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Identification of Website-Based Product Sales Frequency Patterns using Apriori Algorithms and Eclat Algorithms at Rio Food in Bekasi

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Abstract

Sales reports that are not managed automatically may hinder businesses from accurately determining their progress in the short or long term. With increasing community needs for a product, business owners have an opportunity to market their products to a larger audience. The abundance of data highlights the need for information to produce patterns that can be used as a reference for making decisions in buying products on the website. Data mining algorithms can provide support for analysis, which can help avoid inaccurate business progress reports. In this study, the Apriori and Eclat algorithms were applied to analyze frequent itemsets in association rule mining. The dataset used in this study consists of 20 transaction data from frozen food sales. The results showed that the combination of Nugget and Chicken Sausage itemsets were the most frequent, with higher support, confidence, and lift ratio values than the others. These results can be used as product recommendations that are most in demand by customers.

Keywords*: frequency patterns, apriori algorithm, eclat algorithm, association rule mining, product marketing*

1. Introduction

Frozen and non-frozen foods are two distinct types of food that differ significantly in terms of their storage, shelf-life, and nutritional value. Frozen foods, as the name suggests, are foods that have been frozen and stored at low temperatures to preserve their quality and freshness. One of the benefits of frozen food is that they can be stored for a longer time without spoiling, making them a convenient option for busy individuals who may not have time to shop for fresh food regularly. Rio Food, a forzen foods store, operates in the frozen food sales industry. It was one of the profitable businesses during the pandemic last year (Mayanti, 2021). Frozen food is known to have safe, clean, and long-

lasting quality for food storage (Jermias, 2016). The aim is to slow down decomposition by converting moisture into ice and inhibiting the growth of most bacteria species (Patriani et al., 2020). Frozen food itself has various types of food, ranging from meatballs, frozen meat, frozen fish, dim sum, nuggets, and others (Aziz, 2022).

When sales reports are not managed automatically, it makes it difficult for the business to accurately determine its progress in the short or long term. The increasing demand for a product from the community presents a significant market opportunity for business owners to market their products (Hidayat et al., 2019).

The Apriori algorithm can help in forming candidate item combination, followed by testing whether the combination meets the minimum support and confidence parameters set by the user, and the results will be recommended to website visitors (Romindo, 2022). Similar to previous research titled 'Analysis of Snack Sales System Patterns Using the Apriori Algorithm,' the study aims to find patterns in which manufacturers can meet customer demand without running out of product stock. The results of the study show that using the Apriori algorithm can determine the sales patterns of snacks, enabling manufacturers to efficiently manage their snack stock and prioritize this sales pattern to determine their snack stock (Zulham et al., 2021).

For comparison, the Eclat Algorithm (Equivalence Class Transformation) was used, which is a simple algorithm for finding the most frequently occurring itemsets by performing a depth-first search on the database. Depth-first search (DFS) is an algorithm for searching data structures that starts at the root node and explores each branch as far as possible until backtracking occurs (Sulastri et al., 2017). The aim is to find the recommended products resulting from its iterations.

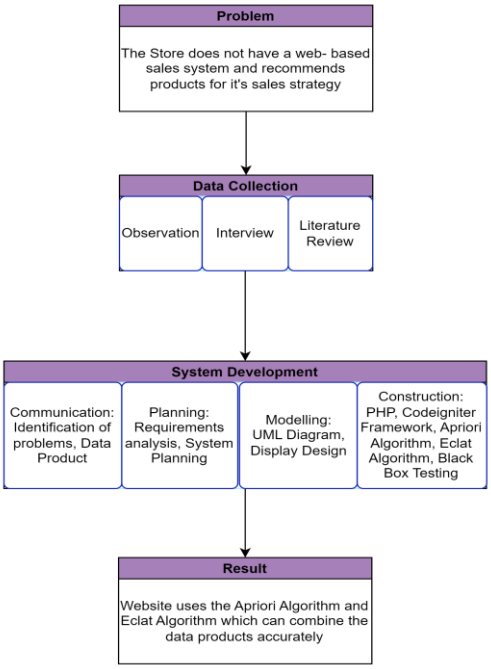
2. Research Method

The research should be explained chronologically, including research design, research procedures (in the form of algorithms, pseudocode, or others), testing methods, and data acquisition. The description of the research process

should be supported by references to ensure scientific validity. Tables and figures should be centered and cited in the manuscript.

2.1. Research Framework

In a study, it is required to have a flow or plan in doing it to achieve the goal. For its visualization as in figure 1. This flow or plan is important to ensure that the study is conducted in a systematic and organized manner, which in turn can increase the reliability and validity of the research findings.



Source: Research Result (2022)

Figure 1. Research Framework

2.2. Association Rule

Generally, association rule analysis is used to obtain a set of items or itemsets that appear together in transactions. An itemset is made up of pieces called i-itemsets. The percentage of transactions or combinations consisting of one item set is called the support itemset, and the confidence (certainty value) is the measure of the strength of the relationship between items in the association rules. Support and confidence are the two basic criteria in association rule analysis (Saputra & Sibarani, 2020). To find the support, the formula is as follows:

$$Support(A \rightarrow B) = \frac{\text{Probability (A} \cup \text{B)}}{\text{Total Number of Transaction}} \text{x100\%} \quad (1)$$

While confidence is the value of trust, namely the strong relationship between items in a rule. Confidence can be searched after the frequency pattern of the appearance of an item is found (Herlawati et al., 2022). Here is the confidence formula:

$$Confidence\ (A \rightarrow B) = \frac{\text{Probability (A} \cap \text{B)}}{\text{Total Transaction (A)}} x100\% \quad (2)$$

The lift ratio is an important measuring instrument in the rules of association. Its function is to measure the accuracy and accuracy of a measuring instrument (support and confidence) so that it can be fully trusted. Lift ratio can ensure that the use of media A is used simultaneously with media B. In the end an itemset combination is declared valid and strong if the lift ratio value > 1. Here's the lift ratio formula (Pratiwi & Herlawati, 2019):

$$Lift\ Ratio\ (A \rightarrow B) = \frac{\text{Probability (A} \cap \text{B)}}{\text{Probability (A) x Probability(B)}} x100\% \quad (3)$$

Where, Lift (A ∩ B) represents Correlation between A and B, Probability (A ∩ B) is the number of occurrences between A and B divided by the total transaction. Probability (A) x Probability (B) is Number of occurrences A times the number of occurrences of B on the total transaction.

2.3. Apriori Algorithm

The apriori algorithm begins by searching for frequent itemsets (sets of items that meet the minimum support) from the transaction database, then removing low frequency itemsets based on a predetermined minimum support level. Next build an association rule from an itemset that meets the minimum confidence value in the database.

2.4. Eclat Algorithm

The existence of the Eclat algorithm enables scientific analysis to estimate the necessary actions or make important decisions. The goal is to find itemsets starting from the most frequent to the rarest without regard to order and using vertical databases and cannot use horizontal databases (Sulastri et al., 2017). It also tests the validity of recommended products from the results of the apriori algorithm calculations. Considering that the purpose of market basket

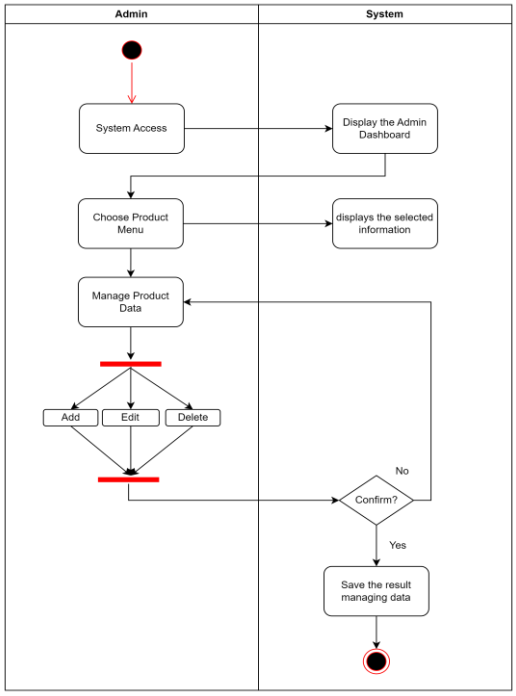
analysis is to determine which products are most frequently bought or used by consumers (Apridonal M et al., 2019).

3. Results and Analysis

To manage sales transaction data more effectively, it is essential to have an information system that utilizes the apriori algorithm to identify the best-selling products. Additionally, the validity of the recommended products obtained from the apriori algorithm can be tested by comparing it with the results obtained using the eclat algorithm.

3.1. System Design

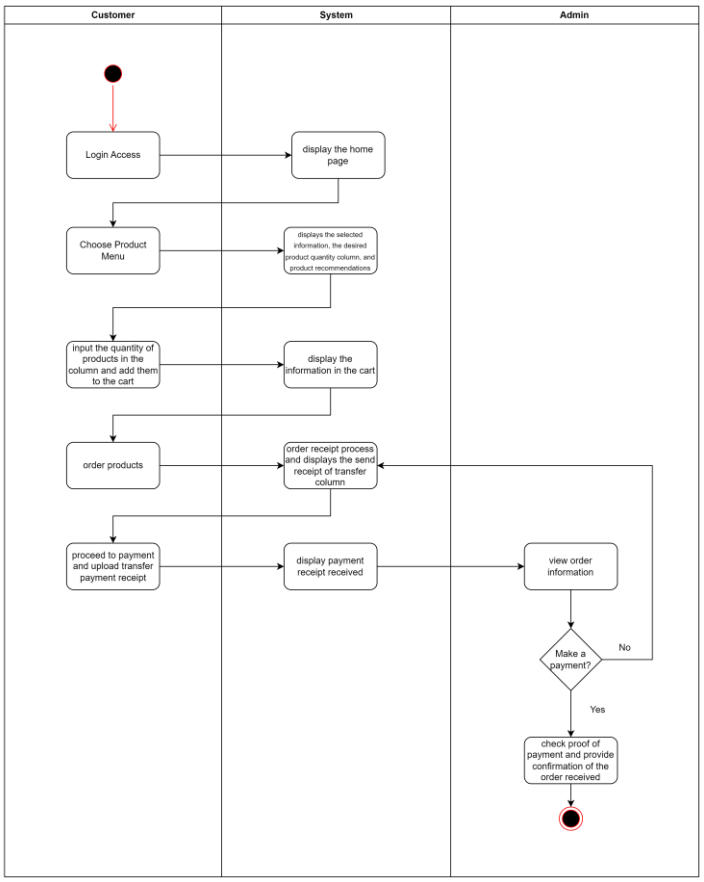
Figure 2 shows the activity for product management by the admin. The product data management activity diagram in Figure 2 can be explained as follows: (1) Admin enters the system; (2) The system displays the main page; (3) Admin selects the product menu; (4) The system displays product data; (5) Admin manages product data (create, update, read, delete); (6) The system confirms the changed product data, if it is appropriate then the process will be continued, if it is not appropriate then it will return to the data product data; (7), the system stores the data results management if valid.; (8) The system saves the results manage updated products data.



Source: Research Result (2022)

Figure 2. Activity Diagram Manage Product Data

The product data management activity diagram in Figure 3 can be explained as follows:(1) the customer enters the system; (2) The system displays the main page; (3) the customer selects the product menu; (4) The system displays product data and fields that need to be filled in; (5) the customer enters data information in the available column and adds the product to the cart; (6) The system displays products that have entered the basket; (7), the customer proceeds to the ordering stage.; (8) The system processes proof of order and sends a column to send proof of payment; (8), the customer makes a payment and sends proof of payment in the column provided; (9), the system displays proof of payment sent; (10) the admin sees the order information provided enter; (11) the admin confirms, whether the customer makes a payment or not, if appropriate, a confirmation will be given to the order being processed and if not the order is canceled and will return to the payment display.



Source: Research Result (2022)

Figure 3. Customer Places an Order

3.2. Application of the Algorithm

Process of providing products requires planning so that the product remains available if consumers need it. Based on the explanation, the apriori algorithm is the method used to process sales data in accordance with the main purpose of this study. The eclat algorithm is used to test the validity of the recommended product from the calculation results of the apriori algorithm.

3.2.1. Apriori Algorithm

a. Result of Iteration 2 Itemset

In table 1, the minimum support is set at 20%, with the aim of eliminating and showing products that are widely enjoyed by consumers. Out of 20 products, 2 itemsets with the highest values were obtained in iteration 1.

Table 1. Result of Iteration 2 Apriori Algorithm

No	Items	Qty	Support	Confidence	Lift ratio
1	If you buy Nuggets, you will buy Chicken Sausage	12	30%	57%	1.19
2	If you buy Meatball Tofu, you will buy Beef Meatballs	10	25%	71%	1.58

Source: Research Result (2023)

b. Result of Iteration 3 Itemset

From table 2, in the formation of association rules from 2 itemsets and 3 itemsets, 5 rules were obtained with support values that meet the minimum threshold and a minimum confidence of 50% and lift ratio >1. From these 5 rules, the top 3 itemsets were obtained, each with a support value of 30% and a confidence value of 57%.

Table 2. Result of Iterations Apriori Algorithm

No	Items	Qty	Support	Confidence	Lift ratio
1	If you buy Cheese Dumpling, you will buy Chicken Dumpling	9	23%	50%	1.16
2	If you buy Nuggets and Chicken Sausages you will buy Beef Sausage	12	30%	57%	2.45
3	If you buy Cheese Dumpling and Chicken Dumpling, you will buy Beef Sausage	10	25%	56%	2.38

Source: Research Result (2023)

3.2.2. Eclat Algorithm

a. Result of Iteration 2 Itemset

Table 3 shows the highest iteration result of itemset 2, including the items, transaction ID, support, ABC confidence, and lift ratio.

Table 3. The Highest Iteration Result of Itemset 2

No	Items	Transaction ID	Support ABC	Confidence	Lift ratio
1	If you buy Nuggets, you will buy Chicken Sausage.	1, 2, 8, 10, 12, 14, 19, 21, 24, 26, 27, 31, 33, 34, 39	37,50%	71%	1.5
2	If you buy Nuggets, you will buy Beef Sausages.	1, 2, 8, 10, 12, 21, 24, 26, 27, 30, 31, 32, 33, 36, 39	37,50%	71%	1.56
3	If you buy Sausage, you will buy Beef Sausage.	1, 2, 8, 10, 12, 21, 24, 26, 27, 30, 31, 32, 33, 36, 39	37,50%	71%	1.56

Source: Research Result (2023)

Two itemsets were identified by showing transaction data ID, support, confidence, and lift ratio. By setting a minimum support of 22%, minimum confidence of 50%, and lift ratio greater than 1, table 3 presents the results of the 2nd iteration which yielded 13 rules from 2 itemsets. The table shows the values of the support, confidence, and lift ratio of each rule, and the 4 highest rules obtained from the 2nd iteration are presented.

b. Result of Iteration 3 Itemset

Based on 1121 pieces of data, the transaction IDs are displayed by counting the occurrences of item A meeting item B, followed by item C, which becomes one combination or rule. If item A is no longer found, item B takes its place, and so on. Using a minimum support, minimum confidence, and lift ratio of <1, three rules were derived from three itemsets resulting from the third iteration, as shown in Table 4.

Table 4. The Highest Iteration Results of Itemset 3

No	Items	Transaction ID	Support ABC	Confidence	Lift ratio
1	If you buy Nuggets and Chicken	1, 2, 8, 10, 12, 21, 24, 26, 27, 31, 33,	28%	52%	2.45

No	Items	Transaction ID	Support ABC	Confidence	Lift ratio
	Sausage, you will buy Beef Sausage	36, 39			
2	If you buy Fish Balls and Otak-Otak, you will buy Dimsum	6, 13, 14, 15, 17, 25, 28, 34, 35	23%	60%	8.00
3	If you buy Fish Balls and Crabstick, you will buy Dim sum	5, 6, 9, 15, 17, 28, 34, 35	20%	53%	7.76

Source: Research Result (2023)

3.3. Results of Apriori Algorithm and Eclat Algorithm

It can be concluded that the highest iteration results of both algorithms show that if a customer buys Nuggets, they are likely to buy Chicken Sausages, and if they buy Cheese Dumplings, they are likely to buy Chicken Dumplings as well. Furthermore, if the customer buys Nuggets, Chicken Sausages, and Beef Sausages at the same time, it indicates a strong association between these three products.

3.4. System Implementation

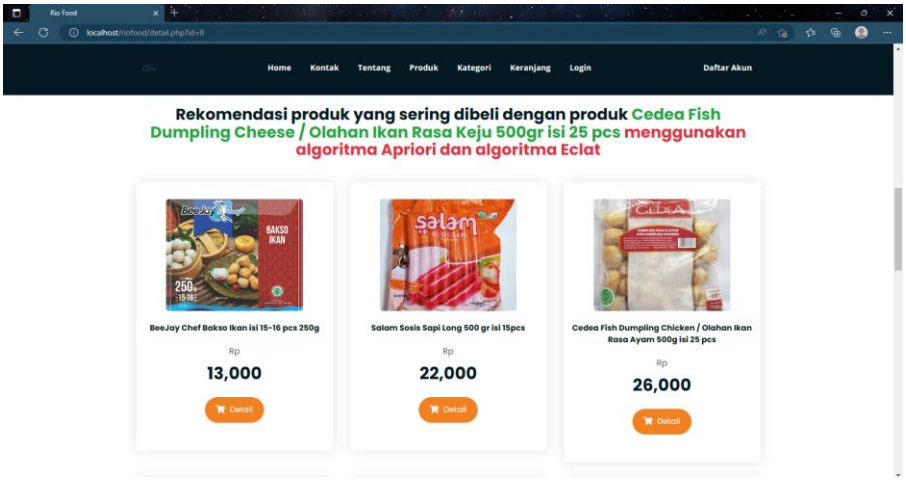
After carrying out the modeling process, the system design has been carried outmade will be implemented with coding program. The following is the interface Rio Food application in recommending products that are most in demand.

Source: Research Result (2023)

Figure 4. Home Page Website Display

On the homepage display of the Rio Food website in the figure 4, costumers can see the available products without logging in to an account. To make product purchases, it is expected to have an account first.

In the figure 5, the recommended product will appear when the costumers or user selects the desired product and is located at the bottom of the selected product.



Source: Research Result (2023)

Figure 5. Recommendation Products Display

In figure 6, stage iteration 1 displays with 1 itemsets showing the support value of each rule. The support value is the frequency of the occurrence of the items in the transactions, which is used to determine the minimum support threshold for generating association rules.

Source: Research Result (2023)

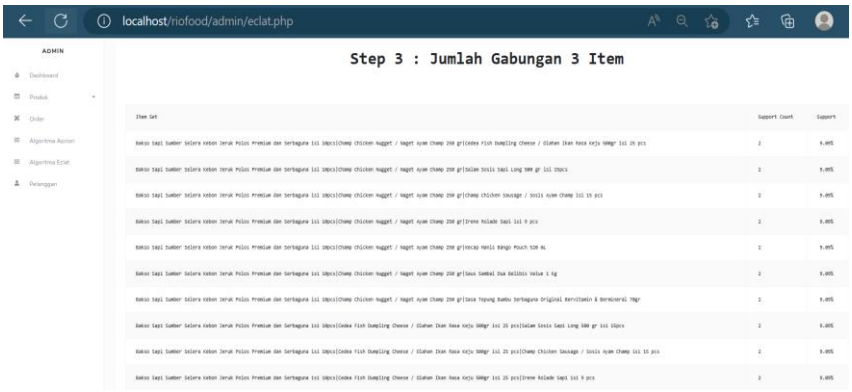
Figure 6. Iteration 1 of the Algorithm Calculation Results

In figure 7, stage 2 displays with 2 itemsets, showing the support value of each rule. It is also shown in a clear user interface.

Source: Research Result (2023)

Figure 7. Iteration 2 of the Algorithm Calculation Results

In figure 8, stage iteration 3 displays with 3 itemsets showing the support value of each rule. The UI as clear as the step 2.



Source: Research Result (2023)

Figure 8. Iteration 3 of the Algorithm Calculation Results

In figure 9, the display of an association rules aimed at analyzing the products that are most in demand by costumers. Admin can analyze, the layout of the products displayed on the Rio Food website.

Source: Research Result (2023)

Figure 9. Association Rule Result Display

4. Conclusion

The website of online sales of frozen food on Rio Food stores based on a website using apriori algorithm can facilitate the shopping activities of costumers and store owners. In the results of calculating the a priori algorithm manually, 3 iterations were obtained showing Nuggets, Beef Sausages, Chicken Sausages, Beef Meatballs, Cheese Dumplings, and Chicken Dumplings product candidates that can be recommended for the efforts of one of the sales strategies to attract the interest of other costumers. And for a comparison of a priori algorithm and an eclat algorithm, it shows the results of each of its iterations contained in the products that appear on both algorithms.

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Author Contributions

Salwa Nabiila Pramuhesti proposed the topic; Salwa Nabiila Pramuhesti, Herlawati, and Tyastuti Sri Lestari conceived models and designed the experiments; Salwa Nabiila Pramuhesti, Herlawati, and Tyastuti Sri Lestari conceived the optimisation algorithms; Herlawati, and Tyastuti Sri Lestari analysed the result.

Conflicts of Interest

The author declare no conflict of interest.

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