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MARKET BASKET IMPROVEMENT IN SALES TRANSACTIONS USING THE APRIORI ALGORITHM

(Case Study: Sari Mulya Welding Workshop)

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Abstract

This study refers to the improvement of Market Basket with Apriori Algorithm to analyze Sari Mulya Welding Workshop data. In the implementation stage, Apriori Algorithm is used to find unique values from the data carefully and accompanied by UAT (User Acceptance Test) testing for tests that can be used as evidence that the software has been accepted with an average value of 4.7 that this application is very satisfying for users and has met the needs of those who request it. To find out the response of the Workshop owner to the application. The results of the analysis show an association between Goods such as Fences and Canopies, by determining a Support value of 15% and Confidence of 20%, resulting in an association rule value with a Support value of 24% and Confidence of 73%. In conclusion, customers who buy fences tend to also buy Canopies in one transaction. These results can be used for marketing strategies and stocking goods, for example, with frequently sold goods such as fences and canopies, you can stock goods such as: 2x4 Galvanized Iron, 4x4 Galvanized Iron, 4x8 Galvanized Iron, 5x10 Galvanized Iron, spandek, Alderon, because from these results you can find fences and canopies that are frequently sold and it can be seen that both use the materials used in making goods, the owner will easily make decisions regarding plans each month.

Keywords: Apriori Algorithm, Transaction Data, Welding Workshop.

1. Introduction

Welding workshop is a business that provides welding services for various types of metal, Welding is also commonly called welding, Welding Workshop is also one of the Factory Industries engaged in the welding sector that provides the manufacture of canopies, fences, trellises, balconies and others [1]. In Welding Workshops, errors often occur in calculating sales and purchases so that the resulting data and information are not precise and accurate, there is no, there is no recapitulation report of the best-selling or most ordered jobs so that the owner has difficulty making decisions regarding plans each month. [2.] Data analysis aims to control the number of orders to be more accurate, there is an order history so that management can find out the most ordered jobs to find out what materials are widely used in making goods.

The Apriori algorithm works by calculating the support value for each item in the transaction data. The support value is the level of occurrence of an item in the transaction data.[3.] The confidence value is the level of validity of an association rule. Association rules that meet a predetermined minimum confidence value are considered valid and can be used as recommendations for placing orders.[4.]

Market Basket Analysis is a method for managing associations in data processing across various fields. The primary goal of Market Basket Analysis in sales is to convey important messages to companies, enabling them to understand consumer shopping cart behavior patterns and enable partners to make informed decisions. This research uses the Apriori Algorithm to account for changes in the data. [5.]

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2. Method

The research method applied in this study is the Software Development Life Cycle (SDLC). SDLC is an approach used for the design and development of information systems or software. SDLC consists of a series of stages carried out sequentially and repeatedly with the aim of producing a quality information system that meets user needs. The complete stages in the SDLC method are illustrated in Figure 1.

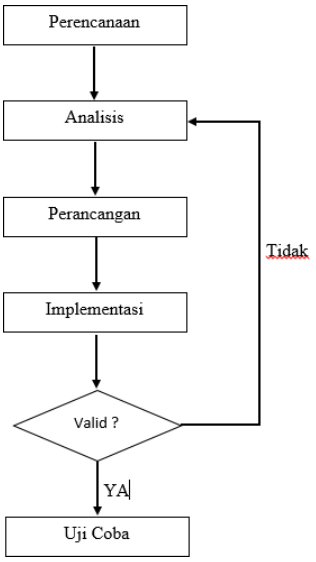


Figure 1.SDLC Model Stages

2.1 Apriori Algorithm

The Apriori algorithm is an algorithm that searches for frequent itemsets using association rule techniques. To find association rules from a data set, the first step is to search for frequent itemsets. [6.].

2.2 Analysis

Analysis is an attitude or attention to an object, fact, or phenomenon, so that it is able to break it down into parts and recognize the relationship of these parts to the whole. Then analysis can be interpreted as the ability to break down material or information into smaller parts so that it is easy to understand. [7].

2.3 Apriori Algorithm Formula

The following is the Apriori method formula:

1. The process of forming C1 or what is known as 1 itemset is obtained based on the following high frequency pattern analysis formula:

$$\text{Number of Transactions Containing A} = \frac{Support(A)}{Total\ Transactions} x100\% \quad \text{.....(1)}$$

2. The process of combining 2 Itemsets The process of forming C2 or called 2 *itemset*searched using the following high frequency pattern analysis formula:

$$Support\ (A, B) = \frac{\sum \text{Transaction Contains A and B}}{Total\ Transactions} x100\% \quad \text{.....(2)}$$

3. The combination of itemsets in C2 can be combined into 3 itemsets with the following formula:

$$Support(A,B) = \frac{\sum \text{Transaction contains A, B, and C}}{\text{Total Transactions}} x100\% \quad (3)$$

4. After all high-frequency patterns are found, the associative rule that meets the minimum confidence requirement is searched for by calculating the confidence of the associative rule A → B with the minimum confidence. The confidence value of the rule A → B is obtained from the following formula:

$$ConfidenceP(B|A) = \frac{\sum \text{transaction contains A and B}}{\text{The number of transactions containing A}} x100\% \quad (4)$$

a. Planning

At this stage, data collection was carried out through interview and observation methods. The purpose of applying this method in the planning phase was to obtain accurate data for research purposes by determining a minimum of 15% Support and 20% Confidence. In addition, a persuasive approach was carried out with stakeholders through interviews to understand the desires, visions, and missions related to the development of the software and systems to be built. From the results of data collection through interviews and observations, 4 (four) data files were obtained. The following are the details of the two files:

1. **Item data**: This data is primary and is stored in Excel format (.xlsx) with a total of 16 data.
2. **Material data**: This data is for the data used to make the goods that are processed with a total of 19 material data.
3. **Goods and materials data**: This data is the data on the materials used to make the goods.
4. **Transaction data**: This data is also primary and is stored in Excel format (.xlsx) with a total of 200 data, covering the time range from August 2023 to August 2024.

Table 1 Item Data

Product Code	Item
01	Fence
02	Trellis
03	Canopy
04	Balcony
05	Railing
06	Spiral Stairs
07	Flagpole
08	Drain Cover
09	Cupboard
10	Clothesline
11	Door
12	Iron Pot
13	Table
14	Chair
15	Iron Bed
16	Iron Billboard

Table 2 Material Data

Material Code	Material Name
1	Alderon
2	Stirrup
3	Galvanized Iron 2x2
4	Galvanized Iron 2x4
5	Galvanized Iron 3x3
6	4x4 Galvanized Iron
7	Galvanized Iron 4x6
8	Nako Iron
9	Fiber
10	Iron plate
11	Iron Pipe
12	Bodres Plate
13	spandex
14	Galvanized Iron 5x10
15	Bodres plate
16	Galvanized Iron 4x8
17	Galvanized Pipe
18	Elbow
19	Galvanized Iron 5x5

Table 3 goods and materials data

Name of goods	Materials used
Fence	Galvanized Iron 2x4, Galvanized Iron 4x4
Trellis	Braces, Iron Plates, Nako Iron
Canopy	Galvanized Iron 4x8, spandek, Alderon, Galvanized Iron 5x10
Balcony	Galvanized Iron 2x4, Galvanized Iron 4x6
Railing	Galvanized Iron 5x5, Nako
Spiral Stairs	Galvanized pipe, bodres plate
Flagpole	Iron Pipe
Drain Cover	Bodres plate, elbow
Cupboard	Galvanized Iron 3x3
Clothesline	Galvanized Pipe
Door	Iron plate, 4x4 Galvanized Iron
Iron Pot	Stirrup
Table	4x4 Galvanized Iron
Chair	Galvanized Iron 3x3
Iron Bed	Galvanized Iron 5x5, Angle
Iron Billboard	Iron Pipe, Elbow

Table 4 Transaction Data

No	TRANSACTION ID	NAME OF GOODS
1	TR-2024-00001	Fence: 1, Trellis: 1, Canopy: 1
2	TR-2024-00002	Chairs: 2, Tables: 2
3	TR-2024-00003	Fence: 1, Railing 1
4	TR-2024-00004	Spiral Stairs: 1
5	TR-2024-00005	Fence: 2, Manhole Cover: 2
6	TR-2024-00006	Fence: 1, Spiral Stairs: 1
7	TR-2024-00007	, Trellis: 1, Fence: 1
8	TR-2024-00008	Door: 1,
9	TR-2024-00009	Fence 1
10	TR-2024-00010	Fence, Canopy
…	…	…
200	TR-2024-000200	Fence 1

The following is an explanation of transaction data ready for analysis. This data includes information on sales transactions of various types of iron goods, sorted by transaction number. Each transaction contains detailed information about the item name and quantity. This data is ready for further analysis, for example, to identify purchasing patterns, measure sales performance, or determine more effective marketing strategies.

b. Apriori Algorithm Calculation

The calculation of each frequency per item is carried out by adding up each item purchased. The following is the formula for finding the value of the item set.

Table 5 Count Item Frequency:

Name of goods	***Frequency***
Fence	76
Trellis	23
Canopy	66
Iron Bed	9
Chair	22
Table	20
Railing	25
Spiral Stairs	6
Flagpole	11
Iron pot	25
Folding doors	20
Clothesline	17
Drain Cover	10
Cupboard	19
Balcony	20
Iron billboard	2

The following is a solution based on the data provided in Table 8 transaction data format. The process of forming C1 or called 1 itemset is obtained based on the formula in equation (1) high frequency pattern analysis, with a minimum support of 15%.

- **Defining Itemset-1**

Support(Fence) = $\frac{76}{200} x100\% = 38\%$

Support(Trellis) = $\frac{23}{200} x100\% = 12\%$

Support(Canopy) = $\frac{66}{200} x100\% = 33\%$

Support(Iron Bed) = $\frac{9}{200} x100\% = 5\%$

Support(Spiral Stairs) = $\frac{6}{200} x100\% = 3\%$

Support(Cupboard) = $\frac{19}{200} x100\% = 10\%$

Support(Chair) = $\frac{22}{200} x100\% = 11\%$

Support(Table) = $\frac{20}{200} x100\% = 10\%$

Support(Railing) = $\frac{25}{200} x100\% = 13\%$

Support(Flagpole) = $\frac{11}{200} x100\% = 6\%$

Support(Iron pot) = $\frac{25}{200} x100\% = 13\%$

Support(Folding Door) = $\frac{20}{200} x100\% = 10\%$

Support(Clothesline) = $\frac{17}{200} x100\% = 9\%$

Support(Drain Cover) = $\frac{10}{200} x100\% = 5\%$

Support(Balcony) = $\frac{20}{200} x100\% = 10\%$

Support(Iron Billboard) = $\frac{2}{200} x100\% = 1\%$

The results of the above calculations are converted into percentage form to determine the Support for each sales item, the results can be seen in Table 6.

Table 6.*Itemset*-1

Name of goods	***Frequency***	***Support (%)***	**Information**
Fence	78	36	Passed
Trellis	13	7	Didn't pass
Canopy	67	34	Passed
Iron Bed	10	5	Didn't pass
Spiral Stairs	6	3	Didn't pass

Cupboard	19	9	Didn't pass
Chair	21	11	Didn't pass
Table	18	9	Didn't pass
Railing	24	12	Didn't pass
Flagpole	10	5	Didn't pass
Iron pot	24	12	Didn't pass
Folding doors	19	10	Didn't pass
Clothesline	17	9	Didn't pass
Drain Cover	9	5	Didn't pass
Balcony	20	10	Didn't pass
Iron billboard	2	1	Didn't pass

From the results that have met 15% Support, we continue to determine the Combination of 2 Itemsets. The process of forming C2 or what is called 2 itemsets is searched using the formula in Equation (2) high frequency pattern analysis.

- **Determine Itemset-2 that has passed Itemset-1**

$$Support(\text{Fence, Canopy}) = \frac{47}{200} x100\% = 24\%$$

$$Support(\text{Canopy, Fence}) = \frac{47}{200} x100\% = 24\%$$

The results of the above calculations are converted into percentage form to determine the Support for each sales item, the results can be seen in Table 7.

Table 7.*Itemset*-2

Combination	***Frequency***	***Support (%)***	**Information**
Fence, Canopy	47	24	Passed
Canopy, Fence	47	24	Passed

From the results that have met 15% Support, we continue to Determine Confidence to find association rules that meet the requirements of Itemset-2 that have been found.

- **Formation of association rules**

After all high frequency patterns are found, then the association rules that meet the requirements are searched for. From the C2 that has been found, the support and confidence values of the association rules can be seen as in Table 8.

Table 8. Apriori results

Rule	***Support(%)***	***Confidence(%)***
Fence → canopy	24	63
canopy→ fence	24	73

From the calculation results above, the association rules that meet the minimum support value of 15% and *confidence*minimum 20% is:

1. If someone buys a Fence, then they are most likely to buy a Canopy (Confidence: 63%).
2. If someone buys a Canopy, then they are more likely to buy a Fence (Confidence: 73%).

Minimum for confidence by calculating the Confidence of the associative rule AB, the Confidence value of the AB rule can be formulated using the formula in the equation (4) Formation of association rules.

$$\text{Confidence} = P(B \backslash A) = \frac{\sum \text{transaction contains A and B}}{\textit{The number of transactions containing A}} 100$$

1. $\textit{Confidence}(\text{Fence, Canopy}) = \frac{47}{76} x100\% = 63\%$
2. $\textit{Confidence}(\text{Canopy, Fence}) = \frac{47}{} x100\% = 73\%$

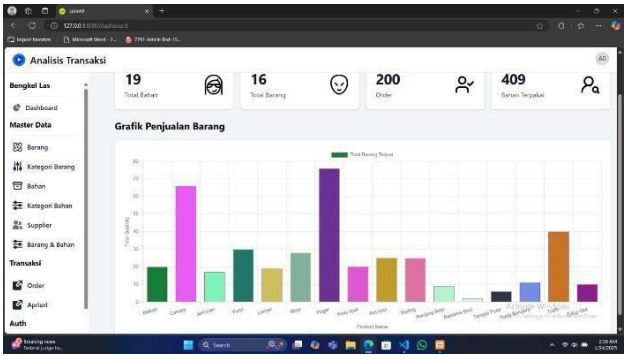
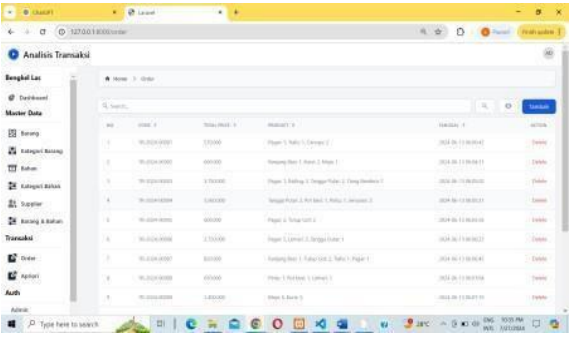
3. Results and Discussion

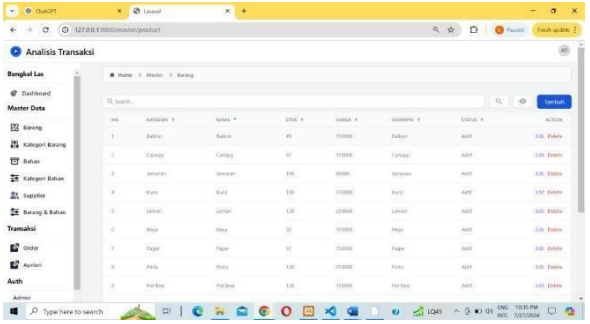
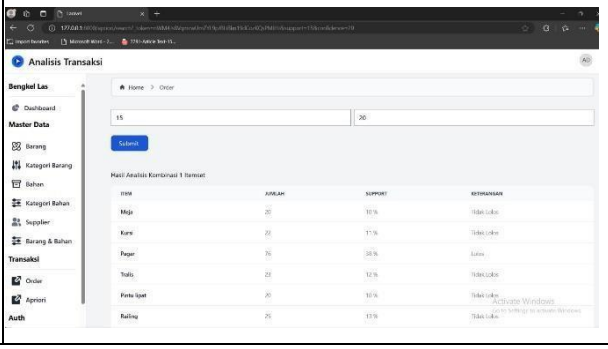
3.1 Results

In this section, we will discuss the implications of the analysis results, the Apriori Method used, and recommendations based on the results obtained. The analysis results show that there is a strong relationship between the fence and Canopy items with a minimum support of 24% and a confidence of 75%. This can be very useful information for workshop management in sales patterns and can identify frequently sold items and frequently used materials. For example, the workshop can consider providing a package discount for purchasing these two items together.

Based on the analysis results, it is recommended that the workshop consider the relationship between fences and canopies in their marketing strategy. Using these analysis results, the welding workshop can conduct cross-promotions between fences and canopies to increase sales. Transaction data analysis using the Apriori method provides an overview of customer purchasing patterns. These results can be used to optimize sales and promotion strategies, as well as improve the overall customer shopping experience. Thus, these results and discussion provide guidance for management in making decisions based on the analyzed data.

3.2 Interface Page

Dashboard Home Page	Order Page
	

Item Data Page	Analysis Page
	

3.3 Functional Test

In functional testing, a series of functional tests were conducted on several pages within the system. Each function on the page was tested using a specific scenario, and the results showed that all tested functions performed as expected.

3.4 Validation Test

Validation testing is a test that checks the accuracy of data entered into the application. This testing involves validating the data entry system, ensuring that the final results match the input data.

3.5 UAT Test (User Acceptance Test)

*User Acceptance*Testing is a testing process carried out by the user with the output of a test result document that can be used as evidence that the software has been accepted and has met the requested needs. To find out the response of the workshop owner to the application, testing was carried out by giving 11 questions to the workshop owner, where the answers to these questions consist of levels that can be selected as follows, as can be seen in table 9.

Table 9 UAT Test (User Acceptance Test)

Answer	Mark
A. Very Good	5
B. Good	4
C. Enough	3
D. Not good	2
E. Not Good	1

No	Question	Mark
1	Is this web display attractive?	4
2	Is this Web View easy to understand?	4
3	Does this Application meet the Needs?	5
4	Is This App Useful?	5
5	Overall, is this application comfortable to use? ?	5
6	Does this application comply with what is needed?	5
7	Are all windows functioning properly?	5
8	After using this application, did the transactions run smoothly?	5
9	Does this application make things easier for employees?	4
10	Can this application make time more efficient?	5
11	Does this application help in determining the stock of materials used?	5
Results		
Total Value		52
Average Value		4.7

The following is the calculation of results from Uat:

1. Calculate Total Value
   Adding Values with 11 Questions:
   Total Value: 4 + 4 + 5 + 5 + 5 + 5 + 5 + 5 + 5 + 4 + 5 = 52
2. Calculate the Average Value:
   The average score is calculated by dividing the total score by the number of questions (11 questions):

$$\text{AVERAGE VALUE} = \frac{\text{Score Value}}{\text{Number of Questions}} = \frac{52}{11} = 4.7$$

3. Evaluation of Results:

- If the average value is between 1 and 2: The application needs major improvements.
- If the average value is between 2 and 3: The application needs some improvements.
- If the average value is between 3 and 4: The application is quite good.
- If the average value is between 4 and 5: The application is very satisfactory.

Based on the UAT results, this application is suitable for use by workshop owners to increase transactions in welding workshops. This application meets the majority of user needs, with a fairly high average value (4.7), indicating that this application is very satisfactory and almost completely ready for use by users.

4. Conclusion

This study uses the Market Basket Analysis approach method by implementing the Apriori Algorithm in processing the data carefully, to find the most effective analysis patterns and marketing strategies that can be applied to the Sari Mulya Welding Workshop. The research stages include Planning, Analysis, Design, Implementation, Testing. At the implementation stage, the Apriori Algorithm is used to find unique values from the research data and is accompanied by UAT (User Acceptance Test) testing of this application, which is suitable for use by workshop owners to increase transactions in welding workshops. This application meets the majority of user needs, with a fairly high average value, namely (4.7), indicating that this application is very satisfying and almost completely ready for use by users.

The results of the analysis that were successfully obtained from the Apriori Algorithm are the Frequent itemset obtained, namely the Canopy and Fence itemset with a total of 47 sold or 24% support and Confidence of 73%. In this study also produces association rules, namely: When consumers buy a Canopy, they will buy a Fence with a level of confidence that the items will be purchased simultaneously of 24%, So with these results the workshop already knows and can stock materials such as: Galvanized Iron 2x4, Galvanized Iron 4x4, Galvanized Iron 4x8, spandek, Galvanized Iron 5x10, Alderon, because from these results it can be found that fences and canopies are items that are often sold and it can be seen that both use the materials used in making goods, the owner will easily make decisions regarding plans each month.

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