GAS Journal of Engineering and Technology (GASJET)

Volume 3 | Issue 3, 2026 Homepage: https://gaspublishers.com/gasjet-home/ ISSN: 3048-5800

Development of Truck Haulage System for Bua Cement Company

Promise Ojochenimi ODIBA, John Temitope OGBITI & Victoria Efe UNAWARE

Department of Computer Science, Edo State University Iyamho, Auchi Edo State Nigeria

Received: *20.02.2026* | ***Accepted:*** *26.02.2026* | ***Published:*** *13.03.2026*

***Corresponding Author:** John Temitope OGBITI

DOI: *10.5281/zenodo.18998998*

Abstract **Original Research Article**

Efficient logistics and haulage operations are critical to the success of large-scale manufacturing industries, especially in sectors like cement production where timely distribution directly affects revenue and market presence. This study focuses on the development of a computerized truck haulage system tailored for BUA Cement Company to replace the existing manual and semi-automated logistics processes. Based on the insights gained, a centralized web-based haulage system was proposed and designed using modern software engineering practices, featuring modules for trip scheduling, truck tracking, driver assignment, delivery monitoring, and report generation. The result is a functional prototype that improves dispatch accuracy, reduces turnaround time, ensures data integrity, and enhances operational visibility across the company's haulage operations.

Keywords: Fleet Management, Logistics, Real-Time Monitoring, Route Optimization, Tracking System.

INTRODUCTION

In the contemporary industrial landscape, efficient logistics and haulage management systems have become critical to maintaining competitiveness and operational excellence. The cement manufacturing sector, characterized by bulk production and continuous distribution cycles, is particularly dependent on robust transportation systems [1]. In Nigeria, BUA Cement Company [2] stands as one of the leading producers of cement with extensive distribution demands across various states. The company's haulage operations involve coordinating a large fleet of trucks, drivers, loading points, delivery destinations, maintenance schedules, and feedback mechanisms functions that are often difficult to manage using traditional or manual methods. The truck haulage process, when poorly managed, can lead to a cascade of inefficiencies including under-utilization of vehicles, delayed deliveries, increased fuel consumption, maintenance neglect, route mismanagement, poor accountability, and customer dissatisfaction. Additionally, the absence of a centralized system to monitor truck movement and analyse haulage data in real-time poses significant operational challenges. Modern technological advancements in software engineering, database systems, GPS integration, and logistics optimization offer practical solutions to these challenges. These technologies have given rise to haulage management systems that provide end-to-end automation, from dispatch scheduling to delivery confirmation. This study is therefore motivated by the need to develop a comprehensive, scalable, and intelligent Truck Haulage Management System (THMS) tailored to the logistics needs of BUA Cement Company. The proposed system will facilitate real-time monitoring, automated route planning, truck assignment, maintenance tracking, and data analytics to support decision-making. By transitioning from semi-automated or manual systems to an integrated software-driven approach, the company can achieve higher levels of efficiency, cost-effectiveness, transparency, and service delivery.

RELATED WORK

The reviewed related works reveal a steady evolution in truck haulage systems, especially for industrial sectors like cement logistics. Ahmed, S [3] developed a fleet management information system to assist logistics firms in managing their vehicle operations efficiently, integrating GPS-based vehicle tracking. . Early innovations in 2018 focused on basic digitization of transport logs and simple fleet monitoring. Eventually, from 2021–2023, emphasis shifted to intelligent systems such as GPS-enabled tracking, IoT-based maintenance, and automated dispatch optimization. Studies by Nwachukwu, C [4] highlighted the importance of implementing IoT sensors and large data analytics in fleet optimization, proposing real-time vehicle tracking, fuel usage and delivery status through a centralized dashboard. Recent System's like Yusuf, H [5] Machine Learning-Based Maintenance System illustrates how a predictive maintenance framework can utilize machine learning models to manage truck engine data and historical service logs, helping logistics managers to schedule maintenance before a breakdown occurs. More recent works (2024–2025) integrate advanced technologies like block chain for delivery verification, AI for predictive maintenance and smart scheduling, as well as mobile apps and geofencing for real-time driver supervision and route management. Collectively, these studies highlight an industry-wide shift toward automation, accountability, and real-time data utilization in haulage systems.

METODOLOGY

The system methodology was based on the OOAD framework, which supports reusability, maintainability, and scalability. This methodology enabled the modelling of real-world entities like trucks, drivers, dispatchers, and trips as objects, each with their own attributes and functions. System requirements were gathered iteratively, with users (dispatch managers and IT personnel) consulted during every sprint. Prototypes were developed and tested early to identify usability issues and guide improvements. The agile model ensured that the system evolved through continuous feedback, reducing the likelihood of user rejection.

3.1 Data Collection Method

In designing the proposed system, a variety of data collection methods were employed to gather accurate, practical information from the field and stakeholders. Structured Interviews conducted with dispatchers, logistics officers, and drivers to understand their workflow and challenges. Questionnaires distributed to operational staff to gather feedback on system requirements, interface preferences, and common logistical issues. Direct Observation from field visits were made to observe how trucks are currently scheduled, loaded, dispatched, and monitored in real time. Document Review from existing transport logs, waybills, and reports were analysed to identify patterns and inconsistencies that could inform system features. Comparative Stud from analysis of similar systems used by logistics firms to identify industry-standard features and gaps in the current BUA process. These methods ensured that the system requirements were based on real-world practices and that the final design would meet user needs effectively.

3.2 Data Coding and Categorization

Data coding was carried out to convert qualitative feedback into structured and analysable formats. Responses from interviews and open-ended questionnaire items were first grouped into categories such as logistics tracking, delivery efficiency, system challenges, and documentation issues. Each category was then assigned a code for easy reference and sorting. Quantitative data were similarly categorized based on variables like truck type, route, trip duration, and frequency of maintenance. The categorization enabled correlation analysis and pattern detection, which helped identify operational inefficiencies. The structured data were then fed into spreadsheets for sorting, filtering, and analysis.

3.3 User Design

The user design phase focused on developing a user-friendly interface that caters to the needs of different users such as dispatch officers, truck drivers, and administrative personnel. Key considerations included Simplicity and clarity of navigation, Role-based access and permissions, Real-time truck tracking dashboard, automated report generation and alerts. Mock-ups and wireframes were created to visualize system components, followed by user feedback sessions to refine design choices. The design ensures that even users with minimal technical knowledge can effectively operate the system, thereby reducing the learning curve and improving adoption.

Figure 1 shows the sequence diagram which illustrates the step-by-step interactions between different system components and users during a specific process, outlining the flow of messages between objects in a time-ordered sequence. For the truck haulage system, one key sequence involves the process of assigning and completing a delivery.

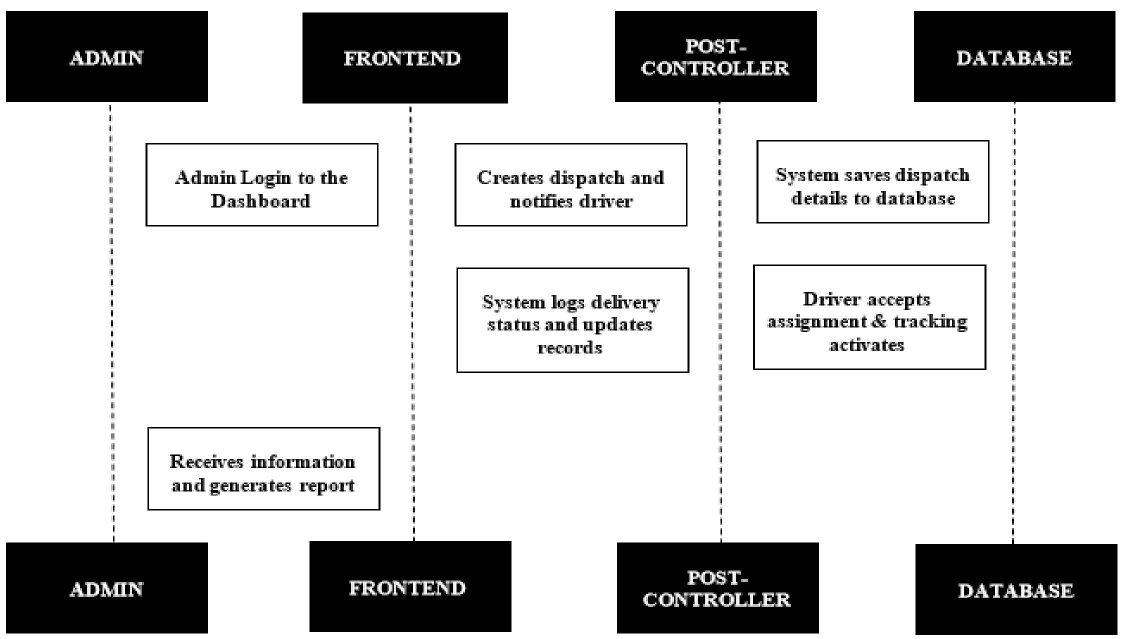

Figure 1: Sequence Diagram

Figure 2 represents the logic design using flowcharts to visually outline the system's decision-making process. For instance, a dispatch request processing flowchart would include the following key blocks.

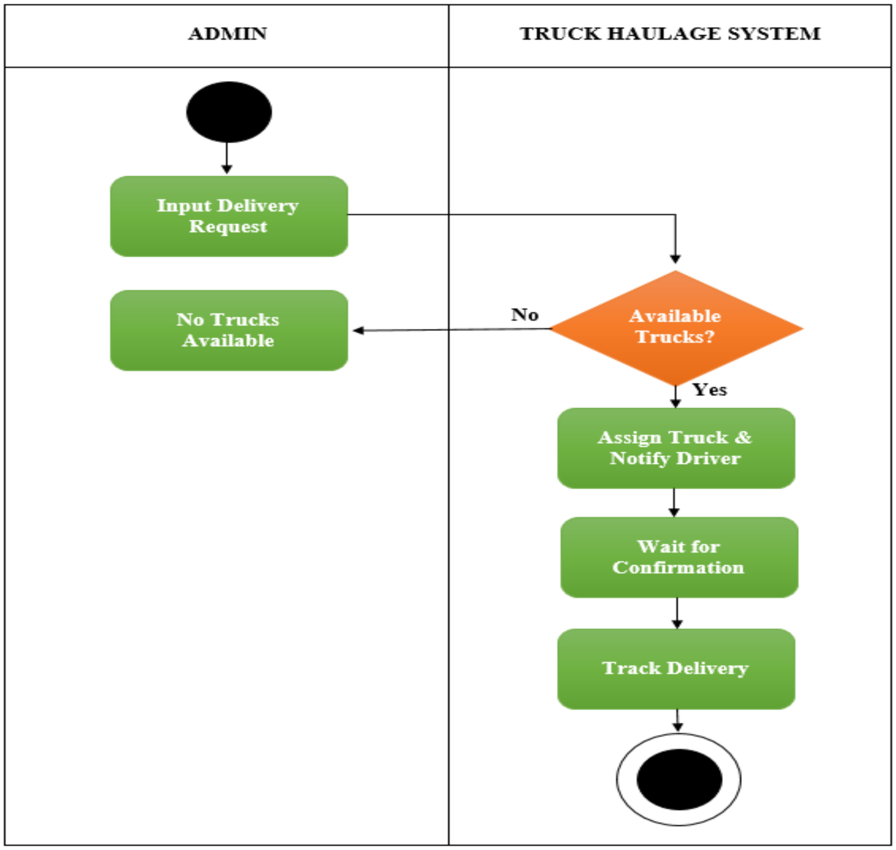

Figure 2: Logic Design (Flowchart)

4. RESULTS AND DISCUSSION

The implementation process was carried out incrementally, beginning with the setup of the development environment and proceeding through the development of modules such as authentication, booking, payment integration, and real-time delivery tracking. The system was implemented using a client-server architecture, with the frontend developed in TypeScript/React and the backend developed in TypeScript/Node.js, connected to a MongoDB database. The backend handled all business logic, data storage, and security controls, while the frontend provided an interactive interface for both administrators and customers. Real-time features, such as delivery status updates and truck tracking, were enabled using Web Socket technology, while payment processing was simulated using secure form submissions and API endpoints. To ensure reliability, the system was developed in iterations, with each module tested before integration into the larger application. For instance, the authentication module was implemented and tested separately before being connected to the dashboard module. This modular approach reduced errors and ensured that each functional requirement was thoroughly validated. The implementation also included data migration from existing manual records into the system for testing purposes. This allowed the research team to evaluate how the system handled real operational data, such as booking history, payment records, and truck allocations. The resulting data formed the basis for the analysis and visualizations presented in the following section.

4.1 Data Presentation

Data presentation is a critical aspect of the implementation phase, as it demonstrates how the system organizes, stores, and displays logistics information in a structured manner. In the Truck Haulage System, data such as booking records, payment statuses, and delivery progress are stored in the MongoDB database and retrieved dynamically through the backend. The frontend then formats and presents this information in user-friendly tables, charts, and dashboards. The data presentation process serves two key purposes:

1. Validation of System Functionality: By examining how booking, payment, and delivery records are captured and displayed, it becomes evident that the system meets its functional requirements.

2. Decision-Making Support: Administrators and customers can interpret visualized data to make informed decisions. For example, administrators can quickly identify overdue deliveries from the dashboard, while customers can track the status of their bookings in real time.

To enhance clarity, data were represented using a combination of tables, figures, and graphs. Tables were employed to display detailed records such as booking IDs, customer names, assigned trucks, and delivery statuses. Figures such as screenshots of dashboards and forms were included to show how users interact with the system. Graphs and charts were generated to provide insights into trends, such as the ratio of completed to pending deliveries or the distribution of paid versus unpaid bookings.

The line chart in Figure 3 illustrates the number of truck bookings from January to June. It shows a clear upward trend, with bookings rising from 25 in January to 60 in June. This indicates increasing system adoption and customer reliance over time. The steady growth reflects improved efficiency and trust in the haulage system.

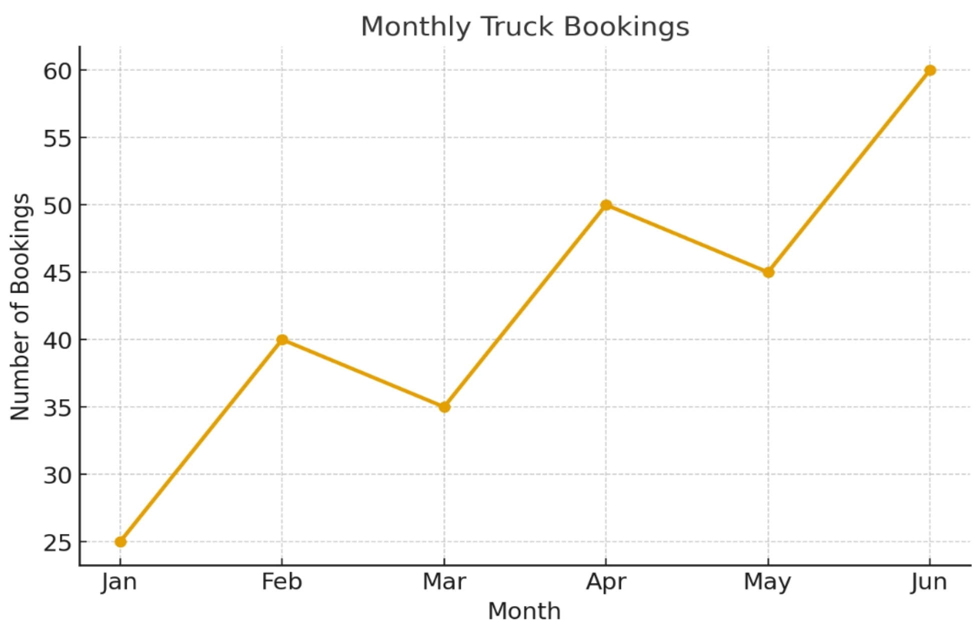

Figure 3: Monthly Truck Bookings

Figure 4 is a pie chart highlights the distribution of payment methods among customers. Online Payment (45%) is the most preferred method, followed closely by Bank Transfer (40%), while

Cash payments (15%) are less common. This suggests that the system should continue prioritizing secure online transactions while still accommodating traditional methods for inclusivity.

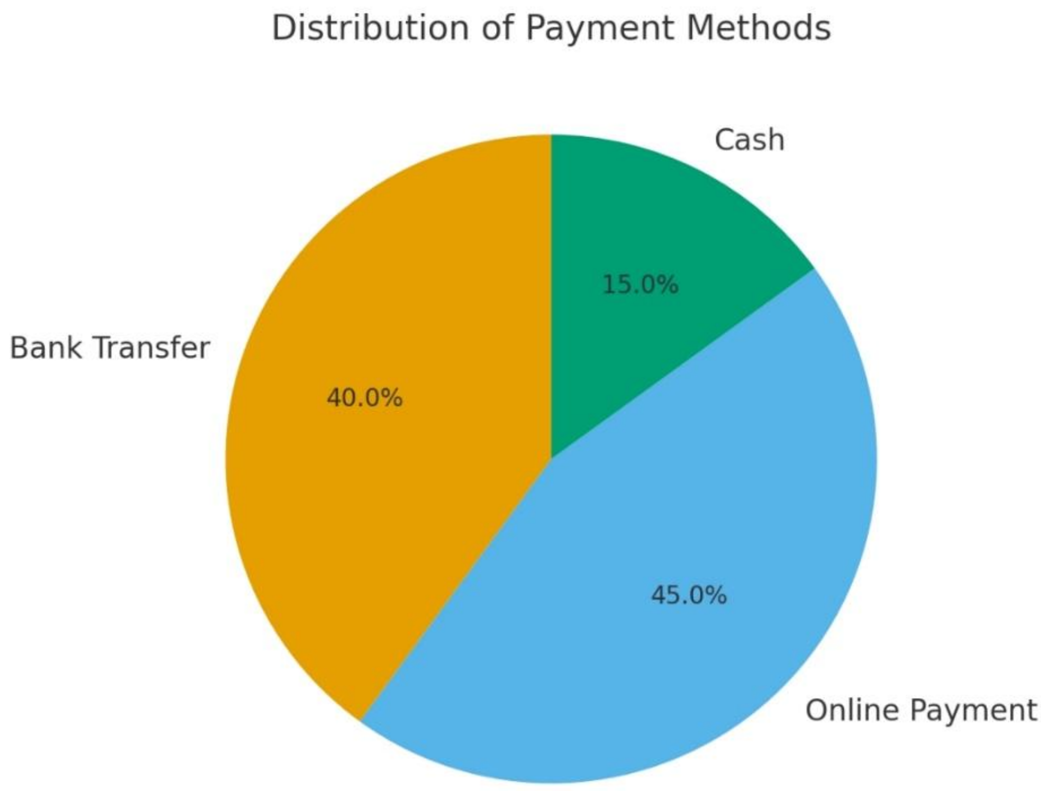

Figure 4: Distribution of Payment Methods

4.2 System Modules

1. Figure 5 and 6 are the authentication modules, designed to control access to the system based on user credentials. It distinguishes between two primary user roles—Administrator and Customer. Authentication is implemented using a secure login system backed by JSON Web Tokens (JWT), ensuring that only authorized users can access their respective dashboards. Customers are able to sign up, log in, and manage their bookings, while administrators log in to oversee and manage the overall haulage operations.

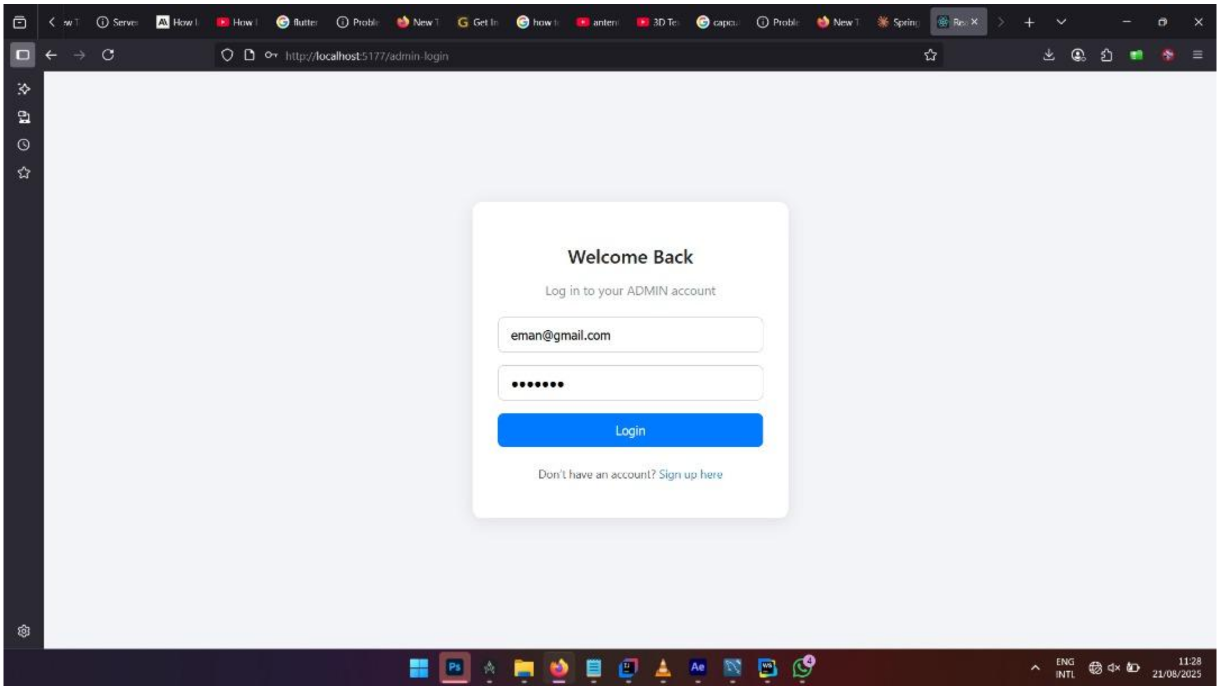

Figure 5: Administrator Login

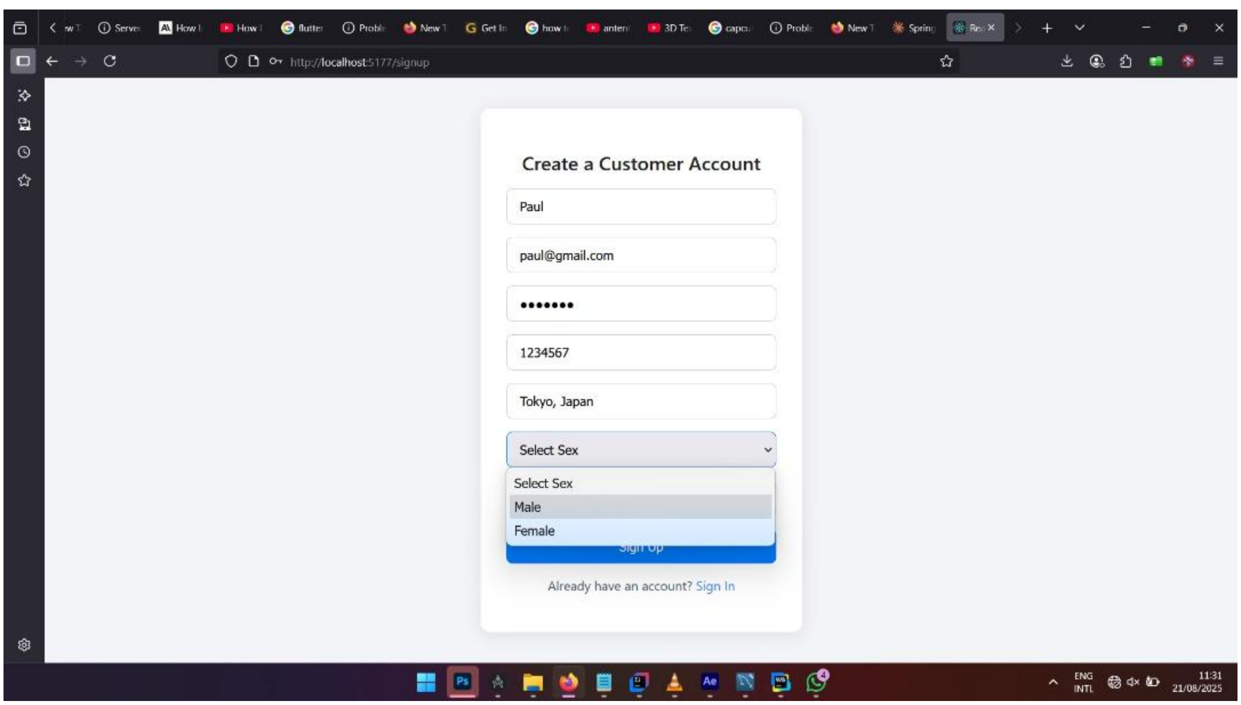

Figure 6: Customer Account Creation

2. Figure 7 is the dashboard module providing a central interface where users can view key system features at a glance. It displays booking records, truck availability, and service packages in a clear layout, making navigation simple. Users can quickly select haulage packages, track ongoing bookings, and access important updates. This design ensures efficiency, easy monitoring, and faster decision-making.

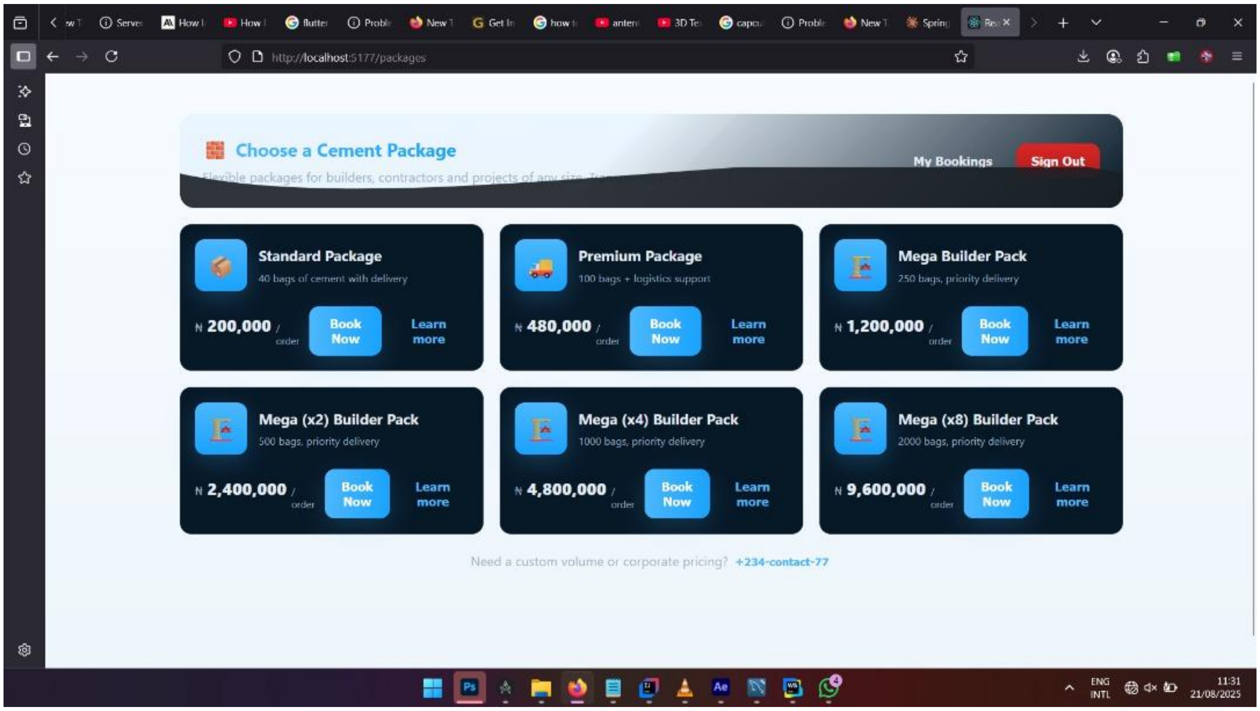

Figure 7: Dashboard Module

3. Figure 8 and 9 shows the role-specific interfaces provided by the dashboard module. Figure 8 is the Administrator Dashboard where the administrators are provided with a central dashboard that allows them to view all bookings, monitor their current status, and delete bookings where necessary (e.g., duplicate or invalid requests). This ensures control over system activities and helps maintain accuracy in haulage operations. While, Figure 9 shows the Customer Dashboard where Customers interact with a user-friendly dashboard where they can create new bookings, select preferred routes, and make payments for services. Additionally, they can view booking details such as assigned trucks and delivery status. The module also allows customers to delete bookings if necessary, providing flexibility and control over their transactions.

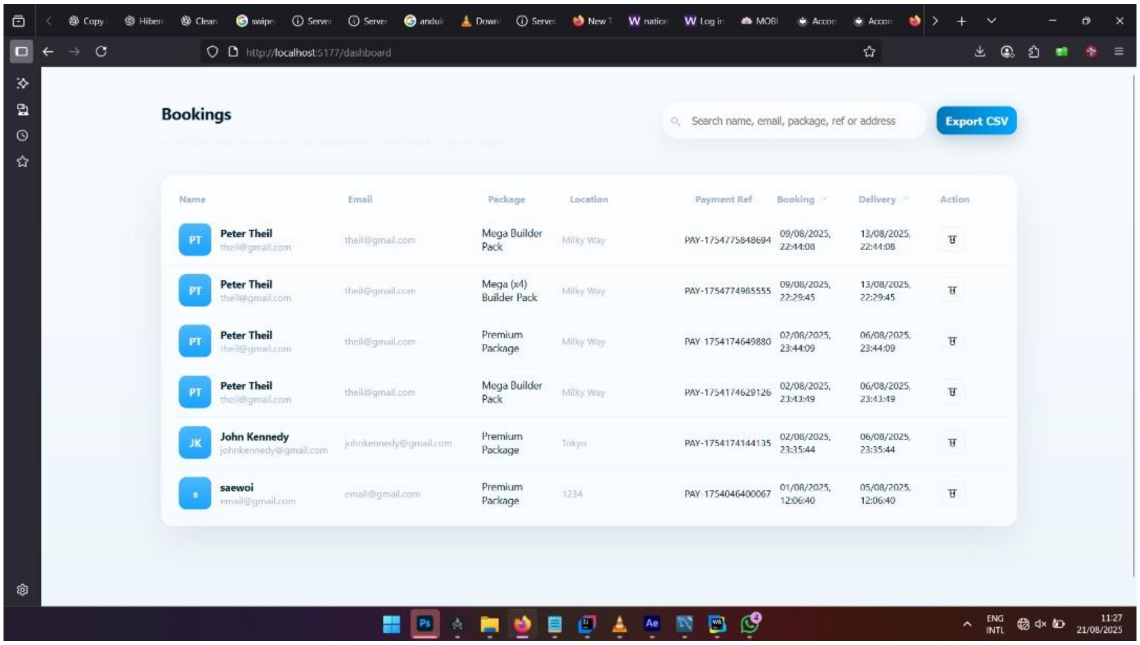

Figure 8: Admin Booking Management

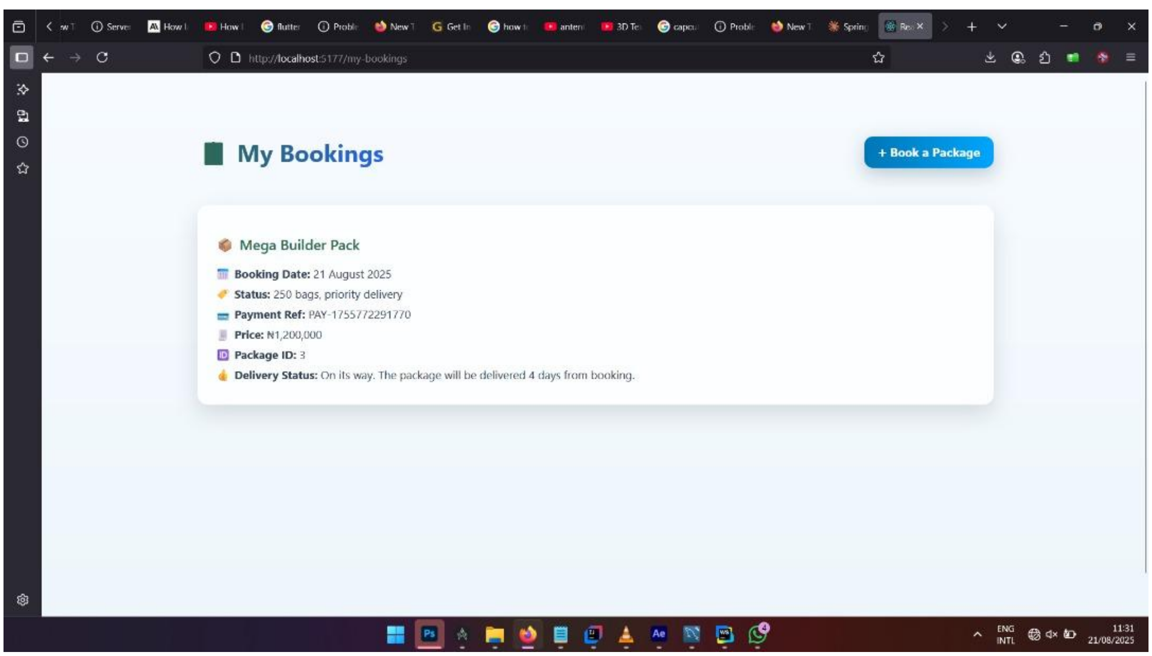

Figure 9: Customer Booking

4.3 System Testing

System testing is a critical phase carried out to ensure that the developed haulage management system meets its functional and non-functional requirements. The testing process involved verifying each module (authentication, dashboard, and booking) to confirm they operated as expected, with emphasis on accuracy, usability, security, and performance. The testing strategy used was black-box testing, focusing on input and output validation rather than internal code structures. Sample booking entries, login attempts, and dashboard interactions were tested for correctness. Table 1 demonstrates that the system's function perform as expected, with no major defects encountered during the testing phase.

TEST CASE	INPUT	EEXPECTED OUTPUT	ACTUAL OUTPUT	STATUS
Admin Login	Valid Credentials	Redirect to Admin Dashboard	Successful	Pass
Admin Login (Invalid)	Wrong Password	Display Error Message	Successful	Pass
Customer Registration	Valid Credentials	Account Created, Redirect to Login	Successful	Pass
Customer Booking	Valid Booking Details	Booking Saved and Displayed on Dashboard	Successful	Pass
Payment Processing	Valid Payment Details	Transaction Successful	Successful	Pass
Role Selection	User Selects "Admin" or "Customer"	Redirect to Respective Dashboard	Successful	Pass
Delete Booking	Customer Cancels Booking	Record Removed from Dashboard	Successful	Pass

Table 1: System Testing Results

5. CONCLUSION

This study set out to design and implement a Truck Haulage System for BUA Cement Company, with the primary aim of addressing inefficiencies associated with manual processes of truck scheduling, record management, and delivery monitoring. Beginning with the background of the study, highlighting the importance of effective logistics and fleet management in the cement industry, while also identifying the pressing challenges faced by BUA Cement, such as delays, human error, lack of real-time monitoring, and data inconsistency. The chapter also established the research objectives, scope, and significance, providing a solid foundation for the project. A detailed literature review of Related Works followed after and was conducted to situate the study within existing research and practical developments. Prior studies on haulage management systems, enterprise resource planning (ERP), geofencing, and autonomous route assignment were examined. The review revealed both theoretical and empirical gaps, particularly in the integration of haulage operations with digital management systems in Nigerian industries. This provided justification for the system proposed in this work. Chapter Three focused on the system analysis and design. The proposed methodology was outlined, including requirement analysis, data collection techniques, and design modelling using use case diagrams, sequence diagrams, and database structures, emphasizing on how the system architecture was built to ensure efficiency, scalability, and user-friendliness. The design phase provided a blueprint for system implementation. In Chapter Four, the implementation, results, and discussions were presented. The system was developed using suitable technologies, tested with sample data, and evaluated for functionality. The results showed that the system improved operational efficiency by automating truck scheduling, enhancing data accuracy, and reducing delays in haulage management. The findings confirmed that the objectives outlined in Chapter One were largely achieved. However, the chapter also acknowledged certain limitations such as the restricted scope of features and limited real-world pilot testing.

Drawing all these together, the study has demonstrated that a computerized truck haulage system can significantly enhance logistics operations in the cement industry, particularly for a large-scale organization like BUA Cement Company. By digitizing core processes, the system reduces human error, supports better decision-making, and lays a foundation for more advanced future enhancements such as real-time tracking and predictive analytics.

In conclusion, the research has successfully bridged the gap between theory and practice by providing both a conceptual framework and a working prototype of a haulage management system. Although there are limitations, the study contributes meaningfully to logistics management research and offers a practical solution that, if adopted and scaled, can transform haulage operations in BUA Cement Company and similar organizations.

REFERENCES

[1] National Bureau of Statistics (2023). Transport and logistics report in Nigeria. Abuja: NBS Publications.

[2] BUA Cement Plc. (2024). Annual report and financial statement. Retrieved from https://www.buacement.com

[3] Ahmed, S. (2018). Fleet management information system. Journal of Transportation Systems and Logistics, 12(3), 45–53.

[4]Nwachukwu, C. (2023). Fleet optimization using IoT and big data. International Journal of Intelligent Logistics Systems, 12(2), 33–42.

[5] Yusuf, M. (2025). Machine learning-based predictive maintenance for haulage fleets. Journal of Artificial Intelligence in Logistics, 13(2), 90–101.