Market Basket Analysis Using Apriori Algorithm: Identifying Consumer Purchase Patterns for Strategic Business Decisions

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Abstract

Market Basket Analysis (MBA) is a data mining technique used to discover association rules from transaction data, supporting the development of effective marketing strategies. This study applies the Apriori algorithm to transaction data from Maetala Café in Tarakan City during the period of October 2024 to January 2025. The Apriori algorithm efficiently identifies frequent itemsets and determines potential associations between purchased items based on minimum support and confidence thresholds. The data were processed using RStudio with the apriori algorithm, involving stages of data preprocessing, rule generation, and evaluation using support, confidence, and lift metrics. The results reveal that the strongest association rule is between Chicken Rice Salad and Mineral Water, with a support value of 4.11% and confidence of 68.13%, indicating a strong and consistent purchasing pattern. These findings suggest that consumers tend to purchase main dishes alongside mineral water as a complementary item. The identified association rules provide valuable insights for café managers in implementing cross-selling, designing bundled promotions, and optimizing product recommendations to increase sales performance.

Keywords: Algoritma Apriori, Data Mining, Market Basket Analysis, Assosiation Rules, R Studio.

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1. Introduction

The big data era and the development of information technology have given companies a lot of chances for effective manage, assess, and use data. Identifying consumer behavior trends and product interactions is crucial to improving operational effectiveness, developing more potent marketing plans, and strengthening a company's edge in its marketing area. Market Basket Analysis (MBA), which focuses on identifying links between items based on the customer buying behaviors, is one of the most frequently employed analytical techniques for this purpose. To find recurring patterns in transaction data, MBA commonly use algorithms based on association rules (Kanti & Indrajit, 2017). One data mining technique for finding association rules is Market Basket Analysis (MBA). To create sales strategies, it makes use of transaction data from a store. Identifying items that customers frequently purchase together is the primary objective of this study. Minimum support and confidence criteria are used to define associations in MBA programs (Rizaldi & Adnan, 2021). Marketers frequently use the Market Basket Analysis (MBA) strategy, especially when performing undirected data mining analysis. Product association analysis, another name for MBA, produces what are known as association rules (Nafi et al., 2023).

Understanding how customers shop in the context of cafes, which have become an essential element in modern lifestyles, offers both enormous opportunities and challenges. Cafes are places to socialize, work, or just unwind in besides providing places to eat and drink. This sector's rapid rise has prompted the Data-driven strategies are required to create more individualized client experiences. Cafe operators can find buy patterns through transaction data analysis, which they can then use to merge promotions, offer personalized menu recommendations, and improve inventory control (Wijayanti, 2017).

Analyzing transaction data has become crucial for comprehending customer purchasing patterns in coffee shops. Discovering connections between menu items or products that are commonly purchased together might be aided by the Apriori algorithm. Cafe users may use this information to create more successful marketing campaigns, such as menu package deals, well-placed products, or menu suggestions based on customer feedback. Managers may use MBA techniques to simultaneously evaluate consumer buying patterns, yielding insights that can be applied to the design of data-driven marketing strategies (Kanti & Indrajit, 2017).

Association rules are a data mining technique used to determine relationships between items in a dataset (Wijayanti, 2017). This method enables it possible to identify the products that customers most often buy together, offering insightful information to develop relevant marketing campaigns. Internal and external variables impact consumer behavior, which includes human behaviors in evaluating, selecting, purchasing, and utilizing goods or services. This study is new since it applies the Apriori algorithm specifically to coffee shops, a topic that hasn't been thoroughly investigated in earlier research. By integrating data mining techniques and consumer behavior analysis, this research provides insights into the local

preferences and consumption habits of cafe shop customers. Unlike traditional applications in large-scale retail sectors, this study focuses on small to medium-sized businesses, resulting in practical recommendations for menu management and marketing strategies. By the integration of customer behavior analysis and data-driven insights, this study aims to support the creation of relevant effective cafe shop marketing strategies. This approach gives entrepreneurs useful advice on how to use basic technologies to improve their competitive edge (Pitoyo & Suhartono, 2018).

The importance of the MBA method in this research lies in its ability to generate marketing strategies based on consumer purchase patterns. marketing strategy increasingly require large amounts of information to better understand client needs, which raises the question of choosing the right marketing strategy to better fit consumer expectations (Rosário & Raimundo, 2021). By understanding purchase behavior patterns, business owners can improve marketing efficiency and deliver a more personalized customer experience. The results of this study are expected to contribute to designing effective, data-driven marketing strategies relevant to customer needs.

2. Literature Review

2.1 Data Mining

Data mining is the process of searching for or discovering patterns or information within selected data using specific techniques or methods. It helps extract important information from databases. Data mining explores data to uncover hidden patterns, seeking predictive information from databases. Its implementation can assist in addressing and resolving existing problems, thereby simplifying the process of classifying data (Tarigan & Simatupang, 2023). Implementing data mining can predict promotional itemsets in a mobile phone store, identifying which products are preferred by consumers and which are not (Sharif, 2019). Data mining is a new concept & an exploration and analysis of large data sets, in order to discover meaningful patterns and rules (Hilage & Kulkarni, 2011). stated that IE merger rule mining, a data mining technique, is offered as an additional strategy for analyzing consumer behavior and boosting sales.

2.2 Market Basket Analysis

Market Basket Analysis (MBA) is a data analysis technique used to understand consumer purchasing behavior based on transaction data. MBA examines consumer habits to determine which products are purchased and which ones are frequently bought together by identifying relationships among various items placed in the shopping cart (Ashari et al, 2022). Using a market basket analysis method to see the association (rules) between a number of sales attributes and determine the pattern of relationships in the transactions that occur (Nurmayanti et al, 2021)

The goal of Market Basket Analysis is to enhance the effectiveness of promotion and sales techniques. A data-driven system is used to analyze buyer behavior

patterns and preferences to boost sales by leveraging existing customer or sales data (Pradana et al, 2022). Conducted a study analyzing sales transaction data using Market Basket Analysis with the Apriori algorithm to identify associations between items based on customer shopping habits (Elisa, 2018). market basket analysis on Google trend data in the context of women's entrepreneurship that uncovers hidden relationships between items (Semerci et al, 2022), sales of these products will increase and supermarket revenue will increase directly (Kaur & Kang, 2016).

2.3   Association Rule

Association Rule is a method in data mining used to identify relationships between items in transaction data using statistical techniques. Association rule mining is a data mining method that examines a large transactional database to determine which items are most fre- quently purchased jointly (Cil, 2012). Association Rule focuses on finding relationships among items, often expressed in "if-then" patterns, such as "if A, then B and C." To determine association rules, support and confidence values are used to evaluate whether a rule is significant or not (Jadhav et al, 2023).

As demonstrated in (Rouza, 2021) study, consumer purchasing patterns at Wahdana Mall resulted in three association rules. First, purchasing overall and gamis tends to be followed by purchasing tunik. Second, purchasing gamis and tunik leads to purchasing overall. Third, purchasing tunik and overall is followed by purchasing gamis, with respective support and confidence levels identified in the analysis. Many resources, especially memory and processing engines, are necessary for the task of identifying unknown association rules from large data. (Verma et al, 2020), sales of these products will increase and supermarket revenue will increase directly (Ünvan, 2021).

2.4   Algoritma Apriori

The Apriori algorithm is used to find frequent itemsets to derive association rules (Rauch & Šimůnek, 2017). As its name suggests, this algorithm leverages prior knowledge of frequent itemset properties to process incoming information. This algorithm begins by generating candidate itemsets and calculating their support to identify itemsets that meet the minimum support threshold (Kumar et al, 2024). Apriori algorithm, which has been usually used for the market basket analysis, was used for analyzing a diabetic database (Duru, 2005) Apriori Algorithm is applied in this for mining frequent products sets and relevant Association rule (Arora et al, 2022). The Apriori algorithm is also applied to identify customer behavior patterns from transaction data (Kurniawanet al, 2018). As a part of data mining, it processes historical data to discover patterns of regularity and relationships within the data.

3. Research Methodology

3.1 Collect Data

Data collection from the database of sales transactions at Maetala Cafe in Tarakan City with historical sales data from October 2024 to January 2025 (four months), observational data on the transaction process, and general company information. Relevant details such as the date and detailed description of transaction items and groups of items purchased are recorded in the recommended method so that the desired model can be refined and analyzed (Kumar et al, 2024).

3.2 Data Preprocessing

Following data collection, transactions with a single item are eliminated, and the data is preprocessed and formatted into an analysis-ready structure. To make sure the data is correct and suitable for analysis, this procedure entails data transformation, integration, and cleansing. To increase efficiency, dimensionality may be decreased and categorical data encoded. This process also entails separating the data for assessment and, if required, including more data sources to improve the dataset.

3.3 Data Analysis

This phase focuses on identifying, selecting, and enriching relevant attributes from the preprocessed data. By carefully selecting attributes such as customer preferences, purchase history, and product details, the module transforms the data into a format that provides meaningful insights for recommendation and optimization algorithms. Confidence values are calculated for each rule, and rules meeting the confidence threshold are selected (Bhimavarapu et al, 2023).

3.4 Association Rule

Association rule forms the central component of market basket analysis. During this phase, utilize algorithms like Apriori, on the preprocessed data to uncover frequent itemsets and establish association rules. Once a collection of association rules is generated, the subsequent task is to assess and choose the most relevant and actionable rules. This entails the application of various metrics, including support, confidence, and lift, to gauge the significance and robustness of each rule. Support -Measures the proportional frequency of an item in the database (Kumar et al, 2024) The support value of an item is determined through the application of the following equation 1:

$$\text{Support(A)} = \frac{\text{Number of Transaction A}}{\textit{Total} \text{ Number of Transaction}}$$

The support value of A → B, where A determines the preceding term and B determines the following term. Support (A → B) is defined by the probability that both A and B are contained in the itemset. It is measured using the equation 2:

$$\text{Support (A-B)} = \frac{\text{Number of Transaction A\&B}}{\textit{Total} \text{ Number of Transactions}}$$

Confidence – Confidence (A → B) is defined by the probability of the itemset containing A contains B at the same time. Which implies quantifying the confidence in the occurrence of one event given another. It is measured using the equation 3:

$$\text{Confidence (A-B)} = \frac{\text{Probability (A\&B)}}{\text{Support (A)}}$$

Lift - A measure that determines whether the probability of an event B increases or decreases given event A. Association Rule analysis consists of two stages (Han, Pei, & Tong, 2022) It is defined by the possibility of including B under the condition of A and the possibility of including B without this condition. It is measured using the equation 4:

$$\text{Lift (A-B)} = \frac{\text{Confidence (A$-$B)}}{\text{Support (B)}}$$

3.5   Apriori Algorithm

The framework is the Apriori method, which is used to extract common itemsets and association rules from the provided data. To find itemsets that satisfy the minimal support threshold, this technique first generates candidate itemsets and then determines their support. Products that are often bought together are portrayed by these frequent itemsets, which serve as the foundation for optimization and tailored product suggestions. The relationships between goods are captured by mining association rules, which offer important insights into consumer preferences. The suggestions are further refined by the algorithm's lift and confidence calculations, which guarantee their correctness. The Apriori algorithm is essential for improving the shopping experience and boosting sales since it is constantly changing in real time (Kumar et al, 2024)

Based on the requirement that all subsets of the frequently recurring object set must likewise be composed of frequently repeating sets, the Apriori algorithm employs an iterative process. First, sets with a single element are commonly repeated. L1 (often recurring 1-element set) is the name of this set. L2 (a repeating 2-element cluster) is obtained from L1. To identify the most repeating sets that may be acquired, the method iteratively works. To locate frequently recurring items, the database is repeatedly searched; these scans contain elements related to the concatenation, pruning, and minimum support criteria of the Apriori method. Both a minimum predefined value of support and association rules above a confidence value are in place (Giudici, 2005).
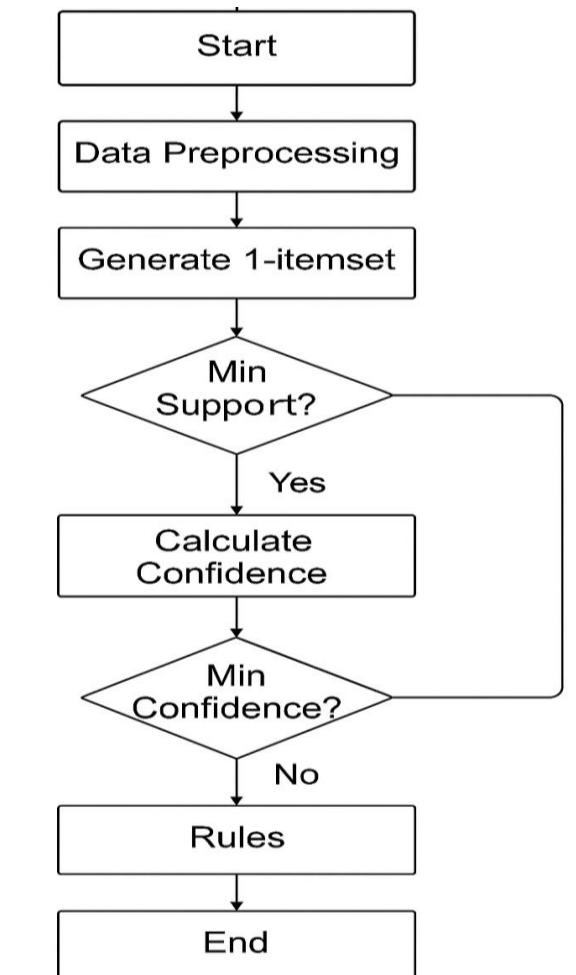
Figure 1: Research *Flowchart*

4. Results and Discussion

This research data was obtained from the Maetala Cafe sales database in Tarakan City, with a total of 10,609 transactions during the period from October 2024 to January 2025. The details of transactions per month are as follows: October had 3,766 transactions, November had 2,127 transactions, December had 2,262 transactions, and January had 2,454 transactions. The distribution of monthly transactions shows seasonal variations in consumer purchasing behavior.
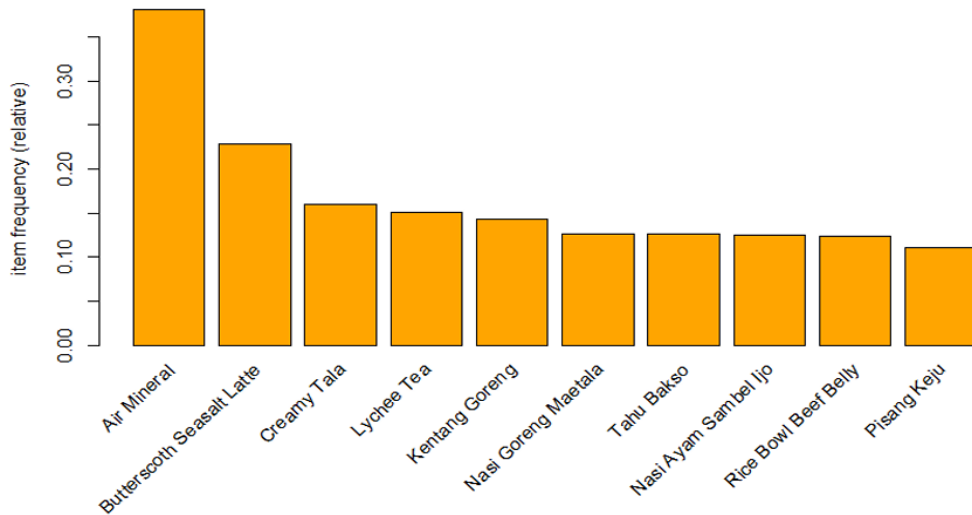
Figure 2 : Item Frequency Chart

According to Figure 2, the 10 items with the highest purchase frequency can be seen. The dominance of Air Mineral (Mineral Water) indicates that this beverage is a primary complementary item in almost every transaction, reflecting the general consumption pattern of consumers who always choose water as an accompaniment to food. Butterscotch Seasalt Latte ranks second, indicating that this specialty beverage has high consumer appeal despite being classified as a premium beverage. This opens up opportunities for bundling promotions with snacks. Snack products Kentang goreng (French Fries), Tahu Bakso (Tofu Meatballs), Pisang Keju (Cheese Bananas) and main meals Nasi Goreng Maetala (Maetala Fried Rice), Rice Bowl Beef Belly, Nasi Ayam sambel Ijo (Chicken Rice with Green Chili Sauce) have a relatively balanced distribution, indicating that consumers are divided between preferences for snacks and main meals. Sweet beverage products (Creamy Tala, Lychee Tea) have a significant contribution, indicating that there is a consumer segment that tends to choose beverage variations other than Air Mineral (Mineral water).

Table 1: Top 10 Assosiation Rule

No	lhs	rhs	Support	Confidence	Coverage	Lift	Count
1	Nasi Ayam Lalap	Air Mineral	0.04109718	0.6812500	0.06032614	1.789399	436
2	Rice Bowl Ayam Chile Padi	Air Mineral	0.02488453	0.6769231	0.03676124	1.778033	264
3	Nasi Ayam Sambel Ijo	Air Mineral	0.08389104	0.6742424	0.12442266	1.770992	890
4	Nasi Lada Hitam	Air Mineral	0.04948629	0.6379101	0.07757564	1.675560	525
5	Nasi Goreng Maetala	Air Mineral	0.07974361	0.6327599	0.12602507	1.662033	846
6	Mie Goreng Maetala	Air Mineral	0.04835517	0.6302211	0.07672731	1.655364	513
7	Sate Taichan	Air Mineral	0.05514186	0.6290323	0.08766142	1.652241	585
8	Rice bowl Beef Belly	Air Mineral	0.07776416	0.6264237	0.12413988	1.645390	825
9	Mie Kuah Beef Belly	Air Mineral	0.03129418	0.6240602	0.05014610	1.639182	332
10	Tahu Cabe Garam	Air Mineral	0.05485908	0.5324794	0.10302573	1.398632	582

The table above shows the ten association rules with the highest support, confidence, and lift values. All rules have the same form, namely food products on the left-hand side (lhs) and Air Mineral (Mineral Water) on the right-hand side (rhs). This shows that Air Mineral (Mineral Water) consistently appears as a consequence in consumer purchasing patterns. Support shows the proportion of transactions containing that product combination. For example, the first rule {Nasi Ayam Lalap} => {Air Mineral} has a support of 0.0411, meaning that approximately 4.11% of total transactions contain both products. Confidence represents the probability of consumers buying Air Mineral (Mineral Water) after purchasing the lhs product. The highest value is found in the first rule at 68.13%, which means that more than two-thirds of consumers who buy Nasi Ayam Lalap also buy Air Mineral (Mineral Water). Lift measures the strength of the association between lhs and rhs compared to random purchases. All rules have a lift value > 1, with the highest value in the first rule at 1.78, indicating a strong positive relationship. Coverage indicates the proportion of transactions that contain lhs. For example, 6.03% of all transactions contain Nasi Ayam Lalap. Count shows the absolute number of transactions that meet the rule. The first rule appeared in 436 transactions, while the rule with the highest number appeared in {Nasi Ayam Sambel Ijo} with 890 transactions.

The products that most frequently appear in the rules with high support and confidence are Nasi Ayam Lalap, Nasi Goreng Maetala, dan Nasi Ayam Sambel Ijo, all of which are main dishes. A consistent lift value above 1.3 indicates that the association between food products and Air Mineral (Mineral Water) is not coincidental, but rather a real purchasing pattern. Products such as Tahu Cabe Garam show a lower confidence value (53.2%) but remain significant in the association, making them potential candidates for secondary promotional combinations. These findings reinforce the role of Air Mineral (Mineral Water) as a key complementary product, enabling it to be used as an anchor in bundling strategies. Menus with high confidence can be automatically paired with Mineral Water in the system or promotional packages to enhance marketing efficiency and consumer experience.
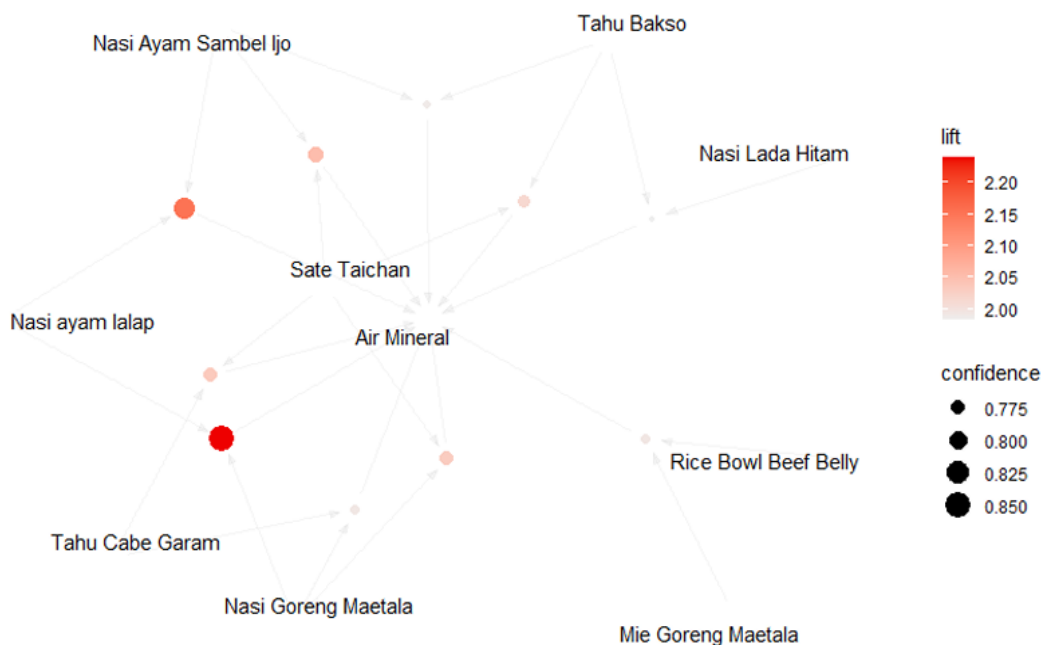
Figure 3: Visualization Assosiation Rule

The figure above shows the relationship between products based on the lift value (represented by shades of red) and confidence (indicated by the size of the circle). Connected products indicate a strong relationship in consumer transactions, which can be used as a basis for cross-selling strategies. Air Mineral (Mineral Water) acts as a hub product connected to various main dishes such as Nasi Goreng Maetala, Nasi Ayam Sambel Ijo, Rice Bowl Beef Belly, dan Sate Taichan. This reinforces the previous finding that Air Mineral (Mineral Water) is the main accompaniment to heavy meals. Tahu Cabe Garam has a very strong association with other products, as seen from the intense red color (lift > 2.20). This means that consumers who buy this product tend to buy other products with a higher probability than random purchases. The highest confidence (indicated by the largest circle) is found in the association between main dishes and Air Mineral (Mineral Water), indicating high consistency

among consumers in choosing this combination. Products such as Sate Taichan and Nasi Ayam Lalap also show a significant connection with Air Mineral (Mineral Water), reflecting consumer preferences in combining spicy/flavored menus with neutral drinks. This network visualization helps cafe management understand which products serve as anchors (main products that trigger other purchases) and which serve as complementary items.
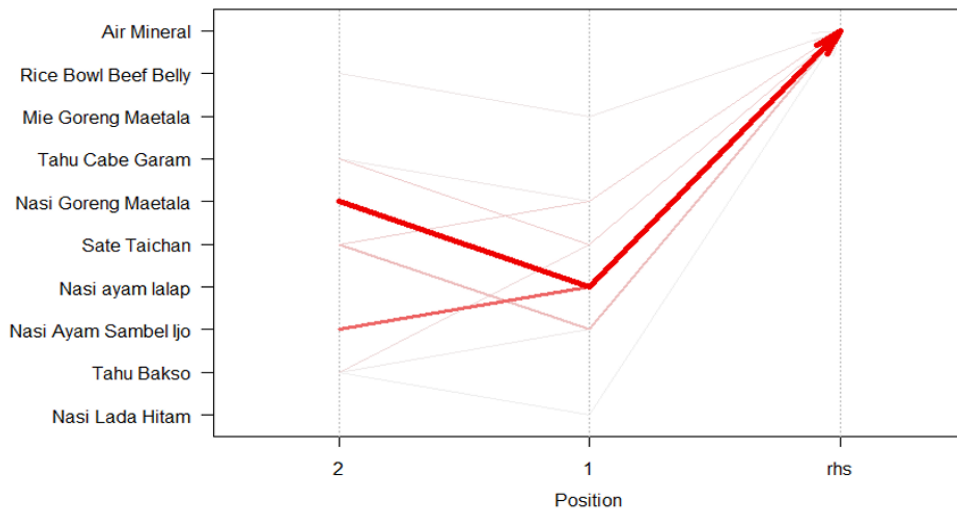
Figure 4: Parallel Coordinates Plot For 10 Rules

The figure shows a representation of association rules by displaying the relationship between the lhs (left-hand side / itemset on the left) and the rhs (right-hand side / itemset on the right). Each line represents one association rule, where the thickness of the line indicates the strength of the rule (support, confidence, and lift). Almost all of the rules in this graph lead to Air Mineral (Mineral Water) as the product on the right-hand side (rhs). This reaffirms that Air Mineral (Mineral Water) is the product that most consistently appears as a consequence in association rules. Products such as Nasi Goreng Maetala, Nasi Ayam Lalap, Sate Taichan, Rice Bowl Beef Belly, dan Tahu Cabe Garam often appear on the left side (lhs), indicating that these menu items are the main triggers for purchasing Air Mineral (Mineral Water). The thicker lines (marked in dark red) indicate rules with higher confidence and lift, for example, the combination of Nasi Goreng Maetala → Air Mineral (Mineral Water). Cafes can set Air Mineral (Mineral Water) as the default pairing product for each main menu item. This pattern indicates consistent consumer preferences, allowing for the integration of automated cross-selling strategies into the system. For example, when a customer selects Nasi Goreng Maetala or Rice Bowl Beef Belly, the system can automatically recommend a package with Air Mineral (Mineral Water). This data also supports simple bundling strategies with low additional costs but the potential to increase customer satisfaction and revenue.

5. Conclusion and Recommendations

5.1   Conclusion

The results of the single-item association rule analysis show that there is a consistent purchasing pattern between main meals/snacks and mineral water as the main consequent product. All rules show a lift value above 1.3, which means that the purchase of mineral water does not occur randomly, but is a real consumption pattern. These findings confirm that mineral water is a major complementary product that appears in almost all main meal purchase combinations. Pattern 1 lhs →1 rhs shows a direct and strong purchasing relationship between the main item Like Nasi Ayam Lalap and Air Mineral (Mineral Water). This information is very useful for designing quick marketing strategies, direct promotions, and sales optimization at the point of transaction, without the need for complex item combinations so that sellers can create special bundling offers at discounted prices. By creating these bundles, customers may be attracted to buy more products, increasing sales and reducing the risk of running out of popular products. Thematic promotions can also be launched to link these products in a special way. With this marketing strategy, companies can provide added value to customers through relevant and attractive offers, while increasing overall product visibility and sales.

5.2   Recommendations

Based on the findings of the single-item rules, the strategic recommendations for businesses are as follows:

First, Simple Menu + Beverage Bundling, Menus with high confidence in mineral water (e.g., Nasi Ayam Lalap and Rice Bowl beef belly) can be made into simple economy packages with mineral water as a standard accompaniment. This will increase sales per transaction and simplify consumer decision-making.

Second, Beverage Stock Planning, Since Mineral Water consistently appears on receipts, planning Mineral Water supplies can be prioritized to avoid stock shortages during peak hours or days with high transaction volumes.

Third, Additional Sales Promotions (Upselling), For customers who select one of the main items but have not chosen a beverage, cashiers or the application system can proactively offer Mineral Water using a light upselling approach

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