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Research Article

DESIGN OF A WEB-BASED GOODS DELIVERY INFORMATION SYSTEM WITH API SERVICES AND IOT INTEGRATION AT PT. ESA MANDIRI RUBBER

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Abstract
The advancement of information technology has driven various industrial sectors, including manufacturing, to transform toward more efficient and responsive distribution systems. PT. Esa Mandiri Rubber, a rubber manufacturing company, still relies on manual processes in managing goods delivery, resulting in various issues such as delays, distribution errors, and a lack of transparency in tracking. This study aims to design a web-based goods delivery information system integrated with Internet of Things (IoT) technology and API services. The system development method used is the Waterfall method, which consists of five stages: requirement analysis, system design, implementation, testing, and maintenance. The developed system includes delivery recording, real-time tracking, IoT device data integration, and access to information through a web interface. The results of the study show that the designed system successfully replaces the previously used manual processes, enhances distribution effectiveness, and facilitates easier monitoring and reporting. Thus, this system is capable of improving operational efficiency and the quality of logistics services at PT. Esa Mandiri Rubber.

Keywords: API, Delivery, IoT, Web, Waterfall

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INTRODUCTION

In the era of digitalization and globalization, the manufacturing industry is required to have an efficient and responsive distribution system (Frontera-Bergas et al., 2025). The delivery system plays a crucial role in the supply chain as it directly affects customer satisfaction, smooth distribution, and the company's competitiveness (Kandasamy et al., 2025). Many manufacturing companies have begun adopting information technology to support logistics activities, such as real-time shipment tracking, system integration, and digital coordination across departments (Zhafar et al., 2023).

However, several companies in Indonesia still rely on manual systems for their delivery processes. One example is PT. Esa Mandiri Rubber, a rubber manufacturing company that continues to depend on manual recording and conventional coordination in its distribution activities (El-Afifi et al., 2024). This approach creates operational challenges, particularly in terms of delivery speed and accuracy (Setyaningsih & Sidqon, 2020).

PT. Esa Mandiri Rubber specifically faces issues such as ineffective reporting and monitoring of shipments (Haider et al., 2025). The absence of an integrated system makes real-time tracking difficult and increases the likelihood of errors, ranging from misplaced items to lost goods (Matekaire & Siriram, 2025). These problems become significant obstacles to achieving optimal efficiency and accuracy in the delivery process (Asmoro et al., 2021). Previous studies have discussed the use of web-based information systems to support logistics, but research focusing on the integration of IoT and external API services in medium-sized companies in Indonesia remains limited (Bellini et al., 2025). This gap highlights the research opportunity addressed in this study.

Therefore, this research aims to design a web-based delivery information system integrated with IoT technology and API services (Sathio et al., 2025). The system is expected to enable real-time tracking, improve inter-department coordination, and enhance delivery speed and accuracy (E. Putri & Matondang, 2023). By implementing this system, PT. Esa Mandiri Rubber can reduce errors caused by manual methods, increase operational efficiency, and improve overall customer service quality.

RESEARCH METHOD

Research Design

This study applies the Waterfall development model to support a structured and systematic process of system development (Adhiwibowo et al., 2025). The model consists of sequential phases, namely planning, requirement analysis, system design, implementation, testing, deployment, and maintenance. This approach was chosen because it provides a clear and linear workflow, making it suitable for the design and development of a web-based delivery information system integrated with IoT devices and API services.

Research Target/Subject

The research target is the delivery management process at PT. Esa Mandiri Rubber, which faces challenges such as shipment delays, errors, and lack of transparency due to its manual system (Mazumdar et al., 2025). The research subjects include warehouse staff, logistics personnel, and shipping administration officers, who were directly involved in providing information regarding workflows, operational issues, and system requirements.

Research Procedure

The research procedure was adapted from the stages of the Waterfall model, which consist of the following phases (Odesanya & Famosipe, 2025): First problem Identification Identifying inefficiencies in delivery management, such as delays, errors, and lack of shipment visibility. Second literature Study Reviewing references on IoT, API services, and web-based systems to establish theoretical foundations and best practices. Thirt data Collection Conducted through observation of delivery workflows and interviews with warehouse and logistics staff to capture detailed requirements. Fourth system Design Designing system architecture, user interfaces, ERD diagrams, and IoT integration models using tools such as Draw.io. Fifth implementation Developing the system using PHP with the CodeIgniter framework, MySQL for database management, and ESP32 microcontrollers for IoT device integration. Sixth testing Applying black-box testing to evaluate functional aspects of forms and modules, ensuring system functionality aligns with specifications. Seventh deployment and Maintenance Deploying the system to the production environment and performing maintenance to ensure system stability.

Instruments, and Data Collection Techniques

Data collection in this study was conducted using several complementary techniques. Direct observation was carried out on the existing delivery process, starting from order processing to shipment, with the aim of identifying bottlenecks and potential areas for improvement. In addition, semi-structured interviews were conducted with warehouse staff, logistics officers, and shipping administrators to validate system requirements and uncover operational issues. To strengthen the theoretical foundation, this study was also supported by a literature review involving the analysis of books, academic journals, and relevant online resources related to Internet of Things (IoT), API services, and logistics systems.

Data Analysis Technique

The data obtained were analyzed qualitatively and functionally (Zeng et al., 2025). Qualitative analysis was used to identify existing problems and user requirements, while functional analysis ensured that the developed system addressed these problems. Black-box testing results were evaluated to validate that each module operated according to predefined specifications (Hassan et al., 2025). The analysis emphasized improvements in operational efficiency, reduction of errors, and enhancement of shipment transparency and customer satisfaction.

RESULTS AND DISCUSSION

System Development Results

The system development process was carried out using the Waterfall methodology, starting from planning, requirement analysis, design, implementation, testing, until deployment (Baskaran & Byun, 2025). The final system provides modules for delivery order creation, shipment tracking with IoT devices, real-time monitoring through API integration, and delivery reporting.

The results of user observation and interviews confirmed several critical problems in the existing workflow: manual documentation of delivery orders, lack of shipment transparency, and high risk of delivery errors such as delays or misplaced items (De Felice et al., 2025). After the system was deployed, functional testing was conducted using black-box testing. The results are presented in Table 1.

Table 1. Results of Black-Box Testing on Realtime Delivery System With IoT and API Servces

No.	Test Scenario	Expected Output	Result	Status
1	Create new delivery order with valid data	Delivery order successfully saved to database	OK	Passed
2	Assign delivery order to courier	Delivery order assigned and recorded in system	OK	Passed
3	IoT device sends GPS location	Location data updated in real-time on system	OK	Passed
4	API retrieves shipment tracking status	Status displayed and synchronized correctly	OK	Passed
5	Generate delivery report	Report displayed/exported correctly	OK	Passed

System Workflow

The system workflow illustrates the end-to-end process of delivery management at PT. Esa Mandiri Rubber. It starts when the warehouse administrator creates a delivery order containing customer data, product details, and delivery schedule. Once created, the system assigns the order to a courier, who is equipped with an IoT-enabled device (ESP32 with GPS).

During the delivery, the IoT device automatically sends location data to the server in real time, which is displayed on the web dashboard (Kharche et al., 2024). At the same time, the system integrates with external API services to synchronize delivery status, ensuring transparency and accountability. If any issue occurs (such as delay or incorrect route), the system provides notifications to both the administrator and the customer. The workflow ensures that each delivery is traceable, transparent, and aligned with company standards.

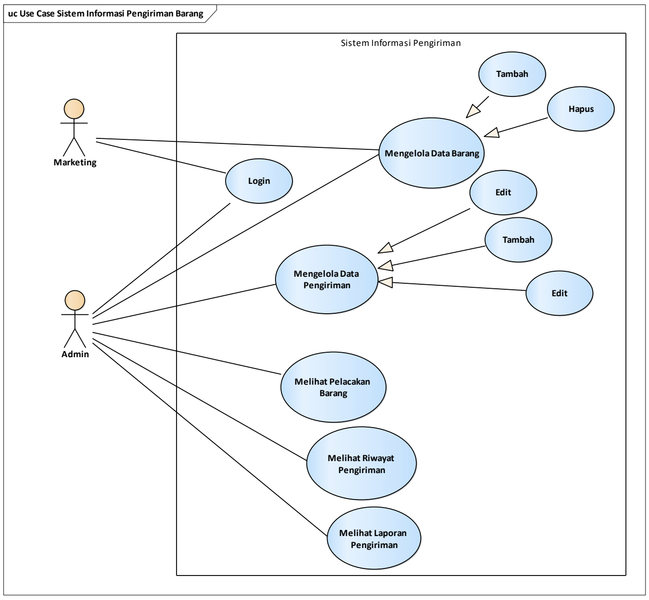

Figure 1. Use Case Diagram System

The Use Case Diagram of the system, showing the interactions between users and the system's main functionalities. The diagram typically identifies key actors such as warehouse staff, logistics officers, and administrators, each performing specific tasks like managing orders, tracking shipments, and updating delivery status. It highlights how the system facilitates communication between these actors and integrates core processes to ensure efficient delivery management.

Database Schema / ERD

The database schema was designed to ensure structured, accurate, and real-time management of delivery operations. It consists of core entities such as Users, Delivery Orders, Locations, IoT Devices, and Shipment Status (Li et al., 2025). Users store role-based access for administrators, couriers, and managers, while Delivery Orders capture essential shipment details including customer, product, and schedule. Locations are integrated with GPS coordinates for precise tracking, IoT Devices log data from ESP32 modules, and Shipment Status maintains updates synchronized from IoT and API services (Kumar et al., 2025). This relational design supports data integrity, enables seamless integration, and facilitates comprehensive reporting for operational analysis.

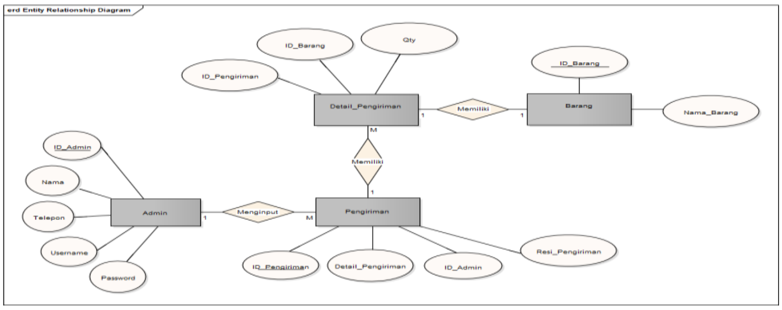

Figure 2. Entity Relatonship Diagram

Figure 2 presents the Entity Relationship Diagram (ERD) of the system, which describes the structure of the database and the relationships between its entities. The diagram illustrates key entities such as orders, products, customers, and shipments, along with their attributes and how they are interconnected. It provides a clear representation of data organization, ensuring consistency, integrity, and efficient data management within the system.

User Interface

The user interface (UI) was developed with a focus on usability, responsiveness, and accessibility across desktop and mobile platforms (Morchid et al., 2025). Warehouse administrators manage shipment data through structured forms, couriers update delivery progress using mobile views, and managers monitor performance via dashboards and reporting modules (Brandín & Abrishami, 2024). Features such as real-time shipment tracking, progress indicators, color-coded statuses, and alert notifications enhance transparency and decision-making (Ullah et al., 2025). Exportable reports in PDF or Excel formats further support managerial analysis, while the overall UI design improves efficiency, accuracy, and user satisfaction in the delivery process.

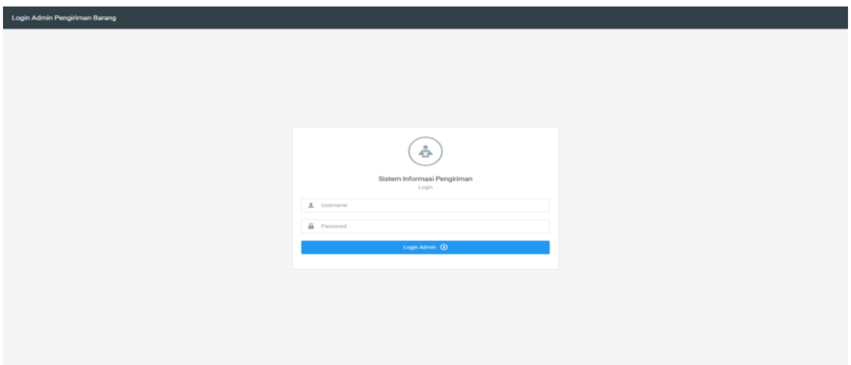

Figure 3. Login View

Figure 3 shows the Login View of the system, which provides the interface for users to securely access the application. This view typically includes input fields for username and password, along with authentication features to verify user credentials. It ensures that only authorized users can enter the system and access its functionalities based on their roles.

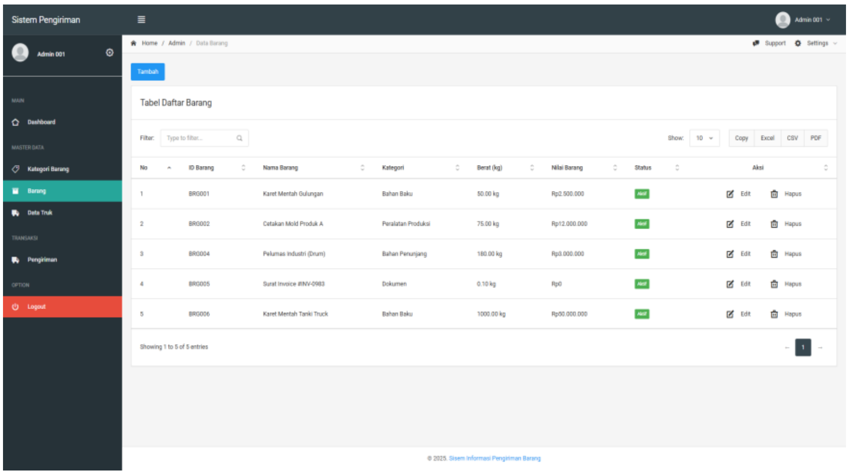

Figure 4. Goods Data View

Figure 4 presents the Goods Data View of the system, which displays detailed information about stored items within the warehouse. This view typically includes data such as item names, codes, quantities, and categories, allowing users to monitor and manage inventory efficiently. It supports accurate record-keeping and helps ensure that stock levels are properly maintained and updated.

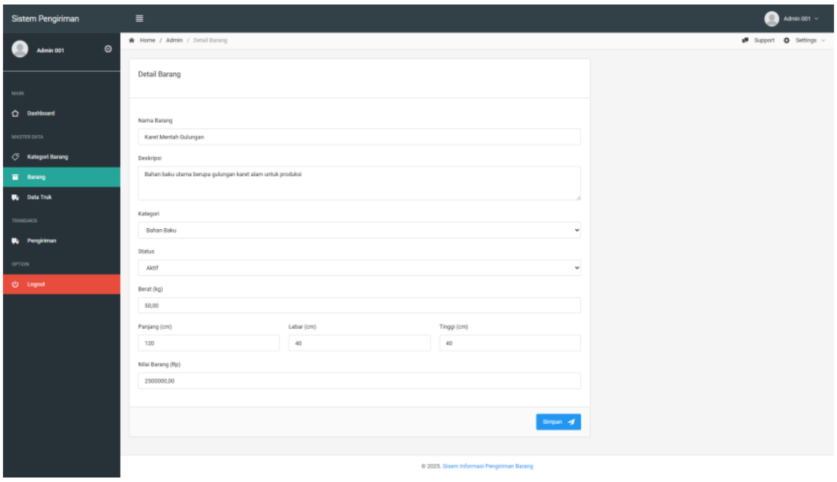

Figure 5. Goods Detail View

Figure 5 presents the Goods Detail View of the system, which provides comprehensive information about a specific item in the inventory. This view typically includes detailed attributes such as item code, name, description, quantity, and related transaction history, allowing users to monitor item status more precisely. It supports better decision-making by offering a clear and complete overview of each product.

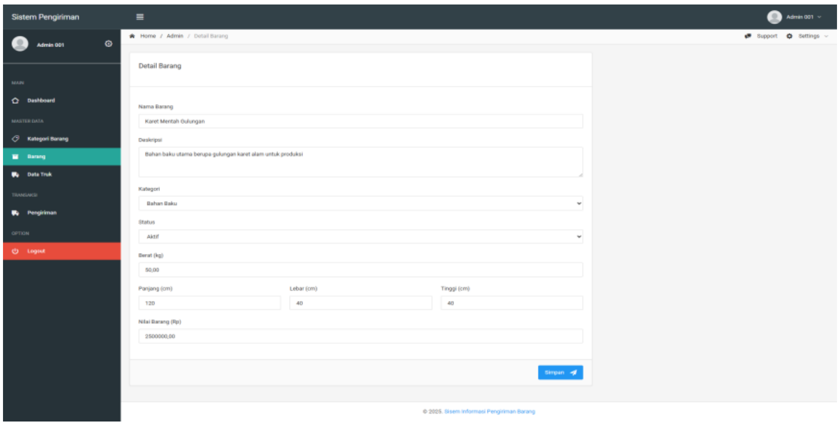

Figure 6. Truck Data View

Figure 6 presents the Truck Data View of the system, which displays detailed information about the vehicles used in the delivery process. This view typically includes data such as truck identification, capacity, status, and availability, allowing users to manage transportation resources effectively. It supports efficient logistics planning by ensuring that the appropriate vehicles are assigned to each shipment.

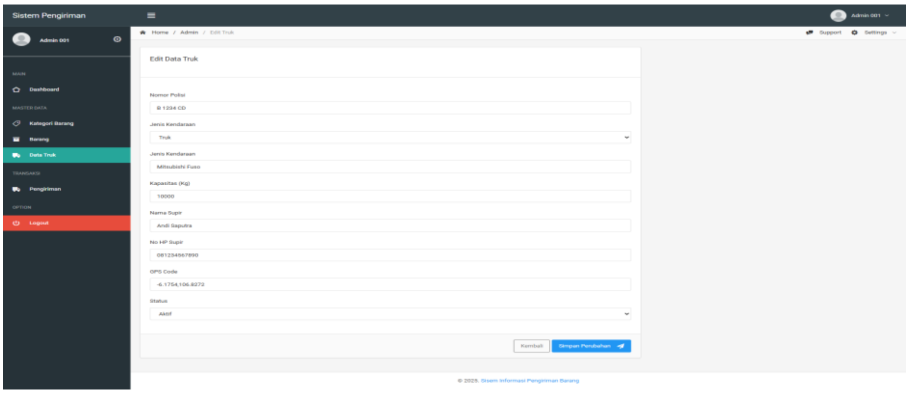

Figure 7. Truck Detail View

Figure 7 presents the Truck Detail View of the system, which provides comprehensive information about a specific vehicle used in the delivery process. This view typically includes details such as truck identification, capacity, condition, assigned routes, and current status, allowing users to monitor and manage each vehicle more accurately. It supports better logistics coordination by offering a clear and detailed overview of truck utilization.

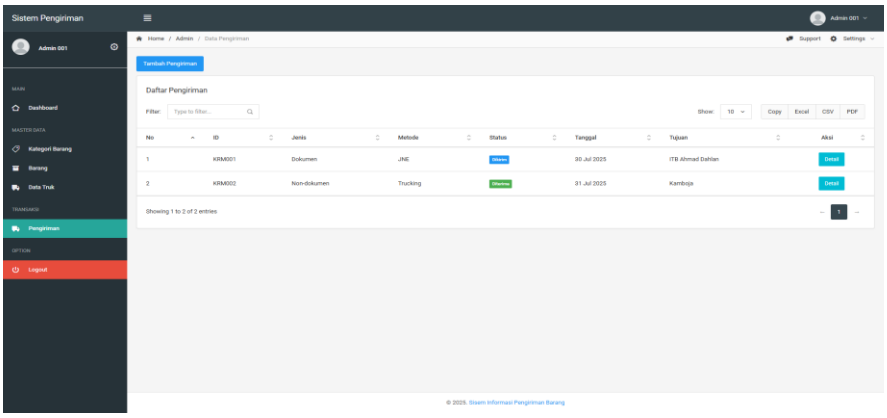

Figure 8. Delivery Main Menu View

Figure 8 presents the Delivery Main Menu View of the system, which serves as the central interface for accessing delivery-related features. This view typically provides navigation options to manage shipments, monitor delivery status, assign vehicles, and view logistics data. It helps users efficiently control and coordinate delivery operations through a structured and user-friendly menu.

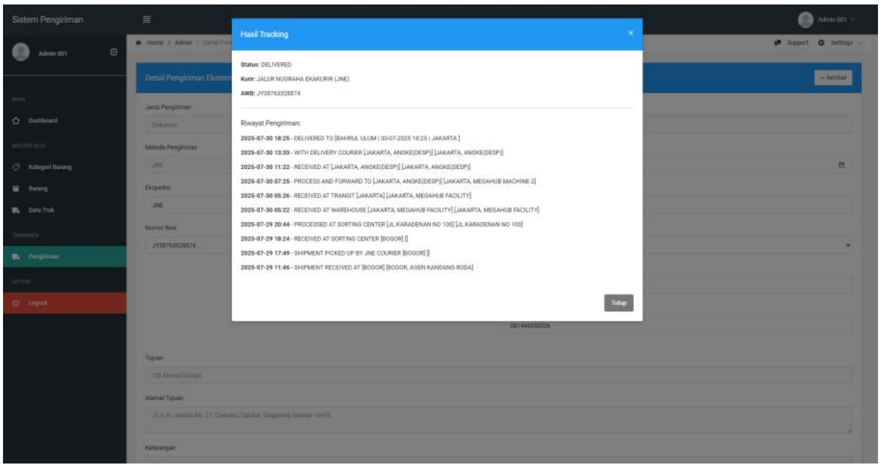

Figure 9. Tracking Document with API

Figure 9 presents the Tracking Document with API feature, which enables real-time monitoring of shipment status through integration with external services. This view typically displays tracking information such as delivery progress, location updates, and document verification results retrieved via API. It enhances transparency and accuracy in the delivery process by providing up-to-date information to users.

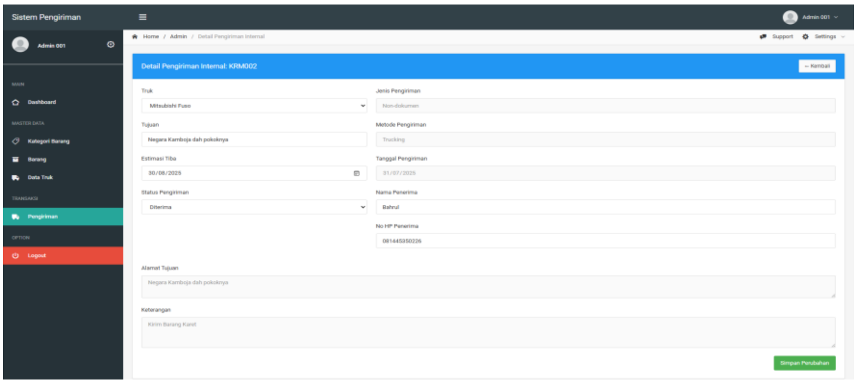

Figure 10. Trucking Delivery Detail

Figure 10 presents the Trucking Delivery Detail view of the system, which provides comprehensive information about a specific delivery operation. This view typically includes details such as shipment data, assigned truck, delivery route, schedule, and current status, allowing users to monitor the progress of each delivery accurately. It supports effective coordination and decision-making in managing transportation activities.

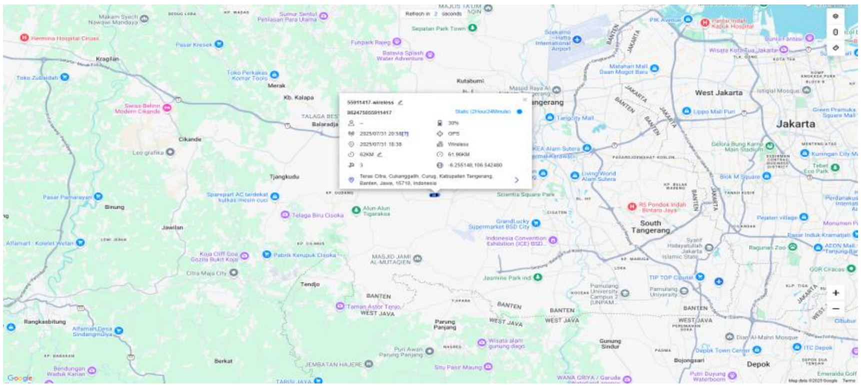

Figure 11. Realtime Tracking

Figure 11 presents the Realtime Tracking feature of the system, which enables users to monitor the live location and status of deliveries as they occur. This view typically displays dynamic updates such as current position, movement progress, and estimated arrival time, allowing users to track shipments with high accuracy. It enhances operational visibility and improves decision-making by providing up-to-date delivery information.

CONCLUSION

This study demonstrates that the integration of IoT and API services into a web-based delivery management system can effectively address inefficiencies in logistics operations. The implemented system improves shipment accuracy, reduces delays and errors, and enhances transparency through real-time monitoring and structured delivery workflows.

The scientific contribution of this research lies in showing how IoT enables real-time data acquisition and tracking, while API services ensure interoperability across heterogeneous systems, resulting in a more automated, transparent, and data-driven logistics framework. This integrated approach provides a foundation for future studies on predictive analytics, third-party logistics (3PL) integration, and broader IoT adoption to further optimize delivery performance.

AUTHOR CONTRIBUTIONS

Author 1 : Conceptualization; Data curation; Formal analysis; Methodology; Project administration; Software development; Validation; Writing original draft; Writing-review and editing.

Author 2 : Conceptualization; Investigation; Supervision; Validation; Writing review and editing.

Author 3 : Investigation; Methodology; Supervision; Resources; Validation.

CONFLICTS OF INTEREST

The authors declare no conflict of interest. The affiliated organization had no role in the design of the study, data collection and analysis, manuscript preparation, or the decision to publish the results..

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