Software Engineering FYP-24-SE-A-04 Proposal: Bus ID Card Scanner for Improved Student Management and Security

Problem Statement:

Many universities, including ours, use bus cards for student transportation management. However, the current system for verifying and managing these bus cards is inefficient and prone to misuse. Students can board buses without proper verification, and there is no effective mechanism to detect fake or unauthorized cards. This creates security risks and hinders proper attendance tracking, leaving gaps in the university's ability to monitor the system efficiently.

Moreover, not all students at the university pay the semester transportation fare, causing an unjust situation for those who do. This leads to overcrowding and misuse of the bus system by students who have not contributed to the transportation fund. As a result, the transportation department experiences inefficiencies and financial strain.

A major security concern is that, while the university enforces strict monitoring at its entrances, requiring every individual to show a student card or ID card to enter, the buses remain an unchecked entry point. Buses pick up students without proper verification and enter the university without further checks, posing a potential security threat. This gap in security undermines the university's efforts to ensure only authorized individuals access the campus.

Key Observations and Gaps:

1. **Manual ID Checking**:
    - **Current Process**: The university bus system relies on drivers or staff manually checking student IDs as they board the bus. This process is slow and often leads to errors.
    - **Gap**: There is no automated system in place to detect fake cards or verify student identity in real-time, allowing unauthorized students to misuse the system.
2. **Lack of Real-Time Data**:
    - **Current Process**: There is no centralized database to track student boarding in real time, making it difficult for the university to know how many students are on the bus or whether certain students missed the bus.
    - **Gap**: The absence of real-time data leads to poor route optimization and limited capacity management, which affects the overall efficiency of the bus system.
3. **No Automatic Attendance Tracking**:
    - **Current Process**: Bus drivers are not equipped with tools to automatically track which students boarded or exited at specific stops.

- **Gap**: Without automatic attendance tracking, the university cannot accurately monitor bus ridership or ensure student safety, particularly for long routes.

4. **Unfair Use of Transportation**:
    - **Current Process**: Many students who have not paid the semester transportation fare are still able to board the buses, creating an unjust situation for those who have paid.
    - **Gap**: There is no system in place to ensure that only fare-paying students are using the transportation service, leading to overcrowded buses and increased operational costs.
5. **Fuel Consumption and Route Optimization**:
    - **Current Process**: Without data on route population or student density, the university cannot efficiently optimize bus routes, leading to unnecessary fuel consumption.
    - **Gap**: The transportation department lacks insights into which routes are most heavily populated and which are underused, making it difficult to allocate resources efficiently.

The Challenge We Aim to Address:

We propose developing an automated **Bus ID Card Scanner System** that addresses the shortcomings of the current bus management system by introducing real-time student verification, automated attendance tracking, and real-time data reporting for university administrators. The system will also ensure that only students who have paid the semester transportation fare can use the service, reducing overcrowding and misuse.

In addition, by analysing real-time route data, the transportation department will be able to reduce fuel consumption and optimize routes based on student density. This will allow for better resource management and open opportunities for future optimizations, such as predicting student demand and reallocating buses accordingly.

Proposed Solution:

We propose developing a **Bus ID Card Scanner System** that will use NFC, QR, or RFID technology to scan student bus cards when they board or exit the bus. The system will instantly verify the authenticity of the card, track attendance in real time, and ensure that only students who have paid the transportation fare can use the service. A mobile app will allow students to manage their bus cards, while an admin panel will offer university staff full control over the system, including route and capacity management based on real-time data.

Key Features Include:

1. **ID Card Scanning**:
    - **Card Technology**: The system will support NFC, QR, or RFID-based student ID cards, which can be scanned by students when boarding or exiting the bus.
    - **Fake Card Detection**: The system will validate the authenticity of the card in real time, ensuring that only authorized and fare-paying students are allowed to board.
    - **Instant Verification**: If a fake or unauthorized card is detected, the system will notify both the bus driver and the admin, preventing the student from boarding.
2. **Real-Time Location Tracking**:
    - **Bus GPS Integration**: The system will integrate with the GPS systems of university buses, allowing real-time location tracking for students, parents (if required), and university administrators.
    - **Route Monitoring**: Admins can monitor bus locations, manage delays, and optimize routes based on real-time traffic conditions and student density.
3. **Attendance and Passenger Records**:
    - **Automatic Attendance Tracking**: Every time a student scans their card to board or exit, the system will automatically update the attendance records.
    - **Passenger Logs**: The system will maintain a log of each student's boarding and exiting times, which can be used to generate reports for bus management and to identify non-paying users.
4. **Parental Involvement (Optional)**:
    - **Real-Time Notifications**: For systems involving parental access, the app will send real-time notifications to parents when their child boards or exits the bus.
    - **Route Tracking**: Parents can track the location of the bus and receive alerts about arrival times and delays.
5. **Admin Panel for Bus Operators/Schools**:
    - **Student and Card Management**: Admins can manage student profiles, issue new bus cards, deactivate lost cards, and track overall system usage.
    - **Reporting and Analytics**: The admin panel will generate real-time reports on student attendance, bus capacity, route efficiency, and more. The transportation

department can use this data to analyse route population and make informed decisions to reduce fuel consumption and optimize bus routes.

6. **Bus Driver Interface**:
    - **Passenger Count**: Drivers will have a simple interface (tablet or phone) displaying the number of students who have boarded and exited at each stop.
    - **Alerts**: The interface will notify drivers if an unauthorized or invalid card is scanned, helping them to maintain order and security on the bus.

Technologies to Be Used:

1. **Firebase**:
    - **Backend Services**: Firebase will be used for real-time data management, user authentication, cloud-based storage, and hosting. It will ensure seamless syncing of boarding records, bus schedules, and real-time data.
2. **React.js and Next.js**:
    - **Admin Panel and Web Interface**: React.js will be used to develop the dynamic user interface for the admin panel, while Next.js will enable server-side rendering for better performance and scalability. This combination will create an efficient and responsive platform for managing student cards, routes, and system reports.
3. **Flutter**:
    - **Mobile App Development**: Flutter will be used to create a cross-platform mobile app for students, bus drivers, and administrators. The app will allow students to check bus schedules, track buses in real-time, and manage their bus ID cards.
4. **Android Mobile Devices**:
    - **Cost-Effective Approach**: Bus drivers will use their own Android mobile phones, or the university will provide them with affordable Android sets. These devices come equipped with all necessary components, including GPS, internet connectivity, and camera, reducing the need for additional hardware.
5. **GPS and Internet Connectivity**:
    - **Real-Time Bus Tracking and Data Sync**: The Android phone's built-in GPS will provide real-time location tracking for buses, while the internet connectivity will ensure data syncs to Firebase in real-time, including ID scans, student attendance, and bus location updates.

6. **Camera (for ID Scanning)**:
    - **ID Card Authentication**: The mobile app will use the Android phone's camera to scan student ID cards (QR, NFC, or barcode) and query the database to validate and authenticate the cards. The system will notify the driver if the ID is valid or fake immediately.

Expected Outcome:

By the end of this project, we will have developed a fully functional **Bus ID Card Scanner System** that addresses the key gaps in the current system, including fake card detection, real-time student tracking, and automated attendance monitoring. The mobile app will enhance the student experience, and the admin panel will provide university staff with the tools they need to efficiently manage transportation.

Furthermore, the system will help reduce fuel consumption by ensuring that only those who truly need transportation are paying for and using it. The transportation department will also gain valuable insights into route optimization and student density, leading to more efficient resource management. Additionally, the security threat posed by unchecked bus entries will be neutralized, ensuring that only verified individuals can enter the university through buses, further strengthening campus security.

Conclusion:

This project will revolutionize the university's transportation system by automating card verification, enhancing security, and providing real-time data to both students and administrators. By ensuring that only students who have paid for transportation can use the service, we can reduce misuse and improve the overall efficiency of the system.

Additionally, the project opens doors to further optimizations, such as route analysis, student density tracking, and reduced fuel consumption, making it a valuable asset for the future of university transportation management. Importantly, the system will also neutralize the security threat posed by unchecked bus entries, reinforcing the university's security measures and ensuring that only authorized students are granted access to the campus through buses.