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Artificial Intelligence-related Mobile Application for Smart Intercity Bus Tracking and Booking System in Sri Lanka

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Abstract **-** *Overall, the bus service is the mode of public transportation that is most frequently used. In particular, in the present situation of Sri Lanka, in a crowded town or city, a bus is the most accessible, most practical, and least expensive mode of transportation. Passengers who are unfamiliar with the timetables and details of the buses may be wasting time, missing the bus, or boarding an overcrowded bus. The best information on existing systems, employed methods, and techniques, as well as their advantages and disadvantages, is provided by requirement gatherings and data analysis approaches such as surveys, interviews, and literature surveys. The proposed application for intercity bus tracking and booking was identified as the best solution for a problem domain using the aforementioned requirement-gathering methodologies. The best approach to make it available to the users so they can locate the bus and make reservations is through a mobile application. The Quick Response (QR) code technology is used for passenger counting and paying online. The passenger who has logged into the system can pay for a ticket by scanning the QR code. The bus is tracked using the Global Positioning System (GPS) technology. A passenger can track a preferred bus and reserve seats by choosing destinations. Artificial intelligence (AI)-based camera technology is used to count passengers. The technology can assess whether a passenger has seated or not a seat by estimating the distance between the camera and the seat. The development of this app uses tools like Google Firebase, React, and React-native.*

Keywords **– Quick Response (QR) code, GPS, Artificial Intelligence (AI), Mobile application**

I. INTRODUCTION

A. Research Problem

Overall, the bus service is the mode of public transportation that is most frequently used. In particular, in the present situation of Sri Lanka, in a crowded town or city, a bus is the most accessible, most practical, and least expensive mode of transportation. Traffic jams, high parking costs, fuel shortages, and a lack of parking spaces at the destination are just a few reasons individuals choose to take the bus over driving their vehicle. However, the information system for the bus transportation service is still very inadequate. Bus users don't yet know the exact arrival time of the buses. The bus transportation system does not have a proper tracking system compared to flight and train systems. Therefore, the bus tracking system is proposed. The system's main objectives are to see the location of the preferred bus using the mobile phone with the help of Google Maps, make seat reservations, and check the availability of seats. In the traditional bus system, it is difficult to identify the exact details of a passenger. The proposed approach introduces the driver monitoring system. The driver can monitor how many passengers are inside the bus in real-time, and it is possible to analyze the paid passengers and their details using both the QR-based system and the AI-based camera system. As an additional facility, the user could check the seats available. the conductor's role is unnecessary. As for the passenger, the system allows the user to pay for the bus ticket using the online payment methods available. Because the passenger does not need to carry money portably, it is a solution to pandemic situations, as the passenger does not interact much with others. Compared to the traditional bus system, it is a very effective method, less time-consuming, and is a proper payment method.

B. Research Aim

This research aims to develop a bus-tracking and seat reservation mobile application (Artificial Intelligence-related Mobile Application for Smart Intercity Bus Tracking and Booking System in Sri Lanka). It is called "Easy-Trace." It would automate the traditional bus system, which unnecessary the role of the conductor, introduce the driver monitoring system, and enable passengers to make payments quickly, make seat reservations via the mobile application, and track the bus and know about seat availability.

C. Research Objective

The main focuses of this research are to make the passengers work more efficiently and to track the locations of the buses currently running on the route, make seat reservations, and check the availability of seats. Make the payments through the online payment method (no need to carry money), Verify the payment details and passenger details using the driver monitoring system, and build a system that does not consume more time from the user or passenger. It is a solution to pandemic situations, as the passenger does not interact much with others. Additionally, the system should assist users in tracking any ongoing trips to determine whether a bus might be available or to determine how far a bus is from a specific

bus stop. Solicit user feedback (e.g., regarding the drivers' behaviour and buses' comfortability). Orientation of drivers and passengers to the new system.

D. Research Questions

This paper's objective is to answer the following research questions from previous research papers and new methods. The main research questions that will be discussed in this research are:

Q1: What methods do not consume more time from the passenger?
Q2: What are the most efficient ways of making seat bookings?
Q3: What techniques can the driver use to analyze passengers' details, such as passenger count, payments, and how many passengers get off and get on the bus halt?
Q4: How do be over the role of the conductor with the use of this system?

II. LITERATURE REVIEW

The projects that were available on the internet helped gather information on the system of bus tracking and seat booking. Furthermore, some researchers have used some technologies and methodologies to develop bus tracking and seat reservation systems. Nonetheless, none of the researchers has developed fully functional bus tracking and seat booking systems.

A. Bus Tracking

(Jisha *et al.*, 2018) The paper, An Android Application for School Bus Tracking and Student Monitoring System, written by Jisha R. C., has proposed to give parents a view of the live location of the school bus in their mobile application with the help of Google maps. The technology used in this system was GPS, GPRS, GSM and Google Maps API. According to the system, it uses Firebase to store the data of the location of the bus, such as latitude and longitude and then retrieves the data to the parents' mobile application to track the bus. The proposed system also uses the technologies GPS, GPRS, and GSM to track the location of the bus and also uses Firebase for real-time data retrieval. and availability of the seats is checked using QR based system.

(Anu *et al.*, 2016) The research done by Maria Anu V and Sarikha D has discussed the tracking of the bus through an RFID-based system for bus location tracking and display. This system has RFID tags combined with a reader. The reader can read information from tags. transmitting radio signals between tags and the reader can identify whether the bus is passed the bus stop. Here, the proposed system involves replacing the hardware parts using GPS-related technology.

(Amjad *et al.*, 2015) According to the paper, Kan Amjad created a bus ticketing application for Android devices that uses NFC to provide an automated ticketing system that deducts the passenger's fare based on the distance travelled. The technology used in this system was near-field communication technology cards. Passengers should carry their NFC cards with them. The passenger should also present the conductor with the NFC card once they get on the bus. The conductor will read the NFC tag using an Android mobile device with NFC capabilities. and subtract the amount based on the passenger's travel distance. But the proposed system uses a QR-based system when the passenger gets into the bus and directs the passenger directly into the proposed method, which stops the role of the conductor.

B. Seat Booking

(Akter *et al.*, 2019) Sharmin Akter, Thouhedul Islam, Rashidah F. Olanrewaju, and Ajayi Adeniyi Binyamin propose a cloud-based bus tracking system based on Internet-of-Things technology in their research. This system has the following core functionalities: nearest stoppage, real-time tracking, approximate time, available ticket, payment, and booking a seat. According to this system, passengers can buy a ticket instead of buying a ticket physically, and if the bus has been missed, the system will allow changing the ticket for any other suitable time. The system allows the passenger to pay the ticket price using the online payment method, and passengers will also be allowed to choose a specific seat for the trip.

(Nayak *et al.*, 2022) The research done by Kundan Nayak, Keval Kushwaha, Kapil Kumar, and J. Sathish Kumar has proposed an android-based bus reservation system. This proposed system, which uses Android Studio, allows passengers to check bus availability and reserve seats. However, they haven't considered iOS users and have only regarded Android users. So the proposed system enables the use of the mobile application for both Android and iOS users.

(Kumar Sharma *et al.*, 2021) Furthermore, Avinash Kumar, Rahul Pandey, Sourav Tarafdar, and Shyamlata Dubey have proposed a bus tracking and booking system. In this paper, the authors have discussed a solution for the bus transformation system in India. This proposed mobile application for both Android and iOS users is enabled by buying the digital ticket and online seat booking, and passengers can see seats from the bus, choose one, and book a seat. This system uses Amason services as a database and makes use of the Google Maps APIs, and React-native packages are used in the development of the mobile application. The proposed system uses a QR-based system for booking seats.

(Kazi *et al.*, 2018) The research done by Sanam Kazi, Murtuza Bagasrawala, Farheen Shaikh, and Anamta Sayyed has proposed a smart e-ticketing system for public transport buses. This system is based on a mobile application and the device, which is fixed at a bus stop. It has provided a facility for payment that will be cashless, thereby promoting digitalization. The passenger who does not have a mobile phone can take a ticket using the normal SMS facility, which is facilitated by the conductor. The proposed system uses a QR-based system for digital tickets.

C. Passenger Counting

(Abedi *et al.,* 2022)Hajar Abedi, Shenghang Luo, Vishvam Mazumdar, Michael M. Y. R. Riad, and George Shaker propose an AI-powered in-vehicle passenger monitoring system using low-cost mm-wave radar. They use a frequency-modulated continuous wave radar to detect occupied seats in a vehicle, as well as the number of occupants and their positions. They combine machine learning algorithms with a low-cost radar system instead of a high-resolution radar, which raises costs and device size. They carry out extensive signal processing with several variables that must be calibrated for each case. They used heat maps acquired from the Capon beamformer to train a machine classifier to predict the number of occupants and their locations in a vehicle. The system uses three classifiers and two separate classification algorithms. There are multiclass and binary classifications used as the two classification modules. The proposed system uses an AI-based camera system to determine the passenger count and verify it using QR-based passenger counting.

(Nakashima, Arai and Fujikawa, 2019) They provide a technique for counting passengers that makes use of a driving recorder and sensors that are already installed in buses. With the location of the bus from the GPS module in the buses, the location of the bus stop utilized for operation management, and the estimated number of passengers from the image processing technique combining YOLOv3 and Deep SORT, they make a model using Random Forest Regression. Four cameras are used for the driver recorder. one for monitoring the driver, and another one for monitoring the passengers. The system first estimates the number of passengers near the front door by analysing the image from the mounted inner camera. The system then uses Random Forest Regression to validate the image processing method's output.

(Abdelwahed *et al.,* 2021)Youssef Abdelwahed and others are researchers who are mainly focused on passenger counting. This paper concluded the research based on the topic, "Privacy-centric AI-based real-time storage-less edge computing approaches for passenger counting and action classification on public transport vehicles." This research has proposed a stream of 2D video frames for human action classification, falling detection, and passenger counting. According to the system, this could help transport operators. The passenger's safety on board could be ensured using the falling detection system. This method analyzes a person's body geometry and the rate of change in their joints over a series of frames to determine whether they are standing or sitting. Additionally, the geometric model continues to operate as expected for each person until it notices a specific change in the position of the human joints.

III. METHODOLOGY

The proposed system uses React Native, which is a JavaScript framework for creating the mobile application, which is called "Easy Trace." This application can be used on both iOS and Android mobile devices. Google Firebase is used for the backend, and an AI-based camera system is used for passenger monitoring so the driver can verify the passenger details. Google Maps APIs are used to track the bus's location, and a QR-based system is used for passenger counting and online payment.

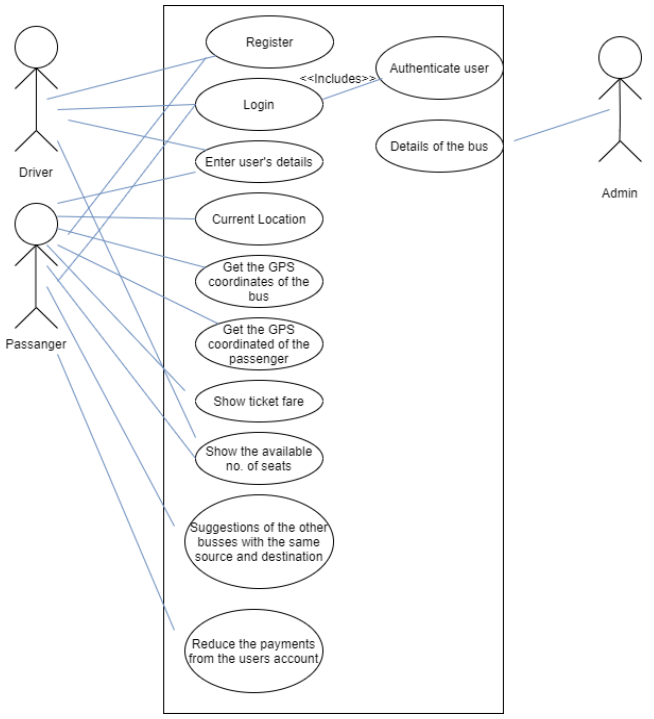

Figure 1. Use Case

The proposed system is a bus tracking and booking system. The user must first create a new account with Google authentication. The user can change account facilities if he/she wishes. The system contains some of the features listed above. So, when the performance of the system is considered, the driver should start the system by using Google Maps. Users can track the bus and view its details using Google Maps. The account holder has to log in by giving his username and password. By logging into the system, the user has to enter his exact location, destination, and preferred date and time. According to the information he provided to the system, the system shows the user the available buses that are going on the route. The user could see the location of the bus whenever the user uses GPS technology. Furthermore, as an additional feature, the user could see the seats available on the preferred bus. After checking the system or by the arrival time and the location of the bus the user could go to the entrance of the preferred route. After the arrival of the bus, the user has to scan the QR code on the door of the bus, and then the system shows that a person got into the bus at a particular location and shows the remaining seats on the bus. When considering the payment after boarding the bus, the passenger has to enter the destination and make the payment from his location and destination. and also, the user can select the bus and be shown the availability of the seats and then the user can book the

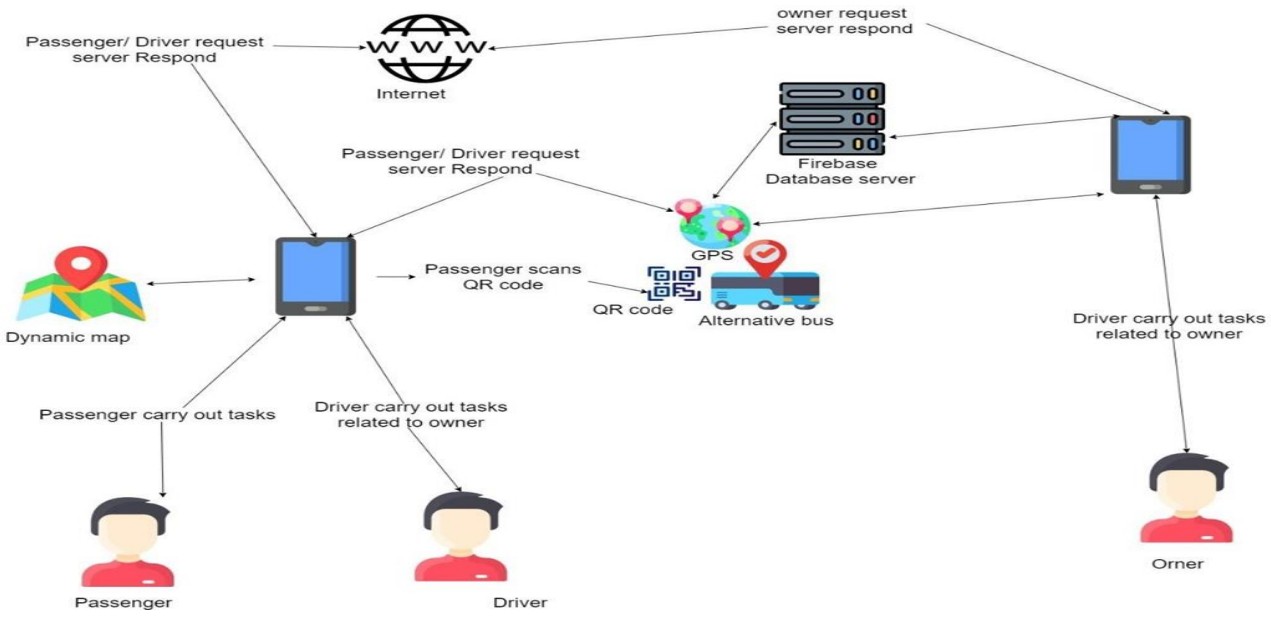

Fig. 2. Logical Design of the system

seats. The use case diagram is shown in Fig.1, and the logical design is shown in Fig.2.

The bus tracking method involves two types of users: the driver and the passenger. The driver starts the bus system by selecting the destination. According to the bus system, the bus location, including latitude and longitude, as well as the bus's direction via GPS, are stored in real-time in the Firebase database. The passenger can then load that data into Google Maps to see the buses that correspond to the direction he or she has selected for buses. If the passenger wants to reserve the seats or check the available seats, he or she should choose the start location and the end location. According to those inputs, the system identifies the direction of the destination automatically and then shows only the buses that relate to the direction of the destination. Passengers can then reserve or check available seats by selecting the nearest bus on the map. When a passenger gets on the bus and scans the QR code, he or she should choose the destination, and the start location is automatically selected according to the bus stop. A particular method is used for getting notifications of the buses that are passing the bus stop. According to this method, the latitude and longitude values are obtained for a circle that includes a 50-meter radius from the bus stop. so, the diameter is 100 meters. The bus details are stored in the database, and when the bus passes this circle, it is happened by equaling the bus location with the location in the circle. The circle is used because the bus should travel through it. Passengers can get notifications using this method.

B. Seat Reservation and Payment Method

A QR-based system is used for seat reservations and payment methods. The front and back doors each have a QR code that is created based on the bus ID. This is used for identifying whether passengers are on the bus. The passenger has two options: sit in the seat or stand on the bus. There are QR codes associated with each seat that can be scanned if the traveler chooses to take a seat. Those QR codes are used to get a count of the passengers. The passenger should then scan the QR code and select a destination. Depending on the destination, an online payment method is available, and after paying, passengers can get an e-ticket. If the passenger chooses the option of standing on the bus, the passenger can directly choose the destination, make the online payment, and get an E-ticket. Passengers can be calculated using those two methods, and the database is updated with the passenger count.

A. GPS Bus Tracking Method

If the passenger wishes to reserve the seats, the system displays the available buses based on the passenger's starting and ending points, and the passenger can reserve the seats of his choice.

C. AI-based Camera System

In this method, four cameras are used. two of them are used for covering the area of the back and front doors. Another two cameras are installed inside the bus. The count of passengers that get on or off can be estimated using the cameras installed near the front and back doors. and information about the passengers sitting on the seat can be identified using the other two cameras by measuring the distance between the camera and the seat, the system can determine whether or not a passenger is sitting on it. By using this method, QR-based passenger count and AI-based passenger count can be verified.

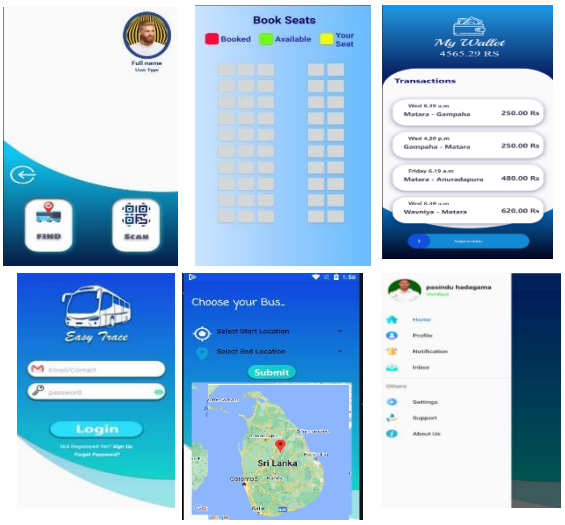

Figure 3. Sample UI designs

Figure 3 images are some designed User Interfaces for the mobile application including some main functionalities.

IV. ANALYSIS

I used a questionnaire and distributed it among people as quantitative data for the research. The questionnaire was used to confirm the specific challenges in manual bus systems based on people's perspectives. The questionnaire contains five main questions. It was distributed among 150 to 200 people and was able to get 86 responses within the week. This research paper's goal is to find solutions for the difficulties with the manual bus system.

at the beginning of the questions, people's satisfaction with the current bus systems should be considered.

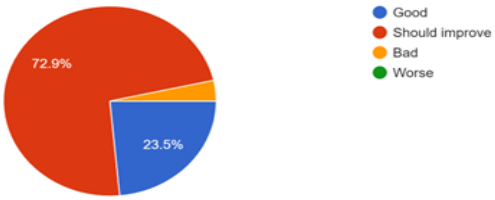

Figure 4. Questionnaire data about satisfaction with the current system

Most people are not satisfied with the current bus system, which means that around 72.9% of people in Sri Lanka think that the current system is not compatible with today's requirements. Also, almost 23.5% of people respond to whether the current system is "good."

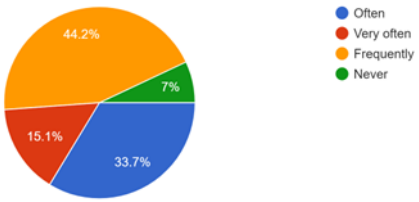

Figure 5. Questionnaire data about the travelling of the bus

A lot of people prefer to use the bus for transportation. The question was whether people often travel by bus. As a result, 44.2% of people say they frequently travel by bus. Around 33.7% of people often travel by bus.

Many passengers prefer to travel without a conductor on buses.

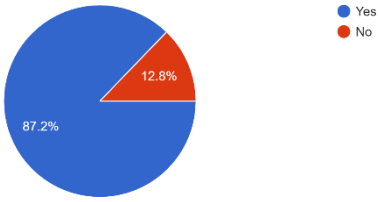

Figure 6. Questionnaire data about the bus without a conductor

The question was whether people preferred a bus without a conductor. As a result, 87.2% of people say they prefer to travel by bus without a conductor. Around 12.8% of people prefer to travel by bus with a conductor.

People prefer to automate payment and booking functions in a bus system. To identify this idea, a question was asked of people, and Figure 7 shows the result of the question.

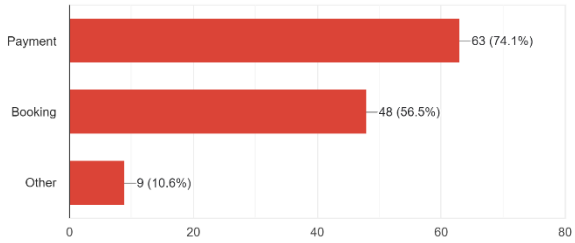

Figure 7. Questionnaire data about automating payment and booking.

According to its result, 74.1% of people think automating payment is more convenient, and 56.5% think automating booking is more convenient.

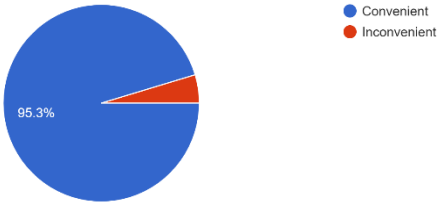

Figure 8. Questionnaire data about automated bus

Figure 8 shows whether people prefer to automate a bus system. According to its result, 95.3% of people think the automated bus system is convenient, and others think it is not.

V. RESULT AND DISCUSSION

Tracking bus and seat reservations is very difficult when compared with the train and air reservation systems. The bus tracking and seat reservation system is a very helpful method,

and a mobile application is a solution to present it. Therefore, before the implementation process, the data collection method is essential to identify the current requirements and find the best solution for the problem domain. Surveys, literature reviews, and interviews are the data collection protocols for the project pre-iteration of project planning. Choosing needed requirements and functionalities and designing the graphical user interfaces, which include identified functions, are the main roles of the system design part.

VI. CONCLUSION AND FUTURE WORK

This research investigated the future scope of the existing systems and used them to understand what features, adaptations, and abilities should be applied to the development. It may be helpful to give the best solution to the problem domain. As a solution, an android-based mobile application is a better way to solve the complexity and not the reliability of existing systems; it uses QR-based and AI-based camera technology to develop the bus system. Using this mobile application after user authentication, users can track the bus quickly, and it is user-friendly. The driver starts the system. it uses GPS technology. The passenger can track the bus and reserve seats using this technology. The passenger can pay online without a conductor by using QR-based technology. This technology is used to count passengers. The driver can verify the passenger count by using an AI-based camera system. This system is used only for travelling intercity in Sri Lanka because it is not suitable for short-distance travel. Another main goal of this project is to develop a more accurate AI camera system by using machine learning and image processing techniques.

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VIII. ACKNOWLEDGEMENT

I would like to express my deepest gratitude to all persons behind me helping my study to become a reality with their kind support and help. Foremost, I want to offer my appreciation to my dearest parents for giving me the strength, and encouragement that assisted me in the accomplishment of this research paper. I convey my special gratitude and thanks to Mrs DU Vidanagama for imparting her knowledge and expertise in this study, without her immense support I cannot succeed in my study. Further, my appreciation goes to all other senior and junior lecturers for their valuable comments and continuous support. Finally, I appreciate my colleagues for the support they offered me in the completion of this research.

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