e-ISSN: 2460-870X | p-ISSN: 2085-1367

Optimizing Supplier Data Management Using Decision Trees at Bambu Makmur Jaya Store

Optimizing Supplier Data Management Using Decision Trees at Bambu Makmur Jaya Store

Lidia Terecia[a,1], Sandy Kosasi[b,2]
[a,b]STMIK Pontianak, Jalan Merdeka No. 372, Pontianak, 78122, Indonesia
lidiatereciaa@gmail.com[1], sandykosasi@stmikpontianak.ac.id[2]

ABSTRACT

The challenge faced by craft stores in the era of digitization is the difficulty in choosing the right suppliers, resulting in unstable product availability and uncompetitive prices. Inefficient supplier selection can also disrupt the supply chain and overall business performance. The objective of developing a supplier data system software using Decision Trees is to enhance supplier selection optimization, ensure the best product quality, and improve decision-making quality. The solution design method used is Extreme Programming (XP), focusing on forming small teams. Testing is conducted using white-box methods that meet functional requirements for several software features. The result of this research is the development of a supplier data website software for Bambu Makmur Jaya store using the Laravel framework. It aims to assist Bambu Makmur Jaya store owners in easily viewing supplier and product recommendations, ensuring warranty deadlines are not missed through real-time notifications, and providing positive impacts in applying technology to business, as well as efficiency in supplier data processing and inventory management.

Keywords : Decision Tree Algorithm, Extreme Programming, Laravel Framework, Supplier Data Management, Optimization.

Article Info :
Submitted: *Reviewed:* *Accepted :*

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1. INTRODUCTION

In the rapidly evolving era of digitalization, the development of website systems has undergone significant changes by applying architecture concepts that separate development from business processes and presentations [1]. Digital technology not only serves as a tool for accessing information and communicating remotely but also drives economic growth by opening up broad business opportunities and increasing product and service competition from micro to macro levels [2]. In digital technology, businesses can access broader markets and enhance competition, providing a crucial boost for economic growth. One application of digital technology is through websites.

A website is a collection of interconnected pages containing various items such as documents and images stored on a web server [3]. In website development, the use of frameworks like Laravel helps reduce repetitive code, enhance security, speed up development, and provide a code base that is easily modifiable. This website includes a supplier data system that facilitates users in efficiently managing supplier information and data. Laravel provides such powerful features as expressive database abstract layer and dependency injection, making it highly scalable and further enhancing the efficiency and flexibility of the system [4].

Efficient and accurate supplier data management is key to ensuring smooth business operations and making informed decisions regarding supplier performance. Therefore, supplier selection is one of the crucial decisions that determine the existence and functionality of a company [5]. Supplier selection must be done correctly because choosing the wrong supplier can lead to various negative consequences and

e-ISSN: 2460-870X | p-ISSN: 2085-1367

losses for the company, such as disrupting production processes and the company's performance [6]. Suppliers are business partners who play a crucial role in ensuring the availability of craft goods needed by the store. To achieve customer satisfaction, stores selling craft goods need to carefully select suppliers who can provide high-quality products and maintain consistent supply availability. Furthermore, the efficiency of delivery services in the supply chain is important, as delays can impact stock and ordering strategies [7].

Toko BMJ is located at Jalan Tanjungpura No. 263 A, Benua Melayu Darat, Kec. Pontianak Sel., Kota Pontianak, West Kalimantan, focusing on selling craft goods, goldsmith tools, and others. Careful supplier management is crucial to maintaining the availability of quality goods at Toko BMJ and meeting customer needs. Currently, Toko BMJ uses Excel as the primary platform for recording suppliers. Therefore, Toko BMJ faces difficulties in selecting suitable suppliers because it has not yet utilized website facilities that can manage supplier data more effectively.

Shifting to a website platform has enabled Toko BMJ to efficiently manage supplier data, select suppliers that meet its needs, including high-quality products and competitive prices. In decision trees for decision-making, it is easier because of their division that maps features into decisions [8]. The use of the Decision Tree algorithm is a crucial step in optimizing supplier data recording at Toko BMJ, assisting in decision-making regarding selection and prioritization based on systematic criteria. Supplier selection is the process of evaluating and selecting potential suppliers to meet business needs [9]. Overall, the shift to a website platform has enhanced supplier data management, operational efficiency, and decision-making with the Decision Tree algorithm, enabling the store to remain competitive in the market. The Decision Tree algorithm is a tree-based technique where each path starting from the root is explained by the data separation sequence to the Boolean result reached at the leaf symbol [10].

In a study previously discussed by Cavalcante et al. (2010), the objective was to identify the optimal supplier capable of sustaining a competitive edge in supply chain management. This study aimed to leverage data-driven decision-making to select a resilient supplier capable of mitigating disruptions in the supply chain [11]. Similarly, in the research conducted by Rashidi et al. (2020), the focus was on retaining suppliers who demonstrate a strong commitment to addressing supply chain issues, thus aligning with the goals outlined in this practical work [12]. Additionally, the study by Hijriani et al. (2020) highlighted the development of a Supplier and Goods Management Information System using Extreme Programming. This research shares similarities with the present work as both aim to establish supplier databases utilizing the Laravel framework, ultimately leading to the creation of a system that streamlines supplier data management [13].

2. RESEARCH METHOD

A. The Solution Design Methodology

The solution design methodology utilized is Extreme Programming (XP). Extreme Programming is a software engineering process that tends to employ an object-oriented approach, and its focus is on small-scale team formation [14]. The following illustrates the Extreme Programming process with several stages [15].

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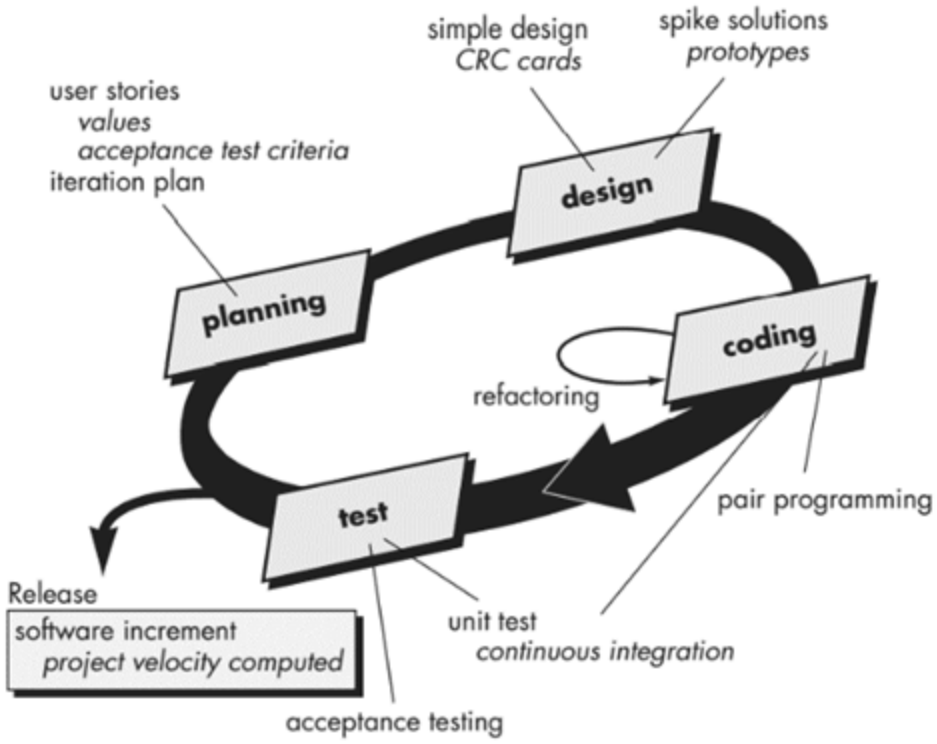


Figure 1. Extreme Programming Methodology

B. The Decision Tree Method

Optimizing supplier data is crucial due to the need to enhance accuracy in supplier information management. One method that can be utilized in decision-making processes related to suppliers is the decision tree method. This method is chosen because of its ability to generate decisions based on a series of logical rules that can be interpreted clearly. The decision tree method employs the entropy formula to calculate the uncertainty of a given dataset. Below is the formula for calculating entropy.

$$Entropy(S) = \sum_{i=1}^{n} -pi * log_2\ pi$$

Explanation:

- S = Set of cases
- A = Feature
- N = Number of partitions in S
- Pi = Proportion of Si to S

The formula for calculating information gain is used in the Decision Tree method to determine which attribute is the best for dividing data. Below is the formula for calculating information gain.

$$Entropy_A\ (S) = \sum_{v} \frac{|S_v|}{|S|} Entropy(S_v)$$

Explanation:

- A = Variable
- V = Possible values for variable A

e-ISSN: 2460-870X | p-ISSN: 2085-1367

- $|S_v|$ = Number of samples for value v
- $|S|$: Total number of samples in the dataset
- Entropy(S_v) : Entropy for samples that have value v

3. RESULT AND DISCUSSION

In determining whether a supplier is selected or not, there are several criteria to consider, namely location, delivery, discount level, and warranty. One attribute in a dataset provides information about the solution for each data item and is known as the target attribute. For example, the "class" attribute may have values such as "select" or "not select". This attribute has specific values called "instances". As an illustration, if we have the "Location" attribute, instances of this attribute may include "within city", "outside city", and "out of island". Below is the dataset information to decide supplier selection based on location, delivery, discount level, and warranty.

Location	Shipping	Dicsount Rate	Warranty	Class
Outside The Island	Fast	Low	No	Not Select
Outside The Island	Fast	Low	Yes	Not Select
Out Of Town	Fast	Low	No	Select
Within The City	Medium	Height	No	Select
Within The City	Old	Height	No	Select
Within The City	Old	Height	Yes	Not Select
Out Of Town	Old	Height	Yes	Select
Outside The Island	Medium	Low	No	Not Select
Outside The Island	Old	Low	No	Select
Within The City	Medium	Height	No	Select
Outside The Island	Medium	Height	Yes	Select
Out Of Town	Medium	Low	Yes	Select
Out Of Town	Fast	Height	No	Select
Within The City	Medium	Low	Yes	Not Select

Figure 2. Data Set

After all attributes have been calculated, the result of the entropy values can be seen as follows.

Atribute	Category	Number Of Cases	Select	Not Select	Entropy
Class	Within The City	5	2	3	0,971
Shipping					
	Old	1	1	0	0
	Medium	2	1	1	1
	Fast	2	0	2	0
Discount Rate					
	Height	2	2	0	0
	Low	3	0	3	0
Warranty					
	Yes	3	1	2	0,918
	No	2	1	1	1

Figure 3. Entropy Values

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Here are the final results of the Decision Tree method, presenting a tree diagram illustrating the decision-making steps.

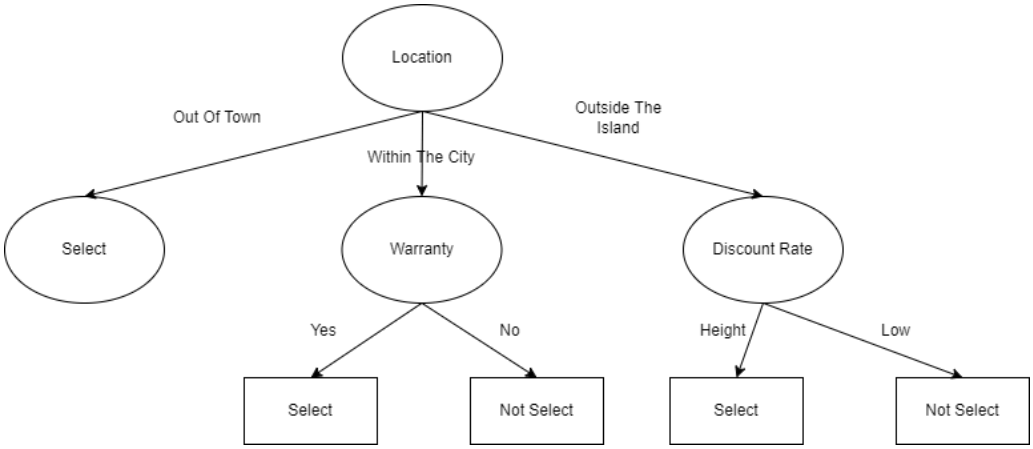


Figure 4. Maximum Gain Value

This diagram illustrates various factors to consider when making decisions, along with the potential outcomes of each option. The purpose of the final outcome of the decision tree method is to provide a clear overview of the available choices and the potential outcomes of each choice. This can assist in considering all relevant factors and making the most appropriate decision. This decision tree can be used to automatically make decisions on the Bamboo Makmur Jaya (BMJ) store website in decision-making processes.

The following illustrates the architecture of the website, including:

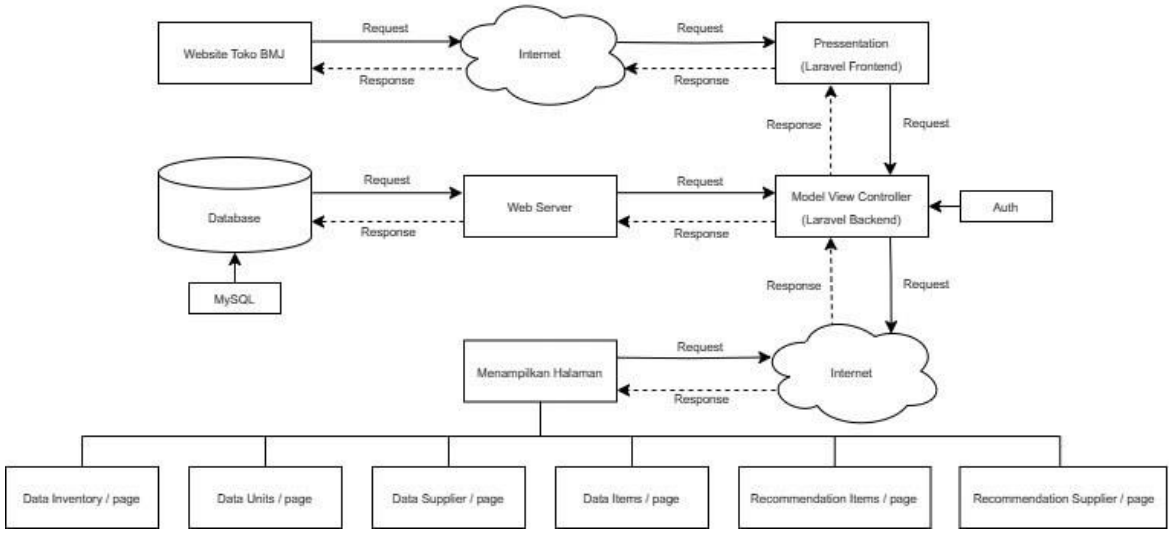


Figure 5. Website Architecture

The website architecture utilized in BMJ online store allows users to access the website via a browser with an internet connection. The browser sends requests through the accessed URL, and Laravel framework, acting as the presentation layer, responds to these requests. The responses are then processed through the Model-View-Controller (MVC) architecture. Subsequently, the controller returns the processed requests in the form of responses, which are then displayed in the view. Users can log in using the Auth feature, and the implementation of MVC architecture in the BMJ store website serves to address difficulties in maintenance and adding features in the future.

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The following illustrates the supplier data architecture implemented on the BMJ store website, including:

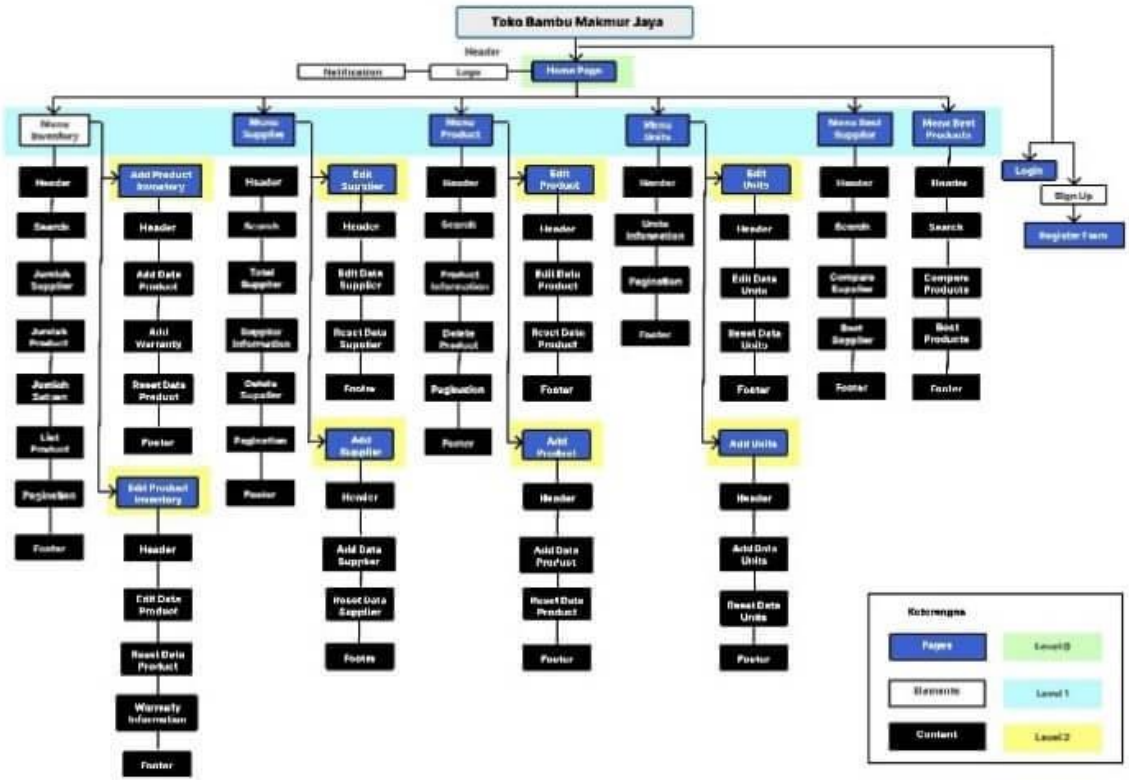


Figure 6. Supplier Data Architecture

The supplier data architecture implemented in the BMJ store website allows users to register and log in first. Then, users can access the home page, which displays a list of data with an inventory menu element that enables them to add and edit product inventory. Under the supplier menu, there are pages for adding suppliers, listing suppliers, and editing suppliers. Under the units menu, there are pages for adding items, listing items, and editing items. Additionally, under the units menu, there are pages for adding units, listing items, and editing units. There are also pages for viewing the best supplier and best items for optimal results.

The Three-Tier Architecture is an innovative development of the commonly known Client-Server model, which typically separates the client (the application with a graphical interface) and the server. In this context, each client has the ability to request data or information directly from the server. Here's the system architecture that applies the concept of client and server, structured into three tiers: client, server, and database.

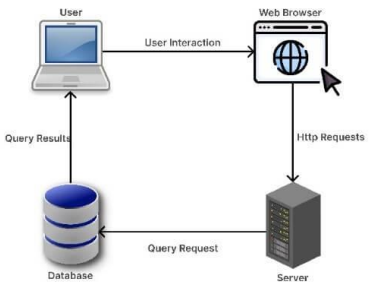


Figure 7. System Architecture

Each tier is interconnected and connected to the internet. Users interact with the system through a web browser to send query requests. The web browser then transfers these requests to the server. The server processes the received queries and sends the query results back to the web browser. Finally, the web browser displays the query results to the user. The use case diagram modeling designed in developing website software to meet user needs for proposed system in data management is illustrated below in a simple manner, including:

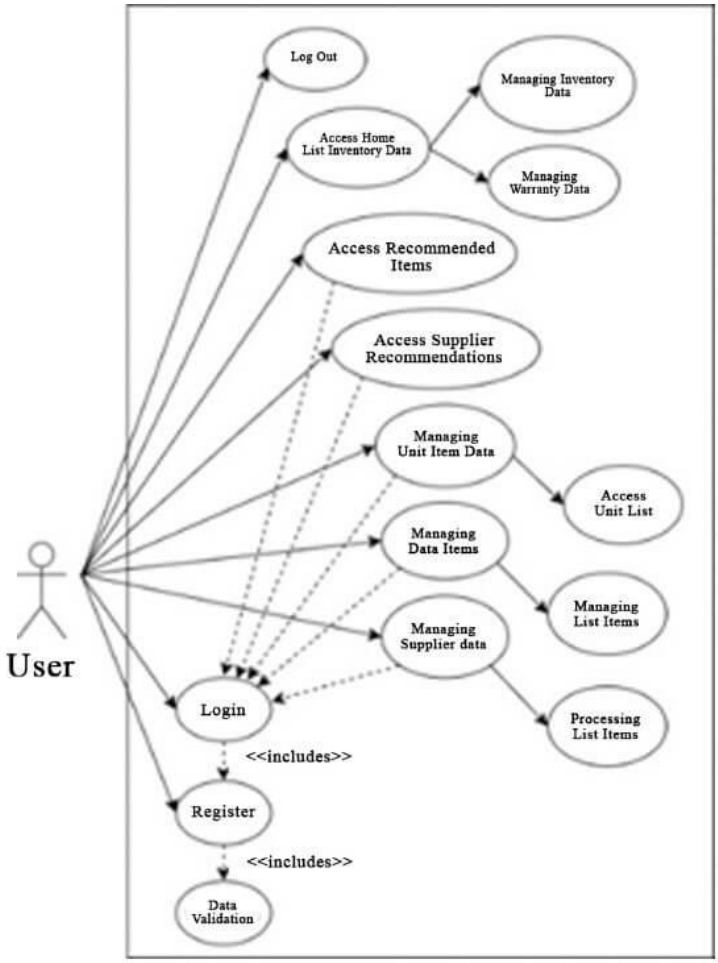


Figure 8. System Use Case Diagram

e-ISSN: 2460-870X | p-ISSN: 2085-1367

The following illustrates a prototype of the BMJ store website, including:

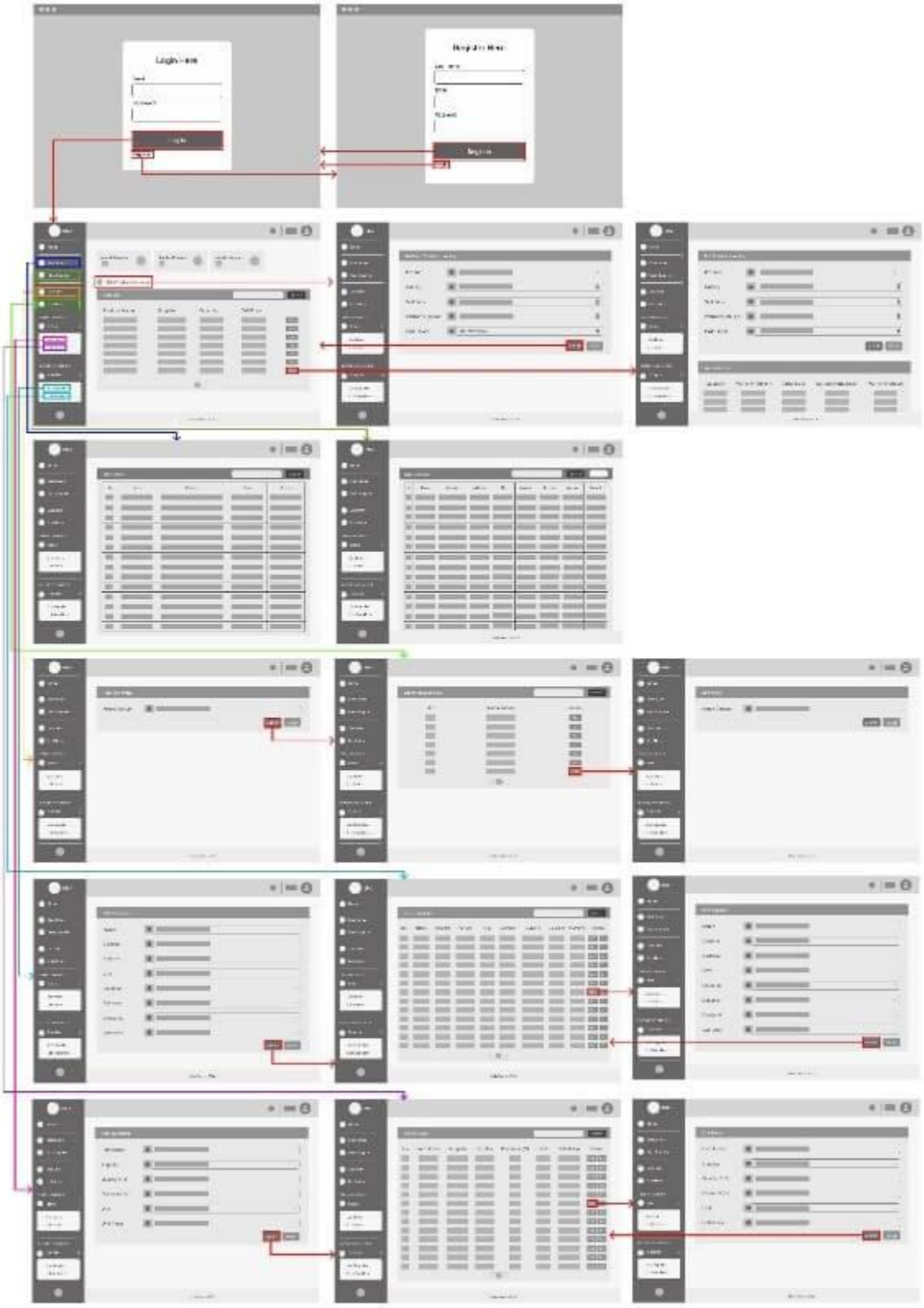


Figure 9. Illustration of Website Prototype

DOI: https://www.doi.org/10.22303/csrid.1.1.2022.01-10

The prototype sketch illustrates the interconnectedness of various pages on the BMJ store website. The register and login pages are interlinked, as the login page can only be accessed after the user registers an account. The home page is linked to both the add inventory and edit inventory pages since both functions are accessible from the home page. The best items and best supplier pages are linked as they both display information about inventory items and suppliers. The add units and list units pages are interconnected, with the list units page being used to edit existing unit information. Additionally, the add supplier and add items pages are connected, as both are utilized to add new data to the BMJ store website. Each page serves a specific purpose within the website's data management system. The following illustrates the prototype for the register and login pages.

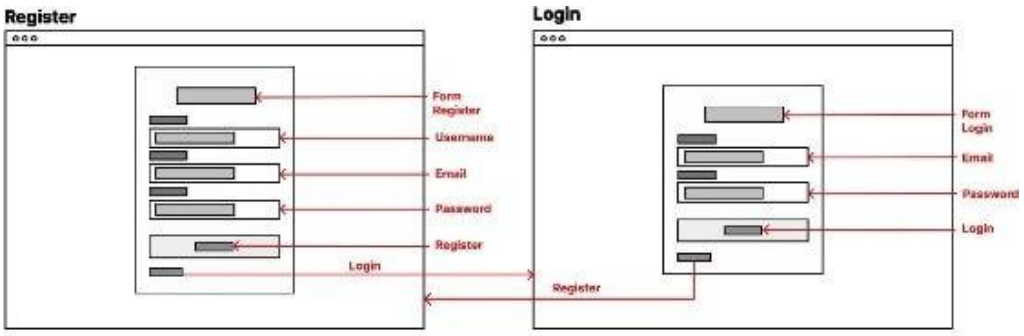


Figure 10. Prototype of Register and Login Pages

The register form consists of three inputs: username, email, and password. Users can then click the register button to create a new account. The login page has two inputs: email and password. If the login credentials are valid, the user will be directed to the home page.

The following illustrates the inventory prototype on the home page.

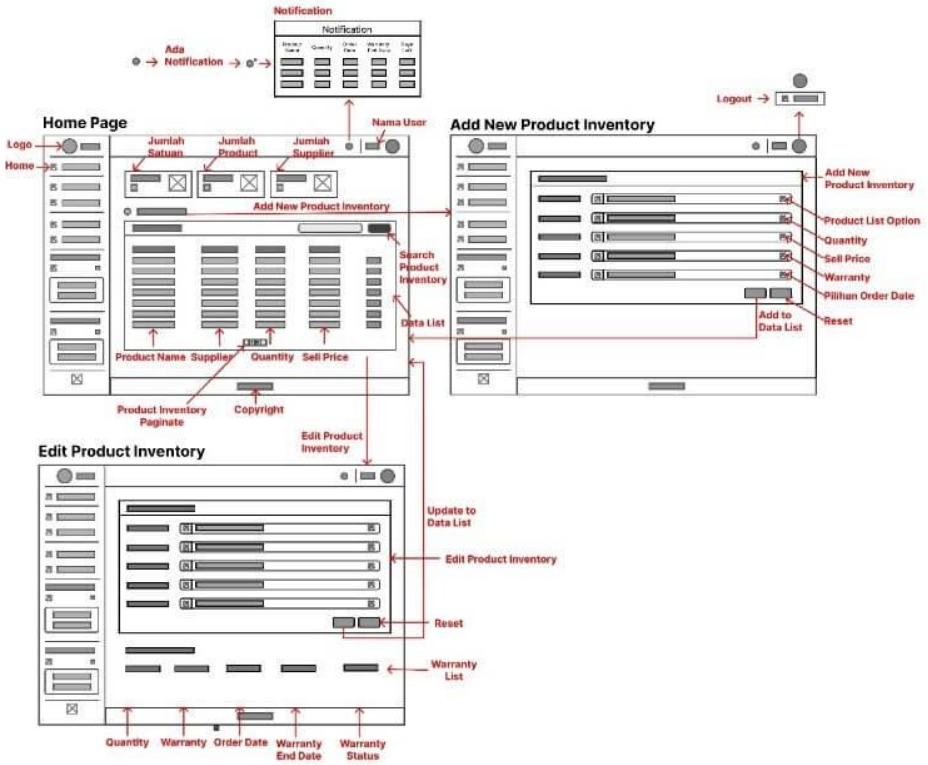


Figure 11. Inentory Prototype

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Based on the BMJ store website, which has notifications to remind users of product warranties within a week. On the home page, it will show the total number of units, products, and suppliers. It also contains a list of product inventory data. Users can also add and edit product inventory, as well as view warranty information.

The following illustrates the prototype page for best items and best suppliers.

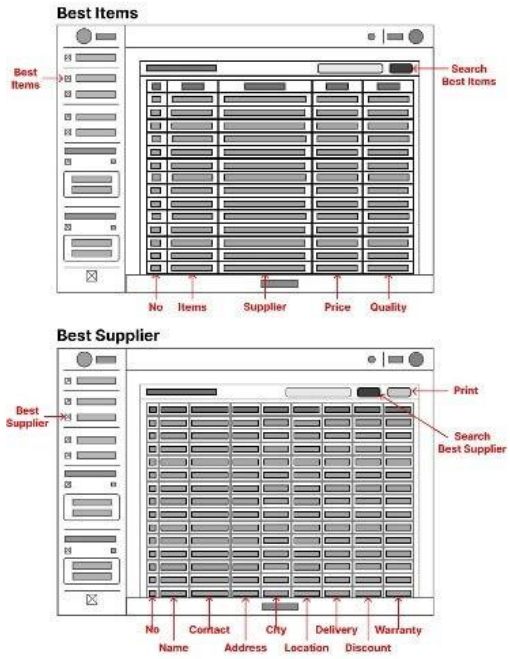


Figure 12. Prototype of Best Item and Best Supplier

The following illustrates the prototype of the supplier.

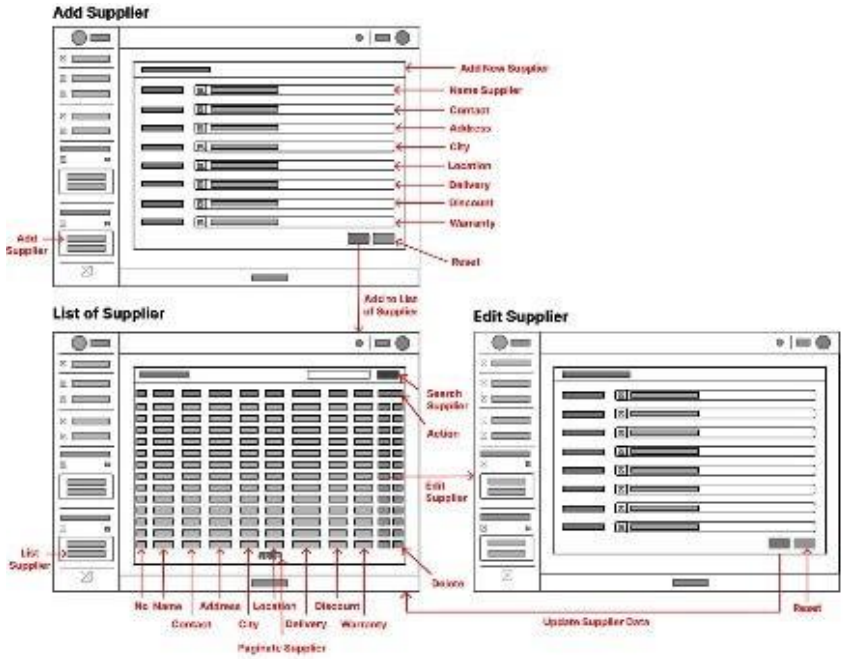


Figure 13. Supplier Prototype

Based on the supplier page comprising 'Add Supplier,' 'Edit Supplier,' and 'List of Suppliers.' These three pages are interrelated, as users can add supplier information, which will be directly appended to the list of suppliers. Users can also edit or delete supplier information and perform a search for suppliers.

The following illustrates the prototype items.

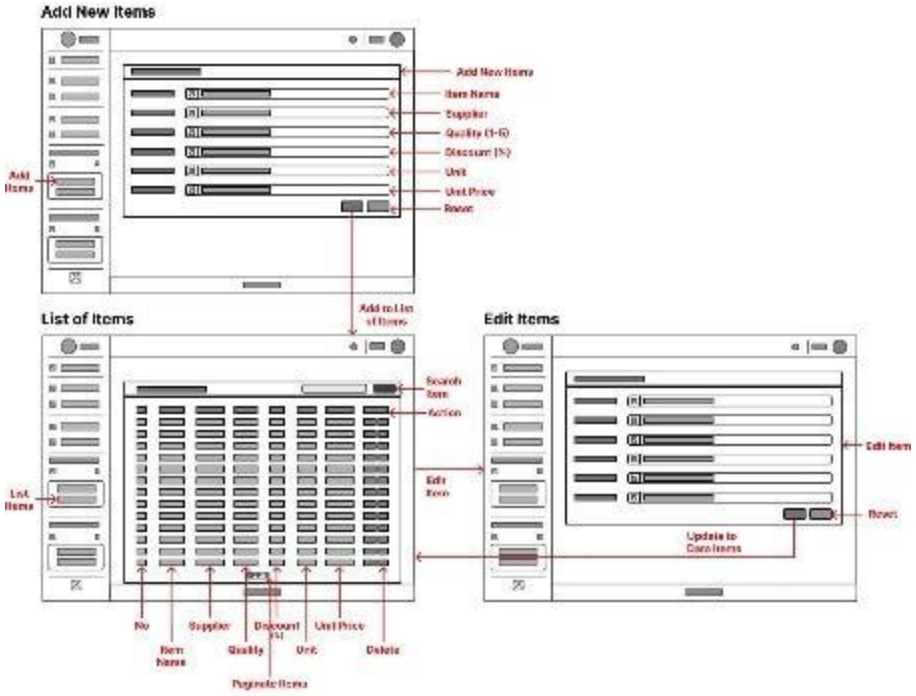


Figure 14. Prototype Items

Based on the item pages consisting of 'Add Items,' 'Edit Items,' and 'List of Items.' These three pages are interrelated, as users can add item information, which will be immediately added to the list of items. Users can also edit, delete item information, and perform item searches.

The following illustrates the prototype units.

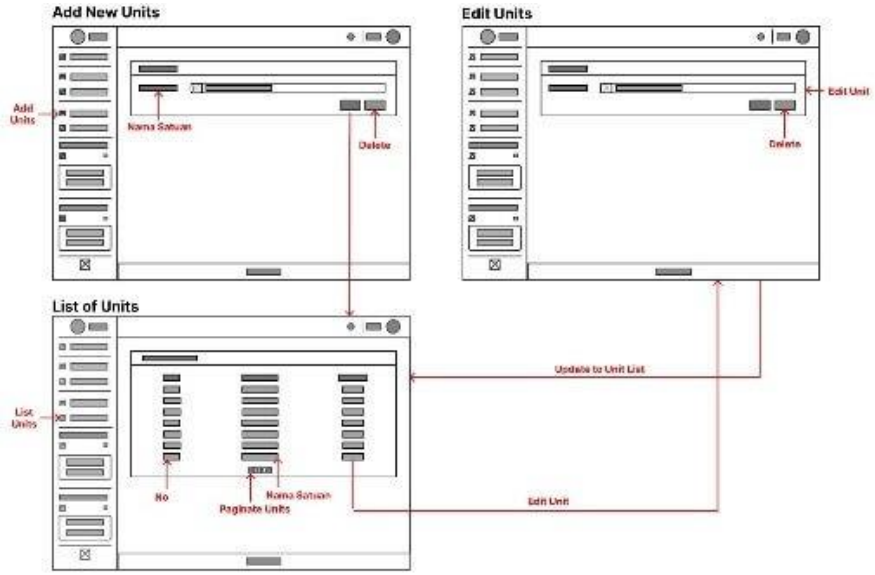


Figure 15. Prototype Units

e-ISSN: 2460-870X | p-ISSN: 2085-1367

Based on the units page consisting of add units, edit units, and list of units. These three pages are interconnected because users can add unit information, which will be immediately added to the list of units. Users can also edit unit information.

A class diagram is a visual representation showing the structure and description of classes, packages, and objects related to each other. The class diagram of the Laravel Framework website is accompanied by a compiler. Below is the design of the class diagram, including:

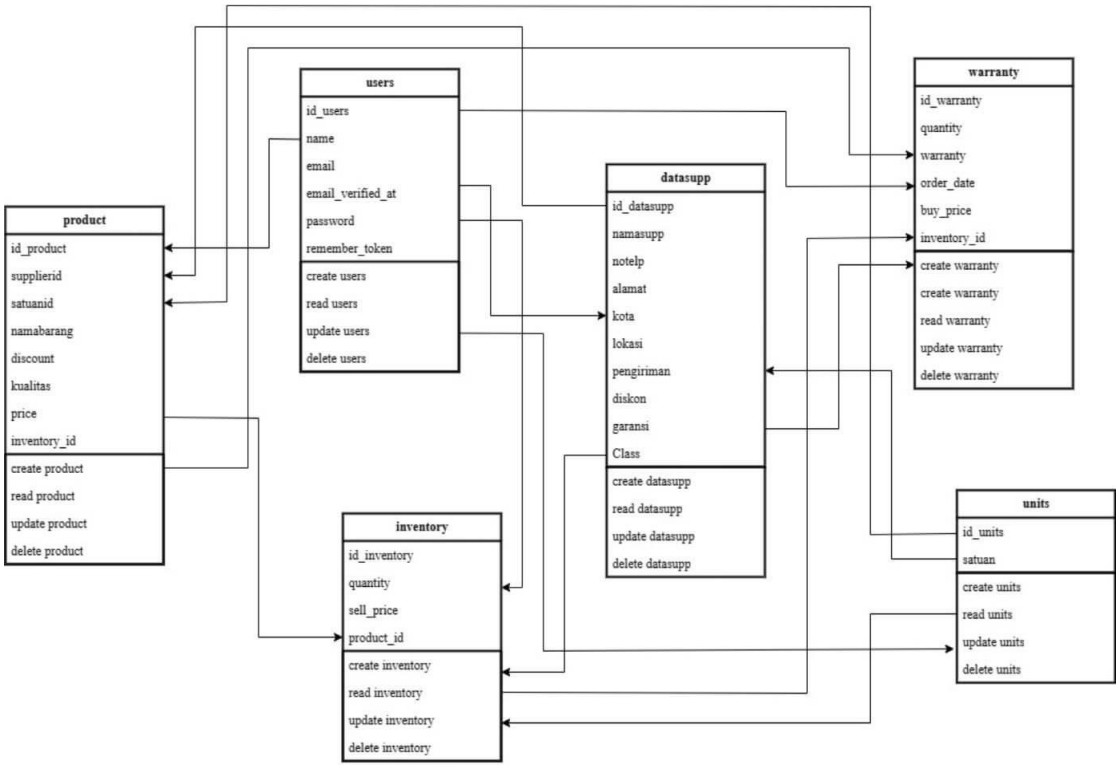


Figure 16. Class Diagram

The class diagram provides a clear schema of the data model, helping to convey the requirements of this software more effectively.

The following illustrates the activity diagram of the supplier data collection system, including:

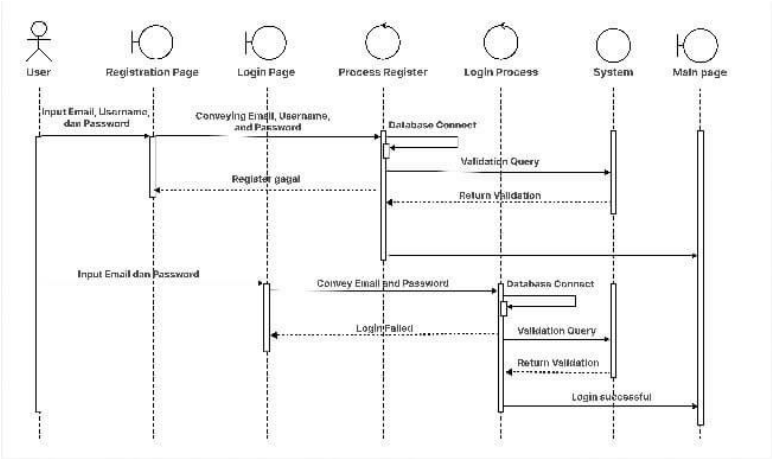


Figure 17. Sequence Diagram for Login and Register

Software architecture utilizes UML (Unified Modeling Language) design models such as Sequence and Activity Diagrams. Below is the design for the login and register sequence diagrams.

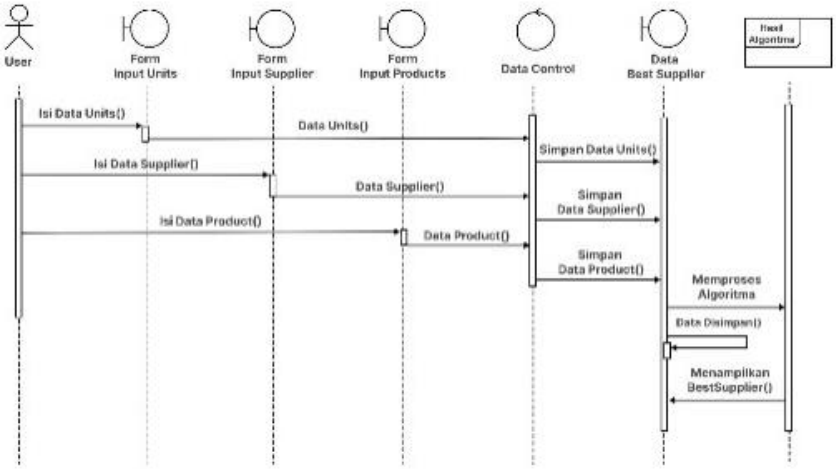


Figure 18. Best Supplier Sequence Diagram

The registration process in the system starts with the user inputting their email, username, and password, which are then validated by the system. If the validation query is successful, the data is stored in the database, and the user is directed to the main page; otherwise, if the validation fails, the user is redirected to the registration page. The login process involves the user inputting their email and password, which are then validated by the system against the data stored in the database. If the credentials are valid, the user is directed to the main page. However, if the credentials are invalid, the user is redirected to the login page. Below is the sequence diagram for the best supplier.

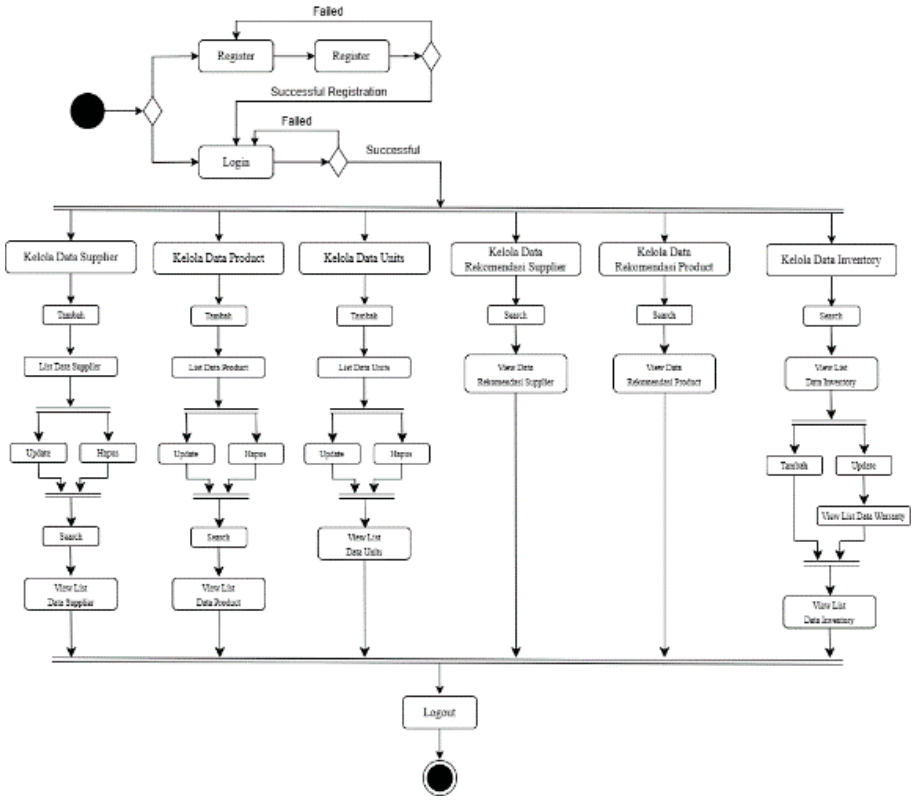


Figure 19. System Activity Diagram

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The user initiates the supplier selection process using an algorithm. This process begins when the user fills in data regarding units, suppliers, and products. Subsequently, this data is stored in the database. Once the algorithm finishes processing the supplier selection data, it displays the algorithm's results, which are the best supplier selection for BMJ store, on the best supplier page.

The interface plays a crucial role in a website as it serves as the intermediary for all input and output processes. Here's an illustration of the registration and login interfaces.



Figure 20. Register and Login Page Design

Based on the register page design, when the user first clicks on the website, this page displays input fields for name, email, and password. The purpose of the register page is to allow users to register and create an account on the website. On the login page, after the user has successfully registered and their information is saved in the database, this page displays input fields for username and password. The purpose of this page is to authenticate users to access the features in the recommendation system. The following illustrates the home page.

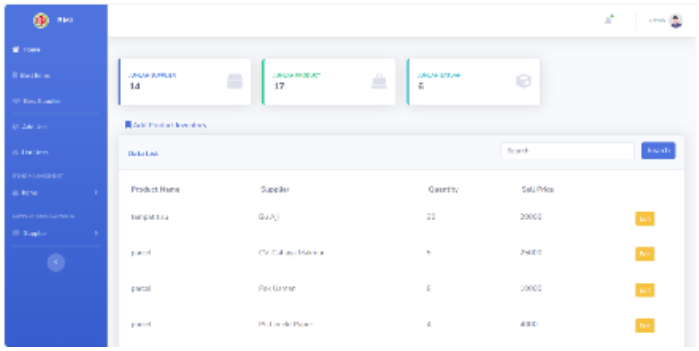


Figure 21. Home Page Design

The homepage displays the total number of suppliers, products, and units. It also features a list of data containing the product name, supplier, quantity, and sell price. This page serves as the initial page upon login and provides access to other pages. The following illustrates the best items display.

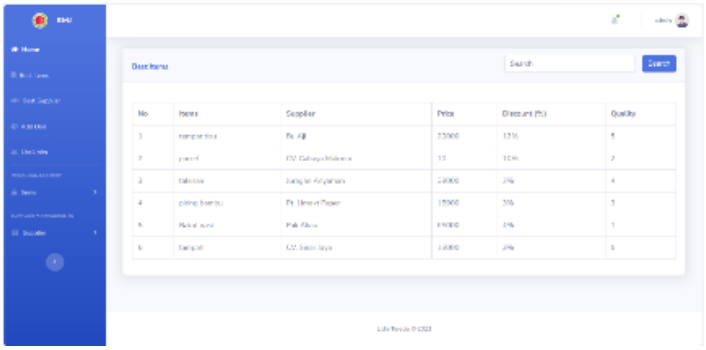


Figure 22. Best Items Display Layout

DOI: https://www.doi.org/10.22303/csrid.1.1.2022.01-10

The best items page displays item numbers, names, suppliers, prices, and quality ratings. Users can also search for the best items on the best items page. The illustration below depicts the best supplier display.

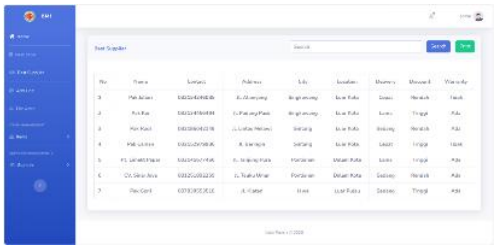


Figure 23. Best Supplier Display Layout

The best supplier page includes columns for the following information: number, name, contact, address, city, location, delivery, discount, and warranty. Users can also search for the best supplier. The following illustrates the add units display.

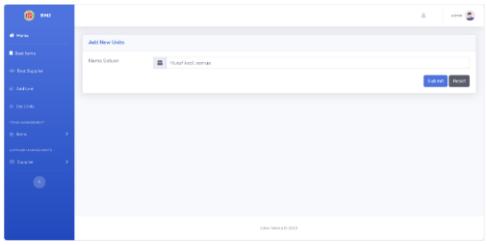


Figure 24. Add Units Interface Design

Based on the add units interface design that allows users to input unit names. The submit button will redirect users to the list units page. The following illustrates the list of units.

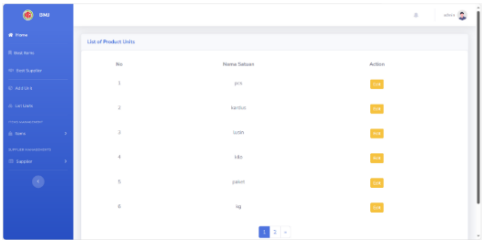


Figure 25. List Units Display Design

In the list units design, after the user has finished adding units, this page displays the unit numbers and names. The following illustrates the edit units display.

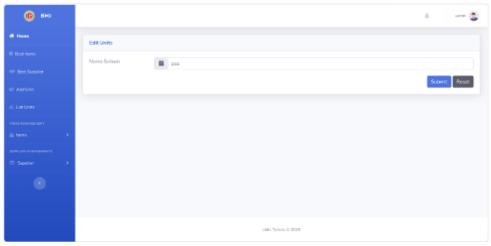


Figure 26. Edit Units Interface Design

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This interface design allows users to modify unit names. The following illustrates the add items display.

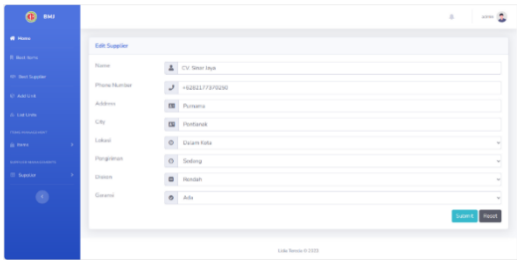


Figure 27. Add Items Interface Design

The Add Items interface design consists of eight input fields: item name, supplier, quantity, discount, unit, and unit price. The submit button directs to the list items page. Below illustrates the list items interface.

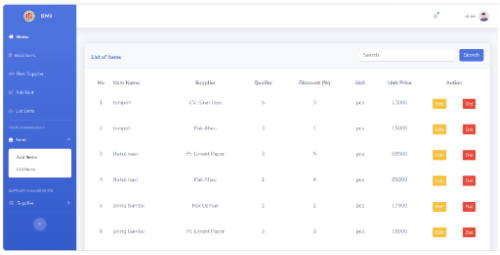


Figure 28. List Items Display Design

In the list items display design, after the user finishes adding items, the page includes the following fields: item number, item name, supplier, quantity, discount, unit, and unit price. The illustration below depicts the edit items interface.

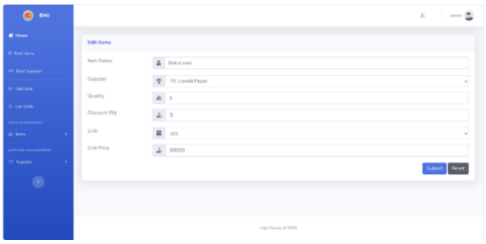


Figure 29 Edit Items Display Design

This display design illustrates the editing of item details such as item name, supplier, quantity, discount, unit, and unit price. Below is an illustration of the add supplier interface.

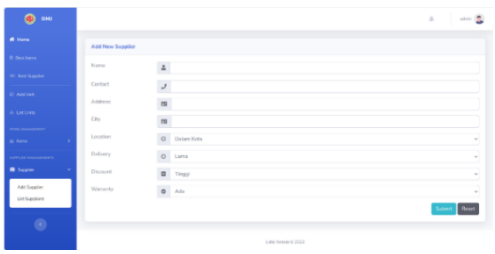


Figure 30. Add Supplier Interface Design

DOI: https://www.doi.org/10.22303/csrid.1.1.2022.01-10

The add supplier interface design consists of eight input fields: name, contact, address, city, location, delivery, discount, and warranty. The submit button will direct users to the supplier list page. Below illustrates the supplier list interface.

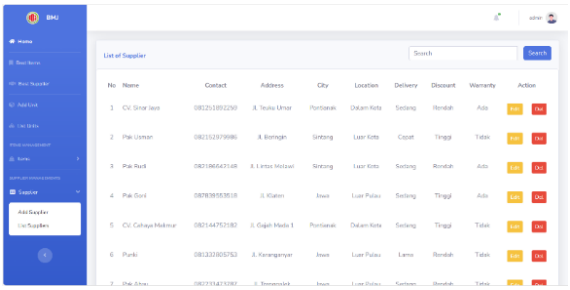


Figure 31. Supplier List Display Design

In the supplier list display design, after the user has finished adding a supplier, the page includes fields for number, name, contact, address, city, location, delivery, discount, and warranty. The following illustrates the edit supplier display.

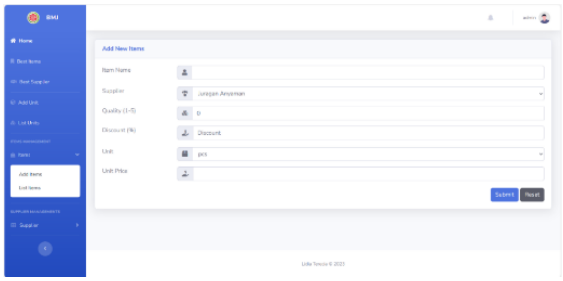


Figure 32. Edit Supplier Interface Design

This design features an input form for editing supplier details including name, contact information, address, city, location, delivery preferences, discount settings, and warranty information.

4. CONCLUSION

From the software design results for Bambu Makmur Jaya (BMJ) Store's website, it can be concluded that this website significantly contributes to supporting BMJ Store's business activities. The website effectively assists BMJ Store in selecting suppliers and products that meet the store's criteria, while also providing real-time notifications to remind them not to miss warranty deadlines. Additionally, the presence of the supplier data system on the website has a positive impact on the store by incorporating technology into its business operations. Therefore, this website not only facilitates the store owner in managing supplier and inventory data but also accelerates processes and reduces excessive expenditure.

The results of optimizing supplier data with the Decision Tree method at BMJ store propose several suggestions for future research. It is hoped that the website's security can be enhanced to protect data from potential misuse and strengthen routine maintenance systems and efficient data backups to maintain data integrity under various conditions, both expected and unexpected. Additionally, there is a need to develop the website's capability to directly record sales transactions within the data management system, strengthening the overall operational function of the store.

e-ISSN: 2460-870X | p-ISSN: 2085-1367

ACKNOWLEDGEMENT

Acknowledgements for this research extend to Makmur Jaya Bamboo Store for graciously granting permission for the study to be conducted on their premises. Gratitude is expressed for their cooperation and support throughout the duration of this project, without which this research would not have been possible. The willingness of Makmur Jaya Bamboo Store to facilitate the research efforts is sincerely appreciated, and their contribution is invaluable to the completion of this study.

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