Heavy Equipment Rental Information System Development using the Prototyping Method

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ABSTRACT

A private company engaged in heavy equipment rental services, established on June 19, 2012, in Pekanbaru. In the current business process, customers who wish to rent heavy equipment or seek information about it can only do so during office hours, making the rental process less efficient. Record-keeping is still done using Excel, which increases the risk of data loss. Therefore, a solution has been proposed to develop a web-based information system to access and manage the process easily. The information system was developed using the prototyping method. The choice of the prototyping method is made to speed up development time, ease system completion, and avoid discrepancies between developers and users. The information system is then tested through Black Box testing and usability testing. From the Black Box testing results, it was found that the system's functionality for all users has been successfully implemented and operates as expected. Meanwhile, the usability testing results showed an average score of 89%, indicating that users strongly agree with the system's usability. This research helps to facilitate customers and administrators in the heavy equipment rental process by providing quick and easy access to information on prices, schedules, and equipment types, while also improving data recording to reduce the risk of data loss and facilitate administrative tasks.

I. INTRODUCTION

In this modern era, the advancement of information technology has undergone remarkable development. Information technology is a combination of computer technology, which includes hardware and software for processing and storing information, and communication technology for transmitting information [1]. Many companies and institutions are embracing technological advancements, particularly computer-based technologies, to meet their information needs and provide better services to consumers.

A private company provides a service specializing in the rental of various types of heavy equipment [2], playing a crucial role in the trading industry. Rental is an agreement between a lessee and an owner of goods [3]. The owner of the goods gives the goods to be rented to the lessee for full use. Heavy equipment refers to machines or tools used in construction, infrastructure development, and other industrial activities [4]. It helps humans work to achieve easy work. A private company not only supports the smooth execution of projects but also contributes to the overall trading ecosystem. The company owns 27 pieces of heavy equipment and has successfully conducted numerous transactions. Examples of heavy equipment include excavators, bulldozers, tow trucks, graders, and more. These machines are essential for construction, excavation, soil compaction, and other tasks that require significant strength and durability.

In the heavy equipment rental process, customers who wish to rent equipment can either visit the office in person or contact the admin via telephone. Typically, customers inquire about the availability of heavy equipment that meets their timing needs. After checking availability, customers will discuss the rental price, duration, and the location where the equipment will be used. They are then asked to visit the site to inspect the condition and completeness of the equipment directly. This step is crucial before signing the contract to prevent potential issues in the future.

The challenge faced by this company lies in the inefficiency of its rental process. The company operates from Monday to Friday, 8 a.m. to 5 p.m., which limits accessibility and convenience for customers, especially those from out of town or with tight schedules. Although customers can make reservations by phone, the limited operating hours remain a constraint. Additionally, the data storage system at this company still relies on Excel spreadsheets and physical books, increasing the risk of data loss. Therefore, to address these issues, the proposed solution is to develop a web-based information system using the prototyping method.

The prototyping method is an ideal choice for developing a web-based information system for this company because it allows for gradual and iterative system development and accelerates feedback from stakeholders [5]. By applying the prototyping method, developers can present an initial model of the system that can be immediately tested by stakeholders, such as customers and admins. This enables early identification of unmet needs or necessary changes [6]. Compared to the traditional method, namely the waterfall method, it was implemented by sequence stage. The next stage cannot be continued until the previous stage is finished [6]. Therefore, the product can only be seen at the end of the software process.

The development of this website is expected to simplify the heavy equipment rental process for customers, providing easier and faster access to information related to pricing, schedules, available equipment, and other details. The system is also expected to assist the admin in streamlining data recording processes, reducing the risk of data loss, and easing administrative tasks.

Incorporating prior research provides insights and ideas for the current study. Five previous studies have been selected for comparison in this research.

Research conducted by Felix et al. [7] resulted in a web application that facilitates customers in searching for information and renting camping equipment. The website was developed using the waterfall method and tested with black box testing, demonstrating that it can operate on various devices, including smartphones and computers. However, this study lacks a shopping cart feature to accommodate multiple products in a single transaction, as well as a payment method.

A study by Hidayat et al. [8] developed a web-based marketplace information system using the waterfall method to assist rental business owners in promoting their products and making it easier for customers to find desired items. However, the customer cannot access the transaction status.

Research conducted by Kurniawan et al. [9] produced a web-based application using the SDLC, which helps users with venue reservation and payment transactions. The financial workflow became more transparent and more secure with the addition of a financial reporting feature within the application. On the other hand, this research did not mention the SDLC method used, or the testing method used to evaluate the system.

A study by Sari et al. [10] developed a web-based application using the waterfall method to assist customers and administrators in the camera rental process, including a rental report management feature. However, this study lacks an online chat feature, which would make it easier for customers to contact the administrator of Rumah Kamera Semarang.

The research conducted by Saputra [11] created a web-based car rental system that integrates the Midtrans payment gateway to streamline booking payments and automatically update payment status in the system. However, this study lacks a REST API feature for accessing data, limiting its usability across multiple platforms.

According to the research gap, this research proposed the development of a Heavy Equipment Rental Information System using the Prototyping Method (Case Study: A Private Company in Pekanbaru)". This research aims to create an information system that simplifies the rental process for both customers and administrators. The system covers the payment through the transfer system then upload the transfer evidence through the system. The system covers not only the rental process but also the return process after the equipment has been used. Additionally, it includes a financial reporting feature to help the owner monitor financial progress.

II. METHOD

The material used in this study is qualitative data through interviews as the preliminary research. The interview was conducted to get more detailed information related to this study [12]. Then, quantitative data will be collected through black-box testing and questionnaires to evaluate the system. Black-box testing was used to evaluate system specifications where the tester had no access to the source code [6]. The questionnaire is the instrument to gain information from a group of people that is related to this study [13]. Then, the questionnaire used a 5-point Likert Scale [14] to evaluate the usability aspect.

The method used in this research is rapid prototyping. The rapid prototyping method is a software development approach that aims to understand and test concepts before implementing them. The rapid prototyping model is used to design information systems. This method allows program developers and object researchers to interact during the system design process [15].

During the development of information systems, prototyping is often implemented in the form of user interfaces for applications to give users a general overview of the system that will be used. The stages in the prototyping method can be explained based on Figure 1.

A. Listen to the Customer

In this stage, the developer gathers information to identify user needs and understand the problems faced by the client through the interview. The data collected will provide a solution to the issues and serve as a reference for moving on to the next stage.

During the initial prototyping phase, efforts are made to understand and recognize the user's requirements. This is

done through interviews. Based on the interview conducted with the employee at the company, the problems that need to be addressed were identified, along with the necessary solutions.
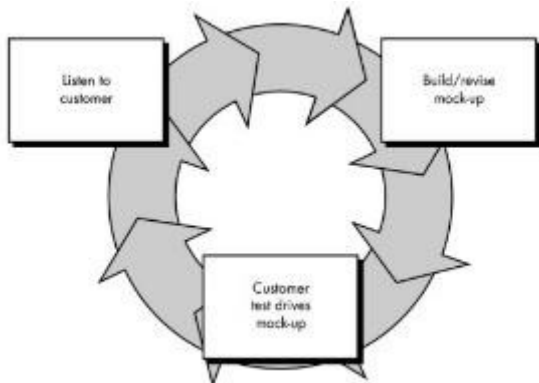

Figure 1. The prototyping method [5]

Following the interview process, the results revealed the user needs and the features required for system development. In line with the interview findings, several pieces of information were identified, outlining the system requirements expressed by the users. The information gathered from users was presented in the form of a Use Case Diagram and System Architecture.

1) Use Case Diagram

The use case diagram is designed based on the system requirements and its corresponding actors, as shown in Figure 2.
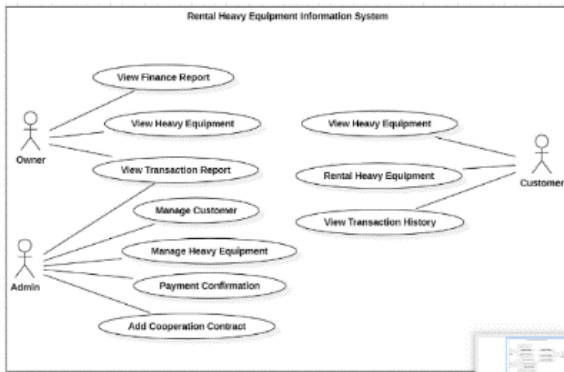

Figure 2. Use Case Diagram

There are three actors in this Use Case Diagram. The Owner is the company owner, the Admin is an employee of the company, and the Customer rents heavy equipment from the company.

2) System Architecture

The system architecture is designed to assist in the system design process and to understand how the system operates. Figure 3 illustrates the system architecture that will be implemented at this company. The company owner, admin, and customers will use the internet to access the web server directly. The web server will respond to user requests through a web browser. Customer requirements will be retrieved from

the database via the web server. This application used Model-Controller-View (MVC) architecture. The architecture of this system will be built as follows:
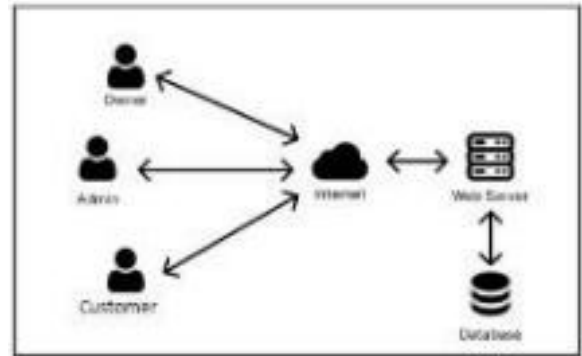

Figure 3. System Architecture

The model has the responsibility of organizing data. The view has the responsibility to display information to users. The controller has the responsibility of organizing between model and view [16]. This application was developed by using the Laravel framework with PHP as the language programming. It used MySQL as a database.

B. Build and Revise Mock-up

The system is designed after the necessary information is collected during the requirement-gathering process. This design becomes the foundation for creating the prototyping, which is the implementation step of the prototyping design using programming. In the stage of Building and Revising the Mock-up. The system mock-up is created by using a wireframe [17] and then demonstrated to users to reduce any mismatches.

C. Customer Test Drives Mock-up

Users will evaluate the prototyping based on their needs. When evaluating the prototyping, the developer's task is to understand what the user wants clearly, and the user needs to know the required steps. This process then continues with designing and building the actual system for users to utilize. In the Customer Test Drives Mock-up stage, evaluation and testing of the system that has been developed are carried out.

III. RESULTS AND DISCUSSION

The development of the information system at this company was conducted for six months. This process involves several iterations to ensure that all features meet the user's needs.

1) First Prototyping Iteration

In the first iteration that was previously conducted, the users approved the results of the wireframe phase.

2) Second Prototyping Iteration

In the first iteration, no changes were made. Then, during the second iteration, the users requested several improvements to the system. There were six improvement

notes requested. The details of these improvement notes can be seen in Table I for further guidance in refining the system.

TABLE I
RESULTS OF SECOND PROTOTYPING EVALUATION

No	System Display	Notes	Review Result
1.	Dashboard	• Add a Financial Graph and Total Heavy Equipment Rented Graph on the dashboard page.	Revised
2.	Heavy Equipment Data	• Modify the values of the type and model of heavy equipment. • Add a Unit Count feature for heavy equipment.	Revised
3.	Customer Data	• Add a heavy equipment type filter feature in the report.	Revised
4.	Customer Page	• Add a "How to Order" menu in the customer section.	Revised
5.	Transaction Page	• Add an 11% VAT feature on transactions.	Revised
6.	Finance Page	• Remove the graph from the finance page. • Add the values of customer name, type, and model to the finance table.	Revised

3) Third Prototyping Iteration

In the third iteration, all notes from the second prototyping iteration were addressed. The results of the third prototyping iteration can be seen in Table II.

TABLE II
RESULTS OF THIRD PROTOTYPING EVALUATION

No	System Display	Notes	Review Result
1.	Dashboard	The prototype met the requirements	Approved
2.	Heavy Equipment Data	The prototype met the requirements	Approved
3.	Customer Data	The prototype met the requirements	Approved
4.	Customer Page	The prototype met the requirements	Approved
5.	Transaction Page	The prototype met the requirements	Approved
6.	Finance Page	The prototype met the requirements	Approved

The evaluation results from the third iteration show that all features in the system have been accepted by the users. Therefore, this iteration marks the final step in using prototyping methodology. After the prototyping iterations, system coding began. The system was developed over 4 months.

4) Implementation Results

The implementation results of the system after the 3rd iteration can be seen in the following subsections:

• *Heavy Equipment Page*

This page is the main page for customers, where it functions to display a list of heavy equipment available for rent. Additionally, there is a filter feature for the type of heavy equipment to assist customers in the rental process, as shown in Figure 4.

Figure 4. Heavy Equipment Page

• *Heavy Equipment Rental Page*

This page is the rental form for heavy equipment, which customers must fill out when they wish to rent. The form requires customers to provide various rental-related information, such as the rental date, project location, and rental duration, as shown in Figure 5. Then, the system will view the invoice page. After the equipment is ready to be used, the customer transfers the payment and uploads the payment evidence to the system. Then, the system changes the status becomes confirmation waiting.

Figure 5. Heavy Equipment Rental Page

• *Transaction Data Page*

This page displays the history of customers' heavy equipment rental transactions. Customers can view the details of each transaction they have completed, as shown in Figure 6.

Figure 6. Transaction Data Page

- *Payment Invoice Page*

This page displays the payment invoice details for each rental transaction. The invoice can also be downloaded in PDF format. This page also functions as a payment gateway where customers can upload proof of payment in the form of a photo, as shown in Figure 7.

Figure 7. Payment Invoice Page

- *Dashboard Page*

This page serves as the main page when the admin successfully logs in. The dashboard page functions to display important information easily. This page shows the number of customers, the number of heavy equipment, the number of transactions, the number of available heavy equipment, pending confirmations, financial charts, and a chart of total heavy equipment rented, as shown in Figure 8.

Figure 8. Dashboard Page

- *Transaction Data Page*

This page displays a list of transactions conducted by customers. The admin can efficiently view and manage transaction activities within the system, as shown in Figure 9.

Figure 9. Transaction Data Page

- *Transaction Detail Page*

This page provides complete details about a transaction conducted by a customer. The admin can view comprehensive information related to the selected transaction. On this page, the admin can confirm payment validity by reviewing the proof of payment submitted by the customer. Additionally, the admin can save or update the contract related to the transaction, as shown in Figure 10.

Figure 10. Transaction Detail Page

- *Financial Report Page*

This page displays information regarding the company's finances from transactions that have been conducted. Detailed information about each transaction can also be viewed. Equipped with date and heavy equipment type filters, this page makes it easy for the owner to search the financial history based on specific criteria. Additionally, there is a PDF print feature for easily documenting the company's financial history, as shown in Figure 11.

Figure 11. Financial Report Page

5) Testing Results

At this stage, the developed application underwent testing using Black Box Testing and Usability Testing to ensure that the system functions properly and is user-friendly. Below are the results of the conducted tests:

- *Black Box Testing*

This testing is carried out by the system developers to determine whether the system is operating as intended. Table III shows the Black Box testing scenario and the results.

TABLE III
BLACK BOX TESTING

No	Test case	Expected result	Result
1.	Log in	Admin, Customers, and Owner can log in to the system.	Successful
2.	Sign up	Customers can register in the system.	Successful
3.	Viewing heavy equipment	Customers can view the heavy equipment along with the details offered by the company.	Successful
4.	Filling out the heavy equipment rental form	Customers can place orders for heavy equipment by filling out the rental form.	Successful
5.	Viewing transaction data	Customers can view their past transaction history.	Successful
6.	Uploading proof of payment	Customers can upload payment proof for the orders they have placed into the system.	Successful
7.	Viewing payment notifications via *WhatsApp*	Customers can receive notifications via WhatsApp to inform them whether their payment was accepted or rejected.	Successful
8.	Viewing the ordering process	Customers can view step-by-step guidelines on how to place a heavy equipment order.	Successful
9	Viewing the about page	Customers can access information about the company.	Successful
10	Managing heavy equipment data	Admin can manage heavy equipment data, including viewing, adding, editing, and deleting equipment details.	Successful
11	Managing heavy equipment types	Admin can manage types of heavy equipment, including viewing, adding, editing, and deleting equipment types.	Successful
12	Managing customer data	Admin can manage customer data, including viewing, adding, editing, and deleting customer details.	Successful
13	Managing transactions	Admin can manage customer transactions, including viewing, validating payment proof, saving contract agreements, and completing transactions.	Successful
14	Viewing transaction reports	Admin can view customer transaction history and print it in PDF format.	Successful
15	Viewing heavy equipment data	Owner can view heavy equipment data.	Successful
16	Viewing financial reports	Owner can view financial information from past transactions and print it in PDF format.	Successful

- *Usability Testing*

The testing conducted involved three types of respondents: twenty-one customers, two admins, and one owner of this company, with a total of 14 questions. Firstly, the users try the system for each role as the customer, admin, and owner. Secondly, they were asked to fill out the usability form. There are 5 rating weightings in the usability testing. The usability testing calculation uses the Likert Scale as the metric. Table IV shows the usability rating weightings and Table V presents the score intervals used for the usability testing results. Finally, usability was calculated using the equation (1) to get the score interval.

TABLE IV
USABILITY WEIGHTS

Number	Answer	Weight
1	Strongly Agree (SA)	5
2	Agree (A)	4
3	Neutral (N)	3
4	Disagree (D)	2
5	Strongly Disagree (SD)	1

TABLE V
SCORE INTERVALS

Interval	Score Interpretation
0% - 19,99%	Strongly Disagree (SD)
20% - 39,99%	Disagree (D)
40% - 59,99 %	Neutral (N)
60% - 79,99%	Agree (A)
80% - 100%	Strongly Agree (SA)

The formula used to calculate the score interval in the Likert scale is presented in equation (1).

$$\frac{\text{Total Points}}{\text{Total Respondents} \times \text{Highest Value}} \; x \; 100\% \qquad (1)$$

Using this formula, we can determine the percentage of each score interval, which is then used to interpret the results

of the usability testing for customers. According to Table VI, P presents the number of questions.

TABLE VI
CUSTOMER USABILITY TESTING QUESTIONNAIRE

Code	Question	SA	A	N	D	SD
LEARNABILITY						
P1	This system is easy to use	15	4	2	0	0
P2	I can use this system without instructions	15	6	0	0	0
P3	I have no difficulty using this system	14	7	0	0	0
EFFICIENCY						
P4	This system works well	10	10	1	0	0
P5	This system works as I expected	11	10	0	0	0
MEMORABILITY						
P6	This system is easy to understand	13	7	1	0	0
P7	I can easily remember how to use this system	14	7	0	0	0
ERRORS						
P8	There are no errors on each page	9	8	3	1	0
P9	There is a clear message when an error occurs	8	7	5	1	0
SATISFACTION						
P10	This system is comfortable to use	11	8	1	1	0
P11	I am satisfied with this system	13	6	2	0	0
P12	This system helps in obtaining heavy equipment information	10	8	3	0	0
P13	This system helps in the heavy equipment rental process	13	6	2	0	0
P14	This system meets my needs as a customer	12	5	4	0	0

Below are the customer responses regarding the ease of use (P1) of the company system, using the formula to calculate the score interval in the Likert scale:

- Strongly Agree = 15
- Agree = 4
- Neutral = 2
- Disagree = 0
- Strongly Disagree = 0

$$\frac{(15x5) + (4x4) + (2x3) + (0x2) + (0x1)}{21 \; x \; 5} \; x \; 100\%$$
$$= 92\%$$

Based on the calculation for the first question, the result is a total of 92%. Therefore, with a score range of 92%, it can be concluded that the majority of this company's website users strongly agree that the system is easy to use. Table VII presents the percentage result for each customer question.

TABLE VII
PERCENTAGE RESULTS FOR EACH CUSTOMER QUESTION

Code	Question	Percentage
LEARNABILITY		
P1	This system is easy to use	92%
P2	I can use this system without instructions	94%
P3	I have no difficulty using this system	93%
EFFICIENCY		
P4	This system works well	89%
P5	This system works as I expected	90%
MEMORABILITY		
P6	This system is easy to understand	91%
P7	I can easily remember how to use this system	93%
ERRORS		
P8	There are no errors on each page	84%
P9	There is a clear message when an error occurs	81%
SATISFACTION		
P10	This system is comfortable to use	88%
P11	I am satisfied with this system	90%
P12	This system helps in obtaining heavy equipment information	87%
P13	This system helps in the heavy equipment rental process	90%
P14	This system meets my needs as a customer	88%

Testing was conducted using black box testing to evaluate the system's functionality and ensure that the system operates as expected. With 9 test scenarios for customers, 6 test scenarios for admins, and 4 test scenarios for the owner, it was found that the system's functionality for all users was successful and performed as expected. Therefore, this testing can be used as evidence that the company website is operating well based on its functionality.

Usability Testing has been conducted by customers using 14 questions. Based on the results of the usability testing for customers, the aspect of learnability received a score of 93%, indicating that users strongly agree that the system is easy to use. The aspect of efficiency received a score of 90%, showing that users strongly agree that the system works well. The aspect of memorability received a score of 92%, indicating that users strongly agree that the system is easy to remember. The aspect of error received a score of 83%, showing that users strongly agree that there are no errors in the system. The final aspect, satisfaction, received a score of 87%, indicating that users strongly agree that the system built meets their expectations and provides satisfaction. Usability testing was also conducted for the Admin and Owner using a Likert scale with 14 questions as well as the customer. The result shows that the final percentage of each question was more than 80%. Compared to the previous system, the customer can get the transaction in working hours only. According to the usability testing result, this means that the user strongly agrees that the system built meets their expectations and provides satisfaction. It also shows that the system makes it easier for customers because it can simplify

the heavy equipment rental process even outside of working hours. Moreover, it can increase the responsiveness of the admin or owner to customer transactions.

IV. CONCLUSION

Based on the implementation in accordance with the design, it can be concluded that the web-based information system effectively meets the needs of both the admin and the owner of the company by facilitating the retrieval of information and assisting with the heavy equipment rental process. The website simplifies the owner's task of viewing transactions and financial reports. It also caters to user needs by allowing customers to process rentals outside of the company's operational hours and providing easy access to product information. Black Box Testing confirmed that the system's functionality for all users was successful and operated as intended. Furthermore, Usability Testing yielded an average score of 89%, demonstrating strong user agreement with the system's usability. Compared to previous studies [8], this system can monitor transaction status. It also compares to [7], this system has a rental cart to get more heavy equipment transactions. However, the system does not cover the response time and load time testing because there are not many system users. According to the research findings, there are several future research studies that could be conducted. For instance, it can be developed for digital payment and can collaborate with several payment methods to make transactions easy, namely Midtrans, PayPal, or virtual bank account, because this system only covers bank transfer payments and uploads the transfer evidence through the system. It can also implement the security aspect to protect the credential data.

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