Sri Lanka Intelligent Bus Navigation and Passenger Information System

2024 - 237

Project Proposal Report

M.Thanusan

B.Sc. (Hons) Degree in Information Technology specialized Information Technology

Faculty of Computing

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1.0 Declaration

Declaration

I declare that this is my own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously publish or written by another person expect where the acknowledgement is made in the text.

Name	Student ID	Signature
Thanusan M.	IT21175848	

The above candidate is carrying out research for the undergraduate Dissertation under my supervision.

Signature of the Supervisor

(Shanika Wijayasekara)

Date

23/08/2024

:

2.0 Abstract

The paper presents the innovative design and development implemented within a real-time tracking system customized for use in public transportation, with a special consideration of improving the travel experience for foreign tourists. The system further incorporates advanced features, such as real-time monitoring of seat availability, personalized travel recommendations, and automated notifications that inform passengers about local points of interest. It is architecturally designed to accommodate dynamic inputs and utilizes state-of-the-art machine learning algorithms for efficient real-time data processing. Additionally, the system includes an OCR vehicle identification feature that allows checking of number plates to ensure that the right vehicles are operating on their respective routes. Moreover, it offers real-time translation of route information displayed on buses, making public transportation more accessible to international tourists and non-native speakers.

Table of Contents

List of Figures

List of tables

3.0.INTRODUCTION

Background and Literature

Advanced tracking systems integrated into public transportation have received much interest in recent years for enhancing the travel experience of tourists and daily passengers. This section provides an overview of the background and fundamental technologies behind the proposed real-time tracking system components.

3.1 Real-Time Seat Availability Monitoring

In most modern public transportation systems, real-time monitoring of seat availability is an added feature that indicates the status of all available seats within the vehicle. This system uses a machine learning model trained on labeled datasets to process seat occupancy data without relying on Internet of Things sensors. The model is trained on various data inputs, such as images obtained from onboard cameras or other relevant sensors, allowing it to accurately determine and classify seats as either occupied or unoccupied.

This method leverages computer vision and machine learning algorithms to capture data continuously for real-time updates on seat availability. The collected data is transmitted via cellular or Wi-Fi networks to centralized servers, where it is processed and made available to end-users through mobile applications or onboard displays. This approach enhances travel efficiency and comfort by allowing passengers to know where to go even before boarding.

3.2 Automatic Notifications About Nearby Points of Interest

The automatic notifications feature of nearby points of interest is developed in the quest of making the journey more interesting, especially to tourists who may not be familiar with the area. This utilizes GPS technology and location-based services to ascertain the location of the user and establish how close they are to different points of interest or sources of attraction. Some level of geofencing may be applied to trigger the notifications once a user enters or exits the area. It will depend on the effective integration of GPS data with a rich database of Points of Interest, from historical places to restaurants, cultural events, and other attractions. This could also be made more effective by integrating it with user preferences and historical behavior to offer more relevant and personalized suggestions.

3.3 Image Capture and Text Detection

The integration of image capture and text detection technology within public transportation systems provides essential security and accessibility enhancements. This subsystem operates in two main scenarios: vehicle identification and route information translation.

Vehicle Identification: The system uses image capture technology to scan and identify vehicle license plates. When a bus is photographed, optical character recognition (OCR) algorithms extract the text from the license plate. This number is then compared with a database of authorized vehicle license numbers. If the system detects a mismatch, an alert is triggered to notify authorities of a potentially unauthorized vehicle. This is vital for preventing unauthorized or rogue vehicles from operating on the route, thereby enhancing passenger safety and system integrity

Route Information Translation: The system also assists non-native speakers, especially tourists, by capturing images of route name boards displayed on buses. OCR technology reads the text on these boards, and with the help of a translation API such as Google Translate, the text is translated into English, Tamil, and Sinhala. This real-time translation is displayed to passengers via mobile apps or onboard screens, ensuring that travelers can easily understand and navigate bus routes regardless of language barriers. This feature significantly improves the accessibility of public transportation, making it more user-friendly for international tourists and local populations who speak different languages.

This version now includes a detailed and humanized explanation of the image capture and text detection component, focusing on its role in enhancing security and accessibility within the public transportation system.

4.0 Research Gap

Despite the increasing interest in enhancing public transportation systems, current solutions often fall short in addressing the specific needs of foreign tourists and daily commuters. Traditional systems lack advanced features such as real-time seat availability monitoring and automated notifications about nearby points of interest, which are crucial for improving the overall travel experience. Existing methods predominantly rely on Internet of Things (IoT) sensors for seat occupancy detection, which can be costly and difficult to maintain. In contrast, the proposed system leverages cutting-edge machine learning algorithms and computer vision techniques to monitor seat availability in real-time using onboard cameras, eliminating the dependency on IoT sensors. Additionally, while location-based services have been employed in various contexts, the integration of AI-driven personalized recommendations for nearby points of interest based on user preferences is an innovative approach that has not been extensively explored in public transportation. Furthermore, the incorporation of image capture and text detection technology for vehicle identification and route information translation addresses the persistent challenge of language barriers, particularly for non-native speakers. This research aims to fill these gaps by introducing a comprehensive, AI-enhanced tracking system that not only improves the accuracy and reliability of seat availability data but also enhances security and accessibility for both local commuters and foreign tourists.

Features	Smart Vehicle Identification and Alert System (Proposed System)	R (1)	R(2)	R(3)	R(4)
Image Capture	✓	✓	✗	✓	✗
Text detection and extraction And tranlation	✓	✗	✗	✗	✗
Select purpose to traveling	✓	✗	✗	✗	✗
Tracking System for Moving Buses for Foreign Tourists	✓	✗	✗	✗	✗
Check seat availability	✓	✗	✗	✗	✗

Figure 1.1: Research gap table

5.0 Research Problem

The challenge of enhancing the travel experience for foreign tourists on buses presents a significant research problem: how could real-time geolocation and AI-driven recommendations be employed to develop the best overall journey experience? Existing public transportation systems are rarely advanced or intelligent enough to provide services tailored to foreign tourists. Specifically, there is a need for a system that can share real-time data on seat availability, allowing passengers to make informed decisions before boarding. Additionally, automatic checking and verification of vehicle license plates against a database of authorized buses would greatly enhance security and operational efficiency.

Language barriers also pose a persistent challenge, especially for foreign tourists who need to interpret route information and navigate through unfamiliar environments. By integrating a robust text translation feature that automatically translates bus route names and related information into languages such as English, Tamil, and Sinhala, the problem of accessibility can be resolved. Addressing these issues through real-time geolocation and AI suggestions will not only enhance the quality of information provided to tourists but also ensure a more streamlined, secure, and user-friendly travel experience.

6.0 Main objectives

This study is focused on building a smart bus system to enhance the travel experience by providing real-time seat availability, automated license plate verification, and multilingual text translation. The system will be powered by AI-driven personalized recommendations and contextual notifications about nearby points of interest. By breaking language barriers and improving information accuracy, the system aims to offer a seamless and user-friendly experience for both locals and tourists

6.1 Sub objectives

1. Realization of a real-time monitoring system for seat availability: so that passengers are informed in real time about the occupancy rate before boarding the bus.

2. Automate license plate verification: to increase safety by allowing only authorized vehicles on their established routes.

3. Integrate multilingual text translation: within, which automatically translates the names of bus routes and associated information into English, Tamil, and Sinhala.

4. Personalize recommendation algorithms that are AI-enabled: to give custom suggestions regarding travel and other contextually important notifications about nearby points of interest.

5. Develop a seamless and user-friendly interface: to enhance the overall travel experience, accessible by both locals and tourists.

7.0 Methodology

The research employs a holistic approach to enhance the travel experience using a smart bus system. The real-time seat availability monitoring component will be developed using machine learning models trained on labeled datasets. Onboard cameras will capture seat occupancy data, and a trained model will process this information in real-time, providing highly accurate updates to passengers via mobile applications. The automatic notifications feature will incorporate GPS technology and Location-Based Services (LBS) to track the bus's location and trigger notifications as the vehicle enters or exits predefined geofenced areas near points of interest. This system will be further refined by incorporating user preferences and historical behavior data to deliver personalized recommendations.

The image capture and text detection subsystem will enhance security and accessibility by employing Optical Character Recognition (OCR) to detect vehicle license plates and interpret bus route information. License plates captured by onboard cameras will be compared to a centralized database, triggering alerts for unauthorized vehicles. Simultaneously, route name boards will be translated into multiple languages using OCR and a translation API, with real-time results displayed to passengers. The integrated system will undergo comprehensive testing to ensure accuracy, reliability, and user-friendliness, ultimately creating an improved, seamless travel experience for both local and international travelers.

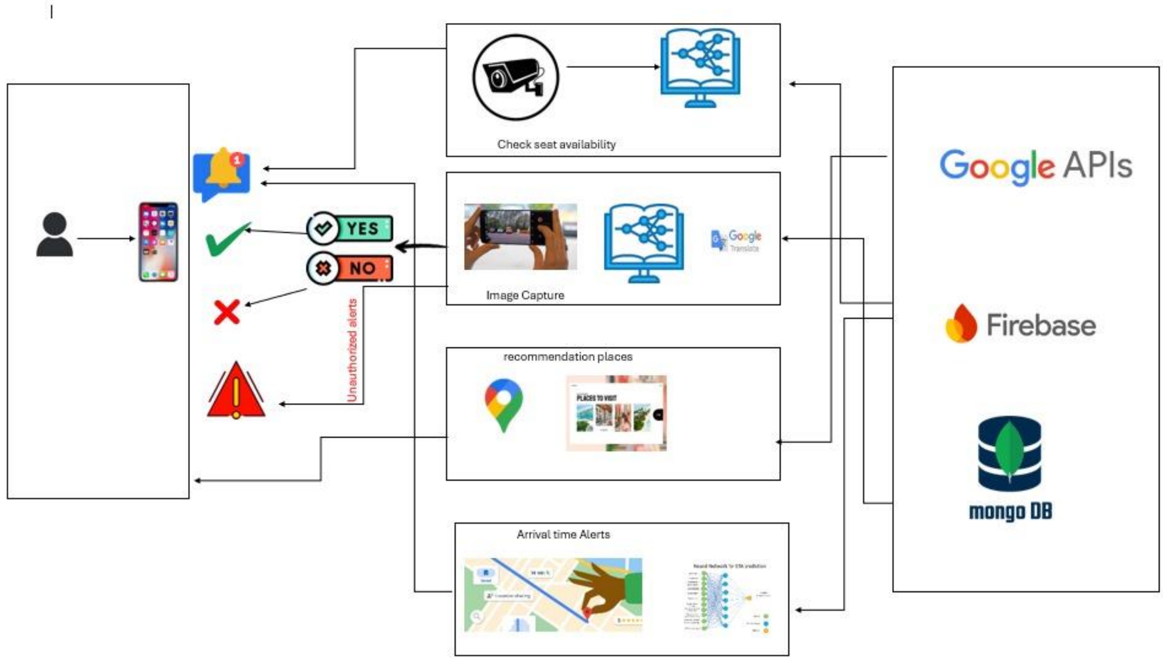

Figure 1.2: Methodology Daigram

8.0 Software solutions

The development process for the proposed real-time tracking system will utilize the Agile methodology, specifically the Scrum framework, to ensure flexibility and responsiveness to changing requirements. Scrum will organize the work into iterative sprints, allowing for continuous progress and refinement based on stakeholder feedback. Daily standups, sprint reviews, and retrospectives will help maintain alignment and promptly address any issues. This approach will enable the delivery of a high-quality, user-centric solution that meets the dynamic needs of the public transportation system.

9.0 Feasibility Study

9.1 Economic Feasibility

The economic feasibility of the proposed smart bus system is primarily centered on the potential return on investment (ROI) through improved passenger satisfaction and increased ridership, especially among tourists. The system's ability to enhance the travel experience for both locals and international visitors is likely to attract more users to public transportation, leading to higher ticket sales and, consequently, increased revenue. Additionally, the integration of personalized recommendations and automated notifications about nearby points of interest can open up opportunities for partnerships with local businesses, such as restaurants, tourist attractions, and retail stores, who could pay for advertising within the system. This could provide an additional revenue stream that would help offset the initial costs of implementing the system. The system's real-time seat availability feature could optimize bus capacity usage, potentially reducing the need for extra services during peak times, thereby lowering operational costs. Furthermore, the cost savings from preventing unauthorized vehicles from operating on routes could also be significant, as it would reduce potential liabilities and the costs associated with security breaches.

9.2 Scheduled Feasibility

The project's scheduled feasibility will depend on the successful and timely integration of the various technologies involved, such as real-time data processing, machine learning models, GPS technology, and OCR for text detection. Given the complexity of the system, the project timeline should allow for extensive testing phases, particularly for the real-time seat availability monitoring and the multilingual text translation features, to ensure they function seamlessly under real-world conditions. The project would likely need to be rolled out in phases, beginning with pilot programs in selected regions or cities where tourist traffic is high. These pilots would allow for the identification of any potential technical challenges and user adoption issues, which can then be addressed before a full-scale implementation. A realistic timeline would include initial development and integration phases, followed by pilot testing, refinement based on feedback, and final deployment. Each phase should be carefully scheduled with buffers for unexpected delays, ensuring that the system can be launched without compromising quality or user experience.

9.3 Technical

Feasibility From a technical standpoint, the proposed system is feasible but will require the integration of multiple advanced technologies. The real-time seat availability feature, which relies on machine learning models trained on image data, must be capable of operating efficiently with minimal latency to ensure real-time accuracy. This requires robust computing infrastructure both on the buses (for initial data capture and processing) and in centralized servers (for deeper processing and data distribution). The automatic license plate verification system, which also relies on OCR technology, must be integrated with a secure and regularly updated database of authorized vehicles. This system must be resilient to variations in image quality and external conditions such as lighting, which might affect the accuracy of OCR. The multilingual text translation system will require the integration of reliable translation APIs capable of handling multiple languages, particularly for languages that use different scripts (e.g., Tamil and Sinhala). The system must also be robust enough to handle various fonts and text orientations on bus route boards. Finally, the integration of AI-driven personalized recommendations and notifications involves advanced machine learning algorithms that must be able to process large amounts of data in real-time, taking into account user preferences, historical behavior, and current location. This feature will need to be supported by a large and dynamic database of points of interest and user profiles. Overall, while the technical challenges are significant, they are surmountable with the current state of technology. However, the system's success will depend on careful planning, thorough testing, and iterative development to ensure that all components work together seamlessly in real-world conditions.

10.0 System Analysis

10.1 Software Solution Approach

1. Data Collection:

- Focus on gathering a dataset specifically composed of images that depict occupied and unoccupied seats within public transportation vehicles.

- The dataset should capture various angles, lighting conditions, and seating arrangements to ensure robustness.

- Use onboard cameras and other relevant sensors to collect these images, ensuring diversity in the dataset for effective model training.

2. Pre-processing:

- Clean and pre-process the collected seat images to remove noise and inconsistencies.

- Apply data augmentation techniques like rotation, scaling, and flipping to increase the variability within the dataset.

- Normalize images and perform necessary cropping to standardize the input data, ensuring that the model receives high-quality and consistent images.

3. Model Training:

- Train a machine learning model, such as a Convolutional Neural Network (CNN), specifically for the task of identifying and classifying seat occupancy.

- The model should be trained using the pre-processed dataset of occupied and unoccupied seat images to achieve accurate seat availability predictions.

4. Model Evaluation:

- Evaluate the trained model on a test set comprising different images of occupied and unoccupied seats to measure accuracy and reliability.

- Use metrics like precision, recall, F1 score, and accuracy to assess model performance, identifying areas for improvement.

5. Integration with the Portal:

- Integrate the seat availability monitoring system with the relevant public transportation portal or application.

- Utilize APIs and web services to ensure seamless communication and real-time data transfer between the model and the user interface.

6. Face Detection:

- Implement a face detection algorithm to assist in scenarios where facial recognition might be necessary, but this point primarily focuses on seat detection.

- Ensure that the face detection mechanism does not interfere with seat availability monitoring.

7. Age Estimation:

- Although not the main focus here, if integrated, ensure that any age estimation model does not compromise the primary goal of seat availability detection.

8. Authentication:

- Implement authentication mechanisms if necessary, based on the context of the application, ensuring users are granted access to seat availability data appropriately.

9. User Experience:

- Design a user-friendly interface that clearly displays real-time seat availability data, categorized as occupied or unoccupied.

- Ensure the interface is intuitive and accessible, providing clear visual cues for available seating options.

11.0 Tools & Technologies

- OpenCV
- TensorFlow
- Keras
- pyTorch
- Google maps API
- Google geofencing API
- Firebase cloud mssaging
- Scikit-learn
- OCR algorithms
- Tesseract
- Google translation API

12.0 Requirements

12.1 Functional requirements :

outline the specific actions and operations that the system must be capable of performing. These include detailed features such as user authentication, data processing, reporting, and other core functionalities that the system needs to fulfill to meet its objectives. Essentially, functional requirements describe what the system must do to achieve the desired outcomes.

12.2 Non-functional requirements:

focus on the quality attributes of the system, defining how it performs its functions rather than what functions it performs. These requirements encompass aspects like performance, scalability, security, and usability. Non-functional requirements ensure that the system operates efficiently, is secure from threats, and provides a smooth user experience, all while adhering to specific performance benchmarks.

12.3 System requirements:

refer to the technical specifications and infrastructure necessary to support the system's operation. This includes the hardware, software, network configurations, and other technical resources that need to be in place. System requirements ensure that the system runs smoothly within its intended environment and is compatible with other systems or platforms it may interact with.

12.4 User requirements:

capture the needs and expectations of the end-users who will interact with the system. These requirements are typically high-level and focus on what the users want to achieve, such as ease of navigation, quick access to key features, and personalized user experiences. User requirements ensure that the system is designed with the end-user in mind, making it accessible, intuitive, and aligned with user goals.

13.0 Testing

Testing is a crucial phase in the development of any system, ensuring that the final product performs as expected and meets all specified requirements. For the proposed system, which includes real-time seat availability monitoring, automatic notifications about nearby points of interest, and image capture with text detection, a comprehensive testing strategy will be implemented.

13.1 Seat Availability Monitoring System Testing:

Initial Functionality Test: The system will first be tested with a small dataset of images, focusing on the basic functionality of seat detection. This will involve checking whether the system correctly classifies seats as occupied or unoccupied.

Comprehensive Testing: A larger and more diverse dataset will be used to test the system under various conditions, such as different lighting, angles, and seating arrangements. The system's accuracy in classifying seats will be evaluated, ensuring it can reliably operate in real-world scenarios.

Performance Metrics: The system’s performance will be measured using metrics such as precision, recall, F1-score, and accuracy. These metrics will provide insights into the system's ability to accurately detect seat occupancy.

13.2 Automatic Notifications for Nearby Points of Interest Testing:

Functionality Test:Initial testing will involve verifying that the system correctly identifies nearby points of interest based on GPS location and triggers notifications as expected.

Geofencing Accuracy: The accuracy of geofencing will be tested by evaluating whether notifications are correctly triggered when a user enters or exits a predefined area.

Personalization Test: The system’s ability to provide personalized recommendations based on user preferences and historical behavior will be assessed, ensuring that the suggestions are relevant and timely.

13.3 Image Capture and Text Detection Testing:

Vehicle Identification: Testing will begin with the functionality of the vehicle identification component. The system will be evaluated on its ability to correctly capture images of license plates, apply OCR to extract text, and match this text against a database of authorized vehicles.

Route Information Translation: The effectiveness of the OCR and translation components will be tested by capturing images of route name boards in various conditions. The accuracy of text extraction and the correctness of translations into English, Tamil, and Sinhala will be measured.

13.4 User Interface and Experience Testing:

User Testing: A group of potential users, including both local and foreign tourists, will be involved in user testing to assess the overall user experience. Feedback will be gathered on the system's usability, intuitiveness, and effectiveness in providing real-time information.

Usability Metrics: The system's user interface will be evaluated based on user satisfaction, ease of use, and accessibility. Necessary adjustments will be made based on user feedback to improve the overall experience.

13.5 Overall System Performance Testing:

End-to-End Testing: The entire system will be tested in a real-world environment to ensure that all components—seat availability monitoring, automatic notifications, and image capture with text detection—work together seamlessly.

Stress Testing: The system will be subjected to high load conditions to test its robustness and performance under stress, ensuring that it remains reliable and responsive even in crowded or high-traffic scenarios.

14.0 Gant-Chart

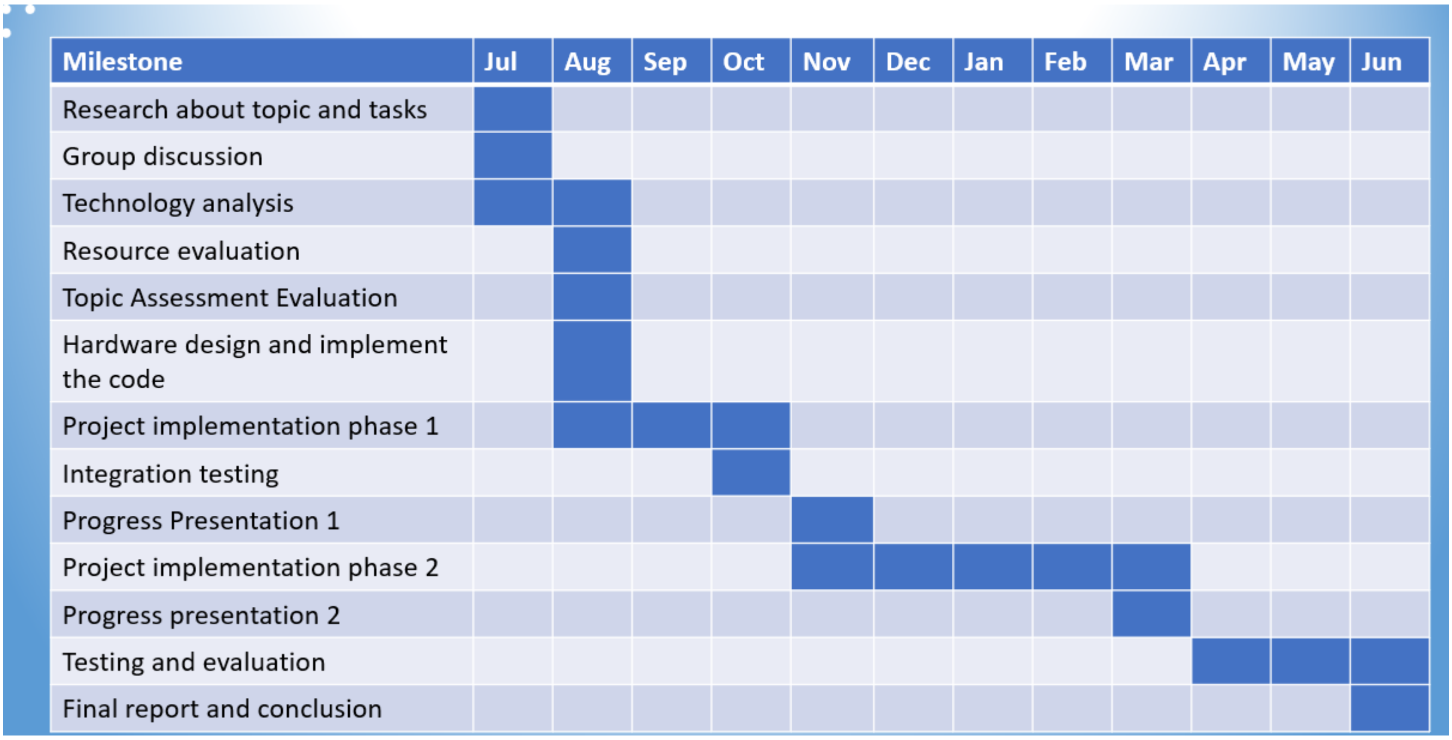

Figure 1.3: Gant-Chart

15.0 Work Breakdown Structure

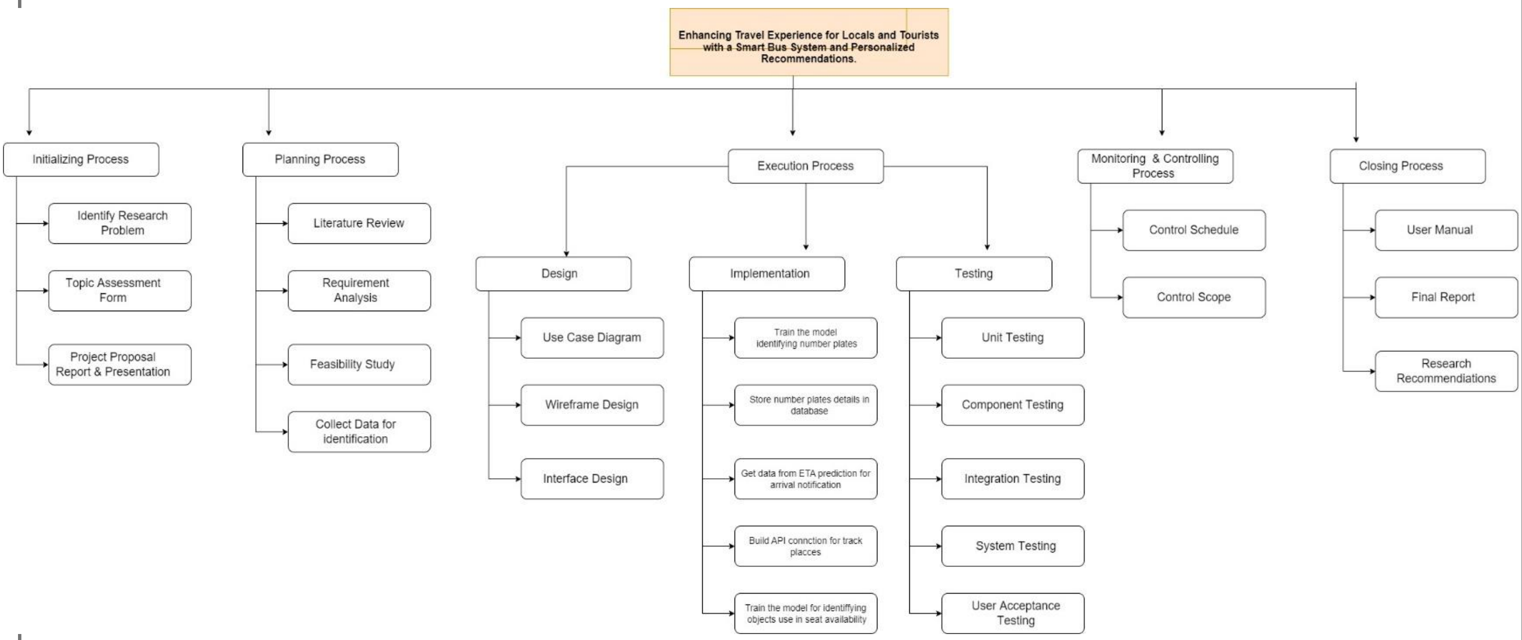

Figure 1.4: Work breakdown structure

16.0 BUDGET AND BUGET JUSTIFICATION

Requirements	Cost (Rs)
Camera	**3000.00**
GPS Module	4950.00
Travelling cost	1000.00
Data cost	900.00

17.0 Commercilization

1. Partner with public transportation agencies: to integrate the system into existing infrastructure.

2. License the technology: to transportation companies or smart city initiatives.

3. Offer a subscription-based mobile app: for tourists and commuters, providing real-time updates and personalized recommendations.

4. Monetize through targeted advertising: by collaborating with local businesses for promotions within the app.

5.Explore government grants or funding : for innovations in smart transportation and tourism enhancement.

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