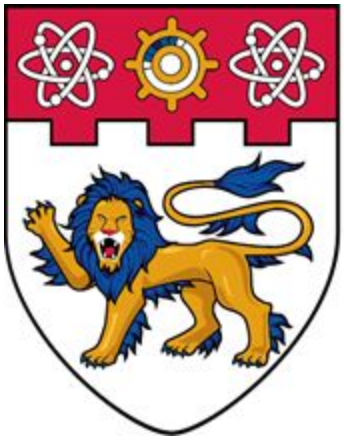


NANYANG TECHNOLOGICAL UNIVERSITY
SINGAPORE

CZ3002 Advanced Software Engineering Project: CashTrack

Name:

Ravishankar Amrita (U1822377F)

Datta Anusha (U1822948G)

Kumar Mehul (U1822146E)

Alex Leong (U1921599D)

Nicklaus Tan (1403385F)

Elliott Ong (U1922981C)

Daniel Loe (U1921408A)

S Sri Kalki (U1921575L)

Class: B2

School of Computer Science and Engineering (SCSE)

Contents

Executive Summary

The past few years have seen an exponential growth of e-commerce, digital payments (including contactless), instant payments, and cash displacement. As exciting as this paradigm shift is, it has introduced its own set of drawbacks. Since most of our payments have taken a digital turn, it is only intuitive to expect a digital solution which integrates seamlessly with this payments ecosystem.

We identified the great effort & inconvenience while settling shared bills, potential of data analysis on spending patterns, and difficulties in keeping record of your own expenses - all of which we aim to address through our proposed application CashTrack. CashTrack is a web-based expense tracker that acts as a one stop destination to track personal expenses, ease the process of resolving shared bills and view comprehensive insights into your spending patterns.

The core concept revolves around creating a detailed shared expense record with an identified Payee (original payer of bill) and Payer (person who owes Payee). With distinct functionalities available to each Payer and Payee, the tracking and settlement of the shared expense becomes a smooth and uncomplicated process. The application allows the Payee to send reminders and edit the record, leading upto when the Payer settles up and requests a final acknowledgement action from the Payee to resolve expenses.

The development of the web application is estimated to take a maximum of 12 months with an estimated budget of $529,634 involving a team of eight developers and managers with a diverse skill set.

Statement of Problem

CashTrack provides an integrated platform solution that enables users to collectively record, analyse and settle their monetary transactions between each other.

Studies show that the ongoing shifts toward e-commerce, digital payments (including contactless), instant payments, and cash displacement have all been significantly boosted in the past six months. [1.1] This significant boost has been motivated by the existence of a global pandemic encouraging individuals to either use contactless payment or digital payment. According to data gathered by AksjeBloggen, the global digital payments market is expected to continue rising in the following years, reaching $6.7 trillion value by 2023. According to the same research, more than 6.1 billion people will use digital payments by 2023. [1.2] As faster and real time payments are gaining stream, the need for a seamless expense lifecycle is growing exponentially as well.

Runtime Terror, conducted an extensive survey on Singaporeans in the age groups 18 - 55. Our survey affirms the purpose of developing an application like CashTrack. Our survey research suggests that 79.2% Singaporeans split bills amongst a group of friends at least 2 to 6 times per week [2.1]. Further, our study shows that 66.7% [2.2] of Singaporeans almost never volunteer to pick the check for the table. The reason being sighted by most is either that they find splitting bills a cumbersome process or that they are unsure about whether people will pay their share eventually [2.3]. Further, a staggering 77.1% of individuals say that they are almost always put into an awkward situation as they do not wish to ask someone for the money they are owed [2.4]. 66.7% of individuals who took the survey stated that they spend over 5-10 minutes [2.5] just splitting the bill amongst the group, and almost always end up paying for more than their share to avoid unpleasantness amongst friends [2.6][2.7]. This entire situation boils down to accountability, convenience and efficiency. Hence, there is a need for a system to monitor and track these shared expenses, amongst friend groups, to enforce these factors.

When our diverse group of Singaporeans were asked whether they would make use of an expense tracker application, that enables an effortless and efficient process for splitting bills and setting reminders for individuals who owe them money, 85% of individuals voted 7 or above on how likely they would be to use such an application. [2.8]

Thus, the Runtime Terror team aims to develop CashTrack, an expense tracker application, to ease the process of splitting bills amongst friends, tracking the status of the payments owed and more.

Objectives

Aside from the aim of developing an intuitive, efficient and seamless solution, other primary objectives of the proposed expense tracker application, CashTrack, are as follows:

1. Personal Expense Tracking
2. Split/Group Expense Tracking
3. Data Analytics
4. Chat

1. Personal Expense Tracking

The application allows tracking of an individual's expenditure, more specifically how much they owe and are owed by other people, as well as their own expenditure such as food, travel, etc. Users are able to add personal expense records by navigating to the 'Personal Expenses' page. They can categorise these personal expense records by using category 'tags', and may also choose to use the optional feature of currency conversion. These records are then used for data analytics and to manage the expenditure under the spending limit set by the user on the 'Settings' page.

2. Split/Group Expense Tracking

As users expand their social circle, frequent get-togethers are quite likely, in these scenarios, splitting the bill can be quite cumbersome for many. The application must therefore allow the tracking of a group bill actively monitoring and notifying the parties involved.

Users are able to add expenses with their friends and family in which they paid for everybody's bill or lent them some money. Users adding the record can choose the category of the record by selecting a category 'tag', use the automatic split by ratio/percentage/shares option, and also choose to add some comments for everyone to see. These expenses can be added from 'Share Expenses' if the user only paid one person, or they can also choose to create a group by navigating to the 'Your Groups' page where they can create a group like 'Tennis Club' or 'ASE Group' and add a shared expense record with the members of the group.

The expense record shows up on the 'Dashboard' of every party involved, with the option to all the people who borrowed money to view all the details of the expense and settle up by pressing the 'Acknowledge' button. Once the original author confirms that they have received the money

from the payer, the record is indicated as ‘settled up’ and closed. This ensures that the author (original payer) of the bill will get back his owed amount.

3. Data Analytics

The application performs a comprehensive analysis of users’ expense data over time or by categories. This aims to reveal any underlying spending patterns or interesting insights into user payment trends. The user can view these insights by navigating to the “Dashboard” page, which will convey the data through the following visualizations:

- Pie Chart

  This data visualisation aims to convey the user spending categories (Food, Travel, Shopping, Entertainment, Others) by percentages, based solely on the personal expense records of the user.

- Line Chart (Personal Expenses)

  This data visualisation shows the quantitative spending trend of the user with respect to their set personal expense limit, in the form of a line chart. This helps them easily realise the magnitude of their expenses over a specified time frame.

- Line Chart (Shared Expenses)

  This data visualisation represents the transactory relationship between the user and their friend, by showcasing the magnitude of inflow or outflow of funds for their shared expenses over a specified time frame. This is achieved through a line chart, wherein X-axis denotes no outstanding expenses between the two parties. Therefore, data points above the X-axis denote the amount owed to the user, while data points below Y-axis denote the amount the user owed to his/her friend.

4. Chat

CashTrack also implements an integrated chat feature to facilitate inter-user communication through the application itself. This chat feature not only facilitates user interaction regarding expenses, but also encourages increased engagement with the application platform. From a business perspective too, a higher user engagement with the product is a very desirable outcome.

Technical Approach

a. Customer Needs

From personal experiences to friends and family to even extended social circles, there has been increasing evidence that when it comes to the subject of bill payment, it is a bit of a gray area where everyone will be staring at each other seeing who will volunteer to pay the bill first.

From anecdotal evidence, our team gathers that this is due to the fear of not getting their money back after they pay the bill, forgetting who owes who or paying more than one should. Other than anecdotal evidence, we also plan to conduct surveys and interviews to better identify the needs of users.

Given that most of us use electronic devices, a web application based on tracking expenses would be ideal in allowing us to track who and how much we owe or are owed within our social circle. In addition, being a web application means that we do not need to have a phone to be able to use the application.

b. Target Specifications

Specification 1: The web application must load all the dashboard (landing page) information within 3 seconds
Rationale: The application will not provide a smooth user experience if the user is made to wait too long

Specification 2: The main menu of the application must be loaded within 2 seconds of starting the application
Rationale: The application will be considered inefficient if the user is made to wait longer than 2 seconds

Specification 3: The application must respond to user input within 2 seconds of the user completing a specific action
Rationale: A delay longer than 2 seconds, will lead to the user getting frustrated

Specification 4: The dashboard information must be updated each time a new expense is added by the user
Rationale: The application will be considered malfunctional if the dashboard summary information is inconsistent with information in the other tabs

Specification 5: The split bill expenses must reflect in every payee's list of payments owed.

Rationale: The application will be considered malfunctional if the split bill expenses do not show up in every payee's "You Owe" tab

Specification 6: All users involved in a split bill or a chat must receive relevant notifications within 10 seconds
Rationale: A delay longer than 10 seconds, will cause the parties involved to be unknown to new developments regarding their account, and is thus required to ensure CashTrack can provide real time updates.

c. Technology Consideration

The development of our proposed web application, CashTrack, shall make use of the free and open-source Javascript software stack MEAN (MongoDB, Express.js, Angular 2, Node.js). MEAN stack enables one language (JavaScript) for both server-side and client-side execution environments, a feature we hope to channelise towards building a reusable, maintainable and scalable application.

The following key technologies have been identified -

Name	Description	Reason
MongoDB	**Non-Relational/NoSQL Database** MongoDB is a free and open-source cross-platform document-oriented database program. Classified as a NoSQL database program, MongoDB uses JSON-like documents with schemata.	Due to its relational data structuring properties, MongoDB is highly scalable and can easily handle large amounts of data.
Express.js	**Web Application Framework** Express.js, or simply Express, is a web application framework for Node.js. It is designed for building web applications and APIs.	Since Express.js is utilized in conjunction with Node.js, it facilitates writing more secure, modular, and faster applications.

Angular 2	**JavaScript MVC Utility** Angular is a TypeScript-based open-source web application framework and development platform for creating efficient and sophisticated single-page apps.	Developed and maintained by Google, Angular 2 allows for rapid development of dynamic, single page web apps. Its modular structure simplifies development and testing and allows for easy scalability.
Node.js	**Server-Side Framework** Node.js is an open-source, cross-platform JavaScript run-time environment that executes JavaScript code outside of a browser (for example, to run as a server).	Node.js uses Chrome's V8 engine, to compile the JavaScript source code to native machine code before execution. This allows for building scalable and performant web apps.

d. System Design/Architecture

CashTrack is designed to follow the Model-View-Controller (MVC) architectural pattern. This approach separates the program logic into three distinct components, each built to handle a specific development aspect of the application.

1. **Model** represents the shape of the data . It is the data used by a program. This may be a database, file, or a simple object, such as an icon.

   The MongoDB is the model component of the CashTrack application, which defines the structure of the data, stores the data in a cloud server, and updates the view with the relevant changes and model data for the user to interact with.

2. **View** is the graphical user interface (GUI). Using Model, View displays data to the user and also enables them to modify the data. The view contains all functionality that directly interacts with the user - like clicking a button, an enter event, or viewing data in the form of a chart.

   Angular acts as the view component of the application, as it interacts with the user to visually present data and information, and also record the changes and the events that the user performs in the web browser.

3. **Controller** connects the model and view. The Controller converts inputs from the View to demands to retrieve/update data in the Model. The Controller receives input from View, uses logic to translate the input to a demand for the Model, the Model retrieves the data which the Controller passes back to the View for the user.

   The NodeJS Express server acts as the controller for this application. It parses requests for information initiated by the user from the view component, and fetches and saves the relevant data in the database. The Google OAuth is also a controller in the application, as it takes a login request from the user from the frontend, and returns back the corresponding user data, access token and error status.

In conclusion, MVC helps achieve low coupling and high cohesion between various software components, which is ideal for clean and modular code.

The interactions between the various components of our software development stack, MEAN and Google OAuth API 2.0 (used for User Authentication), are visualised in the diagram below.

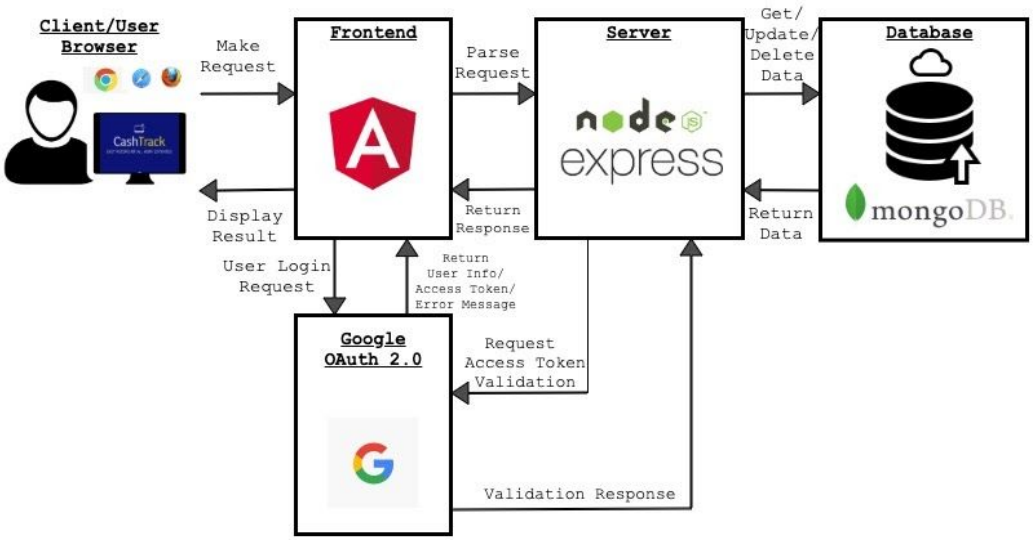


Figure 1. System Architecture

e. Design Concepts

To achieve the intuitive design required to meet the design objectives and customer needs, the Runtime Terror team will incorporate Shneiderman's 8 golden rules throughout the design process of CashTrack.

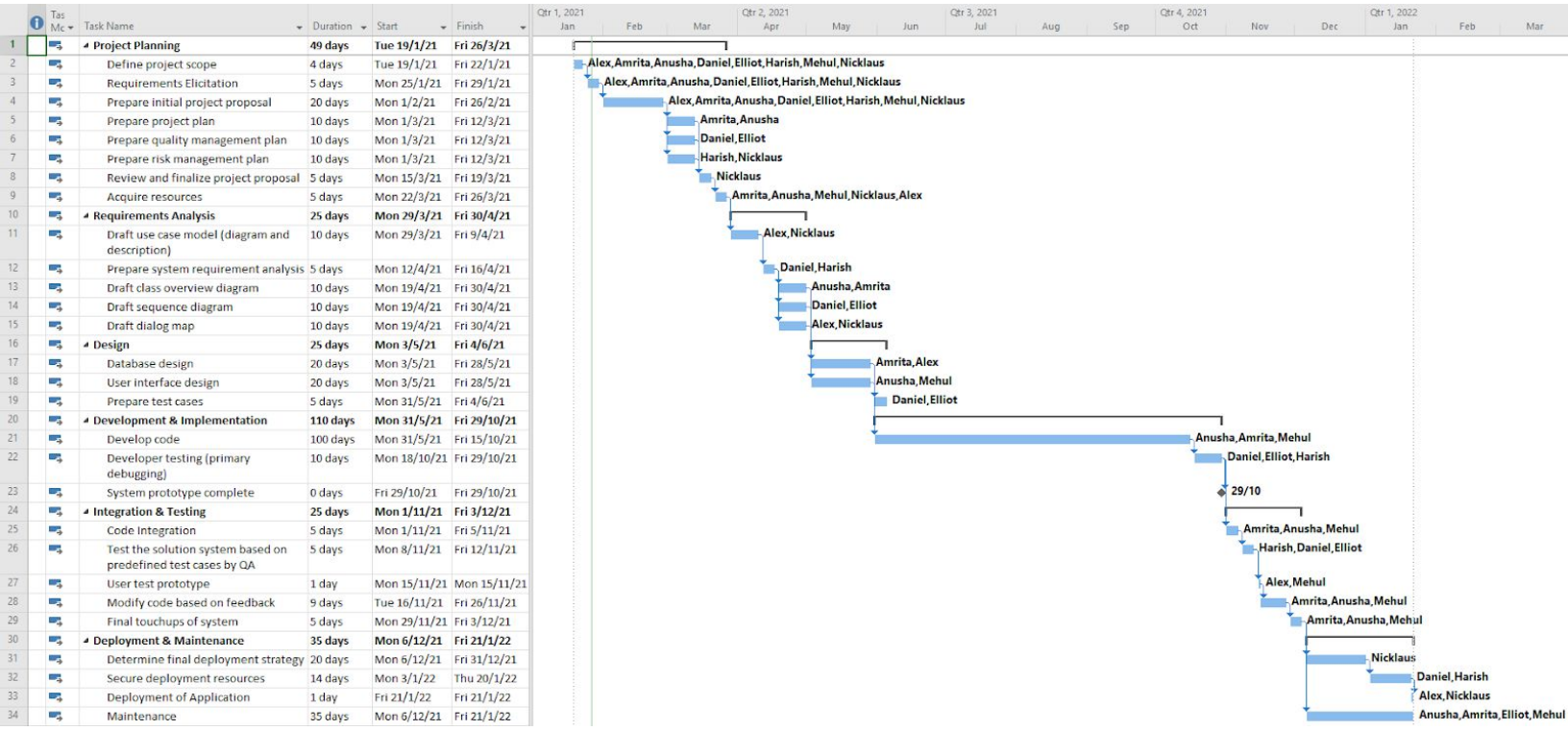
The table below shows a detailed analysis of how the team plans to incorporate the 8 golden rules as well as explain the significance of each rule and how it ultimately contributes to making an intuitive, reliable and easy-to-use application.

Shneiderman 's 8 Golden Rules	**How the rule will be incorporated**	**How the rule will contribute to an intuitive, reliable and easy-to-use application**
Strive for consistency	Consistent terminology will be used throughout the design of CashTrack. I.e. no single word can represent two or more different meanings. Consistent visual layout (fonts, color symbolization, etc.) will be used. Consistent sequence of actions for similar situations will be used (e.g. closing of pop-ups, Back navigation)	Learning curve of CashTrack will be less steep as terminology and sequences of actions are similar throughout giving users a sense of familiarity. Consistency creates trust, it provides an experience which users can rely on any time.
Cater to universal usability	The option of currency exchange will be included under the methods of splitting to facilitate ease of transfer between people who might not exclusively use the same type of currency. (e.g. People from other countries)	By catering the application for universal use, people from all walks of life can CashTrack more effectively without feeling ostracized.
Offer informative feedback	Informative feedback such as success/failure messages will be used User interactions such as button presses will be highlighted to signify that the user is currently selecting it. Visual representations such as progress bars will be used to allow users to easily view the information in a glance.	Users will not feel lost or confused on what they are doing wrong, as clear feedback will be provided to them. Users can feel comforted and reassured that they are performing the correct actions.

Design dialogs to yield closure	The process of creating a group expense record will include a beginning (e.g. name, category, amount, friends, etc), a middle (e.g. options of splitting cost), and an end (e.g. a pop-up mentioning that the expense record has been successfully created).	To provide the user the satisfaction of accomplishment, a way of reassurance and indication that the user can now move on to the next set of actions.
Permit easy reversal of actions	Navigational back buttons will be primarily used for the backtracking of navigation should the user want to move back to a previous window. The ability to delete an expense record (only for personal expense records or the author of a shared expense record record) is also another way that reversal of actions is supported.	To eliminate the feeling of being trapped/stuck, as well as enhancing CashTrack's intuitiveness by using real world terminologies such as back buttons to ease the learning load of the application.
Support internal locus of control	Users can control the amount of notifications received by the personal expense limit tracker by setting his/her desired percentage for which the system would then issue the notification that he/she is nearing that limit Notifications will not force pop-up on the user interface, but rather marked with a red color for unread messages so that users can open them when they are ready without being interrupted should they be performing some other action then.	By giving the user control, there would be no surprises/annoyance of any sorts allowing the user to focus on his/her current task.
Reduce short term memory	Design will be simple yet	Users will not feel bombarded

	elegant following the rule of thumb that humans can only remember 7 +/-2 chunks of information. Only necessary information will be displayed on every page.	with information that they would have to remember to continue a particular task, which in turn reduces the complexity of learning the application.
Prevent errors	Predefined formats and dropdown lists (e.g. spending category or reminder frequency options) will be used to limit the errors made on users' part. Proper organization of screens/transitions and consistency of actions will also be incorporated to minimize the chances of errors. In the case of errors, informative error messages will be displayed to enable users to correct them fast and easily.	By having mitigation plans for errors, the chance of errors a user might make will be reduced increasing the ease of use of the application. By having contingency plans for errors, users will be able to correct their mistake fast and efficiently without feeling frustrated.

Project Management



	Task Name	Duration	Start	Finish
1	**Project Planning**	**49 days**	**Tue 19/1/21**	**Fri 26/3/21**
2	Define project scope	4 days	Tue 19/1/21	Fri 22/1/21
3	Requirements Elicitation	5 days	Mon 25/1/21	Fri 29/1/21
4	Prepare initial project proposal	20 days	Mon 1/2/21	Fri 26/2/21
5	Prepare project plan	10 days	Mon 1/3/21	Fri 12/3/21
6	Prepare quality management plan	10 days	Mon 1/3/21	Fri 12/3/21
7	Prepare risk management plan	10 days	Mon 1/3/21	Fri 12/3/21
8	Review and finalize project proposal	5 days	Mon 15/3/21	Fri 19/3/21
9	Acquire resources	5 days	Mon 22/3/21	Fri 26/3/21
10	**Requirements Analysis**	**25 days**	**Mon 29/3/21**	**Fri 30/4/21**
11	Draft use case model (diagram and description)	10 days	Mon 29/3/21	Fri 9/4/21
12	Prepare system requirement analysis	5 days	Mon 12/4/21	Fri 16/4/21
13	Draft class overview diagram	10 days	Mon 19/4/21	Fri 30/4/21
14	Draft sequence diagram	10 days	Mon 19/4/21	Fri 30/4/21
15	Draft dialog map	10 days	Mon 19/4/21	Fri 30/4/21
16	**Design**	**25 days**	**Mon 3/5/21**	**Fri 4/6/21**
17	Database design	20 days	Mon 3/5/21	Fri 28/5/21
18	User interface design	20 days	Mon 3/5/21	Fri 28/5/21
19	Prepare test cases	5 days	Mon 31/5/21	Fri 4/6/21
20	**Development & Implementation**	**110 days**	**Mon 31/5/21**	**Fri 29/10/21**
21	Develop code	100 days	Mon 31/5/21	Fri 15/10/21
22	Developer testing (primary debugging)	10 days	Mon 18/10/21	Fri 29/10/21
23	System prototype complete	0 days	Fri 29/10/21	Fri 29/10/21
24	**Integration & Testing**	**25 days**	**Mon 1/11/21**	**Fri 3/12/21**
25	Code Integration	5 days	Mon 1/11/21	Fri 5/11/21
26	Test the solution system based on predefined test cases by QA	5 days	Mon 8/11/21	Fri 12/11/21
27	User test prototype	1 day	Mon 15/11/21	Mon 15/11/21
28	Modify code based on feedback	9 days	Tue 16/11/21	Fri 26/11/21
29	Final touchups of system	5 days	Mon 29/11/21	Fri 3/12/21
30	**Deployment & Maintenance**	**35 days**	**Mon 6/12/21**	**Fri 21/1/22**
31	Determine final deployment strategy	20 days	Mon 6/12/21	Fri 31/12/21
32	Secure deployment resources	14 days	Mon 3/1/22	Thu 20/1/22
33	Deployment of Application	1 day	Fri 21/1/22	Fri 21/1/22
34	Maintenance	35 days	Mon 6/12/21	Fri 21/1/22

(Please see Gantt Chart.png in the project proposal folder for a clearer view of the picture)

The project schedule has been structured into six main task phases for development. The six key phases are project planning, requirement analysis, design, development & implementation, integration & testing and lastly deployment & maintenance. Each of the task phases is further divided into subtasks to monitor and control the development process of the project.

1. Project Planning
    - Define Project Scope
    - Requirements Elicitation
    - Prepare Initial Project Proposal
    - Prepare Project Plan
    - Prepare Quality Management Plan
    - Prepare Risk Management Plan
    - Review and finalize project proposal
    - Acquire resources

2. Requirements Analysis
    - Draft Use Case Model (diagram and description)

- Prepare System Requirement Analysis
- Draft Class Overview Diagram
- Draft Sequence Diagram
- Draft Dialog Map

3. Design
    - Database Schema
    - User Interface Design
        i. Lo-Fi User Interface
        ii. Hi-Fi User Interface
    - PrepareTest Plan

4. Development & Implementation
    - Develop code
    - Developer testing (primary debugging)
    - System prototype complete

5. Integration & Testing
    - Code Integration
    - Test the solution system based on predefined test cases by QA
    - User test prototype
    - Modify code based on feedback
    - Final touch ups of system

6. Deployment & Maintenance
    - Determine final deployment strategy
    - Secure deployment resources
    - Deployment of application
    - Maintenance

The requirements and objectives of the project have been reviewed and fully approved by all team members, ensuring that the team is always on the same page.

a. Deliverables

Project Deliverable	Estimated Deadlines	Stakeholders	Description
Project Proposal	30 Jan 2021	Project Committee	Problem statement, project objectives and system design are prepared in a document.
System Requirement Specification	8 Feb 2021	Project Manager Lead Developer Front-end Developer Back-end Developer	Identifying functional, non-functional and technical requirements. Those requirements are further analyzed into detailed information.
Quality Management Plan	13 Feb 2021	Project Manager QA Manager QA Engineer	Problem reporting and corrective actions, software reviews and different controls are documented.
Project Plan	23 Feb 2021	Project Committee	Project schedule and key activities are established and documented.
Risk Management Plan	2 Mar 2021	Project Committee	Identifying and classifying risks and its impact. In addition, establishing the corresponding corrective actions to mitigate the impacts of risks.
Configuration Management Plan	25 Mar 2021	Project Manager Lead Developer Front-end Developer Back-end Developer	Configuration rules and controls are identified and documented.

Change Management Plan	27 Mar 2021	Project Committee	The change request process flow requirement and management log are identified and documented.
Test Plan	29 Mar 2021	Project Manager QA Manager QA Engineer Release Manager	Testing plans including UAT and SPT are created and documented. Test report is produced, and corrective action is taken.
Prototype	31 Mar 2021	Lead Developer Front-end Developer Back-end Developer	Initial prototype of the web application

b. Budget

With a team of 8 members and a completion time of 12 months, the estimated budget required for this project will be $529,634. The amount is inclusive of a 1 year maintenance and support cost after the deployment of the project. In addition, a contingency cost estimated to be 10% of the Implementation Cost is being accounted for any unforeseen circumstances during the duration of the project.

The selection process involves communicating with the client regarding both the functional and non-functional requirements of the application. In addition, the monthly meetings with clients and sponsors are also included in the selection process.

Ref	Project Expenditures	Rate ($ per Unit / Day)	Quantity (Units / No. of days)	Total (SGD)
1.	**SELECTION PROCESS**			
1.1	Travel & Expenses	$40.00	35	$1,400.00

2.	**IMPLEMENTATION PROCESS**			
2.1	**Software Costs**			
2.1.1	Private Git Repository	$205 per month	12	$2,460.00
2.1.2	Database	$350 per month	12	$4,200.00
2.2	**Hardware Costs**			
2.2.1	Servers	$340 per month	12	$4,080.00
2.3	**Manpower Costs**			
2.3.1	Project Manager	$6000 per month	12	$72,000.00
2.3.2	QA Manager	$5500 per month	12	$66,000.00
2.3.3	QA Engineer x 2	$4600 per month	12	$110,400.00
2.3.4	Lead Developer	$4800 per month	12	$57,600.00
2.3.5	Release Engineer	$4250 per month	12	$51,000.00
2.3.6	Front-End Developer	$4250 per month	12	$51,000.00
2.3.7	Back-End Developer	$4250 per month	12	$51,000.00
3.	**CONTINGENCY**	10% of Implementation costs	-	$46,554.00
4.	**MAINTENANCE COST** *(To keep the application live)*			
4.1	**Software (Private Git Repository)**	$205 per month	12 months	$2,460.00
4.2	**Hardware (Server)**	$340 per month	12 months	$4,080.00

5	**OFFICE RENTAL**	$450 per month	12 months	$5,400.00
	Total Costs			**$529,634.00**

c. Communication and Coordination with Sponsor

Currently, CashTrack is actively seeking potential investors/sponsors. As we believe in transparency and open communication, as well as to establish mutual trust, CashTrack proposes the following strategies to realise the goals our team promises to deliver.

To facilitate coordination, communication channels such as live meetings, progress reports as well as collaborative tracking dashboards such as JIRA will be used to relay the development progress of the project along the way. To further specify, two types of communication will be used, namely synchronous and asynchronous communication. For a formal meeting/emergency issue, synchronous communication such as live meetings/conference calls or video conference calls will be used. On the other hand, asynchronous communication such as email can be used where immediate attention to an issue is not necessarily required.

Update reports shall be provided to clients/sponsors on a bi-weekly basis, by the project manager who will serve as the direct point of contact between the clients and the development team. Moreover, comprehensive meetings with client, project manager and development team shall be conducted monthly to ensure the project objectives are aligned. If necessary, ad hoc meetings may be arranged if specific changes or additional features are required in the application. Finally, all update reports should be acknowledged by sponsors, project manager, and development team to minimise miscommunication.

Team Qualifications

Nicklaus Tan (Project Manager): Nicklaus has previously interned at Facebook and managed extensively with mobile application projects. Coupled with his background in Computer Science, technical projects are his expertise. He has ensured his project is a success in every measure.

Kumar Mehul (Lead Developer): Mehul has a rich experience of leading teams to develop scalable and robust full-stack software. He has the technical knowledge to design and implement software systems, and also possesses the leadership skills to delegate and split tasks within the team to complete it in an efficient and timely manner.

Datta Anusha (Back-End Engineer): Anusha has immersed knowledge in the development of high security back-end servers and software systems design. Coupled with her background in Cyber Security, she brings a diverse skill set to the team.

Ravishankar Amrita (Front-end Developer): Amrita has previously interned with Visa Inc. as a Software Engineer Intern and has extensively worked with Angular. She has previously worked on multiple applications on the frontend side. She further specialises in crafting human-centric applications.

Alex Leong (Release Engineer): Alex has previously interned at tech companies like Razer and Google Singapore as a Software Engineer Intern and has developed and released various projects. He also has technical knowledge and experience in data analytics which will be very helpful when the team is designing the analytics portion of the project, he will be a valuable asset to the team.

Elliott Ong (QA Engineer): Elliott is well experienced in quality assurance testing and has been doing quality assurance as an intern in various companies that have multiple different target audiences. With his experience, he is very focused and thorough, and is able to test software from many different perspectives.

Daniel Loe (QA Engineer): Daniel has a wealth of experience when it comes to software development and security. Having first hand experience working with tech giants such as Facebook and Dyson previously, he has the technical knowledge and understanding to design and implement quality software and security systems.

S Sri Kalki (QA Manager): Kalki has been a part of multiple teams of developers and collaborated with developers to bring various projects. His past experience in different projects / internships will help him ensure that project he is a part of can be completed smoothly.

Conclusion

In conclusion, we aim to build a web-based expense tracker application, CashTrack, which serves the purpose of effortless tracking of all your expense records. CashTrack's functionality also includes features such as informative graphs and charts showing users their spending patterns and chat messenger-like capabilities to enable users to chat with other users.

The proposed application is intended to be coupled with extensive quality benchmarks along with the detailed objectives outlined above. All in all, we aim to achieve the final outcome of an intuitive, responsive and seamless integrated expense tracker application platform, delivered fully on time and within budget.

References:

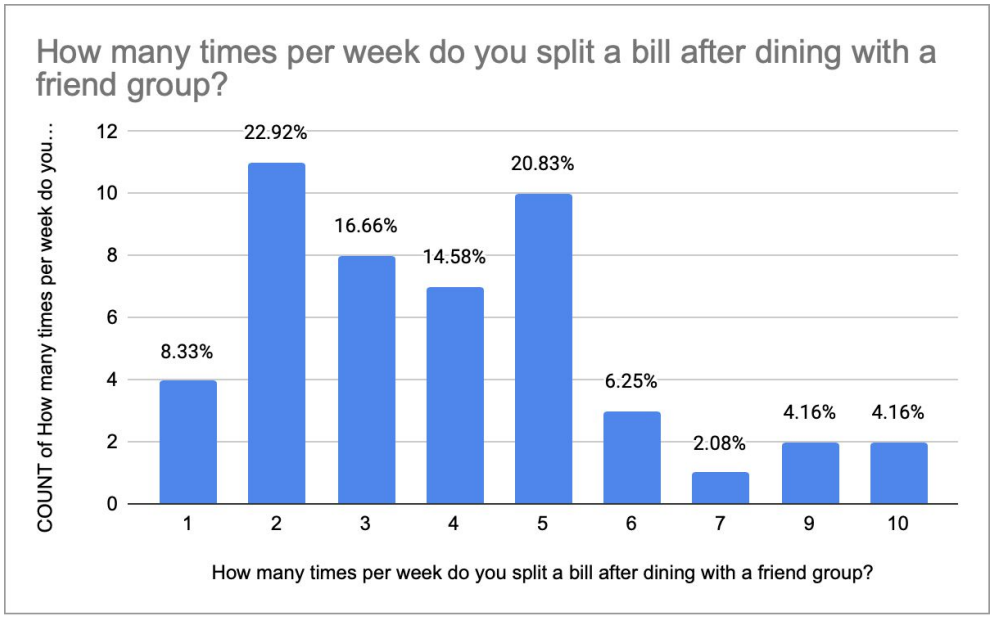
[1] Sources of Information

[1.1] McKinsey & Company. “The 2020 McKinsey Global Payments Report.” McKinsey & Company, Oct. 2020.

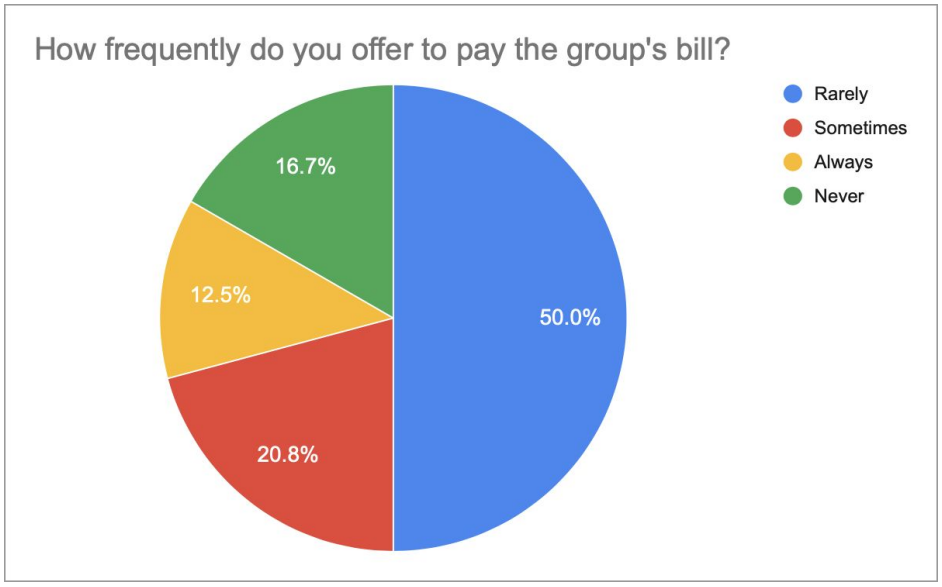
[1.2] Rob Clymo “More than 6.1 billion people will use digital payments by 2023.” TechRadar online publication, 12 May, 2020.

[2] Graph Data - User Survey

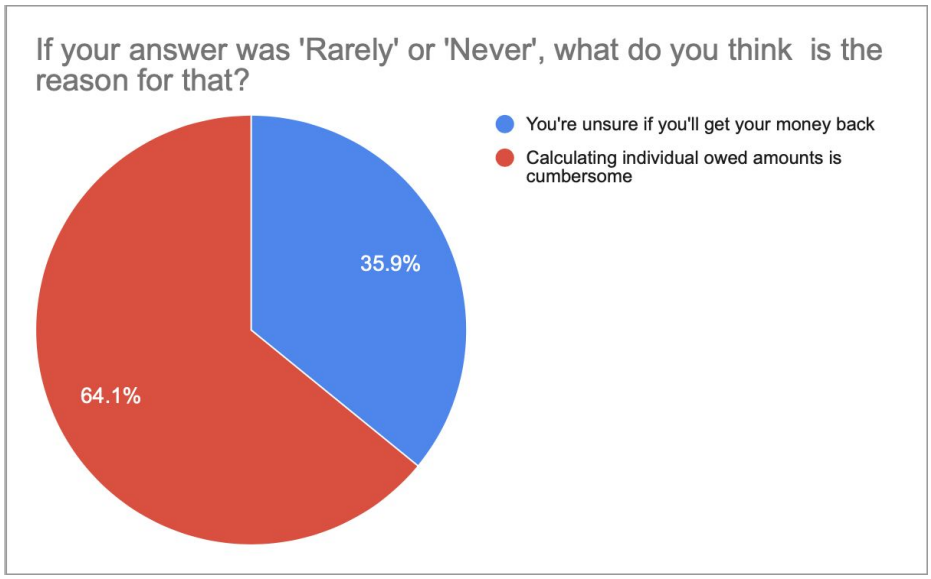
[2.1]



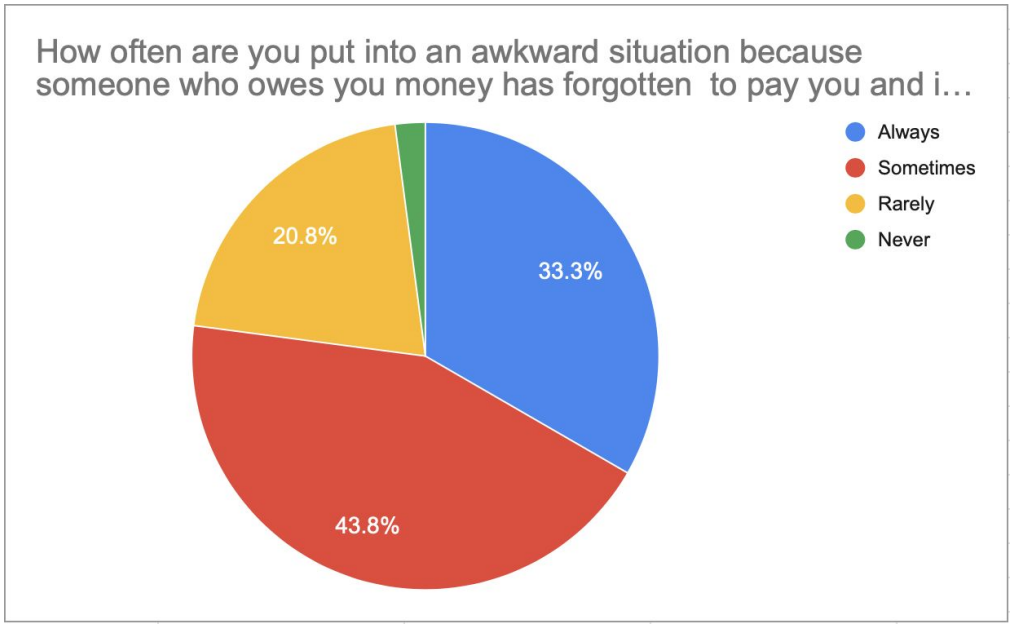
[2.2]


How frequently do you offer to pay the group's bill?
Rarely
Sometimes
Always
Never
16.7%
12.5%
50.0%
20.8%

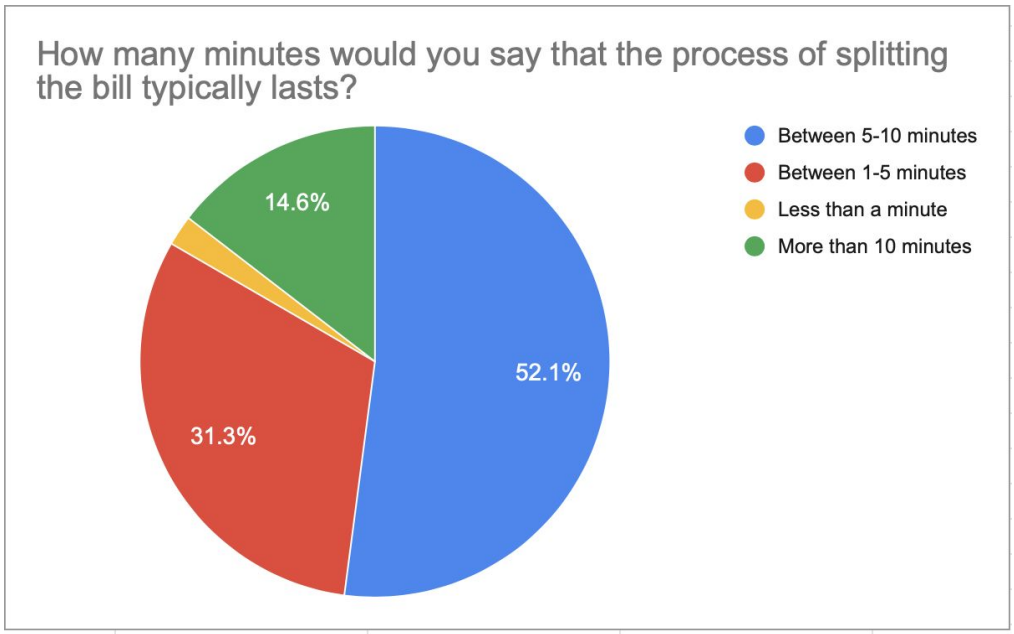
[2.3]


If your answer was 'Rarely' or 'Never', what do you think is the reason for that?
You're unsure if you'll get your money back
Calculating individual owed amounts is cumbersome
35.9%
64.1%

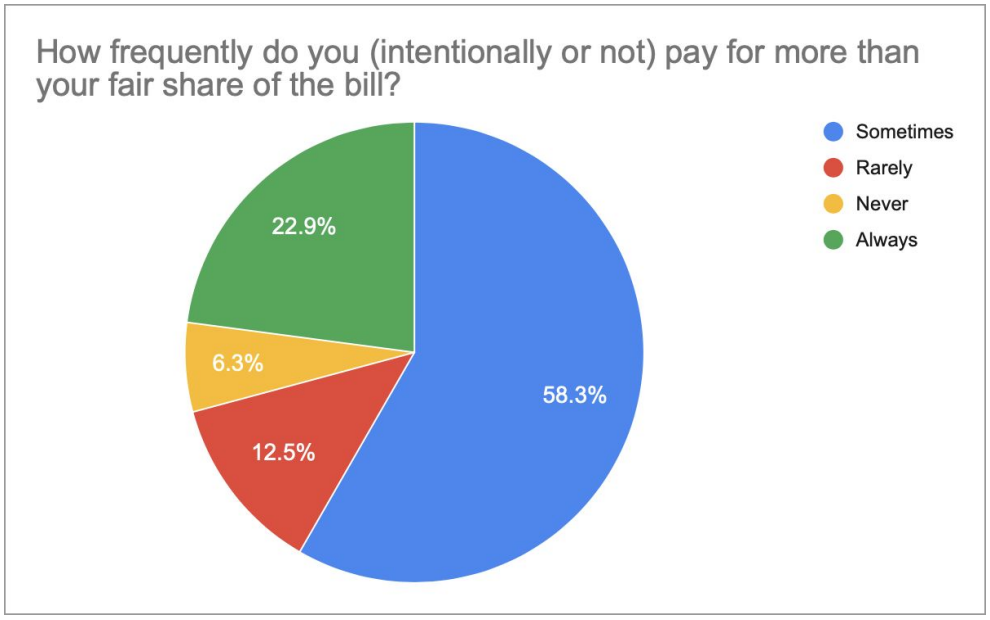
[2.4]


How often are you put into an awkward situation because someone who owes you money has forgotten to pay you and i…
Always
Sometimes
Rarely
Never
33.3%
43.8%
20.8%

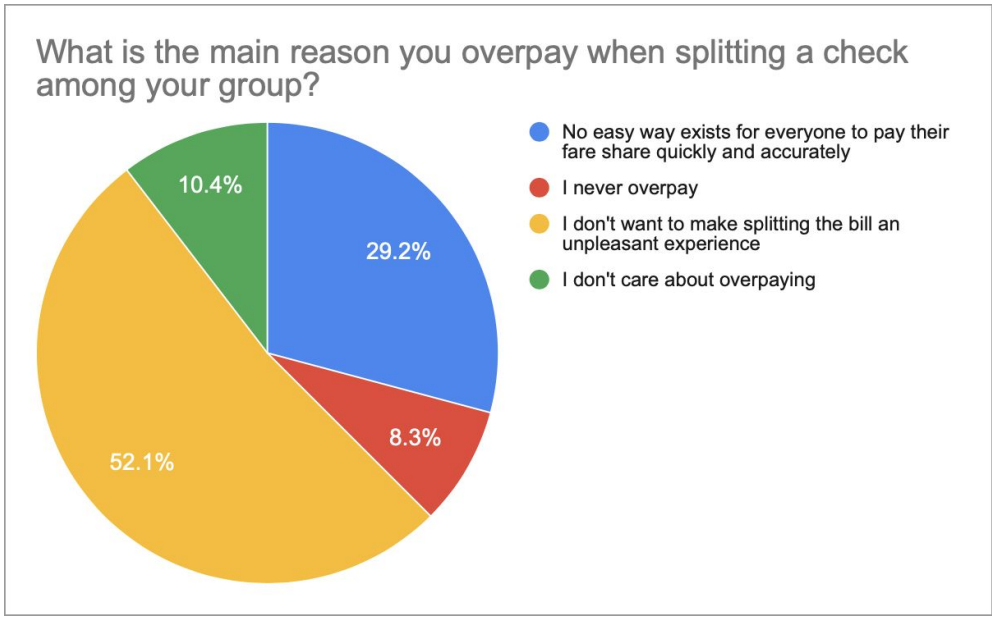
[2.5]


How many minutes would you say that the process of splitting the bill typically lasts?
Between 5-10 minutes
Between 1-5 minutes
Less than a minute
More than 10 minutes
52.1%
31.3%
14.6%

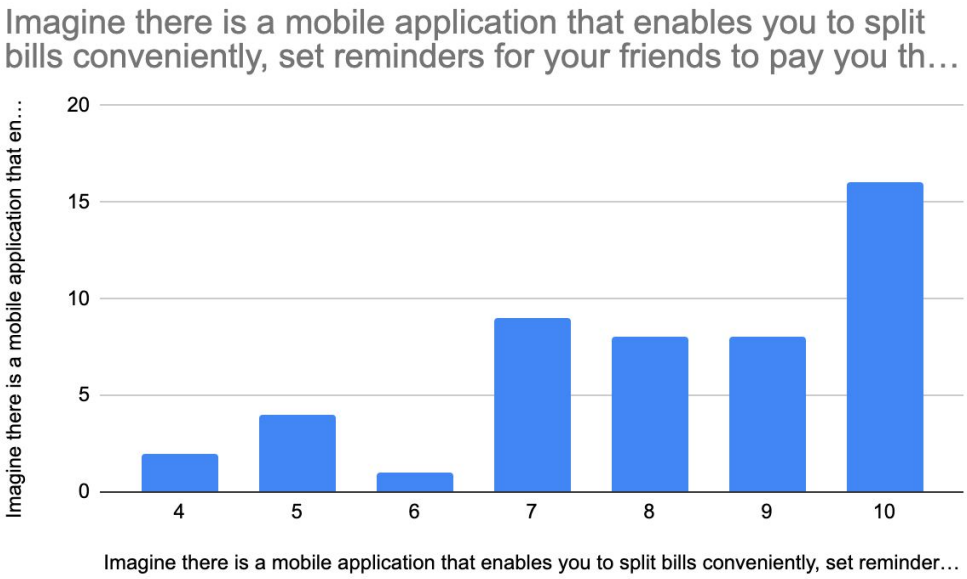
[2.6]


How frequently do you (intentionally or not) pay for more than your fair share of the bill?
Sometimes
Rarely
Never
Always
22.9%
6.3%
58.3%
12.5%

[2.7]


What is the main reason you overpay when splitting a check among your group?
No easy way exists for everyone to pay their fare share quickly and accurately
I never overpay
I don't want to make splitting the bill an unpleasant experience
I don't care about overpaying
10.4%
29.2%
8.3%
52.1%

[2.8]


Imagine there is a mobile application that enables you to split bills conveniently, set reminders for your friends to pay you th…
Imagine there is a mobile application that en…
20
15
10
5
0
4
5
6
7
8
9
10
Imagine there is a mobile application that enables you to split bills conveniently, set reminder…

APPENDIX A: RESUME OF TEAM MEMBERS

Nicklaus Tan

+65 83458462
nick0253@e.ntu.edu.sg

Project success is key

EXPERIENCE

Amazon, Singapore— Assistant Project Manager

MAY 2020 - DECEMBER 2020

Assist in managing an Symbian mobile application that uses advanced Machine Learning algorithms to analyse text messages and detect bubble tea drinking behaviour

Facebook, Singapore— *Project Management Intern*

MAY 2019 - DECEMBER 2019

Assist in managing an Palm OS mobile application to facilitate transactions between business and customers using Facebook Pay.

EDUCATION

Nanyang Technological University, Singapore — Bachelor's *Degree, Computer Science*

AUGUST 2019 - PRESENT

School of Computer Science & Engineering Club: Member
NTU Student Union: Member

PROJECTS

Project Cat Eye — *Mobile Application*

Developed an mobile application that allows users to use their pager to identify objects.

SKILLS

Programming Language: Python, C, C++, Java, R

Development Tools: MySQL, SQL, Android Studio

AWARDS

Google Throwstart (2019) Champion

Runner Up | Google Punchstart (2018)

RELEVANT COURSEWORK

- Algorithms
- Data Structures
- Data Science
- Software Engineering
- Object Oriented Design Principles

Mehul Kumar

Full Stack Developer and Finance Enthusiast

mehul.kumar171@gmail.com
linkedin.com/in/mehul-k
github.com/mehul-k

EXPERIENCE

Shopee, Singapore — *Software Engineer Intern*

AUGUST 2020 - JANUARY 2021

Developed a desktop debugging platform for non-developers (PMs, QAs) for the Shopee Mobile App with wireless connection support, with a plugin-based architecture for scalability.

Resync Technologies, Singapore — *Full Stack Intern*

DECEMBER 2019 - JULY 2020

Developed Resync Mobile Application on Flutter, with automated testing and deployment using Gitlab CI pipeline with Fastlane.

EDUCATION

Nanyang Technological University, Singapore — Bachelor's *Degree, Computer Science*

AUGUST 2018 - PRESENT

Activities and Societies: Vice President, Tech - IEEE NTU Student Branch (AY19/20), Under Secretary General Operations - NTU Model UN (AY19/20)

Minor in Business, Minor in Entrepreneurship
CFA Investment Foundations Program Certificate Holder

PROJECTS

Forex Prediction Using Neural Networks — *Data Science | Python, LSTM*

Developed a new deep-learning model for forex rate prediction using Long-Short Term Neural Networks with high accuracy of 80%

SKILLS

Languages / Frameworks
· Expert: Java, Python, JavaScript, Typescript, SQL, Flutter, React-Native, React, Redux, ElectronJS, ExpressJS, Angular, Flask, Pandas, AWS, Google Cloud Platform, Firebase

· Intermediate: C++, Photoshop/Sketch, Swift, MongoDB, Influx DB, Jenkins, Travis CI

Tools
Jupyter Notebook, VSCode, GitLab, GitHub, Sublime Text, Android Studio, XCode

ACHIEVEMENTS AND SCORES

· SAT Subject Test (Physics, Chemistry, Math-2) 2390/2400 2018

· KWHS Wharton Investment Competition Finalist 2018

· CBSE National Science Fair 3rd Position (Among 10k projects) 2017

RELEVANT COURSEWORK

Data Structures, Algorithms, Business Finance, Enterprise Strategy, Entrepreneurial Accounting, Advanced Computer Architecture, Software Engineering

Anusha Datta

Software Developer & Machine Learning Enthusiast

anushadatta@gmail.com
anushadatta.com
linkedin.com/anusha-datta
github.com/anushadatta

EXPERIENCE

Apple, Singapore — *Data Enhancement & Automation Intern*

JUNE 2020 - DECEMBER 2020

Worked within a cross-functional team, using AppleScript, JavaScript & PHP to support automation and enhancement of business data processing activities.

Google, Singapore —Software Product Sprint

MAY 2020 - AUGUST 2020

Ideated and developed a Full Stack Web Application aimed at minimizing food wastage, by redistributing excess food from F&Bs to charities.

VEBITS AI, Singapore — *Computer Vision & Deep Learning Intern*

JUNE 2019 - AUGUST 2019

Established an end-to-end deep learning framework, and developed a lightweight model for GPU-enabled devices for real-time distracted driver detection using computer vision.

EDUCATION

Nanyang Technological University, Singapore — Bachelor's *Degree, Computer Science*

AUGUST 2018 - PRESENT

Activities and Societies: Vice President - NTU Open Source Society (AY20/21), Vice President, Business - IEEE NTU Student Branch (AY19/20)

PROJECTS

URECA — Undergraduate Student Researcher

AUGUST 2019 - JULY 2020

Conducted extensive research on the correlation of Sentiment Analysis & Natural Language Processing with the prediction of socio-political or financial events.

SELECTED SKILLS

Programming Languages: Python, Java, JavaScript

Development Tools: MongoDB, Express.js, Angular, Node.js

Others: UI/UX

AWARDS

Runner Up | Goldman Sachs Hack Wars 2020

Gold Medal | International English Olympiad

Academic Gold Medal | Delhi Public School, India

Zonal Excellence Award | National Financial Literacy Test, India

RELEVANT COURSEWORK

- Algorithms
- Data Structures
- Artificial Intelligence
- Software Engineering
- Software Systems Analysis and Design
- OODP
- Adv. Computer Architecture
- Business Finance
- Investments

Amrita Ravishankar

Full Stack Developer

linkedin/amritaravishankar
github.com/amritaravishankar
+65 85316901
AMRI0006@e.ntu.edu.sg

EXPERIENCE

Visa Inc., Singapore — *Software Engineer Intern*

AUGUST 2020 - DECEMBER 2020

Implemented a Role-Based Authorisation System for an employee dashboard using Angular8, Spring Boot and MySQL.

Panasonic R&D Centre, Singapore — *Deep Learning Intern*

MAY 2020 - JULY 2020

Performed Image Segmentation on Electrical Line Images. Developed an end-to-end pipeline on the processes involved in 3D-Object Recognition.

Grab, Singapore — *Software Engineer Intern*

MAY 2019 - AUGUST 2019

Developed an Android mobile application to facilitate transactions between vendors using GrabPay.

EDUCATION

Nanyang Technological University, Singapore — *Bachelors of Engineering _ Computer Science*

AUGUST 2018 - JUNE 2022 (EXPECTED)

Co-Curricular Activities and Leadership Positions: NTU IEEE Technical Director (AY 20/21); NTU Red Cross FundRaising Portfolio Head (AY 19/20); NTU Model United Nations Head Of Events (AY 19/20)

PROJECTS

BlogPost — *A Web Application*

Developed an application using Python's Flask framework to create a web application that allows users to register, login and then create, update, delete and read others' blog posts.

SKILLS

Programming Languages: Python, Java, JavaScript, C++

Frameworks: Angular8, ReactJS

Other Development Tools: ExpressJS, NodeJS, Spring Boot, MySQL, MongoDB

AWARDS

Top Performing Intern - Grab - 2019

RELEVANT COURSEWORK

- Algorithms
- Data Structures
- Object Oriented Programming and Design
- Software Engineering
- Software System Analysis and Design

Alex Leong

Interested in Software Engineer & Data Science

github.com/aleong011
+65 83458462
aleong011@e.ntu.edu.sg

EXPERIENCE

Lazada, Singapore— Data Analyst

MAY 2020 - DECEMBER 2020

Worked with advanced Machine Learning algorithms to analyse shoppers spending behaviour and analyse market trends.

Razer, Singapore— *Software Engineer Intern*

MAY 2019 - DECEMBER 2019

Developed and released an Android mobile application to facilitate transactions between vendors using Razer Pay.

Google, Singapore— *Android Software Development Intern*

March2018 - DECEMBER 2018

Developed and released an Android application interface to convert images of people into animal emoji in real time using state of the art image recognition algorithms.

EDUCATION

Nanyang Technological University, Singapore — Bachelor's *Degree, Computer Science*

AUGUST 2019 - PRESENT

School of Computer Science & Engineering Club: Member
NTU Student Union: Member
NTU E-Sports Team Captain: Counter-Strike GO, League Of Legends

PROJECTS

Project Eagle Eye — *Web Application*

Developing an online web application that allows users to view their opponents games performance statistics and game history. (Current supported games: Counter-Strike GO, Fortnite, League Of Legends)

SKILLS

Programming Language: Python, C, C++, Java, R

Development Tools: MySQL, SQL, Android Studio

AWARDS

Google Kickstart (2017)
Champion

Runner Up | Google Kickstart (2016)

RELEVANT COURSEWORK

- Algorithms
- Data Structures
- Data Science
- Software Engineering
- Object Oriented Design Principles

Elliott Ong

QA slave

github.com/perorin2
+65 8299 0953
jong107@e.ntu.edu.sg

EXPERIENCE

OCBC Bank, Singapore — *Software QA Analyst Intern*

APRIL 2019 - OCTOBER 2019

Worked with a team to fix bugs and implement more advanced security features in the OCBC SG Mobile Banking application.

Ubisoft, Singapore — *QA Assistant Intern(Tester)*

MARCH 2020 - SEPTEMBER 2020

Did quality assurance testing for multiple game releases, such as Watch Dogs: Legion, Assassin's Creed Valhalla and Immortals Fenyx Rising.

EDUCATION

Nanyang Technological University, Singapore — *Bachelor's Degree in Computer Science*

AUGUST 2019 - AUGUST 2023 (EXPECTED)

Activities and Societies: NTU Taekwondo, 33rd Main Committee - Logistics Officer

PROJECTS

vController — *Windows program*

Developed an application in C++ that allows keyboard and mouse users to emulate a controller. It is a DirectInput and XInput wrapper that can convert keyboard and mouse inputs to analog and digital controller inputs.

SKILLS

Programming Languages: Python, JavaScript, C, C++

Development tools: Unity, SQL

RELEVANT COURSEWORK

- Algorithms
- Data Structures
- Object Oriented Design Principles
- Software Engineering
- Software Systems Analysis and Design
- Cyber Security

Daniel Loe

Passionate Software Developer interested in Cyber Security

github.com/DLOE001
+65 81823913
DLOE001@e.ntu.edu.sg

EXPERIENCE

Facebook, Singapore — *Software Engineer Intern*

JULY 2020 - DECEMBER 2020

Developed an analyst tool to help better predict targeted ads for consumers.

Dyson, Singapore — *Security Engineer Intern*

JANUARY 2020 - MAY 2020

Enhanced the security features supporting dyson's day to day processes and its monitoring of the network to intelligently detect and counter any cyber related incidents.

Urban Redevelopment Authority, Singapore — *Software Development Intern*

APRIL 2019 - OCTOBER 2019

Using ArcGiS to automate various key processes as well as enhancing the communication system between the different infrastructure agencies.

EDUCATION

Nanyang Technological University, Singapore — Bachelor's *Degree, Computer Science*

AUGUST 2019 - PRESENT

University Mountaineering Club: Part of the competition team
Students' Union (Welfare Service Club): Assistant Vice President

PROJECTS

Project Stonks — *Mobile Application*

An ongoing project determining key relations between the causation of fluctuations of the stock market and predicting its trajectory through rigorous data learning algorithms.

SKILLS

Programming Languages: Python, Java, C++, HTML

Development Tools: MySQL, Android Studio

AWARDS

Facebook Hacker Cup Champion (2020)

Runner Up | Hackathon Singapore (2019)

RELEVANT COURSEWORK

- Algorithms
- Data Structures
- Software Engineering
- Software Systems Analysis and Design
- Object Oriented Design Principles
- Cyber Security
- Cryptography & Encryption

S Sri Kalki

Interested in AI Engineer & Data Science

www.linkedin.com/in/ssrikalki
+65 8152 5595
SRIKALKI001@e.ntu.edu.sg

EXPERIENCE

Defence Science & Technology Agency, Singapore — *Data Analyst*

December 2016 - March 2017

Identify, analyze and interpret trends in complex data sets using statistical technique and provide ongoing reports and dashboards.

A*STAR, Singapore — *Research Assistant*

May 2015 - August 2015

Research on current trending vu;nerabilities occurring in web applications and developed an application using static code analysis to identify any security flaws in the source code of a given web application.

EDUCATION

Nanyang Technological University, Singapore — Bachelor's *Degree, Computer Science*

August 2019 - December 2022 (EXPECTED)

School of Computer Science & Engineering Club: Member
NTU Running Club: Member

Singapore Polytechnic, Singapore — *Diploma, Computer Engineering*

April 2014 - March 2017

Area of focus : Computer Networking and Cloud Computing

SP Robotics Club : Sub committee

PROJECTS

Project Mozzify — *Mobile Application*

Developed an mobile application that allows users to increase awareness of dengue in Singapore and to report potential breeding grounds.

SKILLS

Programming Language: Python, C, C++, Java, JavaScript, R

Framework : ReactJS

Development Tools: MySQL, SQL, Android Studio

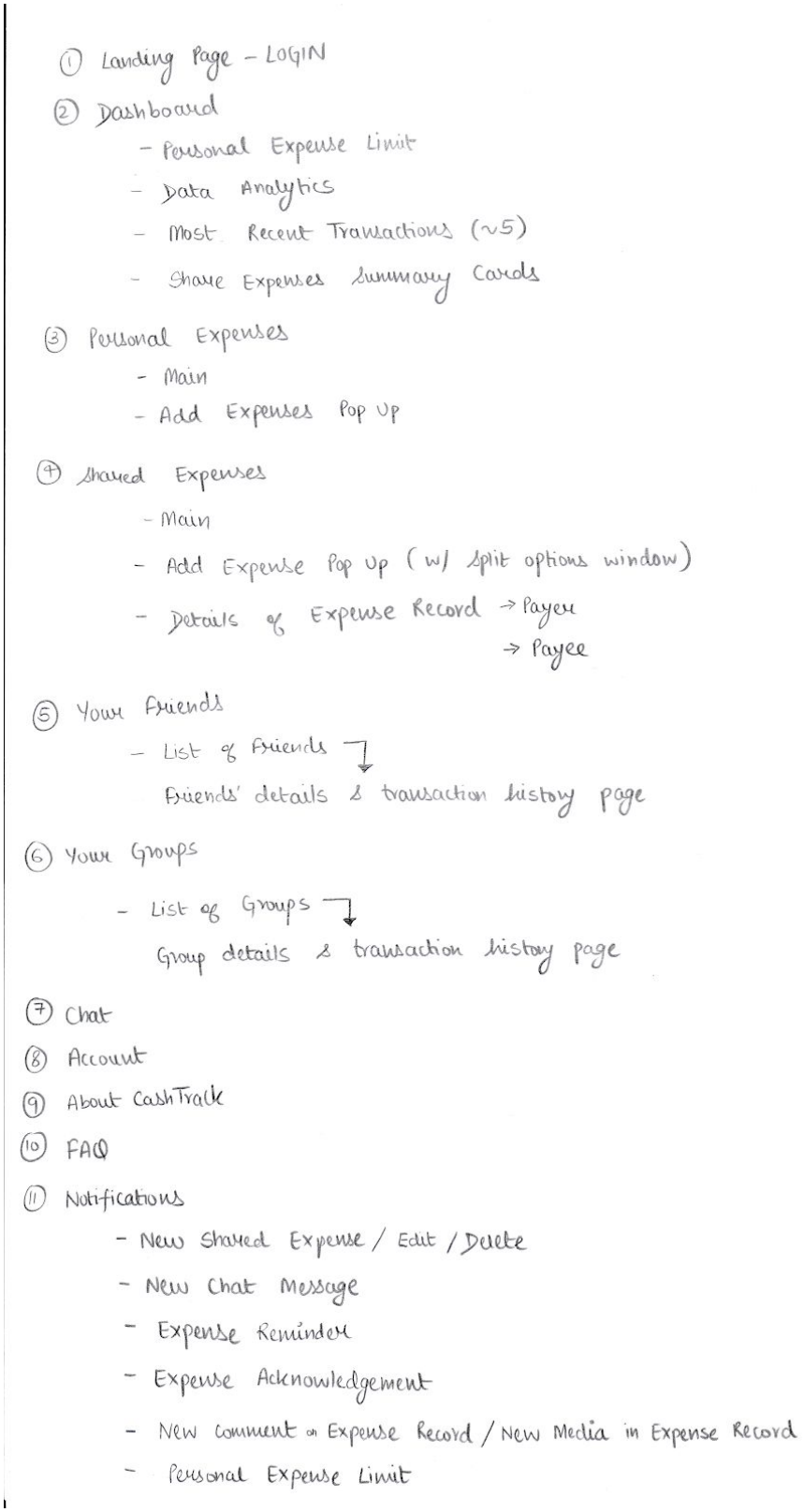
AWARDS

2nd Runner Up | Green Wave Environmental Care Competition 2015

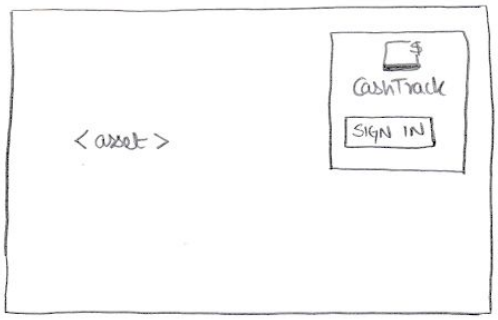
RELEVANT COURSEWORK

- Net Centric Computing
- Algorithms
- Data Structures
- Object Oriented Programming and Design
- Software Engineering

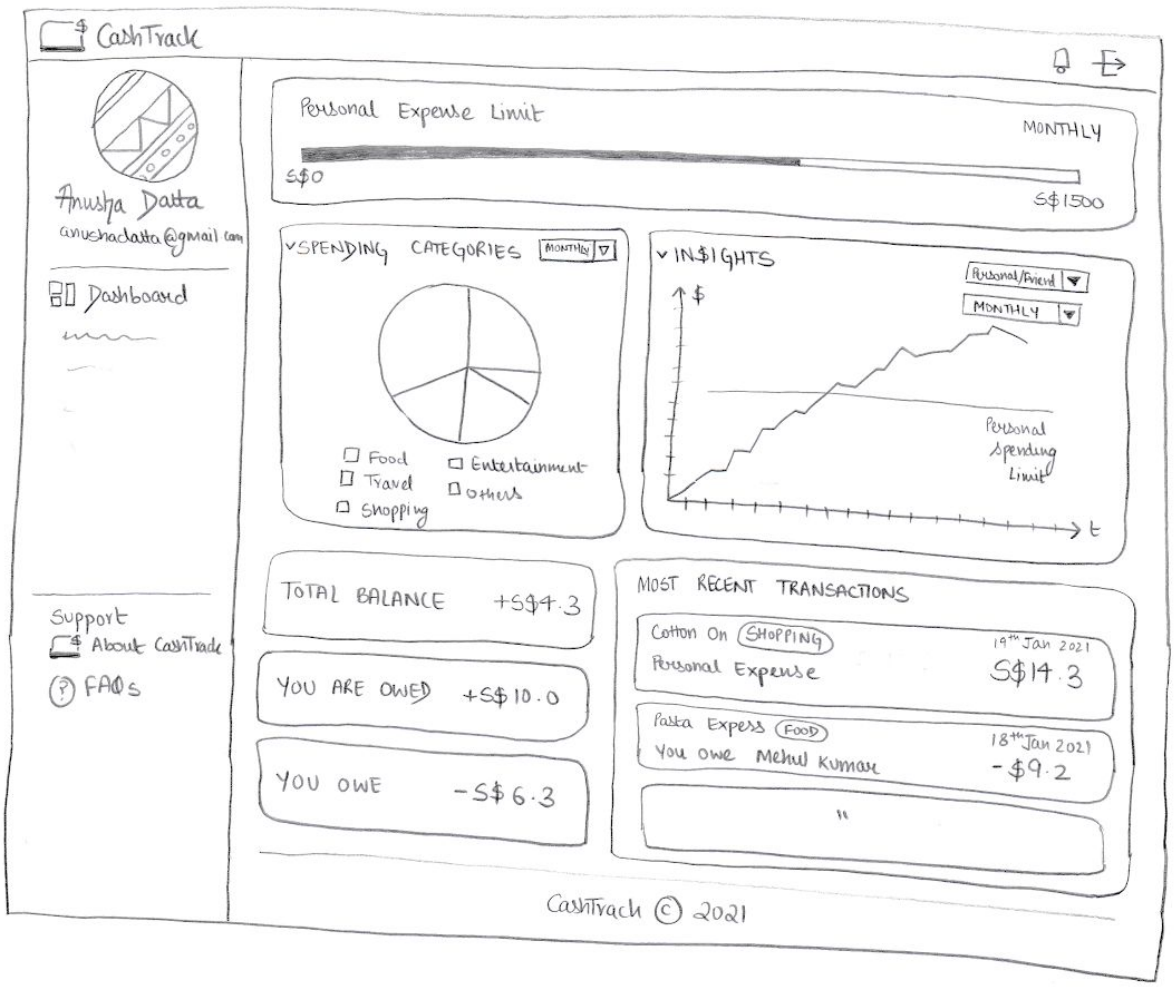
APPENDIX B: UI Wireframe Mockups



①

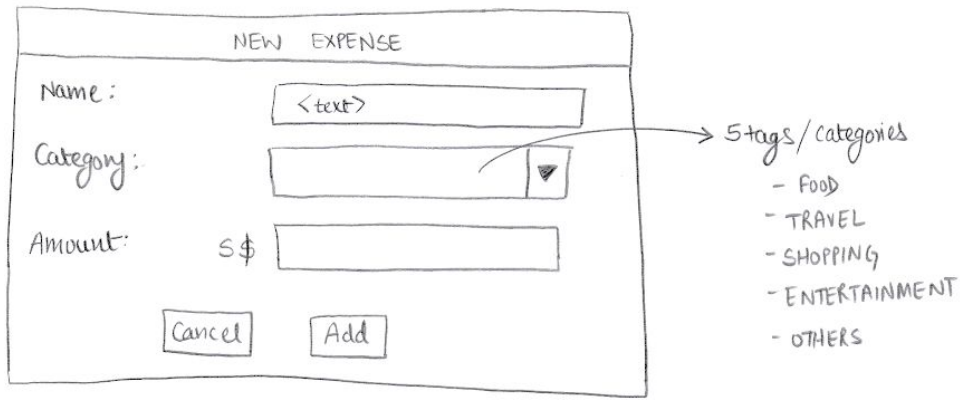

<asset>
CashTrack
SIGN IN

②


CashTrack
Anusha Datta
anushadatta@gmail.com
Dashboard
Support
About CashTrack
FAQs
Personal Expense Limit
MONTHLY
S$0
S$1500
SPENDING CATEGORIES
MONTHLY
Food
Entertainment
Travel
Others
Shopping
INSIGHTS
Personal/Friend
MONTHLY
$
t
Personal Spending Limit
TOTAL BALANCE +S$4.3
YOU ARE OWED +S$10.0
YOU OWE -S$6.3
MOST RECENT TRANSACTIONS
Cotton On SHOPPING
19th Jan 2021
Personal Expense
S$14.3
Pasta Express FOOD
18th Jan 2021
You owe Mehul Kumar
-$9.2
CashTrack © 2021

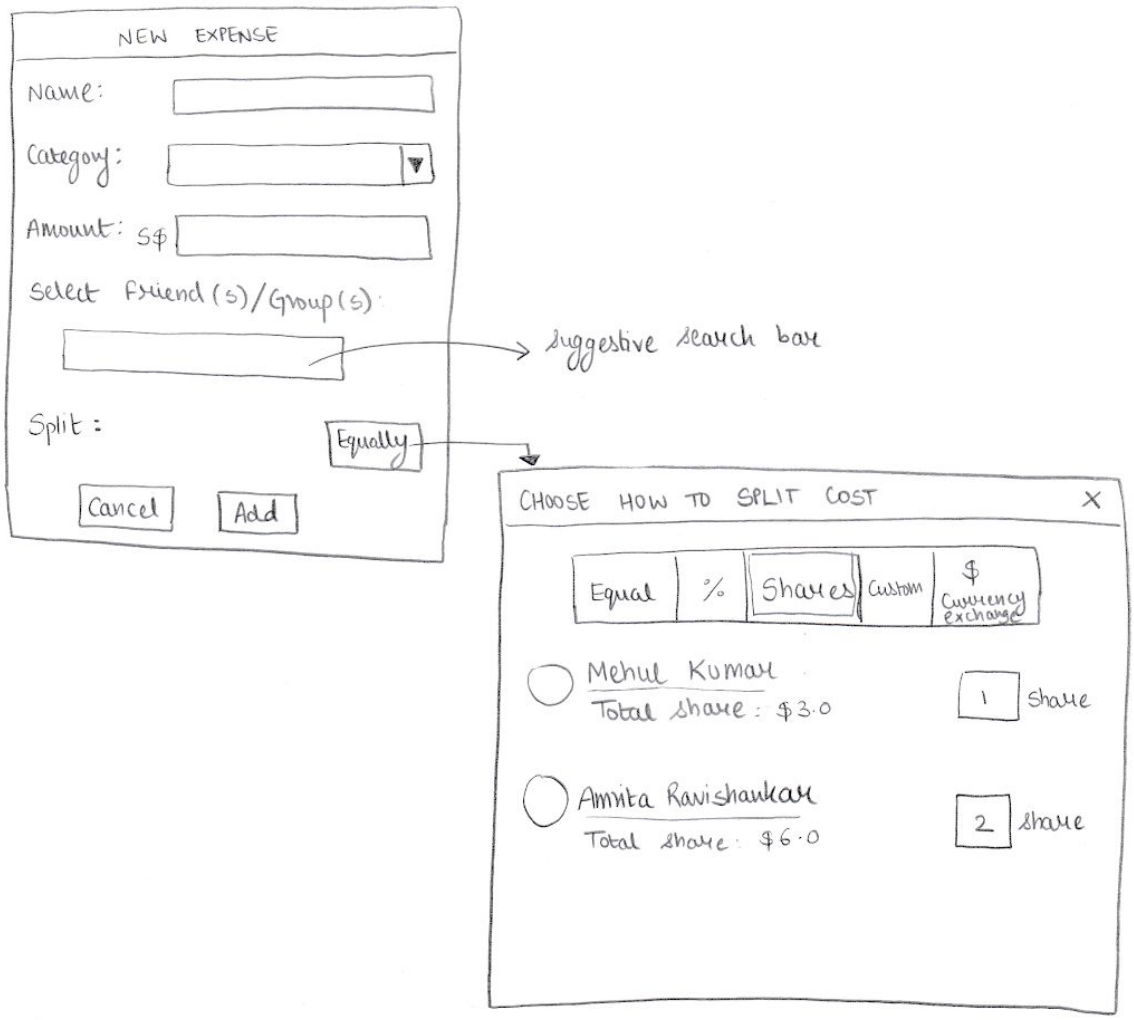
③ (i) Main Page in Wireframe Figma Workspace

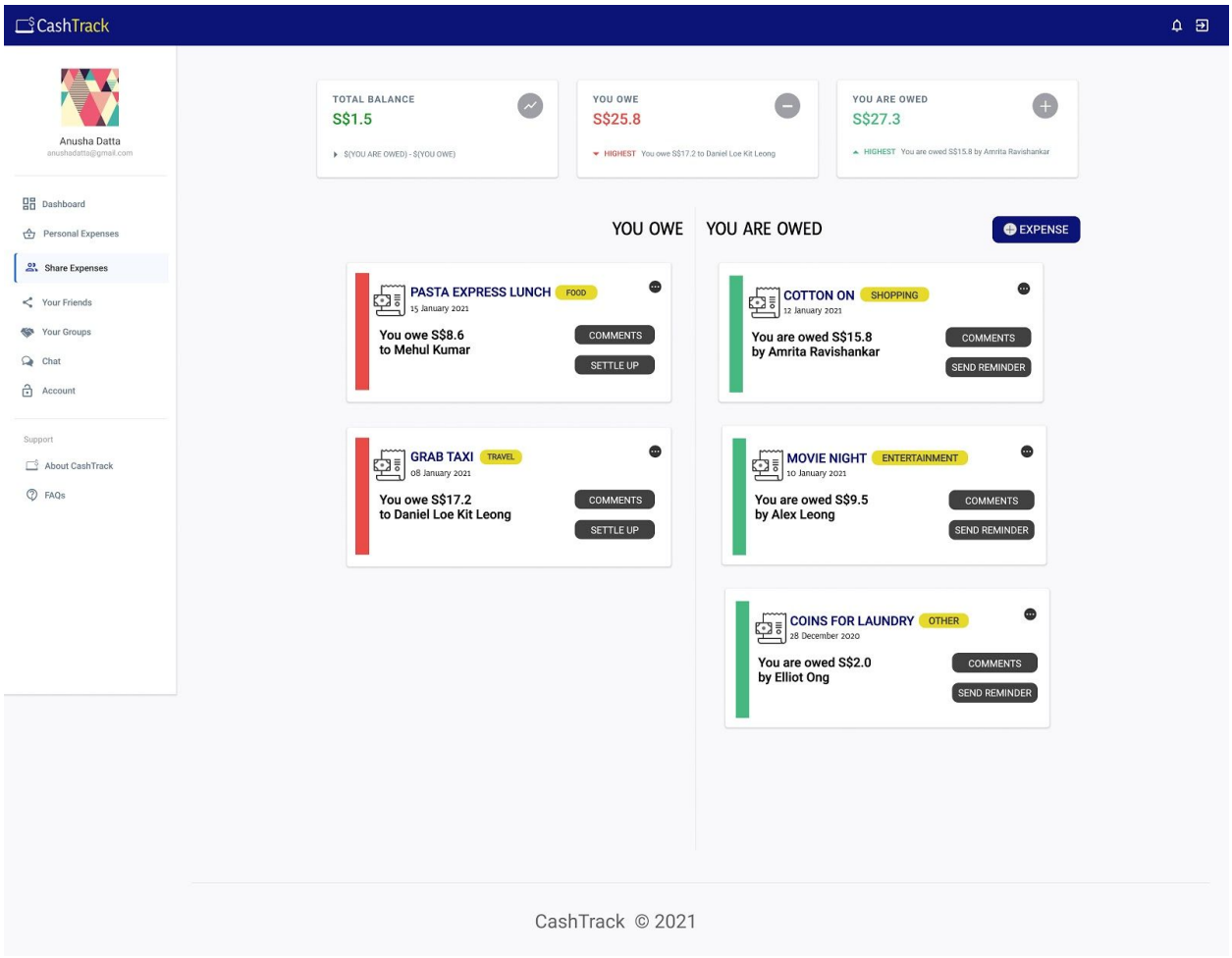
(ii)



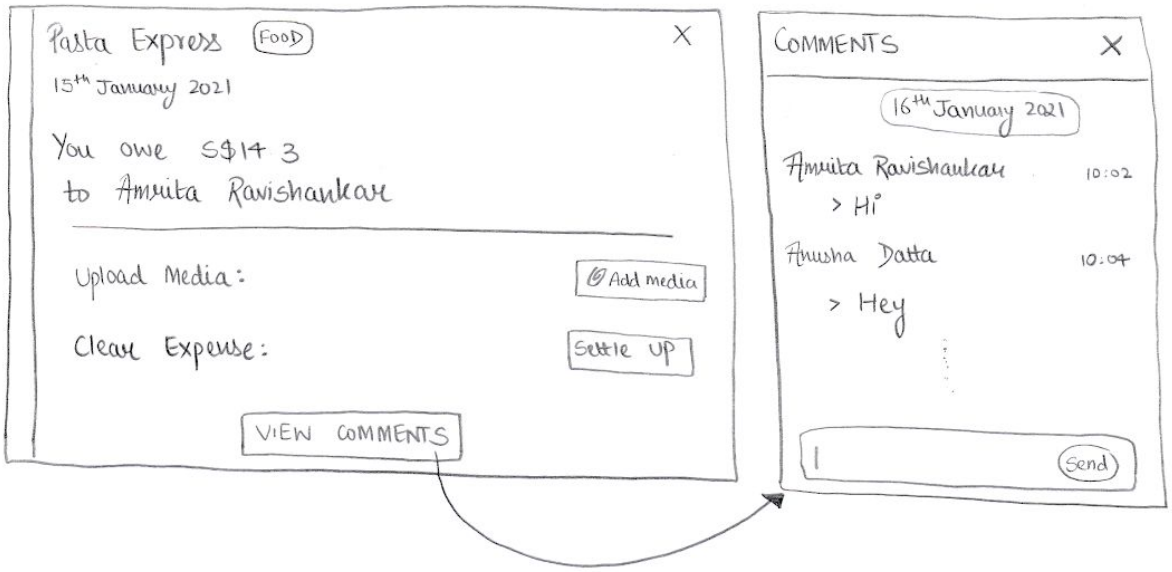
④ (i) Main Page in Wireframe Figma Workspace

(ii)

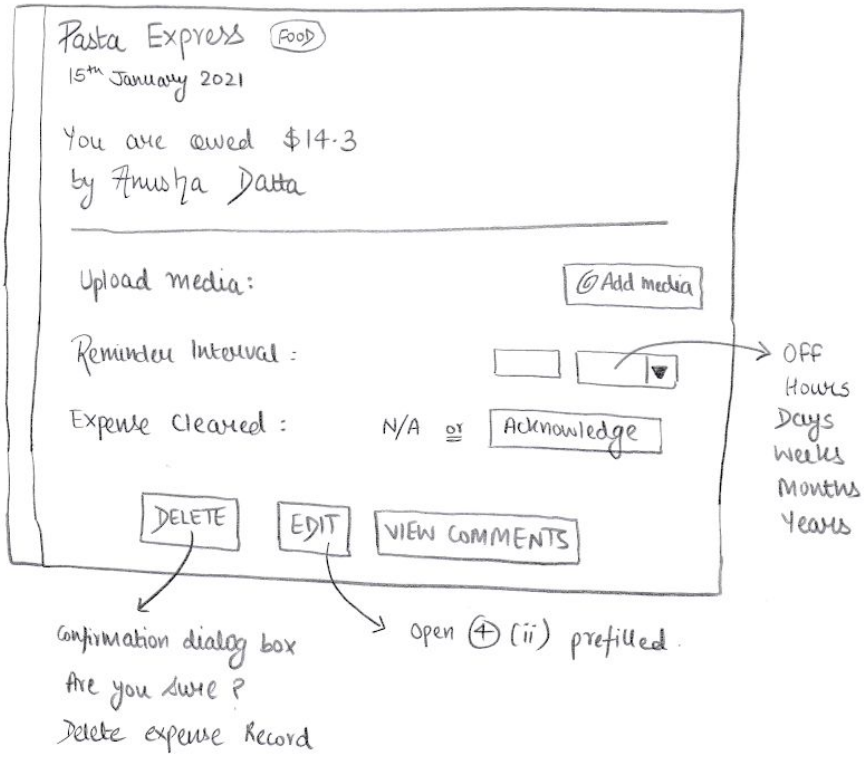



CashTrack
Anusha Datta
anushadatta@gmail.com
Dashboard
Personal Expenses
Share Expenses
Your Friends
Your Groups
Chat
Account
Support
About CashTrack
FAQs
TOTAL BALANCE
S$1.5
$(YOU ARE OWED) - $(YOU OWE)
YOU OWE
S$25.8
HIGHEST You owe S$17.2 to Daniel Loe Kit Leong
YOU ARE OWED
S$27.3
HIGHEST You are owed S$15.8 by Amrita Ravishankar
YOU OWE
YOU ARE OWED
EXPENSE
PASTA EXPRESS LUNCH
FOOD
15 January 2021
You owe S$8.6
to Mehul Kumar
COMMENTS
SETTLE UP
COTTON ON
SHOPPING
12 January 2021
You are owed S$15.8
by Amrita Ravishankar
COMMENTS
SEND REMINDER
GRAB TAXI
TRAVEL
08 January 2021
You owe S$17.2
to Daniel Loe Kit Leong
COMMENTS
SETTLE UP
MOVIE NIGHT
ENTERTAINMENT
10 January 2021
You are owed S$9.5
by Alex Leong
COMMENTS
SEND REMINDER
COINS FOR LAUNDRY
OTHER
28 December 2020
You are owed S$2.0
by Elliot Ong
COMMENTS
SEND REMINDER
CashTrack © 2021

④ (iii) Payer

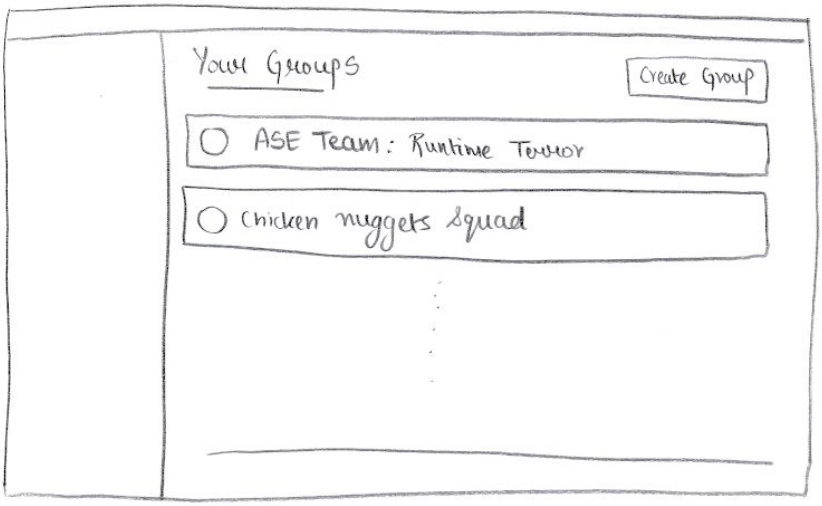


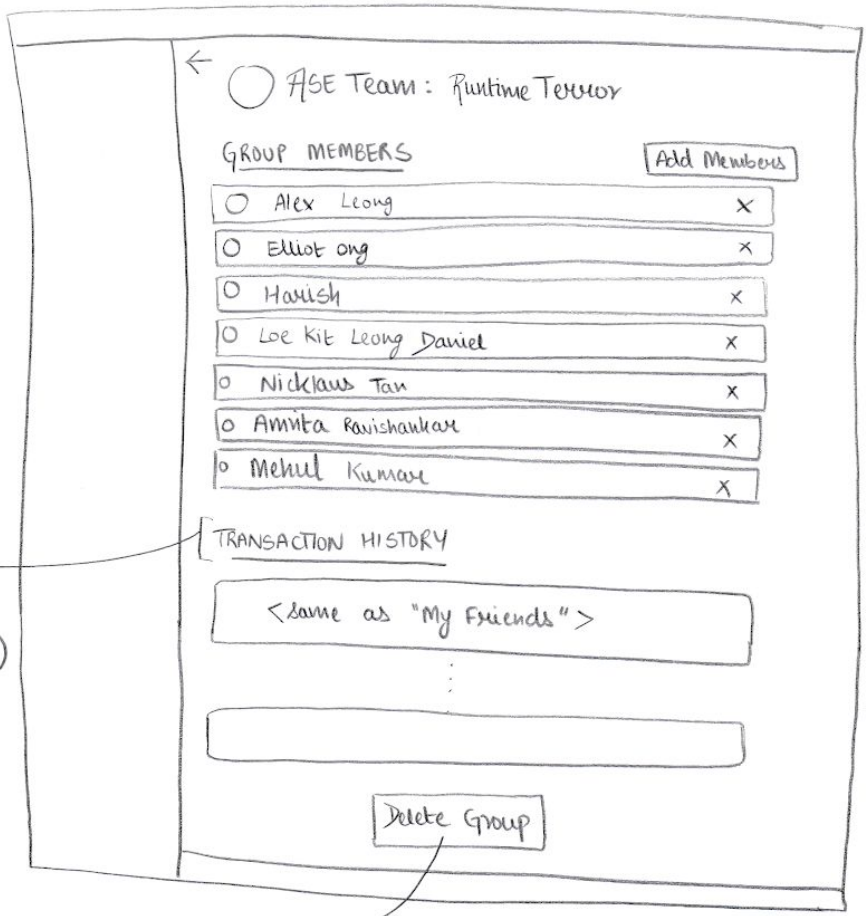
Payee



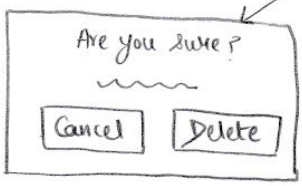

5
Your Friends
Add Friend
Amrita Ravishankar
Mehul Kumar
Amrita Ravishankar
$
t
TRANSACTION HISTORY
(Same expense record as in wireframe Figma Workspace)
Remove Friend
Are you sure?
Cancel
Remove

⑥ "My Groups" main page list similar to "My Friends"

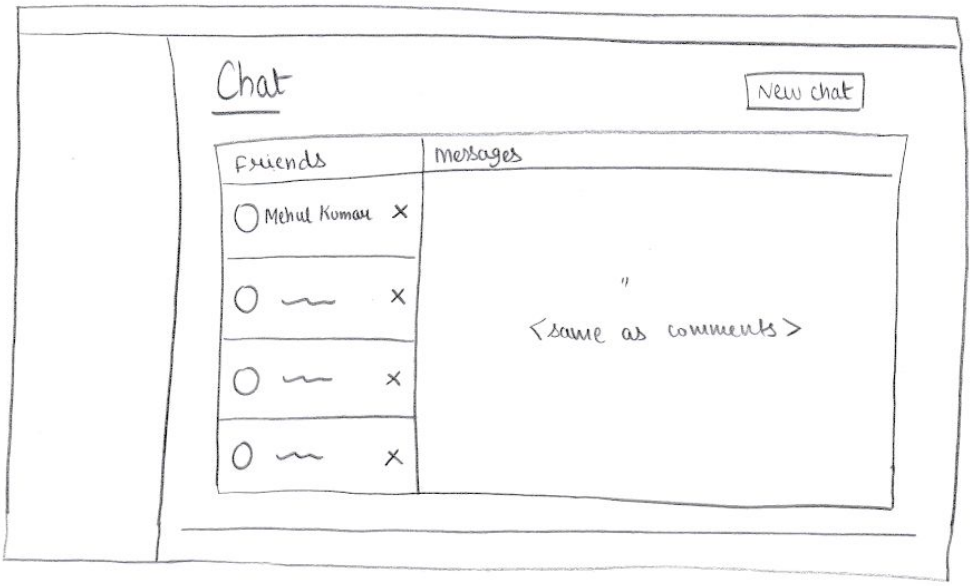




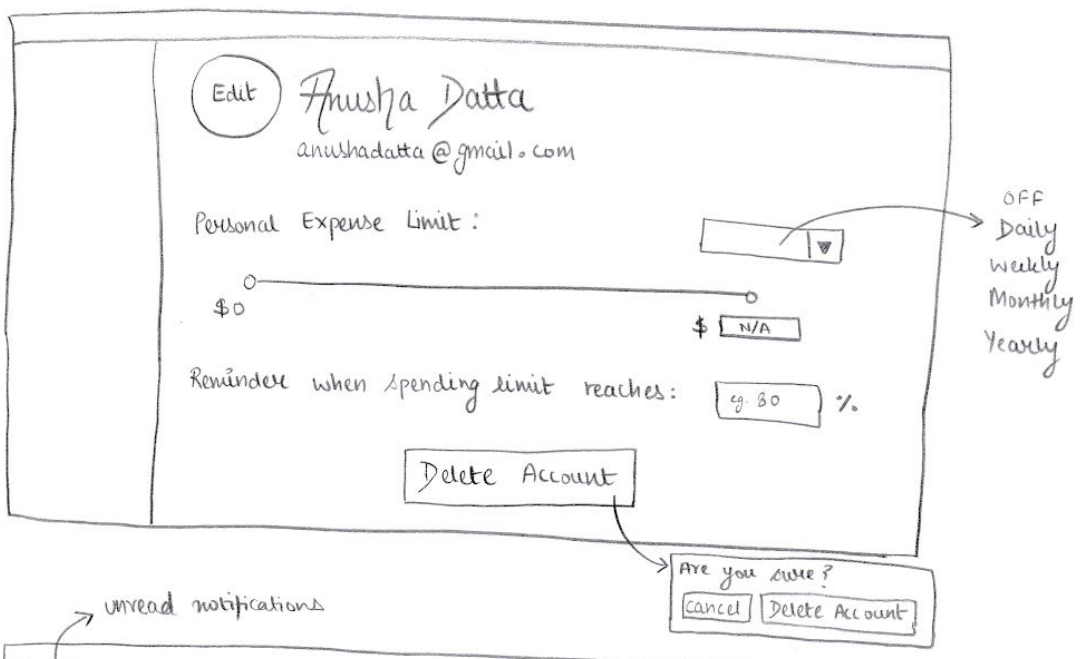
For group, transaction history contains only those expense records created by user to this group.
(He/She is always payee)



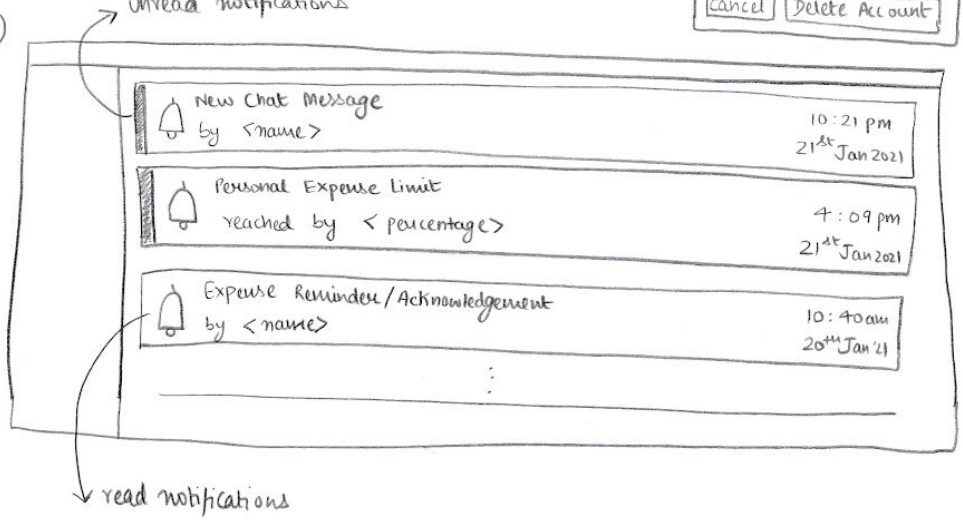
(7)



(8)



(11)



* create flexible notification templates