

## Waterfall-Based Vehicle Service Management Information System

Andika Pratama<sup>1</sup>, Muhammad Arif Hidayat<sup>2</sup>

<sup>1,2</sup>Department of Information Systems, Faculty of Science and Technology, Universitas Negeri Makassar, Indonesia

### Article Info

#### Article history:

Received Jul 16, 2026

Revised Agust 10, 2026

Accepted Sept 14, 2026

Online First Sept 20, 2026

#### Keywords:

Black Box Testing

MySQL

System

Vehicle Service Management

Waterfall Model

Web-Wased Information

### ABSTRACT

**Purpose of the study:** This study aims to develop a Waterfall-based web vehicle service management information system for PT Toyota Hadji Kalla Makassar. The system is designed to improve the management of customer data, vehicle records, service transactions, and reporting activities through an integrated database environment.

**Methodology:** Qualitative research approach; observation; interviews; literature review; Waterfall software development method; Unified Modeling Language (UML) including Use Case Diagram, Activity Diagram, Sequence Diagram, and Class Diagram; PHP programming language; MySQL database management system; XAMPP web server environment; Notepad++; Mozilla Firefox; Black Box Testing technique.

**Main Findings:** A web-based vehicle service management information system was successfully developed and implemented. The system integrated customer data, vehicle information, service records, and reporting functions into a centralized database. Black Box Testing confirmed that all major functions, including login, data management, service processing, and report generation, operated successfully according to system requirements.

**Novelty/Originality of this study:** This study presents an integrated vehicle service management information system specifically designed for workshop administration using the Waterfall development model. Unlike previous studies focusing on sales transactions or service queues, the proposed system combines customer information, vehicle records, service data, and reporting functions within a single web-based platform, supporting comprehensive service data management.

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### Corresponding Author:

Andika Pratama,

Department of Information Systems, Faculty of Science and Technology, Makassar State University,

Jl. A.P. Pettarani, Makassar, 90222, Indonesia

Email: [andikapratama@gmail.com](mailto:andikapratama@gmail.com)

## 1. INTRODUCTION

The rapid advancement of information technology has significantly transformed business operations across various sectors, including the automotive industry. Automotive service companies increasingly rely on digital systems to support operational efficiency and service quality [1], [2]. Effective management of vehicle service data is essential to ensure accurate recording, monitoring, and reporting of maintenance activities [3], [4]. Information systems play a crucial role in organizing customer information, vehicle histories, and service schedules in an integrated manner. Therefore, the implementation of a web-based information system has become an important strategy for improving service management processes in automotive workshops [5].

Despite technological developments, many automotive service providers still face challenges in managing service data efficiently. PT Toyota Hadji Kalla Makassar previously utilized spreadsheet-based tools

for recording vehicle service activities and customer information [6], [7]. This approach often resulted in data redundancy, difficulties in data retrieval, and increased risks of data loss. The absence of an integrated database also limited the effectiveness of service monitoring and reporting processes. Consequently, administrative activities became time-consuming and less efficient, particularly when handling large volumes of service records.

Several previous studies have examined the implementation of information systems in the automotive sector. Research on spare-part sales management systems demonstrated that web-based applications could improve data processing and transaction management [8], [9]. Other studies focused on customer service management using specific service queue methods to enhance customer satisfaction. Furthermore, web-based management information systems have been developed to support operational and managerial activities in automotive companies. These studies confirm the importance of information technology in improving organizational performance and service quality [10], [11].

Although previous studies have contributed to the development of automotive information systems, several limitations remain evident. Most existing systems focus on sales transactions, service queue management, or general operational monitoring. Limited attention has been given to the comprehensive management of vehicle service data, customer information, and service history within a single integrated platform. In addition, previous studies rarely emphasize the use of structured software development methodologies to ensure system reliability and maintainability [12], [13]. Therefore, there is a need for a more focused study that addresses these aspects simultaneously through a web-based management system.

The development of an integrated vehicle service management information system is increasingly important in today's data-driven business environment. Accurate and accessible service information supports better decision-making and improves operational efficiency [14]. A centralized database can minimize data duplication while enhancing data security and consistency. Furthermore, timely access to service records can improve customer service quality and support routine vehicle maintenance management [15]. For these reasons, the implementation of a web-based information system represents a practical solution to current administrative challenges in automotive workshops [16], [17].

This study offers a novel contribution by developing a Waterfall-based vehicle service management information system specifically designed to integrate customer data, vehicle information, service records, and reporting functions within a unified web platform [18], [19]. Unlike previous studies that focused on specific operational aspects, the proposed system provides comprehensive service data management tailored to workshop administration requirements. The study also applies the Waterfall development model systematically, covering requirements analysis, system design, implementation, testing, and maintenance stages. In addition, the system supports long-term service history storage and facilitates efficient information retrieval for managerial purposes. Therefore, this research contributes both practically and academically to the advancement of information system applications in the automotive service sector.

## 2. RESEARCH METHOD

### 2.1 Research Design

This study employed a qualitative research approach to investigate the existing vehicle service data management process at PT Toyota Hadji Kalla Makassar. The qualitative method was selected because it enables researchers to understand operational problems and administrative activities in their natural setting. Data were collected through direct observation, interviews with workshop administration personnel, and literature reviews of relevant studies and technical references [20]. The collected information was analyzed to identify system requirements and determine appropriate solutions for managing vehicle service data. This approach provided a comprehensive understanding of organizational needs and supported the development of a web-based information system.

Table 1. Data Collection Techniques

| Technique         | Source                                | Purpose                              |
|-------------------|---------------------------------------|--------------------------------------|
| Observation       | Workshop activities                   | Identify existing business processes |
| Interview         | Administrative staff                  | Gather user requirements             |
| Literature Review | Journals, books, and previous studies | Support theoretical foundation       |

### 2.2 System Development Method

The proposed system was developed using the Waterfall software development model due to its systematic and sequential development process. This model consists of five main phases, namely requirements analysis and definition, system and software design, implementation, integration and system testing, and

operation and maintenance [21], [22]. During the requirements phase, information related to service data management processes was collected and analyzed. The design phase focused on database structures, user interfaces, and system architecture before being translated into program code during implementation. After development was completed, the system underwent testing and maintenance activities to ensure that all functions operated according to user requirements.

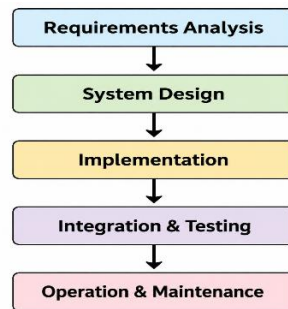


Figure 1. Waterfall Development Model

### 2.3 System Modeling and Testing

Unified Modeling Language (UML) was utilized to represent system requirements and design specifications. The modeling process included use case diagrams, activity diagrams, sequence diagrams, and class diagrams to describe system functionality and interactions among users and system components. The developed application was implemented using PHP as the programming language and MySQL as the database management system, supported by the XAMPP environment. To evaluate system functionality, Black Box Testing was applied by examining each feature based on predefined input and output scenarios. The testing results were used to verify that the system functions met the specified requirements and supported effective vehicle service data management.

## 3. RESULTS AND DISCUSSION

### 3.1 Existing System Analysis

The existing vehicle service data management process at PT Toyota Hadji Kalla Makassar relied primarily on spreadsheet-based applications for recording customer and service information. This approach resulted in several operational challenges, including data redundancy, difficulties in retrieving historical service records, and inefficient report generation processes. Service-related information was not integrated into a centralized database, increasing the risk of data inconsistency and loss. Administrative personnel were required to manually manage and update records, which consumed considerable time and effort. Consequently, the existing system was considered insufficient to support efficient vehicle service management activities.

### 3.2 Proposed System Design

To overcome the identified limitations, a web-based vehicle service management information system was proposed and developed. The system was designed to integrate customer data, vehicle information, service records, and reporting functions within a centralized database environment. The proposed workflow allows administrators to input and manage service-related data efficiently while enabling workshop management to access reports when required. UML modeling techniques were utilized to represent system functionality and user interactions during the design stage. The resulting design provides a structured framework for improving administrative performance and information accessibility.

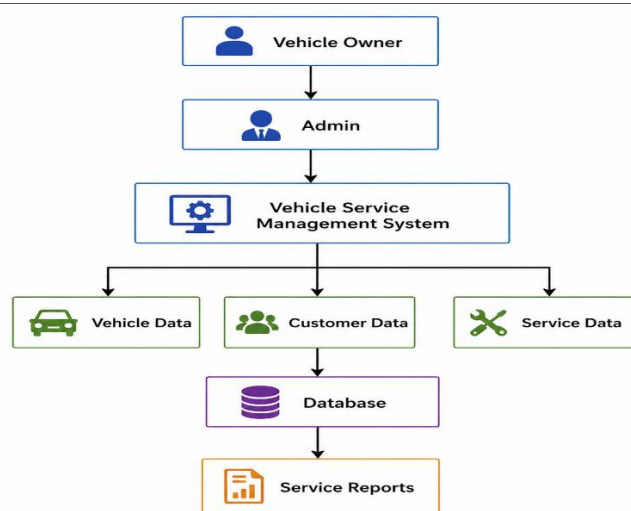


Figure 2. Proposed System Architecture

### 3.3 System Implementation

The developed application was implemented as a web-based information system using PHP and MySQL technologies. The system includes authentication functionality that restricts access to authorized users through a login mechanism. Administrators can manage vehicle information, customer records, and service transaction data through dedicated interfaces [23], [24]. All information entered into the system is automatically stored within a centralized database to ensure data consistency and accessibility. In addition, the application provides reporting features that facilitate monitoring and evaluation of vehicle service activities.

Table 2. Main Features of the Developed System

| Feature                  | Function                               |
|--------------------------|----------------------------------------|
| Login                    | User authentication and access control |
| Vehicle Data Management  | Manage vehicle information             |
| Customer Data Management | Manage customer information            |
| Service Data Management  | Record and update service activities   |
| Service Reporting        | Generate and display service reports   |

### 3.4 System Testing Results

The developed system was evaluated using the Black Box Testing method to verify functional performance. Testing was conducted by examining each system feature based on predefined input and expected output scenarios. The evaluation covered authentication processes, vehicle data management, customer information management, service transaction processing, and report generation functions. The testing results demonstrated that all major functionalities operated successfully according to system requirements [25], [26]. Therefore, the developed application was considered capable of supporting vehicle service management processes effectively and reliably.

Table 3. Summary of Black Box Testing Results.

| Tested Function         | Result     |
|-------------------------|------------|
| Login Process           | Successful |
| Vehicle Data Input      | Successful |
| Customer Data Input     | Successful |
| Service Data Processing | Successful |
| Report Generation       | Successful |

Results obtained from this study indicate that the developed web-based vehicle service management information system successfully addressed several limitations of the previous spreadsheet-based approach.

Integration of customer information, vehicle records, service transactions, and reporting functions into a centralized database improved data accessibility and management efficiency. Administrative activities became more organized because all service-related information was stored within a single system environment. User authentication features also contributed to securing operational data from unauthorized access. Consequently, workshop administrators were able to manage vehicle service information more effectively and accurately. Implementation outcomes demonstrate that the proposed system supports faster and more reliable service data processing. Dedicated modules for customer management, vehicle records, and service transactions simplified administrative workflows and reduced manual effort. Availability of automated reporting functions enabled users to generate service reports more efficiently than previous manual procedures [27]. Centralized data storage minimized redundancy and improved information consistency across different operational activities. Improvements observed during implementation suggest that the system contributes positively to administrative performance within the workshop environment.

Findings of this study are consistent with previous research emphasizing the importance of web-based information systems in automotive service operations. Earlier studies reported that computerized systems improve data management, facilitate information retrieval, and support organizational decision-making processes. Similar benefits were identified in this study through enhanced service data management and reporting capabilities. Application of the Waterfall development model also aligns with previous findings indicating that structured development approaches support software quality and system reliability [28], [29]. Evidence from both current and previous studies confirms the effectiveness of information system implementation in automotive service management. Novel contributions of this research can be observed in the development of an integrated vehicle service management platform specifically designed for workshop administration. Previous studies generally focused on spare-part sales management, service queue processing, or broader organizational management systems. Integration of customer data, vehicle information, service records, and reporting functions within a single application distinguishes this study from earlier works. System development was also conducted using a structured Waterfall framework that ensured systematic implementation from requirement analysis to testing stages [30]. Capability to maintain comprehensive service histories further strengthens the uniqueness of the proposed solution.

Practical implications of this research extend to automotive workshops seeking to improve service administration and information management practices. Adoption of the developed system can support managerial decision-making through accurate and timely service information. Improved accessibility of customer and vehicle records may contribute to higher service quality and more responsive operational processes. Centralized information management also helps reduce administrative workload and minimizes the possibility of data inconsistencies. Benefits generated by the system indicate its potential applicability in similar automotive service organizations. Several limitations should be considered when interpreting the findings of this study. System development and evaluation were conducted within a single workshop environment, which may restrict broader generalization of the results. Evaluation activities focused primarily on functional testing using the Black Box Testing approach without incorporating quantitative performance measurements or user satisfaction assessments. System features were specifically designed for Toyota vehicle service management requirements and may require adjustments before implementation in other contexts. Future studies are encouraged to involve multiple organizations and additional evaluation metrics to provide a more comprehensive assessment of system effectiveness.

#### 4. CONCLUSION

Development of the Waterfall-Based Vehicle Service Management Information System successfully addressed the administrative challenges associated with spreadsheet-based service data management at PT Toyota Hadji Kalla Makassar. Integration of customer information, vehicle records, service transactions, and reporting functions within a centralized database improved data accessibility, consistency, and operational efficiency. Implementation results demonstrated that the developed system was capable of supporting more effective service administration processes and reducing the risks of data redundancy and information loss. Application of the Waterfall development model provided a structured framework that facilitated systematic system design, implementation, and testing activities. Findings of this study confirm that web-based information systems can contribute significantly to improving information management practices within automotive workshop environments. Future research may focus on integrating mobile-based services, real-time service monitoring, customer notification features, and broader evaluation methods involving multiple organizations to enhance system scalability and effectiveness.

#### ACKNOWLEDGEMENTS

The author would like to express sincere gratitude to PT Toyota Hadji Kalla Makassar for providing access to research data and operational information required for this study. Appreciation is also extended to

academic supervisors, reviewers, and all parties who contributed valuable guidance and support throughout the completion of this research.

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