

Developing an Android Application for SplitMateEZ

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Abstract

In shared accommodations, dividing utility bills among roommates often proves to be a complex and contentious issue. Many current solutions for bill-splitting rely on estimations and manual reporting, which can lead to discrepancies and disputes among residents. The implementation of SplitMateEZ system addresses this problem by leveraging the latest advancements in Internet of Things (IoT) technology, security cameras, and Large Language Models (LLMs) to provide a more accurate and efficient solution for bill-splitting. SplitMateEZ offers a user-friendly Android application that allows residents to monitor their utility usage, receive real-time notifications, and access detailed reports. The system uses security cameras to track residents' movements and activities, which are then analyzed by LLMs to determine the amount of time each resident spends in resource areas. This data is used to calculate each resident's share of the utility bills, ensuring a fair and transparent distribution of costs. SplitMateEZ also provides a platform for residents to communicate and resolve any disputes that may arise, promoting a harmonious living environment.

Keywords

Android Application, Shared Accommodation, Bills Splitting, Large Language Models, IoT, Usage Tracking, Face Recognition, Text Recognition

1 Introduction

In shared accommodations, dividing utility bills among roommates often proves to be a complex and contentious issue. Many current solutions for bill-splitting rely on estimations and manual reporting, which can lead to discrepancies and disputes among residents. The implementation of SplitMateEZ system addresses this problem by leveraging the latest advancements in Internet of Things (IoT) technology, security cameras, and Large Language Models (LLMs) to provide a more accurate and efficient solution for bill-splitting.

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2 Motivation

The biggest problem of splitting bills in shared accommodations is the lack of usage tracking. With cameras and Cloud sever, we can

store the captured data and analyze it to determine the amount of time each resident spends in different resources. This data is used to calculate each resident's share of the utility bills, ensuring a fair and transparent distribution of costs. The data can also be used to generate detailed reports and provide insights into residents' usage patterns, helping them to identify areas where they can reduce their consumption and save money.

The data collection and data storage parts are done by my two teammates. I am responsible for developing the Android application that will be used by residents to display their usage data, receive notifications, and communicate with other residents, etc.

3 Existing Work

Guo [1] had a early attempt on developing an Android application for bill splitting in shared accommodations. Some useful tools are used in the design and development of the application, such as Figma for designing the user interface, Android Studio for developing the application, MongoDB for storing the data, Flutter for building the application, and Visual Studio Code for coding. The idea of treating all events that required to split the payment as events is straightforward and innovative [1]. However, the application is not user-friendly and lacks some important functions, such as usage tracking, face recognition, and text recognition.

Installing cameras in the house common area makes the privacy a big problem for system designers, Lodge et al. [7] raised the concern of data privacy and protection at the design stage among developers. They adopted Databox IDE for personal data tracking, risk assessments, transparency of processing and runtime inspection to make sure user's privacy is guaranteed.

Moazzami et al. [8] states that a unified smartphone application is necessary because the significant heterogeneity in IoT devices may lead to fragmented smart-home systems. Zhong et al. [10] also mentioned that an universal monitoring and controlling interface on smartphones is needed in current and future smart home environment. They implemented an interactive app that provides a visual presentation of all devices and a direct-manipulation user interface. A system called qToggle was developed by Stolojescu-Crisan, Crisan and Butunoi [9] to control sensors, actuators and other data sources with network. It is pioneering and inspiring to us because it is also based on Raspberry Pi.

Lewis et al. [6] proposed a new model for knowledge-intensive NLP tasks, which is called Retrieval-Augmented Generation (RAG). It is a combination of retrieval and generation models, which can be used to generate reports for residents' usage data and provide insights or recommendations. We considered integrating this model into our application to generate reports for residents' usage data and provide insights or recommendations. However, we eventually decided to use OpenAI's API for generating reports due to the complexity of implementing the RAG model.

Mitch Koko's video [2] on YouTube provides a good introduction to the backend development of an Android application. He and his friend discussed the database choice when developing an Android application. They said that Firebase could not be a good option because developers cannot clearly see the data structure of their App or system. It will eventually become a chaos if your system keeps growing and you did not choose RDBMS at the beginning. He also uploaded some videos on how to build bar graph [3], pie chart [5], and timeline [4] in Android application using Flutter, which are very helpful for me to implement the usage tracking and actions history functions in our application.

4 My Work

My part in this project is to develop an Android application that will be used by residents to check their usage data, receive notifications, pay bills, and communicate with other residents living in the same house. The application will have some basic functions such as:

- (1) **User authentication:** Users can log in to the application using their email address and password.
- (2) **Notifications:** Residents will receive real-time notifications about their unpaid bills or strangers trespassing.
- (3) **Communication:** Landlord can communicate with all residents, and residents can only talk to the landlord.
- (4) **Management:** Landlord can add new properties and add new tenants into a property.

Besides these basic functions, I also implemented some specialized functions including:

- (1) **Face recognition:** Tennants can only upload their profile photo through phone camera and ensure there is a face in that photo, otherwise they have no access to other pages.
- (2) **Text recognition:** Landlords can take a photo of their bills, and the application will automatically extract the information from the photo and save it into the system for the bill Splitting.
- (3) **Usage tracking:** All residents can view their usage data for different resources, such as electricity, water, Internet, and gas. It will show the total usage durations for each resource in a day, a week, or a month.
- (4) **Actions history:** All residents can view their actions history from a continuous timeline interface.
- (5) **Pay bills:** Residents can pay their bills through the application.
- (6) **Generate Report:** Residents can generate a monthly usage report for their usage data and can also get some insights or recommendations from it.

5 Results

Aforementioned functions have been implemented in the SplitMateEZ Android application. The application has been tested on two different models of Android phones and is working as expected. The application is user-friendly and provides a seamless experience for residents to check their usage logs, pay their bills and communicate with their landlord.

5.1 Basic Functions

5.1.1 User Authentication. The user authentication function allows residents to log in to the application using their email address and password (Figure 1b). Email address is required for the registration (Figure 1a). Users can sign up as a tenant or a landlord if they are the owner of the property. The application verifies the user's credentials and grants access to the user's account if the credentials are correct. If the credentials are incorrect, the application displays an error message and prompts the user to enter the correct information.

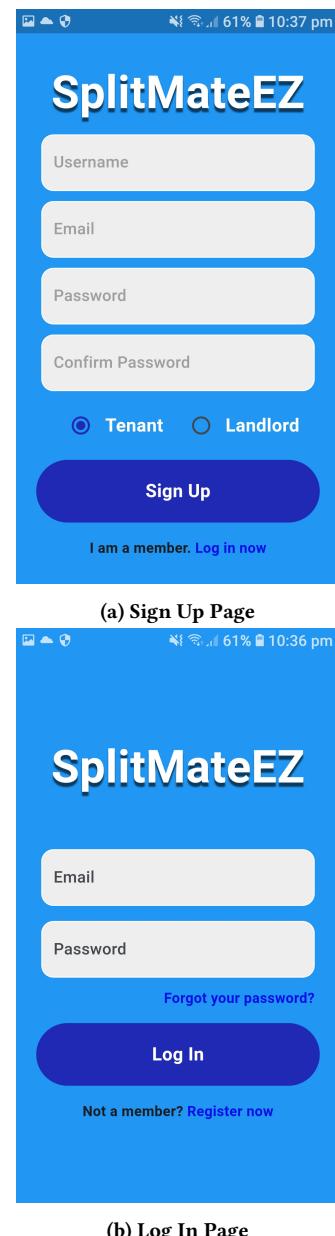


Figure 1: Authentication Pages

If the user forgets the password, they can reset it by clicking the "Forgot your password?" link on the login page (Figure 1b). The application will send an email to the user's registered email address with One Time Password (OTP) to reset the password. The user can then enter the OTP and set a new password to log in to the application (Figure 2).

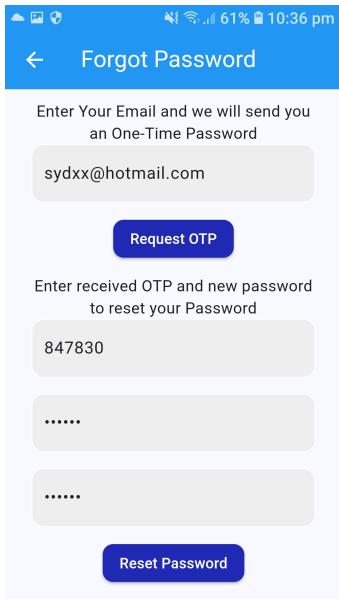


Figure 2: Reset Password Page

5.1.2 Notifications. The notification function allows residents to receive real-time notifications about their unpaid bills or strangers trespassing (Figure 3). The server pushes notifications to the user's device when a new notification is generated. It is achieved by importing a cross platform plugin called [flutter_local_notifications](#). Users can view the notifications by clicking on the notification badge in the notification centre.

5.1.3 Communication. The communication function allows residents to communicate with the landlord and landlord can communicate with all residents (Figure 4a). Residents can send messages to the landlord to report any issues or ask questions. The landlord can send messages to all residents to inform them about any important updates or announcements (Figure 4b). The chat feature was implemented by using [Firebase Cloud Messaging](#) plugin. It provides a convenient way for residents and landlords to communicate and resolve any issues that may arise.

5.1.4 Management. The management function allows the landlord to add new properties and add new tenants into a property. The landlord can create a new property by entering the property details, such as the property name, address, and postcode (Figure 5). The landlord can then add new tenants to the property by entering the tenant's email (Figure 6). The landlord can also view the list of properties (Figure 7a) and tenants (Figure 7b) and edit or delete them (Figure 8) as needed.

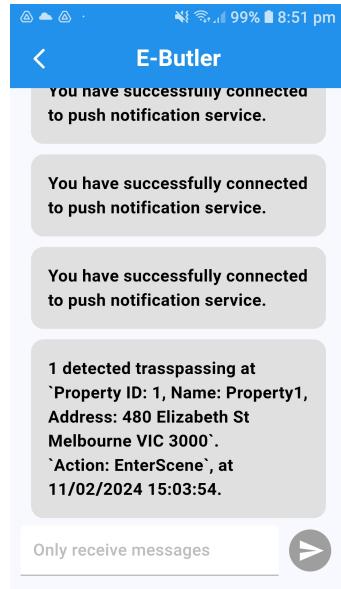


Figure 3: Received Notifications

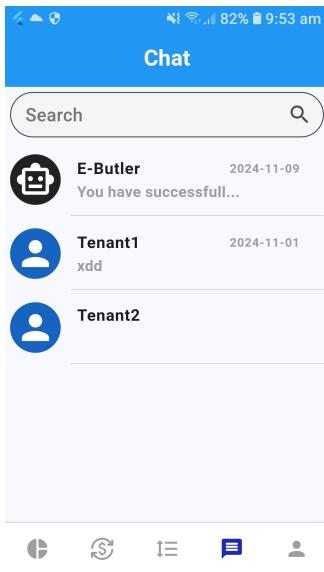
5.2 Specialized Functions

Some specialized functions have been implemented in our application to provide additional features and enhance the user experience. These functions include face recognition, text recognition, usage tracking through graphs, actions history through timeline, pay bills, and generate report using Large Language Model.

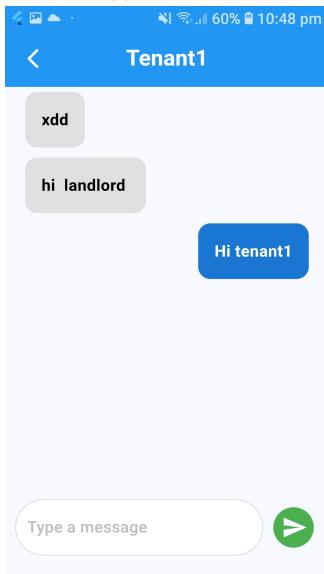
5.2.1 Face Recognition. A new registered user cannot access other pages until they upload their profile photo by taking a photo through the phone camera (Figure 9). The face recognition function allows residents to upload their profile photo only through the phone camera and ensures there is a face in that photo (Figure 10) using [Google's ML Kit Face Detection](#) SDK. If the photo does not contain a face, the user will not have access to other pages and must retake a proper photo (Figure 11). If a face is successfully detected, it will be immediately uploaded to the server (Figure 12). This feature provides an additional layer of security and ensures that only authorized, real users can access the application.

5.2.2 Text Recognition. The text recognition feature allows landlords to take a photo of their bills, and the application will automatically extract the information from the photo and save it to the Cloud server for bill splitting. The text recognition function uses [Google's ML Kit Text Recognition](#) SDK to extract text from the image (Figure 13). When the text is successfully recognised, the application will display the extracted information to the user (Figure 14) in green. Accordingly, the upload button becomes clickable and turn green. This feature saves time and effort for landlords and ensures accurate data entry for bill splitting.

5.2.3 Usage Tracking. The usage tracking function allows residents to view their usage data for different resources, such as electricity, water, Internet, and gas. The application displays the total usage durations for each resource in a day, a week, or a month



(a) Chat List



(b) Chatting Page

Figure 4: Communication Pages

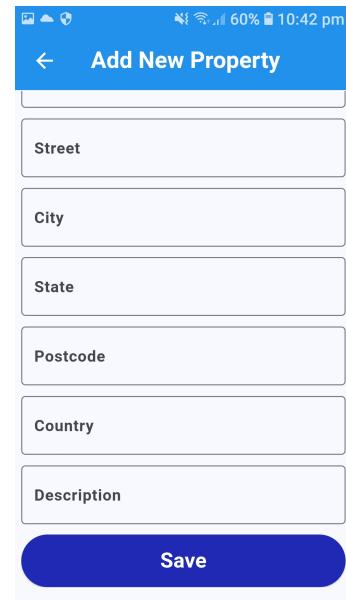


Figure 5: Add new property

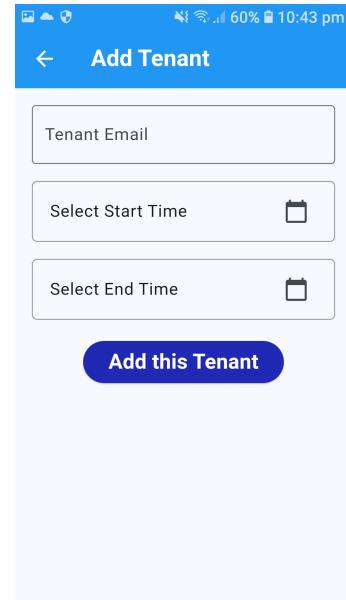


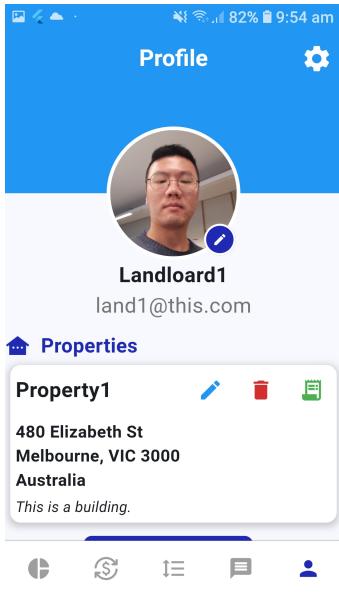
Figure 6: Add new tenant

(Figure 15). The usage data is presented in a graph format (Figure 16), making it easy for residents to understand their consumption patterns and identify areas where they can reduce their usage and save money.

5.2.4 Generate Report. The generate report function allows residents to generate a report for their last 30-day usage data (Figure 17). The report includes the total usage duration for each resource, daily usage patterns, and recommendations for reducing consumption and saving money. We implemented this by sending usage data to

the API of OpenAI. With proper prompt, it can return appropriate results.

5.2.5 Actions History. The actions history is displayed in a continuous timeline interface. Residents can view their actions history, such as using WIFI, turning on the light, turning on the gas or faucet, etc. The timeline interface provides a visual representation of the residents' activities in a chronological order (Figure 18). Residents can scroll through the timeline to view their past actions and



(a) View property info

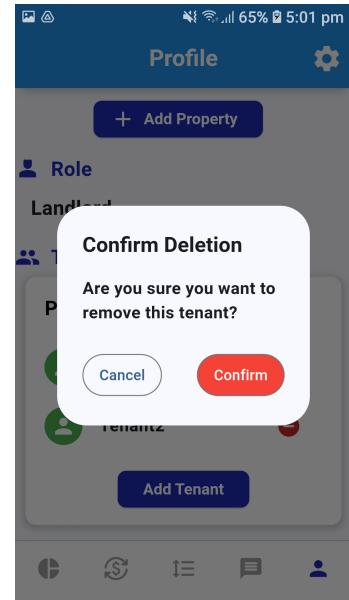
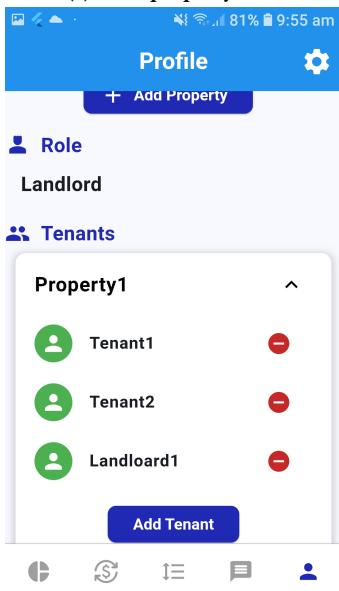


Figure 8: Ban a tenant



(b) Tenants of a property

Figure 7: House Management Pages

identify any unusual patterns or activities. Landlords can also view the actions history of all residents to monitor their activities and ensure compliance with the house rules.

5.2.6 Pay Bills. Pay Bills page (Figure 19) allows residents to query their unpaid bills and pay them through the application (no real money is involved, see Figure 20).

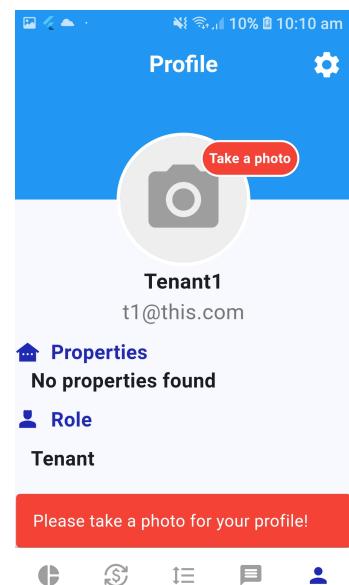


Figure 9: Profile Photo Required

6 Evaluation

Our SplitMateEZ Android application has been tested on two different models of Android phones, including Samsung Galaxy A5 and LG K4. The functionality, accuracy, and performance of the application were thoroughly evaluated, confirming that it meets expected standards. Residents benefit from a smooth experience as they access usage logs, make payments, and communicate with the landlord. The landlord can manage properties and tenants effectively, and upload bills info easily by taking a photo. The design

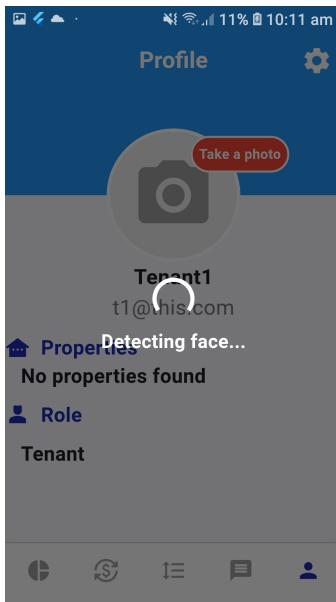


Figure 10: Face Detecting

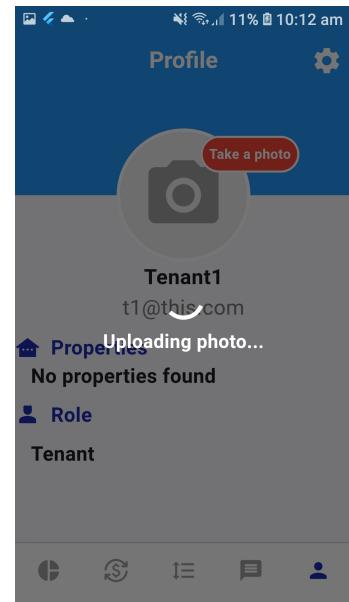


Figure 12: Face Detected

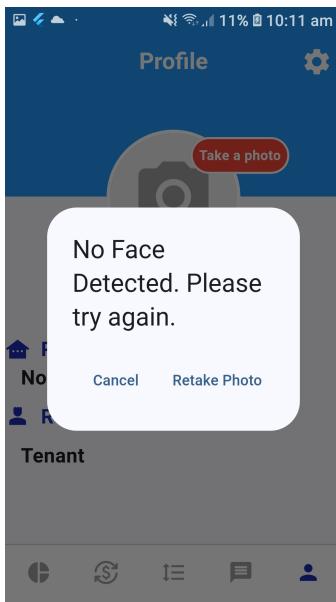


Figure 11: Face Not Detected

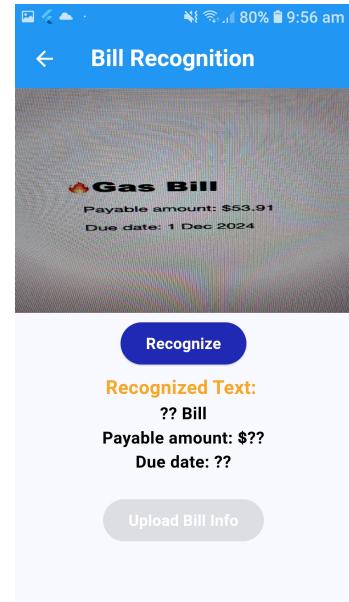


Figure 13: Before Recognition

prioritizes user-friendliness, with an intuitive layout and helpful prompts, ensuring ease of navigation. Responsiveness is optimal, with minimal lag, contributing to an efficient user experience. Data protection is achieved through encryption and authentication, guaranteeing security for user information. Reliability is demonstrated through stable performance, with minimal instances of crashes or freezes under normal usage conditions. Additionally, the application scales effectively to support numerous users and properties while remaining resource-efficient, without excessive battery or

memory consumption (Figure 21). The network connection is stable and fast (Figure 22), ensuring seamless data transfer and real-time notifications.

7 Conclusion

The SplitMateEZ Android application offers a comprehensive solution for residents in shared accommodations to manage utility bills effectively. By leveraging advanced features such as face recognition, text recognition, and usage tracking, the application provides

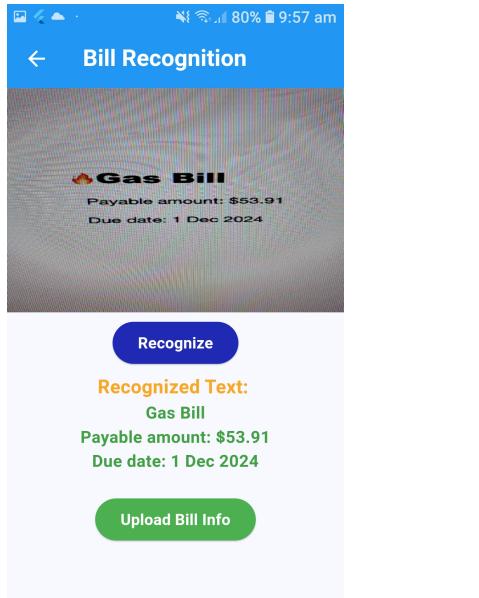


Figure 14: Successful Recognition

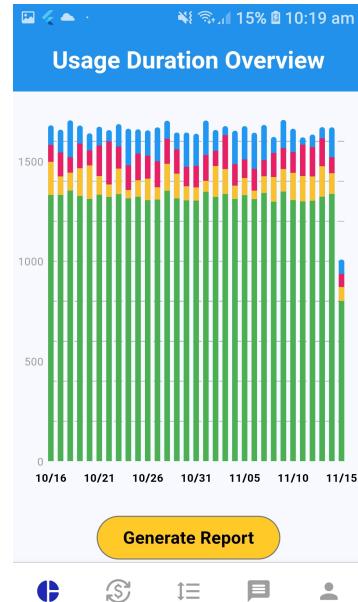


Figure 16: Bar Chart Showing One-Month Usage

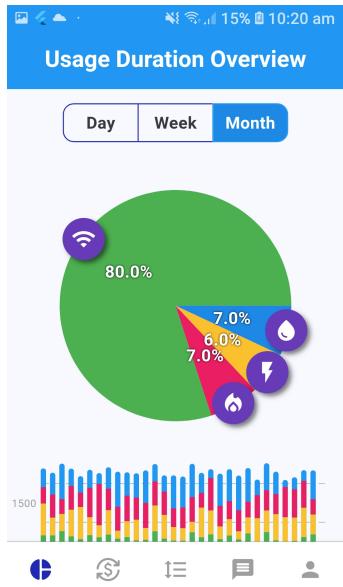


Figure 15: Usage Overview

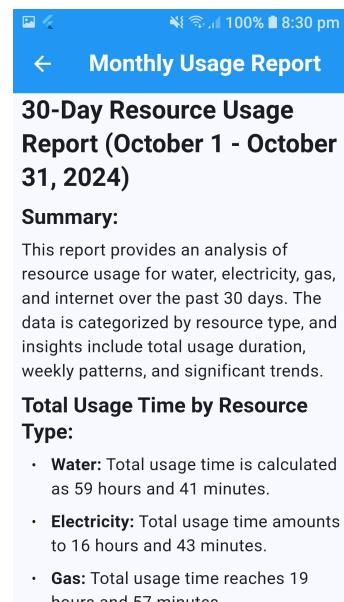


Figure 17: Monthly Usage Report

a user-friendly interface for residents to monitor their usage, receive notifications, and communicate with the landlord. The application has been rigorously tested and evaluated, demonstrating high performance, accuracy, and reliability. Residents can benefit from a seamless experience as they access their usage logs, pay bills, and generate reports, ensuring transparency and fairness in bill-splitting. The SplitMateEZ application represents a significant advancement in utility management for shared accommodations,

offering a secure, efficient, and user-friendly solution for residents and landlords.

8 Future Work

In the future, we plan to further enhance the SplitMateEZ Android application by implementing additional features and improvements. These include: 1. use cache to store the data for enhance the speed of the application; 2. implement a feature that allows residents to



Figure 18: Events Timeline

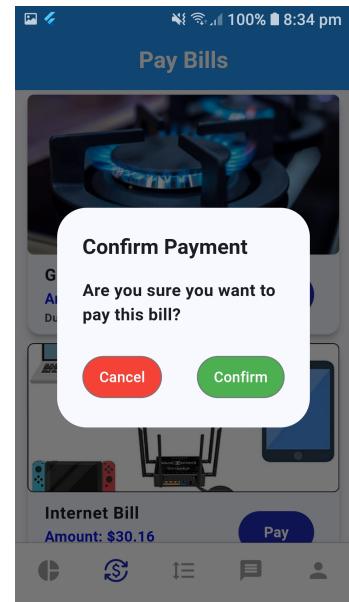


Figure 20: Pay Bills

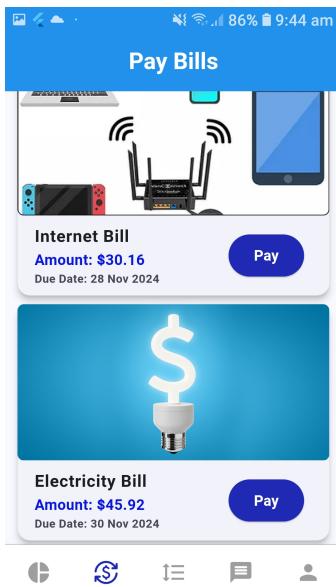


Figure 19: Pay Bills Page

set usage limits for each resource and receive notifications when they exceed the limits; 3. integrate the application with smart home devices to enable landlords to remotely control resource areas and monitor residents' activities; 4. add video streaming feature to allow residents to view live feeds from security cameras and monitor their property remotely; 5. implement a feature that allows residents to report maintenance issues and request repairs through the application; 6. integrate the application with payment gateways to enable residents to pay their bills directly through the application;

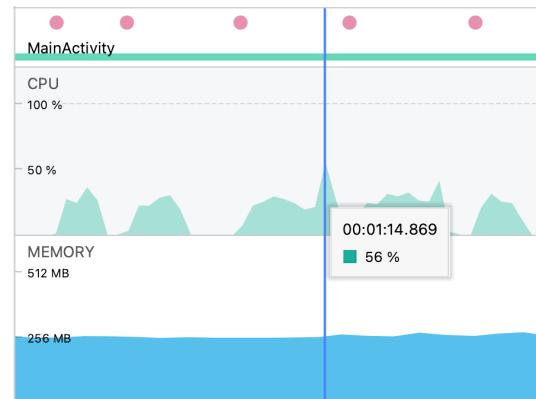


Figure 21: CPU and Memory Usage

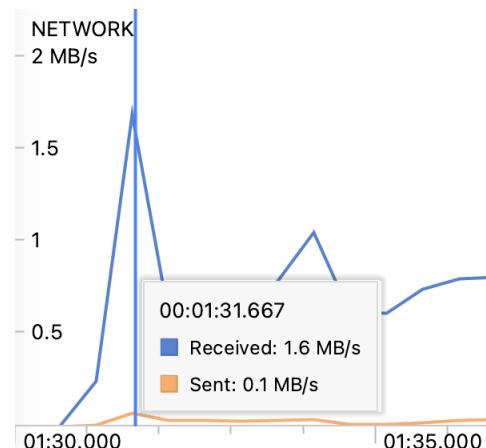


Figure 22: Speed of Network

7. add a feature that allows residents to view their usage data in comparison to other residents in the same property or in other properties; 8. integrate the application with social media platforms to enable residents to share their usage data and insights with their friends and family.

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