual plot is a scatter chart of the residuals with the value of the independent variable on the x-axis. The residuals should be at each value appear to have a mean of zero, to have similar variance, and to be concentrated around the zero. But due to the data records is not big and clear, the residual plot is not randomly and around the zero.

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Here comes the better multiple linear regression model:

To calculate a person's credit score with the ability to pay ($= \hat{y}$),

IncomePerMonth ($= x_1$),

CarLoan ($= x_2$),

HouseLoan ($= x_3$),

StudentLoan ($= x_4$),

OutstandingBills ($= x_5$),

Rental ($= x_6$),

The estimated multiple linear regression equation for Debt data:

$$\hat{y} = 45.5813 + 0.0036x_1 - 12.2428x_2 + 6.8032x_3 + 9.5314x_4 + 5.8109x_5 + 4.2801x_6$$

Multiple linear regression – Mobile Data

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.7993859
R Square	0.63901782
Adjusted R Square	0.58922717
Standard Error	9.5575298
Observations	100

ANOVA

	df	SS	MS	F	Significance F
Regression	12	14068.1753	1172.348	12.83409	1.157E-14
Residual	87	7947.134696	91.34638		
Total	99	22015.31			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	32.3011296	6.94382117	4.65178	1.17E-05	18.49953309	46.102726	18.4995331	46.102726
IncomePerMonth	0.00430161	0.000543931	7.908377	7.59E-12	0.003220491	0.0053827	0.00322049	0.00538274
Social Media Platforms (positive)	1.25017589	0.613001904	2.039432	0.044441	0.031768226	2.4685835	0.03176823	2.46858355
Social Media Platforms (negative)	-3.93998036	2.282461962	-1.7262	0.087862	-8.47662066	0.5966599	-8.4766207	0.59665993
Data Usage	-1.29442636	2.24901575	-0.57555	0.566404	-5.76458869	3.175736	-5.7645887	3.17573597
Mobile Games	-0.67432937	0.832885957	-0.80963	0.420362	-2.3297804	0.9811217	-2.3297804	0.98112165
Subscription Fees	0.1266739	1.821620622	0.069539	0.94472	-3.49399433	3.7473421	-3.4939943	3.74734214
SMS	-1.2129866	1.489006112	-0.81463	0.417509	-4.17254748	1.7465743	-4.1725475	1.74657428
Geolocation	1.57280028	1.263731638	1.244568	0.216633	-0.93900318	4.0846038	-0.9390032	4.08460375
Top-up history	2.16182318	0.69820207	3.096272	0.002637	0.774070962	3.5495754	0.77407096	3.5495754
Calling Behavior	1.07876038	1.274027567	0.846732	0.399467	-1.45350736	3.6110281	-1.4535074	3.61102812
E-Wallet	3.18757185	0.989158663	3.222508	0.001789	1.2215119	5.1536318	1.2215119	5.1536318
Email	-0.90010009	0.738058394	-1.21955	0.225931	-2.36707107	0.5668709	-2.3670711	0.56687089

Figure 5.3.3.19 Multiple linear regression for Mobile Data

In regression, p-values less than the significant level (95%) indicate that the term is statistically significant. When a variable is not significant, it needs to be removed from the model. A good regression model should include only significant independent variables. The highlighted p-values shown in *Figure 2.1.5.15* which are exceed than 0.05 significant level.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.832918441
R Square	0.693753129
Adjusted R Square	0.670451736
Standard Error	8.560602256
Observations	100

ANOVA

	df	SS	MS	F	Significance F
Regression	7	15273.19019	2181.884	29.77303	4.44917E-21
Residual	92	6742.11981	73.28391		
Total	99	22015.31			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	43.13151761	6.520093832	6.615168	2.41E-09	30.18204846	56.0809868	30.1820485	56.08098675
IncomePerMonth	0.005424435	0.000393367	13.78974	4.11E-24	0.004643174	0.0062057	0.00464317	0.006205697
SocialMediaPlatforms(negative)	-3.25920632	1.593218969	-2.04567	0.043644	-6.42347672	-0.0949359	-6.4234767	-0.094935928
DataUsage	-4.5038989	1.350418718	-3.33519	0.00123	-7.18594704	-1.8218508	-7.185947	-1.821850762
SubscriptionFees	-3.29177155	0.964349375	-3.41346	0.000955	-5.20705264	-1.3764904	-5.2070526	-1.376490448
Top-upHistory	2.295194945	0.623509272	3.681092	0.000391	1.056851712	3.53353818	1.05685171	3.533538178
E-Wallet	3.441767594	0.860954102	3.99762	0.000129	1.731838431	5.15169676	1.73183843	5.151696756
SocialMediaPlatforms(positive)	1.111943925	0.558635205	1.990465	0.049507	0.002446188	2.22144166	0.00244619	2.221441662

Figure 5.3.3.20 Multiple linear regression for Mobile Data

To ensure the variables may or not may be significant in new model, we should drop it one by one to look at the changing of Adjusted R square and also the other independent variables p-value. After dropped and replaced the variables in several times, here came out the final version of multiple linear regression. All of the independent variables p-value is less than 0.05 which is represent a good regression model. Other than that, the Adjusted R Square has increased to 67% compared to the *Figure 2.1.5.15* (59%), which indicates that the model has improved. An adjusted R Square will consider the marginal improvement added by an additional term in the model. So it will increase if added the useful terms and it will decrease if added the less useful predictors. For the p-value is less than the significance level, therefore we can reject the null hypothesis that each partial regression is zero and conclude that each of them is statistically significant. \

	PercentageOfAbilitytoPay	IncomePerMonth	SocialMediaPlatforms(negative)	DataUsage	SubscriptionFee	Top-upHistory	E-Wallet	SocialMediaPlatforms(positive)
PercentageOfAbilitytoPay	1							
IncomePerMonth	0.669142543	1						
SocialMediaPlatforms(negative)	-0.057184018	0.122420195	1					
DataUsage	0.168351723	0.437887579	0.069613282	1				
SubscriptionFees	-0.033104664	0.300660149	0.041782379	0.047306956	1			
Top-upHistory	0.04340388	-0.31292433	-0.082301392	-0.054572744	-0.178015995	1		
E-Wallet	-0.149130571	-0.56503013	-0.007289567	-0.198597744	-0.257130904	0.254175219	1	
SocialMediaPlatforms(positive)	0.038420107	-0.288721118	-0.212115966	-0.115077864	-0.214218776	0.240994953	0.2872012	1

Figure 5.3.3.21 Correlation and Multicollinearity for Mobile Data

The 0.7 is bottom-line, which is still acceptable in this project. There should be exists correlation between the independent variables. It is better to use independent variables that are not correlated or repetitive when building multiple regression models that use two or more variables. Figure 5.3.3.21 show the exist of -1.0 correlation, which is negative correlation. Due to the data records is not big and clear, the correlation is out of expectation.
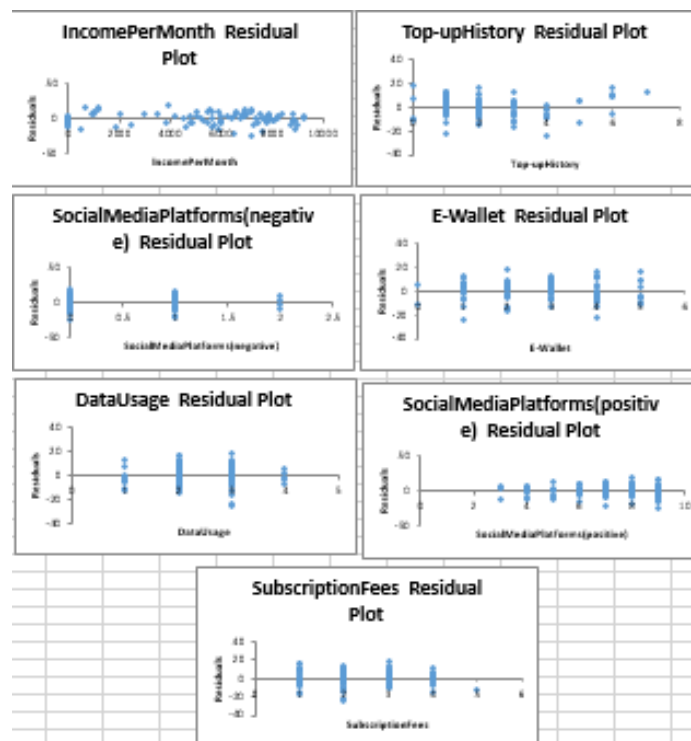
Residual Plot

Figure 5.3.3.22 Residual Plot for Mobile Data

Residual plot is a scatter chart of the residuals with the value of the independent variable on the x-axis. The residuals should be at each value appear to have a mean of zero, to have similar variance, and to be concentrated around the zero. But due to the data records is not big and clear, the residual plot is not randomly and around the zero.

Here comes the better multiple linear regression model:

To calculate a person's credit score with the ability to pay (= $\hat{y}$),

IncomePerMonth (= x_1),

SocialMediaPlatforms (negative) (= x_2),

DataUsage (= x_3),

SubscriptionFees (= x_4),

Top-upHistory (= x_5),

E-Wallet (= x_6),

SocialMediaPlatforms (positive) (= x_7),

The estimated multiple linear regression equation for Mobile data:

$\hat{y} = 43.1315 + 0.0054x_1 - 3.2592x_2 - 4.5039x_3 - 3.2918x_4 + 2.2952x_5 + 3.4418x_6 + 1.1119x_7$

Multiple linear regression – Shopping Data

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.80132047
R Square	0.6421145
Adjusted R Square	0.61902512
Standard Error	8.40998415
Observations	100

ANOVA

	df	SS	MS	F	Significance F
Regression	6	11801.62149	1966.937	27.80994	8.62819E-19
Residual	93	6577.688512	70.72783		
Total	99	18379.31			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	43.6424015	3.331908314	13.09832	7.85E-23	37.02589189	50.258911	37.0258919	50.258911
IncomePerMonth	0.00329696	0.000463671	7.110554	2.33E-10	0.002376202	0.0042177	0.0023762	0.00421772
Ecommerce Transaction	2.58240973	0.907683947	2.845054	0.005461	0.779929299	4.3848902	0.7799293	4.38489016
Ecommerce Buying Habits	2.35143384	1.023747815	2.296888	0.023869	0.318473574	4.3843941	0.31847357	4.38439411
Airline Bookings	2.88608606	1.567779659	1.840875	0.068828	-0.227213637	5.9993857	-0.22721364	5.99938575
Hotels Booking	-2.3335145	1.612302596	-1.44732	0.15117	-5.535227873	0.868199	-5.53522787	0.86819897
Food Delivery Platforms	2.47538386	1.027987898	2.407989	0.018014	0.434003624	4.5167641	0.43400362	4.51676409

Figure 5.3.3.23 Multiple linear regression for Shopping Data

In regression, p-values less than the significant level (95%) indicate that the term is statistically significant. When a variable is not significant, it needs to be removed from

the model. A good regression model should include only significant independent variables. The highlighted p-values shown in *Figure 2.1.5.17* which are exceed than 0.05 significant level.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.791550616
R Square	0.626552378
Adjusted R Square	0.610828268
Standard Error	8.49997499
Observations	100

ANOVA

	df	SS	MS	F	Significance F
Regression	4	11515.60039	2878.9	39.8466	1.47542E-19
Residual	95	6863.709609	72.24957		
Total	99	18379.31			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%
Intercept	43.89386891	3.290072146	13.34131	1.69E-23	37.36224988	50.4254879	37.3622499
IncomePerMonth	0.00313849	0.000373027	8.413573	4.02E-13	0.002397938	0.00387904	0.00239794
EcommerceTransaction	2.718212246	0.914162275	2.973446	0.003732	0.903370672	4.53305382	0.90337067
EcommerceBuyingHabits	2.273133063	1.022608469	2.222877	0.028596	0.242998573	4.30326755	0.24299857
FoodDeliveryPlatforms	2.593359212	1.008655685	2.571105	0.01169	0.5909245	4.59579392	0.5909245

Figure 5.3.3.24 Multiple linear regression for Shopping Data

To ensure the variables may or not may be significant in new model, we should drop it one by one to look at the changing of Adjusted R square and also the other independent variables p-value. After dropped and replaced the variables in several times, here came out the final version of multiple linear regression. As result, the adjusted R Square has decreased to 61% compared to the *Figure 2.1.5.17* (62%). However, all of the independent variables p-value is less than 0.05 which is represent a good regression model.

An adjusted R Square will consider the marginal improvement added by an additional term in the model. So it will increase if added the useful terms and it will decrease if added the less useful predictors. For the p-value is less than the significance level, therefore we can reject the null hypothesis that each partial regression is zero and conclude that each of them is statistically significant.

	PercentageOfAbilitytoPay	IncomePerMonth	EcommerceTransaction	EcommerceBuyingHabits	FoodDeliveryPlatforms
PercentageOfAbilitytoPay	1				
IncomePerMonth	0.73114144	1			
EcommerceTransaction	0.369073792	0.226867981	1		
EcommerceBuyingHabits	0.496057811	0.490089301	0.14470268	1	
FoodDeliveryPlatforms	-0.206864334	-0.506708656	-0.03367025	-0.198084461	1

Figure 5.3.3.25 Correlation and Multicollinearity for Shopping Data

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The 0.7 is bottom-line, which is still acceptable in this project. There should be exists correlation between the independent variables. It is better to use independent variables that are not correlated or repetitive when building multiple regression models that use two or more variables. Due to the data records is not big and clear, the correlation is out of expectation.
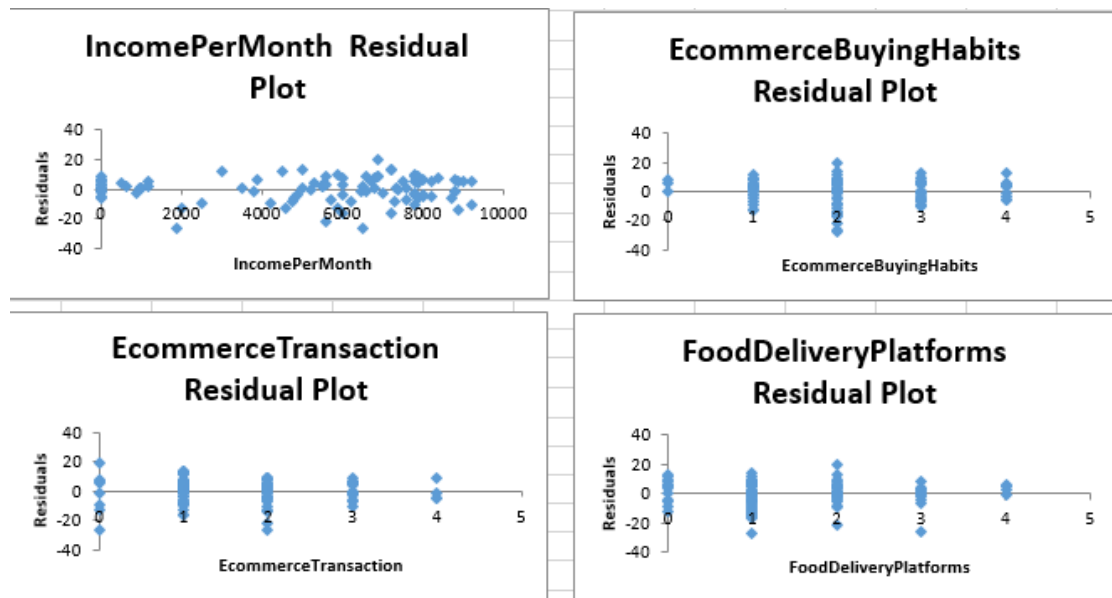
Residual Plot

Figure 5.3.3.26 Residual Plot for Shopping Data

Residual plot is a scatter chart of the residuals with the value of the independent variable on the x-axis. The residuals should be at each value appear to have a mean of zero, to have similar variance, and to be concentrated around the zero. But due to the data records is not big and clear, the residual plot is not randomly and around the zero.

Here comes the better multiple linear regression model:

To calculate a person's credit score with the ability to pay (= $\hat{y}$),

IncomePerMonth (= x_1),

EcommerceTransaction (= x_2),

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EcommerceBuyingHabits (= x_3),

FoodDeliveryPlatforms (= x_4),

The estimated multiple linear regression equation for Shopping data:

$$\hat{y} = 43.8939 + 0.0031x_1 + 2.7182x_2 + 2.2731x_3 + 2.5934x_4$$

<u>The final formula to calculate the alternative credit scoring of an individual</u>

1. Traditional Bank Data

The estimated multiple linear regression equation for traditional bank data:

$$\widehat{y1} = 70.2657 + 0.0058x_1 - 2.1553x_2 - 3.1449x_3 - 1.3840x_4 - 3.3681x_5$$

2. Utilities Data

The estimated multiple linear regression equation for Utilities data:

$$\widehat{y2} = 56.0311 + 0.0036x_1 + 9.0094x_2 - 9.1627x_3 + 3.6289x_4 - 3.4194x_5$$

3. Debt Data

The estimated multiple linear regression equation for Debt data:

$$\widehat{y3} = 45.5813 + 0.0036x_1 - 12.2428x_2 + 6.8032x_3 + 9.5314x_4 + 5.8109x_5 + 4.2801x_6$$

4. Mobile Data

The estimated multiple linear regression equation for Mobile data:

$$\widehat{y4} = 43.1315 + 0.0054x_1 - 3.2592x_2 - 4.5039x_3 - 3.2918x_4 + 2.2952x_5 + 3.4418x_6 + 1.1119x_7$$

5. Shopping Data

The estimated multiple linear regression equation for Shopping Data:

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$$\widehat{y5} = 43.8939 + 0.0031x_1 + 2.7182x_2 + 2.2731x_3 + 2.5934x_4$$

The final equation for alternative credit scoring of an individual:

$$\hat{y} = y1 + y2 + y3 + y4 + y5$$

5.3.4 Summary of the Technologies Review
Machine Learning/ Analytic tools

The technologies used in this project are machine learning and analytic tools with MS Excel. MS Excel is a spreadsheet programme that allows users to store data in tabular format and conduct simple mathematical calculations. On the other hand, Excel is a strong computing tool that capable of solving complex issues. It also includes a number of capabilities that let users develop machine learning models directly in the spreadsheets. Excel leads users through the fundamentals of machine learning step by step, showing how to use basic Excel functions and a few of the application's advanced tools to create a variety of algorithms.

This would allow the users to evaluate Excel data in less time and produce more consistent findings, resulting in a higher rate of production. For instance, linear regression is an important machine learning approach for analysing data and forecasting results. From the tabular data in the spreadsheet, Excel can simply generate regression models. For example, Excel formulas such as SUM and SUMPRODUCT can assist in the process building of linear regression. Apart from that, the data chart tool in Excel can be used to create a machine learning model that predicts changes in data values. Trendline is a feature that allows users to create a regression model from data. Different types of regression algorithms, such as linear, exponential, polynomial, and logarithmic can be used to create the trendline. The chart tool may be set up to display the machine learning model's parameters. It may be used to make estimates about the outcome of a new experiment. A single chart with many trend lines may be added to speed up the process of testing and comparing the results of several machine learning models on the same data [12].

ANOVA

	df	SS	MS	F	Significance F
Regression	5	15375.30755	3075.06151	25.51963	3.5267E-16
Residual	94	11326.80245	120.4978984		
Total	99	26702.11			

Figure 5.3.4.1 Analytic tools (ANOVA)

For the analytic tool, ANOVA (Analysis of Variance) tests for significance of the entire model in multiple linear regression. *df* (Degrees of freedom) which is the number of independent variables in the regression model. It is the total number of observations in the dataset is deducted from the number of variables being estimated [1]. Total *df* is the sum of the regression. For **residual *df*,** which is equals the dataset size minus one. Next, *SS* (Sum of Square) is the entire variance in the dependent variable. It is sum of the square of the differences between the predicted value and mean of all the data point's value. The entire variance in the dependent variable that the regression model fails to explain is known as **residual *SS***. The sum of the square of the difference between the predicted and actual values of all the data points is known as the **Error Sum of Squares**. Apart from that, **Total SS** is the total of both regression and residual SS, and *MS* (Mean Squared Errors) are the sum of squares or mean of the sum of squares divided by the regression and residuals *df*. Then, *F* is used to test the null hypothesis that the independent variable's slope is equal to zero [5]. Lastly, Significance F is the p-value. We may reject the null hypothesis that all coefficients are equal to zero since it is less than the 0.05 significance level which is 95 % confidence level. It helps to reduce the variation in the dependent variable and increases the model's ability to predict the dependent variable more accurately. However, if cannot reject the hypothesis, which mean the independent variables is not significant and should not be included in the model [10].

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	70.26574213	4.672714389	15.03745709	9.44E-27	60.9879582	79.54352608	60.98795817	79.54352608
IncomePerMonth	0.0057755328	0.000598691	9.646593071	1.04E-15	0.00458661	0.006964042	0.004586613	0.006964042
Deposits	-2.155273841	0.931407792	-2.31399593	0.022847	-4.00460585	-0.305941836	-4.004605845	-0.30594184
Insurance	-3.144907108	1.300058197	-2.41905102	0.017486	-5.72620313	-0.563611082	-5.726203134	-0.56361108
CreditDebitCardsTransaction	-1.384007874	0.600346116	-2.30534993	0.023347	-2.57600916	-0.192006588	-2.57600916	-0.19200659
NumDebitCards	-3.368103197	1.682130032	-2.00228468	0.048135	-6.70801181	-0.028194587	-6.708011808	-0.02819459

Figure 5.3.4.2 Analytic tools (ANOVA)

Figure 2.1.6.2 are details for the intercept and predictors. From left, **coefficients** are estimated using the least-squares method; **Standard error** is standard deviation of

the least-square estimates; **t-Stat** is the t-statistic for the null hypothesis that the coefficient is equal to zero, versus the alternative hypothesis that it is different from zero; **P-value** for the Significance F and t-statistic; **Lower and Upper 95%** is the confidence interval for the coefficients.

Next is Residual Output. Residuals are the difference between the actual value and the regression model's predicted value, and residual output is the regression model's predicted value for the dependent variable and the residual for each data point. These graphs can be used to see if the sample data meets the variance's linearity and homogeneity assumptions.

Moreover, for each of the independent variable, the model gives a Line Fit Plot. This graph compares the expected (ŷ) and observed values (y). The closer these regressors match, the better the model predicts on the dependent variable.

Therefore, alternative credit scoring models for individuals can be calculated and predicted by using machine learning and analytics tools with MS Excel.

5.4 System Implementation
5.4.1 Hardware Setup

Table 5.4.1.1 Specification of laptop

Description	Specifications
Model	Asus X441U series,
Processor	Intel(R) Core(TM) i3-6006U CPU @ 2.00GHz 1.99 GHz
Operating System	Windows 10
System Type	64-bit operating system, x64-based processor
Installed RAM	12.0 GB
Storage	223 GB

5.4.2 Software Setup

5.4.2.1 Visual Studio Code Flutter
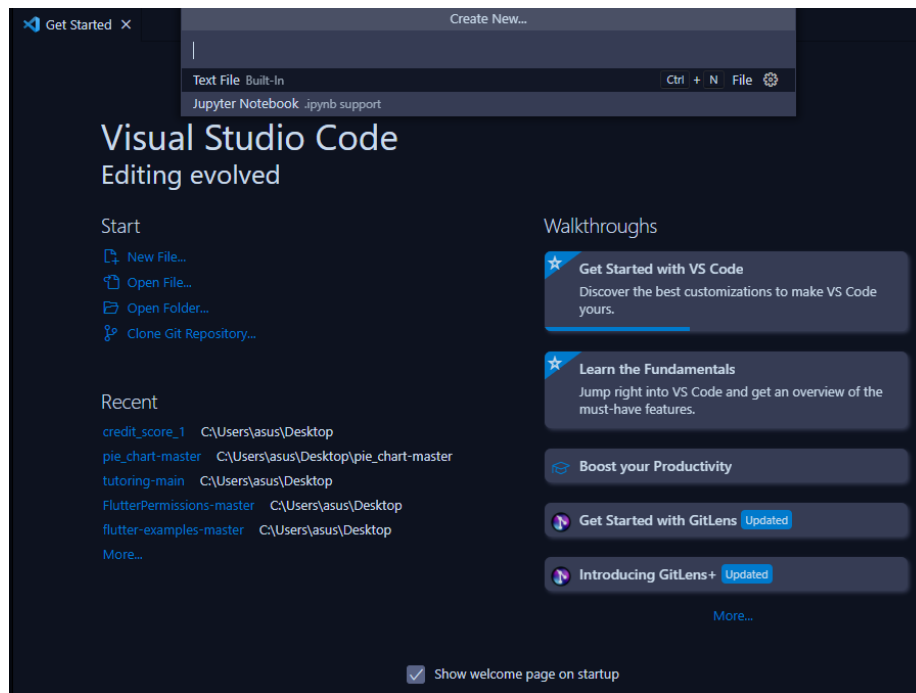
Figure 5.4.2.1 Visual Studio Code Flutter New Project Setup

This project is built by using the Visual Studio Code with Flutter. Flutter SDK need to install in order to develop the application.

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5.5.2 Cloud Firestore
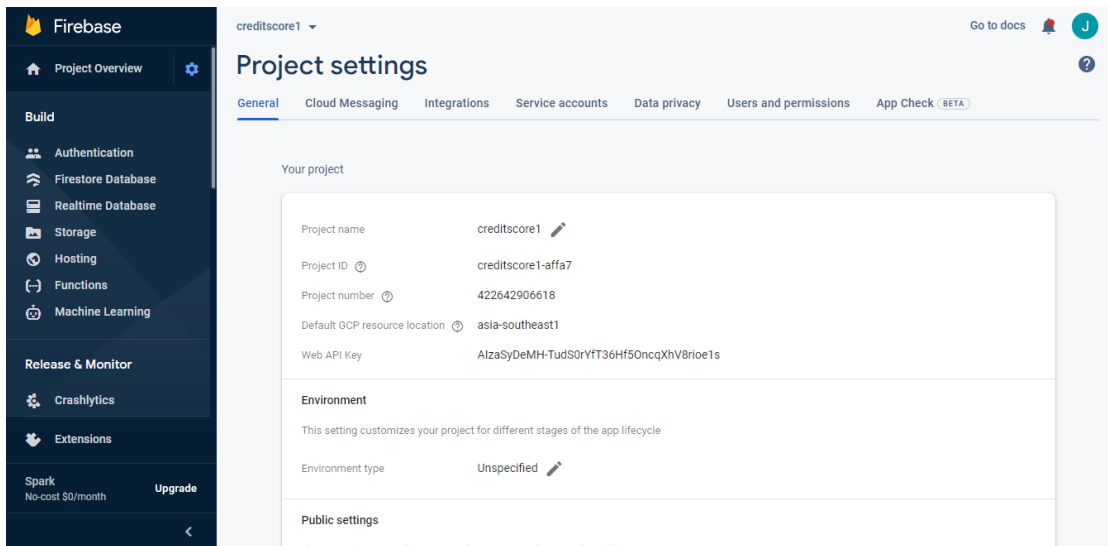
Figure 5.5.2.1 Firebase Project Setup
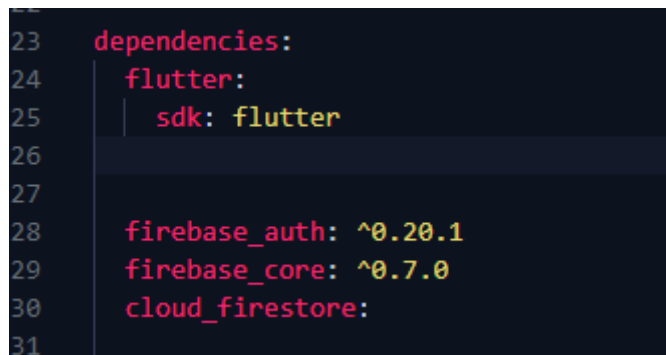
Figure 5.5.2.2 Firebase Package

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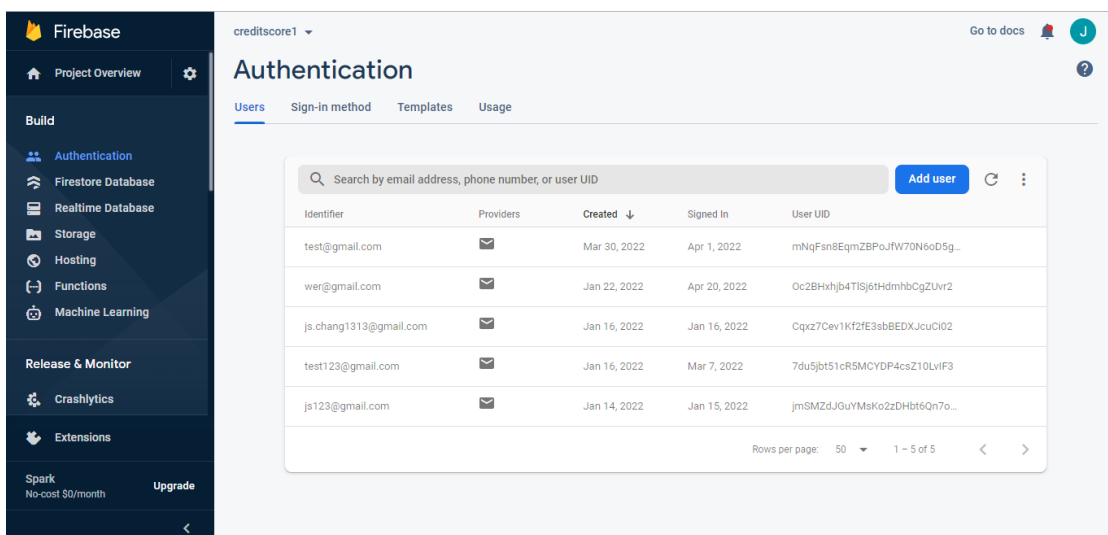
Figure 5.5.2.3 Firebase Authentication

```
try {
  await FirebaseAuth.instance
      .createUserWithEmailAndPassword(
        email: emailController.text.trim(),
        password: passwordController.text.trim(),
      )
      .then((value) => {postDetailsToFirestore()})
      .catchError((e) {
    Fluttertoast.showToast(msg: e!.message);
  });
} on FirebaseAuthException catch (e) {
  print(e);

  Utils.showSnackBar(e.message);
}
```

Figure 5.5.2.4 Catch Repeat Email

Cloud Firestore is used to store the user login authentication and user account information in the cloud database. First, developers need to register the application in Firebase they want to develop. Then, they need to enter the Android package name, download the configured files and install the Firebase SDK into the application. Figure x is shown that the project is done with registration and settings. Next, Figure x is the Firebase dependencies and packages which are firebase_auth, firebase_core, cloud_firestore are imported. Figure x is setup the Firebase Authentication to allow the user to create a new account and use email and password to login into the application. For Figure is try to catch the repeated email. For example, if the users want to sign up for a new account by using the existing email, then the system will display the error message. Lastly, after users successful create an account, the Firebase Cloud Firestore will store the information such as full name, email address, date of birth other related details.

5.6 Implementation Issues and Challenges

The first issue is the data are not good indicators. The data is not really from bank institutions, but it is from respondents on the Google survey form and data from Github. The 100 of data is not big enough to run the multiple linear regression, and it causes the result of correlation and multicollinearity, and the residual plot is not in the good model as expected. Other than that, the challenge is to come out with an algorithm. It takes a lot of time to finalize the equation with run multiple times of regression analysis, and research on how to implement the equation into the project. Another challenge in this project is to develop the functions, there is not much information about how to retrieve the user's alternative credit score in an application, and there are some alternative credit score websites system and mobile applications that are not suitable in our country religion, which means that it spends more time and effort to explore and code on how to build the functions in the proposed system.

5.7 System Operation

Splash Screen

Figure 5.7.1 Splash Screen

When the user opens the application, the splash screen will display for 2 seconds. After the splash screen, the system will display the Sign in page.

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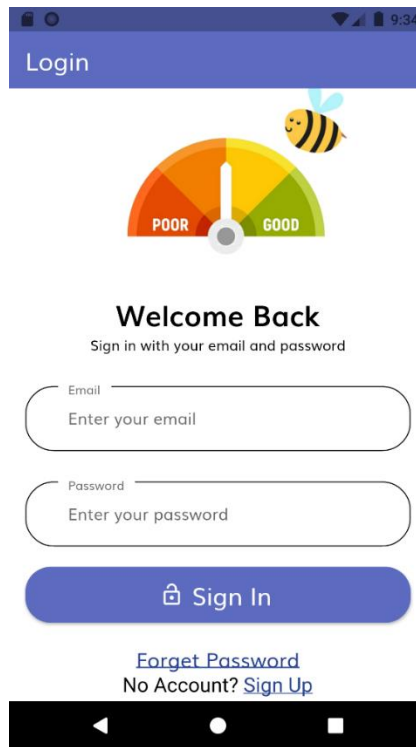
Sign in Page

Figure 5.7.2 Sign in Page

Figure 5.7.2 is Sign in Page. Before the user get into the main page to access the function in this application, they are required to login their account with email and password. For the new user, they are required to click onto the "No Account? Sign Up" to register a new account. The system will check for the email address to make sure the email is new and to avoid duplicate in the database. If the user forgot their password, they can click the forget password button and the system will redirect them to reset password page.

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Reset Password Page
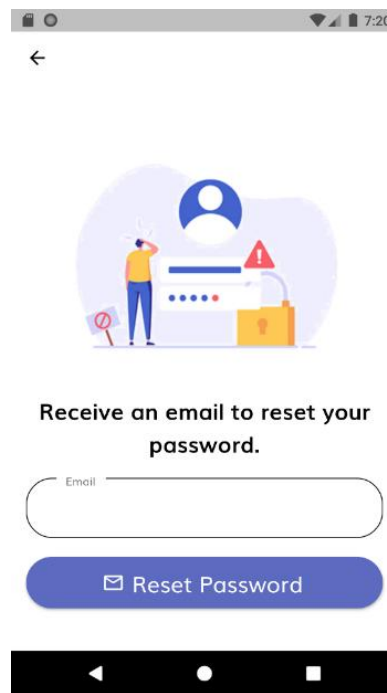
Figure 5.7.3 Reset Password Page
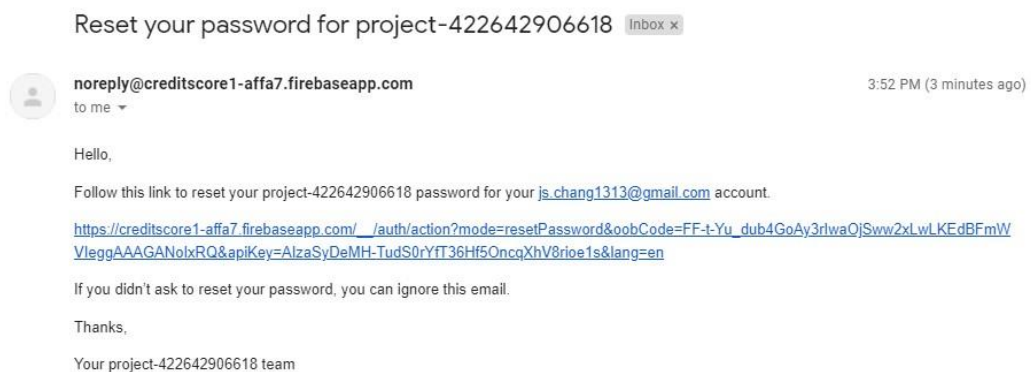
Figure 5.7.4 Reset Password Verification Link
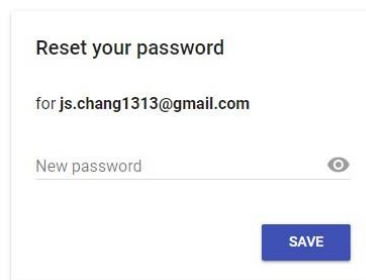
Figure 5.7.5 Reset Password

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If the exist user forgot their password, they can click the "Forget password", and the system will redirect the user to Figure 5.7.3 to reset the password. Then, after user enter their email address, the system will send a verification link to their email address. User can reset their new password then click on the save button. Lastly, the system will prompt to the Login page, and user can enter their email and the new reset password to login to the system.

Sign Up Page

Figure 5.7.6 Sign Up page

After user clicked onto the "No Account? Sign Up", system will bring them to sign up page to register a new account. User is required to enter the following account details such as their full name, email, password, bank, bank account, and education level. The user's details will update to the Firebase. If the details are duplicate in Firebase, the system will display the error message, and the user need to resubmit the form. After

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register new account successfully, the screen will redirect to the login page and user can login their account now.

Home Page
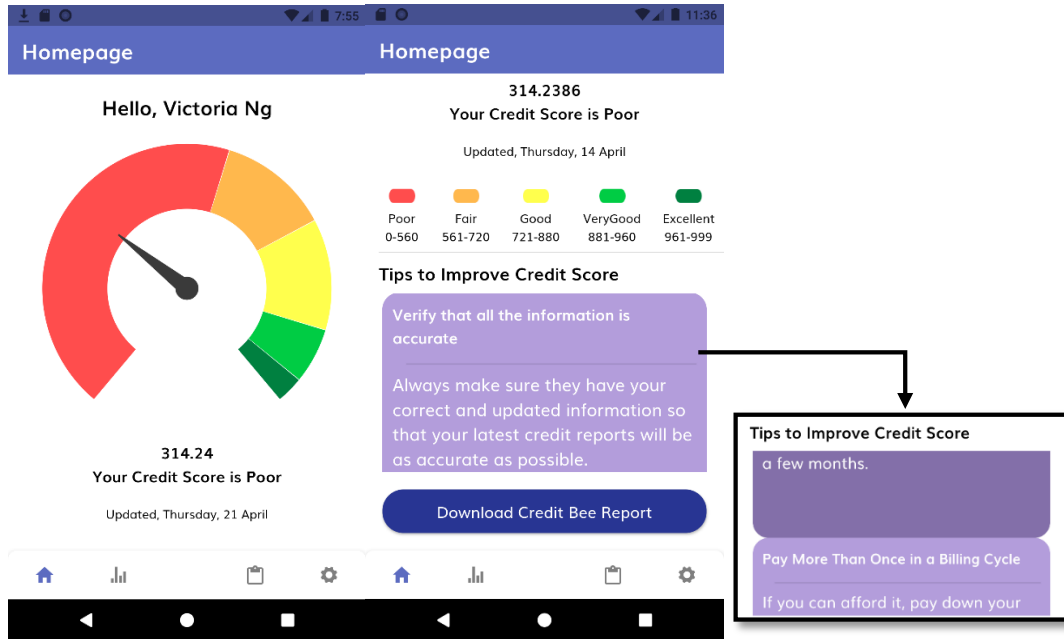
Figure 5.7.7 Home Page
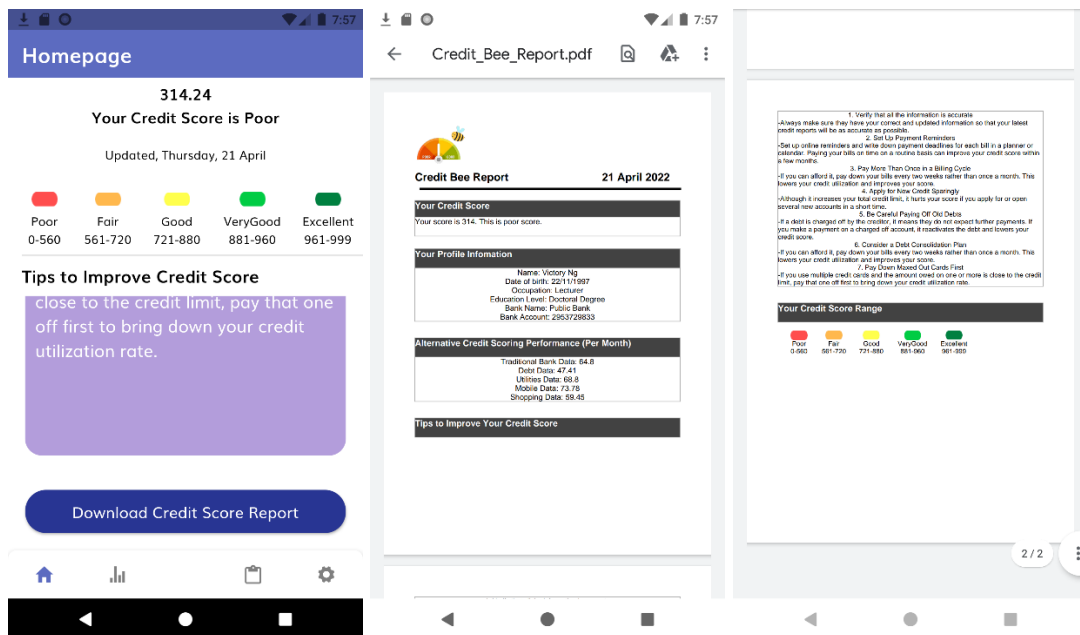
Figure 5.7.8 Alternative Credit Score Report

The system will redirect the user to the Home Page after login their account. First and foremost, the system will display the user name with "Hello, [user name]". The following is the gauge and total alternative credit score with the description "Your Credit Score is [Poor/Fair/Good/Very Good/Excellent]". All the data records are retrieve from the firebase and implement it into the equation. Other than that, the user able to view the tips to improve their credit score. Lastly, the user can download their alternative credit score report. When the user clicks on the Download Credit Bee Report button in Figure 5.7.8, the system will redirect them to the PDF view. Therefore, the user can choose to download the report or back to the system.

Statistics Chart
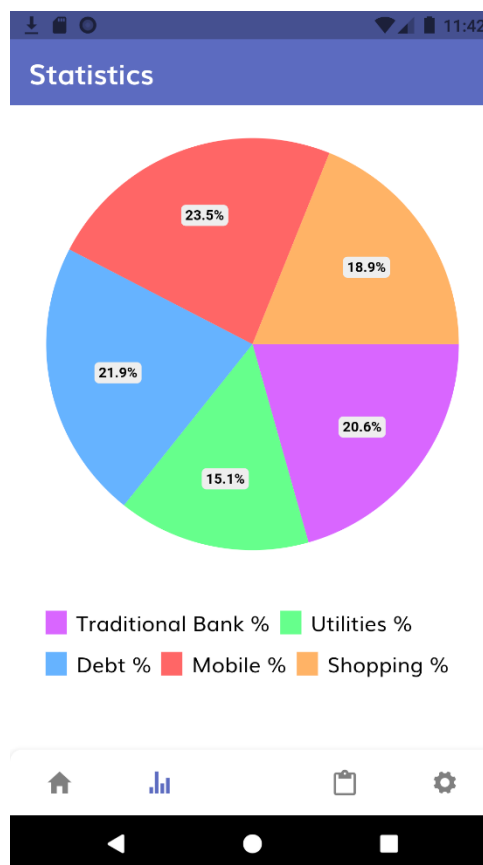
Figure 5.7.9 Statistic Chart

The system will display the user's alternative credit score pie chart. Pie chart can let the user easy to understand the information. It clearly shows facts as a percentage of a total, which may be an effective communication tool for the inexperienced user. Other than that, chart allows the user to view a data comparison such as alternative data at a glance,

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which allowing them to perform an immediate analysis or quickly understand the information. Therefore, the user can have a clear view of their alternative data categories in the overall total score.
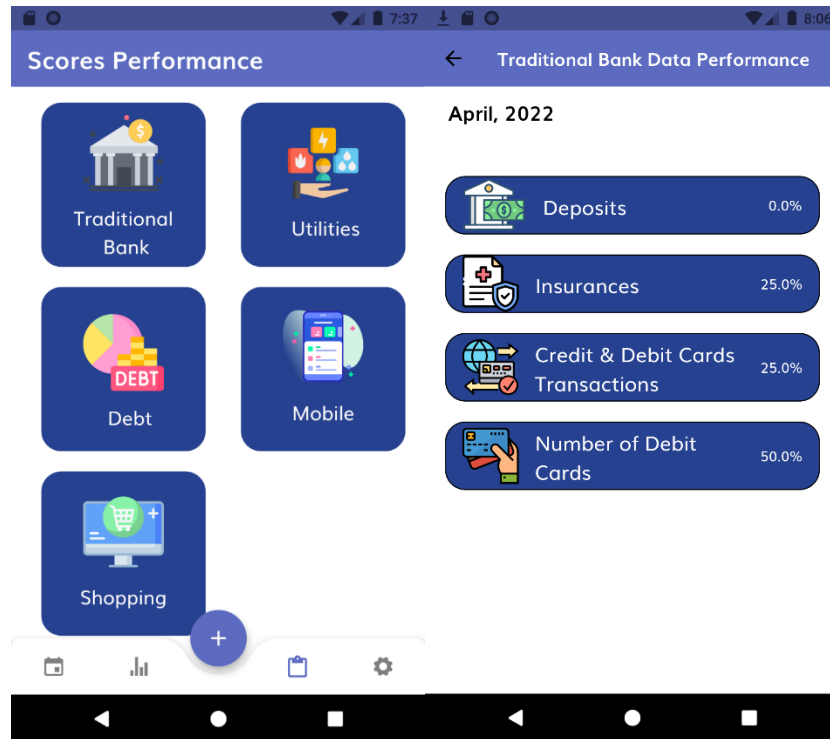
Score Performance Page

Figure 5.7.10 Score Performance Page

On the scoring performance page, users can view the scoring performance of each alternative data. When the user clicks on traditional bank data, the system will show the particular categories such as deposits, insurance, credit & debit cards transaction, and number of debit cards. Hence, the user can view their particular percentage from the total percentage and understand which they need to score higher or maintain.

Settings Page
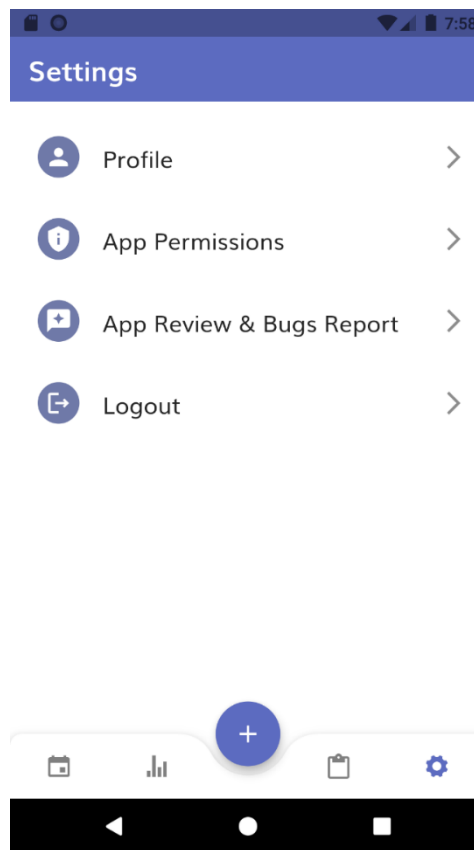
Figure 5.7.11 Setting Page

Setting page is to let user can edit their profile, view the app permissions, review the app and bugs report, and logout the application.
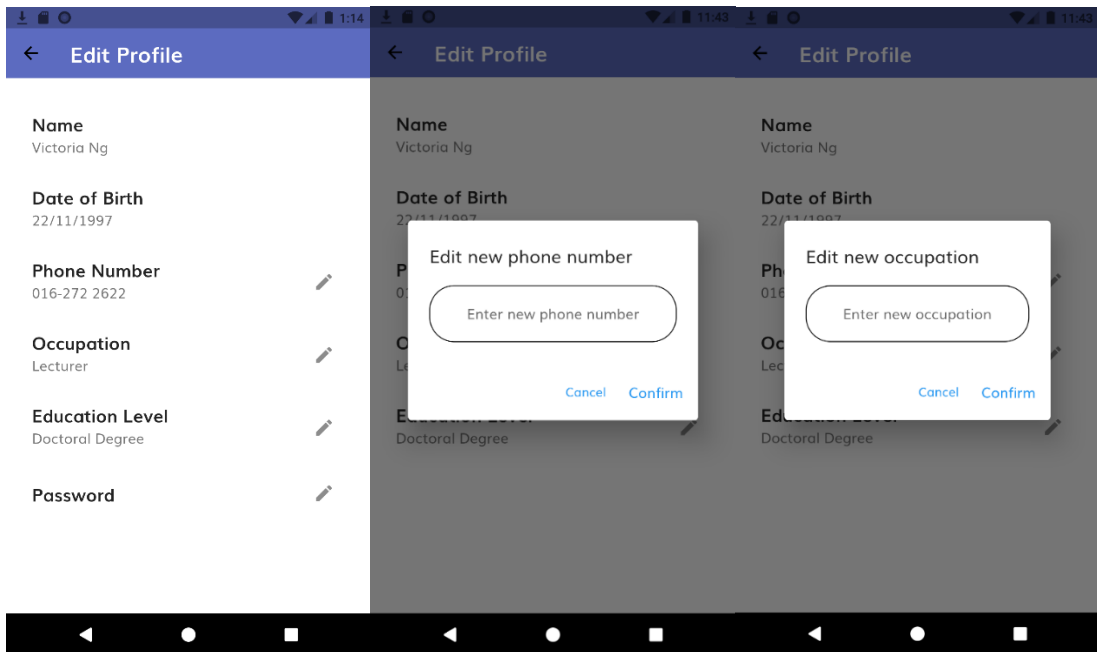
Update Profile Page

Figure 5.7.12 Update Profile Page

Users can edit and update their profiles in settings. First, the user's name and date of birth will be defaulted to determine if it is an actual user to view their credit score and download a credit report. Users can edit their phone number, occupation, education and password. After clicking on the edit icon button that the information wants to edit, the system will pop out the dialogue and the user need to fill in. If users do not want to change, they can click on cancel. The details will remain the same. The system will update user information immediately so that users can check their own information in time.

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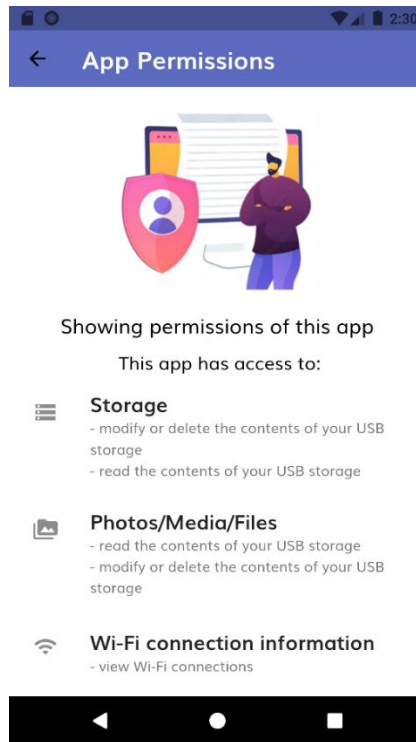
App Permission Page

Figure 5.7.13 App Permission Page

The app permission page is to let the users view on what permission on this application has access to such as storage, files and so on.
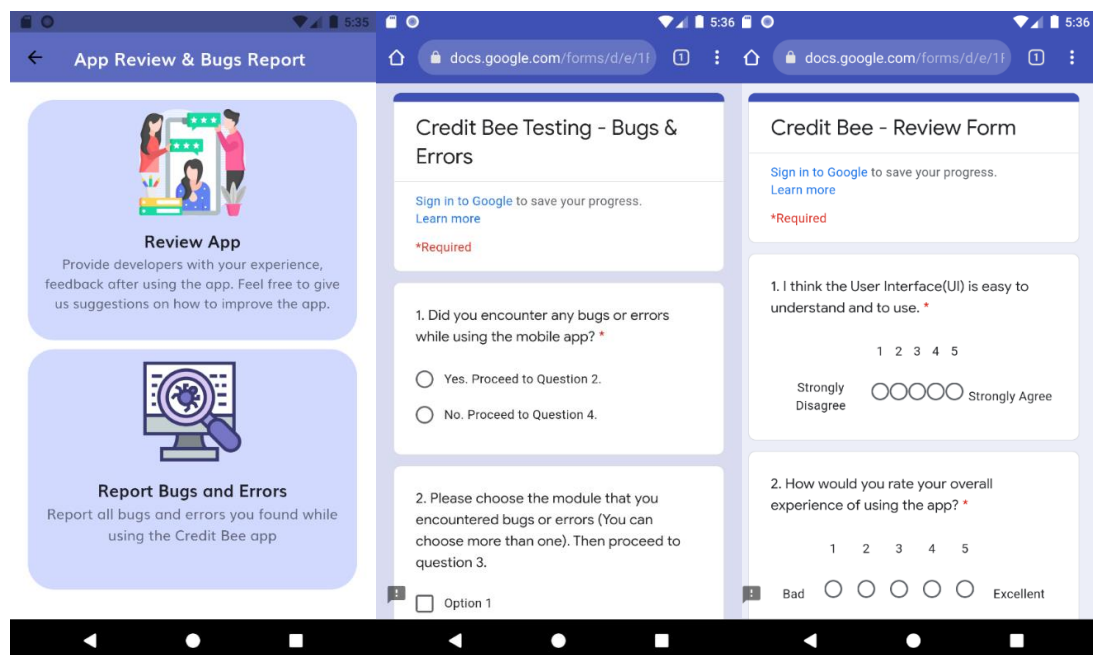
App Review & Bugs Report Page

Figure 5.7.14 App Review & Bugs Report Page

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Users can provide feedback or report bugs on the App Review and Bugs Report page. The system will present 2 options to the user. The user is then redirected to a google form, where the user can provide feedback to improve the system or report bugs to let developers know.

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CHAPTER 6: SYSTEM EVALUATION AND DISCUSSION

6.1 System Testing and Performance Metrics

6.1.1 Use Case Testing

Table 6.1.1.1 Use Case Testing for Sign Up Account

Use Case Name: Sign Up Account			ID: 1	
	Test Steps	Action	Expected Result	Status (Fail/Pass)
Main Flow	1	The system displays Sign Up button.	The system will direct user to the login page	PASS
	2	The user presses Sign Up button.		PASS
	3	System validate the information such as full name, email, password, bank, bank account, and education level.		PASS
	4	The user presses Sign Up button.		PASS
Alternate/Exceptional Flows	1	Enter a registered email address.	Account will not be created	PASS

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Table 6.1.1.2 Use Case Testing for Sign in Account

Use Case Name: Sign in Account			ID: 2	
	Test Steps	**Action**	**Expected Result**	**Status (Fail/Pass)**
Main Flow	1	The system displays Sign in button.	After user login, the system will direct user to the Homepage	PASS
	2	User enter valid email address and password.		PASS
	3	The user presses Sign In button.		PASS
	4	System validates user email address and password.		PASS
Alternate/Exceptional Flows	1	User inputs invalid email address and password.	System will display the errors message to the user.	PASS
	2	User presses Login button.		PASS
	3	System check the validity of entered email address and password.		PASS

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Table 6.1.1.3 Use Case Testing for Logout Account

Use Case Name: Logout Account			ID: 3	
	Test Steps	Action	Expected Result	Status (Fail/Pass)
Main Flow	1	The system displays Logout button	The system return to the Login Page	PASS
	2	The user presses Logout button		PASS
	3	The system will logout the user from the application		PASS

Table 6.1.1.4 Use Case Testing for Reset Password

Use Case Name: Reset Password			ID: 4	
	Test Steps	Action	Expected Result	Status (Fail/Pass)
Main Flow	1	The system displays Forget Password button	User enters their new password and login to the system.	PASS
	2	The user presses Forget Password button		PASS
	3	A forgot password page will display to user, the users need enter the email address		PASS
	4	The user enters the email address, the system will send the verification code to the user's email.		PASS
	5	After user enters verification code, the reset password page will		PASS

		let the users key in the new password.		
Alternate/Exceptional Flows	1	Enter a not registered email address	System will display the errors message to the user.	PASS
	2	Password does not meet requirement		PASS

Table 6.1.1.5 Use Case Testing for Homepage

Use Case Name: Homepage			**ID:** 5	
	Test Steps	**Action**	**Expected Result**	**Status (Fail/Pass)**
Main Flow	1	System will retrieve the user's personal information and data, and show the total of the credit score of the user.	The personal information and data of user is correct.	PASS
	2	User can check their credit score by using the range of credit score		PASS
	3	The system will provide improvement tips to the user according their credit score range		
	4	User can download their credit score report.		PASS

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Table 6.1.1.6 Use Case Testing for Statistic

Use Case Name: Statistic			ID: 6	
	Test Steps	Action	Expected Result	Status (Fail/Pass)
Main Flow	1	System retrieves the user's alternative data	System will show the chart of overall alternative data scores.	PASS
	2	User can view the chart of traditional bank data scores in the system.		PASS
	3	User can view the chart of debt data scores in the system		PASS
	4	User can view the chart of utilities data scores in the system		PASS
	5	User can view the chart of mobile data scores in the system		PASS
	6	User can view the chart of shopping data scores in the system		PASS

Table 6.1.1.7 Use Case Testing for Credit Score Performance

Use Case Name: Credit Score Performance			ID: 7	
	Test Steps	**Action**	**Expected Result**	**Status (Fail/Pass)**
Main Flow	1	System display the information that chosen by the user	User check their the percentage of alternative data categories in the system	PASS
	2	User clicks on the "Traditional Bank"		PASS
	3	System will display the traditional bank categories to the user		
	4	Users can view the traditional bank performance percentage for the current month		PASS
	5	When user clicks on the "Debt"		PASS
	6	System will display the debt categories to the user		PASS
	7	Users can view the debt performance percentage for the current month		PASS
	8	When user clicks on the "Utilities"		PASS
	9	System will display the utilities categories to the user		PASS
	10	Users can view the utilities performance percentage for the current month		PASS
	11	When user clicks on the "Mobile"		PASS

	12	System will display the mobile data categories to the user.		PASS
	13	Users can view the mobile data performance percentage for the current month		PASS
	14	When user clicks on the "Shopping"		PASS
	15	System will display the shopping data categories to the user.		PASS
	16	Users can view the shopping data performance percentage for the current month		PASS

Table 6.1.1.8 Use Case Testing for Update Profile

Use Case Name: Update Profile			ID: 8	
	Test Steps	**Action**	**Expected Result**	**Status (Fail/Pass)**
Main Flow	1	The user presses Update button	The system will display the updated personal information	PASS
	2	The information entered by the user will store to Firebase Cloud Firestore.		PASS

Table 6.1.1.9 Use Case Testing for App Reviews and Bugs Report

Use Case Name: App Reviews and Bugs Report			ID: 9	
	Test Steps	**Action**	**Expected Result**	**Status (Fail/Pass)**
Main Flow	1	The user presses App Review button	The system will return the user to App Reviews and Bugs Report page.	PASS
	2	System redirects to App Review Google form		PASS
	3	User can give the feedbacks in Google form		PASS
	4	The user presses Error and Bugs Report button		PASS
	5	System redirects to Error and Bugs Report Google form		PASS
	6	User can report the error and bugs in Google form		PASS

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6.2 System Function Testing

Each module is tested separately to ensure the project's functionality.

Splash Screen

Table 6.2.1 System Function Testing for Splash Screen

Test Action	Expected Result	Meet Expectation (✓/✗)
User launches application.	The system displays the splash screen when the user launches the application	✓

Login Screen

Table 6.2.2 System Function Testing for Login Sceen

Test Action	Expected Result	Meet Expectation (✓/✗)
Users enter email and password	The system validates user's email and password.	✓
Users press signup button	The system will direct user to the signup page	✓
Users press forgot password button	The system will direct user to the reset password page	✓

Sign up Screen

Table 6.2.3 System Function Testing for Sign up Screen

Test Action	Expected Result	Meet Expectation (✓/✗)
Users enter their personal information	The system validates user's personal information	✓
Users press signup button	The system will direct user to the Login page	✓

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Users press login Button	The system will direct user to the Login page	✓

Home Page

Table 6.2.4 System Function Testing for Home Page

Test Action	Expected Result	Meet Expectation (✓/✗)
Users view their name and total score.	The system validates user's personal information and score	✓
Users can view the tips to improve credit score	The system display the tips	✓
Users press download credit report button	The system will direct user to the report view	✓

Statistic Chart Page

Table 6.2.5 System Function Testing for Statistic Chart Page

Test Action	Expected Result	Meet Expectation (✓/✗)
Users press menu button	The system display the data categories	✓
Users press the data categories	The system display the chosen data categories	✓

Scores Performance Page

Table 6.2.6 System Function Testing for Scores Performance Page

Test Action	Expected Result	Meet Expectation (✓/✗)
Users press data categories button	The system display the data categories	✓

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Settings Page

Table 6.2.7 System Function Testing for Setting Page

Test Action	Expected Result	Meet Expectation (✓/✗)
Users press profile button	The system direct user to update profile page	✓
User press app permission button	The system direct user to app permission page	✓
User press app review & bugs report page button	The system direct user to app review & bugs report page	✓
User press logout button	The system will direct the user to the sign in page	✓

CHAPTER 7: CONCLUSION AND RECOMMENDATION

7.1 Project Review, Discussion and Conclusion

The proposed project is to develop a mobile application for alternative credit scoring at a Fintech company to improve personal financial planning. A credit score is a statistical analysis performed by financial institutions to assess a person's creditworthiness in order to decide whether to extend or deny their credit. Credit scores can affect many financial transactions, including mortgages, loans, credit cards, and more. Lenders can make decisions about borrowers based on past and present credit score data and avoid or minimize the risk of borrower default because they can only be determined based on the characteristics of the borrower.

According to research, there are still many unbanked, underbanked individuals which do not use financial service in the bank. There are no able to obtain the loans from banks due to no history with financial institutions, the credit assessment data and credit scores of individuals are not available or not made known to a lender, there are high number of unbanked and underbanked population in Malaysia cannot get loans approved easily due to the process take time and complicated. Therefore, the proposed project will be an alternative credit scoring system using alternative data in the mobile application because it is easy and convenient for those unbanked, underbanked users as they only need their mobile phone usage to know their credit scoring compared to a traditional bank. The borrowers can easily access the financial planning products without going to the bank, queuing up, and filling many forms that they live in the rural and remote location.

The similar application I compared, analysed, and reviewed are Credit Karma, Credit Sesame, WalletHub, and Mint: Personal Finance & Money. Since it is an alternative credit scoring application, the bank institution and lenders can view an individual's personal information and records and the system will calculate the score. Therefore, comparison, analysis, and review on the similar system will contribute the good design of the project and also the functions. Hence, this can help to provide the better financial services to serve the users and give them the accurate credit score report in this mobile application.

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Moreover, regression analysis calculates a user's alternative credit score using data records provided by the banking institution. The formula is done by using multiple linear regression to predict a person's creditworthiness. The categories of data such as Traditional Bank data, Debt data, Utilities data, Mobile data, and Shopping data. Besides, the data records provided by the banking institution is linked to the Cloud Firebase. Therefore, after user login, all the data given by the banking institution is applied into the equation and derived in the algorithm, which is the final formula for calculating an individual's alternative credit score.

In a nutshell, the proposed project is to develop a mobile application for alternative credit scoring at a Fintech company to improve personal financial planning. The algorithm to calculate a user's alternative credit score is using multiple linear regression. Then, the user can download his/her credit report in this mobile application, an overall view graph of the data records in percentage, and their data categories performance.

7.2 Future Work

The project is still having some limitations that can be improved in the future. First, the data of the users must be big enough to run a perfect regression analysis. Because of the data, the regression model is not perfect and no reach the expectation and will cause inaccurate prediction. The data can be collected from bank institutions that can cooperate with the proposed system, with more details information fields in the future.

Next, the system can calculate the alternative credit score for the company, but not only for personal. Due to the lack of resources to get the company alternative data, it lacks many details and which may bring the wrong information into the project. In future, the system can use to calculate the company's alternative credit score to help the company increase their creditworthiness.

Lastly, the project can improve on the features such as income and expenses categories. The data is needed to retrieve the user's income and expenses records which link to their bank account. In this way, when the users register and enter their bank information in details such as a real bank account, the system will display the user's

income and expenses in a statistic chart or graph view. Hence, the user can know their income and expense in a clear view.

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APPENDIX

APPENDIX A-1
App Review Form

Credit Bee - Review Form
Form description

1. I think the User Interface(UI) is easy to understand and to use. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

2. How would you rate your overall experience of using the app? *

	1	2	3	4	5	
Bad	○	○	○	○	○	Excellent

3. I think all the functions in this app are well developed. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

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4. I need the support of a technical person to be able to use this app. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

5. How likely would you recommend Credit Bee to others? *

	1	2	3	4	5	
Unlikely	○	○	○	○	○	Very Likely

6. What do you like the most in the Credit Bee mobile app? *

Long answer text

7. What do you like the least in the Credit Bee mobile app? *

Long answer text

8. In your opinion, which part of the system can be improved and how? (If none, you can leave this section empty)

Long answer text

9. Are there any features that you would like to proposed to the developers for this app? (If none, you can leave this section empty)

Long answer text

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APPENDIX

APPENDIX A-2
Bugs and Errors

Credit Bee - Bugs & Errors

Form description

1. Did you encounter any bugs or errors while using the mobile app?   *

○ Yes. Proceed to Question 2.

○ No. Proceed to Question 4.

2. Please choose the module that you encountered bugs or errors

☐ Sign Up Account

☐ Login Account

☐ Reset Password

☐ Home Page

☐ Download Credit Bee Report

☐ Statistic Chart

☐ Credit Score Performance

☐ Edit Profile

☐ Logout

☐ Other...

3. Please explain the bugs or errors that you encountered.

Long answer text

4. Is there anything changes you want to make to the app? If yes, please provides us with suggestions on how we can improve the app. If no, just leave it blank.

Long answer text

APPENDIX

APPENDIX A-3
Survey Form

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APPENDIX

○ Chinese

○ Indian

Religion *

Your answer

Married Status *

○ Yes

○ No

Employed status *

○ Yes

○ No

Occupation *

Your answer

Income Per Month (RM) *

Your answer

Bank *

Your answer

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APPENDIX

Section 3 of 7

Section B: Traditional Bank

Description (optional)

1. Percentage of ability pay to the bank *

Short answer text

2. How many times is the deposit paid per month? *

Short answer text

3. How many times is the Insurance paid per month? *

Short answer text

4. How many transactions per month on credit and debit cards? *

Short answer text

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APPENDIX

5. Number of Debit Cards

Short answer text

6. The number of Investment per month

Short answer text

7. Number of Credit Cards

Short answer text

8. The number of times you withdrawals per month

Short answer text

Section C: Debt

Description (optional)

1. Percentage of ability to pay the debt

Short answer text

2. The number of times you pay car loans per month

Short answer text

3. The number of times you pay house loans per month

Short answer text

4. The number of times you pay student loan per month

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APPENDIX

5. The number of times you pay outstanding bills per month

Short answer text

6. The number of times you pay rent per month

Short answer text

7. The number of times you pay credit card loan per month

Short answer text

8. How many times you make monthly mortgage payments?

Short answer text

APPENDIX

Section D: Utilities

Description (optional)

1. Percentage of ability to pay the utilities payment

Short answer text

2. How many times do you make monthly water bills payments?

Short answer text

3. How many times do you make monthly electricity bill payments?

Short answer text

4. How many times do you make monthly Wi-Fi bills payments?

Short answer text

5. How many times do you make monthly mobile phone bill payments?

Short answer text

6. How many times do you make monthly Cable TV payments?

Short answer text

7. How many times do you make monthly gas bill payments?

Short answer text

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Section E: Mobile

Description (optional)

1. Percentage of ability to pay the mobile payment

Short answer text

2. How many social media platforms are in a negative state? (e.g. gambling app)

Short answer text

3. How many times do you make monthly data usage payments?

Short answer text

5. Your top-up history per month

Short answer text

6. How many E-Wallets do you have?

Short answer text

7. How many social media platforms are in a postive state? (e.g. learning apps, Instagram)

Short answer text

8. How many times do you make monthly SMS payments?

Short answer text

9. The email received per month (e.g. Receipts, Invoice)

Short answer text

10. Your calling behavior per month

Short answer text

11. The number of downloaded mobile games in your smart phone

Short answer text

12. Your monthly geographic location

Short answer text

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APPENDIX

Section F: Shopping

Description (optional)

---

1. Percentage of ability pay the shopping payment

Short answer text

---

2. How many times do you make monthly E-commerce transaction ?

Short answer text

3, The number of times your monthly e-commerce purchasing habits

Short answer text

---

4. The number of transactions you make on the food delivery platform per month

Short answer text

---

5. The number of transactions you make on the airline bookings per month

Short answer text

---

6. The number of transactions you make on the hotel bookings per month

Short answer text

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APPENDIX A-4
Survey Response

Age	Gender	Highest Level Education	Race	Religion	Married Status	Employed status	Occupation	Income Per Month (RM)	Bank	1. Percentage of ability pay to the bank	2. How many times is the deposit paid per month?	3. How many times is the Insurance paid per month?
18 - 28 years old	Female	Diploma	Malay	Islam	No	No	Student	0	Maybank	50	0	1
18 - 28 years old	Female	Diploma	Malay	islam	No	No	Student	0	CIMB	50	0	1
18 - 28 years old	Female	SPM Level	Malay	Islam	No	No	student	0	Ambank	50	2	1
18 - 28 years old	Female	Bachelor's Degrees	Chinese	Buddhism	No	No	Student	0	Public bank	55	0	0
18 - 28 years old	Female	Bachelor's Degrees	Chinese	Christianity	No	No	Student	0	Cimb	50	1	1
18 - 28 years old	Female	Bachelor's Degrees	Malay	Islam	No	No	Student	0	Cimb	50	0	1
18 - 28 years old	Female	Bachelor's Degrees	Malay	Islam	No	No	Student	0	CIMB	50	0	0
18 - 28 years old	Male	SPM Level	Chinese	Buddha	No	No	Student	0	Ambank	20	0	1
18 - 28 years old	Female	Bachelor's Degrees	Chinese	Christian	No	No	Student	0	Cimb	50	1	1
18 - 28 years old	Male	SPM Level	Indian	Christian	No	No	Student	0	Ambank	50	0	1
18 - 28 years old	Female	Bachelor's Degrees	Indian	Hindu	No	No	Student	0	Maybank	50	0	1
18 - 28 years old	Male	Bachelor's Degrees	Chinese	Christian	No	No	Student	0	Public bank	55	0	1
18 - 28 years old	Female	Bachelor's Degrees	Indian	Hindu	No	No	Student	0	Public bank	50	0	1
18 - 28 years old	Male	Bachelor's Degrees	Indian	hindu	No	No	student	0	Maybank	50	0	1
18 - 28 years old	Male	SPM Level	Chinese	buddha	No	No	student	0	ambank	40	0	1
18 - 28 years old	Female	Diploma	Chinese	buddha	No	No	student	0	cimb	50	0	1
18 - 28 years old	Female	Bachelor's Degrees	Malay	Islam	No	Yes	Student	500	Maybank	70	0	1
18 - 28 years old	Female	Bachelor's Degrees	Malay	Islam	No	Yes	Student	650	Public Bank	65	1	1
18 - 28 years old	Male	Master's Degree	Malay	Islam	No	Yes	Student	900	Maybank	80	0	1
18 - 28 years old	Female	SPM Level	Chinese	Buddha	No	Yes	Student	1200	Ambank	80	0	1
18 - 28 years old	Male	Diploma	Chinese	Buddha	No	Yes	Student	1200	Public bank	95	1	1

Form Responses 1

4. How many transactions per month on credit and debit cards?	5. Number of Debit Cards	6. The number of Investment per month	7. Number of Credit Cards	8. The number of times you withdrawals per month	1. Percentage of ability to pay the debt	2. The number of times you pay car loans per month	3. The number of times you pay house loans per month	4. The number of times you pay student loan per month	5. The number of times you pay outstanding bills per month	6. The number of times you pay rent per month
3	2	0	1	3	60	0	0	1	1	1
6	1	0	0	4	60	0	0	1	1	1
7	1	0	1	4	60	0	0	0	0	0
1	5	1	0	2	60	0	0	1	1	1
6	1	0	1	2	60	0	0	1	1	1
7	2	0	1	1	60	0	0	1	1	1
1	6	1	1	2	60	0	0	1	1	1
7	2	1	1	2	60	0	0	1	0	0
5	2	1	0	1	60	0	0	1	1	1
5	1	4	4	4	60	0	0	1	0	1
3	2	0	1	1	60	0	0	1	1	1
4	2	1	1	3	60	0	0	1	1	1
3	2	0	1	2	60	0	0	1	1	1
1	3	1	0	2	60	0	0	1	1	1
2	2	0	1	1	60	0	0	1	0	1
3	2	0	1	2	60	0	0	1	1	1
2	1	0	0	0	70	0	0	1	1	1
5	2	0	1	4	65	0	0	1	1	1
5	2	2	1	3	80	0	0	1	1	1

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7. The number of times you pay credit card loan per month	8. How many times you make monthly mortgage payments?	1. Percentage of ability to pay the utilities payment	2. How many times do you make monthly water bills payments?	3. How many times do you make monthly electricity bill payments?	4. How many times do you make monthly Wi-Fi bills payments?	5. How many times do you make monthly mobile phone bill payments?	6. How many times do you make monthly Cable TV payments?	7. How many times do you make monthly gas bill payments?	1. Percentage of ability to pay the mobile payment	2. How many social media platforms are in a negative state? (e.g. gambling app)
0	0	52	1	0	0	2	0	0	55	0
0	0	52	1	0	0	1	0	0	55	0
0	1	52	0	0	0	1	0	0	55	0
0	0	52	1	0	0	1	0	0	55	0
0	0	55	1	0	0	1	0	0	55	0
0	0	52	1	0	0	2	0	0	55	0
0	0	52	1	0	0	1	0	0	55	0
0	0	52	0	0	0	2	0	0	55	0
0	0	55	1	0	1	2	0	0	55	0
0	0	52	0	0	0	1	0	0	55	0
0	0	52	1	0	0	2	0	0	55	1
0	0	50	1	0	0	2	0	0	55	0
0	0	52	1	0	0	3	0	0	55	0
0	0	52	0	0	0	2	0	0	55	1
0	0	52	1	0	1	2	0	0	55	0
0	0	65	1	0	0	1	0	0	55	0
0	0	65	1	0	0	2	0	0	75	1
0	0	80	1	0	0	2	0	0	85	0

3. How many times do you make monthly data usage payments?	4. How many times do you make monthly subscription payments?	5. Your top-up history per month	6. How many E-Wallets do you have?	7. How many social media platforms are in a postive state? (e.g. learning apps, Instagram)	8. How many times do you make monthly SMS payments?	9. The email received per month (e.g. Receipts, Invoice)	10. Your calling behavior per month	11. The number of downloaded mobile games in your smart phone	12. Your monthly geographic location	1. Percentage of ability pay the shopping payment
3	3	5	3	8	1	5	0	2	2	60
1	2	4	3	8	0	6	1	3	0	60
1	2	3	4	6	1	5	1	2	2	60
1	2	2	3	9	1	5	0	2	2	60
1	3	2	4	8	1	6	1	3	3	60
2	4	2	5	8	0	6	2	3	3	60
1	2	3	5	9	1	6	0	6	2	60
2	2	2	4	8	0	6	0	3	3	60
2	2	3	5	8	1	7	0	5	3	60
1	2	2	4	9	1	7	4	7	4	60
2	1	2	4	8	0	6	0	3	3	60
2	1	3	5	9	1	5	0	2	2	60
2	1	4	4	9	1	6	0	3	3	60
3	1	4	4	8	1	7	0	4	4	60
2	1	2	5	9	1	7	0	4	4	60
2	1	2	4	8	0	6	0	2	2	60
1	1	3	4	9	1	3	0	1	1	60
2	1	2	4	9	1	2	0	3	3	60
2	1	6	5	9	1	1	2	3	3	60

2. How many times do you make monthly E-commerce transaction ?	3. The number of times your monthly e-commerce purchasing habits	4. The number of transactions you make on the food delivery platform per month	5. The number of transactions you make on the airline bookings per month	6. The number of transactions you make on the hotel bookings per month
2	3	2	0	0
3	3	1	0	0
1	1	2	0	0
3	3	3	0	0
3	0	3	0	0
0	0	3	0	0
2	2	2	0	0
0	2	2	0	0
0	0	4	0	0
0	3	4	0	0
2	2	2	0	0
4	1	3	0	0
2	1	2	0	0
1	1	3	1	0
2	1	2	0	0
1	1	3	0	0
1	1	2	0	0
1	1	3	0	0
1	2	2	0	0

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APPENDIX B-1

FINAL YEAR PROJECT WEEKLY REPORT
(Project II)

Trimester, Year: T3Y3	Study week no.: 1
Student Name & ID: CHANG JE SEE 18ACB04578	
Supervisor: Mr. SU LEE SENG	
Project Title: MOBILE APPLICATION DEVELOPMENT OF AN ALTERNATIVE CREDIT SCORING SYSTEM AT A FINTECH COMPANY TO IMPROVE PERSONAL FINANCIAL PLANNING	

1. WORK DONE

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

- Completed Chapter 1 and Chapter 2

2. WORK TO BE DONE

- Chapter 3
- Research on how to do algorithm to calculate alternative credit score for an individual
- Make changes and code on UI

3. PROBLEMS ENCOUNTERED

None

4. SELF EVALUATION OF THE PROGRESS

So far so good

_____
Supervisor's signature

_____
Student's signature

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FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3Y3	**Study week no.: 4**
Student Name & ID: CHANG JE SEE 18ACB04578	
Supervisor: Mr. SU LEE SENG	
Project Title: MOBILE APPLICATION DEVELOPMENT OF AN ALTERNATIVE CREDIT SCORING SYSTEM AT A FINTECH COMPANY TO IMPROVE PERSONAL FINANCIAL PLANNING	

1. WORK DONE

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

- Completed Chapter 3

2. WORK TO BE DONE

- Research on how to do algorithm to calculate alternative credit score for an individual
- Chapter 4

3. PROBLEMS ENCOUNTERED

- None

4. SELF EVALUATION OF THE PROGRESS

- Need to explore more and find resources from articles or websites.

_____
Supervisor's signature

_____
Student's signature

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FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3Y3	**Study week no.: 6**
Student Name & ID: CHANG JE SEE 18ACB04578	
Supervisor: Mr. SU LEE SENG	
Project Title: MOBILE APPLICATION DEVELOPMENT OF AN ALTERNATIVE CREDIT SCORING SYSTEM AT A FINTECH COMPANY TO IMPROVE PERSONAL FINANCIAL PLANNING	

1. WORK DONE

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

- Completed Chapter 4

2. WORK TO BE DONE

- Chapter 5
- Continue work on the coding part

3. PROBLEMS ENCOUNTERED

- The data records need more times to find and filter. A lot of downloaded GitHub CSV files and internet resources is not meet the expectations.

4. SELF EVALUATION OF THE PROGRESS

- Need to speed up the process
- Do more research and follow the supervisor's advice and solutions to find out the ideas.

_____

Supervisor's signature

_____

Student's signature

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FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3Y3	Study week no.: 8
Student Name & ID: CHANG JE SEE 18ACB04578	
Supervisor: Mr. SU LEE SENG	
Project Title: MOBILE APPLICATION DEVELOPMENT OF AN ALTERNATIVE CREDIT SCORING SYSTEM AT A FINTECH COMPANY TO IMPROVE PERSONAL FINANCIAL PLANNING	

1. WORK DONE

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

- Completed Chapter 5, technologies and tools involved part

2. WORK TO BE DONE

- Filter and categorize the data records
- Calculate the equation using multiple linear regression

3. PROBLEMS ENCOUNTERED

- Calculating the multiple linear regression takes a lot of time to come out the better model.

4. SELF EVALUATION OF THE PROGRESS

- So far so good

_____

Supervisor's signature

_____

Student's signature

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FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3Y3	Study week no.: 10
Student Name & ID: CHANG JE SEE 18ACB04578	
Supervisor: Mr. SU LEE SENG	
Project Title: MOBILE APPLICATION DEVELOPMENT OF AN ALTERNATIVE CREDIT SCORING SYSTEM AT A FINTECH COMPANY TO IMPROVE PERSONAL FINANCIAL PLANNING	

1. WORK DONE

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

- Filter and categorize the data records

2. WORK TO BE DONE

- Come out with an algorithm and implement the equation into code
- Chapter 5, use case testing part

3. PROBLEMS ENCOUNTERED

- Still in the process of calculating the multiple linear regression

4. SELF EVALUATION OF THE PROGRESS

- Need to speed up the process

_____
Supervisor's signature

_____
Student's signature

B-5

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FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3Y3	Study week no.: 12
Student Name & ID: CHANG JE SEE 18ACB04578	
Supervisor: Mr. SU LEE SENG	
Project Title: MOBILE APPLICATION DEVELOPMENT OF AN ALTERNATIVE CREDIT SCORING SYSTEM AT A FINTECH COMPANY TO IMPROVE PERSONAL FINANCIAL PLANNING	

1. WORK DONE

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

- The equation of calculating an individual alternative credit score.

2. WORK TO BE DONE

- Implement the equation into code
- Retrieve the user records from Cloud Firestore
- Debug some errors in the code
- Chapter 6 and Chapter 7
- Poster design
- Finalized FYP2 report

3. PROBLEMS ENCOUNTERED

- The data model is not good as expected, but the data is referring from survey form and download files from GitHub.

4. SELF EVALUATION OF THE PROGRESS

- Need to speed up the process

SuLee

_____   _____

Supervisor's signature   Student's signature

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APPENDIX

APPENDIX C-1:
POSTER

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APPENDIX

APPENDIX D-1

PLAGIARISM CHECK RESULT

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APPENDIX

10	Submitted to University of Wollongong Student Paper	<1%
11	Submitted to Universiti Tunku Abdul Rahman Student Paper	<1%
12	towardsdatascience.com Internet Source	<1%
13	lo-motion.de Internet Source	<1%
14	Submitted to Asia Pacific University College of Technology and Innovation (UCTI) Student Paper	<1%
15	millennialmoney.com Internet Source	<1%
16	www.consumerfinance.gov Internet Source	<1%
17	Submitted to Wawasan Open University Student Paper	<1%
18	mikewdesign.com Internet Source	<1%
19	Submitted to Coventry University Student Paper	<1%
20	Submitted to Binus University International Student Paper	<1%

21	Submitted to Imperial College of Science, Technology and Medicine Student Paper	<1%
22	digitalcommons.lasalle.edu Internet Source	<1%
23	lendfoundry.com Internet Source	<1%
24	fict.utar.edu.my Internet Source	<1%
25	ejournal.unsrat.ac.id Internet Source	<1%
26	www.intechopen.com Internet Source	<1%
27	www.thebalance.com Internet Source	<1%
28	dspace.daffodilvarsity.edu.bd:8080 Internet Source	<1%
29	www.cs.mun.ca Internet Source	<1%
30	Submitted to University of Bedfordshire Student Paper	<1%
31	Submitted to DeVry University Onlline Student Paper	<1%
32	Submitted to University of Greenwich	

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"chapter 3 Disciplined Teams vs. Agile Teams", IGI Global, 2022
Publication

54   Submitted to Daffodil International University
     Student Paper   <1%

55   Hyojin Kim, Jeff Haberl. "Development and
     application of weather-normalized monthly   <1%
     building water use model", Energy and
     Buildings, 2014
     Publication

56   Submitted to President University
     Student Paper   <1%

57   Ranajoy Mallik, Amlan Protim Hazarika,
     Sudarshana Ghosh Dastidar, Dilip Sing, Rajib   <1%
     Bandyopadhyay. "Development of An Android
     Application for Viewing Covid-19 Containment
     Zones and Monitoring Violators Who are
     Trespassing into It Using Firebase and
     Geofencing", Transactions of the Indian
     National Academy of Engineering, 2020
     Publication

58   Submitted to University of Ulster
     Student Paper   <1%

59   elysiumproblogs.blogspot.com
     Internet Source   <1%

60   hdl.handle.net
     Internet Source   <1%

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APPENDIX E-1 FYP2 CHECKLIST

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)	CHANG JE SEE
ID Number(s)	18ACB04578
Programme / Course	FICT/IB
Title of Final Year Project	Mobile application development of an alternative credit scoring system at a Fintech company to improve personal financial planning.

Similarity	**Supervisor's Comments** **(Compulsory if parameters of originality exceeds the limits approved by UTAR)**
Overall similarity index:___11_____ % **Similarity by source** Internet Sources: ___7_____% Publications: ____1_____% Student Papers: ____8_____%	
Number of individual sources listed of more than 3% similarity: 0_____	
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SuLee

_____   _____

  Signature of Supervisor   Signature of Co-Supervisor

  Name: ____Mr. Su Lee Seng____   Name: _____

  Date: _____19 April 2022_____   Date: _____

Bachelor of Information Systems (Honours) Business Information Systems
Faculty of Information and Communication Technology (Kampar Campus), UTAR

UNIVERSITI TUNKU ABDUL RAHMAN

FACULTY OF INFORMATION & COMMUNICATION TECHNOLOGY (KAMPAR CAMPUS)

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