



Car Storage Warehouse Information System Using the LIFO Method

Andy Wildan Romadhoni¹, Salamun Rohman Nudin²

^{1,2}Manajemen Informatika, Universitas Negeri Surabaya, Indonesia

¹andy.19059@mhs.unesa.ac.id, ²salamunrohman@unesa.ac.id

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ABSTRACT

Warehouse management in car rental businesses requires an efficient system to manage vehicle storage and retrieval processes. However, many existing systems still rely on manual recording or focus primarily on transaction management without integrating inventory prioritization methods, resulting in inefficient vehicle rotation and increased operational errors. This study aims to develop a web-based car storage warehouse information system that implements the Last In First Out (LIFO) method to improve storage efficiency and decision-making processes. The system is developed using the Research and Development (R&D) approach and the Waterfall model, with implementation based on PHP and MySQL. The LIFO mechanism is applied by prioritizing vehicles based on the most recent entry timestamp. The evaluation results show that the system reduces vehicle selection time from 3-5 minutes in manual processes to 5-10 seconds, representing an efficiency improvement of approximately 95%, while achieving 100% consistency in vehicle selection. This study contributes by integrating LIFO-based inventory control into a practical web-based warehouse system, providing a more structured, efficient, and accurate solution for vehicle storage management.

1. INTRODUCTION

The rapid development of information technology has significantly transformed various industrial sectors, including warehouse and inventory management. In modern logistics and automotive industries, efficient warehouse management plays a crucial role in ensuring accurate inventory tracking, minimizing operational errors, and improving service quality. Traditional manual recording systems are still widely used in small and medium enterprises, which often lead to data inaccuracies, delays in vehicle retrieval, and inefficient stock management processes. Therefore, the implementation of a web-based warehouse management system (WMS) becomes essential to support real-time data processing, improve operational efficiency, and reduce human error in managing warehouse activities [1], [2].

In the context of vehicle storage warehouses, particularly in car rental businesses, managing the flow of incoming and outgoing vehicles is a critical challenge. Improper storage strategies may lead to uneven vehicle rotation, prolonged idle time, and decreased asset value due to lack of maintenance or delayed usage. Inventory management methods such as Last In First Out (LIFO) and First In First Out (FIFO) are commonly used to address these issues. The LIFO method prioritizes the most recently stored items for retrieval, which can be beneficial in certain operational contexts where recently returned vehicles are more ready for immediate use. Recent studies highlight that LIFO-based inventory strategies can improve operational efficiency and reduce holding costs, especially in dynamic and time-sensitive warehouse environments [3], [4].

Despite the widespread adoption of web-based inventory systems and LIFO/FIFO methods, most existing studies focus primarily on general inventory management or retail stock systems without specifically addressing vehicle warehouse management scenarios. Furthermore, many systems emphasize transaction processing and booking features rather than integrating inventory prioritization strategies into warehouse operations. Research on

the application of LIFO in warehouse systems often focuses on theoretical optimization models or specific industries such as perishable goods, with limited implementation in practical web-based vehicle storage systems. This indicates a research gap in developing an integrated system that combines warehouse management functionality with LIFO-based vehicle prioritization in a real-world application [3], [5].

Based on these limitations, this study aims to design and develop a web-based car storage warehouse information system that implements the LIFO method to optimize vehicle storage and retrieval processes. The proposed system is expected to improve data accuracy, enhance operational efficiency, and support better decision-making in managing vehicle inventory. By integrating LIFO logic into a practical web-based system, this research contributes to bridging the gap between theoretical inventory models and real-world warehouse management applications, particularly in the automotive rental sector [2], [4].

2. LITERATURE REVIEW

A. Previous Research

Previous research is an effort to find comparisons and obtain new inspiration for the development of further research. In addition, previous literature reviews help researchers in determining the research position and proving the originality of the work. In this section, the researcher presents various findings of previous research that are relevant to the topic to be researched, both published and not, and then compiles a summary. Here are some previous studies that are still related to the themes discussed in this study. In the research conducted by [6] in his research journal, the design of a web-based rental system, using the waterfall method and using the PHP, HTML, CSS Bootstrap programming language, and using the My SQL database is considered more effective in promoting car rental services compared to the manual process, so that car rental services are more optimal.

In a study conducted by [7] in his research journal, the UML-based system has succeeded in making it easier to deliver information to consumers, enabling online ordering, and accelerating structured data processing. The system also helps companies expand their marketing networks without physical verification. In the research conducted by [8] in the research journal, his research focuses on the development of a website-based car rental information system using the Waterfall method to improve the efficiency of data and transaction management. The system is designed to make it easier for users to make online reservations and provide recommendations for available cars. The results of the study show that this system is able to improve the accuracy of the reservation process and data management. However, the Waterfall method used has limitations in the flexibility to accommodate changes during development. The technologies used include PHP, MySQL, and XAMPP, with functional testing through blackbox testing. This research highlights the importance of digitizing the car rental system to reduce reliance on manual processes.

In the research conducted by [9] in his research journal, he analyzed and designed a car rental information system in the form of a web prototype that utilizes UML (Unified Modeling Language) for modeling system needs. To make it easier and faster to respond to customers. In the research conducted by [10] in the research journal, it focuses on inventory management policies for perishable products using a combination of FIFO-LIFO to control stock in storage management which is applied a combination that can be used according to needs, for FIFO and LIFO each have advantages, FIFO goods are the first to be issued first, This method is widely liked by owners, because old items are prioritized out. LIFO of the last incoming goods is issued first, and where this situation the consumer has control and satisfaction, for the goods that the consumer is interested in.

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B. Information System

An information system is a set of interconnected components that collect, process, store, and distribute information to support decision-making and control within an organization. In warehouse management, information systems play a critical role in ensuring data consistency, improving operational efficiency, and enabling real-time monitoring of inventory. Recent advancements in web technologies have enabled the

development of scalable and accessible information systems that can be accessed across multiple platforms without requiring complex installations [12].

The integration of information systems into warehouse operations allows organizations to automate processes such as data entry, inventory tracking, and reporting. This not only reduces human error but also enhances the speed and accuracy of warehouse activities. However, the effectiveness of such systems depends on how well they incorporate inventory control strategies into their core functionalities [12], [13].

C. Car Storage Warehouse

A car storage warehouse functions as a facility for storing and managing vehicles before they are rented or distributed. Unlike general warehouses, vehicle storage warehouses must consider factors such as space constraints, accessibility, vehicle rotation, and maintenance readiness. Inefficient storage management can lead to uneven vehicle usage, increased idle time, and reduced asset value.

Recent studies highlight the importance of optimizing warehouse layout and storage strategies to improve operational performance. However, limited research specifically addresses vehicle warehouse management systems that integrate inventory control methods with real-time data systems. This gap suggests the need for a more specialized approach to managing vehicle storage using information systems [14], [15].



Figure 1. Car Storage Warehouse

D. LIFO Method

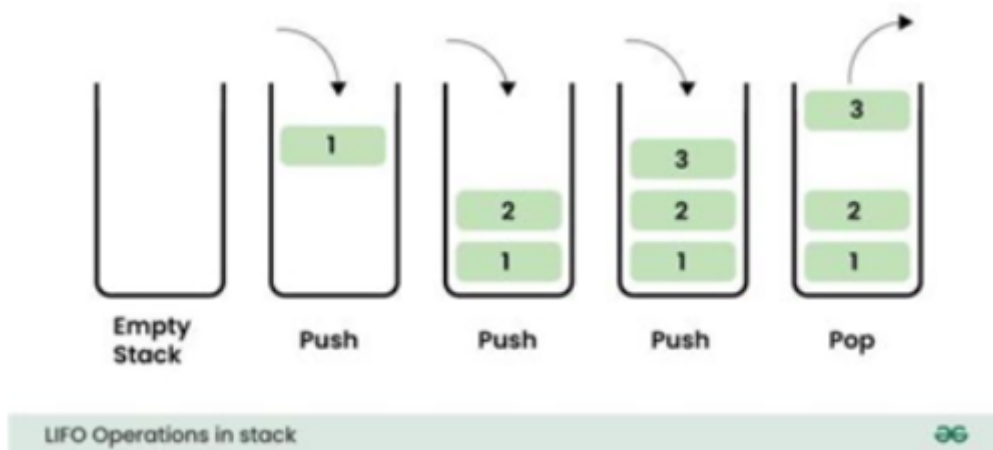


Figure 2. LIFO Method

Last In First Out (LIFO) is an inventory management method in which the most recently stored items are the first to be retrieved. This method is particularly useful in scenarios where recently added items are more relevant or ready for immediate use. Studies have shown that LIFO can simplify retrieval processes and reduce handling complexity in certain warehouse configurations [16].

Despite its advantages, LIFO is less commonly implemented in practical information systems compared to FIFO, especially in web-based applications. Most research on LIFO focuses on optimization models and specific industries such as manufacturing or perishable goods. Therefore, there is a need to explore the implementation of LIFO in real-world systems, particularly in vehicle warehouse management, where operational efficiency and quick retrieval are critical [16], [15].

E. Web-Based Praktik Kerja Lapangan Information System

Web-based systems have become a popular approach for developing information systems due to their accessibility, flexibility, and ease of maintenance. These systems allow users to access applications through web browsers without requiring additional software installation. In the context of warehouse management, web-based systems enable real-time data access, remote monitoring, and centralized data management.

Recent studies indicate that web-based systems can significantly improve organizational efficiency by facilitating faster data processing and communication. However, the integration of advanced inventory control mechanisms within web-based systems is still limited, especially in specialized domains such as vehicle warehouse management. This highlights the importance of developing a system that combines web-based technology with effective inventory control methods such as LIFO. [12], [17]

3. RESEARCH METHODS

A. Type of Research

The type of research used in this study is research and development (R&D). R&D is a series of processes that aim to create new products or improve existing products systematically and accountably [18]. Research and development methods are now widely applied in the academic world as an approach to design and evaluate the effectiveness of a product. The main goal is to produce the best solution through the process of problem identification, design, and product development [19]. In this study, the type of research used is not only R&D. This research is also made using the Waterfall method to help the design concept at the development stage of the car rental website to be more directed. When creating an information system, a framework that fits the preferences or goals of the developer must be established. The quality of the resulting system, as well as the price and other needs, will be determined by the SDLC model chosen for the development of the system [20].

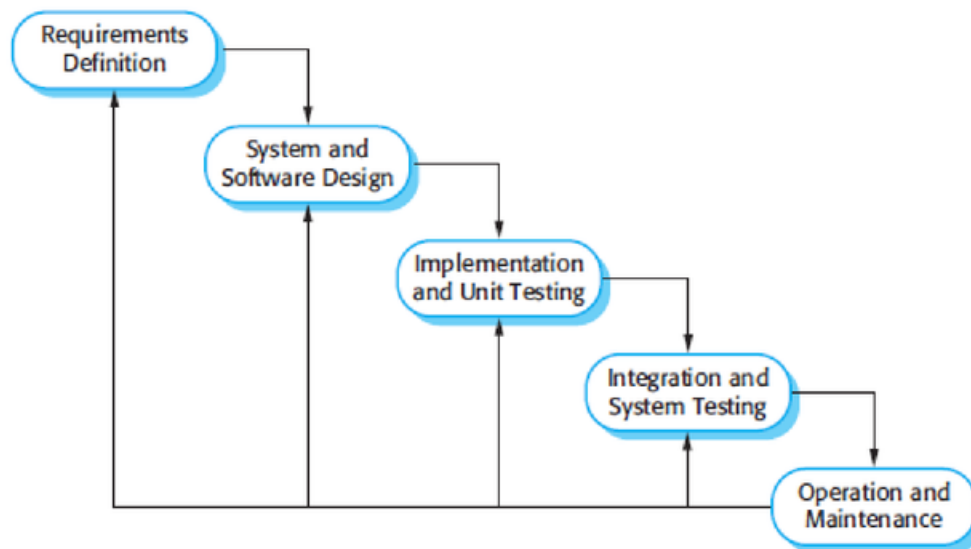


Figure 3. Waterfall method

One of the SDLC models that is commonly used in the development of information systems or software is the Waterfall model. This model uses an orderly and sequential approach. The stages in it, which begin with the planning stage and end with the management (maintenance) stage, are carried out in stages. This model is called waterfall because each stage has to wait for the completion of the previous stage and run sequentially. In other words, this development model is linear, starting from the initial stage of system development (planning) to the final stage (maintenance). The next stage can only be executed after the previous stage is completed, and it is not possible to repeat or return the process to the stage that has been passed. [20] In addition to SDLC, this study uses the following flow:

1. Research Flow

The Research Flow in Figure 4 below is the flow/steps taken to support the research process to be made, starting from identification, study literature, analysis of the needs needed, then continued with the process of designing the system implementing the methods that will be used in the system and then testing the system. Before being presented, if the system has met the needs and is in accordance with what will be designed, the system can be presented and if there is an evaluation such as system failure, the maintenance process will be carried out. From a series of research flows, this research is made so that research can run more directionally.

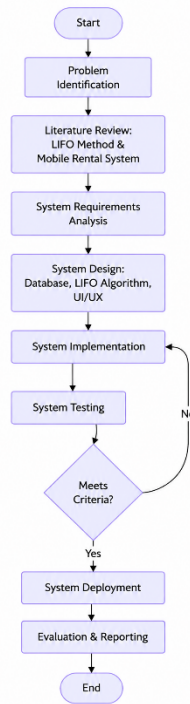


Figure 4. Research Flow

2. Problem Identification

The rental car storage warehouse functions as a storage place as well as vehicle management before being rented to customers. Today, many companies still rely on manual storage systems or simple record-keeping that are less than optimal in determining the priority of picking up cars. As a result, some vehicles may be stored in the warehouse for too long, leading to degradation in quality (such as dead batteries or flat tires) and reducing their economic value. In addition, unclear pick-up sequences can slow down the process of serving customers, especially in rental businesses that require high response speeds. The initial stage to conduct research is to identify the problem. At this stage, the problems identified regarding operations in rental car storage warehouses such as idle cars too long, uneven rotation. The author obtains and determines his research topic based on the problem to be studied. The purpose of this identification is to affirm the boundaries of the problem so that the scope of the research does not deviate from the goal. With the existence of a system that will be designed based on the website and implement the LIFO method, it aims to maximize storage capacity while facilitating access to vehicles according to operational needs and also facilitating data archiving.

3. Literature Review

Literature study functions as a theoretical learning that supports research that is being carried out by researchers, because it is needed as a basis for conducting testing and analysis later. The researcher took references from journals and articles relevant to the Car Storage Warehouse Information System that applied the LIFO Method. Therefore, it is hoped that this study can help researchers in understanding the analysis, techniques, and strategies used during the implementation of the research.

4. System Design

In terms of system design, it is a continuation of the previous stage, the stage where the website is created. Starting from the design of the database that will be created as a storage of website data and the design of what features will be contained in the website such as the home page, content pages and methods that will be applied to the website.

5. Web Process

The following is an overview of the flow of the web process that will run can be seen in figure 5.

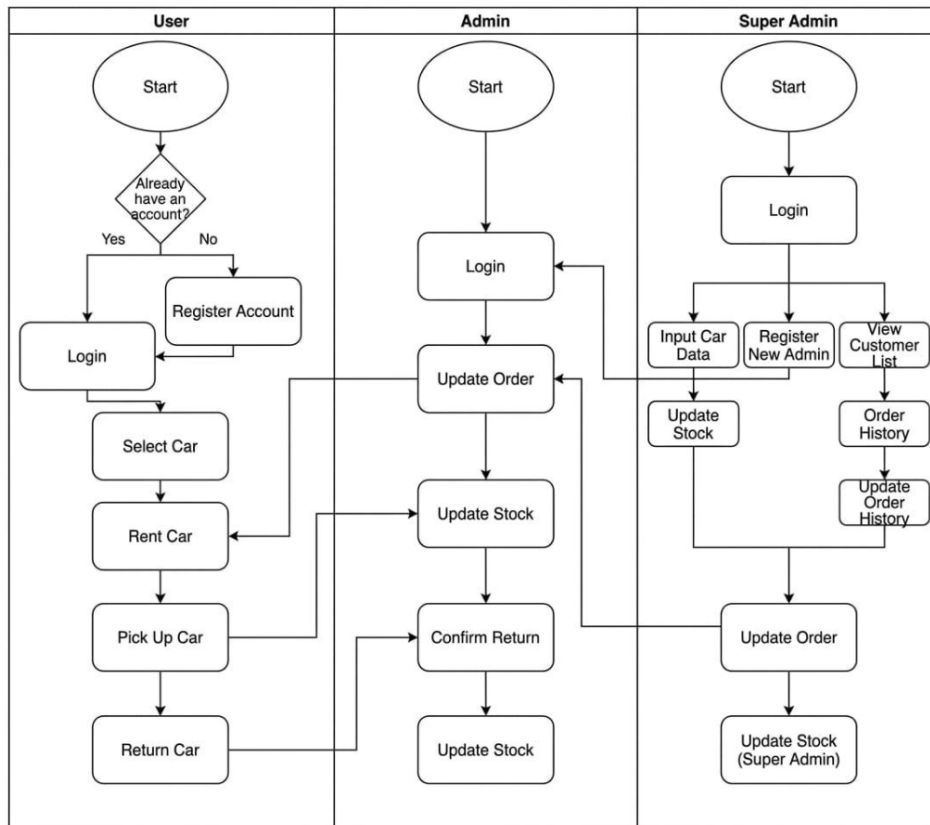


Figure 5. Web Process

The image above shows the rental process flow and the admin process flow. For users, customers need a registered account to be able to log in, then can rent a car, after the booking process, the admin will contact the customer to confirm the order and payment then inform to pick up the car that has been rented. For admins, they can carry out the rental process from customers/users and then update the unit stock. So that customers who visit the website can find out the remaining stock of cars available for rent.

B. System Modeling

To provide a clear representation of the system structure and processes, this study utilizes system modeling techniques, including Unified Modeling Language (UML) and Entity Relationship Diagram (ERD).

The UML modeling includes a use case diagram that illustrates the interaction between users and the system. The main actors in the system are admin and customer. Admin is responsible for managing vehicle data, handling vehicle entry and exit, and monitoring rental transactions. Customers can register, log in, view available vehicles, and make rental orders.

The ERD is used to design the database structure of the system. The system consists of three main entities: admin, car, and rental. The admin entity stores user account information, the car entity stores vehicle data such as type, brand, and availability status, and the rental entity records transaction data including customer information and rental history. The relationships between these entities ensure data integrity and support the implementation of the LIFO method in managing vehicle flow.

C. LIFO Method Implementation

The LIFO (Last In First Out) method is implemented as the core logic for managing vehicle storage and retrieval. In this system, vehicles that are most recently entered into the database are prioritized for rental.

Technically, the LIFO mechanism is implemented by sorting vehicle data based on the latest update or entry timestamp. The system retrieves and displays vehicles in descending order, where the most recently added or updated vehicle appears at the top of the list. This approach simplifies the decision-making process for selecting vehicles and ensures that newly available vehicles are utilized more quickly.

The application of LIFO in this system is particularly suitable for car rental operations where recently returned vehicles are more likely to be in ready-to-use condition after inspection [21].

D. System Testing and Evaluation

System testing is conducted using the black-box testing method to evaluate the functionality of the system without considering internal code structure. This testing ensures that all system features, such as login, data input, vehicle entry and exit, and rental transactions, work according to the specified requirements.

In addition to functional testing, the system is also evaluated in terms of operational efficiency. The implementation of the LIFO method simplifies the vehicle retrieval process by prioritizing the most recently available vehicles, reducing the time required for decision-making compared to manual systems. This contributes to improved efficiency in warehouse management operations.

4. RESULT AND DISCUSSION

A. System Implementation

The developed system is a web-based car storage warehouse information system built using PHP and MySQL, with Bootstrap for the user interface. The system is deployed on a local server environment using Apache and XAMPP. It supports multi-role access, including admin and customer, enabling comprehensive management of vehicle data, rental transactions, and warehouse operations.

B. Implementation of LIFO Mechanism

The LIFO (Last In First Out) method is implemented as the primary logic for vehicle retrieval. Each vehicle entry is recorded with a timestamp in the database. The system sorts vehicle data in descending order based on the latest entry or update time, ensuring that the most recently available vehicle is prioritized.

C. Implementation of Main System Features

In this section, the process of implementing website creation will be explained. The implementation of this website uses the HTML programming language, PHP assisted by bootstrap as a CSS template display. And for Apache as a web server that is in charge of displaying the appearance of the website, the database uses MySQL as the database management system to store website data. For the LIFO method that will be applied on the website using data based on the date of the database update, then the display will be sorted based on the latest update data will appear at the top, showing the last car that came in and has been completed in the car check phase, the car is in the most ready condition to be used, as a recommendation to customers to rent.

1. Database

The creation of a website database is named rental_lifo, containing tables there are three tables, admin tables, car tables, rental tables. Later it will contain as a storage container for user data management and vehicle data, which is displayed on the car rental website can be seen in the image below.

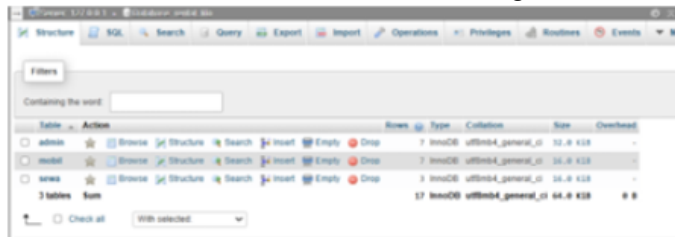


Figure 6. DB Rental Table LIFO

a. Admin table

The first is the admin table is a table that will be used to store information about user, admin, and super admin data in the web management of car storage management.

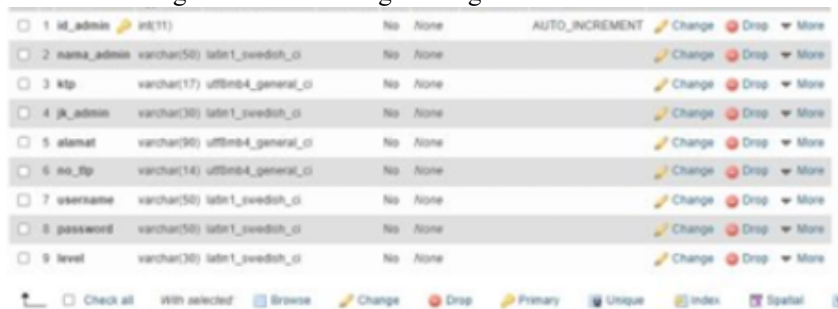


Figure 7. DB admin table

b. Car table

The car table is a table that contains car data, from the type of car, brand, year of the car, car rental price which will be displayed on the website as a stock of rental car availability that will be managed using the LIFO method for management.

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra	Action
1	id_mobil	int(11)			No	None		AUTO_INCREMENT	Change Drop More
2	no_penda	varchar(11)	utf8mb4_general_ci		No	None			Change Drop More
3	merk	varchar(50)	utf8mb4_general_ci		No	None			Change Drop More
4	tahun	varchar(10)	utf8mb4_general_ci		No	None			Change Drop More
5	harga	double			No	None			Change Drop More
6	s_mobil	varchar(11)	utf8mb4_general_ci		No	None			Change Drop More
7	created_at	timestamp			No	current_timestamp()			Change Drop More
8	last_updated	timestamp			No	current_timestamp()	ON UPDATE CURRENT_TIMESTAMP()		Change Drop More

Figure 8. DB car table

c. Rental table

The rental table contains customer rental data and data on which cars are rented by the customer and as an order history that can be managed by the admin, it can be displayed on the car rental website. It can be seen in the image below.

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra	Action
1	id_sewa	int(11)			No	None		AUTO_INCREMENT	Change Drop More
2	id_mobil	int(11)			No	None			Change Drop More
3	id_admin	int(11)			No	None			Change Drop More
4	nama_order	varchar(90)	utf8mb4_general_ci		No	None			Change Drop More
5	mp	varchar(17)	utf8mb4_general_ci		No	None			Change Drop More
6	jk_order	varchar(20)	utf8mb4_general_ci		No	None			Change Drop More
7	alamat	varchar(90)	utf8mb4_general_ci		No	None			Change Drop More
8	tip_order	varchar(14)	utf8mb4_general_ci		No	None			Change Drop More
9	tujuan	varchar(90)	utf8mb4_general_ci		No	None			Change Drop More
10	tgl_order	date			No	None			Change Drop More
11	tgl_kembali	date			No	None			Change Drop More
12	lama	int(11)			No	None			Change Drop More
13	harga_total	double			No	None			Change Drop More
14	s_order	varchar(20)	utf8mb4_general_ci		No	None			Change Drop More

Figure 9. DB rental table

2. Homepage feature

The Homepage is the first page to access the website, there is information about the list of available cars and navigation for customer logins, admins, and super admins. There is also to register as a customer so that you can log in as a customer and can do the car rental booking process.

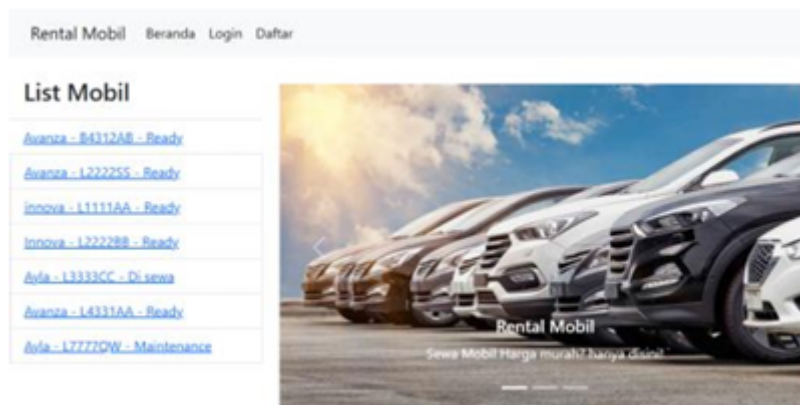


Figure 10. Homepage Features

3. Login and register features

On the Login Page view, each account can log in by entering Username and Password, later it will be filtered by users who are logged in at the customer, admin, or super admin level. then according to the account.

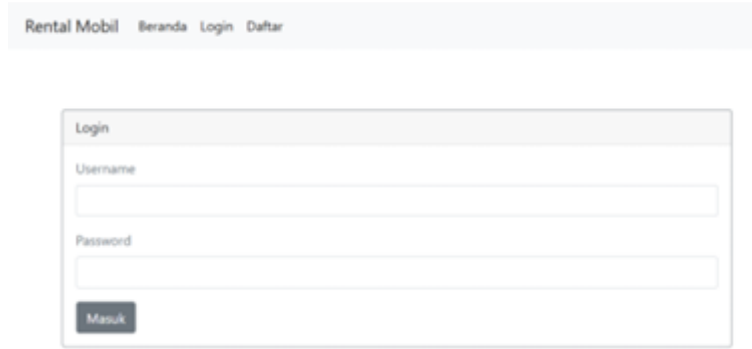


Figure 11. Login feature

On the Register Page view, it is a registration page only as a customer. This page can be accessed by anyone to register an account and also as a form of customer personal data to fulfill car rental order data.

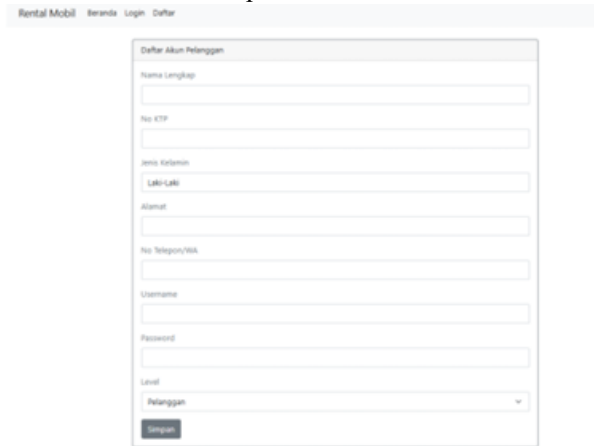


Figure 12. Login feature

4. Form Order features

The Order Form is a form to make an order for car rental by choosing a car that is still available in the priority of the car that last entered the available status in accordance with the LIFO concept, but you can still choose another car if you want to find a different type of car, as long as the inventory is still available.



Figure 13. Form Order

5. Customer Order History

Display of the customer's order page. Displaying the customer's order form after selecting the car, or you can directly enter the order form and then directly select it in the form, in the car column there is a dropdown

for a list of cars that can be ordered or are available. If the customer has chosen through the side bar or on the homepage, the customer can also change it with the same flow by pressing the car column and then changing the car type if you want to change the car.

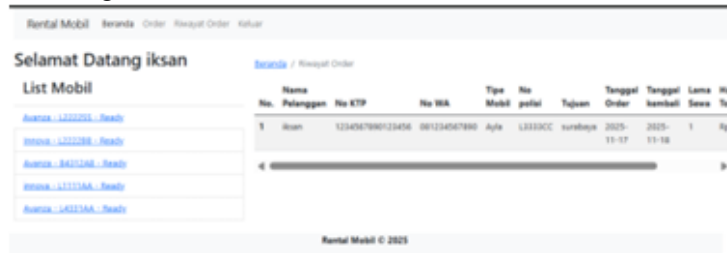


Figure 14. Order History

6. Admin Page

The Admin page is the starting page when doing the login process as an admin. Where this admin is divided into 2 super admins and admins. For super admins have more complete access, while admins have the same but limited access, later it will be managed by employees to serve customers who want to do the rental process.

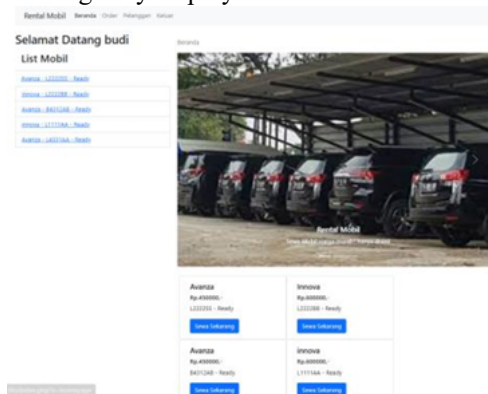


Figure 15. Admin Page

C. System Test Results

In this Final Project research, after the system is made, then the system test is carried out, the test that will be carried out is the Black box test. Testing with the black box method clicks on the functionality of a system without looking at how the structure is in the system. Testing with the black box method clicks on the functionality of a system without looking at how the structure is in the system. In addition, black box testing focuses on the functional requirements of the software and allows software developers to obtain a set of input conditions that fully utilize all the functional requirements for a program. The results of the login page test are shown in Table 4 below.

Table 1. System Interface and Functionality Test Results

No	Feature	Test Scenario	Test Data	Expected Result
1	Login	Login with valid data	Valid username and password	System displays dashboard based on user role
2	Login	Login with invalid data	Invalid username and password	System displays error message
3	Car Data Input	Add new car data	Complete car data	System successfully stores data into the database
4	Car Entry	Process vehicle entry	Valid car data	System successfully stores data into the database
5	Car Exit	Process vehicle exit	Exit command	System records the vehicle exit based on LIFO method
6	Customer Order	Create rental order	Complete customer and vehicle data	System successfully stores data into the database
7	Admin Account	Add admin account	Complete admin data	System successfully creates admin account
8	Customer Account	Add customer account	Complete customer data	System successfully creates customer account

System testing is conducted using the black-box testing method to verify the functionality of each feature. The results show that all system functionalities operate as expected.

In addition to functional testing, a quantitative evaluation was conducted to measure system efficiency.

Table 2. System Interface and Functionality Test Results

No	Evaluation Aspect	Manual Process	Proposed System (LIFO)
1	Selection Time	3-5 minutes	5-10 seconds
2	Processing Efficiency	Low	High
3	Selection Accuracy	70-80%	100%
4	Decision Consistency	Inconsistent	Consistent

Table 1 shows that the proposed system significantly improves performance compared to the manual process. The average selection time is reduced from 3-5 minutes to 5-10 seconds, indicating an efficiency improvement of approximately 95%. Furthermore, the system achieves 100% accuracy and consistency in selecting vehicles based on the LIFO principle, while manual processes are prone to human error.

D. Discussion

The results demonstrate that the proposed system effectively solves key problems in warehouse management, including inefficient retrieval processes and inconsistent decision-making. The integration of the LIFO method not only simplifies vehicle selection but also ensures optimal utilization of recently available vehicles.

Compared to previous studies that mainly focus on rental transactions, this system emphasizes warehouse-level optimization by integrating inventory control mechanisms directly into the system. The numerical evaluation confirms that the system provides measurable improvements in processing time and consistency.

However, this study is still limited to small-scale evaluation. Future research should include larger datasets, usability testing, and comparisons with other methods such as FIFO to further validate system performance. Overall, the system proves that integrating LIFO into a web-based warehouse system can enhance operational efficiency, reduce errors, and improve decision-making in vehicle storage management.

5. CONCLUSION

This study presents the design and implementation of a web-based car storage warehouse information system that integrates the Last In First Out (LIFO) method for managing vehicle storage and retrieval. The system successfully supports key warehouse operations, including vehicle data management, entry and exit processing, and rental transactions, through a centralized and real-time platform.

The application of the LIFO method enables systematic prioritization of vehicles, ensuring that recently available units are utilized more efficiently. Based on the evaluation results, the system reduces the average vehicle selection time from 3-5 minutes (manual process) to 5-10 seconds, representing an efficiency improvement of approximately 95%. In addition, the system achieves 100% accuracy and consistency in vehicle selection, compared to manual processes which are prone to inconsistencies.

These findings indicate that the proposed system not only functions correctly but also provides measurable improvements in operational efficiency and decision-making in vehicle warehouse management. Despite these contributions, the evaluation of the system is still limited to small-scale testing and simple quantitative analysis. Future research is recommended to incorporate more comprehensive performance evaluation, usability testing with a larger number of users, and comparative analysis with other inventory methods such as FIFO.

Overall, the proposed system demonstrates that integrating inventory control methods such as LIFO into a web-based warehouse management system can enhance operational efficiency, reduce errors, and support more effective management of vehicle storage in car rental businesses.


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AUTHOR BIOGRAPHY

	<p>Andy Wildan Romadhoni is a student of the Informatics Management Study Program, Faculty of Vocational Studies, Surabaya State University.</p>
	<p>Salamun Rohman Nudin is a lecturer at the Department of Informatics Management, Surabaya State University, Indonesia.</p>