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Development of a Transparent Vehicle Administration System Using Web-Based Information Architecture

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Abstract

The management of official vehicles has historically relied on fragmented manual processes leading to inefficiencies, data inaccuracy, lack of transparency, and weak governance oversight. To address these challenges, this study designed and implemented Sikendi (Sistem Informasi Kendaraan Dinas), a web-based vehicle information system aimed at enhancing transparency and administrative governance. Using the System Development Life Cycle (SDLC) Waterfall approach, the system was developed with PHP, MySQL, JavaScript, and AJAX, featuring role-based access (Admin/User), integrated modules for vehicle registration, borrowing workflow with approval mechanisms, maintenance scheduling, fuel logging, document management, and activity auditing. Black-box testing confirmed functional compliance across 24 test cases for Admin and 15 for User roles. Results show the system significantly improves data accuracy, operational efficiency, and accountability, enabling real-time monitoring, automated reporting, and digital audit trails. This work demonstrates that digitizing fleet management in public sector institutions strengthens governance, reduces misuse risk, and supports data-driven decision-making, offering a replicable model for other governmental units.

Keywords—*Vehicle information system, Web-based application, Fleet management*

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1. INTRODUCTION

In the current era of digital transformation, the integration of information technology is essential for enhancing the operational effectiveness of defense and security organizations. The Indonesian National Armed Forces (TNI) is committed to strengthening institutional governance through system modernization to support its primary duties. Specifically, the Center for Information and Data Processing of the TNI (Pusinfolahta TNI) holds a strategic role in managing information systems and data processing to support both administrative and operational functions of the TNI Headquarters. To maintain optimal readiness, this unit relies heavily on the mobility of its personnel and the efficient distribution of logistics, which is facilitated by a fleet of official vehicles.

However, despite Pusinfolahta TNI's core function as a technology enabler, the internal management of its official vehicles remains largely conventional and inefficient. Preliminary observations at Pusinfolahta TNI indicate that the recording of vehicle specifications, borrowing schedules, and maintenance history is still conducted manually using physical logbooks and fragmented spreadsheets. This legacy approach creates significant operational bottlenecks. For instance, determining the real-time availability of a vehicle for urgent technical deployment becomes time-consuming, and the lack of a centralized tracking system increases the risk of asset misuse. The urgency of this research lies in the critical need to align internal logistics governance with the unit's technological standards, ensuring that administrative delays do not hinder operational support duties.

The reliance on manual paper-based correspondence for borrowing approvals further exacerbates the issue, hindering the workflow and lacking the necessary transparency for auditing state-owned assets. Without a digitized system, leadership lacks data-driven insights into vehicle utilization and maintenance costs, leading to potential budget inefficiencies and reduced fleet readiness. Therefore, modernizing this sector is not merely an administrative upgrade but a strategic necessity to ensure accountability and responsiveness.

Previous research has widely discussed digitalization in fleet management. Studies suggest that implementing computerized asset management systems minimizes data redundancy and accelerates reporting cycles. Other research highlights that web-based applications with centralized databases are highly effective for real-time asset monitoring. However, limited studies focus on the specific

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context of military administrative units, which require strict authorization hierarchies and rigorous accountability. This study addresses this gap by designing Sikendi (Official Vehicle Information System), a web-based application tailored to the specific operational needs of Pusinfolahta TNI.

Specifically, the Center for Information and Data Processing of the TNI (Pusinfolahta TNI) holds a strategic role in managing information systems to support the administrative and operational functions of the TNI Headquarters. Ideally, as a technology-driven unit, internal operations should reflect high standards of digital governance. However, preliminary observations indicate a significant gap: the management of official vehicles—a critical asset for personnel mobility and logistics still relies on fragmented manual processes such as physical logbooks and spreadsheets.

The urgency of this research lies in addressing this operational bottleneck. The current legacy approach results in data inconsistency and delays in vehicle allocation, which directly hinders the unit's responsiveness. Furthermore, the lack of a centralized digital tracking system creates a vulnerability in auditing state-owned assets (Barang Milik Negara), increasing the risk of misuse. Therefore, modernizing this sector is not merely an administrative upgrade but a strategic necessity to ensure accountability, auditability, and operational readiness within Pusinfolahta TNI.

By utilizing PHP and MySQL, Sikendi integrates vehicle registration, digital borrowing workflows, and automated maintenance scheduling. This system aims to transform the vehicle administration at Pusinfolahta TNI from a reactive, manual process into a proactive, transparent, and data-driven mechanism, thereby directly supporting the unit's operational effectiveness and strengthening the governance of state assets.

2. RESEARCH METHOD

To achieve the research objectives, this study adopts the System Development Life Cycle (SDLC) approach using a modified Waterfall model. While the standard Waterfall model typically consists of six stages, this research focuses on four core phases: Requirement Analysis, System Design, Implementation, and Testing.

The stages of Deployment and Maintenance were excluded from the scope of this study due to the time constraints of the On-Job Training (OJT) period and the research focus, which is centered on the prototyping and functional validation of the system rather than long-term lifecycle management.[3].

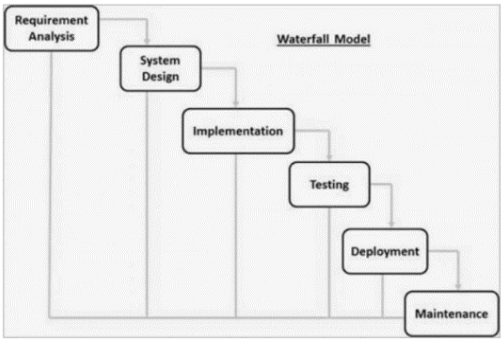

Figure 1. Waterfall Method

The development process consists of the following phases:

1. Requirement Analysis

The initial phase focused on defining the software specifications required to solve the identified operational problems. Data elicitation was conducted through observations of the manual workflow and in-depth interviews with key stakeholders, specifically the Head of Administration and the Head of Information Systems.

The analysis phase produced a detailed Software Requirement Specification (SRS) document, which categorized the system needs into two core components:

a. Functional Requirements: The system must be capable of managing vehicle master data (CRUD), automating the borrowing workflow with a digital approval hierarchy, recording maintenance history with automated alerts, and generating real-time utilization reports.

b. Non-Functional Requirements: The system requires a web-based architecture for accessibility within the local intranet, role-based access control (RBAC) to separate Admin and User privileges, and a user-friendly interface to ensure adoption by non-technical staff.

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These defined requirements served as the foundational blueprint for the subsequent System Design phase, ensuring the proposed solution directly addressed the issues of data redundancy and lack of transparency found in the legacy manual process.

2. System Design

Following the requirement analysis, the system architecture was designed to translate the user needs into a technical blueprint. This phase utilized Unified Modeling Language (UML) diagrams to visualize the system structure and behavior[4].

Use Case Diagrams were created to define actor roles (Admin and User) and their interactions with the system, such as managing vehicles, approving requests, and logging activities. Activity Diagrams and Sequence Diagrams were developed to detail the logic flow for critical processes like login authentication, borrowing requests, and report generation[5]. Class Diagrams and Database Design were constructed to structure the relational database using MySQL, defining entities such as Users, Vehicles, Maintenance Records, and Fuel Logs.

3. Implementation (Coding)

In this phase, the design specifications were transformed into a functional web-based application. The development environment utilized XAMPP as the local server, with Visual Studio Code serving as the primary text editor[6]. Back-end Development: The server-side logic was built using the PHP programming language, ensuring robust data processing and secure interaction with the database. Front-end Development: The user interface was developed using HTML, CSS, and JavaScript to create a responsive and intuitive experience for users. AJAX (Asynchronous JavaScript and XML) was implemented to enable seamless data updates without requiring full page reloads. Database: MySQL was employed as the Relational Database Management System (RDBMS) to store and retrieve high volumes of operational data efficiently.

4. Testing

The final phase of development involved rigorous testing to ensure the system met the specified requirements and was free of critical errors[7]. The testing methodology used was Black Box Testing, which focuses on the functional output of the application without examining the internal code structure. Testing was conducted on both Admin and User modules, covering scenarios. The test results confirmed that the system functionality aligns with the design specifications, handling both valid and invalid inputs appropriately as detailed in the test cases[8].

3. RESEARCH RESULTS

This section outlines the results of the system development, starting from the modeling of system processes using Unified Modeling Language (UML), followed by the user interface implementation, and concluding with system testing and comparison[9].

3.1 Use Case Diagram

A use case diagram is a graphical representation that illustrates the interaction between actors and the system, defining the functional requirements of the application. Through this diagram, the functions available within the Sikendi system can be identified clearly[10].

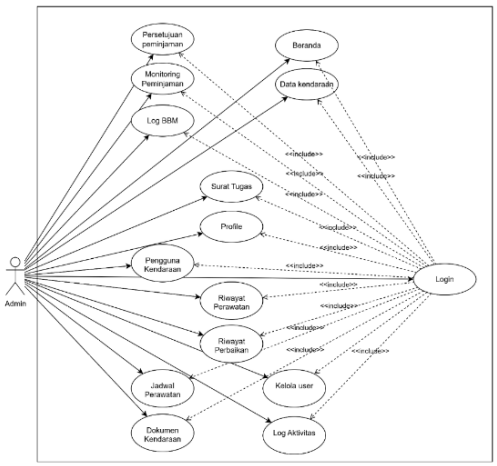

Figure 2. Use Case Admin

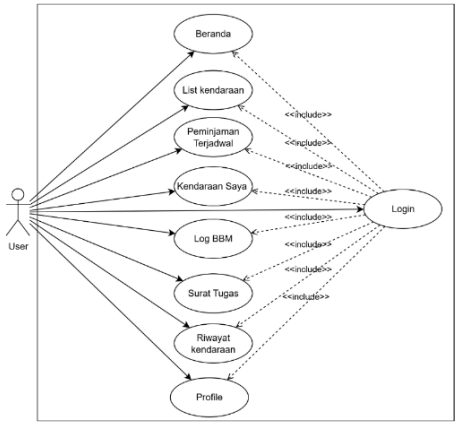

Figure 3. Use Case User

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As shown in the diagrams above, the system involves two primary actors: the Admin and the User. Admin once logged in, the admin has full privileges to manage master data (vehicles and users), approve or reject borrowing requests, manage maintenance schedules, and monitor vehicle usage history and fuel logs .

The user role is designed for personnel who need to utilize the vehicles. Their capabilities include viewing the list of available vehicles, submitting borrowing requests, and inputting fuel usage logs (Log BBM) for the vehicles they are using[11].

3.2 Activity Diagrams

Activity diagrams represent the workflow of specific processes within the system. This section details the core activities for both Admin and User roles[12].

Activity Diagram for Admin Login The login

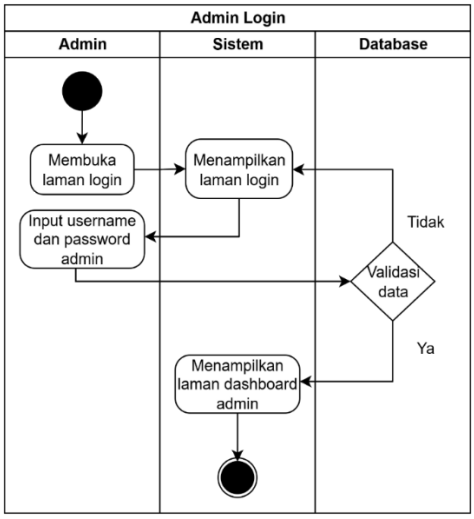

Figure 4. Activity Diagram for Admin Login

Activity Diagram for Admin Login The login process ensures secure access to the system. The flow begins with the admin accessing the login page and entering valid credentials. The system validates the data against the user_account table in the database. If valid, the admin is redirected to the dashboard; otherwise, an error message is displayed.

Activity Diagram for Managing Borrowing Requests (Admin)

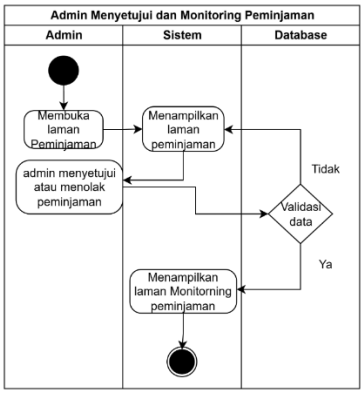

Figure 5. Activity Diagram for Managing Borrowing Requests (Admin)

This activity illustrates the admin's role in processing loan applications. The admin reviews incoming requests that are in "Waiting" status. The admin can then decide to either Approve or Reject the request. If approved, the system updates the vehicle status to "Booked" or "In Use" to prevent double booking.

Activity Diagram for Creating a Borrowing Request (User)

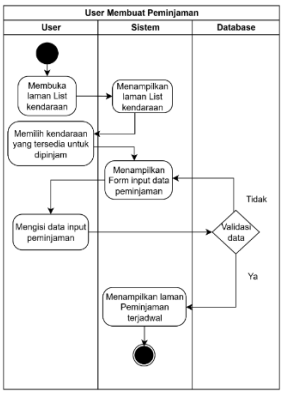

Figure 6. Activity Diagram for Creating a Borrowing Request (User)

This diagram shows the flow when a user applies for a vehicle. The user views the list of vehicles, selects an available unit, and fills in the borrowing form (dates and purpose). The system validates availability before saving the request with a "Pending" status.

3.3 Interface Display

This section presents the implementation of the user interface (UI) designed to be user-friendly and responsive.

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Login Interface Display

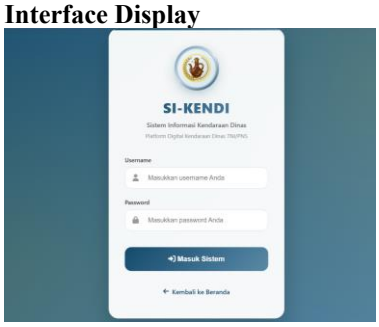

Figure 7. Login Interface Display

The login page serves as the gateway to the system. It requires users to input their username and password. This page is essential for maintaining security and ensuring that access rights correspond to the user's role (Admin or User)[13].

Admin Dashboard Display

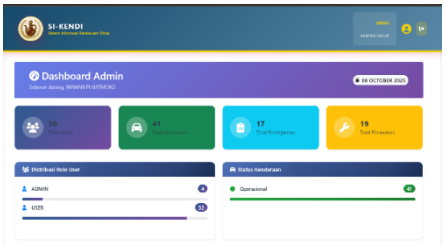

Figure 8. Admin Dashboard Display

The dashboard provides a comprehensive overview of the system's status. It displays key statistics such as the total number of vehicles, active loans, maintenance alerts, and recent user activities. This centralized view aids the leadership in monitoring operational readiness.

Borrowing Approval Interface Display

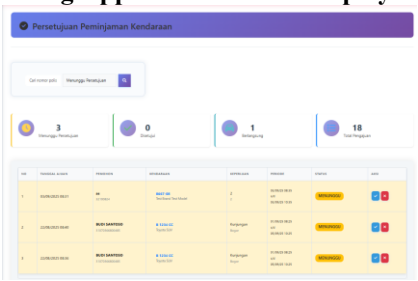

Figure 9. Borrowing Approval Interface Display

This interface allows the admin to manage incoming vehicle requests. It lists the details of the applicant, the selected vehicle, and the intended duration. The admin can execute approvals or rejections directly from this page, streamlining the administrative workflow[14].

User Vehicle List Interface

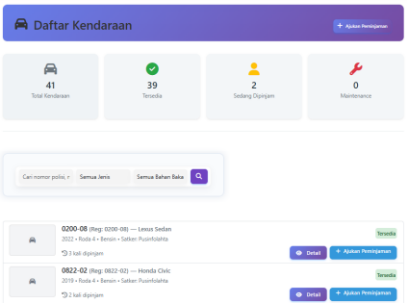

Figure 10. User Vehicle List Interface

For users, this interface acts as a catalog of official vehicles. It displays vital information such as vehicle type, condition, and current availability status (Available/In Use), enabling users to make informed decisions before submitting a request.

3.4 Testing

System testing was conducted using the Black Box Testing method to ensure that all functional requirements were met without examining the internal code structure. The testing covered various scenarios for both Admin and User module[15].

Table 1. Testing Admin

Module	Test Case Description	Expected Result
Login	Input correct Username and Password.	Login successful; redirected to Admin Dashboard.
	Input wrong Username, correct Password.	Login failed; error message displayed.
	Input correct Username, wrong Password.	Login failed; error message displayed.
	Leave one or both fields empty.	Login failed; warning message displayed.
	Access Dashboard URL without session.	Redirected back to Login page.

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Loan Approval	Select 'Waiting' request and click Approve.	Status changes to 'Approved'; success notification appears.
	Select 'Waiting' request and click Reject.	Status changes to 'Rejected'; success notification appears.
	Apply filter for 'Waiting' status.	Table displays only requests with 'Waiting' status.
Monitoring	Filter by Start and End date.	Displays history only within the selected date range.
	Verify data with 'Ongoing' status.	Data includes Borrower, Vehicle, and Approver details.
User Mgmt	Input unique data (NRP/NIP) and Save.	New user saved; list updated.
	Change user details (e.g., Position) and Update.	Changes saved to database.
	Select user and use Reset function.	Password resets to default; notification appears.
Vehicle Data	Input all valid vehicle details.	Data saved; list updated.
	Input existing Registration Number.	Data rejected; validation warning appears.
	Update vehicle details (e.g., Color).	Changes saved to database; list updated.
	Select vehicle and confirm deletion.	Data removed from database.
	Search by Registration Number.	Displays only the matching vehicle.
Other Modules	Input Document Type and Expiry Date.	Document saved; status (Active/Expiring) displayed.
	Input Repair Date, Type, and Cost.	Data saved; history updated.
	Click Export CSV button.	User activity file downloaded in CSV format.

Table 2. Testing User

Module	Test Case Description	Expected Result
Login	Input correct Username and Password.	Login successful; redirected to User Dashboard.
	Input wrong Username or Password.	Login failed; error message displayed.
	Leave Username or Password empty.	Login failed; warning message displayed.
Vehicle List	Select 'Available' vehicle and fill form (dates/purpose).	Data saved; status set to 'Pending Approval'.
	Request vehicle on dates when it is 'In Use'.	Request rejected; error message regarding availability.
	Apply filter by Vehicle Type (e.g., 4-Wheels).	Displays only vehicles matching the filter.
Loan Status	View details of an active loan.	Status displayed as 'ONGOING'.
	View details of a loan rejected by Admin.	Status displayed as 'REJECTED'.

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My Vehicle	Input valid Date, Liters, Cost, and Odometer.	Fuel log saved; database updated.
	Input non-numeric characters in Odometer field.	Data rejected; format validation error displayed.
	Access page during an active loan period.	Vehicle status displayed as 'In Use' / 'On Trip'.
Documents	Access 'My Assignment Letters'.	List of assigned letters displayed.
	Click PDF button on a specific letter.	Assignment downloaded as PDF file.
History	Access 'Vehicle History' page.	Displays summary of past vehicle usage and dates.

3.5 Comparison

To evaluate the effectiveness of the developed system, a comparison was made between the previous manual management system and the new web-based *Sikendi* system.

Table 3. Comparison

Comparison Aspect	**Current Manual System**	**Sikendi Web-Based System**
Data Recording	Performed manually in physical logbooks or simple spreadsheets.	Performed digitally and centralized within a single web platform.
Data Access & Updates	Fragmented and difficult to access; retrieving historical data is time-consuming.	Rapid access via an intuitive web interface with real-time data updates.
Borrowing Process	Manual administration relying on physical application letters.	Automated workflow featuring online submission and digital approval.
Usage Tracking	No clear digital trail; difficult to track users, specific purposes, and usage periods.	Creates a comprehensive digital audit trail for every borrowing transaction.
Maintenance Management	Recorded manually with no automated reminder system for service schedules.	Equipped with automated schedules and reminders for service, oil changes, and document renewals.
Decision Support	Reports are simple, unstructured, and require significant time to compile.	Generates comprehensive automated reports (tables and charts) regarding unit usage and maintenance.

The comparison highlights significant improvements. The web-based system replaces fragmented manual recording with a centralized database, offers real-time access to data, and transforms the borrowing process from a slow paper-based mechanism to a transparent digital workflow. Additionally, the new system provides automated reporting and maintenance scheduling, which were absent in the previous manual process.

4. CONCLUSION

A. Conclusion Based on the analysis, design, and implementation of the Sikendi web-based application for the management of official vehicles at Pusinfolahta TNI, the following conclusions can be drawn:

1. The vehicle administration process, which previously relied on manual recording and fragmented spreadsheets, has been successfully modernized through the implementation of a web-based system. This transformation significantly increases data accuracy and administrative efficiency by

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centralizing all asset information into a single database.
2. The system provides a robust mechanism for transparency and governance. By digitizing the borrowing workflow and providing statistical reports on vehicle usage and maintenance, the system minimizes the potential for misuse and supports strategic decision-making regarding operational readiness and resource allocation .

B. Recommendations During the development and implementation of the system at Pusinfolahta TNI, several recommendations have been identified to further enhance the system's capability and scope in future research:

1. The current system operates on a web-based platform. It is recommended that future development includes the creation of a mobile version (Android/iOS). This would enhance flexibility and accessibility, allowing users and administrators to track vehicle status and input fuel logs (Log BBM) from any location, particularly during field operations .
2. Future iterations should incorporate real-time notification features (via email or push notifications). This would streamline communication by instantly alerting users about loan approvals and notifying administrators about upcoming document expirations or overdue maintenance schedules .
3. It is recommended to expand the analytical modules to include Total Cost of Ownership (TCO) analysis. By integrating data from maintenance history and fuel logs, the system could automatically calculate operational costs per unit, thereby assisting leadership in planning asset regeneration or upgrades .

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