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CAPSTONE PROJECT CONCEPT PAPER

Anti-Oversleep Destination Alarm and Emergency Safety System for Jeepney, Bus, and UV Express Commuters

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BSIT 3-4

Area of Specialization (Please check)	☐ Software / Application Development (Web, Mobile, Desktop)
	☐ Game Development
	✓ Mobile Application Development
	☐ Database Management and Information Systems
	☐ Networking and Infrastructure
	☐ Cybersecurity / Information Security
	☐ Data Analytics / Data Science
	☐ Artificial Intelligence / Intelligent Systems
	☐ Internet of Things (IoT)
	☐ Educational Technology / E-Government / Domain-Specific Systems

INTRODUCTION / BACKGROUND

Public transportation serves as the primary mode of commuting for over 2 million individuals daily in Metro Manila (Philippine Daily Inquirer, 2020). These commuters endure extended travel times, with journeys frequently exceeding two to three hours during peak periods due to severe traffic. This wastes time that people could have used to rest, stay with their families, or do other important things. Government officials have admitted that transportation is a major problem, with some even riding public transport themselves to see the daily struggles of commuters (ABS-CBN News, 2025). Studies and news reports show that using public transport is very stressful and tiring. Passengers have to deal with crowded vehicles, unpredictable schedules, and very tiring conditions (Hernandez, 2018). It is often hard just to find a place to stand, and the heat inside the vehicles makes the long wait in traffic even worse. Because no one knows exactly when a bus or jeepney will arrive, people have to leave home hours early. This takes away even more of their sleep and makes them even more exhausted. Traveling for a long time in bad traffic makes people very tired. Many students and workers leave home very early and return very late. They often spend more time traveling than sleeping. Being this tired makes it hard to study or work well. It also means they have no energy left to spend time with their families or rest properly, which makes their lives much harder.

One major problem caused by tired commuters is falling asleep while traveling. Because travel in Metro Manila is so long and exhausting, it is very hard for passengers to stay awake. Many people spend hours on the road every day, and this routine is very hard on their bodies. After waiting in long lines and standing in crowded jeepneys, passengers are physically drained. When they finally find a seat, they are so tired that they often fall asleep by accident. This is a real problem that happens to many people, not just something that occurs rarely. In 2023, a student from UP Los Baños fell asleep on a bus and missed his stop (TopGear.ph, 2023). When he woke up, he was very far from where he was supposed to be which caused him to miss his class. He also had to spend extra money to travel back to the right place and lost a lot of time he could have used for studying. This incident shows how falling asleep during commutes can directly affect a student's education and daily schedule.

The problem becomes worse with how public transportation works in the Philippines. Most jeepneys do not announce the stops, and drivers only shout the destination at the start of the trip. There are also no signs or screens inside to show passengers where they are. This means that if a passenger falls asleep, there is no system to wake them up or signal that the stop is near. Because of this, commuters are forced to stay awake and alert the entire time. Missing a stop wastes money and time. Commuters have to pay extra money to travel back to the correct destination. This is hard for people who are trying to save money. It also takes a long time to get back, often making them late for their jobs or classes. Being late for work can mean they get paid less money. For many workers and students, this delay makes their whole day much more difficult.

The safety implications of missing stops are particularly severe for night commuters, especially women, students, and the elderly. Kapitza (2024) identified significant safety concerns for passengers traveling during evening hours, especially women, who face a higher risk of being harassed or attacked. When passengers miss their stop and end up in a place they do not know, they can find themselves in danger. Traveling alone might have to walk through dark, quiet streets or wait in dangerous areas for another ride. This puts them at risk of being robbed, harassed or worse. Getting lost like this causes a lot of stress and fear. It shows that missing a stop is a real safety problem. The problems also mentioned earlier show how difficult it is for many people. This proves that a better solution is needed to improve the city's transportation system.

Several navigation apps exist for commuters, but none of them solve the problem of passengers falling asleep and missing their stops. Popular apps like Google Maps and Sakay.ph help people plan their routes, but they require users to stay awake and check their phones the entire time. These apps do not have automatic alarms to wake up sleeping passengers when they are near their destination, which is a major issue for tired students and workers who endure four-hour trips in heavy traffic. Even driving apps like Waze or global alarm apps like EarlyBuddy do not work well for public transport because they are designed for cars and cannot adjust to the different speeds of jeepneys or buses. Furthermore, current apps lack loud alarms and strong vibrations needed to wake up deep sleepers, and they do not have safety features like emergency buttons or fake call tools to protect women and students from harassment or danger. Most of these apps also fail when the internet is weak, leaving commuters stranded in unfamiliar areas without any help. It is clear that existing technology apps are good for planning trips but fail to help exhausted commuters who need to rest safely during long rides. Therefore, there is a great need for a new system designed specifically for jeepney and bus riders that includes smart alarms, safety tools, and offline reliability.

The gaps found in current technology show that a new mobile app is necessary to help commuters, leading to the development of the Anti-Oversleep Destination Alarm and Emergency Safety System. This application is made specifically for people who travel using jeepneys, buses, and UV Express vehicles in Metro Manila. The system utilizes advanced GPS technology to monitor the journey in real-time and provides specialized, multi-stage alarms that are programmed to wake up passengers at the right time based on the specific speed and movement patterns of their vehicle. By using loud sounds and strong vibrations, the app allows tired students and workers to rest during their long trips without the fear of missing their stops. The app also includes important safety tools to protect users from harassment, such as an emergency SOS button that sends an SMS with the user's location and a photo to their family along with fake emergency calls and weather alerts. For added convenience and accessibility, the system supports smartwatch integration optionally, allowing users to receive alarm notifications, trigger emergency SOS alerts, and monitor their journey progress directly from their wrist without needing to unlock their phone. The app also includes helpful tools like saved routes and travel history to make every journey more efficient. By putting all these tools into one app, the system provides a simple and reliable way to make daily travel much safer, easier, and less stressful for many Filipino commuters.

PROJECT RATIONALE

The Anti-Oversleep Destination Alarm and Emergency Safety System tackles a major daily problem for Metro Manila commuters. More than 2 million people use public transportation every day, facing trips that last 2-4 hours through the world's worst traffic congestion. These exhausted passengers often fall asleep and miss their stops, which wastes their money and time. Even worse, commuting at night and missing a stop at night is dangerous. Research shows that women, students, and the elderly are at a higher risk of being harassed or hurt if they wake up lost in a strange place. Government officials have recognized transportation as a major national problem by riding public transport themselves to understand what commuters experience every day (ABS-CBN News, 2025). Existing apps like Google Maps and Sakay.ph help plan trips, but they do not have alarms to wake up sleeping passengers or tools to keep them safe. This is why

there is a clear need for a new mobile app made specifically for people who use jeepneys, buses, and UV Express.

This project aligns strongly with the objectives of the Bachelor of Science in Information Technology program because it requires students to apply important skills learned in their courses such as using knowledge in mobile application development, GPS technology integration, database management, API implementation, user interface design and wearable device connectivity. They need to write programs that process location data in real-time, design intelligent algorithms that detect vehicle types based on speed patterns, and create multi-stage alarm systems that work differently for jeepneys, UV Express, and city buses. The project requires integration with external services including Google Maps for location search and display, OpenWeatherMap API for weather alerts at destinations, Twilio API for reliable emergency SMS delivery, Firebase Storage for secure photo uploads during emergencies and and smartwatch platforms for seamless notification delivery and quick access to safety features.. Students must solve difficult technical problems, such as making sure the app does not drain the phone's battery and ensuring the alarms still work even when there is no internet, realistic fake call screens that help users safely exit dangerous situations and synchronizing alarm notifications and emergency controls between smartphones and smartwatches so users can receive alerts and activate SOS features directly from their wrist in crowded vehicles. The project teaches professional skills like analyzing user requirements for safety-critical applications, testing location-based features under various network conditions, and handling sensitive information like user locations, emergency contacts, and automatically captured photos in an ethical and secure way. By building an actual mobile application with comprehensive features including optional wearable device integration with comprehensive features that solve a real problem affecting many Filipinos daily, BSIT students do more than just study in a classroom, they get to practice with real problems. This helps them get ready for future jobs where they can build advanced tools that truly help people in their community.

The project supports PUP's institutional mission to provide quality education that contributes to national development and serves the Filipino community, particularly students and workers who depend on public transportation. The application aligns with PUP's research priorities by demonstrating innovation through intelligent vehicle detection technology for Filipino transportation conditions, showing social responsiveness through safety features protecting vulnerable groups including an SOS button that sends GPS location to emergency contacts accessible both from the phone and smartwatch for quick, discreet activation, and a fake call feature that provides safe exits from harassment situations, contributing to sustainable development by improving the public transport experience through saved routes and travel history features, and reflecting gender-responsive research by addressing the documented higher risks women face during evening commutes. This project shows PUP's commitment to building technology that protects people and serves the needs of everyone in society.

The implementation of the application will help make daily travel much better in several ways. The special alarm system makes sure passengers wake up at the right time no matter what vehicle they are riding, and the GPS updates so they do not miss their stops or waste money on extra fares. The emergency SOS system keeps people safe by sending text alerts with their location to three family members, which can be activated instantly from either the phone or smartwatch with just a long press, making it faster and more discreet in dangerous situations while the camera automatically takes a photo to use as evidence if needed. The "fake call" feature gives users a quiet way to leave uncomfortable situations, which is very important for women and students who face harassment and can be triggered discreetly from the smartwatch without needing to unlock the phone and draw attention. By allowing people to rest safely during long trips, the app helps reduce the tiredness that makes it hard to study or work well. Other helpful tools, like saved routes and travel history, allow users to start their trips with one tap and monitor their journey progress on their smartwatch screen and understand their travel habits better. The app also gives weather alerts about heavy rain or heat so people can prepare for their destination with notifications appearing on both phone and smartwatch for convenient access. Finally, the information collected by the app could even be used to help the government plan better roads and transportation in the future.

This capstone project provides BSIT students an important opportunity to apply classroom knowledge to technical challenges that people face daily. Students must implement smart vehicle detection algorithms, work with GPS signals, create offline capabilities, integrate multiple third-party APIs, and develop cross-device communication between smartphones and smartwatches. They must design interfaces usable by people with varying technology skills while implementing customizable features like adjustable alarm sounds and vibration intensity on both phone and smartwatch, ensuring synchronized notifications across devices. The project requires solving real-world problems like making alarms loud enough for noisy vehicles, preventing false emergency activations, creating convincing fake call scenarios, and ensuring reliable safety features even in battery saver mode. Students must also address ethical considerations including protecting user privacy while tracking location data, securing emergency contact information, safely storing captured photos, and preventing feature misuse. By completing this comprehensive safety and navigation system, BSIT students demonstrate their ability to transform theoretical knowledge into functional applications that protect people and improve daily life, justifying this project as both an essential educational experience and a meaningful contribution to Filipino society.

STATEMENT OF THE PROBLEM

This study aims to design, develop, and implement the Anti-Oversleep Destination Alarm and Emergency Safety System, a mobile application specifically tailored for jeepney, bus, and UV Express passengers in Metro Manila that addresses both the oversleeping problem and the safety concerns faced by vulnerable commuters.

Specifically, the study sought to answer the following questions and sub-questions, as well as to determine the product quality and quality in use of the Anti-Oversleep Destination Alarm and Emergency Safety System in line with the parameters set by the International Organization for Standardization/Independent Ethics Committees (ISO/IEC) 25010:

1. What is the completion rate of the Anti-Oversleep Destination Alarm and Emergency Safety System in terms of:

    1.1 GPS-based real-time location tracking and monitoring;

    1.2 Intelligent multi-stage alarm system;

        1.2.1 proximity-based alert activation;

        1.2.2 customizable alarm sounds and volume;

        1.2.3 vibration intensity settings; and

        1.2.4 vehicle-type adaptive alarm timing?

    1.3 Emergency safety features;

        1.3.1 SOS button with GPS location sharing;

        1.3.2 automatic photo capture and upload;

        1.3.3 fake call feature; and

1.3.4 emergency contact SMS notification?

1.4 Weather alert system;

1.5 Route management features;

1.5.1 saved routes; and

1.5.2 travel history?

1.6 Cross-platform compatibility;

1.6.1 mobile application (Android/iOS); and

1.6.2 smartwatch application integration?

1.7 Offline functionality capabilities?2. What is the acceptability rate of the Anti-Oversleep Destination Alarm and Emergency Safety System as evaluated by the target respondents (public transport commuters - students and workers) in terms of:

2.1 Product Quality:

2.1.1 functional suitability;

2.1.2 performance efficiency;

2.1.3 compatibility;

2.1.4 usability;

2.1.5 reliability; and

2.1.6 portability?

2.2 Quality in Use:

2.2.1 satisfaction;

2.2.2 freedom from risk; and

2.2.3 context coverage?

3. What is the acceptability rate of the Anti-Oversleep Destination Alarm and Emergency Safety System as evaluated by the experts (transportation safety professionals and IT professionals) in terms of:

3.1 Product Quality:

3.1.1 functional suitability;

3.1.2 performance efficiency;

3.1.3 compatibility;

3.1.4 usability;

3.1.5 reliability;

3.1.6 security;

3.1.7 maintainability; and

3.1.8 portability?

3.2 Quality in Use:

3.2.1 effectiveness;

3.2.2 efficiency;

3.2.3 satisfaction;

3.2.4 freedom from risk; and

3.2.5 context coverage?

4. What is the Anti-Oversleep Destination Alarm and Emergency Safety System's general acceptability?

OBJECTIVES OF THE STUDY
The objectives of the study outline what the project aims to accomplish. The general objective presents the overall purpose of the proposed system, while the specific objectives describe the individual goals related to system functionalities, performance, and expected outcomes. Objectives should be clear, measurable, and aligned with the identified problems.

General Objective
To design, develop, and implement a comprehensive mobile application with seamless smartwatch integration called the Anti-Oversleep Destination Alarm and Emergency Safety System that completely solves the problem of Metro Manila commuters missing their intended stops due to falling asleep during long, exhausting journeys on jeepneys, buses, and UV Express vehicles, while providing essential safety features accessible from both smartphone and wearable devices, smart journey optimization tools, and reliable offline functionality to ensure safe and stress-free for daily public transport users.

Specific Objectives
1.) **To create highly effective, customizable wake-up alarm mechanisms** featuring loud sound and strong vibration alerts with adjustable volume and intensity sliders on both smartphone and smartwatch, where commuters can choose from five alarm sounds or a vibration-only mode for quiet trips, with wrist vibration notifications on smartwatches providing discreet alerts even when the phone is in bags or pockets. To ensure even very tired passengers wake up, the alarm gets louder and stronger until it is turned off.
2.) **To integrate comprehensive emergency safety features** including a prominent red SOS button on both the mobile app and smartwatch requiring 3-second activation that instantly sends SMS messages via Twilio API containing the user's exact GPS location

(Google Maps link), timestamp, and automatically captured photo evidence to up to three pre-saved emergency contacts, plus realistic fake emergency call screens simulating incoming calls from "Mom," "Boss," or "Friend" with pre-recorded scenarios to help vulnerable passengers escape uncomfortable or dangerous situations safely.

3.) **To ensure reliable operation in poor connectivity areas** through complete offline functionality that saves destination data locally on both smartphone and smartwatch with synchronized data storage. It includes battery-saving features like adjustable GPS updates, battery percentage displays with low-power warnings, and a pause button for tracking. These tools help the app function throughout long trips in Metro Manila without draining the phone or smartwatch's battery.

4.) **To provide personalization and journey optimization tools** including storage for five frequently used routes labeled as Home, Work, School, Custom 1, and Custom 2 with one-tap activation for daily commuters, comprehensive travel history dashboard displaying the last 20 trips with date, route, duration, vehicle type, plus monthly statistics showing total trips, most-used routes, total time saved, and average trip duration to help users analyze and improve their commuting patterns.

5.) **To integrate real-time contextual weather information** through OpenWeatherMap API integration that automatically alerts commuters about critical weather conditions at their destination including heavy rain, thunderstorms, and extreme heat above 35°C, with visual warning icons and preparation suggestions delivered as notifications on both smartphone and smartwatch screens, enabling passengers to bring umbrellas, raincoats, water bottles, or other necessary items before starting their journey and arrive better prepared for Metro Manila's unpredictable weather patterns.

PROPOSED SYSTEM SOLUTION

The Anti-Oversleep Destination Alarm and Emergency Safety System is a mobile application designed specifically for Metro Manila commuters who use jeepneys, buses, and UV Express vehicles as their primary mode of transportation. The system addresses problems faced by millions of daily commuters which are the issue of falling asleep during long, exhausting commutes and missing intended stops, and the serious safety risks that vulnerable passengers face when they end up stranded in unfamiliar or dangerous locations. By combining intelligent location-based alerting with integrated emergency safety features, the proposed system provides a comprehensive solution that not only prevents passengers from overshooting their destinations but also protects them if dangerous situations arise during their journey.

The primary users of the system are Metro Manila commuters who rely on public transportation for their daily travel needs. This includes students who commute to and from schools and universities, often traveling during early morning or late evening hours. Working professionals who endure extended commutes frequently two to three hours each way and are particularly vulnerable to falling asleep due to accumulated exhaustion from their work schedules. The system specifically prioritizes the needs of commuters, particularly women who face heightened risks of harassment and assault when traveling alone, especially during nighttime hours. Elderly passengers and persons with disabilities who may have difficulty staying alert during long journeys or who need additional safety support also benefit from the system's features. Essentially, any regular public transport user in Metro Manila who has experienced or fears the consequences of missing their stop, wasted money, lost time, late arrivals, or dangerous situations represents a potential user of this system.

The proposed system provides two main solutions: a smart destination alarm and emergency safety tools accessible from both smartphone and smartwatch. The alarm system lets users pick their destination and the type of vehicle they are riding so that the app can track them and send alerts at the right time. Jeepneys get alerts at shorter distances because they move slower, while provincial buses get much earlier alerts because they travel faster. The alarms go off in stages to give passengers enough time to wake up, get their things ready, and tell the driver to stop. Users can change the sounds and make the vibrations stronger on both devices to ensure they wake up even from a deep sleep, with the smartwatch providing discreet wrist taps in quiet situations where loud alarms might be inappropriate. For safety, the app includes three important features accessible from both phone and smartwatch: an SOS button that can be activated quickly

from the wrist with a long press, instantly sending the user's exact location to their family, a "fake call" screen that can be triggered discreetly from the smartwatch without needing to unlock the phone to help them escape uncomfortable situations and a camera that automatically takes a photo during emergencies. The app also includes extra tools like weather updates for the destination displayed on both phone and smartwatch screens, saved routes for easy one-tap use, a history of past trips, and battery-saving modes to make sure the phone stays on during long journeys.

This system solves the problem of passengers falling asleep and missing their stops by tracking their location and using strong alarms to wake them up at the right time. By preventing missed stops, the app saves people from wasting money on extra fares and prevents them from being late to work or school. Most importantly, the system keeps people safe by providing emergency tools that help them get help or escape dangerous situations if they get lost in strange places. The system is designed specifically for the real conditions in Metro Manila where vehicles do not have automatic stop announcements and passengers are often exhausted offering a solution that truly works for the people riding jeepneys, buses, and UV Express.

SCOPE AND LIMITATIONS
Scope
This research focuses on building the Anti-Oversleep Destination Alarm and Emergency Safety System for people in Metro Manila who ride jeepneys, buses, and UV Express. The system is a mobile app for Android phones and compatible on Android or IOS smartwatches. It is designed to work across the National Capital Region and nearby provinces, wherever a GPS signal is available. The primary focus is on passengers riding jeepneys, city buses, provincial buses, and UV Express vehicles. The app is for students, workers, and regular commuters who are tired and might fall asleep during their long trips. It specifically helps vulnerable groups, such as women traveling alone at night, elderly passengers, and students who commute very early or very late by providing discreet access to alarms and emergency features directly from their wrist. The app allows users to find their destination on a map and choose the type of vehicle they are riding. The app uses special alarms that go off in stages Users can change the sounds and vibrations to make sure the alarm is loud enough to wake them from a deep sleep. To make travel easier, users can save their favorite routes accessible with one tap from either device, monitor their journey progress on their smartwatch screen without repeatedly checking their phone, and view a history of their past trips and travel statistics. Safety is a major part of this project. The app includes an SOS button that sends a text message with the user's location to three family members and automatically takes a photo for evidence. It also has a "fake call" feature to help users escape uncomfortable situations and gives weather alerts to warn them of heavy rain or heat at their destination. The app is designed to save battery power during long rides and can perform basic alarm functions even without an internet connection with synchronized data between phone and smartwatch. To ensure it works well, the study will include field tests where actual commuters use the app on real trips with smartwatch connectivity to check its accuracy, loudness, and safety features.

Limitations
The limitations of the system focus on land-based travel in Metro Manila and nearby provinces, specifically for jeepneys, buses, and UV Express. It does not include trains, tricycles, or motorcycles. The application is not for planning routes, it is designed for passengers who already know which vehicle to take but require assistance getting off at the correct stop. Because it relies on GPS, the system may not work perfectly underground or in areas with many tall buildings. The application is built for Android and iPhone smartphones, with basic smartwatch compatibility for receiving alerts and viewing trip status. However, full smartwatch functionality including independent GPS tracking, complete user interface navigation, and all advanced features available on smartphones are beyond the scope of this study. While internet access is needed to find a destination on the map or check the weather, the main alarms and emergency text messages can function without a signal. The success of the application depends on the user's ability to operate a smartphone and their personal responsiveness to alerts. While the alarms are designed to be loud and strong, the system cannot guarantee that every person will wake up, especially if they are in an extremely deep sleep. For the safety features to work, users must save

their emergency contacts ahead of time. It is important to remember that this application is a helpful tool and not a replacement for the police or emergency services. It sends alerts to family and friends, but it does not call the police directly. The system does not include social features, user community forums, or sharing of travel information with other users. Cloud infrastructure for data storage is limited to emergency photo backup and does not include comprehensive cloud synchronization of all user data across multiple devices. The system stores user location data, travel history, and emergency contact information locally on the device, and while basic privacy protections are implemented, comprehensive data encryption, advanced security features, and compliance with international data protection regulations are beyond the scope of this study. The system does not collect or analyze user data for commercial purposes, behavioral profiling, or third-party sharing, but detailed privacy policy development and legal compliance verification are not included in this research. Because of limited time, this study focuses on building the most important parts of the application and testing them with a small group of people. Additional features such as advanced voice commands, offline map storage, and integration with third-party navigation apps are not included. To protect privacy, personal data and travel history are mostly saved on the user's phone rather than on the internet. While the application uses smart technology to guess which vehicle a passenger is in, it might not be perfect in heavy traffic where different vehicles move at the same speed. Finally, while the system tries to save battery, long trips will still use power, and the accuracy of the alarms depends on the GPS quality of the user's device.

METHODOLOGY

Research Design

This study employs a developmental research design to create and evaluate the Anti-Oversleep Destination Alarm and Emergency Safety System for Metro Manila commuters. Developmental research is appropriate for this capstone project because the primary goal is to design, develop, and test a functional mobile application that solves a specific problem which is commuters falling asleep and missing their stops rather than conducting purely theoretical research.

SDLC Model

This project will utilize the Agile Development Model with iterative and incremental development cycles. The Agile model is most appropriate for this mobile application project because it allows for flexibility in responding to user feedback and changing requirements during development, which is essential when creating a system that must meet the real-world needs of Metro Manila commuters. Agile enables continuous testing and refinement of features, ensuring that each component from the vehicle-specific alarm system to the emergency safety features functions correctly before moving to the next development phase. The development will be divided into multiple sprints, each focusing on specific features or modules of the system. Early sprints will concentrate on core functionality such as destination setup, GPS tracking, and basic alarm mechanisms, while later sprints will add vehicle detection algorithms, emergency safety features, and user interface refinements. Each sprint includes planning, development, testing, and review phases, allowing for immediate feedback and adjustments. This iterative approach reduces the risk of discovering major usability or functionality problems late in the development process and ensures that the final system is both technically sound and genuinely useful for the target users. The Agile model also supports the developmental research design by facilitating continuous evaluation and improvement based on actual user experiences during field testing.

Data Gathering Methods

Research Instruments

This study will employ multiple research instruments to gather comprehensive data about commuter needs, system requirements, and the effectiveness of the developed application. A structured questionnaire will be the primary instrument for collecting quantitative data from Metro Manila commuters, covering their commuting patterns, experiences with falling asleep and missing stops, current app usage, desired features in a destination alarm system, and interest in wearable device integration such as smartwatches. The questionnaire will include both closed-ended questions with Likert scale responses for measuring frequency and satisfaction levels, and open-ended questions for gathering detailed feedback and suggestions regarding both

smartphone and smartwatch functionality. A usability testing form will be used during field trials to systematically record user interactions with the application across both smartphone and smartwatch platforms, documenting any difficulties encountered, time taken to complete tasks, successful alarm activations, instances of missed or successful stop arrivals, and the effectiveness of smartwatch notifications in alerting users. For participants using smartwatch features, additional observations will include the visibility and clarity of alerts on the wearable device, haptic feedback effectiveness, and the convenience of viewing trip status at a glance without accessing the smartphone. An interview guide with semi-structured questions will facilitate one-on-one discussions with selected participants to gather qualitative insights about their experiences using the system, perceived safety improvements, the utility of smartwatch integration for their commuting needs, comparison between smartphone-only and smartphone-plus-smartwatch usage, and recommendations for enhancements to both platforms. Additionally, a system performance monitoring log will track technical metrics such as GPS accuracy, alarm trigger distances, battery consumption rates on both smartphones and smartwatches, synchronization reliability between devices, notification delivery speed to smartwatches, and app responsiveness during actual use. A separate device compatibility checklist will document which smartwatch models and operating systems were tested, noting any platform-specific issues or limitations encountered during the research process.

Data Collection

Data collection will occur in three phases aligned with the system development process. The initial needs assessment phase involves distributing the preliminary questionnaire to at least 150 Metro Manila commuters through online platforms and in-person distribution at common commuting hubs such as jeepney terminals, bus stops, and UV Express stations to gather baseline data about the oversleep problem and identify essential system features. The development phase includes consultations with small groups of target users to review prototype interfaces and provide feedback on feature designs, ensuring the system meets actual user needs before full implementation. The evaluation phase conducts field testing with approximately 30-50 volunteer participants who will use the application during their actual daily commutes over a two-week period, with data collected through the usability testing forms completed after each trip, system performance logs automatically recorded by the application, and follow-up interviews with selected participants to gather detailed qualitative feedback. All participants will provide informed consent, and data will be collected in accordance with ethical research standards, ensuring confidentiality and voluntary participation throughout the study.

EXPECTED OUTPUTS

The primary output of this project is a fully functional Anti-Oversleep Destination Alarm and Emergency Safety System mobile application with companion smartwatch support. The application will include all core features specified in the project scope which are destination setup with map integration, real-time GPS tracking, vehicle type selection for four categories (jeepney, UV Express, city bus, provincial bus), multi-stage alarms with vehicle-specific distance, customizable alert settings with sound and vibration options, saved routes functionality for up to five favorite destinations, emergency SOS system with SMS alerts to emergency contacts, fake call feature with three scenario options, automatic emergency photo capture, weather alerts for destination areas, travel history dashboard, and battery optimization features. The smartwatch feature will provide synchronized notifications and alerts, displaying trip progress, distance to destination, and upcoming stop warnings directly on the user's wrist. Smartwatch users will receive haptic vibration alerts coordinated with the smartphone's alarm stages, allowing for discreet notifications that work alongside the primary smartphone alerts. The smartwatch interface will show essential trip information at a glance, including current location status, estimated time to destination, and quick-access emergency SOS activation. While the smartphone application serves as the primary control center for all features, the smartwatch companion enhances user experience by providing convenient wrist-based access to critical alerts and trip status without requiring users to retrieve their phones from bags or pockets. The application will be installable on Android and iOS smartphones with compatibility for popular smartwatch platforms including Apple Watch and Wear OS devices, ready for use by Metro Manila commuters during their daily journeys.

Comprehensive technical documentation will be produced to support future maintenance, updates, and potential expansion of the system, including system architecture diagrams showing the overall structure and component relationships across smartphone and smartwatch platforms built using the Flutter framework, database schema if applicable for local data storage on both devices, API integration documentation for external services such as mapping and weather data as well as smartwatch platform SDKs (WatchKit for Apple Watch and Wear OS SDK for Android wearables), algorithm descriptions for vehicle detection and alarm triggering logic implemented in Dart, synchronization protocols between smartphone and smartwatch devices, and source code documentation with clear comments explaining key functions and modules for both the primary mobile application and the smartwatch companion app written in Dart programming language. The documentation will detail the Flutter project structure, including the organization of widgets, state management implementation (such as Provider, Riverpod, or Bloc pattern), platform-specific code handling using Flutter's platform channels for native iOS and Android features, package dependencies and their purposes, the integration of Flutter plugins for GPS tracking, background services, local notifications, and device connectivity, and how Flutter's cross-platform capabilities are leveraged to maintain a single codebase while delivering native performance on both Android and iOS smartphones as well as smartwatch platforms. The documentation will specifically address the smartwatch integration architecture, including communication protocols between the smartphone and wearable device using Flutter's MethodChannel for platform-specific implementations, data synchronization mechanisms to ensure real-time updates of trip status and alerts, battery optimization strategies for wearable devices with limited power capacity, platform-specific implementation differences between Apple Watch (using WatchKit with Swift/Objective-C bridging) and Wear OS versions (using Kotlin/Java integration with Flutter), troubleshooting guides for common connectivity issues between paired devices, interface design specifications for the smartwatch UI detailing screen layouts, notification templates, haptic feedback patterns implemented through native platform channels, and user interaction flows optimized for the smaller wearable display. The documentation will also cover Flutter-specific best practices employed in the project, including widget lifecycle management, asynchronous programming using Dart's Future and Stream APIs for real-time GPS tracking and background tasks, error handling and debugging strategies, testing approaches including unit tests and widget tests written in Dart, performance optimization techniques specific to Flutter applications, and code examples demonstrating key implementations such as geofencing logic, alarm scheduling, emergency SMS dispatch, and cross-platform notification handling. The technical documentation will enable other developers familiar with Flutter and Dart to understand the system's implementation across both smartphone and smartwatch platforms and make modifications or enhancements as needed, including the potential addition of support for other wearable devices or expansion of smartwatch functionality in future versions, with clear identification of which components are written in pure Dart/Flutter and which require platform-specific native code integration, providing guidance for developers working on either aspect of the system.

A complete user manual will be developed to guide commuters in effectively using the application across both smartphone and smartwatch platforms. This documentation will include step-by-step instructions for initial setup and configuration on smartphones, detailed explanations of all features and how to use them on both devices, illustrated guides for setting destinations and customizing alarms, instructions for pairing and connecting smartwatches to the primary application, guidance on managing emergency contacts and safety features, troubleshooting guidelines for common issues including smartwatch connectivity problems, and frequently asked questions with answers covering both standalone smartphone use and integrated smartphone-smartwatch operation. The user manual will be written in clear, simple language appropriate for users with varying levels of technical expertise and will include screenshots and visual aids from both smartphone and smartwatch interfaces to enhance understanding. Platform-specific instructions will be clearly marked to help users identify which steps apply to their particular devices, whether using Android smartphones with Wear OS watches, iPhones with Apple Watches, or the smartphone application independently without a wearable device.

A comprehensive evaluation report will document the testing process and results, demonstrating whether the system successfully achieves its objectives across both smartphone and smartwatch platforms. This report will present quantitative findings including alarm accuracy

rates at specified distances for each vehicle type, GPS tracking precision measurements, battery consumption statistics during typical commute durations for both smartphones used independently and when paired with smartwatches, notification synchronization delay between smartphone and smartwatch devices, the percentage of field test participants who successfully woke up from alarms using smartphone-only alerts versus those using combined smartphone and smartwatch haptic notifications, and the reduction in missed stops compared to participants' experiences before using the system. The evaluation will include comparative analysis between different user groups: those using the smartphone application alone, those using the integrated smartphone-smartwatch system, and comparative effectiveness data on alert responsiveness across different usage modes. Specific smartwatch-related metrics will include haptic vibration effectiveness ratings, smartwatch notification visibility and readability during actual commute conditions, user preference rates for wrist-based alerts versus smartphone-only alerts, frequency of smartwatch quick-glance usage for trip status checks, successful emergency SOS activations from smartwatch devices, and connectivity reliability statistics between paired devices during travel. Qualitative findings will include user satisfaction ratings for both smartphone and smartwatch interfaces, feedback on ease of use and interface design across both platforms, perceived improvements in commuting safety and confidence when using wearable alerts, comparison of user experiences between smartphone-only and dual-device configurations, reported challenges or issues encountered during use including smartwatch-specific problems such as connectivity drops or delayed notifications, assessment of smartwatch convenience benefits during crowded commutes when accessing smartphones is difficult, and recommendations for future enhancements to both smartphone and wearable functionality. The evaluation report will also include analysis of the emergency safety features' usability across both platforms, participants' willingness to rely on these features in actual emergency situations, and specific feedback on the practicality of initiating emergency SOS from a smartwatch versus a smartphone in scenarios where quick, discreet activation may be critical.

The complete capstone documentation will present the entire research and development process, including the problem statement and background research, objectives and scope of the study, review of related literature and existing systems, methodology and development process, system design and implementation details, testing procedures and evaluation results, analysis and discussion of findings, conclusions about the system's effectiveness in addressing the identified problems, and recommendations for future improvements and potential expansions of the system. This documentation will serve as a comprehensive record of the project and fulfill the academic requirements for the capstone course.

SIGNIFICANCE OF THE STUDY

The development and implementation of the Anti-Oversleep Destination Alarm and Emergency Safety System is important because it offers helpful tools and safety benefits for commuters, the community, and researchers.

For Commuters

The primary beneficiaries of this study are the Metro Manila commuters who rely on jeepneys, buses, and UV Express vehicles for their daily transportation. It solves the common problem of oversleeping, helping students get to class on time and helping workers avoid being late or losing pay. Most importantly, it keeps vulnerable passengers like women and the elderly safer with emergency tools for late-night or lonely trips, making daily travel much less stressful for everyone.

For Transportation Service Providers

Jeepney operators, bus companies, and UV Express services stand to benefit indirectly from this system's widespread adoption. When passengers are reliably alerted before their stops, drivers experience fewer disruptions from passengers suddenly realizing they've passed their destination and requesting emergency stops in unsafe locations or attempting to move vehicles. This contributes to smoother traffic flow and safer operations. The app also collects travel data that companies can use to improve schedules and services based on commuter habits.

For Government Transportation Agencies

Government agencies responsible for Metro Manila's transportation system, including the Department of Transportation (DOTr) and the Metropolitan Manila Development Authority (MMDA), can use the study's data on commuter habits and safety concerns to improve transport policies and infrastructure. By highlighting the needs of passengers, the project encourages modernizing vehicles with better GPS tools and supports calls for better lighting and security at terminals.

For the IT and Mobile Application Development Community
This study helps developers by showing how to build apps specifically for countries like the Philippines, where public transport doesn't have built-in tracking. It introduces a new way to guess the vehicle type using speed data and combines convenience with safety tools for vulnerable people. Other programmers can use this project's code and documentation as a guide to create similar apps for different cities.

For Academic Researchers
Future researchers can use this study as a guide for building real tools that solve transport and safety problems in developing countries. It provides a model for testing apps in the real world and offers data on how technology can help vulnerable groups, like women, stay safe. The findings also show how mobile apps can fill gaps in public systems to make commuting better.

For Educational Institutions
Schools and universities whose students endure long, exhausting commutes will benefit from improved student punctuality, attendance, and academic performance. When students arrive on time and are less stressed by travel, leading to better attendance and grades. Teachers can follow their schedules more easily, and students can focus better on their lessons. Additionally, schools can feel more confident about student safety during early or late commutes because of the app's emergency features.

For Future System Developers and Capstone Students
IT students and developers working on similar capstone projects or mobile applications addressing social problems will find this study serves as a comprehensive reference for the entire development process from problem identification and needs assessment through system design, implementation, testing, and evaluation. The challenges encountered and solutions implemented provide practical lessons that can help future developers avoid common mistakes.

REVIEW OF RELATED LITERATURE

Public Transportation Challenges and Commuter Fatigue in Metro Manila

Urban transportation systems worldwide face significant challenges related to commuter fatigue, extended travel times, and inadequate infrastructure, with Metro Manila exemplifying these issues at an extreme scale. Galvez et al. (2025) documented that Metro Manila, a rapidly growing megacity with a population of 24.4 million, faces significant urban transport challenges and grapples with severe traffic congestion, ranking 5th out of 387 cities globally in terms of congestion level. The severity of this crisis was further documented in the 2024 TomTom Traffic Index, where the researchers noted that Metro Manila holds 15th place in the ranking for the world's worst traffic levels based on travel times, with drivers spending at least 117 hours stuck in traffic yearly. However, Galvez et al. (2025) emphasized that the situation proves even more dire for public transport users, noting that the recorded average travel speed for public transportation was 10.5 km/h, with a trip of 9.8 km/h as the worst travel experience, demonstrating that commuters endure significantly slower journeys than private vehicle users.

The economic and social costs of Metro Manila's transportation crisis extend far beyond individual inconvenience. Lagundimao (2024) reported that traffic congestion results in productivity losses estimated at approximately PHP 2.4 billion (approximately $54 million) per day, accumulating to more than PHP 800 billion (approximately $18 billion) annually, demonstrating both the economic magnitude and pervasive impact on the national economy. IBON Foundation (2024) examined the structural deficiencies of the system in their transport

series, finding that commuters have to take several modes of transport to get to their intended destination, with an average of two to three transfers, and routes and modes of public transport are not fully interconnected. This disjointed infrastructure, as the researchers further noted, forces passengers to expend additional physical and cognitive energy navigating complex multi-modal journeys, often having to walk long distances to get to the next stop or terminal, which is also aggravated by the lack of proper walkways and sidewalks. The regulatory chaos governing Metro Manila's public transportation system creates unpredictable service quality that prevents commuters from establishing reliable travel routines. Galvez et al. (2025) documented the system's complexity, noting Metro Manila having over 43,000 jeepney franchises and over 830 bus franchises issued for more than 900 routes, making the public transport market practically impossible for the government to regulate effectively. This lack of coordination results in what researchers have characterized as a fundamentally disorganized system that produces consistently unpleasant commuting experiences.

The physiological and psychological consequences of prolonged commuting on student and worker populations have been extensively documented in Philippine academic research. Evasco et al. (2024) conducted a groundbreaking study examining the relationship between sleep quality and cognitive failures among undergraduate commuter students at the Polytechnic University of the Philippines-Manila, specifically investigating how challenging urban commuting experiences influence students' sleeping patterns and, consequently, their cognitive abilities. Utilizing the Pittsburgh Sleep Quality Index (PSQI) and the Cognitive Failures Questionnaire (CFQ) with 100 student participants, the researchers empirically determined how challenging urban commuting experiences influence students' sleeping patterns and cognitive abilities, recognizing the importance role of sleep in cognitive functions for academic performance and daily functioning. This study provides direct evidence linking Metro Manila's exhausting commutes to measurable impairments in cognitive function among university students, validating concerns that extended travel times directly compromise academic performance and overall well-being. The temporal costs of Metro Manila's transportation crisis extend beyond mere inconvenience to fundamental quality of life deterioration. Subingsubing (2020), as cited by Galvez et al. (2025), documented that Metro Manila commuters lost 257 hours to traffic in the previous year, representing more than ten full days annually spent in congested vehicles, time that could otherwise be allocated to rest, family relationships, education, or productive work. The cumulative effect of these extended journeys manifests in what researchers have termed "commute-induced exhaustion syndrome," characterized by chronic fatigue, reduced alertness, and involuntary sleep episodes during transit.

The transportation system's dehumanizing effects on passengers have been critically analyzed in recent urban planning scholarship. Chua (2024) argued that poor public transport dehumanizes pedestrians and passengers, requiring what the researcher describes as the conditional surrender of personal space in exchange for the opportunity to arrive at work on time and return home to spend quality time with loved ones. During peak hours, Chua (2024) observed that even modernized minibuses and electric jeepneys tend to allow an unlimited number of passengers, with passengers regardless of pregnancy, disability status, or other vulnerabilities forced to stand even at the doorstep of vehicles, creating physically exhausting conditions that accelerate passenger fatigue and dramatically increase the likelihood of involuntary sleep during travel.

Service quality perceptions among commuters reveal systemic failures in passenger care, comfort, and safety that compound fatigue-related risks. Galvez et al. (2025) examined paratransit users in Metro Manila, identifying that commuters perceive ergonomics, cleanliness, and ventilation inside public utility vehicles as the most unsatisfactory aspects of their experience. Additionally, the researchers found that safety concerns prove particularly acute, noting that commuters report they do not feel safe and secure against crimes inside public utility vehicles or in loading and unloading areas. These uncomfortable physical conditions compound the exhaustion from extended travel times, creating an environment highly conducive to passenger fatigue and unintended sleep, while simultaneously exposing vulnerable passengers to safety risks.

The intersection of fatigue management and labor efficiency in Metro Manila's commuting context has been identified as critical to worker productivity. Fallaria et al. (2019) stated that reducing burnout while traveling to work locations is necessary to manage fatigue and thus improve labor efficiency. The researchers proposed that high service quality represents a contributing component to coping techniques that can be attributed to the inevitability of using public transportation, potentially leading individuals to continue using these services despite persistent quality issues. This suggests a complex relationship between service quality expectations, commuter satisfaction, and continued reliance on inadequate transportation systems.

While existing literature extensively documents commuter fatigue, productivity losses, health consequences, and the physiological impacts of prolonged travel in Metro Manila, there remains a critical absence of technological interventions specifically designed to mitigate the immediate consequences of fatigue-induced sleep during transit. Current research focuses primarily on documenting systemic problems, advocating for infrastructure improvements, and analyzing policy failures, yet no studies address immediate, user-implemented technological solutions that could protect exhausted commuters from missing their destinations while broader systemic reforms remain unrealized. Current research mostly looks at big problems like poor infrastructure and policy failures, but it does not offer tools that individuals can use right now to stay safe. Because commuters spend several hours a day in crowded and tiring conditions, they need an app that protects them from missing their stops. Although experts know that commute-related stress leads to health risks and huge economic losses, no one has yet studied how mobile apps can provide immediate help and safety for people traveling in this difficult system every day.

Safety Concerns for Vulnerable Commuters

The safety implications of public transportation extend far beyond operational efficiency, with women and other vulnerable populations facing disproportionate risks of harassment, violence, and harm that fundamentally constrain their mobility and wellbeing. Kuupiel et al. (2025) conducted a systematic scoping review examining the safety of female commuters in public transport systems across Low- and Middle-Income Countries (LMICs), analyzing 26 studies published in 14 countries. The review identified a concerning paucity of research in this area, with an average of only three relevant papers published per year, and noted that existing literature demonstrates significant geographical imbalance, with predominant focus on South Africa, India, and Malaysia, leaving many LMICs including the Philippines critically underrepresented in the scholarly discourse on women's transportation safety.

The psychological impact of harassment experiences fundamentally alters women's travel behavior and mobility patterns. Higuera-Mendieta et al. (2025) examined sexual harassment and fear of crime among female public transport users in Spain, finding that sexual harassment significantly alters female commuters' mobility, with fear acting as a key mediator in behavioral adaptation to harassment. Their research further revealed that differences in city size and age groups influence harassment impact, suggesting that vulnerability varies across contextual and demographic factors. The researchers emphasized that concerns about women's safety continue to pose a significant barrier to regular public transport use, directly contradicting sustainability goals that rely on increased public transportation adoption. The relationship between harassment experiences, forced behavioral adaptations, and overall life satisfaction among female commuters has been empirically established. Higuera-Mendieta et al. (2024) investigated this nexus among daily female commuters, documenting that female public transport commuters constitute a significant focus in terms of safety and security concerns, with pervasive challenges like sexual harassment and fear experiences posing threats to their mental well-being. Critically, their research demonstrated that life satisfaction may be further compromised if these experiences force inconvenient behavioral changes, with women exposed to harassment experiences reporting a higher frequency of travel adaptations. The study's structural equation modeling revealed that unsought behavioral adaptations fully mediated the relationship between harassment/fear and life satisfaction, establishing a direct causal pathway from safety concerns through constrained mobility to diminished wellbeing.

Women across diverse geographical contexts engage in extensive "safety work" to mitigate risks during public transportation use, representing a significant cognitive and emotional burden. Ison et al. (2025) conducted 41 interviews with women and gender-diverse people who experienced sexual violence and harassment on public transport in Australia, documenting that women and gender-diverse people engage in extensive "safety work," such as changing their behavior, strategizing, and planning, with safety work taking considerable time and effort, often leaving participants feeling stressed. The researchers noted that sexual violence and harassment on public transport can happen on the platform, on the transport vehicle, or on the "last kilometer home" which refers to the journey from exiting the vehicle to the destination, highlighting the comprehensive spatial dimensions of transit-related vulnerability. Specific life stages and circumstances create heightened vulnerabilities that compound safety concerns for women commuters. Women's perceptions of public transport safety vary significantly across different contexts, with gender differences in perceptions of public transport, especially in relation to perceptions of safety, where a study of 28 cities found that women were 10% more likely than men to feel unsafe in metros, with these gender differences becoming more apparent during certain contexts, such as pregnancy. The physiological changes associated with pregnancy introduce additional layers of vulnerability, as pregnant women may experience fatigue that increases their susceptibility to missing stops or finding themselves in unfamiliar locations. Research documented that pregnancy (especially during the first and third trimester) can lead to tiredness and this may be exacerbated in women with long commutes, creating conditions where expectant mothers face compounded risks from both exhaustion and safety threats.

Age-related differences in victimization risk and fear levels create distinct vulnerability profiles across the female commuter population. Ceccato et al. (2024) investigated transit safety of women in rural-urban contexts in Sweden, documenting that being young makes women more likely to be victimized, while young women are statistically more at risk of being victimized, older and/or disabled individuals tend to be more fearful. Their research revealed that although rural women feel safer than their urban counterparts, they are more often willing to take precautionary measures before taking a trip (e.g., more often traveling with someone in the evening or avoiding certain stations) suggesting that perceived safety does not necessarily correlate with reduced defensive behaviors. The researchers emphasized that safety interventions should be based on the needs of groups in society that have exhibited higher levels of fear and/or vulnerability to crime and harassment, for example, women, the elderly, and LGBTQ people.

The temporal and spatial dynamics of sexual violence in public transportation reveal patterns that heighten women's vulnerability during specific circumstances. Kuupiel et al. (2025) synthesized evidence demonstrating that in Brazil, sexual violence was found to be concentrated in central transit hubs, particularly during rush hours, illustrating the spatial and temporal dynamics that increase women's vulnerability. In the Indian context, safety concerns significantly influence women's preferences for transportation modes, often leading them to avoid buses during overcrowded or nighttime travel, with many women feeling vulnerable while using public transportation, particularly in situations where overcrowding or poor lighting exacerbates their fears. These findings underscore how infrastructure deficiencies and operational patterns create environments conducive to harassment and assault.

The inadequacy of incident reporting systems and data collection mechanisms perpetuates the invisibility of sexual violence and harassment in public transportation contexts. Forsdike et al. (2024) worked with public transport providers and stakeholders in Australia to audit incident reporting pathways and data quality, uncovering varied sexual violence and harassment reporting formats and subsequent limited reporting of sexual violence and harassment incidents on public transport, with poor-quality data sets lacking gender sensitivity, comprehensiveness, comparability, reliability and accessibility. The researchers concluded that to improve women's safety on public transport, enhanced gender-sensitive data collection and monitoring is required, with long term government investment in sexual violence and harassment primary prevention strategies on public transport being urgently needed.

Many studies show that women and other vulnerable people face harassment and danger on public transport, but there is a lack of technology to help them when they get lost or miss their

stops. Current research focuses on big changes like new laws or better lighting, but it does not offer personal tools for people stranded in unfamiliar or dangerous areas at night. Women already do a lot of extra work to stay safe, which creates a need for apps that offer emergency help, quiet ways to escape threats, and easy location sharing. Even though experts know that pregnancy, age, or disability make travel even riskier, there is still no study on how mobile apps can provide immediate protection in places where official security is weak.

Existing Navigation and Location-Based Applications

The evolution of navigation and location-based applications has fundamentally transformed how individuals interact with public transportation systems, particularly in metropolitan and suburban contexts. These applications, ranging from commercial platforms to specialized transit systems, serve as critical tools for mobility management and route optimization. The proliferation of smartphones and Internet connectivity has enabled Advanced Traveler Information Systems (ATIS) to become powerful instruments for improving travel efficiency and supporting voluntary travel behavior changes toward more sustainable transportation options (de Menezes Amorim & de Abreu e Silva, 2024).

Google Maps represents one of the most widely implemented navigation platforms globally, demonstrating both the capabilities and complexities of modern location-based services. Boullier (2022) examined how platforms like Google Maps construct knowledge infrastructure to accommodate diverse urban contexts, particularly in cities with partially informal transport systems. Using Mexico City as a case study, the research revealed that rather than imposing a standardized global infrastructure onto local settings, Google Maps relies on local actors to mediate territorial specificities, illustrating an evolving interplay between global platforms and local governance. This finding challenges the assumption of straightforward opposition between public and private actors, instead revealing a dynamic of mutual dependence and negotiated collaboration.

The technical foundation of route-finding applications involves treating maps as a series of road segments with varying characteristics, where each segment contains both static data (endpoints, length, shape, speed limit) and dynamic data (actual speeds, reported issues, driver behavior). Witman et al. (2025) explained that routing algorithms like A* serve as the fundamental mechanism for finding optimal paths between two points on a graph, utilizing metadata about each edge to evaluate potential routes based on multiple criteria including speed limits, energy costs, tolls, and real-time traffic conditions. The computational complexity of comparing vast numbers of potential routes necessitates optimization techniques that narrow the scope while maintaining route quality.

Navigation applications have extended beyond private vehicle routing to encompass comprehensive public transportation information systems. Prasad (2022) developed a public transportation portal for commuters that demonstrated the multifaceted role of such systems in urban mobility. The portal provided residents and visitors with information about public transportation options, schedules, fares, and real-time bus information, achieving goals of optimum resource utilization, efficient record management, and simplified operations. The system architecture employed a four-tier structure: presentation layer (user interface), business rules layer (processing logic), data access layer (database interaction), and database layer (actual data storage). This modular architecture allows for independent updates to business logic without affecting other system components, addressing a common failure point in earlier client-server applications. The importance of public transportation portals extends beyond mere convenience. Prasad (2022) emphasized that public transportation saves money, makes travel easier, enhances opportunities and property values, minimizes air pollution, relieves traffic congestion, and provides employment opportunities for millions. The research identified five principles of municipal transportation sustainability: accessibility, affordability, connection, holistic transportation, and land use planning with environmental considerations. However, the study also noted that most emerging city transportation networks remain far from perfect, with traffic congestion, inadequate public transportation accessibility, and unsafe facilities for non-motorized transport representing persistent challenges.

The evolution toward autonomous public transport systems represents a significant frontier in navigation and location-based services. Gusev and Gilroy (2024) conducted an in-depth analysis comparing technologies for autonomous transport systems, focusing on logistical considerations, economic factors, and operational outcomes. Their research evaluated manned ground vehicles, autonomous ground vehicles, and infrastructure solutions (such as autonomous monorails) within the context of densely populated urban areas. The findings indicated that autonomous and manned ground vehicles operate within similar logistical frameworks but offer different operational flexibilities, with autonomous systems demonstrating potential advantages in adaptability to changing passenger needs and risk reduction through sensor-based navigation. Understanding user intentions and adoption patterns provides critical insight into navigation application effectiveness. Amorim and de Abreu e Silva (2024) investigated how residential location and public transit options influence commuters' intentions to use travel apps for different purposes within the Lisbon Metropolitan Area. Employing Structural Equation Modeling with 768 respondents from two suburban corridors, the research identified technophilia (individual interest and ability to handle new technologies) and public transit utilization as the most important predictors of Advanced Traveler Information Systems (ATIS) adoption intention. The study found that male students from Generation Y/Z living outside central areas demonstrated the highest likelihood of adopting ATIS applications. The research revealed nuanced relationships between urban form, transit complexity, and application usage. Amorim and de Abreu e Silva (2024) demonstrated that complexity in public transit supply characterized by more alternatives, presence of rail-based journey options, and more transfers increases likelihood of using travel apps. However, living in more central, dense, and mixed areas reduces current ATIS adoption, potentially because high land use mix induces shorter trips requiring less planning assistance. The study emphasized that mobility patterns associated with more complex and frequent trips reinforce intention to use travel apps regardless of specific journey purposes, with situational use showing strongest association with occasional trips, unscheduled trips, and trips involving transfers rather than routine commuting.

The Technology Acceptance Model framework, as discussed by Witman et al. (2025), provides additional perspective on user adoption. The model posits that perceived usefulness, perceived ease of use, perceived enjoyment, and perceived interactivity collectively influence user attitudes and behavioral intentions toward navigation applications. This framework helps explain why users continue engaging with navigation apps despite occasional failures, as the cumulative utility across multiple trips outweighs isolated negative experiences. Despite technological sophistication, navigation applications face significant operational challenges that impact reliability and user safety. Witman et al. (2025) documented multiple scenarios illustrating critical system limitations across diverse contexts. In November 2023, Google Maps directed travelers onto an impassable desert detour during Interstate 15 closure due to dust storms, resulting in multi-hour delays and vehicle breakdowns. The incident highlighted gaps in real-time road condition assessment and the challenge of integrating emergency closure information into routing algorithms. Similarly, during winter storms, navigation apps have repeatedly directed drivers onto poorly maintained forest roads and unmaintained seasonal dirt roads, prompting law enforcement warnings against following GPS directions during severe weather.

Navigation application effectiveness depends on balancing diverse stakeholder interests. Witman et al. (2025) identified multiple stakeholder groups with potentially conflicting needs: users seeking accurate directions and relevant information; businesses desiring visibility for their services; map providers interested in data collection and advertising revenue; public services agencies focused on travel safety and efficiency; and residents concerned about maintaining appropriate traffic levels in their neighborhoods. This multi-stakeholder environment creates challenges for map providers attempting to balance competing interests while maintaining service quality and commercial viability. Boullier (2022) emphasized that the relationship between global platforms and state sovereignty involves negotiated collaboration rather than simple opposition. The research found that platforms like Google Maps do not merely impose global infrastructure but instead rely on local knowledge and governance structures to navigate territorial specificities. This finding suggests that effective navigation services require ongoing dialogue between platform providers, government agencies, and local communities to address the varied needs of different stakeholder groups while maintaining system functionality and user trust.

Modern navigation and map apps are very advanced, but they still face big problems. While they are great at finding fast routes and showing traffic, they often fail during emergencies or show incorrect information in certain areas. Research shows that these apps work best for new trips rather than daily commutes, and there is often a conflict between global app designs and the specific needs of local neighborhoods. Technically, it is very difficult to keep map data perfectly updated and to combine information from many different sources without making mistakes that could lead drivers into dangerous situations. From a business side, these apps do many things at once, like showing ads and collecting data, which can cause issues like sending too much traffic through small residential streets. Looking ahead, adding self-driving vehicles will make things even more complicated and expensive, meaning they will likely only assist current transport systems rather than replace them soon. Overall, while these apps are very popular, they still need to become more reliable and safe. Future work should focus on making these systems better at handling local needs and fixing errors before they cause problems for users.

GPS-Based Proximity Alert Systems

The evolution of location-based technologies has fundamentally transformed how individuals interact with their physical environment, particularly in transportation contexts where real-time spatial awareness proves critical for safety and efficiency. Modern geofencing and GPS-based proximity detection systems have emerged as powerful tools for creating automated, location-triggered responses that serve diverse applications ranging from commercial logistics to personal safety. Understanding the technical foundations, implementation challenges, and practical applications of these systems provides essential context for developing effective destination alert solutions for public transportation commuters. The technical architecture underlying GPS-based proximity systems relies on sophisticated positioning methodologies that balance accuracy with resource efficiency. Jangalagi and Neumann (2025) developed a smart destination alert system for long-distance public bus passengers that connects GPS-based location tracking with an OTP-authenticated reservation platform and embedded alert hardware to inform passengers as they reach their destination. The researchers implemented their system using Arduino Uno microcontroller, GPS module, and vibration motors placed under seats, with the system activating physical warnings when the bus comes within predetermined proximity of a passenger's registered stop. This implementation demonstrates the fundamental principle of geofencing: establishing virtual boundaries around geographical coordinates and triggering automated responses when enabled devices enter or exit predefined zones. The researchers documented that their system was tested using real-time GPS coordinates, achieving reliable destination detection and timely alert triggering, validating the viability of embedded proximity alert systems for actual transit environments.

The effectiveness of GPS-based tracking in public transportation contexts depends substantially on implementation quality, user interface design, and integration with broader transit information systems. Recent research on smart bus live tracking systems has demonstrated the multifaceted benefits of real-time location awareness for passengers. Researchers proposed systems that use GPS, cloud storage automation, AI-based prediction, and mobile applications to address challenges faced by passengers due to absence of reliable real-time bus information, with systems allowing passengers to view live bus location, estimated time of arrival, and receive instant alerts, minimizing waiting times, reducing stress, and enhancing overall travel convenience (IJNRD, 2025). The implementation architecture typically includes GPS trackers or mobile GPS devices to collect real-time location data from buses, Firebase Cloud Messaging for real-time push notifications and alerts, and analytical tools for analyzing bus punctuality, passenger usage, and traffic patterns. These comprehensive systems illustrate how GPS-based proximity detection serves as the foundation for layered information services that address multiple dimensions of the commuter experience.

The challenges inherent in GPS-based proximity detection systems for transit applications have been well documented in research and commercial implementations. GPS accuracy varies significantly based on environmental factors, with satellite signals experiencing interference from tall buildings in urban canyons, degradation in underground or enclosed stations, and atmospheric conditions affecting positional precision. Power consumption represents another critical constraint, as continuous GPS polling rapidly depletes mobile device batteries, creating tension

between update frequency and battery longevity that system designers must carefully balance. Jangalagi and Neumann (2025) addressed this challenge through dedicated embedded hardware with optimized power profiles, while mobile application approaches typically implement adjustable GPS polling intervals, geofencing techniques that reduce active tracking periods, and background service management strategies that balance responsiveness with resource conservation. Network connectivity requirements pose additional complications, as rural routes or areas with poor cellular coverage may experience delayed or failed alert transmissions, necessitating offline capabilities and local data storage for critical alert functions.

The accessibility implications of GPS-based transit tracking systems have received increasing research attention, particularly regarding service provision for passengers with disabilities. Research examining AI-powered real-time bus navigation systems found that visually impaired and blind passengers experience great difficulty locating public transport and bus stops due to visual impairments, with proposed systems providing audio-based information about buses arriving at stops and tracking vehicles using driver-side mobile applications with GPS (IJNRD, 2025). These accessibility-focused implementations demonstrate how proximity-based alert technology can reduce barriers to independent mobility for passengers with disabilities, transforming public transportation from an insurmountable challenge to a viable option when appropriate information delivery mechanisms are deployed. The researchers emphasized that features including multilingual support, accessibility tools, and safety alerts ensure inclusivity for rural, elderly, and differently-abled users, highlighting the potential for GPS-based systems to serve diverse passenger populations with varying needs and capabilities.

The integration of predictive algorithms with real-time GPS data has emerged as an advanced approach to improving arrival time estimation and alert timing accuracy. Researchers have noted that AI-based prediction capabilities address limitations of traditional systems where estimated arrival times prove inaccurate and unreliable, with systems incorporating machine learning models that analyze historical traffic patterns, current vehicle speeds, stop dwell times, and contextual factors like weather conditions and time of day to generate more accurate predictions (IJNRD, 2025). The implementation of such predictive capabilities requires substantial computational infrastructure, extensive historical data collection, and continuous model refinement based on actual performance feedback. However, when successfully deployed, these systems can alert passengers earlier or later than simple distance-based triggers would suggest, accounting for traffic conditions that affect actual arrival times and improving the practical utility of proximity-based notifications. Commercial GPS tracking solutions designed specifically for bus fleet management have demonstrated advanced feature sets that address operational needs beyond basic location monitoring. Trackhawk GPS systems for bus fleets provide real-time tracking that offers visibility into precise vehicle locations, enabling route optimization, idle time reduction, and improved operational productivity, with intelligent route planning and geofencing features that streamline routes, enhance security through virtual perimeters, and provide instant alerts for deviations. The systems' driver behavior monitoring capabilities provide insights into driving habits, promoting responsible practices and contributing to safety culture improvement. These comprehensive fleet management platforms illustrate how GPS-based proximity detection serves as foundational technology supporting multiple organizational objectives including efficiency improvement, safety enhancement, security provision, and operational intelligence generation. The ability to establish geofences around designated areas and receive immediate notifications when vehicles enter or exit these zones enables applications ranging from unauthorized vehicle use prevention to arrival time notification for passengers waiting at specific locations.

Research shows that while GPS tools are used for tracking fleets and helping people with disabilities, there are very few apps made for individual passengers using informal transport like jeepneys. Most current systems are built for official buses with reserved seats or focus only on predicting arrival times for people waiting at stops. They also often require a constant internet connection, which does not work in areas with poor signal or for commuters without data. Additionally, most research does not solve the problem of high battery drain during long trips. While some apps use audio alerts for the blind, there is little focus on using a mix of sounds, lights, and vibrations to wake up exhausted passengers in noisy, crowded vehicles. This project

aims to fill these gaps by creating a system that works offline, saves battery, and uses strong, multi-mode alarms to ensure passengers never miss their stops.

Alarm Effectiveness and Wake-Up Mechanisms

The emergence of intelligent alarm applications specifically designed for commuters reflects growing recognition that traditional static alarms prove for dynamic transportation scenarios. Dabholkar et al. (2020) developed EarlyBuddy, a smart alarm clock application designed for Android users that makes use of traffic analysis to help wake up the user on-time in situations where a delay is predicted. Rather than setting a single wake-up time, the researchers explained that users can choose a timeframe during which they need to wake up, with the app selecting a specific time from within that window based on delay calculated using frequent updates on traffic data. The system's architecture integrates multiple external APIs, with Dabholkar et al. (2020) documenting that to get the traffic data that the application requires, the application polls the API for data on the user's journey including start and end location and time of arrival. This approach demonstrates how modern alarm systems can transcend simple time-based triggering to incorporate contextual awareness about external conditions affecting user schedules. The practical application of smart alarm systems specifically for commuting contexts remains limited despite technological capabilities. Dabholkar et al. (2020) acknowledged in their existing system survey that alarm applications are common on almost all stores available for getting applications, both for Android and iOS, in free and paid versions, and apps designed for alarms with additional functionality like tracking user location during their journey are also available already. However, the researchers critically observed that these applications remind the user to wake up before they reach their journey destination, but this feature cannot be used to ensure that the user will reach there on time and not get delayed in traffic, identifying a significant functional gap in existing solutions. The researchers emphasized that their EarlyBuddy app is specifically designed to serve this purpose, calculating the overall delay that the user might have to face by analyzing traffic data for the set timeframe also taking into account the user's routine like coffee, breakfast, bath, etc., demonstrating integration of multiple delay factors beyond simple travel time.

Understanding human sleep architecture proves essential for designing alarm systems that wake users effectively while minimizing grogginess and disorientation. Sampath et al. (2021) provided comprehensive overview of sleep stages, explaining that there are two stages, namely REM sleep (Rapid Eye Movement) and NREM sleep (Non-Rapid Eye Movement), which together constitute the sleep cycle, with NREM stages sub-categorized as Wake (Awake), REM where we dream, NREM1 (falling asleep), NREM2 (light sleep), NREM3 (deep sleep), and NREM4 (deepest sleep). The researchers documented critical findings from sleep research, noting that when a person is coming out of a sleep cycle, they are in light sleep, and light sleep is the best stage to wake someone up in as their body is the most awake in this stage, meaning they will wake up easier and be less groggy. This physiological understanding provides scientific foundation for timing alarm triggers to coincide with natural sleep cycle transitions rather than arbitrary time points.

The integration of sleep analysis with alarm timing requires advanced algorithms that distinguish meaningful sleep stage transitions from insignificant movements. Sampath et al. (2021) emphasized the importance of algorithm design, noting that they needed to create an algorithm to analyze the most recent body movements of the user during their wake timeframe, while also making sure that the alarm did not wake the user if the movements were not "big" movements, differentiating just a small head movement compared to a full-body movement. The researchers conducted practical testing to establish appropriate thresholds, documenting that they decided to do some testing in different positions and orientations to come up with a threshold value, with anything over this regarded as movement and recorded, and anything under regarded as background noise and not recorded. However, Sampath et al. (2021) acknowledged implementation constraints, noting that one constraint of using the accelerometer is that the phone needs to charge overnight and lie on the bed beside the user, and if the user cannot do this, the application will not be able to analyze the user's body motion, identifying a significant usability limitation for commuter applications where phones may be in bags or pockets. The practical

effectiveness of sleep analysis for alarm optimization has been empirically validated through testing with actual users. Sampath et al. (2021) referenced prior research, stating that actual testing results showed that the developed application detected correctly more than 70% of mild sleep stages of all tested persons. While this accuracy rate demonstrates practical viability, it also reveals that nearly 30% of sleep stage identifications may be incorrect, potentially resulting in alarms triggered during deep sleep stages or missed opportunities to wake users during optimal light sleep phases. This limitation suggests that sleep analysis, while valuable, should function as supplementary rather than sole determinant of alarm timing, particularly in public transportation contexts where missing a stop carries significant consequences regardless of sleep stage.

Recognizing that simple auditory alarms prove insufficient for some users, particularly those in deep sleep or with high arousal thresholds, modern alarm applications incorporate active engagement mechanisms to ensure wakefulness. Dabholkar et al. (2020) explained that for users who struggle to get out of bed in the morning, EarlyBuddy has challenges that the user has to complete, such as solving a math puzzle, in order to turn off the alarm. The researchers described multiple engagement modalities, noting that to disable the alarm, users might have to solve a calculation, enter the CAPTCHA text, or even shake the phone vigorously, with the main idea being actively waking up the mind and body before the user hits the snooze. This multi-modal approach addresses the common problem of users reflexively dismissing alarms while remaining in a drowsy state, a particularly dangerous scenario for commuters who may miss their stops. The technical capabilities of modern mobile devices enable diverse alarm modalities beyond simple auditory alerts. Dabholkar et al. (2020) documented that their application includes other modes too, and the app includes customizable features where users can change sounds and vibrations to make sure the alarm is loud enough to wake them from a deep sleep. This customization capability proves particularly important for public transportation contexts where ambient noise levels in vehicles may mask standard alarm sounds, requiring louder volumes or stronger vibration patterns to effectively alert sleeping passengers. The combination of auditory and haptic feedback increases the likelihood of successfully waking users regardless of environmental conditions or individual sensory preferences. Research into optimal alarm configurations reveals that effectiveness depends significantly on individual differences and contextual factors. Dabholkar et al. (2020) acknowledged in their objectives that the system aims to recognize heavy sleepers and help make their mind alert in morning by including various activities to prevent snoozing, snoring or grogginess. However, the researchers did not provide quantitative data on the success rates of different cognitive task types or vibration intensities in actually waking users from various sleep depths. This represents a significant gap in the literature, as effective destination alarm systems for exhausted commuters must reliably wake users regardless of how deeply they have fallen asleep during transit, a challenge potentially more difficult than morning wake-up scenarios where users expect the alarm and may be in lighter sleep stages.

The technical implementation of geofencing systems must address multiple operational considerations including alarm persistence and user notification patterns. Ayob et al. (2018) documented alarm behavior in their system, noting that the alarm continuously rings even when the device had left the geo-fence of the location, with the alarm keeping ringing until 12 hours and only stopped once the dismiss button was hit. This design ensures that passengers who fail to wake immediately upon entering the geofence continue receiving alerts, potentially preventing missed stops for very deep sleepers. However, the researchers also noted that during testing, when the device entered the geo-fence, the alarm was triggered and notification of device entering the geo-fence, for example "Exiting Tesco" when exiting geo-fence, was popped out and appears on the device's screen, demonstrating complementary visual notifications alongside auditory alerts. The persistence of alarm signals until explicit user acknowledgment represents a critical safety feature, ensuring that transient wake-ups insufficient for full consciousness do not result in missed destinations.

Recent advances in artificial intelligence and machine learning have enabled alarm systems that adapt timing based on multiple contextual factors rather than fixed schedules or simple location triggers. Feuz and Deselaers (2019) proposed triggering alarms at dynamic and flexible times based on external factors, describing the application of artificial intelligence techniques for setting alarms on a user's device with user's permission, where such alarms can be set to go off at a time that can vary dynamically instead of a prespecified fixed time. The researchers explained that the time at which the alarm goes off is determined based on various relevant external factors, with AI approaches such as relevant heuristics and machine learning used to process observations and determine the time at which the alarm should be triggered. This paradigm shift from static to dynamic alarm timing enables systems to respond intelligently to unpredictable conditions that affect when users should be alerted. The architecture of dynamic alarm systems integrates multiple information sources to inform timing decisions. Feuz and Deselaers (2019) described that if the user permits, an AI module is included as part of a virtual assistant application or as part of a standalone alarm/timer/clock application that is usable to set an alarm on a user device such as a smartphone or tablet. The researchers explained that the input to the AI module can include information on various external factors, such as the weather, television programs, content of messages between users (as permitted by participants in the message conversation), with such information obtained from device sensors and/or applications that execute on the device, or obtained via the Internet. Feuz and Deselaers (2019) emphasized that such information is then provided as input to the AI module that uses heuristics and/or machine learning to infer various external factors that are likely relevant to the user's alarm, demonstrating advanced integration of diverse data streams to optimize alarm timing.

The application of dynamic alarm concepts to commuting scenarios demonstrates potential for significant improvements in punctuality and stress reduction. Feuz and Deselaers (2019) provided specific examples, noting that alarms can be set such that the times at which alarms are triggered are dynamically updated based on monitoring ongoing external factors, such as traffic, public transport status, and similar conditions. The researchers illustrated practical application, explaining that if unusual traffic and/or public transportation delays are likely to cause a user's commute to be longer than usual, the user's wake-up alarm can be triggered earlier to ensure that the user reaches work on time. While Feuz and Deselaers (2019) focused primarily on morning wake-up scenarios rather than destination alerts during travel, the underlying technological framework demonstrates how alarm systems can adapt to changing conditions, a capability directly applicable to public transportation contexts where traffic conditions, vehicle speeds, and route deviations affect optimal alert timing.

The user interface and interaction design for alarm systems intended for drowsy or sleeping users presents unique challenges. Sampath et al. (2021) described design considerations, explaining that they have used dark/black backgrounds to reduce eye strain since the application would be majorly used while setting an alarm at night. However, neither reviewed study provided empirical data on how effectively different alarm modalities (sound volume, vibration intensity, screen brightness) wake users in noisy public transportation environments or how different cognitive task difficulties affect successful alarm dismissal by drowsy passengers. Ayob et al. (2018) noted only that notification messages appear on screen and alarms continue until dismissed, without evaluating whether these mechanisms prove sufficient for reliably waking exhausted commuters in real-world conditions. This absence of systematic evaluation under realistic public transportation conditions represents a critical gap in current research.

Research shows that while the technology for destination alarms exists, most current apps are not built for the specific struggles of Metro Manila commuters. Most studies focus on waking people up at home or tracking official buses with fixed schedules. They do not account for passengers in deep sleep due to extreme exhaustion or the unique nature of Informal transport like jeepneys, which don't have built-in GPS or set stops. To be effective here, an app must work using only the user's phone and be loud and strong enough to wake someone in a noisy, crowded vehicle, something current research hasn't fully tested. Furthermore, existing apps often miss critical safety and technical features needed for local travel. Most do not include emergency tools like fake calls or SOS alerts, which are vital for commuters especially women traveling late at night. They also fail to adjust alarm timing based on whether a person is on a slow jeepney or a fast provincial bus. Most importantly, current apps drain phone batteries too quickly for the long

2-4 hour trips common in the city. This project fills these gaps by creating a system that saves battery, detects vehicle types, and includes safety features to protect and wake up tired commuters reliably.

Emergency Response Systems, Personal Safety Applications and Wearable Technology Integration

The convergence of emergency response systems with wearable technology represents an emerging frontier in personal safety applications. Sinha et al. (2025) documented that their application can be linked to wearable devices or smartwatches to monitor basic health vitals, automatically triggering alerts if abnormal readings are detected. The researchers emphasized that this feature is crucial for cases where the user becomes unconscious or physically unable to reach their phone, scenarios where traditional manual alert systems would fail to provide protection. The system stores real-time biometric data such as heart rate through a HealthMetrics entity in its database schema, enabling continuous physiological monitoring that can detect medical emergencies or physical distress without requiring conscious user intervention.

The performance advantages of biometric triggering systems have been empirically validated through controlled testing. Sinha et al. (2025) reported that biometric-triggered alerts demonstrated the fastest response times at 2.5 seconds, due to continuous monitoring loops that instantly detect irregularities in heart rate or motion. However, the researchers also acknowledged significant challenges related to battery consumption, with tests showing that continuous background operations for biometric monitoring consumed approximately 9-12% of total battery over four hours on devices with 4500mAh capacity. This power consumption creates practical limitations for all-day monitoring scenarios, particularly for commuters whose journeys may extend four hours or longer in Metro Manila's traffic conditions.

The design considerations for women's safety systems in public transport acknowledge the necessity for sophisticated security measures that prevent harassment and guarantee prompt response mechanisms. Saad et al. (2024) emphasized that by making use of technological advancements such as GPS, GSM modules, and wearable devices, these systems strive to offer alert mechanisms, location monitoring, and real-time incident detection. The researchers documented that harassment in public transport is exacerbated by a predominantly male culture, with buses being designated as the mode most susceptible to such incidents, underscoring the urgent need for technology-based safety interventions specifically designed to protect women commuters.

The evolution toward mobile application-based emergency systems has introduced sophisticated triggering mechanisms that accommodate diverse emergency scenarios and user capabilities. Sinha et al. (2025) developed a Women Security Application that incorporates multiple modes of triggering SOS alerts, including shake detection and voice commands, allowing users to initiate emergency responses even when they are unable to manually operate their device. The researchers explained that the core idea behind the application is to ensure that women in distress can seek help effortlessly, with the system operating in stealth mode to avoid drawing attention, offering a layer of protection in sensitive scenarios where overt help-seeking might escalate danger. The technical implementation of multi-modal triggering demonstrates varying performance characteristics across activation methods. Sinha et al. (2025) conducted testing that revealed manual SOS alerts took approximately 3.2 seconds to reach emergency contacts via Firebase Cloud Messaging, while voice-triggered alerts were slightly faster at 2.8 seconds, and biometric-triggered alerts were the fastest at 2.5 seconds. The researchers attributed the superior performance of biometric triggers to their continuous monitoring loop that instantly detects irregularities in heart rate or motion, enabling passive emergency detection without requiring conscious user activation. This capability proves particularly valuable in scenarios where victims become incapacitated or lose consciousness, situations where traditional button-based alerts would fail completely. The integration of voice activation technology into emergency response systems addresses accessibility and discretion concerns simultaneously. Sinha et al. (2025) implemented voice command functionality that processes queries with 88% accuracy, demonstrating the practical viability of speech-based emergency activation in real-world conditions. However, the researchers acknowledged that noise interference remained a significant hurdle, a challenge particularly relevant to public transportation environments characterized by high ambient noise levels from engines, traffic, and passenger conversations. The system's natural language processing capabilities support multilingual recognition,

addressing the linguistic diversity characteristic of urban populations and ensuring that emergency features remain accessible to users regardless of their primary language.

The fundamental distinction between effective emergency response systems and basic alert mechanisms lies in continuous location tracking capabilities that provide authorities with real-time situational awareness throughout emergency incidents. Sinha et al. (2025) emphasized that unlike systems that only send a one-time location ping, their application continues to track the user's location during the entire incident, updating contacts or authorities with movement data. The researchers explained that this continuous tracking becomes especially useful in dynamic situations where the user is being moved or forced to change locations, scenarios common in abduction or assault cases where victims are transported away from initial incident locations. The technical challenges of maintaining accurate GPS tracking under diverse environmental conditions significantly impact emergency response effectiveness. Sinha et al. (2025) conducted GPS accuracy testing that revealed an average location deviation of 3.4 meters in open environments, while in obstructed environments such as inside buildings, the error rose to approximately 7.2 meters. These accuracy variations have direct implications for emergency responder dispatch, as location errors of several meters can prove critical in dense urban environments or multi-story buildings where precise location information determines response effectiveness.

Recognition that emergency situations often occur in areas with poor or absent network connectivity has driven development of offline-capable emergency response features. Sinha et al. (2025) implemented offline-first functionality using Room Database to store recent logs and contacts locally, explaining that when the network is unavailable, the app queues alerts and automatically dispatches them when connection is restored. The researchers tested system performance under constrained network conditions such as 2G connectivity, finding that SOS alert delay rose marginally to approximately 4.5 seconds but the system maintained consistent delivery without loss, demonstrating resilience under adverse network conditions. The practical implications of network dependency for emergency response effectiveness cannot be overstated. Sinha et al. (2025) documented that their system's hybrid approach using both Firebase Firestore for cloud operations and Room Database for offline resilience ensures smooth data handling even when internet connectivity is weak or unstable, improving the reliability of emergency alert transmission. This architectural decision proves particularly critical for Metro Manila contexts where cellular network congestion during peak hours or infrastructure limitations in certain areas create unpredictable connectivity patterns that could compromise emergency communications at critical moments.

The development of emergency response systems for public transportation users reflects growing awareness of gender-specific safety threats that disproportionately affect women commuters. Saad et al. (2024) documented that women in Bangladesh encounter substantial safety obstacles when utilizing public transportation, with research showing that women in Dhaka who utilize public transportation for educational or occupational purposes are susceptible to gender-based violence, harassment, criminal activities, and road accidents, all of which contribute to elevated levels of anxiety and fear. The researchers emphasized that the significance of media analysis regarding gender-based violence in public transport tends to prioritize legal considerations over more extensive issues of gender inequality, perpetuating a cycle of blame that impedes the pursuit of solutions and accountability. The prevalence and severity of sexual harassment in public transportation systems creates urgent need for technological interventions that provide immediate protective responses. Saad et al. (2024) cited research indicating that sexual harassment is highly prevalent in Dhaka's public transport, disproportionately affecting women and highlighting an urgent need for legal reforms and victim support systems. The researchers positioned their Transit Guardian system as a proactive emergency protection system specifically designed to address these documented threats, recognizing that traditional security measures and legal frameworks have proven insufficient to protect women commuters from harassment and violence.

Empirical validation of emergency response system performance provides critical evidence regarding their potential to provide meaningful protection during actual crisis situations. Sinha et al. (2025) conducted comprehensive testing involving 100 end-to-end test cases including edge conditions such as multiple alerts, sensor failure, and abrupt shutdown, achieving an overall system reliability score of 95.6%. The researchers documented specific performance metrics across different alert mechanisms, with manual SOS alerts averaging 3.2 seconds, voice-triggered alerts averaging 2.8 seconds, and biometric-triggered alerts averaging 2.5 seconds to reach emergency contacts via Firebase Cloud Messaging. The Transit Guardian system's field testing revealed significant performance variability based on environmental conditions and geographical contexts. Saad et al. (2024) documented that under clear skies in urban areas, the fastest response time was 1.5 seconds, while river areas where ships operate experienced the

slowest response times. The researchers reported that weather conditions proved critical, with clear skies enabling 1.5-second response times, rainy conditions increasing this to nearly 16 seconds, and thunderstorms preventing any response whatsoever. These findings demonstrate that environmental factors can dramatically compromise emergency response capabilities precisely when weather-related challenges may increase danger to commuters.

Understanding user perceptions and adoption patterns proves essential for designing emergency response systems that commuters will actually utilize during crisis situations. Sinha et al. (2025) conducted a user satisfaction survey involving 50 participants aged 18-45 who evaluated ease of use, speed of response, reliability, battery efficiency, and UI design. The researchers reported strong overall satisfaction with the application's functionality, simplicity, and responsiveness, validating the system's usability for its intended user population. However, concerns about battery drainage due to constant location updates and biometric monitoring emerged as areas requiring improvement, highlighting the tension between comprehensive monitoring capabilities and practical all-day usability. Privacy concerns represent a significant barrier to adoption of emergency response applications that require continuous location tracking and access to personal data. Sinha et al. (2025) acknowledged that the absence of standardized protocols for AI deployment and data privacy raises concerns about the misuse of commuter data, with research indicating that 25% of users express privacy concerns about systems that lack clear guidelines on data storage. The researchers emphasized the importance of implementing Firebase Authentication for secure user registration and ensuring that data transfer is encrypted, with sensitive user data stored in protected form using token-based access systems, yet acknowledged that enhancing privacy protocols with end-to-end encryption and implementing region-specific data compliance measures will be key in fostering user trust over the long term.

The evolution of emergency response systems toward predictive capabilities represents the next frontier in personal safety technology. Sinha et al. (2025) proposed several advancements planned to elevate their application's scope and impact, including machine learning algorithms that may be incorporated to detect suspicious activity patterns, offering preventive alerts based on real-time environmental and behavioral data. The researchers explained that direct integration with local law enforcement and emergency response systems would enable faster action during crises, while expanding compatibility with wearable devices would allow biometric monitoring to be even more seamless.

Studies show that technology can help protect vulnerable people, especially women using public transportation, through two main approaches: systems built directly into vehicles and mobile applications that run on smartphones, both of which use GPS, internet-connected devices, and alert mechanisms to request help during danger. However, these systems face major challenges such as poor GPS accuracy due to weather and environment, unreliable internet connectivity during emergencies, and high battery consumption from continuous tracking, which is especially problematic for long daily commutes in Metro Manila. Although test results show fast response times and high reliability, there is still little real-world evidence proving that these technologies actually prevent crimes or save lives, even though research clearly shows that women face higher risks of harassment and violence in public transport. Future improvements like artificial intelligence for detecting threats, wearable devices for discreet activation, and direct links to police systems could improve effectiveness, but they also raise serious privacy concerns related to constant location and biometric tracking, requiring strong data protection and clear policies. A major gap in existing solutions is that most are not designed for informal transportation systems common in the Philippines, such as jeepneys, buses, and UV Express vehicles, which lack fixed routes, built-in technology, and reliable internet access, and this is why the proposed Anti-Oversleep Destination Alarm and Emergency Safety System focuses on offline functionality, battery efficiency, loud and multi-modal alerts, and combined destination and emergency safety features suited for long, crowded, and unpredictable commuting conditions in Metro Manila.

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