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Streamlining Student Shuttle Using Campus Commute Monitor

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Abstract - *In response to the growing need for enhanced convenience and safety in student transportation within the academic sphere, this article presents Campus Commute Monitor, an innovative application leveraging advanced IoT technology. This solution represents a significant advancement in university transportation systems, offering real-time tracking functionalities for college buses and a smart bus pass system is integrated, facilitating seamless payment processing and user authentication through ID tapping mechanisms. The proposed solution not only enhances the efficiency of bus operations but also offers users a convenient and streamlined experience. By integrating meticulous development practices, Campus Commute Monitor aims to redefine the university commuting experience, providing users with the ability to monitor live bus locations and check seat availability remotely. The application's seamless payment processing and user authentication mechanisms ensure not only enhanced operational efficiency but also a convenient and streamlined experience for commuters and their families. The utilization of cutting-edge hardware components such as the ESP32, Neo 6M GPS module, and PN532 underscores the technical sophistication driving this solution. Campus Commute Monitor develops as an innovative answer to the growing need for ease and safety in student commuting. Universities that use this sophisticated application may proactively meet the demands of their student population by providing real-time tracking capabilities and modernized access options. Furthermore, including full boarding and disembarking logs assures accountability while also providing vital data for optimizing transportation services*

***Key Words*: ESP32, NEO 6M GPS module, PN532, Commute, Smart bus pass system.**

1.INTRODUCTION

In recent years, the realm of student transportation within university campuses has encountered notable challenges and evolving needs. As universities expand and diversify, the importance of providing efficient, dependable, and safe transportation options for students becomes increasingly evident. Many universities maintain extensive bus networks to facilitate student commuting, both for those residing on and off campus. However, conventional transportation systems often grapple with issues like unpredictable bus schedules, overcrowded buses, and complex payment procedures. These issues not only inconvenience students but also raise safety concerns, particularly during peak commuting times. Furthermore, the expectations of students and their families regarding transportation have undergone significant shifts. With the widespread adoption of smartphones and digital technologies, there is a rising demand for real-time information and streamlined services. Students now anticipate access to accurate bus schedules, live bus tracking capabilities, and user-friendly payment methods, all contributing to a smoother commuting experience. In response to these evolving demands, universities are increasingly exploring innovative solutions to modernize their transportation systems and elevate the overall student experience.

1.1 Problem Description

The challenges facing traditional university transportation systems are complex and multifaceted, encompassing various aspects of scheduling, safety, and administrative processes. One primary issue is the lack of real-time information available to students regarding bus schedules and locations. Without timely updates, students often experience frustration and inconvenience, unsure of when buses will arrive at their stops. This uncertainty can lead to delays in reaching classes and other commitments, impacting academic performance and overall student experience. Moreover, overcrowded buses present significant safety risks and discomfort for commuters, especially during peak hours when demand for transportation is highest. Beyond the inconvenience of standing-room-only conditions, overcrowding can compromise passenger safety and exacerbate issues related to social distancing, particularly in light of public health concerns. Additionally, many universities still rely on traditional paper-based bus pass systems, which can be cumbersome and prone to errors. Students may encounter difficulties in obtaining or renewing their bus passes, leading to disruptions in their commuting routines and hindering access to essential campus resources. The manual verification of bus passes by drivers or transit staff further contributes to inefficiencies, potentially causing delays and frustration for students attempting to board buses. Addressing these challenges requires innovative solutions that leverage technology to enhance the efficiency, reliability, and accessibility of university transportation systems. Implementing real-time tracking mechanisms, mobile applications, and digital payment

systems can provide students with up-to-date information and streamline the process of accessing transportation services. Moreover, transitioning to electronic bus pass systems can simplify administrative procedures, reduce errors, and improve overall system efficiency, ultimately enhancing the commuting experience for students and promoting a safer, more convenient campus environment.

1.2 Purposes of research

The purpose of this research is to address the shortcomings of traditional university transportation systems and introduce an innovative solution Campus Commute Monitor. This application leverages advanced IoT technology to provide real-time tracking functionalities for college buses and integrates a smart bus pass system to streamline payment processing and user authentication. By offering students and university administrators access to accurate bus schedules, live tracking of buses, and seamless payment options, Campus Commute Monitor aims to redefine the university commuting experience. Through meticulous development practices and the integration of cutting-edge hardware components, Campus Commute Monitor seeks to alleviate the challenges faced by students and enhance the overall efficiency and safety of university transportation systems. This research aims to shed light on the practical implications and benefits of technological integration in optimizing transportation services within university campuses, ultimately contributing to a more seamless and enjoyable commuting experience for students and their families.

2. LITERATURE REVIEW

Review based on reference research paper

Pengfei Zhou et al. [1] This study presents a bus arrival time prediction system utilizing participatory sensing from passengers' mobile phones to address the inconvenience caused by long waiting times at bus stops. By leveraging environmental context data, such as cell tower signals and movement statuses, the system accurately estimates bus routes and arrival times. Independent of bus operators, it supports universal bus service systems without specific company support. Unlike GPS-based approaches, it utilizes widely available and energy-efficient resources like cell tower signals and movement statuses. Through extensive testing over 7 weeks with various Android phones, the system demonstrates superior prediction accuracy compared to conventional methods, offering a more accessible and energy-friendly solution for public transportation users.

Thosar et al. [2] The contemporary world witnesses rapid technological advancements that significantly impact modern business practices and improve people's daily lives. Among these technologies, Android stands out as a rapidly growing platform widely embraced by users. The project focuses on leveraging the latest GPS technology to enhance college bus management, offering real-time bus location updates to students. The College Bus Management System, encompassing both web and Android applications, caters to students and college administration, streamlining bus facility management and providing flexibility in the process. This system generates comprehensive reports regarding bus management aspects such as fees, dues, routes, and bus stops. Developed to address the shortcomings of manual bus management systems, the Web & Android-based College Bus Management System offers efficient tracking and monitoring capabilities, utilizing keywords like college bus tracking, GPS Location tracker Android, Web Application, and Real-Time Tracking to characterize its functionalities and features.

S. Sankaranarayanan et al. [3] This study discusses the importance of efficient and well-scheduled public transportation systems, highlighting existing research on RFID and GPS technologies for passenger tracking and bus monitoring. It proposes an intelligent mobile bus tracking system for the Jamaican Urban Transport Corporation, enabling commuters to track their chosen bus and receive notifications about expected arrival times. The system also facilitates topping up RFID-enabled smart tickets for travel, enhancing commuter convenience. Implemented using Android, the system allows for real-time bus tracking and proactive credit reminders on commuters' mobile devices, reducing reliance on static timetables or LCD displays at bus stops. This solution addresses the challenges faced by commuters and offers a more dynamic and user-friendly approach to bus tracking and ticket management. The implementation was validated using an Android emulator, demonstrating the feasibility and effectiveness of the proposed system.

Subramanian et al. [4] This study highlights the importance of safety in transportation, especially for school children, in the context of embedded systems and RFID technology. It emphasizes the need for a Smarter Bus pass using RFID for student tracking, enhancing security measures. The system involves providing RFID tags to students, which are detected upon entering or leaving the bus, with information sent to a central server for tracking. Parents or guardians can trace their children using a unique tracking ID. The paper demonstrates the applicability of RFID technology in tracking and monitoring children in school buses, citing its cost-effectiveness and ease of maintenance. Experimental tests conducted in a college laboratory validate the effectiveness and stability of RFID tags for successful tracking and monitoring of children during bus transportation.

Elijah et al. [5] This study explores the challenges faced by developing countries in their public transportation systems, including infrequent services and limited real-time information. It proposes an alternative approach to

GPS-based fleet tracking using IoT-enabled Bluetooth Low Energy (BLE) systems for public bus services. BLE proximity beacons deployed on buses track their journeys, with Raspberry Pi (RPi) Zero devices placed at terminals and stops to detect BLE signals emitted by the beacons. Experimental results demonstrate the reliability of BLE signals, with detection up to 20 meters even within metal enclosures. A field trial in Malaysian cities validates the effectiveness of the IoT-based BLE proximity sensing system, showing a reduction in journey time on public holidays. The paper underscores the significance of addressing public transportation challenges and provides insights into the deployment and mitigation strategies, affirming the feasibility and reliability of IoT-based proximity sensing in tracking public bus services.

Zina Balani et al. [6] This study addresses the issue of unnecessary waiting times in public transportation by developing a web-based system for bus route tracking. Integrated with Google Maps, the system provides real-time updates on bus locations and schedules, enhancing user convenience. Users can access detailed information about bus drivers, including contact details and shift timings, from any location with internet access. Additionally, QR code scanning at bus stops facilitates quick access to relevant information. By improving visibility into bus routes and schedules, particularly for students, the system enables better journey planning and minimizes waiting times. Its user-friendly interface and comprehensive features enhance the overall public transportation experience, offering a valuable solution for commuters.

Garigipati et al.[7] This introduces of EASY BUS addresses the challenges posed by unpredictable road conditions and daily issues in bus transportation for students. This interactive application offers real-time information on bus locations, resolving concerns about arrival times and missed buses. Users benefit from GPS tracking of bus locations every thirty seconds, displayed on a map via the app. Additionally, the app features a virtual bus pass system for users to create or renew passes conveniently, with charges processed through online payment methods. By simplifying the use of college buses and providing timely updates, EASY BUS enhances accessibility and convenience for students, optimizing their transportation experience.

R et al. [8] The paper proposes the development of a GPS-tracking application aimed at enhancing bus tracking accuracy and efficiency. It offers detailed information on bus location, routes, and estimated arrival times, featuring a real-time monitoring system for continuous tracking. The system also alerts the driver of missed passengers and notifies the nearest hospital in case of emergencies. Engine faults are monitored through an OBD connected to the vehicle, with data stored in a Firebase database and displayed on an Android app via the Google Maps API. By enabling students to track bus coordinates, the system improves punctuality and time management for both students and staff. Designed to be user-friendly, it can be implemented in diverse public transportation systems, catering to rural and urban environments alike.

Sree et al. [9] The paper introduces a smart College Bus Tracking System app designed for Android smartphones, offering students real-time access to bus locations to avoid lateness or early arrivals. The application aims to provide precise bus locations and details, leveraging the widespread availability and affordability of Android smartphones among college students. Operating in real-time, the system updates the bus location continuously through latitude and longitude coordinates, ensuring accurate and timely information for students. This innovation addresses the need for efficient and reliable transportation services in educational institutions, enhancing the overall student experience and reducing uncertainties associated with bus schedules.

M et al. [10] The study shows the evolving technological landscape continues to drive advancements in various sectors, notably in enhancing business methods and improving people's lives. Android technology stands out as a rapidly developing platform, witnessing significant user acceptance. Utilizing the latest GPS technology and IoT integration, college students can efficiently track bus movements and schedules in real-time, addressing challenges posed by road conditions and unforeseen delays. The primary objective is to provide precise bus locations via Google Maps, coupled with alarm signals for drivers when users are near bus stops. The system operates in real-time, updating bus locations through latitude and longitude coordinates received via Google Map API. Management and College Bus Operation teams benefit from real-time fleet tracking and operational performance monitoring. Additionally, ridership statistics help in optimizing routes and service frequency, while features like the CTGo app and SMS notifications enhance user experience by providing timely updates on bus arrivals. Key terms include Google Map API, CTGo app, IoT, and College bus tracking system.

Ashokan et al. [11] This study shows the increasing prevalence of advanced technologies is reshaping modern business practices, with Android emerging as a leading technology choice for consumers. This proposal introduces a GPS-based tracking system leveraging IoT to enable college students to monitor bus movements and schedules in real-time, addressing challenges posed by road conditions and daily disruptions. The system aims to provide precise bus locations on Google Maps and includes features like driver alerts for approaching passengers. With real-time updates on bus locations and estimated arrival times, students can effectively plan their schedules and

manage delays. Furthermore, the system offers the potential for seamless payment of bus fees through various online channels, enhancing convenience for users.

Vijayalakshmi et al. [12] This study aims to streamline college transport fare collection while enhancing safety and efficiency through the integration of GPS contactless smartcard technology and industrial IoT facilities. By automating fare collection and providing real-time information on vehicle location and arrival times, the system addresses the contemporary need for timely information dissemination. Recognizing the increasing reliance on technology, the project proposes a "Vehicle Tracking System Using GPS and GSM" to overcome limitations of previous methods. Beyond fare collection, the system extends its utility to accident detection and alert mechanisms, catering to diverse tracking needs such as taxis, stolen vehicles, and school buses. Notably, the system prioritizes student safety by introducing a low-cost solution for parents to track their child's location via a mobile application, leveraging RFID for student identification and GPS for live bus tracking. This comprehensive approach not only enhances operational efficiency but also addresses concerns regarding child safety and parental reassurance in tracking their children's whereabouts, offering a valuable contribution to transportation and safety systems.

Velayudham et al. [13] This paper explores in light of the COVID-19 epidemic, maintaining the safety and health of kids has become a top priority for both parents and school administrators. To address these challenges, recent technical breakthroughs have resulted in smart vehicle systems. This study presents an individual student monitoring system that uses RFID tags and a notification-based communication system to improve reliability and efficiency. Integration with Google APIs provides exact position tracking of the school bus, which is aided by a GPRS module for real-time monitoring. Furthermore, the Ziff Wi-Fi module is used to send geocoordinates to satellites, ensuring precise tracking. The suggested smart bus includes an automatic door opening system with a two-stage verification process: first, RFID tag matching confirms the student's identification, then temperature sensing ensures the student's health and safety. This approach provides a comprehensive answer to the safety problems around school travel during the epidemic.

Taha et al. [14] this study shows the rise in vehicle thefts for illicit activities such as terrorism and armed robberies necessitates effective vehicle tracking systems for theft detection. This study proposes a comprehensive vehicle tracking system utilizing GPS via GSM communication. The system relies on GPRS for transmitting location data, integrating ARDUINO (UNONO6M) controllers and SIM800L modules for GSM and GPS functionalities. GPS accurately determines the vehicle's global location with precision ranging from 2.5m to 3.5m in latitude and longitude coordinates. Data transmission occurs via GPRS to a remote server using TCP, enabling visualization on web maps embedded within a web-based application. Notably, the proposed system demonstrates superior accuracy compared to previous solutions, offering a robust approach to vehicle theft detection and tracking.

M. kassim et al. [15] This comprehensive in metropolitan areas, effective bus transportation networks are critical to public mobility, with fixed-route buses providing economical and convenient choices for city commuters. However, in Malaysia, the lack of organised bus route applications frequently results in erratic timetables and excessive wait times for customers. This study describes a mobile application that implements a bus tracking system to decrease wait times and solve issues such as route deviations and needless pauses. The programme uses Global Positioning System (GPS) technology for bus location and Radio-Frequency Identification (RFID) for bus identification, and it saves bus data on a cloud server that is available online. The system uses the Internet of Things (IoT) concepts and two ESP8266 Wi-Fi modules to split GPS and sensor operations, using GPS Neo-6m tracking. Bus routes and RFID MFRC522 allow for communication with passengers via the Blynk mobile app. The prototype has been successfully tested over three bus routes, with infrared sensors assisting with passenger counts. This project uses IoT, GPS, and RFID technologies to improve bus tracking and monitoring, allowing drivers and passengers to better manage their time and receive real-time information via internet connectivity.

3. METHODOLOGY

The Campus Commute Monitor system tackles the limitations of traditional university transportation systems through a meticulously designed blend of hardware components and software applications. This section delves into the specific methodologies employed to develop and implement this system.

The Campus Commute Monitor system adheres to a three-tiered architecture, ensuring modularity and efficient information flow:

Hardware Tier: The Foundation for Data Acquisition

ESP32 Microcontroller: The Brains of the Operation: The ESP32 serves as the central processing unit, the heart of the on-board hardware. It is responsible for:

•Gathering data from the GPS module and RFID scanner.

•Processing the collected information.

•Communicating with the software tier via a network connection (Wi-Fi or cellular).

Neo-6M GPS Module: Providing Real-Time Location Awareness: This module seamlessly integrates with the ESP32, capturing crucial real-time location data, including:

•Latitude

•Longitude

•Speed of the bus

PN532 RFID Scanner: Facilitating Secure Student Identification: This scanner empowers students to tap their ID cards for validation and boarding purposes. The ESP32 reads the student ID from the scanned card and transmits it securely to the software tier for further processing.

Software Tier: The Engine for Data Management and User Interaction

Spring Boot Framework: Building a Robust Backend: This framework provides the groundwork for developing the backend application. Spring Boot offers functionalities for:

•Database interaction for persistent data storage and retrieval.

•Web service development for seamless communication between the backend and user interface.

•Security management to safeguard sensitive student information and system operations.

MySQL Database: The Central Repository for System Data: The MySQL database acts as the heart of the system, storing critical information such as:

•Student details (e.g., names, IDs)

•Bus locations (including historical data for tracking purposes)

•Payment records to ensure student eligibility for boarding

•Boarding logs for accountability and ridership pattern analysis

Leaflet Library: Powering the Interactive Map on the User Interface: This JavaScript library plays a vital role in creating the interactive map displayed on the user interface. It allows users to visualize the real-time location of buses on a digital map, enhancing transparency and providing a user-friendly experience.

User Interface (UI): The Gateway for User Interaction

Web-based or Mobile-based Design: The UI can be designed as a web application accessible through a web browser or a mobile application downloadable on smartphones. This flexibility caters to user preferences and ensures wider accessibility.

Functionalities: The UI empowers students to:

•Track bus locations in real-time, allowing them to make informed decisions about their commutes.

•View estimated arrival times at their desired bus stops, facilitating better time management.

•Potentially manage their bus passes (depending on the specific implementation), offering a convenient way to view validity periods and potentially renew passes online (if applicable).

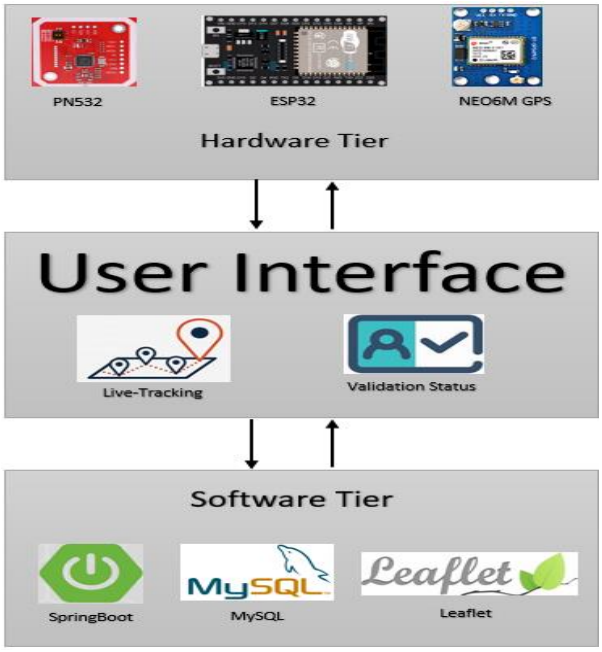

Figure-1: Three-tiered architecture of Campus Commute Monitor

4. CONCLUSION

The Campus Commute Monitor system emerges as a compelling answer to the long-standing challenges faced by conventional university transportation systems. This innovative solution harnesses the power of the Internet of Things (IoT) to provide a multitude of benefits for both students and university administrators.

At the core of the system lies real-time bus tracking. Students can ditch the guesswork and long waits at bus stops by utilizing the system's live tracking functionalities. The user interface, accessible through a web application or mobile app (depending on the chosen implementation), displays the real-time location of each bus on a digital map. This empowers students to make informed decisions about their commutes, arriving at classes and

appointments on time. Additionally, the system generates estimated arrival times, offering valuable insights for better time management.

Beyond convenience, the Campus Commute Monitor system prioritizes safety and security. Student ID validation via RFID technology ensures that only authorized users with valid passes are permitted to board buses. This not only safeguards against fare evasion but also contributes to a more secure commuting environment. The system meticulously validates all collected data, including GPS location and student identification, to ensure accuracy and reliability.

Furthermore, the Campus Commute Monitor system streamlines the bus pass management process. The integration of a smart bus pass system eliminates the need for physical passes, offering a more convenient and environmentally friendly alternative. Students can potentially manage their bus passes directly through the user interface, viewing validity periods and potentially renewing passes online.

In conclusion, the Campus Commute Monitor system signifies a paradigm shift in university transportation solutions. By leveraging cutting-edge technology, this system fosters a more efficient, secure, and user-friendly commuting experience for students, ultimately contributing to a more vibrant and connected campus environment.

5. REFERENCES

[1] Pengfei Zhou, Yuanqing Zheng, and Mo Li. 2012. How long to wait? predicting bus arrival time with mobile phone based participatory sensing. In Proceedings of the 10th international conference on Mobile systems, applications, and services (MobiSys '12). Association for Computing Machinery, New York, NY, USA, 379–392. https://doi.org/10.1145/2307636.2307671.

[2] Thosar, Devidas. (2022). COLLEGE BUS MANAGEMENT SYSTEM. INTERANTIONAL JOURNAL OF SCIENTIFIC RESEARCH IN ENGINEERING AND MANAGEMENT. 06. 10.55041/IJSREM16924.

[3] S. Sankarananrayanan and P. Hamilton, "Mobile enabled bus tracking and ticketing system," 2014 2nd International Conference on Information and Communication Technology (ICoICT), Bandung, Indonesia, 2014, pp. 475-480, doi: 10.1109/ICoICT.2014.6914108.

[4] Subramanian, D. & Rathan, J. & Jeyapreetha, J. & Mounica, Madasu & Alagarsamy, Sumithra. (2015). Student buspass tracking system using RFID technology in cloud computing. 10. 1249-1253.

[5] Elijah, Olakunle & Keoh, Sye & Rahim, Sharul & Seow, Chee Kiat & Cao, Qi & Sarijari, Mohammad & Ibrahim, Noor & Basuki, Achmad. (2023). Transforming urban mobility with internet of things: public bus fleet tracking using proximity-based bluetooth beacons. Frontiers in the Internet of Things. 2. 10.3389/friot.2023.1255995.

[6] Zina Balani & Mohammed Nasseh Mohammed (2023). Web-based Bus Tracking System in the Internet of Things IoT. International Journal of Science and Business, 28(1), 31-40. doi: https://doi.org/10.58970/IJSB.2203.

[7] Garigipati, Nagababu & Reddy, C. & Charitha, Challa & Pujitha, Kalwa & Krithika, Rajoli. (2023). Easy Bus (Virtual Bus Pass and Bus Tracking System): Design and Implementation Using Machine Learning Algorithms. International Journal for Research in Applied Science and Engineering Technology. 11. 3652-3661. 10.22214/ijraset.2023.54177.

[8] R, Athira & Neha, R & Sreehari, C & Zenaani, & Kishor, Krishna & Balamurugan, V. (2023). Android-Based Transport Tracking and Monitoring System. 282-288. 10.21467/proceedings.160.36.

[9] Sree, J. & Mamatha, T. & Sreekanth, B. & Mohammed, Noor. (2021). Integrated College Bus Tracking System. International Journal of Scientific Research in Science and Technology. 732-735. 10.32628/IJSRST2183164.

[10] M, Abinash & S, Mohanram & G, Vinodhan & K, Dr. (2023). College Bus Location Tracking and Stop Notification System using Lora WAN. International Journal of Innovative Research in Engineering. 83-89. 10.59256/ijire.2023040359.

[11] Ashokan, Meenakshi. (2023). Campus Connect - A College Bus Tracking System. International Journal for Research in Applied Science and Engineering Technology. 11. 7435-7444. 10.22214/ijraset.2023.53417.

[12] Vijayalakshmi, Mrs. (2023). College Bus Tracking System. International Journal for Research in Applied Science and Engineering Technology. 11. 119-123. 10.22214/ijraset.2023.53280.

[13] Velayudham, Sumitra & Bharkavi, S & Rakshitha, Akkireddy & Swaminathan, K & Lalitha, R. (2023). The smart CO-VID school bus tracking system. AIP Conference Proceedings. 2523. 020027. 10.1063/5.0110980.

[14] Taha, Mustafa & Hashim, Mohammed & Khalid, Hiyam & Aman, Azana. (2021). An Advanced Vehicle Tracking

System Based on Arduino Electronic Shields and Web Maps Browser.

[15] M. Kassim, A. S. Salleh, S. Shahbudin, M. Yusoff and N. A. Kamaluddin, "IoT Bus Tracking System Localization via GPS-RFID," 2022 IEEE International Conference in Power Engineering Application (ICPEA), Shah Alam, Malaysia, 2022, pp. 1-6, doi: 10.1109/ICPEA53519.2022.9744710.