


Optimization of Kaayana Store Inventory through Transaction Pattern Analysis Using the Apriori Algorithm

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Article Info	ABSTRACT
<p>Keywords: Inventory Optimization Apriori Algorithm, Transaction Patterns, Kaayana Store, Stock Management.</p>	<p>This study aims to optimize inventory management at Kaayana Store by analyzing sales transaction patterns using the Apriori algorithm. The transaction data collected shows that products with the codes ACC (accessories) and BJU (clothing) dominate purchases, accounting for 71.4% of total transactions. The analysis results identify a strong relationship between these products, which are frequently purchased together by consumers. Based on these findings, Kaayana Store needs to ensure the availability of ACC and BJU stocks to meet high demand, avoid stockouts, and improve operational efficiency. Proposed inventory management strategies, such as more precise product placement and bundling promotions, are expected to enhance customer satisfaction and support the sustainability of Kaayana Store's business.</p>
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INTRODUCTION

The availability of products that align with customer preferences is a crucial factor in maintaining customer satisfaction and loyalty. By analyzing sales transaction patterns, companies can identify the most frequently purchased products by consumers. This information can serve as a basis for optimizing inventory management, ensuring that the most in-demand products are always available (Harahap et al., 2021). This approach enables companies to effectively meet consumer needs, prevent stockouts that may reduce customer satisfaction, and simultaneously enhance operational efficiency and profit potential (Falakhi, 2023).

Kaayana Store, located at Jalan Proklamasi No. 7, Langkat Regency, sells clothing, accessories, snacks, and perfumes. The store frequently encounters overstock issues, where inventory exceeds demand, leading to increased storage costs and the risk of product damage and expiration. One possible solution is to utilize the Apriori algorithm, a data mining method, to analyze customer purchasing patterns. This analysis helps identify products that are often purchased together, allowing for more effective inventory management. By implementing this strategy, the store can reduce overstock, improve efficiency, and better meet customer needs.

Data mining is the process of using statistical, mathematical, artificial intelligence, and machine learning techniques to extract valuable information and knowledge from large databases. This process, also known as Knowledge Discovery in Databases (KDD), involves collecting and analyzing historical data to uncover patterns, regularities, or relationships

within extensive datasets (Erwansyah, 2019; Mulya et al., 2019; Nozomi, 2023; Pratama & Haerul Jaman, 2023). Fajar Adhinda Kusuma Wardani et al., in their research, also explain that data mining is an iterative and interactive process for discovering new patterns or models that are complete, useful, and comprehensible within massive databases (Wardani & Kristiana, 2020)

The Apriori algorithm, developed by Agrawal and Srikant in 1994, is a fundamental algorithm in data mining used to identify frequent itemsets in association rule mining. This algorithm detects patterns of relationships between items using two key metrics: support (the percentage of itemset occurrences within a database) and confidence (the strength of relationships between items). Apriori is utilized to uncover high-frequency patterns in data, enabling efficient identification of item associations (Hernawati, 2018; Hylenearti Hertyana et al., 2021; Madani et al., 2024; Sunarti et al., 2021).

Previous studies have demonstrated that the Apriori algorithm effectively analyzes purchasing patterns, optimizes inventory management, and enhances sales across various business sectors. A study by Anzas Ibezato Zalukhu et al., titled " Penerapan Algoritma Apriori untuk Optimasi Strategi Penjualan Berdasarkan Analisis Pola Pembelian di Torsa Cafe," identified consumer purchasing patterns, such as the frequent combination of Sanger Espresso, Avocado Cappuccino Torsa, and Kopi Susu Torsa. The findings provided insights for optimizing marketing strategies, stock management, and promotional activities, ultimately improving operational efficiency and the competitiveness of Torsa Café in a highly competitive market (Zalukhu et al., 2024). Another study by Bambang Sugito and Sri Wahyuni, titled " Optimasi Strategi Penjualan Am2000 Tirtamart Dengan Algoritma Apriori Untuk Mengidentifikasi Produk Favorit Pelanggan" highlighted the effectiveness of the Apriori algorithm in recognizing consumer purchasing patterns. This research identified a strong association between Water Softener and Filter Tank products, with a confidence level of 80.6% (Sugito & Wahyuni, 2024)

Other studies by Feny Rosalina Pare et al., Rika Perdana et al., and Arief Budiman et al. confirm that the Apriori algorithm is effective in analyzing sales patterns. The research conducted by Feny Rosalina Pare et al. utilized data mining to optimize product arrangement at BE-Mart based on item relationships, while Rika Perdana et al. identified purchasing patterns of bed sheets at H. Manti, facilitating stock management to ensure the availability of popular brands such as My Love and Divalinen. Arief Budiman et al. applied the Apriori algorithm to analyze vegetable purchasing patterns in an online store, providing strategic insights such as product bundling. Although challenges related to efficiency and rule complexity exist, the Apriori algorithm has proven to be a reliable tool for transaction data analysis in supporting marketing strategies (Budiman et al., 2024; Perdana & Meri, 2023; Rosalina Pare et al., 2023)

This study aims to analyze sales transaction patterns at Kaayana Store using the Apriori algorithm to identify products that are frequently purchased together. This information will be used to optimize inventory management, such as ensuring product availability, designing placement strategies, or creating bundling promotions to enhance operational efficiency and customer satisfaction.

METHODS

Research Stages

The following are the research stages conducted:

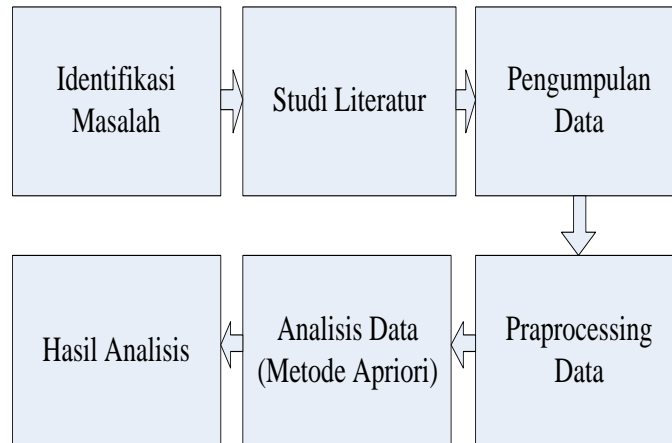


Figure 1. Research Stages

1. Problem Identification

The issues faced by Kaayana Store in menu and inventory management include overstock, where stock levels exceed demand, leading to increased storage costs and the risk of product damage or expiration. Inventory management is also not yet optimal due to the absence of customer purchase pattern analysis, making it difficult to determine which products should be prioritized. Without a deep understanding of customer preferences, stock management and marketing strategies become less efficient.

2. Literature Review

The researcher will gather theoretical references from various literature sources and research journals related to the Apriori algorithm, transaction patterns, and sales trends to support this study. The selected literature will be used to understand the fundamental theories of data analysis, particularly in identifying customer purchasing patterns and sales trends. By reviewing these studies, the researcher can strengthen the theoretical foundation, develop an appropriate analytical framework, and compare findings from previous research. This approach is expected to provide in-depth insights to develop more effective and practical solutions in addressing the challenges faced by Kaayana Store.

3. Data Collection

Data collection for this study is conducted by gathering sales transaction data from Kaayana Store, specifically focusing on transactions from December 2024 as the primary sample. The collected data includes information on purchased products, purchase time, quantity, and product types. The data collection process involves direct interviews with the store owner and employees to obtain relevant transaction data.

4. Praprocessing Data

After data is collected, the next step is data preprocessing, which includes removing duplicate data, handling missing values, and normalization. Duplicate data removal ensures that each transaction is recorded only once, while handling missing values involves filling in or removing incomplete entries. Normalization is performed to ensure that the data is in a consistent format and ready for analysis. This preprocessing stage ensures that the data used for analysis is clean, accurate, and capable of producing valid patterns.

5. Data Analysis

This study aims to analyze product sales data using the Apriori algorithm method. The process begins with selecting transaction data, followed by identifying item categories in each transaction. Then, the quantity of each item category is calculated, along with the support and confidence values for each itemset. The results of these calculations are used for further analysis to uncover sales patterns that can serve as a reference for making strategic decisions.

6. Analysis Results

The analysis results are obtained by applying the Apriori method to identify sales patterns emerging from transaction data. These patterns provide insights into products that are frequently purchased together, which can be used to optimize inventory management at Kaayana Store. By understanding these purchasing patterns, the store can manage stock more efficiently, ensure the availability of high-demand products, reduce the risk of overstock, and enhance customer satisfaction. Additionally, this analysis can support more effective marketing strategies and product placement.

Apriori Algorithm Method

The Apriori method is an approach used to address product sales pattern issues at Kaayana Store by utilizing the Apriori algorithm.

The following is the formula for the Apriori algorithm. (Zalukhu et al., 2024):

1. Rumus *Support*

Rumus *1-itemset* =

$$\text{Support } A = \frac{\text{Number of Transactions Containing } A}{\text{Total Transaksi}} \times 100\% \quad (1)$$

Rumus *2-itemset* =

$$\text{Support } A, B = \frac{\text{Number of Transactions Containing } A \text{ and } B}{\text{Total Transaksi } A} \times 100\% \quad (2)$$

2. Rumus *Convindence*

$$\text{Convindence } P(B|A) = \frac{\text{Support } A \text{ dan } B}{\text{Support } A} \times 100\% \quad (3)$$

RESULTS AND DISCUSSION

This study analyzes sales transaction data from Kaayana Store for the period of December 2024 using the Apriori algorithm to identify frequently occurring purchasing patterns. The selection of this period aims to ensure that the data is both representative and manageable.

The analysis results are expected to support better business decision-making and enhance inventory management at Kaayana Store.

Determining the Minimum Support Value

To analyze the minimum support and confidence values between one item and another, a series of transaction processing steps is required to generate an itemset list. This process begins with identifying transaction data, followed by calculating the frequency of each item's occurrence within the dataset. The minimum support value is applied to filter itemsets that meet the criteria, producing an initial itemset list. These itemsets are then used to form new combinations and evaluate relationships between items using confidence values, ultimately generating relevant and significant associative patterns.

Tabel 1. List of 1-Itemsets

No	Product_Code	Total_Transaction
1	ACC	14
2	BJU	28
3	CLN	9
4	HJB	11
5	KME	7
6	SPT	18
7	TAS	18
8	MKN	5
9	PFM	3

To calculate the support value for each product type, the following formula can be used:

$$Support A = \frac{\text{Number of Transactions Containing A}}{\text{Total Transaksi}} \times 100\%$$

From the formula above, the support value for each product can be determined as follows:

$$Support (ACC) = \frac{14}{35} \times 100\% = 40,00\%$$

$$Support (BJU) = \frac{18}{35} \times 100\% = 51,43\%$$

$$Support (CLN) = \frac{28}{35} \times 100\% = 80,00\%$$

$$Support (HJB) = \frac{18}{35} \times 100\% = 51,43\%$$

$$Support (KME) = \frac{9}{35} \times 100\% = 25,71\%$$

$$Support (SPT) = \frac{5}{35} \times 100\% = 14,29\%$$

$$Support (TAS) = \frac{11}{35} \times 100\% = 31,43\%$$

$$Support (MKN) = \frac{3}{35} \times 100\% = 8,57\%$$

$$Support (PFM) = \frac{7}{35} \times 100\% = 20,00\%$$

From the identified list of frequent 1-itemsets, the next step is to generate a list of candidate frequent 2-itemsets. By applying a minimum support value of 30%, itemsets that meet this criterion are selected, resulting in the final list, which is presented in Table 2 below.

Table 2. List of Candidate 2-Itemsets

No	Product_Code	Total_Transaction	Support
1	ACC	14	40,00%
2	BJU	28	80,00%
4	HJB	11	31,43%
5	SPT	18	51,43%
6	TAS	18	51,43%

The next step is to calculate the support for 2-itemsets using the following equation:

$$Support\ A, B = \frac{\text{Number of Transactions Containing A and B}}{\text{Total Transaksi A}} \times 100\%$$

From the formula above, the support value for each product pair can be determined as follows:

$$Support(ACC, BJU) = \frac{10}{35} \times 100\% = 32,26\%$$

$$Support(BJU, SPT) = \frac{8}{35} \times 100\% = 25,81\%$$

$$Support(ACC, HJB) = \frac{5}{35} \times 100\% = 16,13\%$$

$$Support(BJU, TAS) = \frac{9}{35} \times 100\% = 29,03\%$$

$$Support(ACC, SPT) = \frac{8}{35} \times 100\% = 25,81\%$$

$$Support(HJB, SPT) = \frac{9}{35} \times 100\% = 29,03\%$$

$$Support(ACC, TAS) = \frac{4}{35} \times 100\% = 12,90\%$$

$$Support(HJB, TAS) = \frac{4}{35} \times 100\% = 12,90\%$$

$$Support(BJU, HJB) = \frac{3}{35} \times 100\% = 9,68\%$$

$$Support(SPT, TAS) = \frac{6}{35} \times 100\% = 19,35\%$$

From the support calculation results for the 2-itemsets above, the itemsets with a minimum support above 30% are selected. These selected itemsets are then used to calculate the confidence values for each itemset, as presented in Table 3 below.

Table 3. Support 2-itemset

No	Product_Code	Total_Transaction	Support
1	ACC, BJU	10	32,26%

Determining the Minimum Confidence

The next step is to calculate the Confidence value of the candidate 2 items with the following formula:

$$Confidence\ P(B|A) = \frac{\text{Support A dan B}}{\text{Support A}} \times 100\%$$

$$Confidence\ (ACC, BJU) = \frac{10}{14} \times 100\% = 71,4\%$$

Next, after obtaining the confidence values for each itemset, association rules ($A \rightarrow B$) are generated by applying a minimum confidence threshold of 60%.

Table 4. Association Rules A → B

No	Rule	Quantity	Support	Confidence
1	{ACC} → {BJU}	10	32,26%	71,4%

Determining Association Rules

The association rules (A → B) derived from Table 4 are then further explained with additional details, as presented in Table 5:

Table 5. Description of Association Rules

No	Rule	Confidence	Description
1	{ACC} → {BJU}	71,4%	71.4% of purchases for products with the ACC category code will also include products with the BJU category code each month.

In Table 5, the purchasing pattern at Kaayana Store is dominated by products with the ACC and BJU category codes, accounting for 71.4% of total purchases. Therefore, Kaayana Store needs to ensure the availability of ACC and BJU products to meet high demand and prevent potential stock shortages in the upcoming month.

CONCLUSION

Based on the transaction pattern analysis using the Apriori algorithm at Kaayana Store, it was found that products with the ACC and BJU category codes dominate purchasing patterns, accounting for 71.4% of total transactions. This information indicates that these two categories have high demand and are customer favorites. Therefore, Kaayana Store needs to optimize inventory management by ensuring the availability of ACC and BJU stock to meet customer needs promptly, prevent stock shortages, and enhance operational efficiency. This strategy also has the potential to increase customer satisfaction and support business sustainability

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