UNIVERSITY OF WESTMINSTER

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Software Development Group Project

5COSC021C

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SaveNest

SE- 41

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I. Declaration

We declare that this report in its entirety, together with all of the artifacts to it, is our original work and hasn't been submitted for credit toward any degree, certificate, or academic qualification to any other institution, college, or organization.

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Table 1: Team members

Date-08/01/2024

II. Abstract

Inflation is one of the major problems the modern world is facing. Due to this almost every human is living a hard life. But most of the time it is because of unnecessary spending and spending more than necessary. Sometimes people tend to spend money on unnecessary things because of an appealing offer or because of someone's recommendation. These types of situations cause them to lose their hard-earned money on something completely unnecessary and this will also tighten their budget until the next paycheck. If you search for a product in a marketplace you can see that the same product has different pricings. Most people won't even check this. They just order the one that comes at the top. Because of this most of the time they will spend more than the value of the product. To prevent these things from happening this report proposes a budget planning application. This application will help the user to prevent those two issues above with many other benefits such as budget plan recommendations, priority alerts, price drop alerts, future price predictions …etc. The application will also have a minimalistic design that is easy to understand.

Keywords: Budget Planning, Machine learning, Priority alerts, Web Scrapping, Image Analyzing

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VII. Abbreviations table

Abbreviation	Definition
E	Electronic
ML	Machine Learning
IDE	Integrated Development Environment
API	Application Programming Interface
OOP	Object - Oriented Programming
UML	Unified Modeling Language
GUI	Graphical User Interface
UI	User Interface
IMF	International Monetary Fund
COVID-19	Coronavirus Disease 2019
YNBA	You need a Budget
iOS	iPhone Operating System
SQL	Structured Query Language
RDBMS	Relational Database Management System
OS	Operating System
FCM	Firebase Cloud Messaging
SDK	Software Development Kit
HTTP	HyperText Transfer Protocol

APN	Apple Push Notification
OOAD	Object-Oriented Analysis and Design
SSADM	Structured Systems Analysis and Design Methodology
PRINCE2	Projects IN Controlled Environment
CPI	Consumer Price Index
CCPI	Colombo Consumer Price Index
WBS	Teamwork Breakdown Structure

Table 2: Abbreviation table

Chapter 1: Introduction

1.1. Chapter Overview

This chapter introduces the research problem and provides background information to ensure readers grasp the problem and its proposed solution. It outlines the research gap and defines the project scope to identify key terms associated with the problem. The primary focus of this chapter revolves around establishing the boundaries of the problem and clarifying the nature of the “SaveNest” project and its aim. Lastly, resource requirements, encompassing hardware and software needs, are presented along with a detailed, and rich picture diagram for better understanding.

1.2.Problem Background

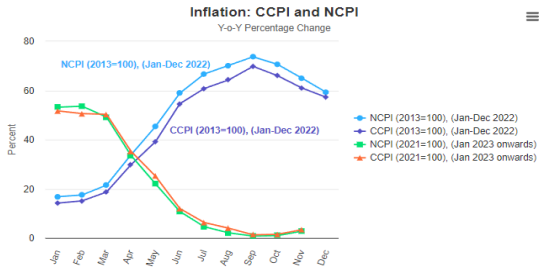
With economic inflation, it has become difficult for people in those inflationary countries to fulfill their needs with their usual wages. Simply put, inflation is a persistent rise in average price levels over a period of time. Or the purchasing power of money decreases or the value of money declines. In order to calculate the inflation rate of a country, it is important to understand the consumer price index (CPI) of that country. Simply put, CPI is a comparison of all pre - determined prices of all goods and services and presents the average value of those prices as a single digit presentation. (Premarathne, 2022) This change of CPI is simply known as the inflation. And the change in the consumer price index that occurs in a year is known as the inflation rate.

Due to the careless decisions of politicians in countries like Sri Lanka, this inflation rate increased very rapidly in the years 2021 and 2022. From the Sri Lanka’s Colombo Consumer Price Index(CCPI), it can be seen how inflation has changed from 2021 to 2023. It is represented in the figure 1 (A.J.F. Shifaniya, 2022)

Due to this hyperinflation, people's essential expenses have greatly increased. Some of the major expenses are, non - alcoholic beverages, footwear, food, clothing, fuel, housing, electricity, water, communication, health, entertainment, culture, etc. People have become unable to bear the exorbitant amount of money to spend even on such essential small expenses. It is a very difficult task for people to manage their expenses in accordance with their incomes in such difficult times. And people find it very difficult to handle some aspects of their financial management, such as creating a budget, assessing their overall financial situation, and keeping track of their expenses. Keeping track of spendings manually which is inefficient is also laborious and prone to mistakes. So people can find it very difficult to keep a precise record of their spendings. (Khandre, 2022)

	(CCPI, 2013=100)		(NCPI, 2013=100)	
	Headline Inflation (Y-o-Y)	Core Inflation (Y-o-Y)	Headline Inflation (Y-o-Y)	Core Inflation (Y-o-Y)
2022				
January	14.20	9.90	16.80	12.90
February	15.10	10.90	17.50	14.10
March	18.70	13.00	21.50	17.30
April	29.80	22.00	33.80	27.90
May	39.10	28.40	45.30	37.70
June	54.60	39.90	58.90	49.30
July	60.80	44.30	66.70	57.30
August	64.30	46.60	70.20	60.50
September	69.80	50.20	73.70	64.10
October	66.00	49.70	70.60	62.40
November	61.00	49.40	65.00	60.10
December	57.20	47.70	59.20	57.50
2021				
January	3.00	2.70	3.70	4.20
February	3.30	2.60	4.20	4.10
March	4.10	3.10	5.10	4.30
April	3.90	3.00	5.50	4.10
May	4.50	3.20	6.10	4.20
June	5.20	3.20	6.10	4.10
July	5.70	3.70	6.80	4.40
August	6.00	4.10	6.70	4.70
September	5.70	5.00	6.20	4.80
October	7.60	6.30	8.30	7.20
November	9.90	7.00	11.10	8.80
December	12.10	8.30	14.00	10.80

Consumer Price Inflation



Date	Colombo Consumer Price Index (CCPI) (CCPI, 2021=100)		National Consumer Price Index (NCPI) (NCPI, 2021=100)	
	Headline Inflation (Y-o-Y)	Core Inflation (Y-o-Y)	Headline Inflation (Y-o-Y)	Core Inflation (Y-o-Y)
2023				
January	51.70	45.60	53.20	52.00
February	50.60	43.60	53.60	50.10
March	50.30	39.10	49.20	44.20
April	35.30	27.80	33.60	31.80
May	25.20	20.30	22.10	21.60
June	12.00	9.80	10.80	11.30
July	6.30	5.90	4.60	6.30
August	4.00	4.60	2.10	4.10
September	1.30	1.90	0.80	1.70
October	1.50	1.20	1.00	0.60
November	3.40	0.80	2.80	0.80

Figure 1: Colombo Consumer Price Index(CCPI)

In financial management and budget planning, a prevailing trend is emerging with the widespread use of online web applications and mobile apps. These tools have become instrumental in streamlining various financial tasks, including budgeting, expense tracking, investment management, and more, making a notable shift in today's world.

However, the challenge lies in the world's lack of a dedicated application for effectively managing its economic landscape. Furthermore, there is a noticeable absence of a virtual

platform that fosters discussions on common financial challenges, uncertainties, and the exchange of ideas within the financial community. Other than that there can be many reasons. When considering some instances, people may forget to pay their bill's payments on time because of their busyness can result in late fines, penalties, and even overdrafts in their bank accounts. This can be caused by lack of timely reminders and awareness. According to their own financial circumstances, goals, objectives and their spending patterns people might not receive specific guidance on how to divide their income. This absence becomes particularly pronounced when individuals encounter urgent financial concerns. Traveling long distances to meet with financial advisors can be impractical, emphasizing the need for a constant connection through virtual platforms and communities dedicated to financial matters. Lack of awareness of their spending patterns and areas for cost - cutting, many people pass up possibilities to save money. Due to uncertainty of future expenses and lack of access to financial education most of the population will fail to make wise choices regarding investing, budgeting, saving and could find it difficult to prepare for impending financial problems and future opportunities. When concerned about security, people could be reluctant to utilize financial management tools because they are worried about what will happen to their private and sensitive financial data. Even though there is some technology available to assist their financial management, some people are not using those available tools. Maybe they are not aware of those options that could benefit them. (Fozzard, 2001)

In order to solve the above-mentioned problems, there should be a proper and user-friendly software base platform to plan their budget with tailored timely alerts, recommendations, and predictive insights which will empower people to make wise decisions and take control of their finances and achieve better financial stability, for a successful future.

1.3.Problem Statement

According to research, lots of people do not have a platform to manage their financial problems and income.

1.4. Proposed Solution

The proposed solution is “SAVE NEST”. A budget planning app that can actively manage a user's budget. It has several key features, and it actively uses machine learning (ML) to give an optimal budget plan for your budget.

Save Nest provides a user-friendly easy-to-use interface. users can easily use this app with an easy-to-use graphical user interface.

Save Nest will alert you if your favorite online purchasing sites update their prices. Price can either increase or decrease, either way, this app will alert the user and also give notifications for the price-changed items in the user's wish list. Through this user can save money by buying the item whenever the price drops.

One of the key features of Save Nest is whenever the user spends more than he planned to spend on a certain category in his budget plan. The app will alert the user saying he spends too much on that category. This will help users stay on track and manage their budget money efficiently.

The best thing is when the user needs to enter the user’s spending into the budget plan they are using, the user will not have to enter them manually one by one, the user only needs to enter a clear photograph of the bill and the save nest app will use machine learning and reduce those spendings from the respective categories of the user’s budget.

1.5.Aim

The project aims to provide an easy-to-use budget planning app to users that can allow these users to take the maximum out of their income.

Further explaining, Save Nest will use a simple and attractive user interface to make it easy to use by the user. Also, Save Nest will use machine learning(ML) to suggest the user with a budget plan for another user with the same salary who manages his way more productively. Also, this app has easy budget updating methods such as uploading photographs of bills. Also, the app will alert the user when he spends too much as well and the app will notify users about price changes in real-time.

1.6.Project Scope

This project intends to guide users to maintain their budget effectively, give alerts when the user exceeds their budget limit, expense tracking, track real-time price changes, and allow users to set financial goals. Furthermore, this application will generate a personalized budget recommendation, and identify spending patterns using user's behavior.

1.6.1. In-scope

As the In-scope, the application will give alerts when they exceed their budget limit, expenses tracking, track real-time price changes in e-commerce websites, and allow users to set financial goals and give personalized budget recommendations. The project encompasses the following scope,

- Data Quality and Entry Standards

  To ensure accurate financial insights, users are encouraged to input high-quality data. Clear and precise details about expenses, income, and financial

transactions are more important for effective budget planning.

- User Interface and Accessibility

  This application's initial prototype will be designed for mobile platforms, offering a user-friendly interface that simplifies budget management. It will focus on providing comprehensive features to cater to various financial needs.

- Scope Financial Management

  The primary focus of the application will be on budget alerts, real-time expense tracking monitoring price changes on e-commerce platforms , and empowering users to set and achieve financial goals.

- Alerts and Notifications

  Users will receive timely alerts when approaching or exceeding their budget limits. This Proactive feature aids in maintaining financial discipline and preventing overspending.

- Expenses Tracking

  The app will facilitate comprehensive expense tracking, allowing users to categorize and analyze their spending patterns. This Feature ensures a detailed overview of financial activities for informed decision-making.

- Real-Time E-Commerce Price Prediction

  Users can stay updated on real-time price changes on e-commerce websites , enabling them to make cost-effective purchasing decisions. This functionality aligns with the app’s goal of empowering users to save money.

- Financial Goal Setting

Users will have the ability to set personalized financial goals within their app. Whether it is saving for a specific purchase or long-term financial objectives, the app provides a platform for goal setting and progress tracking.

- Personalized Budget Recommendations

  The application will analyze user spending patterns and provide personalized budget recommendations. This feature aims to guide users in optimizing their financial plans and achieving their monetary objectives.

1.6.2. Out-of-scope

This application will exclude the following features and functionalities as the out-scope. Implementation of these out-of-scope elements would demand more complex technologies, tools, hardware, increased costs, and additional time, which are presently beyond our current capabilities. Due to the project's time constraints, our focus is solely on incorporating essential features and functionalities.

The Following Areas won't be covered in this project;

- Advanced predictive analysis

  The app will not include advanced predictive analytics or forecasting capabilities. Implementing such features would require more complex technologies and increase development time and costs.

- Offline Functionality

  Offline features such as offline transaction recording , are excluded . Implementing that kind of functionality requires more advanced tools and technologies. Not only that, It increases development time.

- Multi-currency Support

  The app will not support multi-currencies. Introducing this feature would demand additional capabilities and increase project complexity, which is not feasible within the current scope.

1.7.Rich Picture Diagram

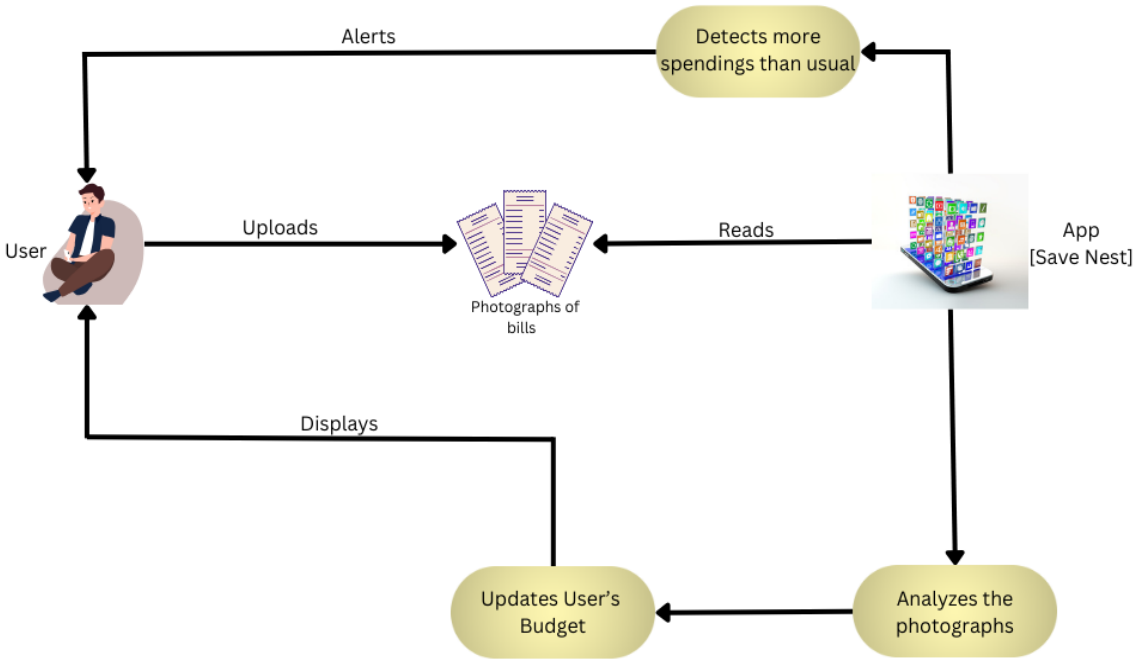


Figure 2: Rich Picture Diagram

1.8.Resource requirements

This section describes the resources that will be used in the creation of the “SaveNest” project. It includes hardware, software, and data requirements to ensure a thorough grasp of the technological infrastructure supporting the application.

1.8.1.Hardware requirements

This section contains the hardware requirements for each member of the development team. It contains information on the owner’s device, specs, and internet connection type. The hardware requirements are critical for ensuring that the development team has enough processing power and connection to work on the project properly.

Owner	Device	Specifications
1. Dumindu Induwara Gamage	Microsoft Windows PC (Primary development environment) - Choose Windows OS due to the availability of software	Windows 11, Core i5, 12 GB RAM, 512GB SSD, ITB HDD
	Dialog 4G Router(Internet connection)- Fast Internet connection.	ShenZhen Tozed Technologies LTE ZLT s10
2. Rajeen Balasooriya	Microsoft Windows PC (Primary development environment)	Windows 10, i5 12th gen, 8GB RAM, NVIDIA GeForce GTX 360
	Dialog 4G Router(Internet connection)	ShenZhen Tozed Technologies LTE ZLT s10
3. Savin Pathirana	Microsoft Windows PC(Primary development environment)	Windows 10, Ryzen 5, 5600x, 16GB RAM, 1TB SSD, 10TB HDD, NVIDIA

	SLT Fiber Router (Internet connection)	GeForce RTX 3070 8GB GPU
4. Sakith Dissanayake	Microsoft Windows PC	Windows 11, Core i9 12th gen, 16GB DDR5 RAM, 1TB SSD, NVIDIA GeForce RTX 3070 TI 8GB GPU
	SLT Fiber, Dialog 4G Router (Internet connection)	
5. Kavindu Hasaranga	Microsoft Windows PC(Primary development environment)	Windows 11, Core i7 11th gen, 8GB RAM, 512GB HDD
	SLT Fiber Router (Internet connection)	FTTx Technology
6. Himan Welgama	Microsoft Windows PC(Primary development environment)	Windows 10, Ryzen 7, 16GB RAM, 512 SSD, NVIDIA GeForce RTX 3050 TI Laptop GPU
	Dialog 4G Router(Internet connection)	

Table 3: hardware Requirements

1.8.2. Software requirements

This section describes the software necessary for the development environment. It outlines the operating systems and software tools that each member of the “SaveNest” development team will utilize. Software tool compatibility and standardization are critical for a collaborative and effective software development process.

In the initial research phase, it was recognized that the successful completion of the project would require the following languages, Integrated Development Environments (IDEs), and other software and APIs.

Languages	
Python (V3.10)	For machine Learning, Image Processing, and Web - scraping purposes
JAVA (V16)	Backend
JavaScript (ECMA 2023)	Backend
Kotlin	For Mobile application development
Dart	For Flutter Development

Table 4: Languages

IDEs and other Software	
PyCharm	For programming with Python with OOP
IntelliJ	For programming with JAVA with OOP
Android Studio	For Android App Development.
Visual Studio Code	For Editing code
Figma	For Designing User Interfaces.
Adobe Photoshop/Canva/GIMP	For editing and creating images and icons
Microsoft Office Package	For making reports and other documents.
Google Drive	For Managing the documents and data in the cloud.
Google Meet	For collaboration with other team members
Click-Up	For managing the project
Darw.io	For designing UML and other diagrams.
Git	For Version Control
GitHub Desktop	For Interacting with GitHub using a GUI
Zotero	The research assistant tool is employed to oversee and safeguard research papers and artifacts, providing management and backup functionalities.

Table 5: IDEs and other Software

Frameworks and Environments for Mobile Application Development	
Flutter	UI toolkit is designed for creating visually appealing, natively compiled applications across mobile, web, and desktop platforms using a single code base.
NodeJS	For the backend runtime environment, based on Chrome's V8 JavaScript Engine

Table 6: Frameworks and Environments for Mobile Application Development

API's	
Facebook API	To sign in with a Facebook account, read and write social media posts, and manage social media.
Twitter API	For sign-in with a Twitter account
Free OCR API	For scanning receipts.
Google Accounts Authentication API	For sign-in with Google Account
Fire Base	For real-time data syncing, capturing, and analyzing.

Table 7: API's

Libraries and Machine Learning Frameworks	
Scrapy/Beautiful Soup	For web-scraping purposes.
Matplotlib	Visualize and analyze the results of the machine learning model
NumPy	Numerical Computing
Scikit-learn	For Machine learning tasks.

Table 8: Libraries and Machine Learning Frameworks

1.8.3.Data requirements

Requirement	Datasets
Analyzing the factors that are required to predict the price of a product	• UK Optimal Product Price Prediction Dataset by Asaniczka (Kaggle Dataset) https://www.kaggle.com/datasets/asaniczka/uk-optimal-product-price-prediction
Analyzing reviews of products for product recommendation	• Consumer Review of Clothing Product by Jocelyn Dumlao (Kaggle Dataset) https://www.kaggle.com/datasets/jocelyndumlao/consumer-review-of-clothing-product • Ebay reviews by Wojtek Bonicki (Kaggle Dataset) https://www.kaggle.com/datasets/wojtekbonicki/ebay-reviews
Analyzing spending behavioral patterns	• Analyzing Customer Spending Habits by The Devastator (Kaggle Dataset) https://www.kaggle.com/datasets/thedevastator/

	analyzing-customer-spending-habits-to-improve-sa • Customer Spending Dataset by Aditya Goyal (Kaggle Dataset) https://www.kaggle.com/datasets/goyaladi/customer-spending-dataset
Analyzing the images of bills and understanding it.	• Generated Dataset using photographs of local supermarket bills.

Table 9: Data Requirements

1.9.Business Model Canvas

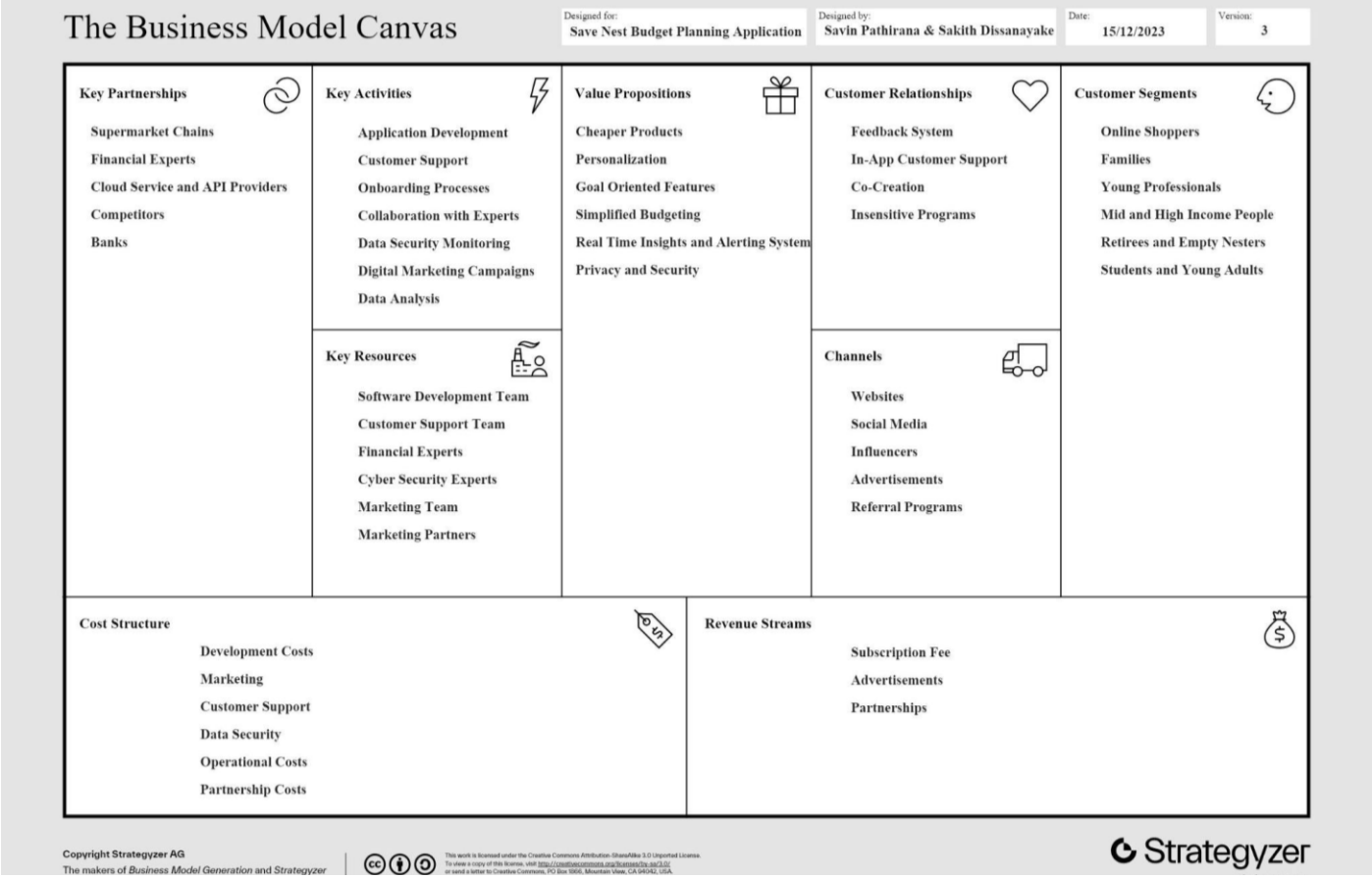


Figure 3: Business Model Canvas

1.10.Chapter Summary

This chapter provides a clear description of the Save Nest app describing what was the cause to design such an app, what developers aim by developing Save Nest, and also what will be its key features and features that developers will add to this budget planning application. Also, this chapter provides a clear understanding of the software, hardware, and data requirements that are going to be used in the proposed project.

Chapter 2: Existing work

2.1.Chapter Introduction

This chapter is based on earlier studies and research on the same problem. It is crucial to know about these existing works as it will shape developers' understanding of the problem. By referring to existing work developers can know where they are now and also they can find where they can learn more.
It establishes the foundation for new ideas by examining important studies to understand the work of other researchers. This chapter serves as an invitation to academics to look deeper and expand upon the discoveries made by others.

2.2.Existing Work

2.2.1 Commercial Applications

2.2.1.1 YNAB-You Need A Budget

YNAB is an enterprise-level personal finance application launched in 2004 with the goal of helping people save money through proactive budgeting. This application uses a zero-based budgeting system (Payne and Dasko,2023), where users have to allocate their entire income among specific categories. When users want to check their balances, the application displays available funds and overspent categories. Apart from the basic financial management features YNAB also has distinguished features such as,

1. Age of money:

   A feature that counts the number of days that a certain amount of money that is set for a particular object stays in the account (Smith,2023).

2. True Cost Spending:

True expenses are the expenses that will come up at some point in the future. YNBA has a feature that helps users save money for predictable and true expenses by treating them as monthly expenses.

3. Debt Management:

A feature implemented to manage user's debt in a strategic way.

Although YNAB is a popular finance management app that has helped many people, some users have expressed their concern about the limitations of the mobile app and the steep learning curve (Hezretov,2018). In the “Save Nest” application, the developers try to make a simpler UI so that users can learn how to manage the app easily. ”Save Nest” is not based on a zero-based budgeting system. Instead, the application will treat savings as a category in the budget, to which the user has to allocate funds at the start of the month. Throughout the month, the application will encourage users to save funds from other categories and move them into savings, resulting in maximum savings. YNAB has a latest feature where multiple users can handle a single budget.

2.2.1.2 Goodbudget

Goodbudget has garnered customer satisfaction due to its features and methodologies. This application is available for both web and mobile devices. As with any other finance management application, goodbudget manages the budget according to a specific money management system named “envelope system"(Holzhauer and Dasko,2023). In this method, for every purpose, there should be an envelope, and the money for that purpose throughout the month should be in that envelope. As there were limited electronic payments in the past, the envelope system helped a lot of people to manage their money successfully. But when it comes to modern society, most people have a tendency to use electronic payment method. This has become a considerable problem for people who manage their budgets using the envelope system method. The Goodbudget application effectively tackled this problem by implementing the envelope system as an application.

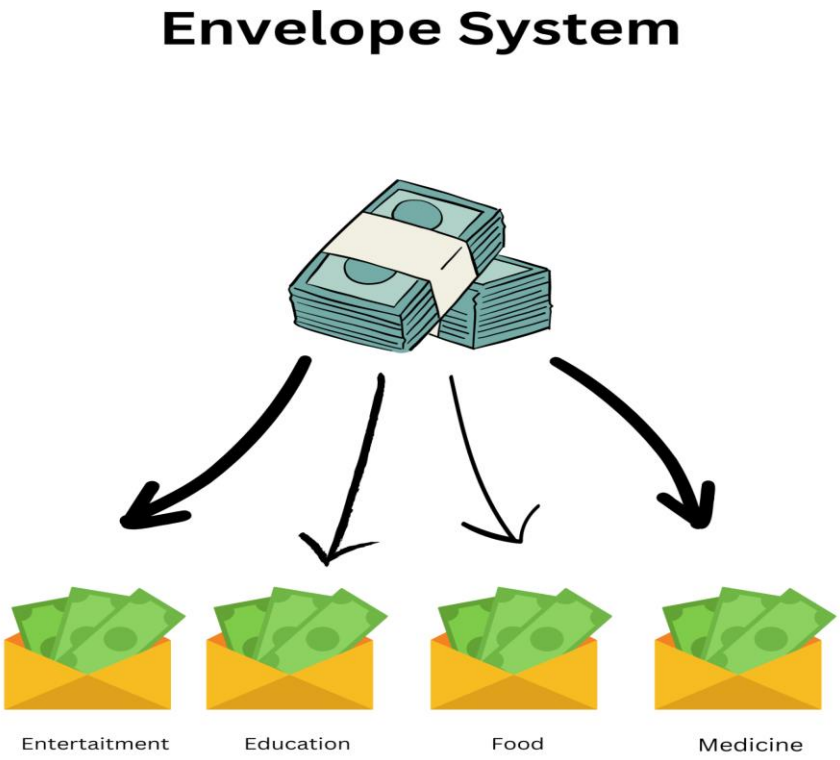


Figure 4: The Envelope System

Although the most distinguished feature of the application is the envelope system, there is a limit to the number of envelopes in the free version. Furthermore, as the Goodbudget application is not synced with a bank account, the update of the envelope has to be done manually. Because of this, users of the Goodbudget application have to allocate a time each day to update the budget. Although the “Save Nest” application is not synced with a bank account, the application can help users easily update their budget by taking a photo of a bill. The application, which implements machine learning algorithms, will resolve the problem of identifying the categories in the bill. The "Save Nest" photo update feature will help people save time to maintain their budget.

2.2.1.3 PocketGuard

PocketGuard stands out as a popular budgeting app because of features like detailed reporting and automatic expense tracking. The PocketGuards’ pie charts represent the user's expenses in a manner that can be easily understood. Another distinguished feature of this budget application is the “In My Pocket” feature, or the IMP. This feature is based on a simple equation that will show remains available for spending after achieving financial goals and savings (Holzhauer and Dasko, 2023).

“Estimated income – upcoming bills – financial goals – spending/budget = IMP”

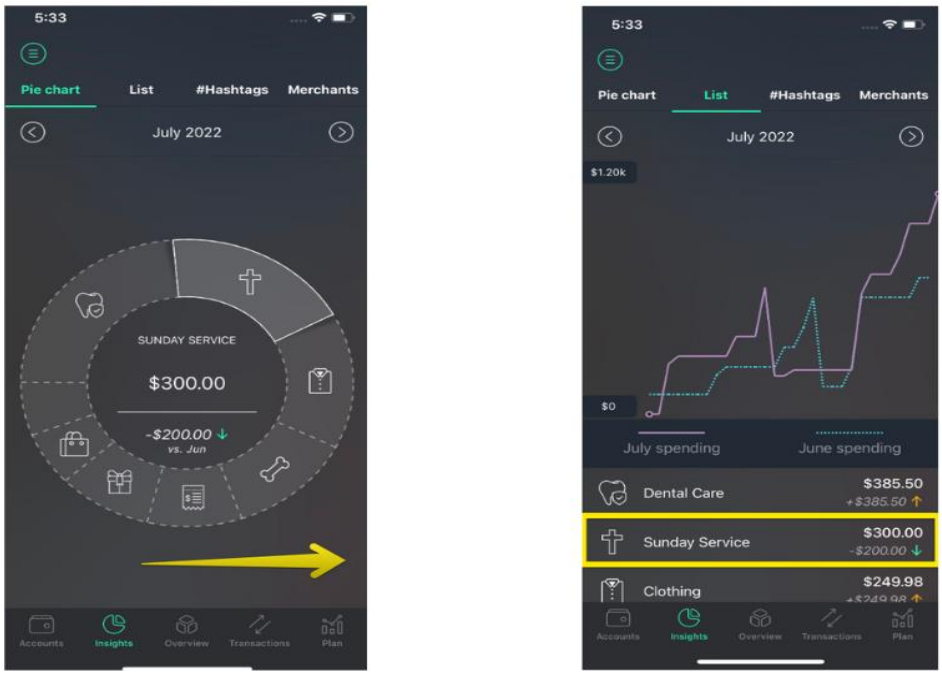


Figure 5: The Envelope System

According to the International Monetary Fund (IMF), global inflation has gone to 7.5 percent in August 2022 from an average of 2.1 percent in the decade before the COVID-19 pandemic (Binici et al.,2023).Due to global inflation, most countries have price fluctuations of items. Under those circumstances, features like IMP may not be accurate. Save Nest's real-time price tracking system will track the prices of items in users' favorite supermarkets. With the help of this feature, the app can give accurate information depending on the current situation. Overall, PocketGuard offers valuable insights and real-time tracking for many. SaveNest builds upon this foundation by adding dynamic price updates, giving users the flexibility to adapt to unexpected changes and potentially optimize their savings even further.

2.2.2 Research Projects on Budget Applications

2.2.2.1 Budget Tracker-Highly Customizable Budgeting Mobile Application

Budget tracker is a research project done by the University of Colombo School of Computing. Budget Tracker research project identifies the gaps in personal finance management applications and addresses them successfully. Budget tracker features can be listed as follows,

- Free and available for Android and iOS
- Native mobile application for fast and reliable performance
- Simple and user-friendly interface with a guided onboarding process
- User-friendly dashboard with current accounts and recent transactions
- Easy access to features through a drawer navigation menu
- Track income and expenses with customizable categories
- Visualize spending patterns with graphs and charts.
- View transactions and account balances daily, weekly, monthly, etc.
- Set budgets for different categories and track progress.

Although the budget tracker research project has covered some research gaps in the personal finance management area, there is still work to be carried out by researchers. The current limitations of the budget tracker can be listed as follows,

- Limited currency support.
- Lack of duplicate alert: Entering duplicate expense categories can lead to errors and redundant data.
- Missing payment reminders: No feature to alert users about upcoming bills, increasing risk of missed payments.
- Separate income/expense reports: Lack of comparison between income and expenses hinders understanding of overall financial health.

From the above limitations save nest application will surpass limitations like lack of duplicate alert and missing payment reminders.

2.2.2.2 Comparison between existing works

Applications have been developed in the field of personal money management. The existing applications “YNAB(You need a budget)”, “Mint”, “Good Budget”, “CashSave” and the latest app “SaveNest” anticipated creation. The primary objective of these tools is to aid users in budgeting, expense tracking, and overall financial management. This study will examine the merits and demerits of these existing applications. Subsequently, an analysis of the strategies employed by the forthcoming “SaveNest” application will be presented, highlighting its intention to transcend the identified limitations and deliver a more efficacious and user-centric money management experience.

Feature	Save Nest	YNBA(You Need a budget)	Mint	GoodBudget	CashSave
In-App Purchases	Free	Free/Premium	Free/Premium	Free/Premium	Free
Investment ideas suggesting	✓	✓	✗	✓	✓
Alerts of price Changes	✓	✗	✗	✗	✗
Priority alerts when spending	✓	✗	✗	✗	✗
Different types of accounts can be created(Private/Business)	✓	✗	✗	✗	✗
Updating the budget by taking a photo of a bill.	✓	✗	✗	✗	✗
Current investment	✓	✓	✓	✗	✗

Table 10: Comparison Between Existing work

2.2.3 Insights gained from existing mobile applications: shaping the development of Save Nest.

By analyzing both commercial and research-level personal finance management applications, it is clear that there are common characteristics among all the finance management applications. One thing that is highlighted apart from the technical solution is that there should be a proper money management technique that the application should follow. When analyzing the above applications, the report discussed the zero-based budgeting and envelope systems carried out by the YNBA and GoodBudget, respectively. PocketGuard applications allow users to freely use any methodology in a way that they like.

In the “Save Nest” application, money management methodology is a hybrid of “reverse budgeting” and “envelope system." When initializing the budget, the user must add the amount of money to the savings category, which is a principle of "reverse budgeting." Then the user should identify the categories according to their preferences and add the amount of money they are planning to spend to the categorized categories. By using the “Save Nest” feature “Priority Alerts," users are encouraged to save money from categories other than the savings category, which will maximize their savings. Extra savings from other categories can be used for spending in other categories according to the user's preference. ”Save Nest” will look for growth in the financial management of the user depending on savings and how he manages the extra savings.

Another significant factor that can be seen when analyzing the applications is that users need constant guidance with alerts throughout the month. Most of the applications have bill reminder alerts. ”Save Nest” is pushing the boundaries of personal finance management applications by introducing new alert features.

- Real-time Price Alerts: Users can select their favorite supermarket, and the application will send an alert notification when the price of an item changes.

- Priority Alerts: Users should select their priority list when initializing the budget. When users spend money in a category where it is less important, the application will send an alert notification to remind them of their priorities.

PocketGuard applications have won users trust because of the quality reports and charts that they visualize for the users. By analyzing PocketGuard, it is clear that data representation and visualization play a huge part in a personal finance management application. The developers of the “Save Nest” application will develop features for visualization and data representation that will help users track their spending patterns.

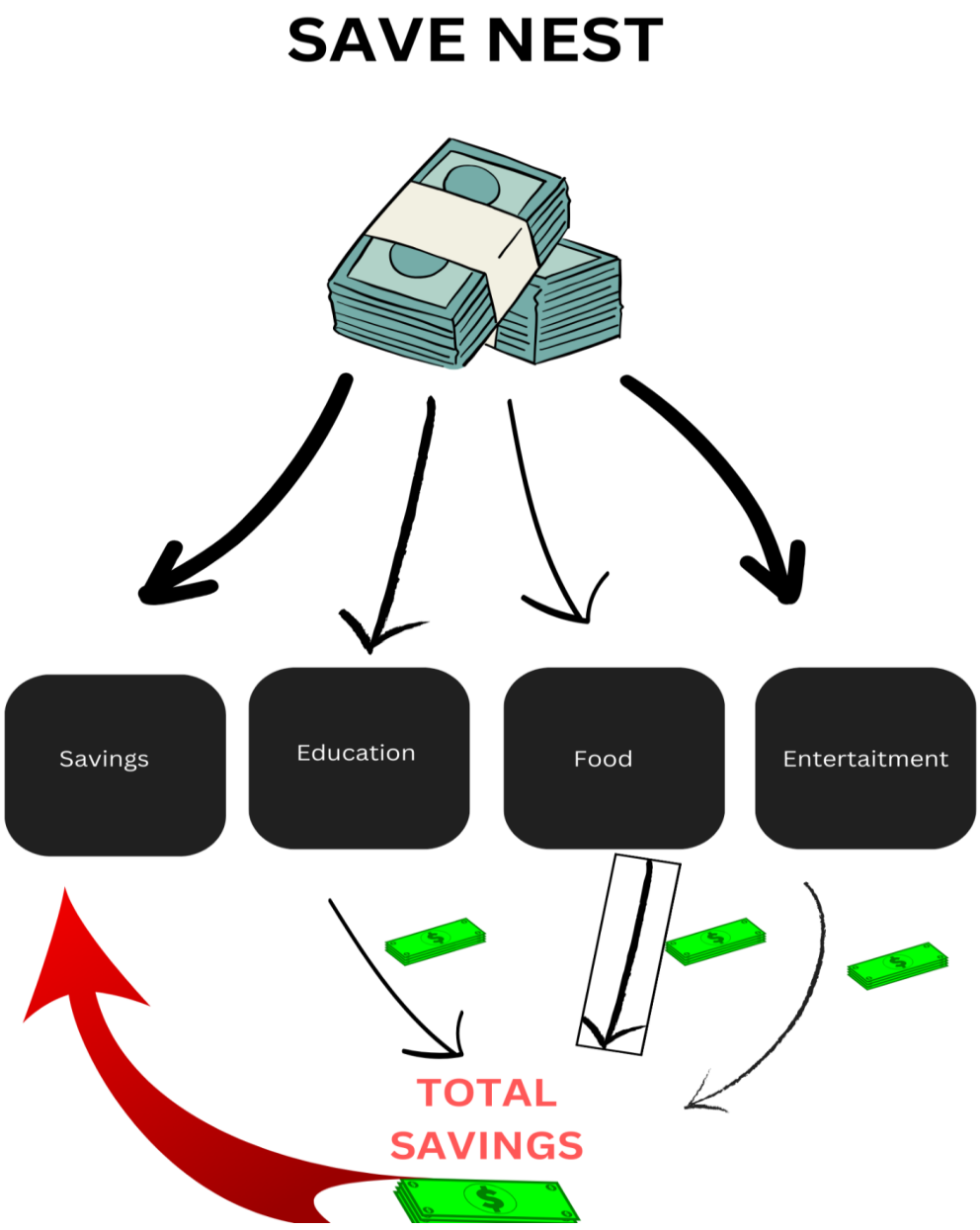


Figure 6: Save Nest

2.3. Tools and Implementation Plan

2.3.1.Tools

2.3.1.1. Scikit-learn

Scikit-learn is a popular open-source machine learning library for python. It provides simple and efficient tools for data analysis and modeling, including various machine learning algorithms for tasks such as classification, regression, clustering and dimensionality reduction. Scikit-learn is built on other widely-used Python libraries such as NumPy. SciPy and Matplotlib.

Classification

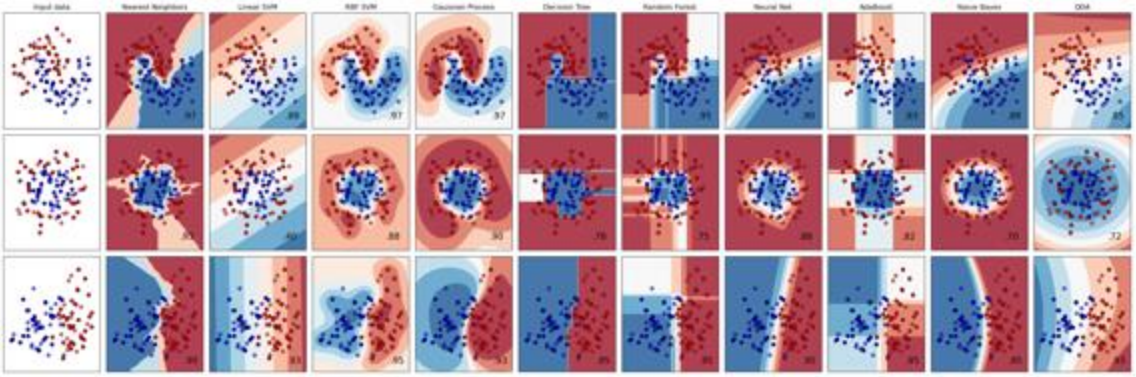


Figure 7: Classification

In Scikit-learn, classification is a type of supervised machine learning task where the goal is to predict the categorical labels of instances based on their features. The scikit-learn library provides a comprehensive set of tools and algorithms for classification tasks. It can be used for image recognition.

2.3.1.2. MySQL

MySQL is an open-source relational database management system(RDBMS) that is widely used for managing and organizing structured data. It is a key component in many web development stacks, powering numerous dynamic websites and applications.

Relational Database Management Systems (RDBMS)

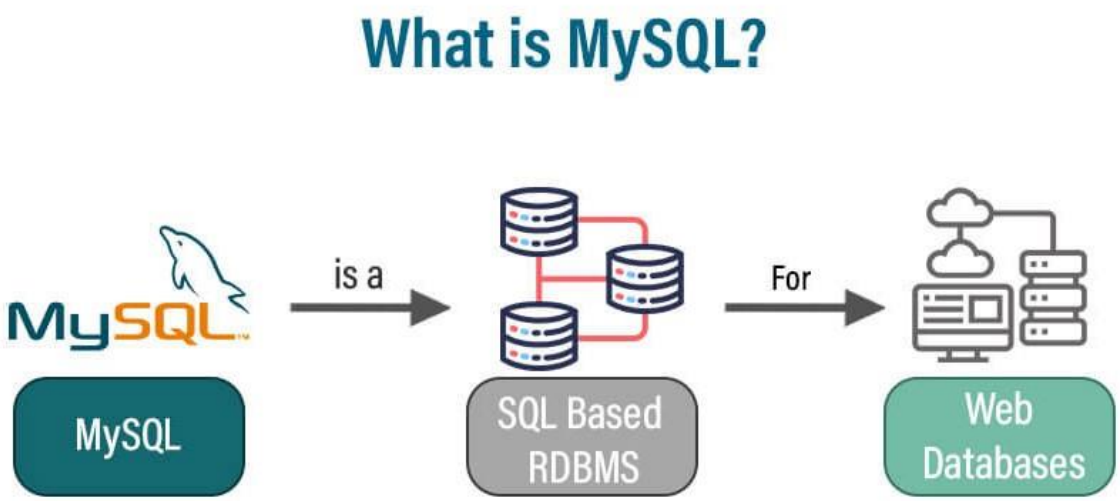


Figure 8: MySQL

MySQL follows the relational model, which means it organizes data into tables with rows and columns . It supports SQL (Structured Query Language) for defining, querying, and manipulating data.

Cross-Platform Compatibility of MySQL

My SQL is designed to run on various operating systems, including Windows, Linux, macOS and others. This makes it a versatile choice for developers working in different environments.

Data Security

MySQL provides robust security features, including user authentication, access control and encryption. Database administrators can define user privileges to control who can access, modify or administer the database.

2.3.1.3. Mobile Push Notifications

Mobile Push notifications are short messages or alerts sent from a centralized server to a user's mobile device. These notifications are a crucial component of mobile app engagement and user retention strategies. They provide a way for app developers and businesses to communicate with users in real-time, even when the mobile app is not actively in use.

Firebase Cloud Messaging(FCM)

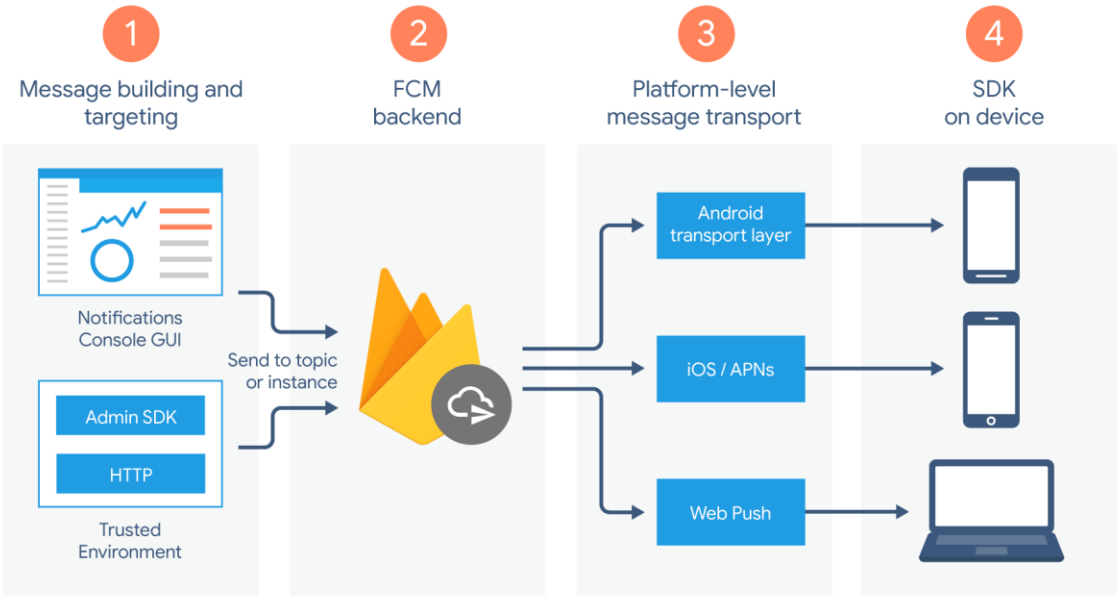


Figure 9: Firebase Cloud Messaging

Firebase Cloud Messaging (FCM) is a cloud solution by Google that enables developers to send real-time messages and notifications to Android devices. It is a cross-platform messaging solution that allows developers to send messages reliably and efficiently to Android devices, as well as to iOS and web applications. FCM is a part of the Firebase suite, which offers various tools and services for building and managing mobile and web applications.

Apple Push Notifications(APNs)

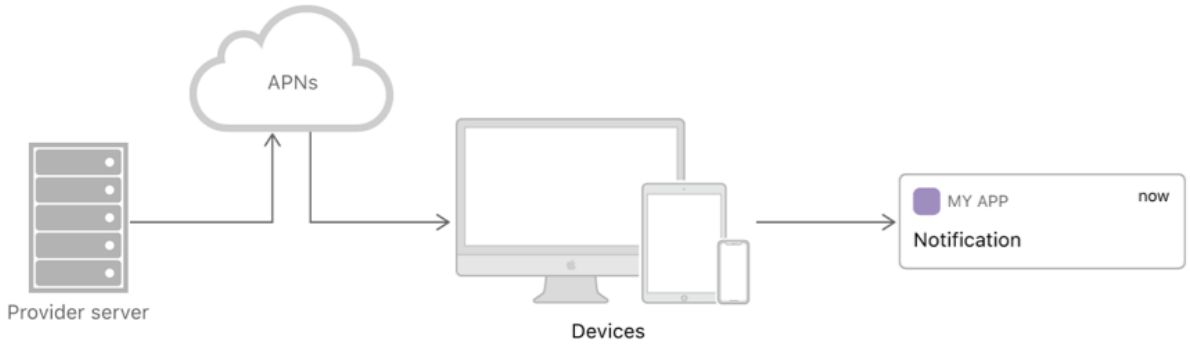


Figure 10: Apple Push Notifications

Apple Push Notification Service(APNs) is Apple's solution for sending push notifications to iOS devices such as iPhones and iPads. It is an integral part of the Ios ecosystem and allows developers to keep users informed by delivering alerts, badges, and sounds directly to their devices.

2.3.1.4. Flutter

Flutter is an open-source UI software development toolkit created by Google for building natively compiled applications for mobile, web and desktop from a single codebase. It gained popularity for its ability to enable developers to create high-performance, visually appealing applications with a single codebase that runs on multiple platforms.

Dart Programming Language

Flutter uses the Dart Programming language , also developed by Google. Dart is designed for building modern, high-performance applications, and it compiles to native code for both mobile and web platforms.

Rich Set of Widgets

Flutter uses a declarative approach to UI development, where the UI is expressed as a composition of widgets. Widgets are building blocks for the user interface, representing everything from structural elements to stylistic components.

Flutter comes with a comprehensive set of customizable widgets for creating a wide variety of UI elements. This includes material design widgets for Android and Cupertino widgets for iOS, allowing developers to adhere to platform-specific design guidelines.

2.3.1.5. Node.js

Node.js is an open-source, cross-platform JavaScript runtime environment that enables developers to execute server-side JavaScript code. It gained its popularity for its efficiency and scalability, particularly in building networked applications.

Real-Time Applications

Node.js excels in building real-time applications, such as chat applications, online gaming and collaborative tools. Its event-driven nature and low-latency make it well-suited for scenarios where real-time communication is crucial.

Single-Threaded Event Loop

Node.js operates on a single-threaded event loop, which efficiently manages multiple client connections without the need for creating a new thread for each connection. This architecture is particularly well-suited for handling a large number of concurrent connections.

2.3.2. Implementation Plan

2.3.2.1. Database Setup (MySQL)

2.3.2.1.1. Data Schema Design

This includes creating the MySQL database's structure and designing the tables that will hold user profiles and financial information. Establishing relationships ensures integrity and effective organization of data.

2.3.2.1.2. Query Optimization

Optimizing SQL queries ensures effective execution of data retrieval and modification processes. For an application to remain scalable and responsive, this step is essential.

2.3.2.2. Backend Development (Node.js)

2.3.2.2.1. Server Configuration

Getting the runtime environment ready to process user requests is part of setting up a Node.js server. As the backend infrastructure, this server helps the mobile application and database communicate with each other.

2.3.2.2.2. Endpoint Implementation

Endpoints are certain URLs on the server used to manage different functionalities. Here, we're putting APIs into place for budget updates, product information retrieval, and user authentication (login/signup).

2.3.2.3. Budget Analysis and Image Recognition (Scikit-learn)

2.3.2.3.1. Spending Pattern Analysis

Based on previous data, Scikit-learn is utilized for classification to analyze and classify user spending habits. This gives information about the user's financial habits.

2.3.2.3.2. Image Recognition

The application can extract useful information from photographs and screenshots, such as identifying product prices and the total that was spent and identifying the income by implementing image recognition algorithms.

2.3.2.4. Real-time Price Tracking and Prediction

2.3.2.4.1. Real-time Data Integration

This entails integrating mechanisms to monitor the current pricing of particular products in real-time, using web scraping to guarantee that the prices are accurate.

2.3.2.4.2. Price Prediction

Applying Scikit-learn for regression tasks enables the application to predict future prices of particular products based on historical data. This helps users make well-informed financial decisions.

2.3.2.5. Mobile Application Development (Flutter)

2.3.2.5.1. Cross-Platform Application

Flutter is used to create a cross-platform mobile application with a single codebase that offers an identical user experience on both Android and iOS devices.

2.3.2.5.2. Widget Customization

The user interface is designed using Flutter's configurable widgets, guaranteeing an aesthetically pleasing and simple application.

2.3.2.6. Push Notifications (FCM and APNs)

2.3.2.6.1. Notification Integration

By integrating Apple Push Notification Service (APNs) for iOS and Firebase Cloud Messaging (FCM) for Android, the application can send notifications to users in real-time regarding price changes and overspending.

2.3.2.6.2. Trigger Setup

By setting up triggers, one can make sure that alerts are sent out in response to certain conditions, including when prices significantly fluctuate or when spending goes over budget.

2.3.2.7. Testing and Deployment

2.3.2.7.1. Comprehensive Testing

This involves thoroughly testing the program to find and fix any errors, security vulnerabilities, or performance problems before distribution.

2.3.2.7.2. App Deployment

After testing is completed successfully, the program is made available to consumers by being released into app stores on both iOS and Android operating systems.

2.3.2.8. Continuous Monitoring and Updates

2.3.2.8.1. Performance Monitoring

Real-time monitoring of the application's performance is made possible by the implementation of monitoring tools, which enable early problem detection and remediation.

2.3.2.8.2 Continuous Improvement

Based on user feedback and shifting requirements, regular updates are made to add new features, improve security, and increase overall user experience.

2.3.2.9. Data Security

2.3.2.9.1. User Authentication

User authentication is done to guarantee that only authorized users can access the application and alter their budget information by utilizing MySQL's security capabilities.

2.3.2.9.2. Encryption Mechanisms

Encryption protects critical user and financial information from unauthorized access by adding an additional degree of security.

2.3.2.10. User Education and Support

2.3.2.10.1. In-App Guides

Users can maximize the functionality of an application by being educated about its features through the inclusion of in-app tutorials and guides.

2.3.2.10.2. Customer Support

By creating customer support channels like chat and email, you can make sure that users can get help when they have questions or run into problems with the application.

2.4. Chapter Summary

This chapter provides what caused the problem of creating the Save Nest application. This chapter examines the body of work already done in the field, including studies of competing technologies, evaluation measures, and rival solutions. It also provides a thorough overview of the project's basis by describing the methods and instruments that will be applied in the execution of our solution. This chapter lays the foundation for the creation and assessment of our innovative product.

Chapter 3: Methodology

3.1. Chapter Overview

The previous chapter focused on identifying and evaluating diverse techniques and approaches applicable to this project. This chapter will mainly concentrate on the methodologies that will be followed to bring the expected outcome for the user. At the outset, it establishes development methodologies, design methodologies, and project management methodologies. Initially, it determines the project management methodologies. Next a visual format of the Usage of the Project management and collaboration Software in the project, the Gantt chart, and the teamwork breakdown structure . Finally, this chapter highlights the possible risks and the mitigation plans.

3.2.Development Methodology

The team must take into account several factors to choose the optimal methodology, including cost, budget, flexibility, stakeholder collaboration, and timeline. Following thorough research into various development methodologies, five were identified as more suitable for “SaveNest” development. After all the studies, the Scrum methodology emerged as the most suitable choice. Scrum is a variant of the agile methodology.

Name of the specific Model	Description
1. Waterfall Model	• Limited Potential for requirement changes • Delayed launch without iterations. • Time-intensive • High costs involved.
2. Spiral Model	• Does not work well with small projects. • Risk analysis necessitates experts with high-level skills.
3. Scrum Model	• Prioritizing productivity for utmost customer satisfaction and increased flexibility. • Facilitating effective communication among team members. • Enhancing traceability. • Strictly adhering to user requirements for development and planning.
4. V-Shaped Model	• Less suitable for projects with fluctuating requirements. • No operational software until the completion of the cycle. • Challenges in altering functionality during the test phase.
5. Evolutionary Prototyping Model	• Expensive to develop a prototype. • Extended development time for the prototype

Table 11: Development Methodologies

The Scrum Structure has been reallocated to Appendix section B-1 for better and clearer presentation.

3.3.Design Methodology

The team has decided to use Object-oriented analysis and Design (OOAD) which aligns well with the agile development methodology . This strategy prioritizes data and reduces the overall complexity, resulting in better system management.

3.3.1.Comparison Between OOAD and SSADM

The analysis of OOAD and SSADM has been relocated to Appendix Section B-2 to enhance clarity.

3.4. Project Management Methodology

A project management methodology serves as a framework or set of guidelines for the planning, execution, and evaluation of a project. Common project management methodologies include Agile, Scrum, Kanban, Lean, XP , Waterfall, and Prince 2. The team has decided to use PRINCE2 due to its foundation in breaking down projects into manageable segments with clearly defined roles and responsibilities.

PRINCE2, which stands for “PR objects IN C controlled Environment”, offers several advantages . The following are some of the advantages of the PRINCE2 methodology.

- PRINCE2 is a good beginner methodology.
- Reusability in project management.
- Better time management
- Cost efficient.

3.5. Teamwork Breakdown Structure (WBS)

The Teamwork breakdown structure has been moved to Appendix B-3 for a detailed version.

3.6.Gantt Chart Diagram

The Gantt Chart diagram has been moved to Appendix B-4 for clarity.

3.7.Usage of Project Management and Collaboration Software In the project

3.7.1. Project Management Tools and Evidence

In this project, the free version of ClickUp was used to organize and create project tasks, set goals, and address queries.

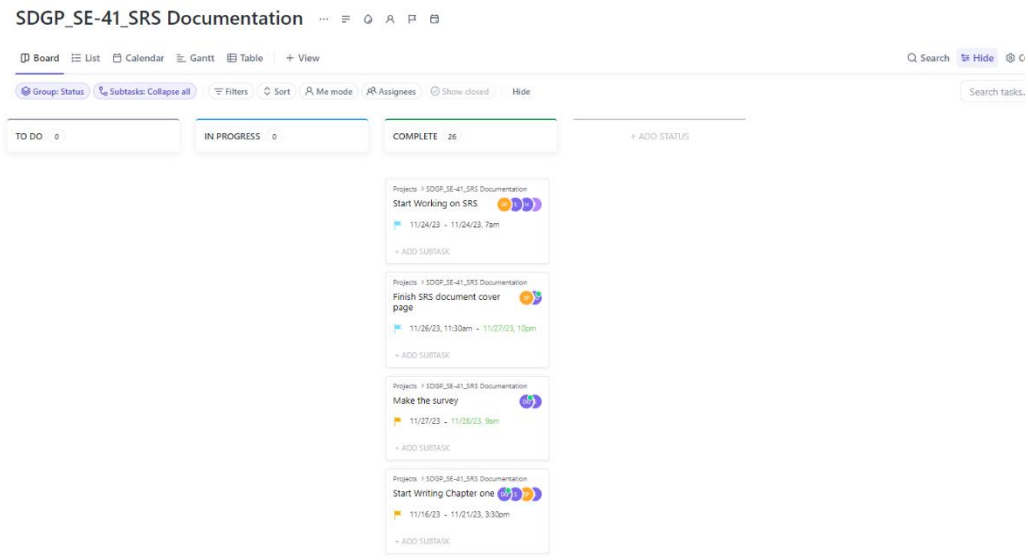


Figure 11: Project Management Tools and Evidence 1

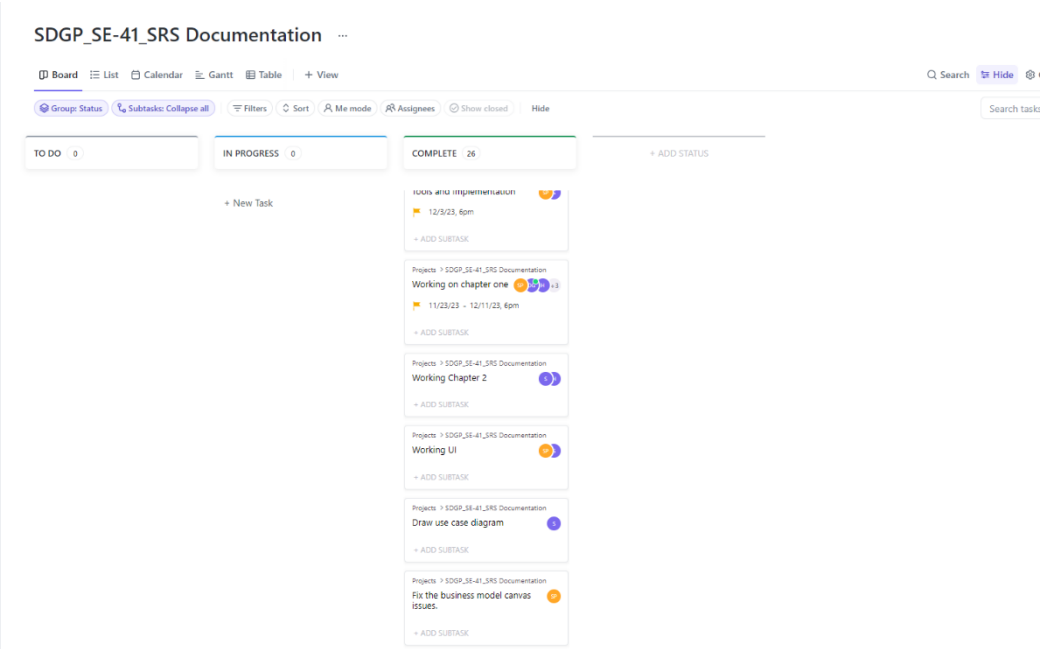


Figure 12: Project Management Tools and Evidence 2

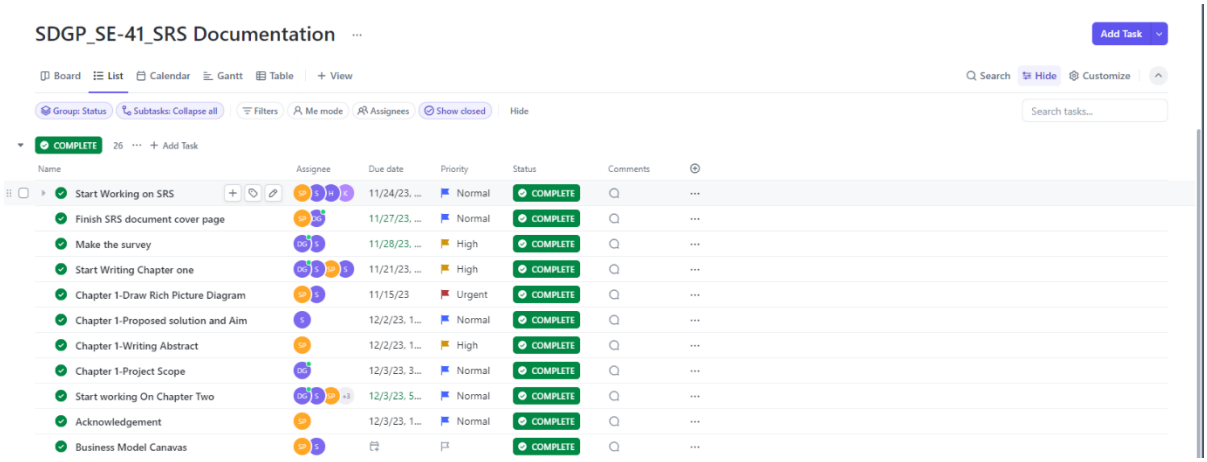


Figure 13: Project Management Tools and Evidence 3

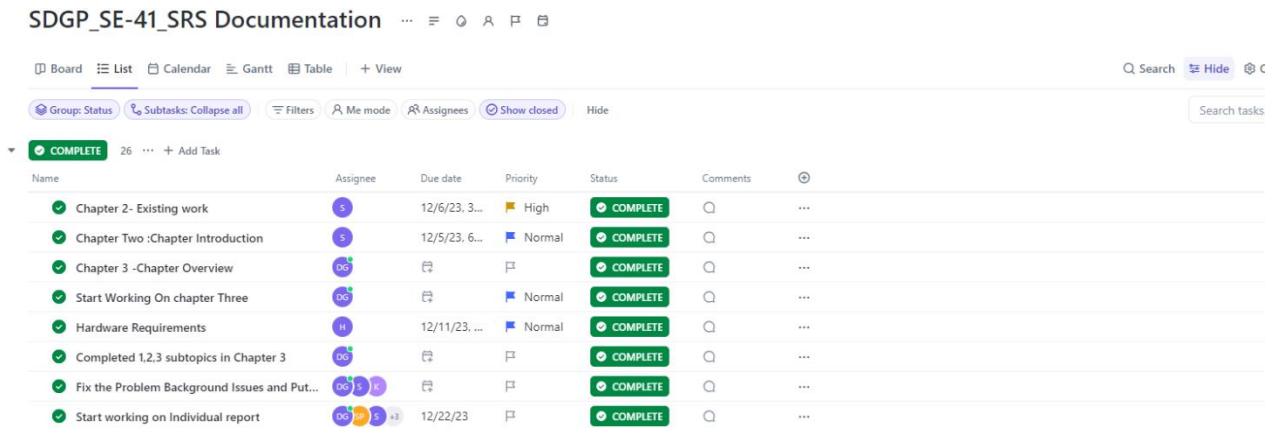


Figure 14: Project Management Tools and Evidence 4

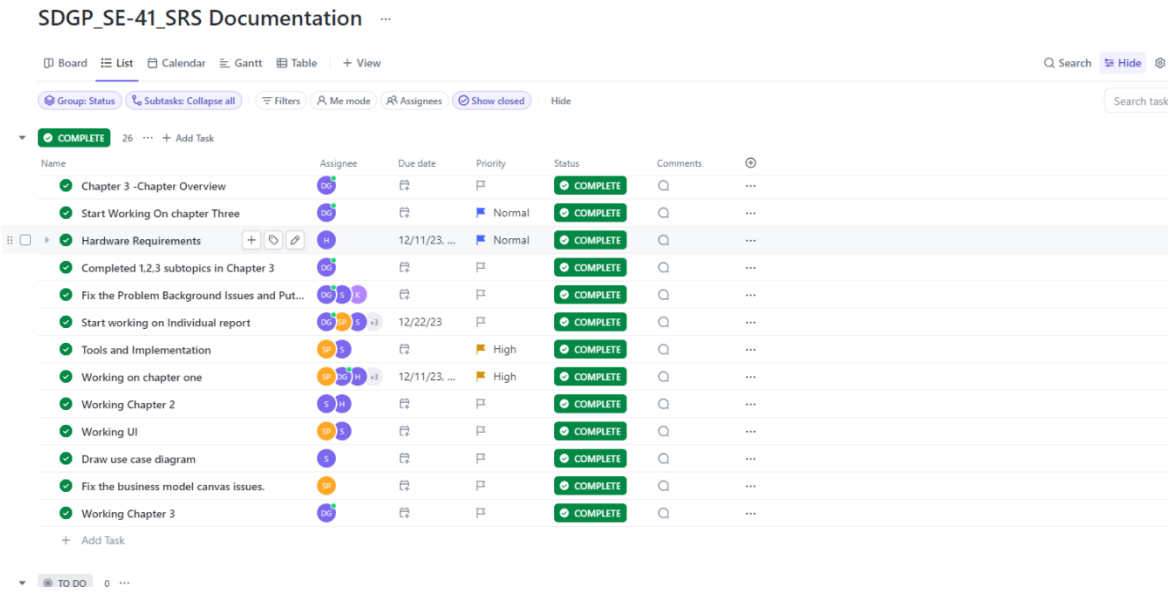


Figure 15: Project Management Tools and Evidence 5

3.7.2. Weekly Meeting Logs

All group meetings were held virtually, using Google Meet, and scheduling was facilitated using the platform's built-in meeting scheduling feature. The team Meeting Log and Evidence for Meetings with Team Members has been relocated to Appendix B-5 for improved clarity.

3.7.3.Communication Plan

Weekly Group Meetings were conducted with the supervisor Prof.Damitha Karunarathna and the SDGP module team, to get feedback, report the progress, discuss the issues, and discover the solutions. In addition to weekly group meetings, email communication was employed in the project to address the concerns as needed. And also some meetings are conducted physically.

3.8 Risks and Mitigation

The project's risks are outlined in the table, along with suggestions for mitigating each one.

NO	Risk Item	Severity	Frequency	Mitigation Plan
01	Lack of clear communication among team members	High	Low	Arranging frequent team meetings using communication technologies, and encourage team members to seek clarifications to their doubts
02	Lack of knowledge and experience and lack of acquaintance with technology	High	High	Defining precisely and documenting the project scope and performing in-depth analysis of the technological viability by self-studying continuously and taking advice from experts.
03	Limitations on Resources (Time, Budget, and Skills)	High	High	Developing contingency plans for unexpected resource constraints, and planning resources early on in the project.
04	Inadequate testing may lead to a product with bugs and issues.	High	High	Putting into an in-depth testing plan by making sure everything is in working order before releasing anything, including unit testing, integration testing, and user acceptance testing.
05	Uncertainties in external dependencies. (APIs, Third	High	Medium	Identifying and recording all external dependencies early, and having back up plans or alternatives, and

	party services)			also communicating with external stakeholders regularly to be updated on any developments.
06	Concerns about data security.	High	Medium	Placing strong security measures such as data encryption and secure data storage, and making sure that users understand the security measures and also making sure that data protection regulations are followed.
07	Unable to meet the expectations of users	High	Medium	Conducting surveys and questionnaires with the right individuals at the outset of the project to gain a clear understanding of their expectations.
08	Falling ill	High	Medium	Planning the work early and sharing the work among team members
09	Passing the deadlines	High	Medium	Managing the time wisely and prioritizing the work.
10	The Project's continuation may be hampered by team members' sudden departure	Medium	Medium	Cross - training the team members on key responsibilities, and encouraging a positive team culture to improve retention and member satisfaction

Table 12: Risks and Mitigation

3.9 Chapter Summary

Simply a detailed explanation of the project's methodologies is provided in this chapter. It contains three sections called development methodology, design methodology and project management methodology. It outlines the benefits of using the right approaches and why doing so will make the project successful. Depending on the project's requirements, the best methodology approaches have been found and selected. Next the sections called Team Work Breakdown Structure (WBS), Gantt chart diagram, Usage of Project Management and

Collaboration Software In the project, Risks and Mitigation are included in this chapter. The WBS and the Gantt chart diagram have been moved to Appendix B-3 for a detailed description and to Appendix B-4 for clarity, respectively. Under the Usage of Project Management and Collaboration Software In the project there are 3 sub sections called project management tools and evidence, weekly meeting logs, and communication plan. As a project management tool a free version of ClickUp has been used and weekly meeting logs have been moved to Appendix B-5 for improved clarity and finally in the risks and mitigation section it has discussed the risks may face during the project and their mitigation plans in the table.

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Appendix B-Methodology

Appendix B-1 The Scrum Structure

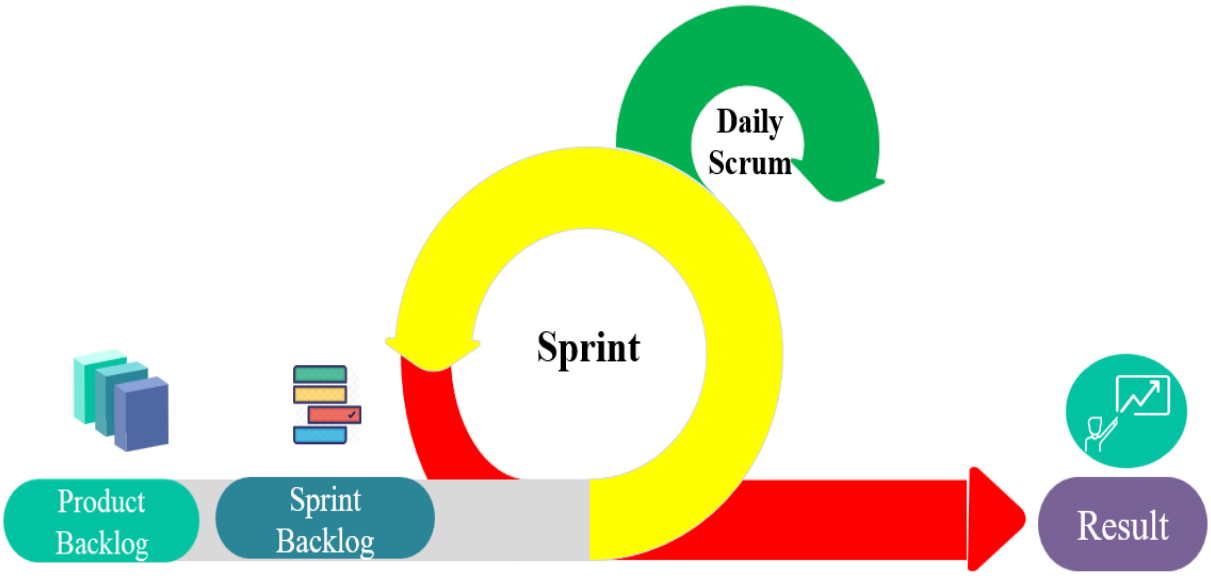

Figure 16: Scrum Structure

Appendix B-2 (Design Methodology)

This section describes the difference between OOAD and SSADM.

	OOAD(Object Oriented Analysis and Design)	**SSADM(Structured System Analysis and Design Methodology)**
Definition	In software engineering, this method entails creating a software system by conceptualizing it as a set of objects. The organization, evolution over time, and deployment of these objects can be depicted using various models, and different notations can be employed to represent these models.	SSADM structures its development through modules, stages, and tasks, providing a management-friendly framework. It is commonly applied in technical and business projects where significant changes are unexpected. SSADM adopts a top-down, linear approach for information system projects. Within its methodology, SSADM employs three primary techniques for data modeling.
Pros	OOAD suits well with Agile Development, which values flexibility and Development of the project.	SSADM is widely utilized and recognized as a well-established approach for developing information systems.
	OOAD enables a data-centric approach, simplifying the design process and making it more straightforward to understand and maintain.	SSADM provides a comprehensive and systematic approach to analyzing and designing systems. This ensures that all elements of the system are thoroughly considered in the process.
		SSADM contains complete documentation, which supports making the system well-documented and easy to

	OOAD promotes the use of reusable code, leading to potential time and resource savings in the long term.	manage.
	OOAD simplifies the maintenance and modification of a system by organizing the code into modular and replaceable objects. This modular structure makes it easier to update and enhance components without affecting the entire system.	SSADM adopts a well-defined and comprehensive approach that helps guide the development process, reducing the likelihood of errors.
Cons	Implementing OOAD might take more time and effort compared to other methods, which can make it less suitable for small-scale projects where a quicker and simpler approach is preferred.	SSADM can take considerable time and resources, making it less suitable for smaller projects or those with tight deadlines.
	OOAD may lead to complex and large systems that can be challenging to understand and manage.	SSADM can exhibit rigidity and may struggle to adapt to projects with constantly changing requirements.
	OOAD may carry a higher risk of errors, especially if the design is not thoroughly planned or if the system has adequate documentation.	SSADM might be changing for individuals unfamiliar with the method due to its intricate nature.
	OOAD may create an overly interconnected design, making it challenging to implement changes in one part without affecting the rest of the system. This interdependence can complicate the modification process and increase the risk of unintended consequences.	Errors can arise in SSADM, especially if the proper steps are not followed or if the system lacks thorough documentation.

Table 13: Difference between OOAD and SSADM

Appendix B-3 Teamwork Breakdown Structure (WBS)

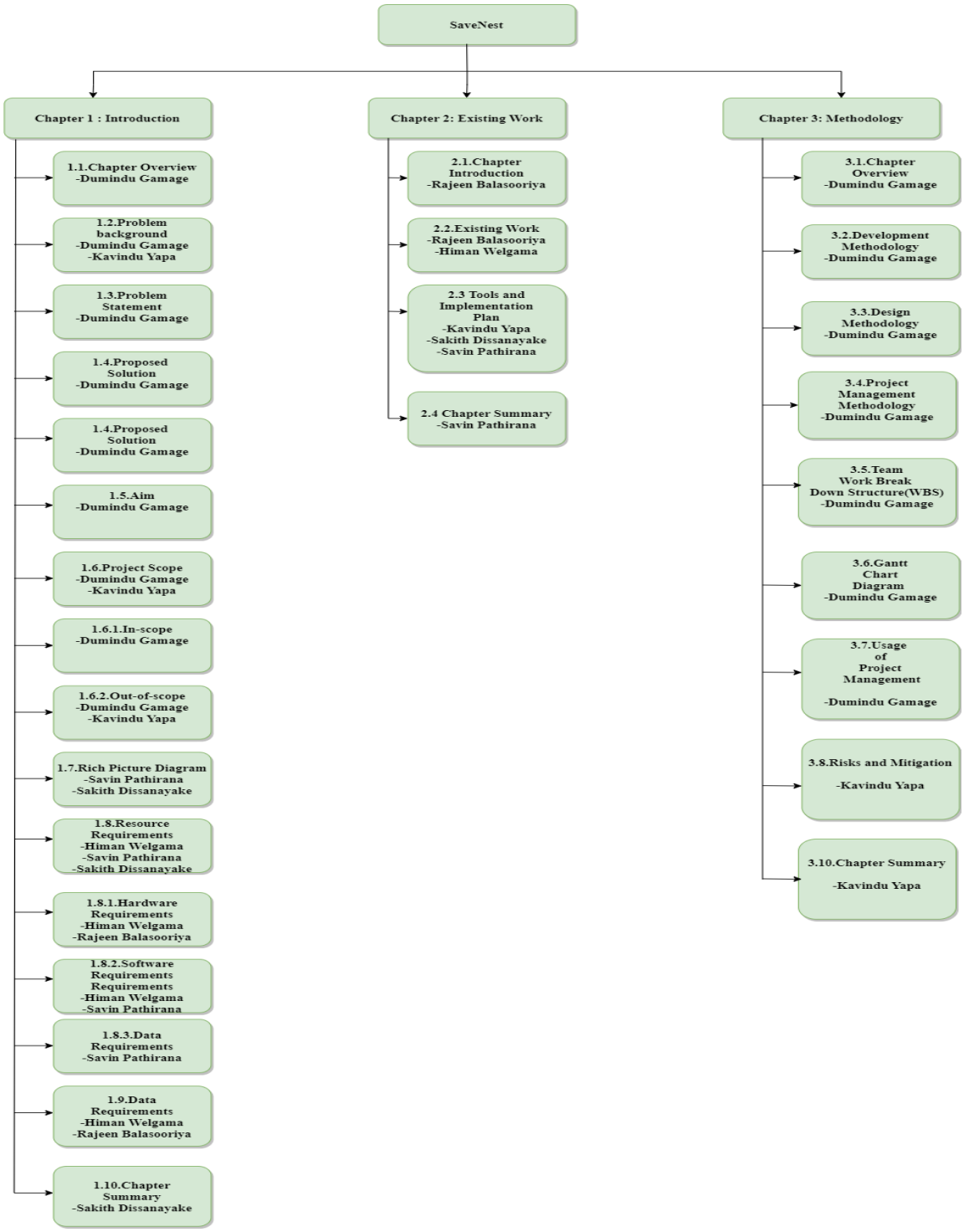

Figure 17: Work Breakdown Structure

Appendix B-4 Gantt Chart Diagram

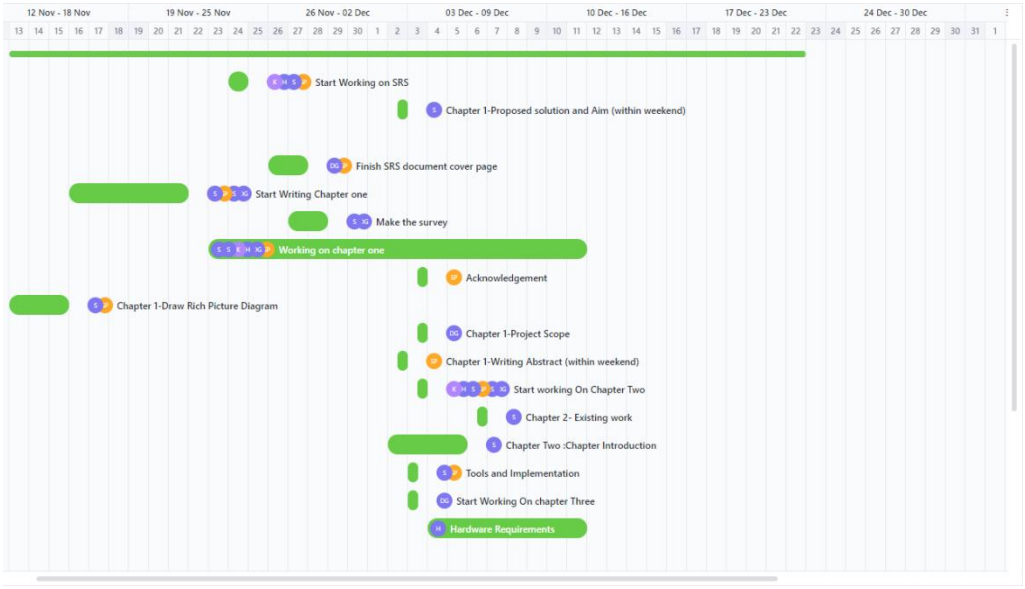

Figure 18: Gantt Chart Diagram 1

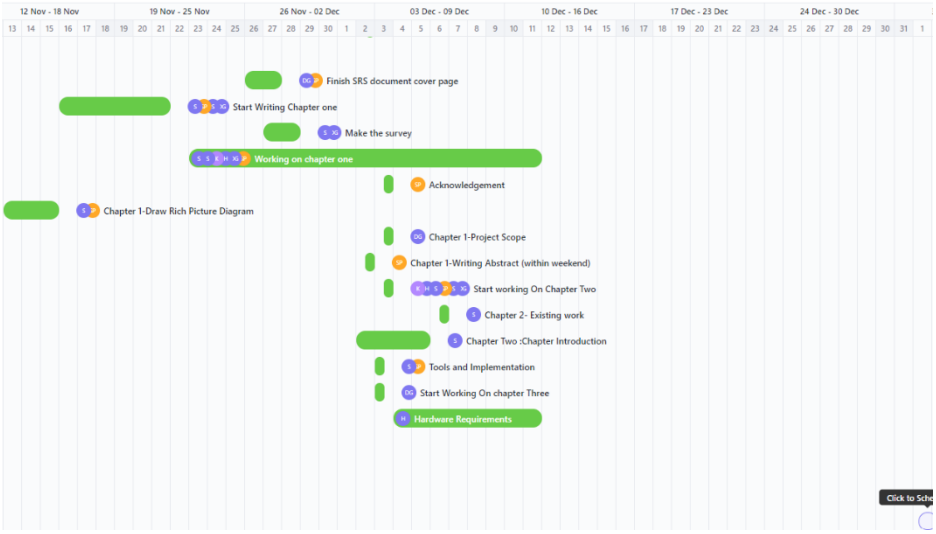

Figure 19: Gantt Chart Diagram 2

Appendix B-5 Activity Schedule

Activity	Expected Start Date	Expected End date	Expected Duration	Actual Start Date	Actual End Date	Actual Duaration
Project Initiation	27/10/2023	5/11/2023	10 days	1/11/2023	14/11/2023	14 days
Introduction	8/11/2023	14/11/2023	7 days	18/11/2023	20/11/2023	3 days
Existing work	16/11/2023	30/11/2023	15 days	23/11/2023	7/12/2023	15 days
SLEP Issues Analysis	1/12/2023	4/12/2023	4 days	9/12/2023	14/12/2023	6 days
Methodologies	17/12/2023	20/12/2023	4 days	23/12/2023	28/12/2023	5 days
System architecture & design	4/12/2023	13/12/2023	10 days	14/12/2023	21/12/2023	8 days
System Requirement specification (SRS)	22/12/2023	29/12/2023	7 days	28/12/2023	31/12/2023	8 days
Finalize the Report	30/12/2023	5/12/2023	7 days	01/01/2024	07/01/2024	6 days

Table 14: Activity Schedule

Appendix B-6 Meeting Schedule

Meeting Number	Date	Time	Task
01	01/11/2023-Saturday	8.00 p.m. -11.00 p.m.	Discussed about ideas with Team Members.
02	03/11/2023 -Friday	8.00 p.m. -11.00 p.m.	Idea discussion with Team Members.
03	06/11/2023-Monday	6.30 p.m. to 8.30 p.m.	Idea discussion with Team Members.
04	08/11/2023 -Wednesday	10.30 a.m-12.30 a.m.	Analysis of three project ideas proposed s by team members.
		3.00 p.m. -4.30 p.m.	Discuss the available risks of choosing each idea.
		8.00 p.m. -11.15 p.m.	Research on the chosen idea was started.

05	10/11/2023 -Thursday	8.00 a.m. -9.00 a.m.	Searched for research papers
		9.00 a.m.- 12.20 p.m.	Did a research for suitable data sets for the chosen idea.
		8.00 p.m-9.00 p.m.	Discussed the project proposal with the team members.
06	12/11/2023-Sunday	10.00 a.m. -11.00 a.m.	Did a discussion with team members about the Prototype.
		3.00 p.m. - 5.00 p.m.	Did Additional research on the project idea.
07	19/11/2023-Sunday	7.00 p.m. -8.30 p.m.	Discussed SRS Chapter 01
08	23/11/2023-Thursday	8.00 p.m. -10.00 p.m.	Discussion on SRS Chapter 02 Exiting work
09	09/12/2023- Saturday	4.30 p.m.-6.30 p.m.	Discussed about Technology Stack
10	14/12/2023-Thursday	10.00 p.m. -01.00 a.m.	Discussion about Chapter 5 and 6
11	23/12/2023 -Saturday	3.45 p.m.-6.00 p.m.	Discussion about SRS Chapter 3 -Methodologies
12	02/01/2023-Tuesday	9.00 a.m-11.00 a.m.	Discussion About Implementation and Discuss doubts about each of these chapters.

Table 15: Meeting Schedule

Appendix B -6 Evidence for Meetings with Team Members

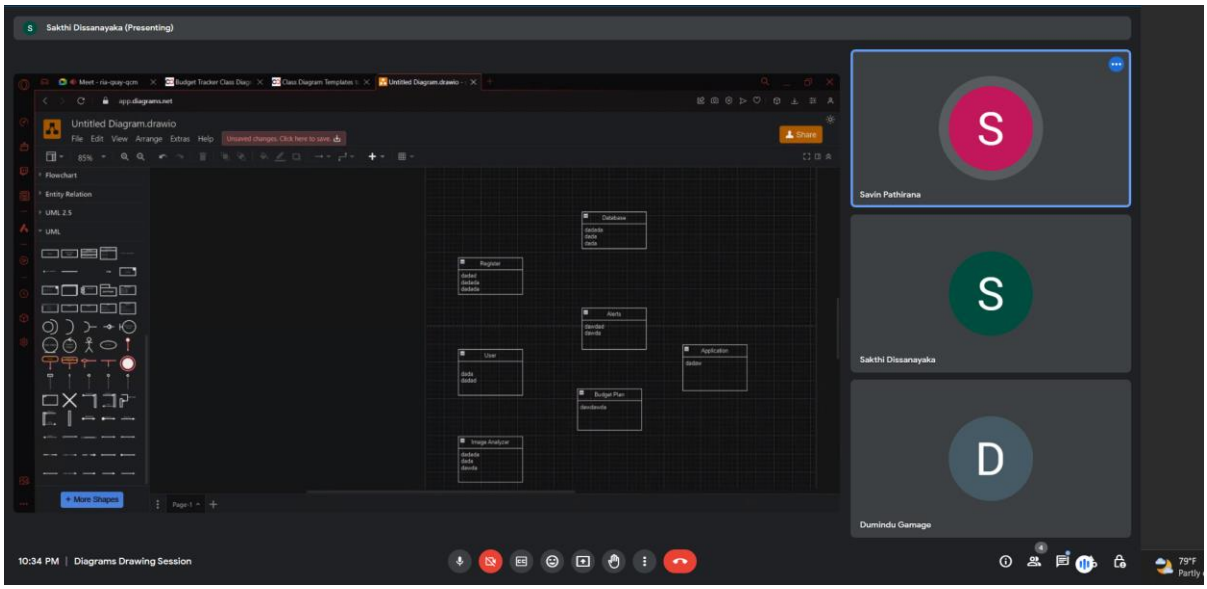

Figure 20: Meet evidence 1

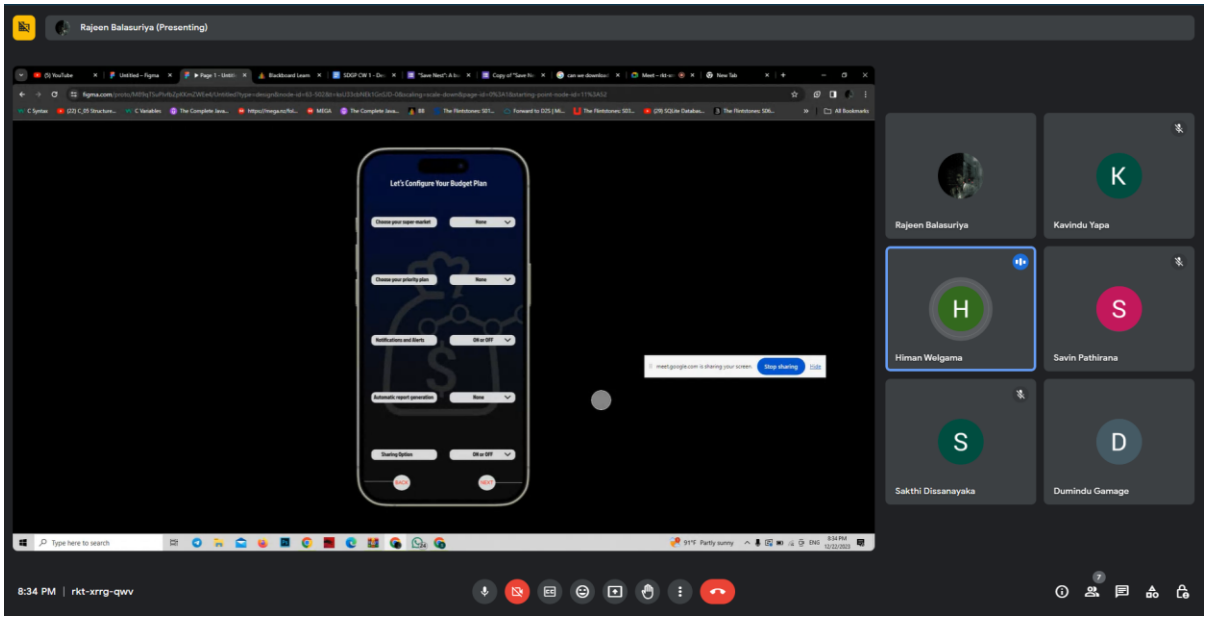

Figure 21: Meet evidence 2

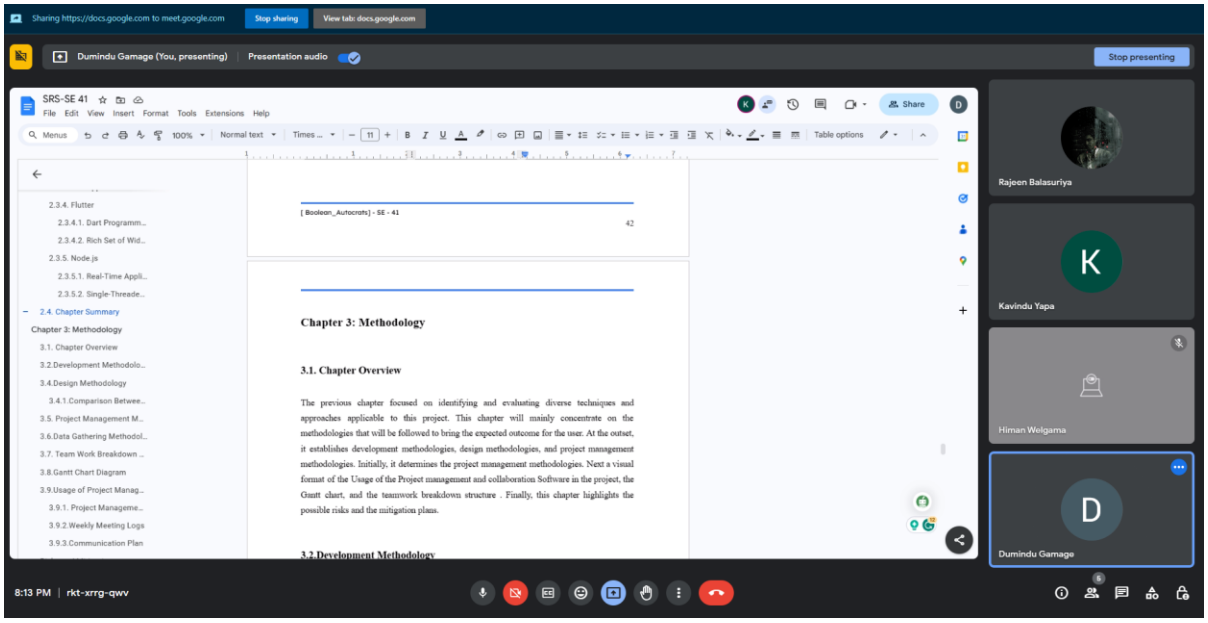

Figure 22: Meet evidence 3

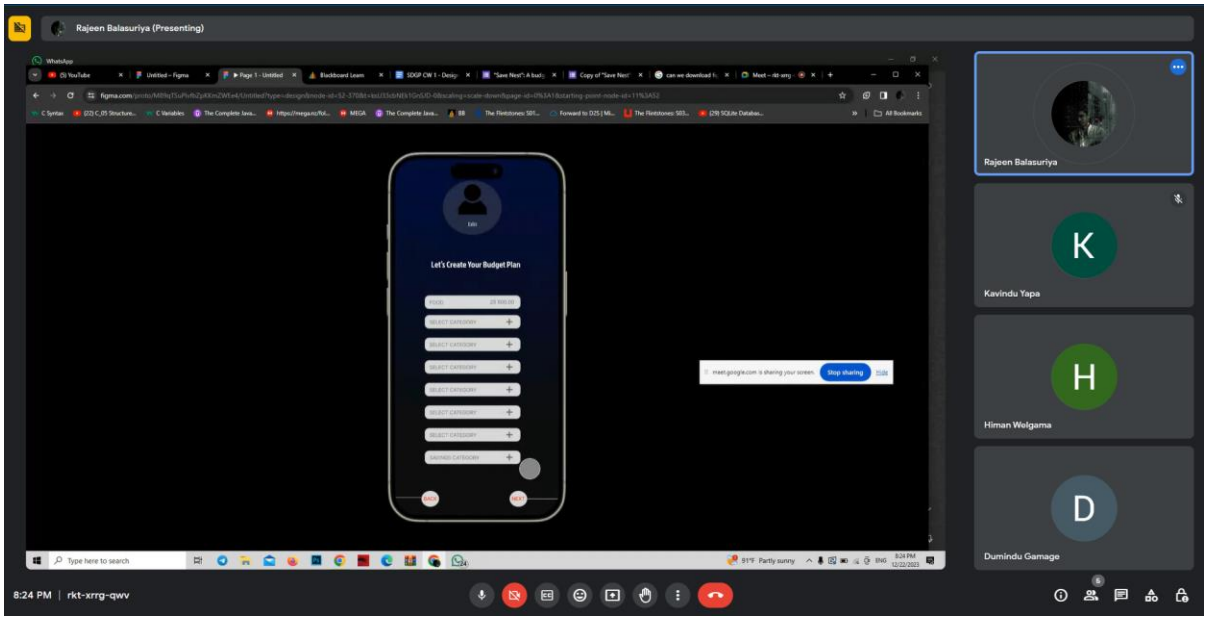

Figure 23: Meet evidence 4