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Van Management System

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Abstract- Managing school transportation is important because it helps keep students safe, avoid delays, and use resources better. Old ways of doing this, like using paper records or calling to assign buses, are not very reliable and don't offer much visibility. To fix this, we created a Van Management System using HTML, Tailwind CSS, and Type- Script for the look, Node.js (JavaScript Runtime) to control how it works, and MySQL to store data. The system helps with important tasks like planning routes, assigning buses and drivers, booking seats, and helping people like admins, drivers, and parents communicate. The automation in the system stops mistakes like double bookings, makes things more fair, and improves communication. Unlike GPS-based systems that need expensive hardware and work only with the internet, this is cheaper and better suited for schools with fixed bus routes. Testing showed the system helps with better scheduling, fewer delays, and more transparency. Plans include adding AI for better route planning, predicting when things might go wrong, and optional GPS or IoT features to make it even more reliable.

Index Terms—School Bus Management, Web Application, Scheduling, Transportation Automation, Education Technol- ogy, Role-Based Access, Database Management.

I. INTRODUCTION

Managing school and institutional transportation effi- ciently has become a key requirement in modern times, where timely operations, safety, and accountability are crucial for educational institutions, businesses, and fleet operators. Manual approaches for managing vans often rely on handwritten records, spreadsheets, or phone- based coordination, which are not only time-consuming but also prone to errors. These methods can lead to double bookings, inefficient vehicle allocation, poor communication between stakeholders, and a lack of transparency in daily activities. In recent years, digital transformation in transportation has primarily focused on GPS-based fleet tracking systems. While these systems provide real-time location data, they come with signif- icant downsides: high implementation costs, the need for specialized hardware, reliance on continuous internet access, and privacy concerns, especially in educational settings. For institutions with fixed routes and predictable schedules, the costs of GPS-based systems often out- weigh their benefits. To tackle these issues, there is growing interest in web-based transportation manage- ment systems that emphasize automation, data central- ization, and accountability rather than costly real-time tracking. Web-based systems offer cross-platform access, require minimal infrastructure (internet and browsers), and can be deployed at a much lower cost compared to traditional fleet management solutions. This paper presents the design and development of a web-based Van Management System using HTML, Tailwind CSS, and TypeScript for the front end, Node.js (JavaScript Runtime) for the backend, and MySQL for database management. The system allows administrators to create and manage routes, assign drivers and vehicles, approve passenger requests, and generate automated reports. At the same time, drivers and guardians interact with the

system through role-specific interfaces that ensure trans- parency and accountability. Adopting such systems helps institutions meet both environmental and legal require- ments more efficiently, supporting green initiatives and simplifying compliance management for fleet certifica- tions and regulatory updates. In turn, schools build safer, more reliable, and inclusive transportation networks for diverse student populations.

II. LITERATURE REVIEW

Transportation management systems have evolved sig- nificantly over the years, ranging from manual regis- ters to advanced IoT-driven frameworks. A thorough review of existing research highlights the opportunities and limitations that have influenced the design of the proposed Van Management System. Malekian et al., in their paper titled "Design and Implementation of a Fleet Management System Using GPS and GSM", proposed a GSM-based tracking system that enabled real-time fleet visibility [7]. While this improved route monitoring, it required high hardware costs and continuous connec- tivity, making it less practical for smaller institutions.

Similarly, Smith and Brown, in their paper titled "Intel- ligent Fleet Management Systems: Enhancing Efficiency in Transportation", emphasized the role of data-driven decision-making in transportation systems [5]. However, their focus was on large-scale fleets, leaving a gap in applicability for educational institutions with limited budgets. IoT-based approaches, such as the IEEE con- ference paper titled "An Intelligent Vehicle Monitoring System Based on Internet of Things (2012)", introduced predictive maintenance and live alerts [20]. Though tech- nologically advanced, these solutions often raised pri- vacy concerns when implemented in schools, as real-time tracking of minors can be ethically challenging. Another example, the paper titled "IoT-Based Smart Bus System" presented at IEEE in 2020, demonstrated integration with mobile apps for passenger updates [14]. Despite its benefits, its reliance on IoT hardware limited scalability for underfunded institutions. Web-based solutions are gaining popularity as cost-effective alternatives. Em- manuel Musonda's work on "Design and Development of a Web-Based Vehicle Management System (VMS)" highlighted the importance of centralized scheduling and role-based access without GPS dependency [6]. This aligns closely with the objectives of the current study, though it focused primarily on fleet companies rather than schools. Kamal Acharya's report, "College Bus Management System Project Report (Authorea)", highlighted practical challenges faced in Indian colleges, such as double bookings and miscommunication [1]. His project emphasized the need for role-based access and affordable tools, which support the motivation for the proposed system. A systematic review by Chiparo et al., entitled "Vehicle Fleet Management Practices: A System- atic Review", analyzed various methodologies, ranging from mobile apps to enterprise-level traffic control [8].

The study concluded that while GPS and GSM remain dominant, scalability and cost-effectiveness remain crit- ical challenges for smaller deployments. Other works, such as the article "Fleet Management System Using Android" published in IJRPR (2022) [11] and "Smart Bus Management and Tracking System" published in IJLES Journal (2021) [13], explored mobile-centric ap- proaches. These systems provided real-time updates but were limited by platform dependency (Android/iOS) and required continuous updates on individual devices. From these studies, a clear research gap emerges: while exist- ing literature highlights GPS tracking, IoT automation, or enterprise-scale solutions, there is a lack of focus on affordable, browser-accessible, and role-based systems tailored for schools and small institutions. The proposed Van Management System addresses this gap by empha- sizing web accessibility, scalability, and minimal infras- tructure needs, ensuring its suitability for environments with limited resources but high demands for reliability and transparency.

III. METHODOLOGY

The methodology for developing the Van Management System (VMS) followed a systematic and iterative approach, ensuring that the final product was reliable, user-friendly, and aligned with institutional requirements. The process began with extensive requirement anal- ysis, where consultations with administrators, drivers, and guardians revealed several challenges with existing manual practices. Problems such as duplicate bookings, lack of transparency, delays in communication, and the absence of centralized data became the starting point for designing the new solution. From these find- ings, the project team outlined both functional require- ments—such as route creation, driver assignment, and role-based booking—and non-functional requirements related to performance, scalability, and usability.

The workflow of the system was structured around three key roles: administrator, driver, and guardian. Admin- istrators were given tools to manage routes, approve bookings, and generate usage reports. Drivers could view their assigned schedules and passenger lists through a simple dashboard, reducing the dependency on paper- based communication. Guardians were provided with a booking interface where they could request seats for their children, monitor confirmations, and receive updates in case of delays or cancellations. A notification module ensured that all stakeholders were updated in real time through web-based alerts and optional email or SMS integration, eliminating the communication gap that had existed in manual systems. The authentication system was developed first, with secure login mechanisms and role-based access control ensuring that only authorized users could access sensitive functions.

The booking system was then created, allowing guardians to submit requests that administrators could approve or reject, with the database automatically updating seat availability. This was followed by the notification module, which was integrated to keep all users informed of status changes. Finally, a reporting feature was implemented to allow administrators to generate summaries of trips, bookings, and system utilization. Overall, the methodology adopted in this study ensured a structured yet flexible develop- ment cycle. By beginning with stakeholder-driven re- quirements, advancing through carefully planned design and iterative implementation, and validating the system with rigorous testing, the Van Management System was able to achieve its objectives of affordability, efficiency,

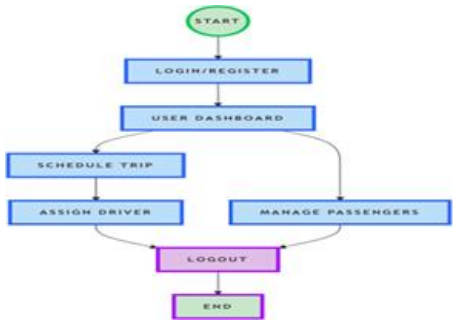

Fig. 1: Flowchart for Van Management System

Comparison of GPS-Based vs. Non-GPS-Based Van Management Systems

Feature	GPS-Based VMS	Proposed Web-Based VMS
Implementation Cost	High (Requires dedicated hardwae)	Low (Browser-based, minimal infrastructure)
Hardware	Requires specialized GPS devices and IoT sensors	Only requires a standard com- puter with an internet browser
Real-time Tracking	Yes (Primary function)	No (Focuses on scheduling and process automation)
Connectivity	High dependency on con- tinuous internet for live data	Minimal infrastructure requiremen- ts; functionality is not halted by
Scalability	Complex to scale due to hardware installation	Highly scalable as new users and routes can be added via the soft-
Primary Focus	Vehicle location and security	Centralized data management, booking, and communication
Key Advantages	Enhanced security, real-time location	Cost-effective, easy to deploy, highly scalable, and user-frieniy

and accessibility. The process also laid a strong founda- tion for future improvements, including AI-driven route optimization and IoT-based integration, which can fur- ther enhance the system's performance and scalability.

Comparison between GPS and Non-GPS Based VMS The table shows a detailed comparison between GPS- based and non-GPS-based Van Management Systems. Based on the provided image, the table contrasts two types of van management systems (VMS): a GPS- based VMS and a Proposed Web-Based VMS. The GPS- based system has a high implementation cost because it

requires special hardware and IoT sensors. It depends on a continuous internet connection for live data, making it hard to scale due to the need for hardware. Its main functions are real-time tracking, vehicle location, and security. In contrast, the proposed Web-Based VMS is more accessible and adaptable. It has low implemen- tation costs as it is browser-based and needs minimal infrastructure, only a standard computer with an internet browser. This system does not offer real-time tracking, focusing instead on scheduling and automation. It has low connectivity needs and functions well even without internet. It is highly scalable, allowing new users and routes to be added easily through software. The web- based system's main focus is centralized data, booking, and communication, offering cost-effectiveness, ease of use, scalability, and user-friendliness.

IV. RESULTS AND DISCUSSION

The implementation of the Van Management System was carried out in a modular fashion, and screenshots of the deployed system are presented to illustrate the developed functionalities.

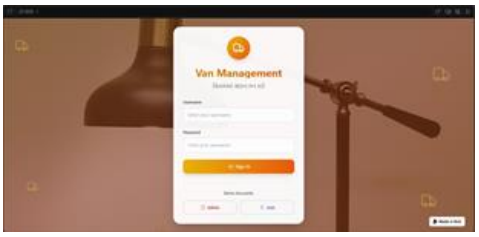

Fig. 2: Login Page of the Van Management System

The login page provides a secure entry point for administrators, drivers, and guardians. Role-based access control ensures that each type of user views only the functions relevant to them.

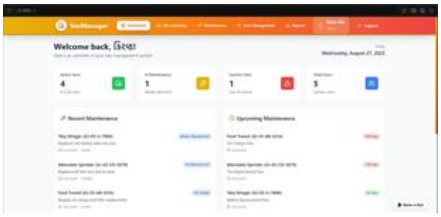

Fig. 3: Admin Dashboard

The administrator dashboard allows for creating routes, assigning drivers and vehicles, approving booking requests, and generating usage reports. This interface reduces manual errors and centralizes system control.

The user dashboard serves as the central hub of the application. From here, administrators can manage routes, assign vans and drivers, and approve or reject seat requests. Guardians can monitor their children's bookings and receive notifications of schedule changes. Drivers can access their assigned schedules and view

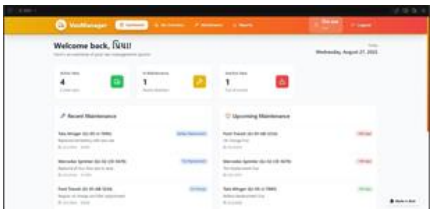

Fig. 4: User Dashboard

passenger lists. By consolidating these functions into a single dashboard, the system ensures ease of use and transparency across all roles.

V. CONCLUSION

Key Takeaways

The Van Management System (VMS) developed in this study successfully addresses the inefficiencies of tra- ditional school and institutional transport management. By integrating role-based dashboards for administra- tors, drivers, and guardians, the system enables stream- lined scheduling, booking, and communication. Unlike GPS-based systems that require costly infrastructure, the web-based VMS leverages lightweight technologies such as HTML, Tailwind CSS, TypeScript, Node.js, and MySQL to deliver affordability, scalability, and accessibility across devices. Testing demonstrated no- table improvements in scheduling accuracy, booking ef- ficiency, communication reliability, and user satisfaction. These outcomes highlight the potential of web-based platforms to modernize school transportation manage- ment without imposing prohibitive financial or technical barriers. Through rigorous testing, the VMS showed im- provements in operational transparency, responsiveness to

scheduling changes, and satisfaction levels among stakeholders. Centralized data storage and automated alerts bolster accountability and reliability, while the modular architecture supports easy customization and future integration with external educational or admin- istrative tools. By leveraging popular web technologies, the system offers a highly affordable, scalable, and user- friendly alternative to GPS-dependent platforms, making it accessible to schools and organizations with limited resources.

Limitations

Despite its effectiveness, the system has some limi- tations. The absence of real-time GPS tracking restricts automatic communication of unexpected events such as delays or breakdowns. Dependence on stable internet connectivity also poses a challenge in areas with poor network infrastructure. Furthermore, system adoption requires a cultural and behavioral shift from paper-based or phone-based coordination to digital methods, which may face resistance among less tech-savvy stakeholders. While these limitations do not hinder core functionality, they highlight areas for further refinement to enhance resilience and adaptability. Another limitation is the ne- cessity for a cultural shift among institutions accustomed to manual or phone-based coordination. The VMS may require targeted training and support, particularly for users with low digital literacy, to fully harness its capa- bilities and foster widespread adoption. Furthermore, the absence of predictive analytics and AI-driven decision support restricts its effectiveness in handling complex scheduling challenges or optimizing resource allocation in real time.

Future Work

Future enhancements of the VMS will focus on expanding functionality and improving system intelligence. Planned improvements include AI-assisted route optimization, predictive maintenance to anticipate failures, and integration of GPS and IoT modules for real-time monitoring. Developing a companion mobile application, multilingual support, and advanced reporting features will further strengthen usability and inclusivity. Integration with institutional enterprise systems could extend its role in administrative decision- making. These directions will ensure that the VMS continues to evolve as a robust, scalable, and user- friendly platform capable of meeting diverse institutional transportation needs. To improve accessibility, the team aims to develop a companion mobile application supporting push notifications, offline booking, and multilingual interfaces, making the VMS more inclusive for non-English users and stakeholders with limited device access. Integration with broader institutional systems—such as school ERP platforms—will enhance data interoperability and administrative efficiency. Finally, refining the reporting suite to offer in-depth analytics and visualizations will empower decision- makers with actionable insights to continuously improve transportation management practices.

In summary, the Van Management System success- fully demonstrates how affordable web technologies can transform institutional transport management by bal- ancing functionality, usability, and cost. With future enhancements, it holds strong potential for broader adop- tion and long-term sustainability.

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