Journal of Information Technology, computer science and Electrical Engineering (JITCSE)
Vol. 2, No. 2, June 2025, pp. 74~82
ISSN: 3046-4900, DOI: 10.61306/jitcse

Analysis and Design of Web-Based Vehicle Management Information Systems to Support Operational Efficiency

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ABSTRACT

Operational efficiency is a top priority for organizations, with effective vehicle management being a crucial component. This research analyzes and designs a web-based Vehicle Management Information System aimed at optimizing vehicle utilization, reducing operational costs, and enhancing accountability. Addressing the problem of error-prone manual fiscal depreciation calculations, this system is designed to automate the process, ensuring greater accuracy and traceability. System analysis is conducted through visual modeling using the Unified Modeling Language (UML). The Activity Diagram maps the workflow of various user roles (Administrator, Operational Staff, Manager) in managing vehicle data, inputting usage and costs, and scheduling services. The Sequence Diagram further details the message interactions between system components (users, system, database) for each core functionality. Meanwhile, the Class Diagram presents the static structure of the system, defining key entities such as User, Vehicle, OperationalCost, Usage, Depreciation, and ServiceSchedule, along with their attributes and relationships. This system is designed for implementation using web-based frameworks like Laravel or CodeIgniter, adhering to the Model-View-Controller (MVC) architecture. This approach is chosen to ensure modularity, ease of maintenance, and enhanced system security. Consequently, the proposed system is expected to provide accurate and timely information, significantly supporting operational efficiency in the management of organizational vehicle assets.

Keyword: Information System; Vehicle Management; Web-Based; Operational Efficiency; UML; Laravel.

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Article history:
Received Jun 03, 2025
Revised Jun 10, 2025
Accepted Jun 13, 2025

1. INTRODUCTION

Operational efficiency is a key goal for many organizations, and effective vehicle management plays a crucial role in achieving this goal (Ali et al., 2021). The web-based Vehicle Management Information System offers comprehensive solutions to optimize vehicle utilization, reduce operational costs, and increase accountability (Andria, 2023). Fiscal depreciation calculations that were previously done manually using Excel spreadsheets have the risk of errors and tracking difficulties (Nasrul et al., 2024). By automating this process, vehicle management information systems can help minimize risk and improve accuracy (F.P et al., 2023). Web-based information systems utilize the internet to provide information and services to users, with information systems in the medical world needed to make test and lab results more accurate, fast, and reliable (Nurajijah et al., 2019). Web-based systems to deal with computer damage can speed up the handling of users' computer problems (Siahaan et al., 2021).

The development of a web-based Vehicle Management Information System can be implemented using the Laravel framework, which is known for its advanced features, such as routing, templating engine, and Eloquent ORM (Suwirmayanti et al., 2023) (Putri & Pakereng, 2021). Laravel offers a structured Model-View-Controller architecture, facilitates the development of modular and easy-to-maintain applications, and provides security features such as protection against Cross-Site Scripting and SQL Injection attacks.

Laravel provides a well-organized structure for complex web application development, making it easier for developers to build and maintain efficient systems (Helda & Suryadi, 2023). The use of the

CodeIgniter framework is also a popular choice because of its open source nature and complete documentation support (Irwansyah, 2018). The framework also offers rich libraries and functions, which can speed up the development process and reduce the amount of code that needs to be written from scratch. The use of MVC in web application development can improve efficiency through the standardization and automation of non-business relationships (Mahmood & Ashour, 2020).

2. Literature Review

Operational Efficiency in Vehicle Management

Operational efficiency is a key goal for many organizations, and effective vehicle management plays a critical role in achieving this goal. The web-based Vehicle Management Information System offers a comprehensive solution to optimize vehicle utilization, reduce operational costs, and increase accountability.

The Role of Information Systems in Vehicle Management

Web-based information systems utilize the internet to provide information and services to users. Web-based systems can speed up problem handling (Siahaan et al., 2021). The web-based Vehicle Management Information System offers comprehensive solutions to optimize vehicle utilization, reduce operational costs, and increase accountability (Andria, 2023).

Utilization of the Laravel Framework in Web Information System Development

The development of a web-based Vehicle Management Information System can be implemented using the Laravel framework, which is known for its advanced features, such as routing, templating engine, and Eloquent ORM (Putri & Pakereng, 2021; Suwirmayanti et al., 2023). Laravel offers a structured Model-View-Controller architecture, facilitates the development of modular and easy-to-maintain applications, and provides security features such as protection against Cross-Site Scripting and SQL Injection attacks. MVC frameworks can standardize development and automate non-business logic relationships (Mahmood & Ashour, 2020).

Case Study and Implementation of Vehicle Management Information System

Web-based Vehicle Management Information Systems can help minimize risk and improve accuracy (F.P et al., 2023).

3. Method

This research will use a mixed methods approach that combines quantitative and qualitative methods to achieve a comprehensive understanding of operational efficiency through the implementation of a web-based Vehicle Management Information System with the Laravel framework.

Data Collection

1. **Literature Studies**
   Conduct an in-depth literature review of previous research on vehicle management information systems, Laravel frameworks, operational efficiency, and other related concepts.

2. **Needs Analysis**
   Identify the needs of users (e.g., vehicle administration staff, operational managers) through interviews and surveys.
   Analyze existing business processes in vehicle management to identify areas that need improvement.

3. **System Development**

Design and develop a web-based Vehicle Management Information System using the Laravel framework with reference to the results of the needs analysis. Implement key features such as vehicle inventory management, maintenance scheduling, operational cost tracking, and report generation.

4. **System Testing**
Perform system functionality testing to ensure that all features are functioning correctly. Conduct *usability* testing to evaluate the user's ease of use.

5. **Impact Evaluation**
Collect quantitative data (e.g., time required for specific tasks, vehicle operating costs) before and after system implementation. Conduct interviews with users to obtain qualitative feedback on the impact of the system on operational efficiency and job satisfaction.

Data Analysis

1. **Quantitative Data**
Analyze quantitative data using descriptive and inferential statistical methods to measure significant differences in operational efficiency before and after system implementation.
2. **Qualitative Data**
Analyze qualitative data from interviews and observations using thematic analysis to identify relevant patterns and themes related to the impact of the system on users and organizations.

Prototype Development

The method used in this research is the prototype method (Anggreini et al., 2023).

4. Results and Discussion

The analysis of system needs aims to identify and formulate the functional and non-functional needs of users and organizations for the vehicle management information system to be developed. This analysis is based on the results of literature studies, interviews, and observations of ongoing business processes.

Functional Requirements

Functional needs are the key features that a system must have to support vehicle management operations.

Yes	Functional Needs	Description
1	Vehicle Data Management	The system should allow users to add, change, delete, and display vehicle data such as police number, vehicle type, year of purchase, active status, etc.
2	Scheduling Treatment	The system can record routine service schedules, periodic maintenance, and remind users of upcoming schedules.
3	Vehicle Use Recording	The system must document the use of the vehicle by a specific user, including the date of use, mileage, and destination.
4	Operational Cost Tracking	The system allows recording of vehicle-related expenses (fuel, services, taxes, etc.).

Yes	Functional Needs	Description
5	Depreciation of Vehicle Assets	The system calculates the fiscal depreciation of the vehicle automatically based on a specific method (e.g. straight lines).
6	User Management & Access Rights	The system supports user roles (admin, manager, staff) with different access levels as authorized.
7	Report Generation	The system must generate periodic reports such as vehicle usage reports, operating costs, and service schedules.
8	Notifications & Reminders	The system provides automatic alerts for vehicle service, vehicle registration validity, and other needs.
9	Authentication & Security	The system provides secure logins with data encryption and protection against unauthorized access.

4.2 Non-Functional Requirements

Non-functional requirements are specifications that support system quality, including aspects of performance, security, and ease of use.

Yes	Non-Functional Needs	Description
1	Accessibility	The system must be web-based and accessible through a desktop browser or mobile device.
2	Security	The system must protect vehicle data from unauthorized access and provide data backup features at regular intervals.
3	Scalability	The system can be developed to support the growing number of vehicles and users in the future.
4	Usability	The system interface should be user-friendly and easy to use by non-technical staff.
5	Performance	The system must be able to process data and generate reports quickly without significant lag.
6	Availability	The system must have high uptime and minimal disruption.
7	Compatibility	The system must be compatible with a wide range of browsers (Chrome, Firefox, Edge) and common operating systems.

User Analysis

User Type	Main Tasks	Special Needs
Administrator	Manage accounts, manage vehicle data, create reports	Full access to all modules
Operational Staff	Input data on usage, maintenance, costs	Limited access to operational data
Manager	View reports, monitor vehicle efficiency	Read access to reports and statistics

System Planning

Usecase Diagram

Use Case Diagrams are used to model the interaction between actors (system users) and the main functions (use cases) provided by the system. This diagram helps visually understand user roles, system limitations, and key functionality.

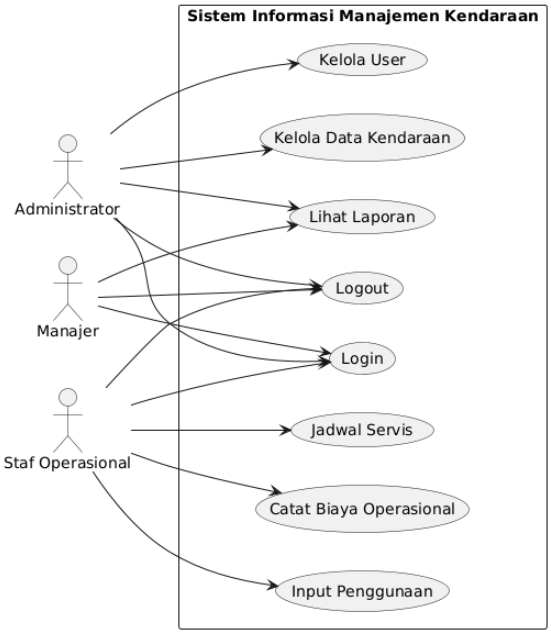

Figure 1. Usecase Diagram

Provides an overview of how the three types of users (Administrators, Operational Staff, and Managers) interact with the system in day-to-day activities.

Table 1. Usecase diagram

Actor	Description
Administrator	Users with full access to manage vehicle, user, and report data.
Operational Staff	Officers who input data on vehicle usage, operational costs, and service scheduling.

Actor	Description
Manager	The responsible user sees the vehicle's usage and efficiency reports.

Activity Diagram

This activity diagram shows the workflows of the various user roles (Administrator, Operational Staff, System, and Manager) in the system.

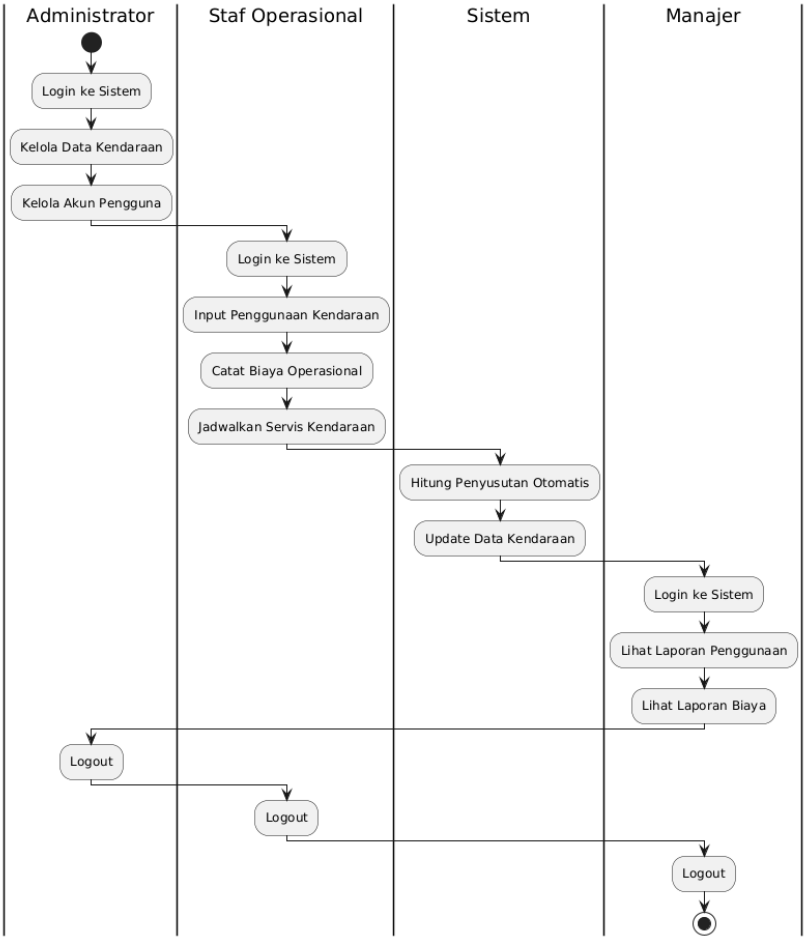

Figure 2. Activity Diagram

This diagram shows how different roles interact with the system to manage vehicle operations. Administrators set up and maintain basic data and user accounts. Operational Staff perform daily data entry related to usage and costs, as well as schedule services. The system automatically processes that data (e.g., calculating depreciation and updating data). Finally, the Manager uses the system to monitor and analyze usage and cost reports, which helps in decision-making.

Sequence Siagram

This diagram illustrates the interaction between actors (Administrators, Operational Staff, Managers) with the "Vehicle Management Information System" and the "Database" in a series of processes.

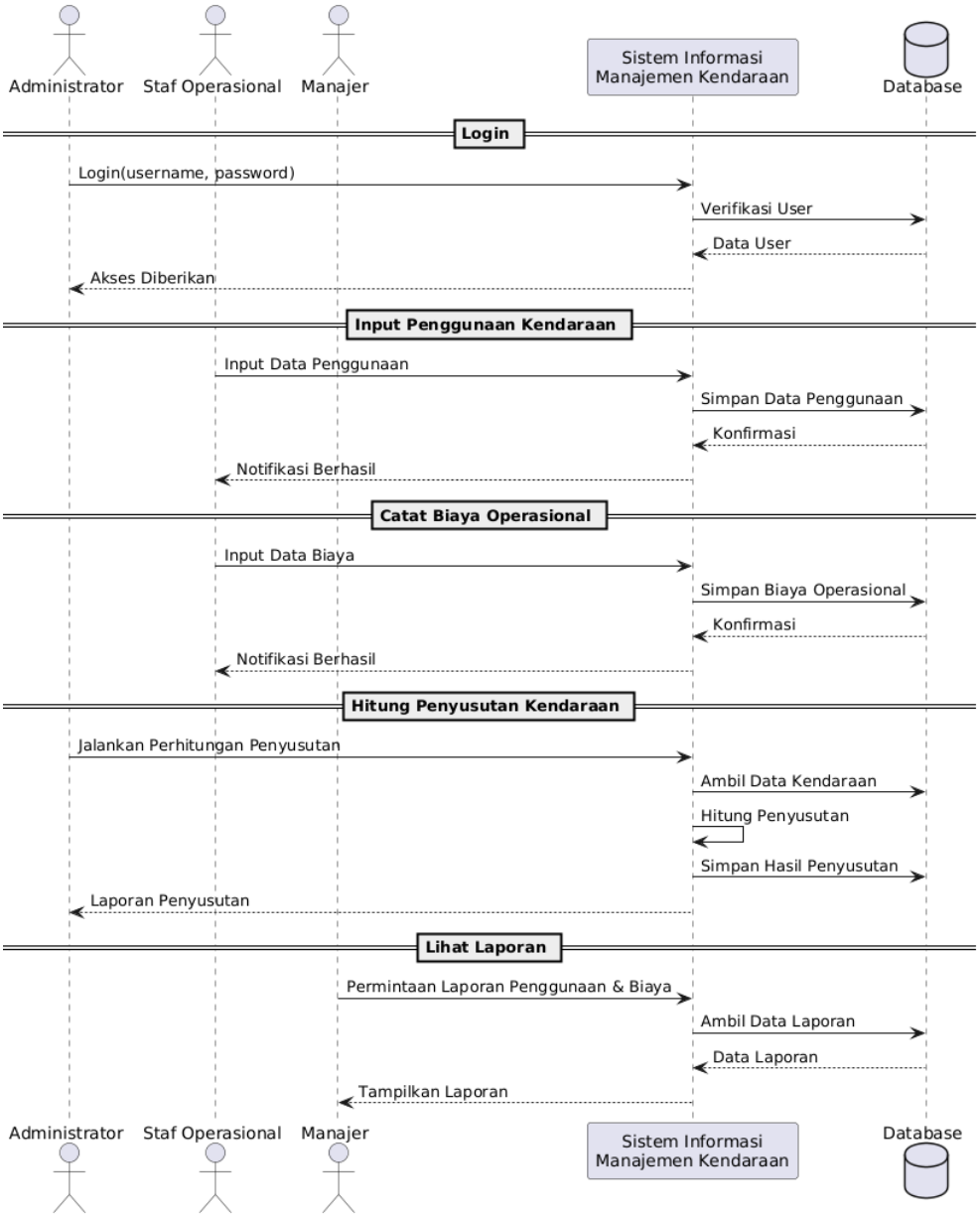

Figure 3. Sequence Diagram

This sequence diagram in detail shows the sequence of messages exchanged between the actor and the system components (Vehicle Management Information System and Database) for each key functionality: login, vehicle usage data input, recording operational costs, depreciation calculations, and viewing reports. This is very useful for understanding how each part of the system interacts and in what order to complete a particular task.

Class Diagram

This diagram illustrates the data structure and relationships between entities (classes) in a Vehicle Management Information System.

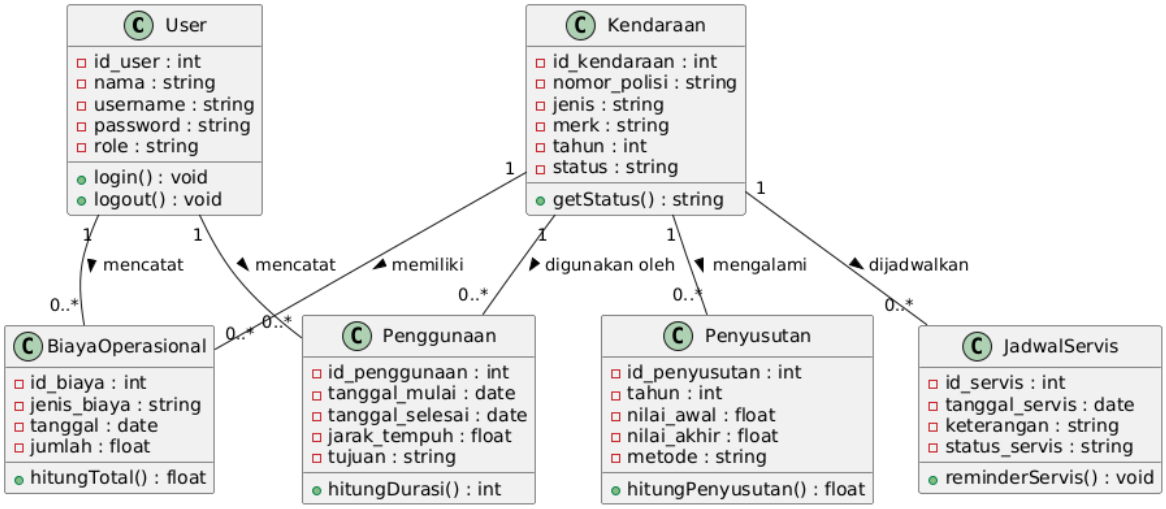

Figure 4. Diagram Class

This class diagram comprehensively models the data structure and core interactions in a Vehicle Management Information System. The User class is the foundation of the system by storing basic user information such as name, login credentials, and roles, and supporting login and login operations. Central to this system is the Vehicle class, which details attributes such as police number, type, brand, and status, complete with a method for obtaining the status of the vehicle.

Other classes support the operational management of vehicles: Operational Costs record each vehicle-related expense with details of type, date, and amount, as well as the ability to calculate total costs. Usage tracks the details of each trip or vehicle usage, including duration, mileage, and destination. For the maintenance aspect, the ServiceSchedule stores information about the date and status of the planned service, and even provides a reminder function. Finally, Depreciation specifically handles the calculation of vehicle depreciation by recording the start, end, and method values used.

The relationships between classes show the flow of information and the interconnectedness of functionality: each User can record various Operational and Vehicle Usage Costs. A Vehicle can have many records of Usage and Service Schedules over time. Uniquely, each vehicle is also associated with a depreciation agency to track its economic value. Overall, this diagram not only defines entities and their attributes, but also illustrates how they interact with each other, forming a solid blueprint for database design and structured application development.

Conclusion

This research designs and analyzes a web-based Vehicle Management Information System that aims to improve operational efficiency, especially in asset management and depreciation calculations that were previously manual. Based on the analysis, the system automates key processes such as recording usage and costs, as well as depreciation calculations, as represented in the Activity and Sequence Diagram. The system's core data structure, including User entities, Vehicles, Operating Costs, Usage, Depreciation, and Service Schedules, detailed through Class Diagrams, shows a solid foundation for implementation. The design of this system is recommended to be developed using a web-based framework (such as Laravel or CodeIgniter) with an MVC architecture, ensuring modularity, security, and efficient maintenance, thus being able to support operational efficiency through accurate and fast data.

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