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Web Based Production Scheduling Information System for a Shrimp Paste Factory Utilizing the Waterfall Method

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ABSTRACT

Communication was essential in various aspects of life due to the rapid development of information technology, including in the management of educational institutions and companies. The subject of this study faced issues in production scheduling, where the process was still carried out manually using bookkeeping. This led to delays in order fulfillment, primarily caused by machine breakdowns and human resource challenges that affected the production process. Additionally, the company struggled to manage order data and machine capacity, making it difficult to estimate order completion times and the amount of output produced. This research aimed to develop a web-based management information system for scheduling using the Laravel framework to assist the company in managing scheduling more effectively and efficiently. The research method employed was R&D, with the system development model following the waterfall method, utilizing PHP as the programming language and MySQL as the database. System testing was conducted using the black box testing method. The results of the research indicated that the developed system could help the company schedule production more efficiently, reduce delays, and improve operational efficiency.

Keywords: Management Information System, Production Scheduling, R&D, Waterfall, EDD

1. INTRODUCTION

The use of information technology was essential for completing tasks that required precision and speed (Batubara & Nasution, 2023). Both trade and manufacturing businesses always needed data and information (Meliana & Hwihanus, 2023). Information systems began with data processing, which was then stored in a centralized database that could be accessed and updated by any authorized individuals (Setyawan et al., 2020). In the modern era, the rapid growth of technology and information had led to increased competition across various sectors that relied on computerization (Kamil et al., 2024). Therefore, it was crucial for human resources (HR) to understand technological advancements that could improve productivity, efficiency, performance, and effectiveness (Syahputra et al., 2024).

PT. Sumber Nelayan Indonesia was established in 2014, having originally been founded as UD. Sumber Nelayan in 1983. The company operated in the field of traditional Indonesian seasoning production and was located in Hessa Air Genting, Air Batu District, Asahan Regency, North Sumatra. PT. Sumber Nelayan Indonesia also provided products such as shrimp paste, tamarind, coconut sugar, and dried shrimp. Based on observations, the main issue faced by PT. Sumber Nelayan Indonesia was the difficulty in production scheduling, as it was still done manually using bookkeeping. Other contributing factors to delays included production machine breakdowns and human resource limitations directly related to the production process.

This situation caused waiting times in the production process, resulting in delays in order completion. These delays were primarily due to the company's inability to manage data optimally, as it did not consider the number of orders, customer priorities, deadlines, and, most importantly, machine capacity. As a result, the company could not accurately estimate when orders would be completed or how much output would be produced.

The researcher took the initiative to develop a Management Information System (MIS) for PT. Sumber Nelayan Indonesia based on the aforementioned issues. This system was expected to help resolve these problems. Additionally, the management information system was expected to improve production scheduling, which had been deemed inefficient and poorly managed. The Earliest Due Date (EDD) method, which prioritizes tasks based on the nearest due dates, was applied to one or more machines.

A Management Information System (MIS) is a collection of complex, organized, and rationally integrated

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subsystems that have the ability to transform data into information in various ways to enhance productivity and meet established quality standards (Attanggo et al., 2021). The role of MIS in addressing the problems at PT. Sumber Nelayan Indonesia involved providing new information for strategic operational decision-making through the analysis of previously obtained data. MIS supported management functions such as planning, control, evaluation, and assessment (Hisabi et al., 2022). The system helped solve company issues by collecting data to provide information that led to better decision-making. This information was highly beneficial for planning, controlling, evaluating, and assessing, allowing for more accurate and timely data processing, thereby increasing productivity and reducing costs. Therefore, MIS contributed to improving business operations by enhancing operational efficiency through easier management, organization, and data storage (Alanudin & Khaza'inullah, 2024).

2. LITERATURE REVIEW

In a previous study, the development of a Production Scheduling Information System using the Earliest Due Date (EDD) method showed that through the EDD stages, jobs were grouped based on machine specifications, ordered according to the nearest or earliest due date, and lateness calculations were performed to determine if any jobs were delayed (Hamida & Sugondo, 2020).

Additionally, a study on the analysis and implementation of the Earliest Due Date (EDD) method to minimize delays in vehicle repair scheduling concluded that companies in the service sector viewed the improvement of service performance in vehicle maintenance and repair as crucial, given the increasing demand for automotive services and the growing competition among automotive service companies. Automotive service companies, especially in body repair, placed great emphasis on customer satisfaction, which relied not only on the quality of repairs but also on the speed of completion. This motivated companies to become more efficient in the vehicle repair process, as customers were increasingly intolerant of long waiting times (Mulya et al., 2020).

The previous studies focused on the application of the Earliest Due Date (EDD) method in specific contexts, such as production scheduling in factories and vehicle repairs in the automotive service industry. In these studies, the EDD method was employed to address delays in production and repairs by grouping tasks based on machine or service specifications and ordering them according to the nearest due date. These studies were more limited to manufacturing and automotive service environments, where time efficiency and customer satisfaction were the primary concerns (Hamida & Sugondo, 2020) and (Mulya et al., 2020).

This study focused on PT. Sumber Nelayan Indonesia a company engaged in the production of traditional Indonesian spices. It highlighted the challenges of manual production scheduling, which led to delays in order completion due to machine breakdowns and the lack of optimal data management. By integrating the EDD method into a web-based Management Information System (MIS), this research aimed to improve the scheduling process, enhance efficiency, and provide better decision-making support for production at PT. Sumber Nelayan Indonesia.

This study introduced an innovation by developing a web-based Management Information System (MIS) that enabled PT. Sumber Nelayan Indonesia to manage production scheduling more efficiently and centrally. The system automated processes previously done manually, reducing delays and increasing the company's productivity. Additionally, the Earliest Due Date (EDD) method was integrated with a centralized database and a web interface accessible by authorized personnel, facilitating more accurate and real-time decision-making regarding order completion estimates and production output. This innovation also accelerated the production process by considering order priorities, machine capacity, and deadlines, which had been persistent challenges in scheduling management.

3. METHOD

Research Method

The method employed in this research was Research & Development (R&D), which is synonymous with development research methodology. This method was used to create a product and test its effectiveness (Syahranitazli & Samsudin, 2023). The research, focusing on needs analysis, aimed to develop a specific product and assess its effectiveness to ensure it functions properly. Subsequently, further testing was conducted to evaluate the product's efficacy (Suendri et al., 2020).

The Research & Development (R&D) method is a research approach that generates a product in a specific field of expertise, followed by secondary products and an evaluation of the effectiveness of the primary product.

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Data Collection Techniques

The data collection stage aimed to gather the necessary information for the research, utilizing the following methods:

1) Interview: The researcher conducted a direct interview with Muhammad Ilham, General Manager of PT. Sumber Nelayan Indonesia, on January 3, 2023. The questions focused on the shrimp paste production process, from raw material input to packaging, as well as the common challenges faced during production.
2) Observation: The researcher conducted an on-site observation at PT. Sumber Nelayan Indonesia to gain a deeper understanding of the issues being studied, under the supervision of General Manager Muhammad Ilham.
3) Literature Study: Data was collected through a literature review, including articles, books, journals, the internet, and theses, to support the preparation of the research proposal and subsequent stages of the study.

System Development Method

This research employed the waterfall method, a linear and straightforward system development approach. Each stage had to be completed before proceeding to the next one. The stages of the waterfall method were as follows (Usla & Ikhwan, 2023):

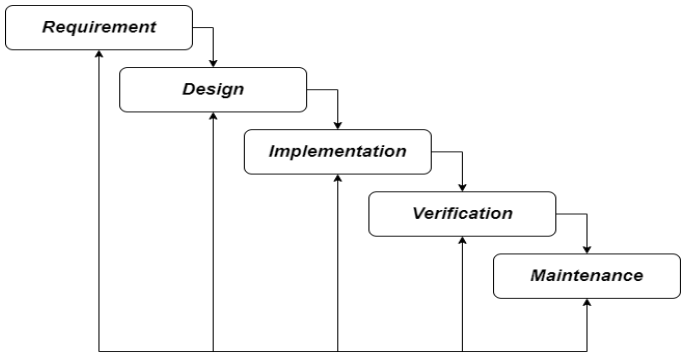

Fig. 1 Waterfall Method (Nuha et al., 2024)

1) Requirement Analysis: Developers collected information from users through interviews or surveys to understand the software requirements.
2) Design: A software design was created based on the gathered requirements, utilizing tools such as UML, including use case diagrams.
3) Implementation: The system was developed in small units that were tested separately (unit testing).
4) Verification: Once all units were integrated, the system was tested as a whole to identify any errors.
5) Maintenance: The completed software was implemented and corrected for any overlooked errors, ensuring the system could function effectively.

4. RESULT

Requirement Analysis

1) Analysis of the Current System

The analysis of the current system was conducted by illustrating the workflow of the existing system at PT. Sumber Nelayan Indonesia in Asahan Regency. The current recording and mapping methods still relied on conventional approaches, starting with receiving orders from the central office. These orders were then received by the admin, who created production order reports and forwarded them to the production head for processing.

2) Proposed System Analysis

After identifying several weaknesses and deficiencies in the current system, the author proposed a web-based system to be used for production planning, specifically for production scheduling. This system would prioritize orders with the nearest deadlines to be processed automatically.

3) Earliest Due Date (EDD) Analysis

The EDD method sorted tasks based on the earliest deadlines. Tasks with delayed due dates were scheduled after those with earlier deadlines. The goal of this rule was to minimize the maximum lateness of tasks. Poor scheduling rules led to many tasks being late and an increase in average lateness. By sorting tasks based on the nearest due dates,

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this method could be applied to manage either a single machine or multiple machines. The Earliest Due Date (EDD) method consisted of several steps adjusted according to the current priority calculation rules. The sample data used in this context was derived from product orders in January 2023. The current production scheduling sample data was as follows:

Table 1
Sample Data

No	Product	Target (KTK)	Start Date	End Date	Production Result (KTK)	Status	Deviation from Target (KTK)
1	Small Samhok	23982	1	7	24,563	Achieved	-581
2	Large Samhok AR	4870	2	10	4,633	Not Achieved	-237
3	Large Samhok Polos	0	3	9	0	Not Produced	0
4	Kesemek Red &Green1:2:1	500	1	10	290	Not Achieved	-210
5	Kesemek Red & Black 2:1	500	4	7	459	Not Achieved	-41
6	Kesemek Bonang	1607	3	12	1,607	Achieved	0
7	GS Bonang	3000	3	11	3164	Achieved	164
8	GS Black	2439	11	20	2464	Achieved	25
9	GS Red	1,500	23	30	1527	Achieved	27
10	5 KG	7475	12	23	7457	Achieved	0
11	Toros	60	12	20	69	Achieved	9
12	Abfood 1 KG	1,000			856	Not Achieved	-144
13	Abfood 7 KG	1000			115	Achieved	15
14	Abfood 1 KG	429			429	Achieved	0
15	Kesemek Black 80 GR	0			0	Not Produced	0

Calculation Using the EDD (Earliest Due Date) Method

Calculations for production scheduling were conducted using the EDD method to determine the average completion time, utility, average number of jobs, and average job lateness.

Calculating the Average Completion Time

The average completion time is calculated as follows:

Average Completion Time = Total Flow Time/ Total Jobs = 16/5 = 3 days

Calculating Utilization

Utilization (%) = (Total Processing Time/ Total Flow Time) x 100% = (20/15) x 100% = 1,3%

Calculating Average Completion Time

Average Completion Time = Total Flow Time/ Total Processing Time = 15/5 = 3 jobs

Job Delays

Job Delay = Total Days Late/Total Jobs = 0/5 = 0 Days

Table 2
Results of Production Scheduling Calculations Using the EDD Method

Average Completion Time (Days)	Utility (%)	Average Number of Jobs (Jobs)	Average Delay (Days)
3	1.3%	3	0

After the calculations were performed using the EDD method, the following results were obtained: The production scheduling process, which had previously experienced an average delay of 3 days, was reduced to 0 days after the implementation of the production scheduling information system utilizing the EDD method.

Design

The system design represented a stage in the design of the system and the operation of the web-based system that was to be developed. This section explained the use case diagram and activity diagram, which illustrated the relationships between each role and the system within it.

1) Use Case Diagram

The use case diagram for the case study of the web-based production scheduling management information system at PT. Sumber Nelayan Indonesia was presented. The use case diagram outlined the expected functions of the system. Use cases included specific tasks such as entering order data, managing production scheduling, and generating reports. Depending on the system to be built, the use case diagram depicted the features that were utilized by the users.

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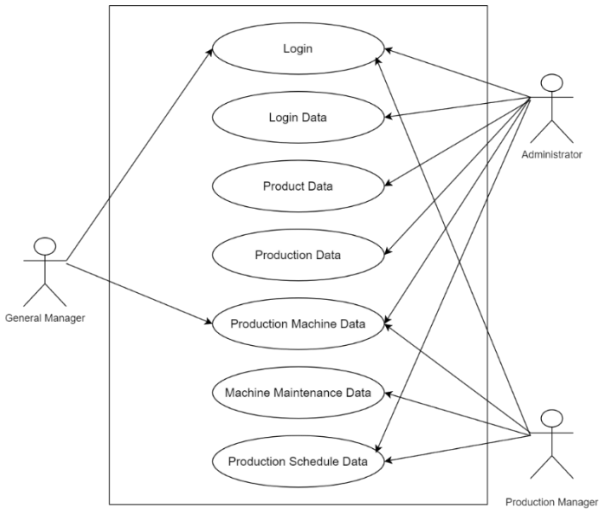

Fig. 2 Use case diagram

2) Activity Diagram

In the activity diagram, the design was carried out based on the previously developed use case diagram. This diagram illustrated the flow of all activities within the system, from the beginning to the end.

Activity Diagram for Product Data

The activity diagram for Product Data illustrated the flow of activities involved in inputting product data, which was performed by users such as the admin, production head, and general manager. The process involved entering the data according to the product data entry form.

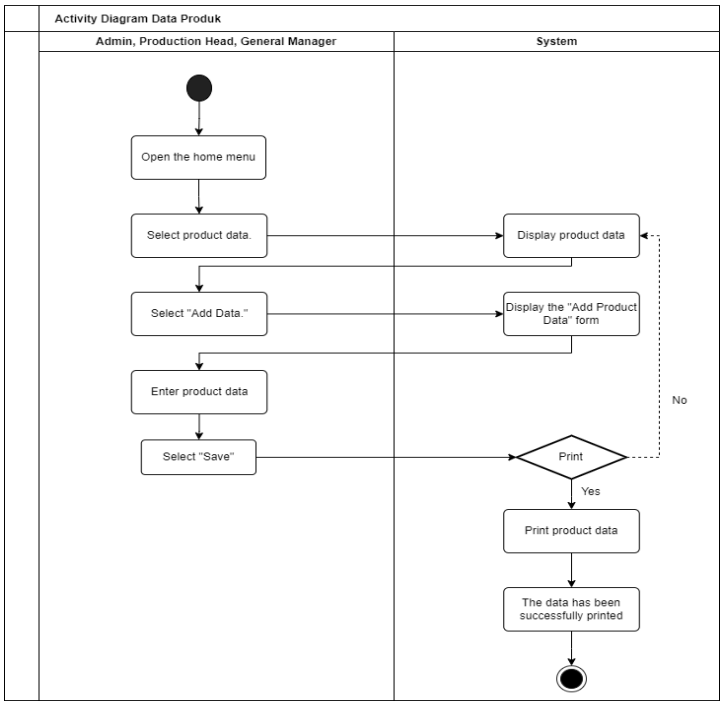

Fig. 3 Product Data Activity Diagram

Production Data Activity Diagram

The production data activity diagram illustrated the flow of activities performed by the company's admin to input

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production data according to the pre-established production schedule. The activities related to production data maintenance were outlined in the steps shown in the diagram below:

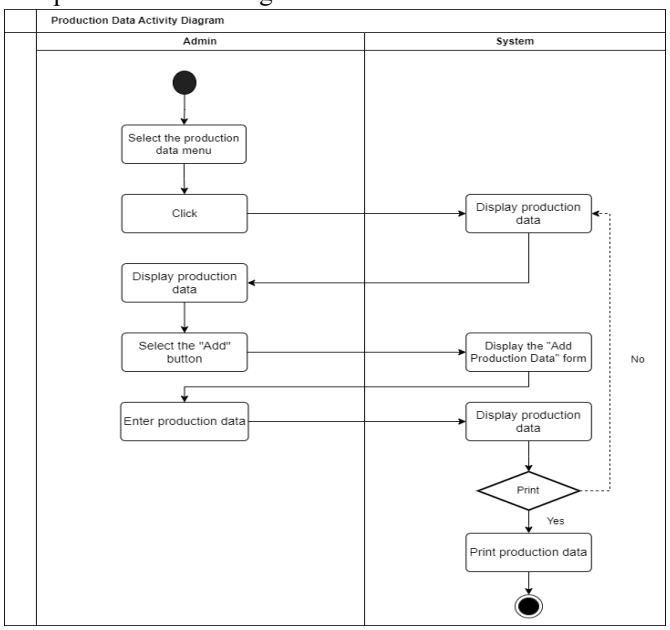

Fig. 4 Production Data Activity Diagram

Production Machine Data Activity Diagram

The Production Machine Data Activity Diagram explained the flow of activities performed by the production head, admin, and general manager of the company to input production machine data, including the machine status. The production head was the only one with access to input the machine status, while the admin and general manager were only allowed to view and print the data. The following are the activities of the machine maintenance data, which are explained in the steps illustrated in the diagram below:

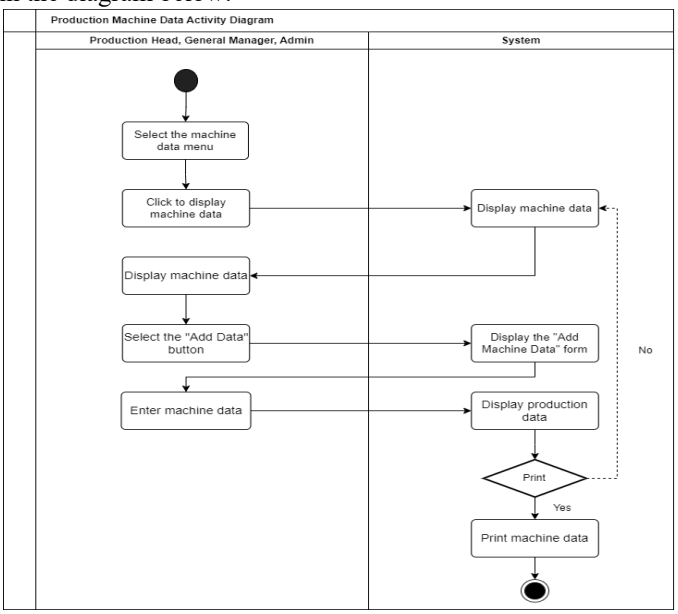

Fig. 5 Production Machine Data Activity Diagram

Production Machine Maintenance Data Activity Diagram

The Production Machine Maintenance Data Activity Diagram illustrated the flow of activities carried out by the

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production head to input the machine repair schedule. In the maintenance machine diagram, it was depicted that the production head had the ability to view, input, and manage machine data, which would later be used for maintenance on machines requiring repairs. The following are the activities related to machine maintenance data, which are explained in the steps shown in the diagram below:

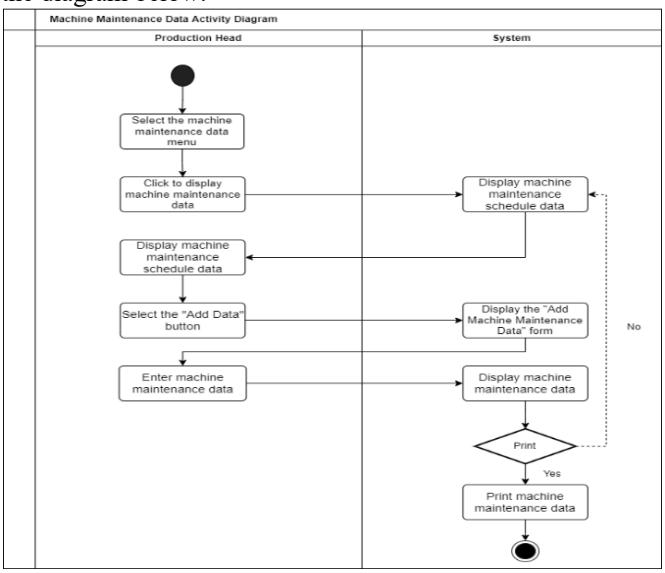

Fig. 6 Machine Maintenance Data Activity Diagram

Production Schedule Data Activity Diagram

The Production Schedule Data Activity Diagram illustrated the flow of activities performed by the admin in creating the production schedule. Using the EDD method, the admin determined the priority of products or orders approaching their deadlines, which were then processed first. Subsequently, the production head would process the prioritized products or orders for production.

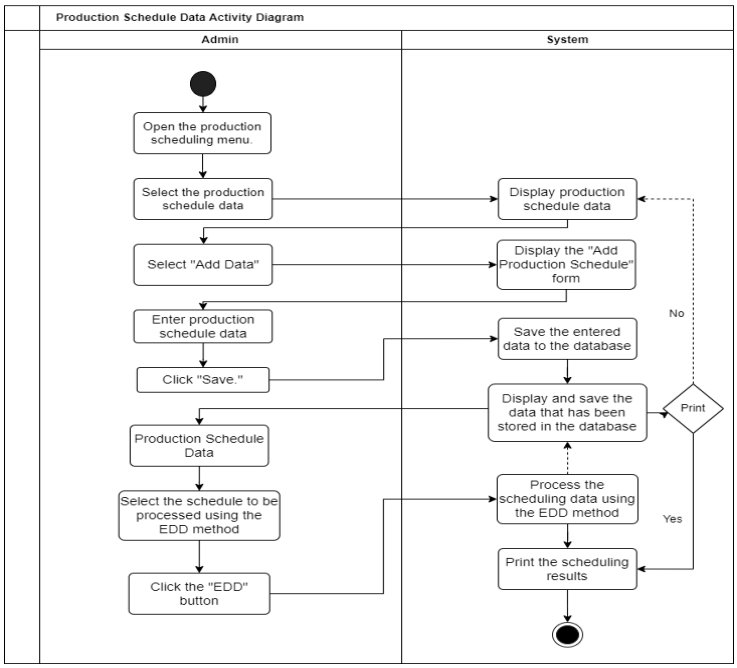

Fig. 7 Production Schedule Data Activity Diagram

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Implementation

In the implementation phase, the design of the interface was transformed into web pages using the following programming languages:

1) Dashboard Page

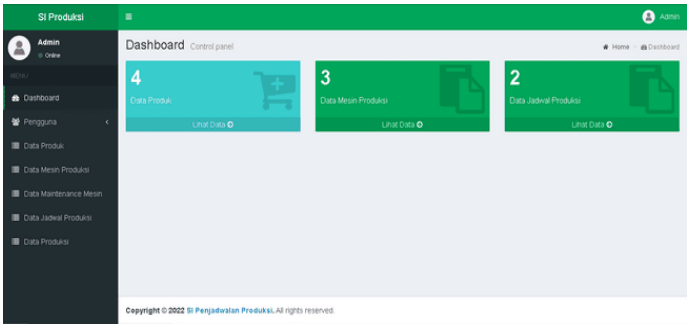

Fig. 8 Dashboard Page.

The dashboard displayed information about the data that had been entered by the user, which included product data, machine data, and production schedule data. By clicking the "View Data" button, the desired data was automatically displayed as shown in the following image.

2) Product Input Page

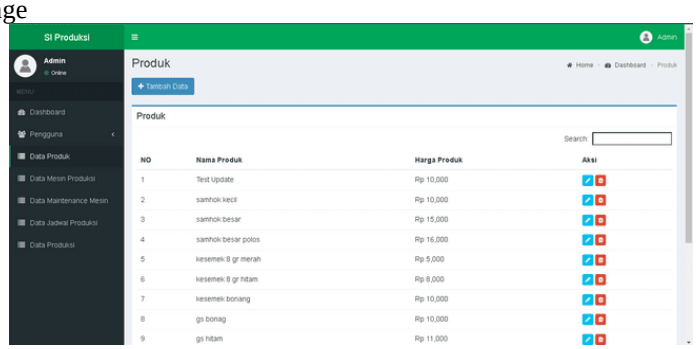

Fig. 9 Product Input Page.

The product input page served as a platform to display and add data or information that had been entered by the user. The product information included the product name and price, and if there was a need to modify a product, it could be done through the action button. To add a product, the "Add Data" button could be clicked.

3) Production Machine Page

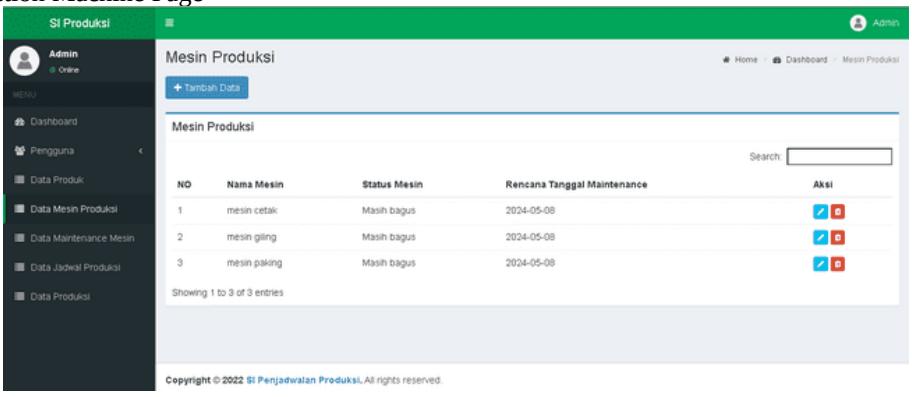

Fig. 10 Production Machine Page.

The production machine page displayed information and allowed for the addition of data regarding the production machines that had been input. The information displayed included the machine name, machine status, maintenance schedule, and an action button used to modify the selected information.

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4) Production Page

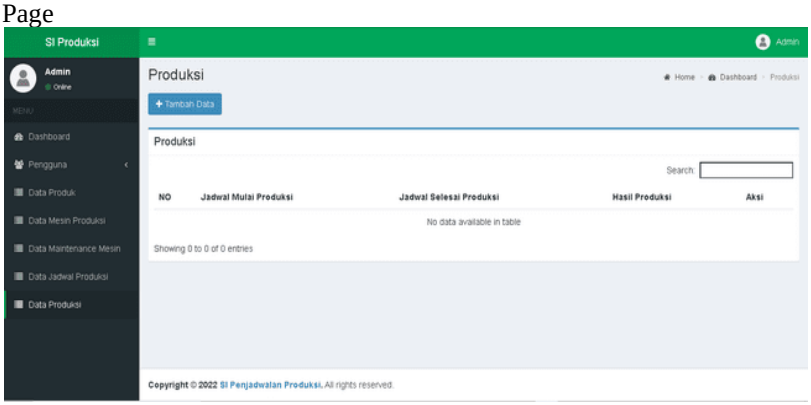

Fig. 11 Production Page

The production page presented the planned production schedule, including start times, production results, and outputs. There was also a button to add data for production and results, along with a print button to print the production data.

5) Production Schedule Page

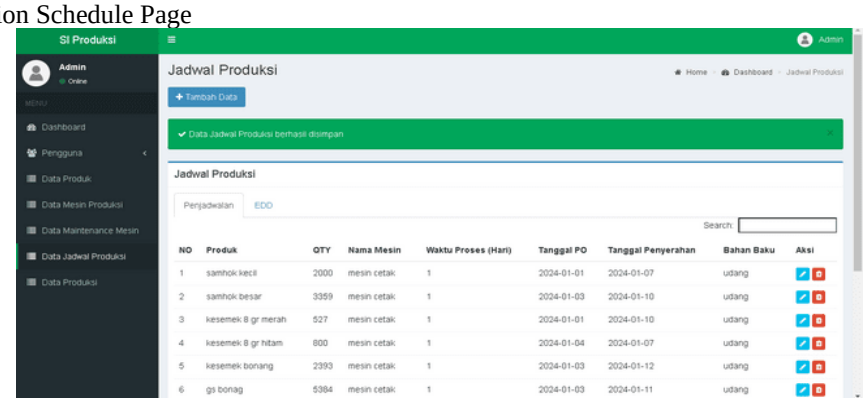

Fig. 12 Production Schedule Page.

The production schedule page displayed and allowed for the addition of production schedule data that had been entered through the "Add Data" button. This information included start dates, end dates, machine names, product names, and raw materials.

6) Production Schedule Using EDD

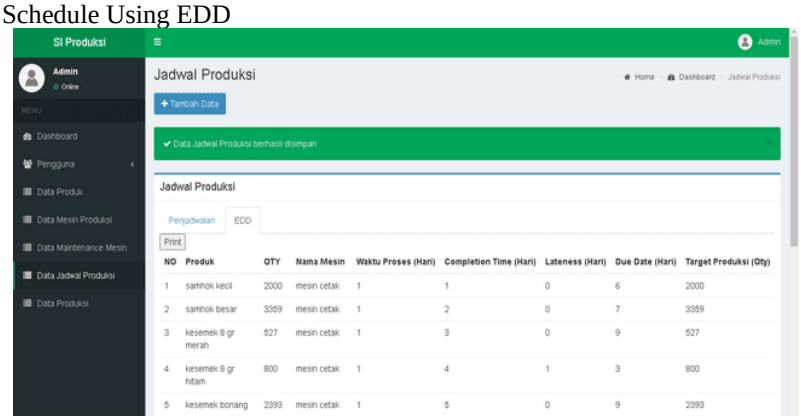

Fig. 13 Production Schedule Using EDD.

The EDD production schedule page displayed information regarding the production schedule utilizing the EDD method. By pressing the EDD button, it automatically recommended which products should be produced first.

7) Machine Maintenance Page

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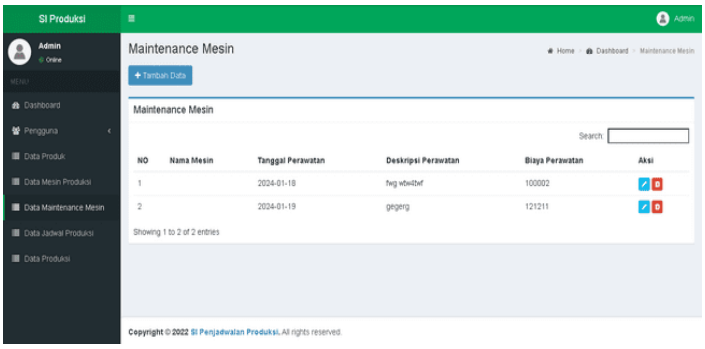

Fig. 14 Machine Maintenance Page.

The machine maintenance page provided information on the machine maintenance schedule, which consisted of the machine name, maintenance date, and maintenance description.

System Testing

Blackbox testing was conducted on August 15, 2024, to ensure that all functions within the Production Scheduling Management Information System application at PT. Sumber Nelayan Indonesia operated correctly. The system was tested by Aninda Muliani Harahap, M.Kom, and validation was performed by Muhammad Ilham, the General Manager, on August 22, 2024. The validation results were attached to this thesis.

Table 3
Blackbox Testing.

Input and Output Design	Expected Result	Outcome	
		Matches	Does Not Match
System Opened	Login page displayed	√	
Login input	Dashboard displayed after login	√	
Product input	Product input page displayed	√	
Add product form	Add product form displayed	√	
Production machine input	Production machine input page displayed	√	
Add production machine form	Add production machine form displayed	√	
Production input	Production input page displayed	√	
Add production form	Add production form displayed	√	
Production schedule input	Production schedule input page displayed	√	
Add production schedule form	Add production schedule form displayed	√	
Production schedule results using EDD	Production schedule page using EDD displayed	√	
Maintenance machine input	Maintenance machine input page displayed	√	
Add maintenance machine form	Add maintenance machine form displayed	√	

The Black Box Testing method in software testing was an approach in which testing was conducted without examining the internal structure or logic of the program or system being tested (Harianto et al., 2024). Based on the testing results, the system functioned effectively; the user interface and buttons operated as expected.

DISCUSSIONS

This study successfully developed a Management Information System (MIS) aimed at enhancing the efficiency of production scheduling at PT. Sumber Nelayan Indonesia, which had previously been identified as lacking organization and proper management. In the development of this system, the Earliest Due Date (EDD) method was applied, which served to prioritize tasks based on the nearest deadlines and could be implemented on one or more machines. The MIS played a significant role in addressing the company's challenges by providing information that supported strategic decision-making through the analysis of available data. This system also assisted management functions in planning, controlling, evaluating, and assessing performance. The results of the system testing indicated that there were several aspects that could be further developed in the future to enhance the production scheduling management information system. Some proposed enhancements included the addition of an automated scheduling feature when the production manager decided to implement overtime, the ability to address delays caused by weather conditions affecting the

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drying process, and the incorporation of a monitoring process for raw materials needed for production but not yet available.

5. CONCLUSION

Based on the results of the research and testing of the Production Management Information System at PT. Sumber Nelayan Indonesia, it was concluded that the implementation of the Earliest Due Date (EDD) method within the production scheduling information system proved effective in facilitating and optimizing the time management of production scheduling. This method enabled the achievement of production targets in accordance with the deadlines of each purchase order (PO), thereby enhancing the company's productivity. In the production scheduling process, jobs were grouped based on the same machine criteria and due dates. Subsequently, completion time and average delays were calculated. By utilizing the EDD method, this research successfully computed average completion time, utility, average job count, and average delays, all of which contributed to a more efficient production management process.

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