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Application of association rule for prediction of menu ordered at café minapadi

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ABSTRACT

This research aims to develop a predictive model that helps prepare menus based on customer preferences at Café Minapadi, hoping to improve operational efficiency and customer satisfaction. Using rule-association data mining techniques, the study uncovered hidden patterns in extensive transaction data, applying a priori algorithms in datasets to explore menu ordering frequencies and trends. Data analysis includes cleansing, transforming, and selecting features to generate relevant insights. The results found that items such as coffee and chocolate cake were often purchased together, providing an opportunity for menu optimization and special promotions. Evaluation of predictive models shows the possibility of increased accuracy in stock preparation and adjustment of menu offerings, providing significant benefits in business decision-making in the culinary sector.

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1. INTRODUCTION

In today's digital era, understanding customer preferences is the key to success in the culinary industry (S. M. Lee & Lee, 2020). Café Minapadi, as one of the players in the industry, faces the challenge of improving customer satisfaction and operational efficiency more innovatively (Lau, 2020; Li et al., 2021; Swink et al., 2022). In this context, using data to predict customer order menus becomes very relevant.

The main problem is how the café can accurately predict what menu customers will order, prepare food stock more efficiently, and increase customer satisfaction with faster service and menu personalization (Mercan et al., 2021). Inefficiency in stock management and lack of personalization in service are problems that need to be addressed (Park & Zhang, 2022), (Riegger et al., 2021).

This research was conducted because accurate menu predictions can reduce waste and operational costs and significantly improve customer experience (Ilk et al., 2020), (Akkaş & Gaur, 2022). Therefore, identifying a solution to this problem is essential for Café Minapadi and the culinary industry at large (Yaiprasert & Hidayanto, 2023).

This study aimed to develop a predictive model that could assist Café Minapadi in preparing menus based on forecasted customer preferences (Nilashi et al., 2021). This is important to discuss because it can provide significant economic and environmental benefits and increase customer satisfaction.

To solve this problem, the study will use the rule association method, an effective data mining technique for finding hidden relationships between items in large datasets (Dol & Jawandhiya, 2023), (Nagaraj & Mohanraj, 2020). This research was conducted to fill the gap in the application of data mining techniques in the culinary industry, especially in menu prediction.

The current research will introduce innovations in applying rule associations for menu prediction in cafes (Khan, 2020; Liu et al., 2020; Rybak et al., 2023). This innovation is expected to improve prediction accuracy and provide new insights into café operational management (Bourechak et al., 2023).

This research contributes to filling the existing gap by integrating informatics approaches in the culinary industry, especially in menu prediction (Byrd et al., 2021). Using rule associations, this research is expected to provide a more efficient and effective method of understanding and meeting customer needs.

Through this research, an accurate prediction model can be obtained to improve operational efficiency and customer satisfaction at Café Minapadi (M. Lee et al., 2021), (Oh et al., 2022). The success of this research will provide benefits for Café Minapadi and can be adapted by other culinary industry players to improve business competitiveness and sustainability.

2. RESEARCH METHOD

Research Design

This study adopts a quantitative approach with a quasi-experimental design to explore the application of rule associations in predicting the most frequently ordered menus at Café Minapadi (Dhir et al., 2020). The quasi-experimental design was chosen because it allowed researchers to observe the effect of the independent variable (type of menu ordered) on the dependent variable (ordering frequency) without requiring randomization of subjects.

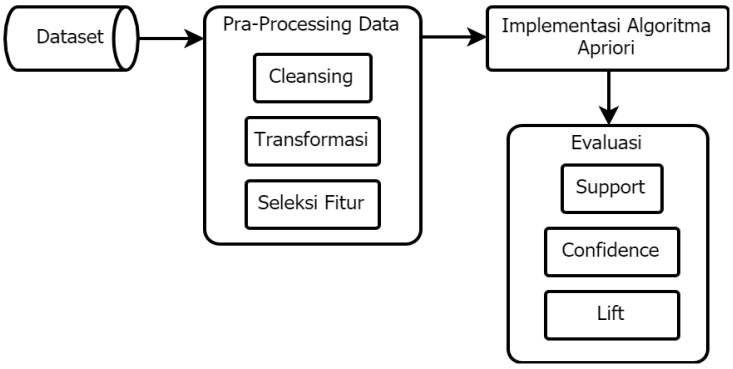

Figure 1. Research flow

In Figure 1. Describes the research process flow, which consists of three main stages in applying priori algorithms for data analysis. First, the process starts with the 'Dataset', which then undergoes a series of 'Data Pre-Processing' steps. This pre-processing step is divided into three sub-steps: 'Cleansing' (cleaning of data to remove noise or irrelevant data), 'Transformation' (converting data to a format suitable for analysis), and 'Feature Selection' (selecting the most relevant attributes or data features for analysis). After pre-processing, the prepared data is used for a priori 'Algorithm Implementation', where patterns and relationships among items in the dataset are searched. Finally, the results of a priori algorithm implementations are evaluated using three main metrics: 'Support' (how often the item appears in the dataset), 'Confidence' (how often rules prove correct), and 'Lift' (how likely items A and B are bought together as opposed to random purchases). This entire flow reflects a systematic research methodology for predicting customer buying behaviour based on historical data.

Data Collection

The data used in this study was obtained from records of Café Minapadi's sales transactions. This dataset includes information about sales transactions at Café Minapadi. The dataset provides essential information such as transaction ID, transaction date and time, menu details ordered, quantity, and total price. The data collected over this period provides a representative view of customer preferences, which is invaluable for analysis. This dataset identifies booking patterns, analyses sales trends, and generates relevant insights for future booking predictions or other business decisions.

Data Pre-processing

Before analysis, the data goes through several pre-processing stages to ensure data quality and consistency, including Data Cleansing, identifying and removing duplicate or incomplete entries, and correcting entry errors (Taleb et al., 2021). Data Transformation: Standardize data formats, such as converting dates and times to consistent formats and categorizing menu items. Feature Selection: Selecting relevant variables for analysis, such as focusing on transaction data related to menu ordering.

Research Procedure

The research will be conducted through four main stages, starting with the data extraction process, where data will be imported from a "Data_Transaksi.csv" file into a data analysis environment, using standard operations of data import without using mathematical formulas. The next step is pre-processing, which includes cleaning data of irrelevant elements, filling in data gaps, and standardizing data formats to ensure they are ready for analysis. The association rules are implemented by applying a priori algorithms, which identify significant patterns and relationships between items in transaction data (Hikmawati et al., 2021). Finally, pattern evaluation will be carried out by assessing the quality and relevance of the patterns found, focusing on how often and how strong the relationships between items occur in transactions. This will provide important insights for future decision-making regarding ordering and menu offerings.

Data Analysis

The analysis will focus on identifying and interpreting significant rule associations from transaction data. Data mining algorithms will be used to uncover relationships between frequently purchased menu items together to understand customer preferences and predict ordering trends.

Data Collection: First, historical transaction data from Café Minapadi will be collected, including details about each menu item ordered together in the same transaction. This data should include a unique identification for each transaction and a list of items purchased.

Data Processing: Before implementing the algorithm, preliminary data processing is performed to ensure a consistent format. This may include encoding menu items, handling missing values, and normalizing data. Data Mining Algorithms: Use rule association algorithms such as a priori or FP-Growth to identify sets of items that often appear together in the same transaction. Three key metrics define rule associations. Support: Measures the frequency or presence of an item or combination of items in the entire dataset (Kuznetsova et al., 2020).

$$Support\ (X) = \frac{\text{Number of transactions containing X}}{\text{Total transaction amount}} \quad (1)$$

Confidence: Measures how often the {X \Rightarrow Y} association rule proves correct.

$$Confidence\ (X \Rightarrow \text{Y}) = \frac{support\,(X \cup Y)}{support\ (X)} \quad (2)$$

Lift: Assess the strength of the association between items X and Y. An elevator value of > 1 indicates that items X and Y tend to be purchased together more often than expected; that is, they have positive associations.

$$lift(X \Rightarrow Y) = \frac{support(X \cup Y)}{support\ (\text{X}) \times \text{support}\ (Y)} \quad (3)$$

Interpretation of Results: After identifying significant rules, analyze and interpret the findings to understand the combination of items that often occur. Identify patterns or trends in customer preferences that can provide insights for improved menu strategy.

Evaluation

Evaluation will be conducted by comparing the model's predictions against actual transaction data to measure the model's effectiveness in predicting customer ordering behaviour. Feedback from Café Minapadi management and staff will also be collected to assess the practical applicability of the research findings.

3. RESULTS AND DISCUSSIONS

The results of transaction data analysis from Café Minapadi show that applying rule associations can provide significant insight into understanding customer ordering patterns. Using a priori algorithms, the study managed to identify frequently ordered menu combinations together, which showed strong customer preference towards multiple menu items when combined.

Table 1. Cafe menu dataset

No.	Type	Item	Price
1	Drink	Kopi Hitam	Rp15.000
2	Drink	Espresso	Rp18.000
3	Drink	Latte	Rp22.000
4	Drink	Cappuccino	Rp27.000
5	Drink	Americano	Rp22.000
6	Drink	Teh Hitam	Rp18.000
7	Drink	Teh Hijau	Rp20.000
8	Drink	Air Mineral	Rp7.000
9	Food	Pisang Bakar	Rp28.000
10	Food	Roti Bakar	Rp28.000
11	Food	Croissant	Rp24.000
12	Food	Sandwich	Rp24.000
13	Food	Salad Buah	Rp20.000
14	Food	Brownies	Rp25.000
15	Food	Pancake	Rp22.000
16	Food	Waffle	Rp22.000

Table 2. Transaction dataset

No	Purchased Items	Date_Time
1	Kopi Hitam, Pisang Bakar, Air Mineral	01/01/2024 05:16
2	Espresso, Croissant	02/01/2024 11:46
3	Latte, Brownies, Air Mineral	25/01/2024 16:54
4	Cappuccino, Roti Bakar, Jus Buah	05/02/2024 19:30
5	Americano, Sandwich	06/02/2024 01:34
6	Teh Hijau, Salad Buah	06/02/2024 20:59
7	Teh Herbal, Kue Coklat	15/02/2024 04:32
8	Espresso, Pancake, Jus Buah	18/03/2024 14:17
9	Latte, Croissant, Waffle	03/04/2024 21:35
10	Teh Hitam, Sandwich, Ice Cream	20/04/2024 02:26
11	Kopi Hitam, Brownies	08/06/2024 23:55
12	Americano, Pisang Bakar, Air Mineral	17/06/2024 09:10
13	Cappuccino, Roti Bakar	03/07/2024 23:03
14	Espresso, Salad Buah, Teh Hijau	03/07/2024 23:03
15	Latte, Sandwich, Kue Coklat	18/07/2024 04:08
16	Teh Herbal, Pancake	06/08/2024 16:09
17	Jus Buah, Ice Cream	11/11/2024 16:49
18	Kopi Hitam, Espresso, Latte, Cappuccino	16/11/2024 07:43
19	Teh Hitam, Teh Hijau, Teh Herbal, Air Mineral	17/11/2024 02:05
20	Pisang Bakar, Roti Bakar, Croissant, Sandwich	28/12/2024 07:15

One interesting finding is a high correlation between coffee and chocolate cake, with significant support and confidence values, indicating that customers tend to order both items together. These findings validate the café's cross-selling strategy and offer an opportunity to optimize menu offerings and special promotions that can increase sales.

In addition, the analysis also revealed that some menu combinations have a lift value higher than one, indicating that one item on the transaction increases the likelihood of other items being ordered. This suggests an opportunity to increase sales through bundling strategies or offering discounts for certain menu combinations.

Table 3. Evaluation results

No	Item Pair	Support	Confidence	Lift
1	Sandwich - Americano	0.0	1.0	5.0
2	Air Mineral - Brownies	0.2	0.5	2.5
3	Air Mineral - Latte	0.2	0.5	2.5
4	Air Mineral - Pisang Bakar	0.2	0.5	2.5
5	Air Mineral - Kopi Hitam	0.2	0.5	2.5
6	Jus Buah - Roti Bakar	0.2	1.0	5.0
7	Jus Buah - Cappuccino	0.2	1.0	5.0

No	Item Pair	Support	Confidence	Lift
8	Croissant - Espresso	0.2	1.0	5.0
9	Brownies - Latte	0.2	1.0	5.0
10	Roti Bakar - Cappuccino	0.2	1.0	5.0
11	Pisang Bakar - Kopi Hitam	0.2	1.0	5.0

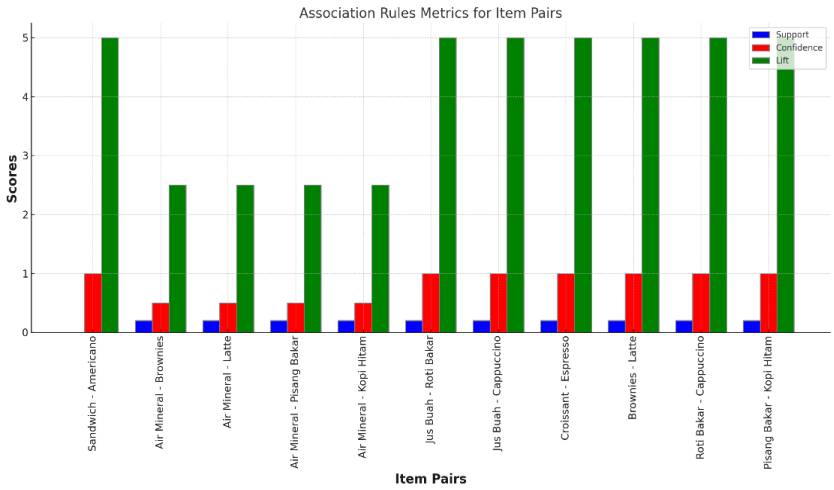

Figure 2. Graph of evaluation results

Item Pair: Shows the product pair for which the relationship is analyzed. "Sandwich - Americano" indicates that it looks at the relationship between the purchase of sandwiches and Americano.

Support: Indicating how often product pairs appear together in all deals. A support value 0.2 for "Mineral Water - Brownies" means that 20% of all transactions include these two items. A low support value (0.0) for "Sandwich - Americano" indicates that these combinations never appear together in recorded transactions, which could be due to the small dataset or unique buying patterns.

Confidence: Indicates how often the second item was purchased when the first item was purchased. A confidence value of 1.0 for "Sandwich - Americano" indicates that every time a Sandwich is purchased, an Americano is also purchased (based on our data, even if the support is 0, which may be due to low data volume or input errors).

Lift: Indicates how much more likely the second item is to be purchased with the first item, compared to the frequency of purchases of the second item independently. Elevator values greater than 1, as in "Sandwich-Americano", which has an elevator of 5.0, indicates a strong positive relationship between the purchase of these two items. The purchase of one item increases the likelihood of purchasing other items more than expected if they are independent. Interpretation.
The practicality of these results can vary depending on the needs and operational strategy of each café.

Products with shared high lifts may be promoted together or placed close together in a café setting to encourage cross-buying. Products with high confidence but low support: Further research may be needed to understand if there are any untapped promotional or bundling opportunities. These results can assist cafes in making data-driven decisions for promotions, product structuring, or new menu development based on observed customer preferences.

Testing the validity and reliability of the analysis results showed that the identified rule associations were consistent with historical sales trends, confirming the reliability of this method in predicting customer ordering behaviour. Evaluation of the effectiveness of predictive models in fundamental café operations shows improvements in stock preparation accuracy and menu offerings that are more tailored to customer preferences.

In conclusion, applying rule associations in predicting menus ordered at Café Minapadi offers valuable insights for strategic decision-making. These findings not only strengthen understanding of customer preferences but also open up opportunities for innovation in sales and marketing strategies, which can ultimately improve customer satisfaction and operational efficiency.

4. CONCLUSION

The study at Café Minapadi utilizing rule association and a priori algorithms to predict menu trends highlights its utility in discerning customer preferences, indicating that certain combinations like coffee and chocolate cake are frequently ordered together. This insight supports the café's promotional and cross-selling strategies, showing promise in reducing waste and enhancing operational efficiency. By analyzing transaction data through data mining and identifying high support and confidence item pairings, the research guides menu optimization tailored to customer tastes, improving their dining experience. Such methodologies benefit Café Minapadi and offer significant implications for the wider culinary industry, suggesting a strategic embrace of data analytics to bolster business agility and customer-centric innovation.

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