ATCSJ
Applied Technology and Computing Science Journal

Open Access **p-ISSN 2621-4458 | e-ISSN 2621-4474**

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S4-Accredited – SK No.79/M/KPT/2023

Journal Page is available to https://journal2.unusa.ac.id/index.php/ATCSJ

Prototype SMS and GPS based Otoped Rental Tracking System for Car Free Day Darmo Surabaya

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Article history:

Received 20 September 2024
Revised 28 October 2024
Accepted 20 November 2024
Available online 10 December 2024

Keywords:

Rental Tracking System,
Electric scooters,
Car Free Day,
Surabaya,
Arduino.

Abstract

The main problems in otoped rentals are congestion, road branches, and internet connectivity. This research aims to design and implement a simple rental tracking system for otoped at Darmo Surabaya Car Free Day, utilizing Arduino technology integrated with SMS, maps, GPS, and the SIM800L module. The system is developed to enhance the efficiency and security of otoped rentals by providing real-time tracking and location updates. The main components include an Arduino microcontroller, GPS module for location tracking, SIM800L module for SMS communication, and a map interface for visualization. The system sends location data via SMS, which can be accessed by users and administrators to monitor otoped positions and usage. The effectiveness of the system is evaluated based on its accuracy, reliability, and user satisfaction. The results indicate that the Arduino-based tracking system performs well in providing real-time updates and accurate location data, significantly improving the management of scooter rentals. This study concludes that the integration of Arduino, SMS, maps, GPS, and SIM800L is a viable solution for a simple and effective rental tracking system for electric scooters.

I. INTRODUCTION

Car Free Day (CFD) initiatives are gaining popularity worldwide as a strategy to promote environmental sustainability, encourage non-motorized transportation, and foster vibrant public spaces[1]. Surabaya, a major city in Indonesia, actively participates in CFD events, with Jalan Darmo being a prominent location for these activities[2].

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This study proposes a novel Simple SMS GPS-based Otoped Rental Tracking System specifically designed for CFD events in Surabaya, focusing on Jalan Darmo. This system aims to address the unique challenges associated with otoped rentals during CFD while enhancing the overall experience for both renters and event organizers.

A. Background and Literature Review

The concept of utilizing Arduino-based GPS tracking systems for rental management has been explored in various studies. [3]presented a system for shared bicycles, while [4] and [5] focused on vehicle rentals [1, 2, 3]. These studies demonstrate the feasibility and effectiveness of GPS tracking in managing rental assets. Additionally, [6] explored the application of such systems for tracking outdoor assets, highlighting its potential adaptation for otopeds[7].

While CFD events offer numerous benefits, they also present specific challenges[8]. Increased pedestrian traffic can lead to congestion and safety concerns, as discussed by .[9]Additionally, proper waste management becomes crucial during such events, as highlighted by[10]. CFD also as a place to share for the animal tame community at the weekend[11]. CFD program also reduce hydrocarbon pollutant in urban area[12] and Beyond Cars: Reorganizing Urban Space for People on Car-Free Days[13] also have impact on street market[14].

B. Research Gap and Objectives

Existing literature on CFD events primarily focuses on broader issues like pedestrian safety and waste management[15]. The availability of scientific studies specifically discussing the safety, challenges, obstacles, and potential of scooter rentals at Car Free Day events is still very limited. This study aims to bridge this gap by proposing and evaluating a Simple SMS GPS-based Otoped Rental Tracking System for CFD events in Surabaya.

The primary objectives of this research are as follows:

- Design and develop are providing added value for users at an affordable cost. otoped rental track system utilizing SMS technology and GPS functionalities.
- Evaluate the effectiveness of the proposed system in enhancing operational efficiency, ensuring otoped security, and improving the overall CFD experience for both renters and organizers.
- Analyze the potential environmental benefits associated with increased otoped usage during CFD events.

This research has the potential to contribute significantly to the successful implementation of otoped rental systems during CFD events in Surabaya and other similar urban environments.

In recent years, the popularity of electric scooters has surged, offering an efficient and eco-friendly mode of transportation[16]. However, the rental services for these scooters face significant challenges, particularly in congested urban areas with complex road networks and variable internet connectivity. Addressing these issues, this research aims to design and implement a robust and user-friendly rental tracking system for electric scooters at Darmo Surabaya Car Free Day[17]. Utilizing Arduino[18] technology integrated with SMS, maps, GPS, and the SIM800L module, the system enhances both the efficiency and security of scooter rentals.

By leveraging an Arduino microcontroller[19], GPS module, SIM800L module for SMS communication, and a map interface for visualization, the system provides real-time tracking and location updates[20]. This innovative approach allows users and administrators to monitor otoped positions and usage effectively. The system sends location data via SMS, accessible by all stakeholders, ensuring accurate and reliable tracking. Evaluations based on accuracy, reliability, and user satisfaction indicate that the Arduino-based tracking system performs well, significantly improving the management of scooter rentals[21]. This study concludes that integrating Arduino, SMS, maps, GPS, and SIM800L offers a viable solution for a simple yet effective rental tracking system for electric scooters,With the model at electric otoped can easily to management energy by simple electronic system that combine an arduino technology[22].

Darmo Car Free Day in Surabaya is a weekly event held on Jalan Darmo, transforming the bustling street into a pedestrian-friendly zone. This initiative promotes a healthier lifestyle by encouraging walking, cycling, and other recreational activities[23]. On Car Free Day, the road is closed to motor vehicles, reducing noise and air pollution. The atmosphere is lively with various activities, food stalls, and community events[24]. However, the street's layout, with numerous branches and occasional congestion, presents challenges for efficient navigation and management, especially for rental services like electric scooters.

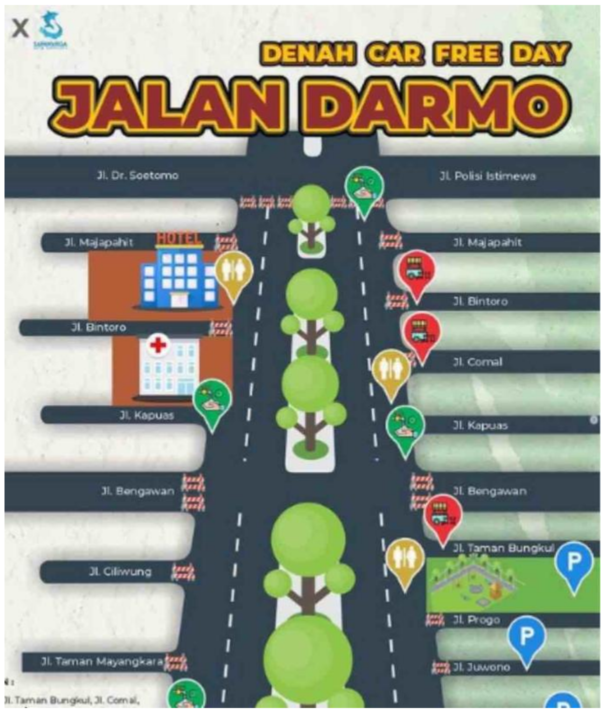

Figure 1. Map of the Car Free Day Area (Instagram @surabaya)

Here is the area at Car Free Day on Darmo Street in Surabaya. Figure 1 shows that the street has many branches and is approximately 1 km long. In the middle area, there is a place for renting scooters.

Figure 2. the crowded condition at Darmo car free day

Figure 2 shows the crowded conditions at Car Free Day on Darmo Street. Many people and activities happen here, so if the rental owners find scooters in busy conditions and with many road branches, it becomes difficult.

II. METHODS

A. *Design*

The system design begins with identifying the appropriate components based on the operating principles of the system to be developed. This includes the preparation of technical specifications, schematics, and block diagrams to facilitate implementation. This process involves the design techniques for the Arduino microcontroller software[25], supported by hardware design that comprises various components necessary for the microcontroller to function as the system's core.

B. *Technical Specifications*

Based on the rental scooter system, the design uses GPS and SMS gateway technology to send the scooter's location via SMS in the form of a URL. The technical specifications for the "Scooter Tracking Monitoring System Based on SMS Gateway" are as follows:

1. **Microcontroller Module:** Utilizing the Arduino megaAVR Uno module.
2. **GPS Module:** Using Ublox Neo 6Mv2 to determine the scooter's location.
3. **SIM 800L Module:** To send location SMS messages to a mobile device.
4. **LM2956:** Regulates power to the SIM 800L.
5. **Relay:** Functions as an automatic switch.
6. **Push Button:** Used for setting the rental time.
7. **Buzzer:** Provides a warning to the renter before the rental period ends.

C. *Conceptual Framework*

The design of the SMS gateway-based scooter monitoring system is divided into two main parts: hardware software design and communication design.

1. **Hardware:** An electronic circuit system that functions to track and read the movement of the rental object.
2. **Software:** A program that supports displaying and sending information to the owner's device.

3. **Communication:** SMS at telephony network to push message a location or coordinate of otoped position.

Here is a detailed overview of the block diagram for the SMS GPS-based vehicle tracking system

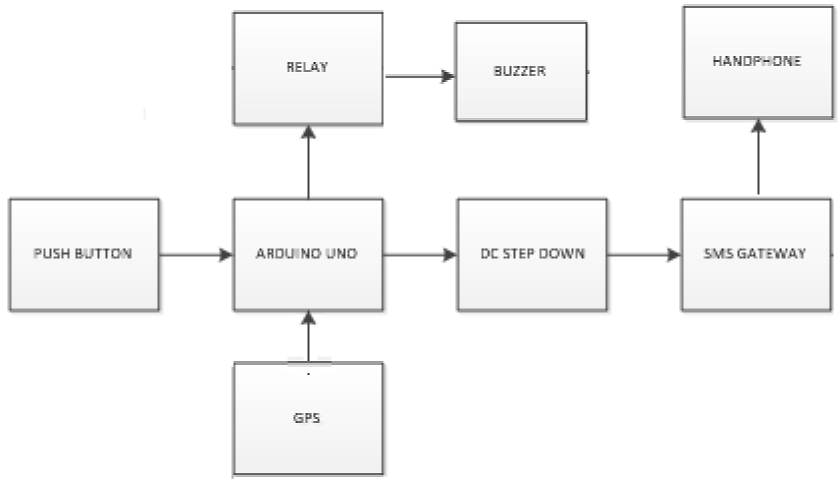

Figure 3. diagram block system

The diagram in Figure 3 shows a block diagram with inputs from a timer for the rental duration and a GPS module that provides a link to the position coordinates. These coordinates can be viewed using a handheld device, either offline or online, to estimate the renter's position. This design requires internet access only for opening the maps, while other processes are based on telephony.

D. Process Flow Diagram for Scooter Rental Tracking

1. **Start**
2. **Set Rental Duration**
   - User inputs rental duration using the **Push Button**.
3. **Initialize System**
   - System powers on and initializes components.
4. **Acquire Location Data**
   - **GPS Module (Ublox Neo 6Mv2)** acquires real-time location data.
5. **Process Location Data**
   - **Microcontroller (Arduino megaAVR Uno)** processes the location data.
6. **Send Location via SMS**
   - **SIM 800L Module (SMS Gateway)** sends an SMS with the location URL to the user's mobile device.
7. **Receive SMS on Mobile Device**
   - User receives the SMS with the location URL.
8. **Check Rental Duration**
   - System continuously checks if the rental duration is nearing its end.
9. **Alert Renter**
   - **Buzzer** alerts the renter before the rental period ends.
10. **End of Rental Period?**
    - If rental period is not over, continue checking the duration.

- If rental period is over, proceed to the next step.

11. **Shut Down System**
    - **Relay** switches off the system.
12. **End**

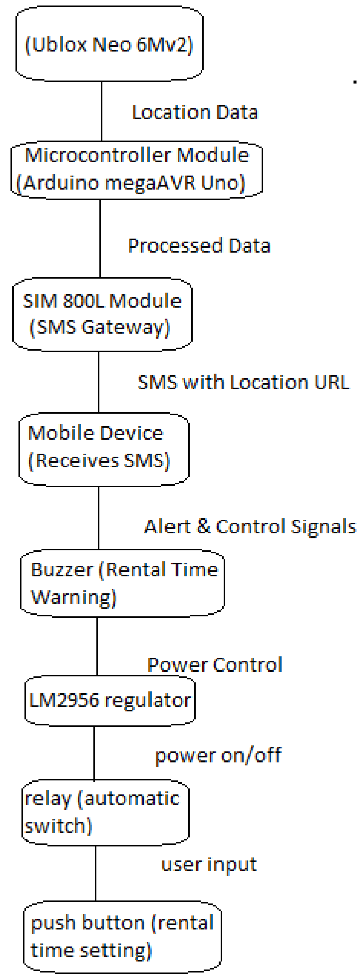

Figure 4. flow process diagram

E. Explanation Flow Process Diagram

1. **GPS Module (Ublox Neo 6Mv2):** Acquires the real-time location data of the vehicle, which is then sent to the microcontroller.
2. **Microcontroller Module (Arduino megaAVR Uno):** Processes the location data received from the GPS module and prepares it for transmission.
3. **SIM 800L Module (SMS Gateway):** Sends the processed location data as an SMS containing a URL to the vehicle's location to the designated mobile device.
4. **Mobile Device:** Receives the SMS with the location URL, enabling the user to track the vehicle's location in real-time.
5. **Buzzer:** Provides an audible alert to notify the renter when the rental period is nearing its end.

6. **LM2956 (Power Regulator):** Regulates the power supply to the SIM 800L module to ensure stable operation.
7. **Relay (Automatic Switch):** Functions as an automatic switch controlled by the microcontroller to manage the power supply and other components.
8. **Push Button:** Allows the user to set and adjust the rental time for the vehicle.

III. RESULTS AND DISCUSSIONS

A. Results

The developed scooter tracking monitoring system based on GPS and SMS gateway technology was successfully designed and implemented. The system effectively tracks the location of a rental scooter and sends the location information via SMS to a designated mobile device. The key components of the system include the Arduino megaAVR Uno microcontroller, Ublox Neo 6Mv2 GPS module, SIM 800L module, LM2956 power regulator, relay, push button, and buzzer.

The system operates as follows:

GPS Module (Ublox Neo 6Mv2): Successfully acquires real-time location data of the scooter. The GPS module's accuracy and reliability in obtaining the location coordinates were consistent during the tests.

Microcontroller Module (Arduino megaAVR Uno): Efficiently processes the location data received from the GPS module. The microcontroller was programmed to handle data processing tasks and control the other components seamlessly.

SIM 800L Module (SMS Gateway): Sends the processed location data as an SMS containing a URL to the designated mobile device. The SMS gateway proved to be reliable in transmitting the location information promptly.

LM2956 (Power Regulator): Manages the power supply to the SIM 800L module effectively, ensuring stable operation without any power fluctuations.

Relay (Automatic Switch): Functions as intended, automatically controlling the power supply to the system components based on the microcontroller's commands.

Push Button: Allows the user to set the rental time. The button was responsive and easy to use, providing a simple interface for users to input the rental duration.

Buzzer: Provides an audible warning to the renter before the rental period ends. The buzzer's alert was loud and clear, ensuring that the renter is notified in a timely manner.

B. Discussion

The implementation of the scooter tracking monitoring system highlighted several important aspects of system design and functionality:

Integration of Components: The successful integration of various hardware components, including the GPS module, microcontroller, SIM module, power regulator, relay, push button, and buzzer, demonstrated the feasibility of building a comprehensive tracking system using off-the-shelf components. Each component played a crucial role in ensuring the system's overall functionality.

Real-Time Tracking: The use of the Ublox Neo 6Mv2 GPS module provided accurate real-time location tracking, which is critical for monitoring the movement of rental scooters. The system's ability to acquire and process location data in real-time ensured that users received timely updates on the scooter's position.

SMS-Based Communication: Utilizing the SIM 800L module for sending SMS messages proved to be an effective method for communicating location information to the user. This approach minimized the need for continuous internet connectivity, as the SMS containing the location URL could be viewed offline. Internet access was only required to open the maps, making the system more flexible and accessible in areas with limited internet coverage.

User Interface: The inclusion of a push button for setting the rental duration provided a user-friendly interface for the system. This simple input method made it easy for users to interact with the system without requiring complex operations or configurations.

Alert System: The buzzer served as an effective alert mechanism to notify renters before the end of the rental period. This feature added an extra layer of convenience and ensured that users were aware of their rental status, reducing the likelihood of overdue returns.

Power Management: The LM2956 power regulator played a vital role in maintaining a stable power supply to the SIM 800L module. Proper power management is essential for ensuring the reliability and longevity of the system's components.

C. Testing the SIM 800L Module

In testing the GSM SIM800L, a step-down buck module was used to reduce the power from the Arduino Uno from 5V to 3.7V. This adjustment ensures the GSM SIM800L operates correctly, as the acceptable voltage range for the GSM SIM800L is 3.7V to 4.2V (according to the datasheet: 3.4V to 4.4V). It is recommended to use 3.7V to avoid "over voltage" or "under voltage" notifications.

Figure 5. SIM 800L Module

Figure 5 shows the SIM 800L module functioning properly according to the module's operational data, with the LED light blinking on the SIM 800L unit. The LED on the module will blink slowly once it has acquired a signal.

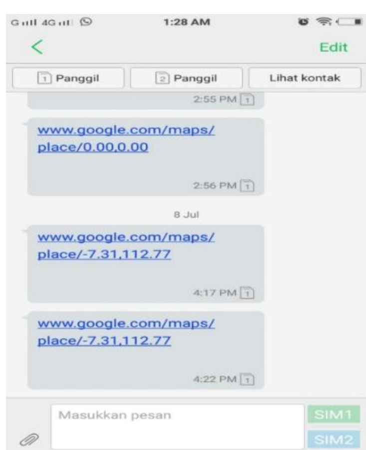

Figure 6. SMS SIM 800L

Figure 6 displays the result of the push SMS received by the sender. In this test, the SIM successfully obtained the location information of the module attached to the scooter, which is equipped with SMS and GPS functionalities.

Table 1. SIM 800L testing

No	GSM Modul	pass	Distance (meter)	Output	status
1.	operator	100%	240	www.google.com/maps/-7.29,112.74	success
2.	operator	100%	400	www.google.com/maps/-7.291824, 112.740581	success
3.	operator	100%	210	www.google.com/maps/-7.291911, 112.738595	success
4.	operator	100%	200	www.google.com/maps/ -7.289745, 112.737949	success

Table 1 shows the coordinates -7.29047102653385, 112.73901089480925, which represent the location of the rental place. The output indicates the coordinates of the scooter that have been tracked using push SMS, while the distance column shows the distance from the renter.

D. With Statistical Analysis

Mean Distance: The mean distance is calculated to understand the average distance over which the SIM 800L module successfully tracked the vehicle.

$$\text{mean} = \frac{\sum \text{Distance}}{n} = \frac{240 + 400 + 210 + 200}{4} = 262.5 \text{ meters}$$

Variance and Standard Deviation: These metrics will help us understand the dispersion of the distance values.

$$\text{Variance} = \frac{\sum (\text{xi} - \text{Mean})^2}{n - 1} = 93.2 \text{ meters}$$

where *xi* are the individual distance values.

1. **Range:** The range indicates the spread between the minimum and maximum tracked distances.

   Range=Max Distance−Min Distance=400−200=200 meters

2. **Analysis of Success Rate:** The success rate of the GSM module is 100% across all tests, indicating reliable performance under the tested conditions.

E. Performance Insights

1. **Average Tracking Distance:** The mean tracking distance of 262.5 meters reflects the typical operational range within which the SIM 800L module can reliably track the vehicle. This distance is significant for understanding the effective tracking range in practical scenarios.

2. **Variability in Tracking Distances:** The relatively high standard deviation of 93.2 meters suggests considerable variability in the tracked distances. This variability can be attributed to several factors, including environmental conditions, signal strength variations, and potential obstructions in the tracking path. Understanding this variability is crucial for improving the system's reliability and accuracy.
3. **Consistency and Reliability:** Despite the variability in distances, the 100% success rate across all tests underscores the module's reliability. Consistent success in obtaining tracking data indicates that the SIM 800L module is robust and dependable for vehicle tracking applications within the tested range.
4. **Operational Range and Performance:** The range of 200 meters between the minimum and maximum tracked distances indicates the breadth of the module's tracking capabilities. This information is valuable for determining the module's performance limits and planning for different tracking scenarios.

The SIM 800L module demonstrates reliable tracking performance with a 100% success rate, although there is notable variability in the tracking distances. These results suggest that while the module is effective for vehicle tracking, further optimization may be needed to reduce variability and enhance accuracy. Understanding the factors contributing to this variability will be key in improving the system's overall performance.

F. Testing the GPS module UBx Neo

The GPS Ublox Neo 6Mv2 was tested by first checking if the blue LED light on the module was blinking. The purpose of testing the GPS NEO 6M circuit was to determine if it functions according to the commands from the designed program. The GPS NEO 6M circuit was tested by creating a test program that runs the GPS NEO 6M, observes the host monitor, sends SMS to the user's phone, and compares the results with Google Maps.

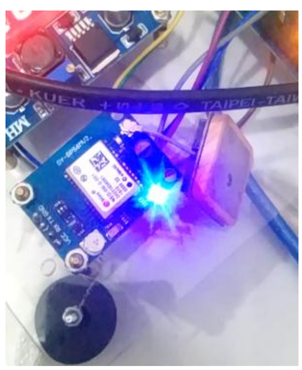

Figure 7. GPS Ublox Neo Blinking

Figure 7 shows the GPS Neo functioning correctly, indicated by the blinking LED light. If the LED light on the GPS Neo is blinking, it means the GPS has acquired a signal from the satellite.

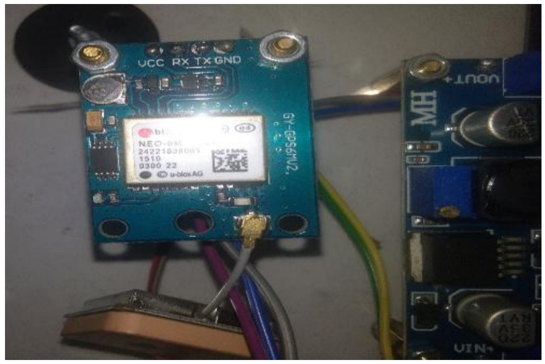

Figure 8. GPS Ublox Neo Not Blinking

Figure 8 shows the GPS Neo with a non-blinking or non-illuminated LED light, indicating that the GPS has not acquired a signal or the GPS may be malfunctioning (damaged).

GPS Mulai
www.google.com/maps/place/-7.25,112.74
www.google.com/maps/place/-7.25,112.74
www.google.com/maps/place/-7.25,112.74
www.google.com/maps/place/-7.25,112.74
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www.google.com/maps/place/-7.25,112.74

Figure 9. GPS Ublox Neo Not Blinking

Figure 9 shows the output received on the serial monitor from the GPS, which includes a location link of the bicycle's position.

Figure 10. Implementation at otoped bike

The strategic placement of components on rental media is paramount for optimal functionality. In Figure 10, the components are deliberately arranged in a separated manner to facilitate maintenance and replacement. Upon integration into a rental system, all power sources are seamlessly connected to the electric bicycle's power supply and contactor for seamless activation. To ensure reliable tracking, a compact module, such as an Arduino Mini, is employed. Alternatively, a frequency wave-based system can be implemented for enhanced tracking capabilities.

In conclusion, the designed scooter tracking monitoring system successfully met the objectives of providing real-time location tracking and communication via SMS. The system's design and implementation were validated through practical testing, demonstrating its potential for application in real-world rental scenarios. Future enhancements could include the integration of additional features such as geo-fencing, more advanced user interfaces, and improved power management strategies to further enhance the system's capabilities and user experience.

IV. Conclusions And Recommendations

The scooter tracking monitoring system developed in this project successfully demonstrates the feasibility of using off-the-shelf components to create a comprehensive and effective solution. By tracking the location of rental scooters in real time and transmitting this data via SMS to a designated mobile device, the system provides a functional and straightforward method for monitoring scooter locations. However, several opportunities exist to further enhance the system's performance, usability, and security, making it a more robust solution for rental scooter companies.

To improve the overall user experience, integrating the system with a dedicated mobile application is a key recommendation. This app could display real-time scooter locations on a map, making the process more intuitive by eliminating the need for users to open separate browser windows. Furthermore, the app could include additional features such as trip history, rental status, and notifications for low battery or approaching rental expiration, significantly enhancing the user interface and engagement.

Another crucial consideration is the reliability of the cellular network used for communication between the scooter and the monitoring system. To avoid potential disruptions in data transmission, it is essential to partner with a cellular provider offering solid coverage in the areas where the scooters will be operating. This would ensure continuous connectivity and timely delivery of location updates or alerts. Additionally, security measures need to be prioritized, particularly to protect against unauthorized access or tampering with the system. Encryption of communication and user authentication for mobile app access could provide essential safeguards against such threats.

Finally, focusing on sustainability and advanced alerting could further enhance the system's effectiveness. The integration of solar panels could reduce reliance on battery replacements, contributing to the long-term viability of the system while reducing environmental impact. Additionally, implementing advanced alert mechanisms, such as SMS or push notifications for abnormal scooter behavior, would add value by increasing safety and monitoring capabilities. By adopting these recommendations, the scooter tracking system can evolve into a more secure, efficient, and user-friendly solution for rental scooter companies.

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