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Research Article

Real-Time Bus Occupancy Tracking With Nearby Stop Details and Schedules Displayed Online

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Abstract— This FLEETSMART system is an innovative solution designed to accurately monitor and manage passenger flow on buses by counting the number of individuals boarding and exiting. Utilizing advanced sensors to the system provides real-time data on passenger boarding and exiting the bus. The system displays the current count on a LED display to show current passenger counts clearly and effectively. And additionally it features visible (flashing lights) and audible(buzzers) alerts to notify drivers and passengers when the bus reaches its maximum capacity to ensure safety and compliance with capacity regulations. By monitoring passenger numbers in real-time, the system helps to prevent overcrowding, reducing the risk of accidents and ensuring compliance with safety regulations. The system allows bus operators to make informed decisions regarding route management and capacity planning. Passengers benefit from a safer environment, knowing that their comfort and safety are prioritized. This innovative counting system represents a significant advancement in public transportation management. By leveraging cutting-edge technology in sensor integration, real-time data display, and alert mechanisms, it not only enhances safety but also improves operational efficiency. And also it displays the nearby stop and availability of the seats the website named as FLEETSMART. It helps passengers to find out the timing of the bus as well as schedules.

Keywords— fleet -vehicles that move together ; compliance - tractability ; leveraging - manipulating ; alert - a warning of possible danger ; prioritized - in order of importance ; buzzers - alarm bell gong signal warning

1. Introduction

The FLEETSMART system is an innovative solution aimed at improving passenger management and safety in public transit. It accurately tracks the number of passengers boarding and alighting from buses, providing real-time data displayed on an LED screen for easy visibility. The system is equipped with advanced sensors that activate visual alerts, such as flashing lights, and audible signals, like buzzers, to inform both drivers and passengers when the bus reaches its maximum capacity. This functionality helps maintain safety standards and prevents overcrowding. By utilizing FLEETSMART, bus operators can enhance route management and capacity planning, while passengers benefit from a safer and more comfortable travel experience. This technology marks a significant advancement in the management of public transportation, integrating real-time data, safety mechanisms, and operational efficiency.

A website will display bus stop locations and schedules, enabling passengers to reroute to other buses or receive real-time updates. This centralized database integrates bus schedules and information about nearby stops, efficiently collecting, processing, and storing data for future analysis. The web application will showcase upcoming bus arrivals and details of nearby stops, accessible to both passengers and transit authorities. FleetSmart can promote staggered commuting times, alleviating congestion during peak hours. Collectively, these solutions enhance the efficiency and comfort of public transit for all users.

The main contribution of the work:

1. To analyze the count of the passengers (ie.,) in which time the passenger count will increase. If passenger count reaches the maximum limit then by using the alert system , alerts the bus.

2. In the website, it shows the bus timings, nearby stop, available seats.

2. Related Work

FootfallCam's Automated Passenger Counting (APC) system is an advanced solution aimed at enhancing bus operations by delivering precise, real-time information on passenger flow. Utilizing 3D stereoscopic cameras and

sophisticated AI analytics, the system monitors the number of passengers boarding and alighting at each bus stop. This data is presented on an intuitive dashboard, providing bus operators with critical insights into occupancy levels, peak travel periods, and route utilization. Such information empowers operators to make informed adjustments to schedules, manage bus capacities effectively, and optimize routes, thereby mitigating overcrowding and ensuring compliance with safety regulations.

Furthermore, the system's GPS integration allows for the correlation of passenger counts with location data, offering a holistic perspective on bus operations throughout routes. This capability is essential for pinpointing high-demand areas and tailoring services to meet passenger requirements, ultimately improving the efficiency and reliability of public transportation. The APC system also contributes to better route management and resource distribution, enhancing operational effectiveness and passenger service quality.

However, the APC system is not without its challenges. A significant concern is the potential decrease in accuracy during peak periods or on crowded buses, particularly those with multiple entry points. In these situations, the sensors may struggle to differentiate between closely packed passengers, impacting the accuracy of the counts. Additionally, the installation process demands meticulous calibration and sensor alignment to ensure reliable data collection, complicating the setup and requiring precise positioning for optimal functionality. Nevertheless, when executed properly, the system offers substantial advantages, including improved safety, reduced overcrowding, and enhanced data visibility.

The **V-Count passenger counting system** represents an advanced technological solution designed to effectively track passenger movement across various modes of transportation, such as buses, trains, and ships. Utilizing state-of-the-art AI-driven sensors strategically positioned above vehicle entrances, this system accurately records the number of passengers boarding and alighting. These sensors are equipped with machine learning capabilities, enabling them to adjust to diverse environments and varying conditions, including changes in lighting and passenger behavior. The information collected by these sensors is processed in real-time and displayed on the BoostBI dashboard, an intuitive platform that allows transportation operators to visualize passenger flow, monitor occupancy rates, and analyze traffic trends.

This real-time information is invaluable for transportation operators, empowering them to make data-driven decisions that enhance operational efficiency. For example, the system facilitates improved route management by pinpointing peak travel periods, allowing for timely adjustments to schedules. Such optimizations can lead to enhanced service delivery, minimized wait times, and an overall better experience for passengers. Furthermore, transportation companies can leverage this data to fine-tune staffing levels, ensuring that personnel are deployed where they are most needed, which further boosts operational effectiveness. Additionally, the system plays a critical role in upholding safety standards by monitoring vehicle occupancy and ensuring adherence to capacity regulations.

V-Count's passenger counting system faces several challenges and receives some negative feedback from users. A common issue highlighted is the complexity involved in the initial setup process. Despite V-Count promoting its system as "plug-and-play," many users report that the installation can be more intricate than anticipated. Proper sensor placement is essential for achieving optimal performance, which can pose difficulties for organizations that lack familiarity with such technology. Additionally, calibrating the sensors to accommodate different door heights, varying lighting conditions, and diverse passenger movements can be time-consuming and may necessitate professional help to ensure the system operates effectively.

Furthermore, although the system boasts high accuracy rates—often claimed to reach up to 99% under ideal circumstances—its effectiveness can fluctuate based on environmental factors. Elements such as changing light conditions, increased passenger volume during busy periods, or rapid passenger movement can occasionally result in counting inaccuracies. These inconsistencies can affect the reliability of the collected data, necessitating continuous adjustments to uphold the system's precision. Nevertheless, once these initial challenges are overcome, V-Count's solution offers significant insights that enhance transportation management and improve the overall passenger experience.

These are the two systems that exist in today's environment. The FleetSmart system varies from these two systems.

3. Theory/Calculation

The calculation of passenger count and available seats in a bus is an important process to ensure the vehicle operates within safe capacity limits. Overloading can lead to unsafe conditions, such as mechanical strain on the vehicle, discomfort for passengers, and reduced effectiveness of emergency procedures. By using a systematic approach to monitor the number of passengers, we can dynamically assess whether the bus is nearing its maximum capacity and provide real-time feedback to the driver and passengers.

There is the calculation for the counting of passengers in the bus. Typically the calculation is calculated for many procedures. The following steps are involved as follows:

Therefore, Number of passengers = (Number of passenger inside the bus + Number of passenger at entry point) - Number of passenger at exit point which can be written as follows,

$$N = (a + b) - c \quad —(1)$$

where N = Number of passengers
a = Number of passenger inside the bus
b = Number of passenger at entry point
c = Number of passenger at exit point

Available seats = Total number of seats - Number of passengers

It can be written as,

$$S_{available} = T - N \quad —(2)$$

where, $S_{available}$ = Available seats
T = Total number of seats

By using these calculations we can fix the maximum limit in the bus to avoid unsafe conditions.

4. Experimental Method/Procedure/Design

FleetSmart represents a cutting-edge solution tailored to tackle the challenge of passenger overcrowding in urban bus networks. By leveraging innovative technologies such as real-time passenger tracking, dynamic bus dispatching, and effective communication systems, FleetSmart enhances the overall performance, safety, and user experience of public transit. The primary objective of this system is to maximize the utilization of bus services, thereby minimizing overcrowding incidents while ensuring consistent service reliability, even during off-peak hours.

A standout feature of FleetSmart is its dynamic dispatching capability, which allows transit authorities to modify bus schedules in response to real-time passenger demand. During peak times, such as morning and evening commutes or during special events, the system can automatically allocate additional buses to routes with high passenger volumes. This proactive measure not only mitigates overcrowding but also contributes to a more pleasant travel experience for riders. In contrast, during quieter periods, FleetSmart intelligently reduces the number of buses in service, thereby curbing unnecessary fuel usage and operational expenses, and optimizing resource distribution while still upholding service quality. This adaptive resource management strategy enables transit operators to effectively balance operational efficiency with passenger satisfaction.

FleetSmart features a sophisticated passenger monitoring system that employs advanced sensors to accurately track the number of individuals boarding and disembarking from each bus. This information is continuously refreshed and presented on an LCD display inside the vehicle, providing real-time updates on the current passenger count and the number of available seats. Such a system enables bus operators to monitor passenger loads effectively, ensuring they are informed when a bus approaches or reaches its full capacity. In instances where the bus is at capacity, the system automatically generates an alert for the driver, facilitating timely decisions such as dispatching additional buses or restricting further boardings until space becomes available.

Beyond its onboard capabilities, FleetSmart significantly enhances the overall passenger experience through an intuitive online platform. This website offers users access to real-time data regarding bus schedules, nearby stops, and estimated arrival times. With this information readily available, passengers can make informed decisions about their travel plans, selecting routes that align with their preferences while avoiding buses that are likely to be overcrowded. This level of transparency not only enhances the convenience for riders but also aids in distributing passenger loads more evenly, as individuals can modify their travel times to steer clear of peak periods.

FleetSmart's centralized database serves as a vital hub that consolidates all bus schedules and stop locations, enabling the effective collection and storage of data for extensive long-term analysis. This integration empowers transit authorities to scrutinize passenger behavior trends, pinpoint routes that frequently face overcrowding, and make informed, data-driven decisions to enhance service quality. For instance, transit agencies can identify routes with high demand and strategically allocate resources to optimize operations. Moreover, FleetSmart is set to broaden its functionality through the introduction of a dedicated web application, which will provide both passengers and transit authorities with easy access to real-time bus information, facilitating informed travel choices. This application is anticipated to promote staggered commuting times, encouraging passengers to opt for less congested travel periods, thereby improving the overall efficiency of urban transit systems.

In essence, FleetSmart embodies a holistic strategy aimed at modernizing urban bus networks by harnessing advanced technology to tackle prevalent issues in public transportation. By prioritizing real-time passenger data, adaptive resource management, and clear information dissemination, FleetSmart seeks to create a public transit experience that is not only safer and more efficient but also more comfortable for both operators and passengers. This innovative approach is designed to enhance the overall functionality of urban transit systems, ultimately contributing to a more sustainable and user-friendly public transportation landscape.

5. Block Diagram

The diagram illustrates a simple data processing and alert system, likely for monitoring and managing overload situations. The system receives data from two types of sensors.

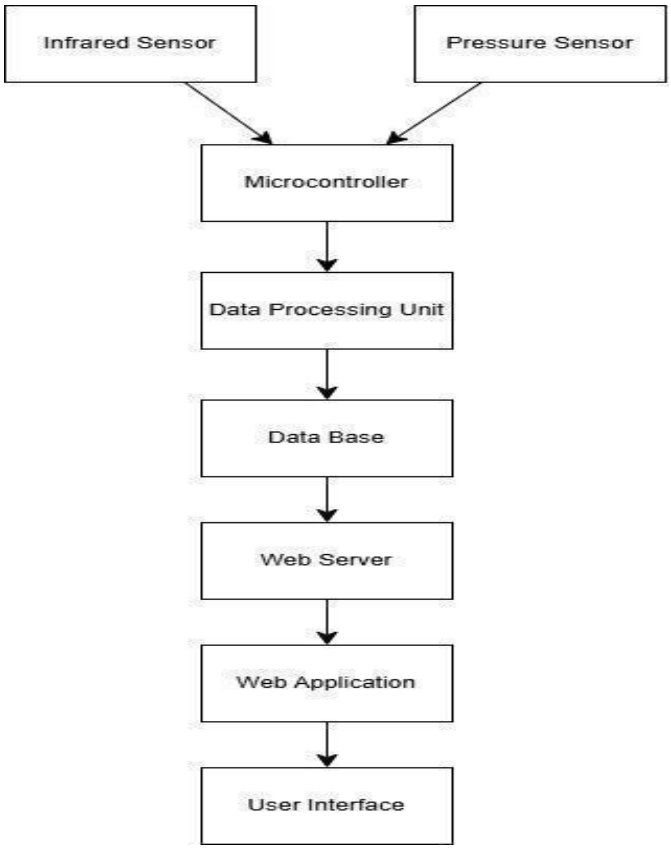

Fig.1

Pressure Sensor : They accurately measure the force exerted per unit area, providing valuable data for process control, safety monitoring, and research. It calculates the human temperature and converts to the pressure. It converts the temperature into pressure.

Infrared Sensor : These detect infrared radiation, commonly used for detecting objects, measuring temperature, or motion detection. The collected data from both sensor types is then processed. This could involve various operations like filtering, averaging, or applying specific algorithms to extract meaningful information. The processed data is analyzed to detect overload conditions.

Microcontroller: A microcontroller is a compact, integrated circuit (IC) designed to perform specific tasks within an embedded system. It contains a processor (CPU), memory (RAM and ROM), and input/output (I/O) peripherals on a single chip, enabling it to control various electronic devices and systems autonomously. This could involve operations like combining infrared and pressure sensors.

Data Processing Unit: A Data Processing Unit (DPU) is a specialized processor designed to efficiently handle tasks related to data processing, particularly in networking, storage, and security. It processes the data from the microcontroller.

Database: It stores the calculated data from DPU to the database for future use. Laterly, it can be shown in the user interface.

Web Server: When a user enters a URL or clicks on a web link, the browser sends a request to the web server. The server processes the request and sends back the requested resource, usually an HTML page, image, video, or other file type.

User Interface: It shows the structure of our websites. The primary goal of a user interface is to provide an intuitive and efficient way for users to interact with a product, ensuring that the system is easy to use and navigate.

This could involve comparing the sensor readings to predefined thresholds, looking for sudden spikes, or using more efficient algorithms depending on the system's requirements. If an overload condition is detected, the system triggers an alert. This could be in the form of visual or audible alarms, notifications sent to a monitoring station, or automated actions to mitigate the overload. And the no. of seats can be visible on the website (FLEETSmart).

6. Survey and Report

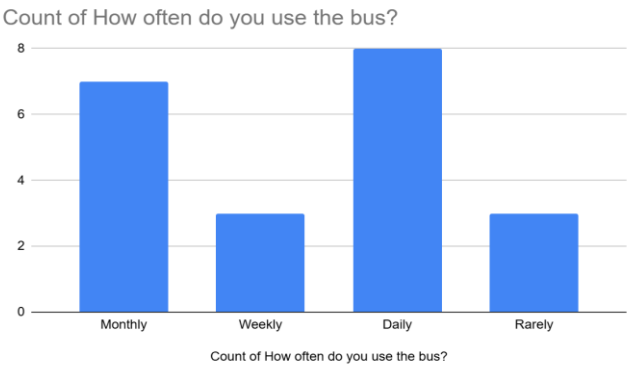

Fig.2

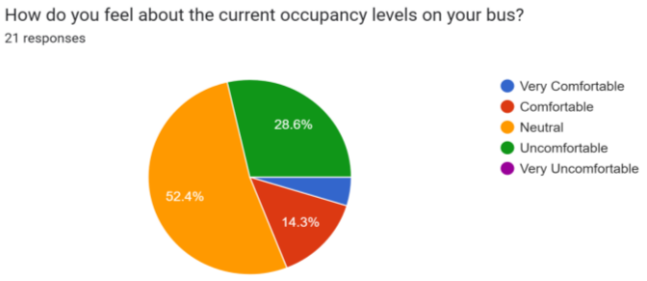

Fig.3

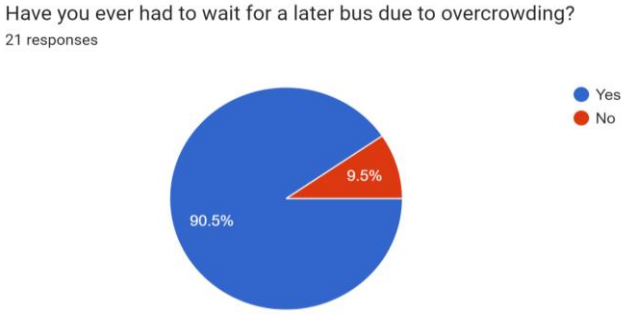

Fig.4

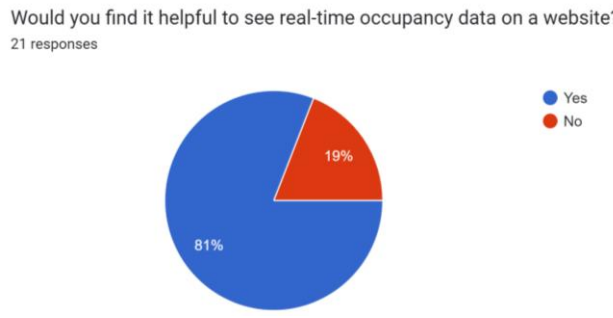

Fig.5

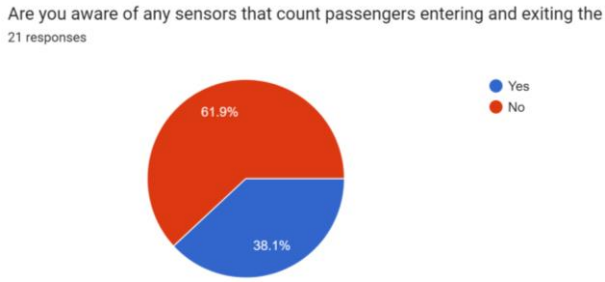

Fig.6

These are the measurements that were taken in the survey report.

7. Market Analysis

Excessive passenger overload in buses is a common issue in urban and metropolitan areas. This leads to passenger discomfort, safety concerns, service inefficiency and negative environmental impact.

Market Size and Opportunity: The urban bus transportation market is significant, given that millions of people rely on buses daily, particularly in densely populated cities worldwide. Cities like New York, London, Mumbai, and Lagos experience intense bus ridership. As cities grow, the demand for efficient public transportation systems increases, with authorities seeking solutions to improve capacity management. Competitive Landscape: The smart transportation and mobility sector is experiencing rapid growth, and several players are providing solutions for fleet management, congestion control, and passenger load optimization. The companies that provide basic tracking, scheduling, and route optimization services are traditional fleet management systems. IoT-driven solutions firms using predictive analytics, and real-time data to optimize operations. Ride-sharing and mobility platform companies like Uber and Lyft indirectly compete by offering flexible and personalized transport solutions, reducing pressure on public transport.

Technological Trends: FleetSmart can leverage emerging technologies to address Passenger overload in Internet of Things(IoT) sensors to track real-time bus occupancy and passenger density. Cloud computing for scalable, real-time data processing and reporting. Web application to provide passengers with live updates on bus availability, occupancy rates, and alternate routes.

Market Entry Strategy: Launching small-scale implementations in major cities to demonstrate the system's effectiveness. Partnerships with bus manufacturers and transit operators collaborating to integrate Fleet Smart with existing fleet management tools and infrastructure. Government incentives and partnership working with municipal governments to access funding and regulatory support for public transport innovations.

Revenue Projections: Given the growing market size and pressing need for smarter transit systems, Fleet Smart has the potential to tap into significant revenue streams.

FleetSmart Solutions: Fleet Smart will address passenger overload through a combination of real-time occupancy monitoring integrating IoT sensors to provide dynamic tracking of passenger numbers on each bus. Dynamic fleet management to optimize routes and dispatch additional buses based on demand patterns. Predictive analytics identifying high-demand routes and times to improve planning and prevent overload. Passenger alerts provide live information to passengers on bus crowding, estimated arrival times, and alternative routes.

Future Opportunities: As Fleet Smart grows, it can expand to other forms of public transport (trains, ferries) and explore partnerships in emerging smart city projects, addressing broader urban mobility challenges.

8. Results and Discussion

The research indicates that vehicle overloading remains a significant and hazardous challenge in public transportation. Solutions like the patented Overload Detection System utilize sensors and real-time monitoring to effectively prevent accidents related to excessive weight. Additionally, overloading poses not only safety risks but also contributes to increased vehicle wear, higher maintenance expenses, and a shorter lifespan for vehicles. Implementing overload detection systems can address these concerns by ensuring vehicles operate within safe weight limits, thereby minimizing the chances of accidents, mechanical failures, and road damage.

In conclusion, the deployment of vehicle overload detection systems, as outlined in the patent, can significantly lower the risk of overloading-related accidents in public transportation. However, this necessitates broad adoption by transportation authorities, rigorous enforcement of load regulations, and heightened public awareness regarding the dangers associated with overloading.

By taking the survey report the passengers responses the difficulties managed while traveling in the bus are tabled as follows:

The below table explains the questions asked in the survey report with a high percentage of the passengers' wishes.

Table 1

How often do the passengers use the bus ?	**Daily** with high percentage of 38.1%
Have you ever had to wait for a later bus due to overcrowding?	**Yes** with 90.5%
How often do you check bus schedules before traveling?	**Sometimes** with 52.4%
Would you find it helpful to see real-time occupancy data on a website?	**Yes** with 81.0%

Equation/Formula

Number of passengers = (Number of passenger inside the bus + Number of passenger at entry point) - Number of passenger at exit point

which can be written as follows,

$$N = (a + b) - c \quad —(1)$$

where N = Number of passengers
a = Number of passenger inside the bus
b = Number of passenger at entry point
c = Number of passenger at exit point

Available seats = Total number of seats - Number of passengers
It can be written as,

$$S_{available} = T - N \quad —(2)$$

where, $S_{available}$ = Available seats
T = Total number of seats

For Example:

Total number of seats = 60
Number of passenger inside the bus = 30
Number of passenger at entry point = 5
Number of passenger at exit point = 7

$N = (a + b) - c$
$N = (30 + 5) - 7$
$N = 28$

$S_{available} = T - N$
$S_{available} = 60 - 28$
$S_{available} = 32$

By using these calculations we can fix the maximum limit in the bus to avoid unsafe conditions.

9. Conclusion and Future Scope

FleetSmart represents an innovative approach to enhancing passenger counting and capacity management within urban bus systems. By prioritizing accuracy, efficiency, and technological advancement, FleetSmart addresses prevalent issues faced by public transportation agencies, including overcrowding and suboptimal route management. Utilizing real-time data and sophisticated technologies, it not only improves the operational efficiency of transit operators but also enriches the overall travel experience for passengers.

Central to FleetSmart's operation is its precise passenger counting mechanism, which employs strategically positioned sensors to track the number of individuals boarding and alighting from the bus. These sensors are located near the bus doors, ensuring accurate counts even during peak travel periods characterized by high passenger volumes. The information gathered is processed in real-time and displayed on an onboard LCD screen, providing bus drivers and conductors with immediate insights into current passenger numbers and available seating. This functionality enables drivers to monitor occupancy levels effectively, thereby preventing overcrowding and enhancing safety and comfort for all passengers.

Another significant aspect of FleetSmart is its real-time alert system, which activates when the bus reaches its designated maximum capacity. This feature promptly notifies drivers of potential safety concerns related to overcrowding, empowering them to take necessary actions, such as notifying dispatch for additional buses or temporarily suspending new boardings until space is available. The alert system employs both visual cues, such as flashing lights, and audible signals, ensuring that drivers remain informed of changing conditions while maintaining focus on the road.

FleetSmart's centralized data management system consolidates information from multiple buses and routes into a single platform, facilitating easier oversight and management for transit authorities. The aggregated data supports long-term strategic planning, enabling agencies to adjust their services in response to changing passenger demands and optimize fleet utilization over time. This unified system also guarantees that any modifications to bus schedules or routes are promptly reflected, ensuring that both passengers and drivers remain well-informed.

Through the integration of real-time monitoring, adaptive resource management, and accessible information sharing, FleetSmart emerges as an essential resource for contemporary public transportation solutions. Its capacity to provide actionable insights while ensuring adherence to safety regulations renders it a crucial asset for municipalities aiming to enhance their public transit offerings. The adoption of FleetSmart not only streamlines bus operations but also plays a significant role in fostering a safer and more pleasant travel experience for passengers, establishing it as a progressive solution in the dynamic realm of urban mobility.

The future implementation is Autonomous Vehicle Integration. The rise of autonomous vehicles presents an opportunity for FleetSmart to enhance the management of self-driving trucks and delivery vehicles, thereby facilitating a significant advancement in the automation of fleet operations. As these vehicles become increasingly common, the need for effective oversight and support systems will be paramount. Furthermore, the integration of mixed fleets, comprising both human-operated and autonomous vehicles, necessitates sophisticated coordination and communication frameworks. FleetSmart is well-positioned to provide the necessary tools and solutions to ensure seamless interaction and efficiency between these diverse vehicle types.

In summary, FleetSmart's innovative approach to data management and operational efficiency positions it as a leader in the public transportation sector. By leveraging technology to meet the needs of both transit authorities and passengers, it contributes to the overall improvement of urban transport systems. As cities continue to evolve, solutions like FleetSmart will be vital in shaping the future of public transportation.

Data Availability

Access to raw, real-time data collected by FleetSmart, including individual passenger counts and specific bus route details, is limited due to the proprietary nature of the software and concerns regarding passenger privacy. Nevertheless, aggregated and anonymized data, which encompasses general operational performance metrics, system efficiency reports, and capacity management statistics, is available for research or academic purposes.

Researchers seeking access to this data should reach out to the corresponding author, and their requests will be evaluated in line with data-sharing policies and applicable legal standards. All data sharing will adhere to privacy regulations and institutional guidelines to safeguard sensitive information.

Conflict of Interest

none

Funding Source

none

Authors' Contributions

Vinothini S researched literature and conceived the study. Akshaya Devi S involved in requirements development, gaining ethical approval, patient recruitment, and data analysis. Abinaya Shree R wrote the first draft of the manuscript. Sandhiya Devi G researched for the future implementation. All authors reviewed and edited the manuscript and approved the final version of the manuscript.

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none

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Vinothini S is currently pursuing a Bachelor of Technology in Computer Science and Business Systems at Sethu Institute of Technology. This is her inaugural publication, contributing a research paper to the ISROSET, showcasing her commitment to advancing knowledge in their field. With a keen interest in integrating technology and business principles, she aims to explore innovative solutions that address contemporary challenges in computer science.

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Akshaya Devi S is an ambitious individual studying for a Bachelor of Technology in Computer Science and Business Systems at Sethu Institute of Technology. This publication represents her debut contribution to the ISROSET, reflecting her dedication to advancing research in her area of study. With a strong interest in combining technology with business strategies, she aims to tackle contemporary issues within computer science.

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Mrs. M. Vijayalakshmi has completed M.E., and is working as an Assistant Professor in Computer Science and Business Systems at Sethu Institute of Technology. "Multiple difference Histogram modification for a Novel Reversible Data Hiding Scheme ", National Conference on RECANT 2K17, Seventh National Level Conference held in P.S.R.Engineering College ,Sivakasi during 10.03.2017 to 11.03.2017.

