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Enhancing web programming education: A data mining approach to feasibility prediction through Project-Based Learning.

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Abstract
This research explores the integration of Project-Based Learning (PBL) in web programming education, focusing on predicting the feasibility of an inventory item application through data mining techniques. Emphasizing student-centered instruction and collaboration, the study aims to assess the impact of PBL on student engagement, knowledge, and skill development. Employing a carefully designed evaluation system, the research anticipates contributing valuable insights into the effectiveness of PBL in teaching web programming. Specific data mining methods employed will be highlighted, and anticipated findings will be discussed. PBL and provide insights into the effectiveness of PBL in teaching web programming subjects.

Keywords: Project-based learning (PBL), Web programming subjects, Inventory items, Data mining,

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Introduction

Web programming and data mining are relevant and crucial topics in the world of information technology today because they play a significant role in the development and management of information systems and applications (Hamed Taherdoost 2022). Web programming enables the development of web applications that can be accessed by users from various devices and locations, facilitating easy and fast access to information and services (Cheikhrouhou et al. 2023, Martín et al. 2023). On the other hand, data mining enables the extraction of valuable information from large and complex datasets, which can assist in making better and more effective decisions (Tsai et al. 2015). In the current digital era, where data is becoming increasingly complex and abundant, the ability to manage and leverage data is becoming more important, making web programming and data mining crucial topics in the field of information technology (Mughal 2018).

In this reasearch, the focus is on predicting the feasibility of items in the inventory system. The inventory system is utilized by companies or organizations to manage their stock of goods (Atieh et al. 2016). Maintaining accurate and efficient inventory is crucial for the operational and financial success of a business (Lwiki et al. 2013, Ali Al Hayek 2020). In the context of specific web programming courses, there are several relevant issues, such as lack of student engagement and limited creativity (Firdaus and Telaumbanua 2018) In developing web applications, there are challenges related to the lack of practical application in learning and limitations in evaluation methods (Eteng et al. 2022, Ndibalema 2022, Anwar et al. n.d.). Therefore, the Project-Based Learning (PBL) approach is utilized to address these issues. By implementing PBL, it is expected to enhance student engagement, provide real-world experience in developing web applications, and enable a more comprehensive assessment of student understanding and skill (Almazroui 2022).

Furthermore, it is challenging for companies to manually determine the feasibility of items in their inventory. Several factors need to be considered, including customer demand, product condition, product lifecycle, and other factors that influence the feasibility and value of the items (Spens and Kovács 2006, Mosca, Vidyarthi, and Satir 2019, Gibson and Hanna 2003). In this study, the author aims to develop an application that utilizes data mining techniques to predict the feasibility of items in an inventory system. By analyzing historical

data of managed items, this application will identify patterns and trends that can be used to predict whether an item is still viable or needs to be updated, replaced, or removed from the inventory.

The implementation of project-based learning and the application of predicting item feasibility in an inventory system offer several significant benefits, including: (1) enhancing practical skills, (2) applying theory in real-world contexts, (3) fostering creativity and problem-solving abilities, (4) fostering collaboration and teamwork experiences, and (5) direct application in the real world (Anwar et al. n.d.). The main objective of this research is to enhance students' understanding of web programming and the application of data mining techniques in the context of inventory applications (Spens and Kovács 2006). Additionally, this research also aims to: (1) Enhance students' understanding of Web Programming (Köse 2010a); (2) Introduce students to data mining techniques and their application in the context of inventory applications (Shilpa and Adilakshmi 2023, Wang 2021); (3) Enhance understanding of web programming and the application of data mining techniques (Isomöttönen and Taipalus 2023).

selection of the appropriate data mining algorithm or technique depends on the characteristics of the data, prediction objectives, and specific needs of this research. It is crucial to conduct in-depth analysis and experiments to determine the most suitable algorithm or technique for predicting the feasibility of items in the inventory system. Some data mining algorithms or techniques that can be used to predict the feasibility of items in the inventory system are as follows: (1) Classification Algorithm, (2) Regression Algorithm, (3) Clustering Algorithm, (4) Association Algorithm, and (5) Artificial Neural Networks Algorithm. In this study, linear regression is employed for prediction, as this method is commonly used to predict a dependent variable based on independent variables (Park et al. 2022). This method operates by finding the best line that minimizes the difference between predicted values and actual values (Wang et al. 2022). In the context of inventory items, linear regression can be utilized to forecast item demand based on factors such as historical sales data, seasonal patterns, and other relevant variables. Additionally, linear regression is a simple and interpretable method that provides an understanding of the relationships between variables (Zhang et al. 2023).

This comprehensive approach, integrating advanced data mining techniques like linear regression, aims to provide valuable insights and practical solutions to the complex landscape of predicting item feasibility in the inventory system within the challenges of web programming education and inventory management. Regarding the uniqueness of this research, the innovation lies not only in the application of linear regression for prediction but also in its contextual application to address specific issues faced in the domain of web programming education and inventory management. Thus, this research makes a significant new contribution by enriching our understanding of how to address practical issues in this field.

Method

Application Development

In developing the predictive application for inventory item feasibility using the Laravel framework, MySQL Server as the DBMS, and programming languages such as PHP and Python, along with the Visual Studio Code editor, the method used may involve a series of steps such as the following:

1. Requirement Identification: The first stage in application development is identifying the needs and objectives to be achieved with the predictive application for inventory item feasibility. This involves a deep understanding of business requirements, prediction goals, the types of data required, and the expected output.

Table 1. Problem Identification and Solution

Problem	Solution
The current system operates conditionally when there is a request from the Faculty/University a few weeks in advance, where the department head informs the technicians and the new technicians prepare a report on the desired needs for goods and equipment. However, the provided requirements are not specific enough regarding the items that need to be replaced, due to time constraints in preparing a report based on the damage or inadequacy of the existing items.	The system will utilize linear regression method in the laboratory to predict the occurrence time of depreciation of items, especially computers. This aims to determine the items that need to be replaced or allocate funds for their replacement.

2. Analysis of Business Processes and Proposed Procedures : The next stage involves analyzing the business processes and proposed system procedures, which can be seen in Table 2.

Table 2. Analysis of Business Processes and Procedures

No	Business Activities / Processes	Procedure	Related Users	Document
1	Data Inventory Management	The Laboratory team imports item data into the system using the item data form.	Laboratory Team	Iventory data
2	Collection of data on damaged or unusable items.	The Laboratory team checks the condition of the items and updates the item data on the item update form if there are any changes in their condition.	Laboratory Team	Update Inventory Data
3	Predicting item data.	1. The laboratory team clicks on the forecast feature to predict which items will be damaged within a specific time frame. 2. The laboratory team receives the predicted lifespan results for the data of the items. 3. The laboratory department manager reviews the predicted lifespan results of the items. 4. The department chair reviews the predicted lifespan results of the items..	○ Laboratory Team ○ The department laboratory manager ○ The department chair	Data to be predicted, Prediction Execution Data.

3. Application Design

The following application design provides a visual overview of the structure and key components involved in the implementation of the proposed system.

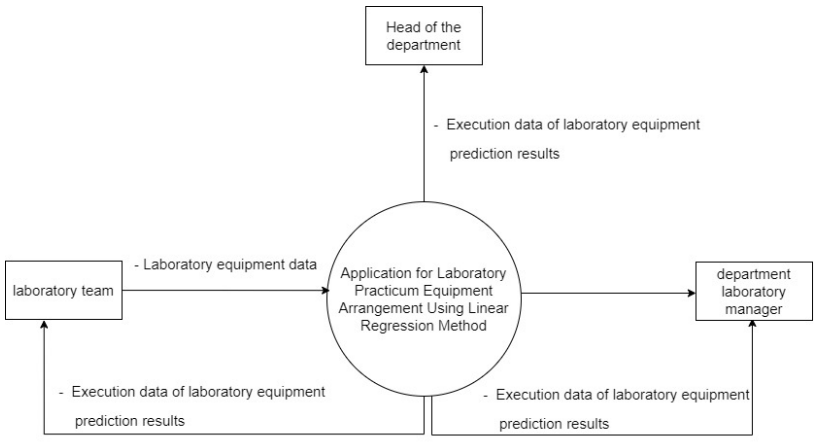


Figure 1. Context Diagram

Figure 2 illustrates the flow of data into and out of the system, performed by the actors involved in the system. Starting with the Laboratory Team user importing the item data, then predicting the lifespan of the predicted data items, and obtaining the forecasted results of which items are likely to be damaged within a specific timeframe. The Laboratory Team will then physically inspect the items based on the system's prediction and update the data for damaged or unusable items. Finally, a report is generated with the predicted data for the items that will be damaged.

Below is an overview of the interaction scenario between the user and the system. The use case diagram depicts the relationship between actors and the activities they can perform within the system.

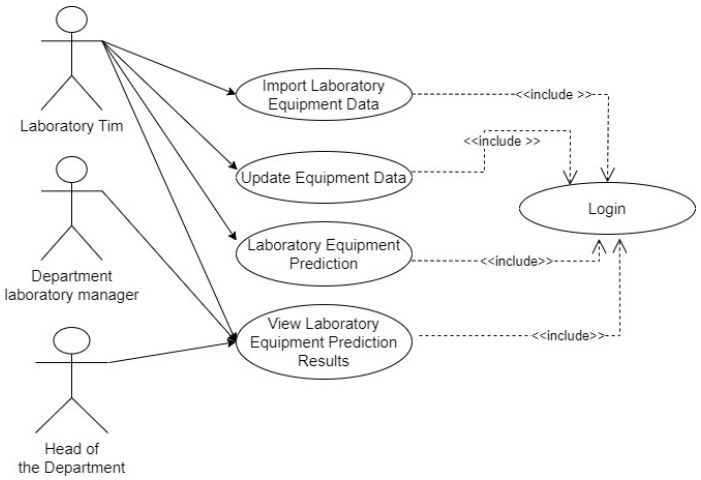


Figure 2. Use Case Diagram

Figure 3 illustrates that there are three actors in the laboratory equipment forecasting system: Laboratory Team (Laboratory Technicians and Laboratory Head), Department Laboratory Manager, and Department Head. Before engaging with the system's activities, the Laboratory Team, Department Laboratory Manager, and Department Head must log in to the system. The Laboratory Team can perform tasks such as importing data, directly checking the items, updating the condition data, making predictions for the items, and creating records for damaged or unusable items based on the prediction results. The results of the predicted damaged or unusable items, obtained from both predictions and direct inspections, can be viewed by the Department Laboratory Manager and the Department Chair.

Result and Discussion

The generated project follows the steps and stages described in the research methodology section. In this phase, the results of the students' work in developing the "Inventory Feasibility Prediction Using Data Mining" application can be observed, as shown in Figure 11.

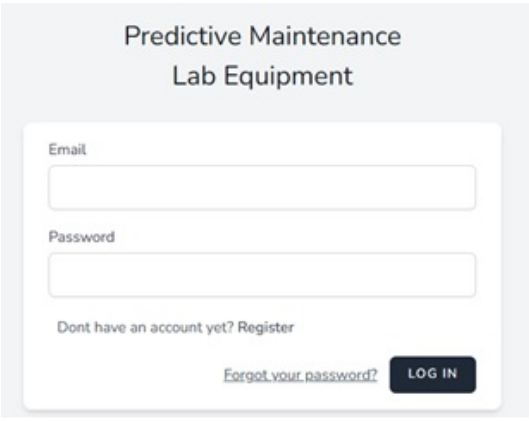


Figure 3. LoginPage

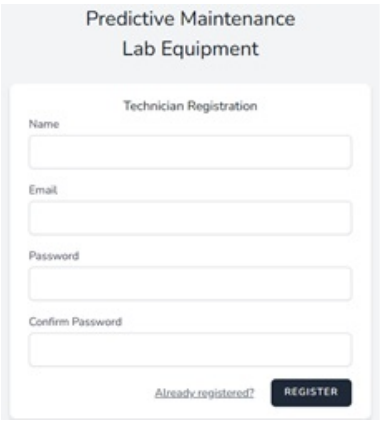


Figure 4. Registration Page

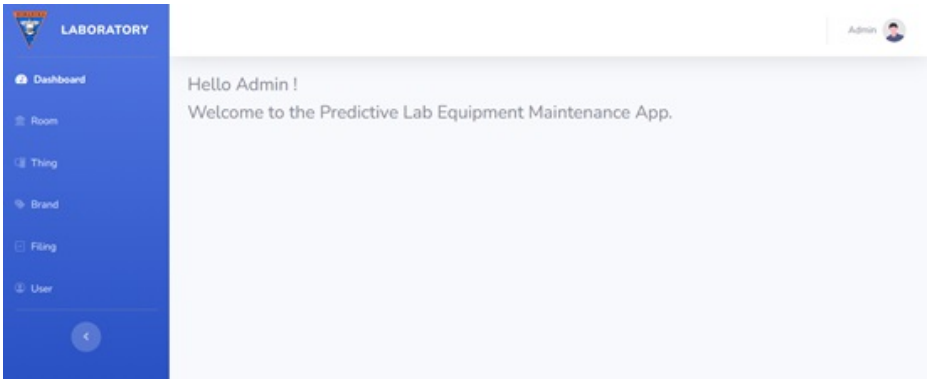


Figure 5. Dashboard Page

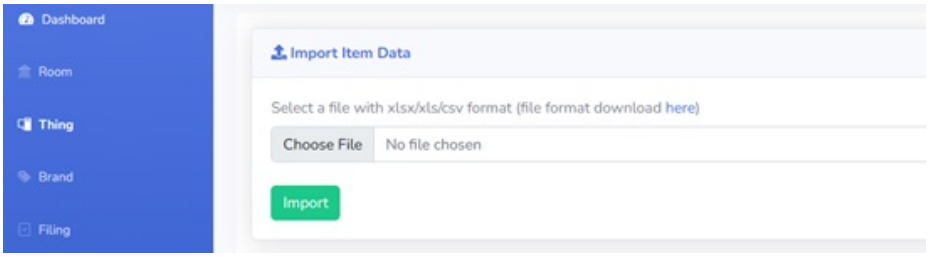


Figure 6. Inventory Page (Import Item Data)

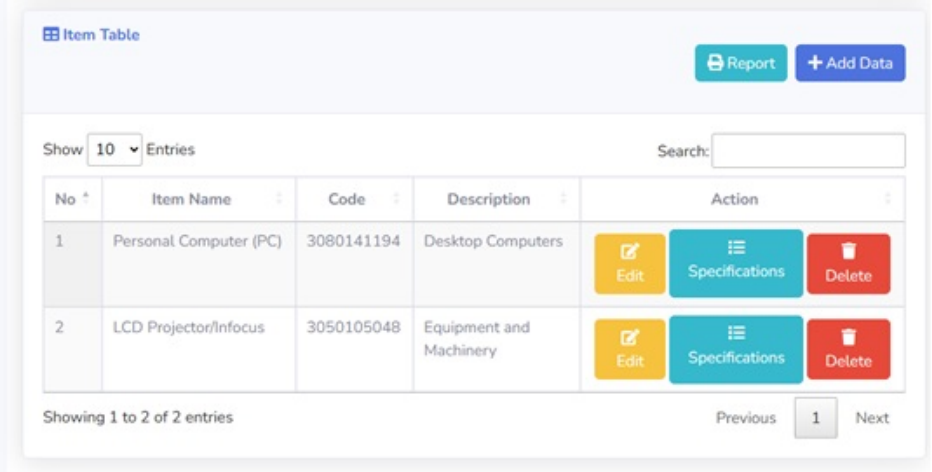


Figure 7. Item Specifications Page

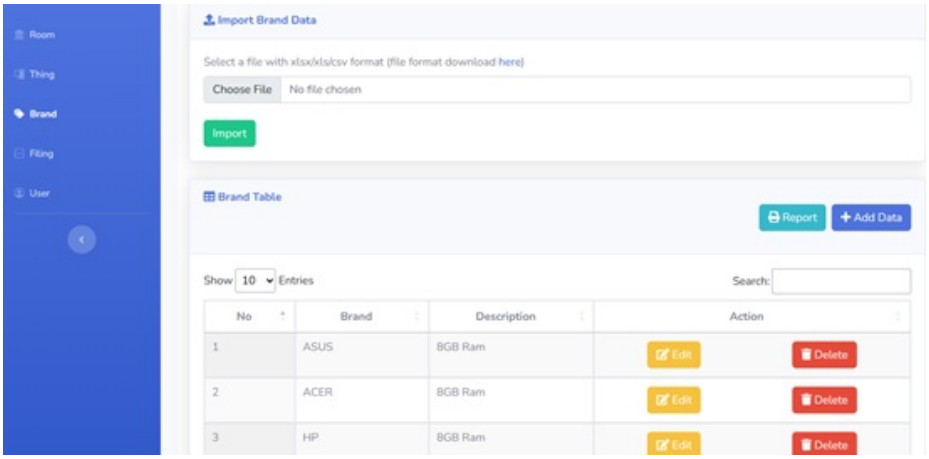


Figure 8. Brand Pages

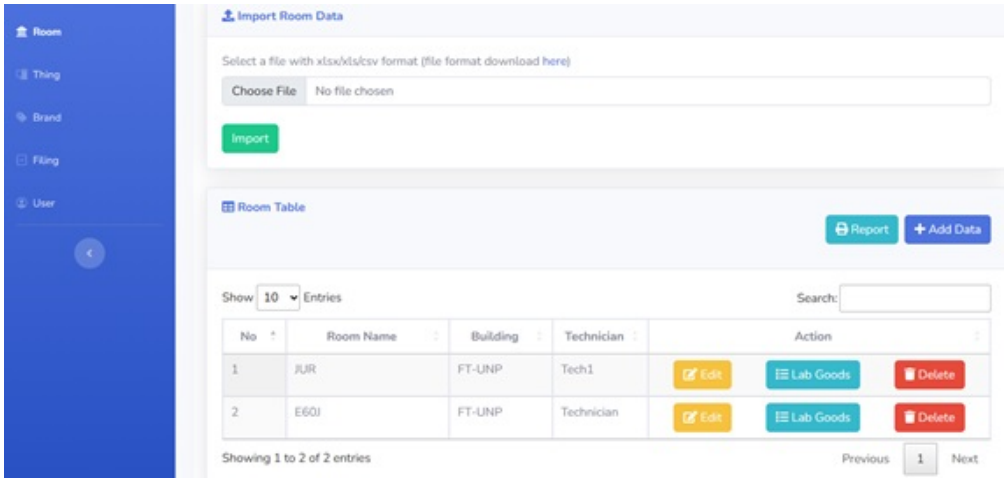


Figure 9. Laboratory Room Page

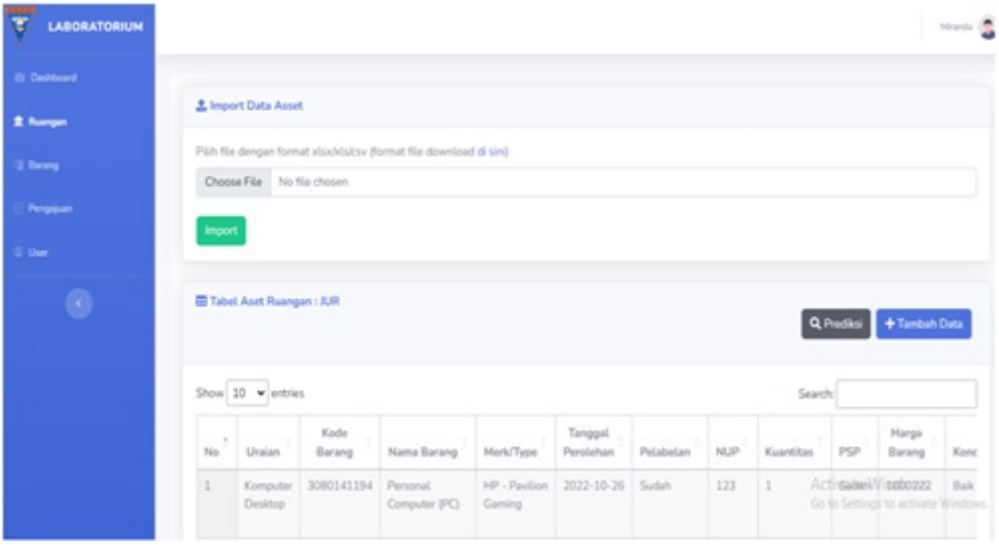


Figure 10. Lab Equipment Room Page

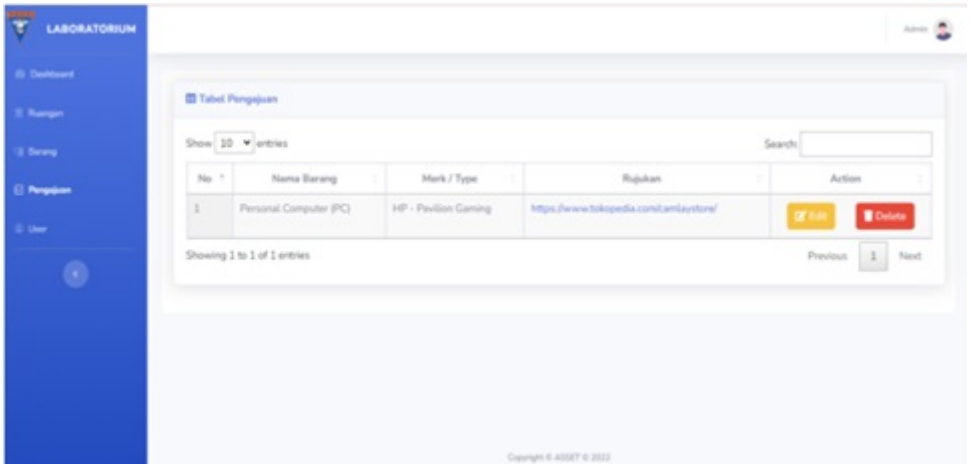


Figure 11. Submission Page

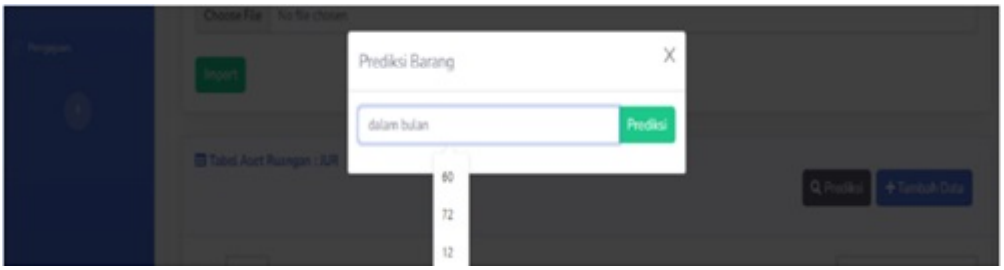
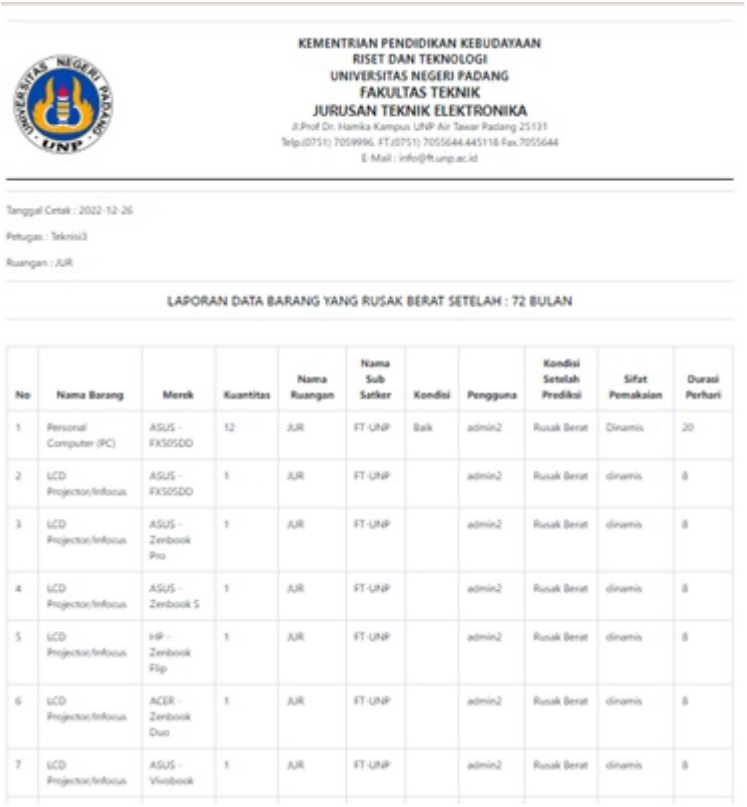


Figure 12. Prediction Display Page


KEMENTRIAN PENDIDIKAN KEBUDAYAAN
RISET DAN TEKNOLOGI
UNIVERSITAS NEGERI PADANG
FAKULTAS TEKNIK
JURUSAN TEKNIK ELEKTRONIKA

LAPORAN DATA BARANG YANG RUSAK BERAT SETELAH : 72 BULAN

No	Nama Barang	Merek	Kuantitas	Nama Ruangan	Nama Sub Satker	Kondisi	Pengguna	Kondisi Setelah Prediksi	Sifat Pemakaian	Durasi Perhari
1	Personal Computer (PC)	ASUS - FX505DD	12	JUR	FT-UNP	Baik	admin2	Rusak Berat	Dinamis	20
2	LCD Projector,Infocus	ASUS - FX505DD	1	JUR	FT-UNP		admin2	Rusak Berat	dinamis	8
3	LCD Projector,Infocus	ASUS - Zenbook Pro	1	JUR	FT-UNP		admin2	Rusak Berat	dinamis	8
4	LCD Projector,Infocus	ASUS - Zenbook S	1	JUR	FT-UNP		admin2	Rusak Berat	dinamis	8
5	LCD Projector,Infocus	HP - Zenbook Flip	1	JUR	FT-UNP		admin2	Rusak Berat	dinamis	8
6	LCD Projector,Infocus	ACER - Zenbook Duo	1	JUR	FT-UNP		admin2	Rusak Berat	dinamis	8
7	LCD Projector,Infocus	ASUS - Vivobook	1	JUR	FT-UNP		admin2	Rusak Berat	dinamis	8

Figure 13. Prediction Result

To test the application, black box testing method was employed. The testing of this application aims to evaluate the functionality of the developed application and ensure its proper functioning. The following table provides an overview of the testing conducted on each page of the system:

Table 3. Test Unit and Test on PageAdmin

No	Module	Unit	Test Results	
			Succeed	Fail
1.	Login User	1. Login form	√	
		2. Login process	√	
2.	Menu Dashboard	1. Dashboard Page	√	
3.	Sidebar	1. Show sidebar	√	
		2. Button Room	√	
		3. Item Button	√	
		4. Submission Button	√	
		5. User Button	√	

No	Module	Unit	Test Results	
			Succeed	Fail
4.	Menu Barang	Item name listing page	√	
		Item Specification Button	√	
		Fill Search	√	
5.	CRUD Barang	1. Add Item Form	√	
		2. Add item proccess	√	
		3. Item view page	√	
		4. Delete Item	√	
		5. Edit Item	√	
6.	Room Menu	1. Room name list page and technician names in the room.	√	
		2. Add room process	√	
		3. Edit room form	√	
		4. Button delete room	√	
		5. Button Barang lab	√	
7.	Inventory Menu in the Lab Room	1. Inventory List Page in the Lab Room	√	
		2. Fill Search	√	
		3. Button Prediction	√	
		4. The Report button appears after making a prediction	√	
		Button pengajuan	√	
8	CRUD : Iventory in the Lab Room	1. Form add indoor lab items	√	
		2. Process of adding lab items	√	
		3. Inventory in the lab room view page	√	
		4. Delete iventory in the lab room	√	
		5. Edit iventory in the lab room	√	
9.	Submission Menu	1. Submission List Page	√	
		2. Fill Search	√	
10.	CRUD Submission	1. Submission view page	√	
		2. Delete submission	√	
		3. Edit submission	√	
11.	Menu User	1. User List Page	√	
		2. User List Table	√	
		2. Verify the account of the user who registered	√	
12.	CRUD User	1. Add user page	√	
		2. Add user process	√	
		3. Form Edit User Form Edit User	√	

No	Module	Unit	Test Results	
			Succeed	Fail
		4. Button delete user	√	

Based on Table 3, it can be observed that the overall expected processes on the accessed pages have been successfully executed. This research utilized the linear regression method to predict the feasibility of inventory item applications. An interesting finding is the significant relationship between inventory attributes and application feasibility. This can contribute to the development of more effective and targeted inventory applications. Furthermore, data mining techniques can be employed to identify hidden patterns or relationships within inventory data, opening up potential for improved inventory management and decision-making. The use of project-based learning can enhance student engagement, conceptual understanding, and practical skills in the context of web application development. Therefore, this application can assist organizations or companies in accurately predicting the feasibility of inventory items, thus supporting more efficient and effective decision-making.

Project-based learning offers several advantages, including: (1) Encouraging active and engaged learning, (2) Enhancing student motivation: As students are involved in interesting and meaningful projects, they are more motivated to learn and complete tasks, (3) Improving social and collaborative skills, (4) Enhancing problem-solving skills, (5) Developing critical thinking skills, (6) Improving technological skills (Köse 2010b). Therefore, PBL has been proven to enhance effectiveness and innovation in learning, particularly in the web programming course (Chen et al. 2019).

In the field of student counseling, the project-based learning approach can be used to develop students' social, emotional, and academic skills (Zulfikar et al. 2018). Projects that involve the application of web programming and data mining in the context of inventory applications can provide students with opportunities to develop critical thinking, problem-solving, creativity, and teamwork skills (Hariko et al. 2021). Furthermore, the prediction of item feasibility in the inventory system can also have relevant implications in student counseling (Arafani, Ilyas, and Zikra 2018). In the context of career counseling, understanding the needs of the job market, industry trends, and the feasibility of a product or item can assist students in making decisions regarding their career choices and education. Information about item feasibility predictions can also be used in decision-making regarding student placement in relevant study programs or training that aligns with their interests and abilities. Overall, this research can complement and contribute to the development of holistic and comprehensive education, as well as empower students to face the increasingly complex challenges of the job market.

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