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Apriori Algorithm and Business Intelligence Methods for Bookstore's Customer Preferences Analysis

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ABSTRACT

This study explores the use of a priori algorithm in analyzing sales transaction data at Rony Jaya Bookstore. By combining data mining and business intelligence, the study successfully uncovered significant customer buying patterns, which were then used to support strategic decision-making. The results of the analysis showed that there was a close relationship between certain book categories, such as Fiction Books and Educational Books with a confidence level of 87.5%, as well as Non-Fiction Books and Educational Books with a confidence level of 88.89%. These findings provide valuable insights into developing marketing strategies, such as creating custom promotional packages and arranging product layouts in stores to make them more appealing to customers. This research also highlights the importance of ensuring data quality so that the resulting analysis is more accurate and relevant. Overall, the study offers a practical guide for Rony Jaya Bookstore and other businesses looking to leverage data mining and business intelligence technologies to improve efficiency and customer satisfaction.

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1. INTRODUCTION

In digital era, customer preference analysis is very important because it can help companies improve operational efficiency and increase customer satisfaction. A study conducted by Muhammad Mushleh in his study on the Case Study of the Association of Purchasing Technology Products in Electronic Stores with a Priori Method shows that customer preference analysis can help stores in optimizing product placement, designing appropriate promotional packages, and improving stock management. Therefore, customer preference analysis needs to be considered as a strategic step to maintain customer loyalty. In this context, technologies such as data mining and business intelligence have an important role to play in analyzing and understanding customer preferences more deeply. [1]

Data mining is the process of analyzing large amounts of data to identify patterns or important information that can be used practically. One of the algorithms that is often used in this context is the Aries algorithm, which aims to find the rules of association between the various items purchased by customers. Based on previous research, the application of the Apriori algorithm has proven to be effective in uncovering significant buying patterns. This information can be used to support more strategic decision-making in designing and implementing more effective and data-driven marketing strategies.[2][3] Additionally, one of the key advantages of the Apriori algorithm is its ability to process large amounts of transaction data to uncover hidden relationships between products. For example, if the analysis shows that many customers often buy fiction books and novels at the same time, the store can take advantage of this information by offering special promotions for both categories.

This kind of strategy not only has the potential to increase sales, but also provides a more personalized shopping experience for customers, thereby strengthening their loyalty to the store.[4][5] Business intelligence (BI) has an important role in processing data from data mining, because BI is able to present information in a way that is easier for decision-makers to understand. By combining data mining and BI, Rony Jaya Bookstore can compile analytical reports that provide an overview of sales trends, customer preferences, and the success of marketing campaigns. This information is a guide for management to design strategic measures that are more targeted and in accordance with customer needs, so that the business can develop more purposefully.[6]

Therefore, data mining and business intelligence have become two key elements in contemporary business strategies. Data mining plays a role in identifying patterns and trends in large and complex data, while business intelligence functions to interpret the data to support more informed business decision-making. These two methods complement each other, where data mining can unearth hidden information in the data, while business intelligence converts that information into actionable insights. Therefore, the use of both in modern business is essential to improve operational efficiency and effectiveness, as well as support more strategic, data-driven decision-making. [7] That way, Rony Jaya Bookstore is the right example to apply the concept of data mining and business intelligence. As a bookstore that has a large and detailed database of transactions, it can use the data to analyze customer preferences more effectively. By applying the priori method, for example, we can find a pattern of association between books that are often purchased together. This knowledge allows stores to strategize better in product placement, design relevant promotional packages, and even manage book stock more efficiently.[8][9]

The implementation of an effective BI system requires a deep understanding of the company's business needs and strategic goals. For this reason, Rony Jaya Bookstore needs to first analyze historical data carefully before implementing BI solutions. This process involves cleaning and validating the data to ensure that the data used is of high quality and accurate. With clean and reliable data, the results of the analysis will be more relevant and reliable, thus helping management make more appropriate and strategic decisions.[10] Thus, this study aims to provide practical guidance for Rony Jaya Bookstore in implementing data mining methods using a priori algorithm and utilizing Business Intelligence. Hopefully, the results of this research will not only help the store in improving its marketing strategy, but also become an inspiration and reference for other businesses who want to utilize information technology to grow and better understand the needs of their customers.

2. METHOD

This research uses a quantitative approach that includes four main stages, namely book sales data collection, data exploration and visualization to understand basic transaction patterns, data processing with a priori algorithm to identify frequent book purchase patterns, and evaluation and integration of analysis results into business intelligence strategies. Each stage is designed to ensure that the results of the research are not only data-valid, but also relevant and can be applied directly in supporting strategic decision-making at the Rony Jaya Bookstore. The stages carried out in this study are as follows:

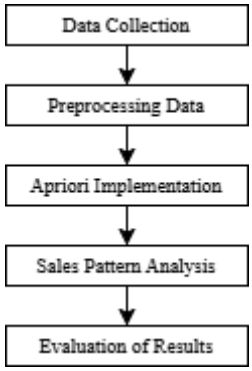

Figure 1. Steps of the study

In the early stages, book sales transaction data is collected from various sources, such as cashier systems or store databases. The data collected includes important information such as the date of the transaction, the list of books purchased, and the amount of each book purchased. The completeness and accuracy of the data is very important because this data will be the basis for subsequent analysis. Once the data is collected, the next step is to prepare the data so that it is ready for analysis using a priori algorithm. This process involves converting transaction data into an appropriate format, which is a collection of books purchased in each transaction. This preparation aims to ensure that data can be analyzed effectively and generate useful insights for Rony Jaya Bookstore.

A priori's algorithm is used to find combinations of frequently purchased books together, called frequent itemsets, using two key metrics: Support and Confidence. Support measures how often book combinations appear in the overall transaction data. The basic formulas used in the Apriori algorithm include:[11][12]

1. Support

$$Support\ (A)\ = \frac{\sum The\ Number\ of\ Transactions\ Contains\ A}{Total\ transaction} * 100$$

Support measures how often itemset *A* appears across transactions

2. Confidance

$$Confidence\ (A \rightarrow B) = \frac{Support\ (A \cup B)}{Support\ (A)} * 100\%$$

Confidence measures the probability that item *B* is purchased if item *A* is purchased first. Where *A* is the first itemset, *B* is the second itemset, and Support measures the frequency of item combinations in the transaction data. The higher the Confidence value, the stronger the relationship between the two items, which indicates that the purchase of item *A* is likely to be followed by the purchase of item *B*[13][14].

3. Elevator

$$Lift\ (A \rightarrow B)\ = \frac{Confidence\ (A \rightarrow B)}{Support\ (B)} * 100\%$$

The elevator measures how strong the relationship between two items is compared to if they were purchased independently.[15]

Frequent itemsets and association rules generated by the Apriori algorithm were then further analyzed to understand customer purchase patterns at Rony Jaya Bookstore. Combinations of books that are frequently purchased together are evaluated using metrics such as elevator ratios, to identify important relationships between items. The results of this analysis can be used to design more effective business strategies, such as making promotional package offers or arranging the layout of books in the store to make them more attractive to customers. Thus, the information obtained can help store managers in making more targeted decisions and increasing customer satisfaction. This analysis also provides deeper insights into consumer preferences that can be optimized to increase sales.

After the analysis, an evaluation is carried out to test the quality of the association rules and measure how effective they are, such as their impact on sales conversions or increased profits. This evaluation is very important to ensure that the results of the research can be applied practically in the management of bookstores. With proper evaluation, businesses can ensure that the strategies resulting from these analyses are truly value-added. It also helps in adjusting strategies to better suit the changing needs of the market and consumer behavior.

3. RESULTS AND DISCUSSION

Data on book sales transactions at the Rony Jaya Bookstore is obtained through sales records that are carried out every week. For the purposes of this study, the data was taken from the week with the highest number of transactions. This information is then compiled in the form of a table to facilitate the process of analyzing and identifying buying patterns using the Apriori algorithm. This structured data presentation will help in the application of data mining and business intelligence to analyze customer preferences at Rony Jaya Bookstore for one month, as well as provide insights that can support more effective business strategies.

Table 1. Sales Transaction Data

It	Transaction Date	Purchased Books
1	01/10/2024	Fiction Books, Non-Fiction Books, Comics, Educational Books, Children's Books
2	02/10/2024	Fiction Books, Non-Fiction Books, Comics, Educational Books
3	03/10/2024	Non-fiction books, educational books, comics
4	04/10/2024	Fiction Books, Educational Books, Children's Books
5	05/10/2024	Non-fiction books, comics, educational books
6	06/10/2024	Fiction Books, Non-Fiction Books, Educational Books
7	07/10/2024	Fiction Books, Educational Books, Children's Books
8	08/10/2024	Non-fiction books, comics, educational books, fiction books
9	09/10/2024	Fiction Books, Educational Books, Comics
10	10/10/2024	Non-fiction books, educational books, children's books
11	11/10/2024	Fiction Books, Non-Fiction Books, Educational Books
12	12/10/2024	Non-Fiction Books, Children's Books, Educational Books
13	13/10/2024	Fiction Books, Educational Books, Comics

14	14/10/2024	Non-fiction books, fiction books, educational books

The presentation of book sales transaction data at the Rony Jaya Bookstore in a table format provides a clear and organized structure, making it easier to analyze customer purchase patterns. With this tabular format, the frequency of book purchases can be identified more easily, and data management can be done more efficiently. This format also supports the application of a priori algorithms to analyze transaction data, so that the results of the analysis can be used to formulate a more targeted and targeted business intelligence strategy. The following is a table of tabular format of transaction data used for the analysis of customer preferences of Rony Jaya Bookstore. The following is a table of tabular format of transaction data:

Table 2. Format Tabular

Day	Transaction Date	Fiction Books	Non-Fiction Books	Comic	Educational Books	Book Children
1	01/10/2024	1	1	1	1	1
2	02/10/2024	1	1	1	1	0
3	03/10/2024	0	1	1	1	0
4	04/10/2024	1	0	0	1	1
5	05/10/2024	0	1	1	1	0
6	06/10/2024	1	1	0	1	0
7	07/10/2024	1	0	0	1	1
8	08/10/2024	1	1	1	1	0
9	09/10/2024	1	0	1	1	0
10	10/10/2024	0	1	0	1	1
11	11/10/2024	1	1	0	1	0
12	12/10/2024	0	1	0	1	1
13	13/10/2024	1	0	1	1	0
14	14/10/2024	1	1	0	1	0
Total		**9**	**10**	**7**	**14**	**3**

3.1. Itemset 1 (C1)

Based on the tabular format table that has been provided, the next step is to form itemset 1 (C1) using a minimum support value of 30%. The following is a calculation table for the formation of itemset 1.
Itemset Formation **Table 1 (C1)** based on **a minimum** support of 30%:

Table 3. Support Itemset C1

Book	Purchase Frequency	Support (%)	Supported Enough?
Fiction Books	9	$\frac{9}{14}$. 100 = 64.29%	Yes
Non-Fiction Books	10	$\frac{10}{14}$. 100 = 71.43%	Yes
Comic	7	$\frac{7}{14}$. 100 = 50%	Yes
Educational Books	14	$\frac{14}{14}$. 100 = 100%	Yes
Children's Books	3	$\frac{3}{14}$. 100 = 21.43%	Not

a. Itemset 2 (C2)

The next step is the formation of itemset 2 (C2). At this stage, two items that have passed the minimum support criteria of 30% of itemset 1 (C1) will be combined. After that, the frequency of occurrence of each pair of items formed will be calculated in the transaction data. Here is a table showing the calculation results for itemset 2 (C2):

Table 4. Itemset pair Frequency

Itemset Pairs	Purchase Frequency
Fiction Books, Non-Fiction Books	7
Fiction Books, Comics	5
Fiction Books, Educational Books	9
Fiction Books, Children's Books	3
Non-fiction books, comics	6
Non-Fiction Books, Educational Books	10
Non-fiction books, children's books	4
Comics, Educational Books	8
Comics, Children's Books	3
Educational Books, Children's Books	4

At the Itemset 2 (C2) formation stage in the Ascending algorithm, two items that have passed the minimum support criteria of 30% of Itemset 1 (C1) are combined to form a new itemset pair. After that, the frequency of occurrence of each itemset pair is calculated in the existing transaction data. The results of the calculation of the frequency of this itemset pair are then used to calculate the support of each itemset pair, namely by dividing the frequency of the itemset pair by the total number of transactions. Support is calculated by the formula:

$$Support(A \cap B) = \frac{Frequency\ of\ pairs\ itemset}{Total\ numbers\ of\ transactions} = \frac{Frequency}{14}$$

Table 5. Support Itemset C2

Itemset Pairs	Purchase Frequency	Support (%)	Supported ?
Fiction Books, Non-Fiction Books	7	$\frac{7}{14}$. 100 = 50%	Yes
Fiction Books, Comics	5	$\frac{5}{14}$. 100 = 35.71%	Yes
Fiction Books, Educational Books	9	$\frac{9}{14}$. 100 = 64.29%	Yes
Fiction Books, Children's Books	3	$\frac{3}{14}$. 100 = 21.43%	Not
Non-fiction books, comics	6	$\frac{6}{14}$. 100 = 42.86%	Yes
Non-Fiction Books, Educational Books	10	$\frac{10}{14}$. 100 = 71.43%	Yes
Non-fiction books, children's books	4	$\frac{4}{14}$. 100 = 28.57%	Not
Comics, Educational Books	8	$\frac{8}{14}$. 100 = 57.14%	Yes
Comics, Children's Books	3	$\frac{3}{14}$. 100 = 21.43%	Not
Educational Books, Children's Books	4	$\frac{4}{14}$. 100 = 28.57%	Not

From the results of the calculations carried out, several pairs of itemsets showed support of more than 30%, such as: "Fiction Books and Non-Fiction Books" (50%), "Fiction Books and Comics" (35.71%), "Fiction Books and Educational Books" (64.29%), "Non-Fiction Books and Comics" (42.86%), "Non-Fiction Books and Educational Books" (71.43%), and "Comics and Educational Books" (57.14%). This pair of itemsets shows a significant relationship between these items, thus meeting the minimum support criteria of 30%.

b. Itemset 3 (C3)

After obtaining 2 itemsets that meet the minimum support value above 30%, the next step is to form 3 itemsets or C3 with the same minimum support criteria, which is 30%. The following is a calculation table for the formation of the 3 itemsets.

Table 6. Support Itemset C3

It	Itemset 3 (C3)	Frequency of Occurrence	Support (%)	Status
1	{Fiction Books, Non-Fiction Books, Educational Books}	4	28.57%	Not Qualified
2	{Fiction Books, Non-Fiction Books, Comics}	3	21.43%	Not Qualified
3	{Fiction Books, Educational Books, Comics}	4	28.57%	Not Qualified
4	{Non-fiction books, educational books, comics}	4	28.57%	Not Qualified
5	{Fiction Books, Non-Fiction Books, Children's Books}	3	21.43%	Not Qualified
6	{Fiction Books, Educational Books, Children's Books}	3	21.43%	Not Qualified
7	{Non-fiction books, educational books, children's books}	3	21.43%	Not Qualified
8	{Fiction Books, Comics, Children's Books}	3	21.43%	Not Qualified
9	{Non-fiction books, comics, children's books}	2	14.29%	Not Qualified
10	{Fiction Books, Non-Fiction Books, Educational Books}	4	28.57%	Not Qualified

From the calculation results, all itemsets 3 (C3) have a support value below 30% and therefore all itemsets do not qualify. In other words, there is no combination of three items that meets the minimum support criteria of 30% based on the sales data provided.

c. Confidance

The next step is to calculate the confidence value with a minimum threshold of 70%. This process aims to evaluate the extent of the relationship between items in the association rule, where the higher the confidence value, the stronger the relationship between the items. The confidence value indicates the likelihood of a second item in a transaction, assuming the first item already exists. Association rules that have a confidence value equal to or higher than the set threshold will be considered valid and can be used in decision-making. Here is a calculation table for the minimum confidence value:

Table 7. Confidance Values

Itemset	Itemset Frequency	Frequency A	Frequency B	Confidence (A → B)	Confidence (B → A)	Status
Fiction Books, Non-Fiction Books	4	8	9	50%	44.44%	Not Qualified
Fiction Books, Comics	5	8	7	62.5%	71.43%	Not Qualified
Fiction Books, Educational Books	7	8	10	87.5%	70%	Escape
Fiction Books, Children's Books	4	8	5	50%	80%	Not Qualified
Non-fiction books, comics	5	9	7	55.56%	71.43%	Not Qualified
Non-Fiction Books, Educational Books	8	9	10	88.89%	80%	Escape

Non-fiction books, children's books	4	9	5	44.44%	80%	Not Qualified
Comics, Educational Books	5	7	10	71.43%	50%	Escape
Comics, Children's Books	4	7	5	57.14%	80%	Not Qualified
Educational Books, Children's Books	6	10	5	60%	50%	Not Qualified
Fiction Books, Non-Fiction Books, Educational Books	4	8	10	50%	40%	Not Qualified
Fiction Books, Non-Fiction Books, Comics	3	8	7	37.5%	42.86%	Not Qualified
Fiction Books, Educational Books, Children's Books	4	8	5	50%	80%	Not Qualified
Non-fiction books, educational books, comics	5	9	7	55.56%	71.43%	Not Qualified
Non-fiction books, educational books, children's books	4	9	5	44.44%	80%	Not Qualified
Comics, Educational Books, Children's Books	4	7	5	57.14%	71.43%	Not Qualified

Based on the results of the calculation of the confidence value for the itemset obtained from the data of book sales transactions at the Rony Jaya Bookstore, it can be concluded that the association rule with a confidence value of more than or equal to 70% indicates a strong relationship between items. Some of the rules that meet these thresholds include the relationship between Fiction Books and Educational Books with Non-Fiction Books (Confidence = 87.5%), as well as between Non-Fiction Books and Educational Books with Fiction Books (Confidence = 88.89%). In addition, the relationship between Comics and Educational Books and Fiction Books also met the criteria (Confidence = 71.43%). These rules reveal a consistent buying pattern, where customers tend to buy Fiction Books, Non-Fiction Books, and Educational Books together. These findings provide important insights for marketing strategies, such as product structuring in stores or the development of promotions that highlight combinations of the books.

The following table shows a combination of 2-itemset or C2 that meets the criteria of a minimum support of 30% and a minimum confidence of 70%. This step ensures that only combinations of itemsets with sufficiently strong and relevant relationships are maintained, so that they can be used for further analysis in identifying significant buying patterns. Thus, this process helps to filter out association rules that have a high potential to be applied in marketing strategies or product structuring. The combination of itemsets that meet these criteria provides deeper insights into customer preferences and their purchasing patterns.

Table 8. Passing Confidence Value

Itemset	Frequency	Support (%)	Confidence (A → B)	Confidence (B → A)	Elevator
Fiction Books, Non-Fiction Books	8	57.14%	88.89%	72.73%	1.54
Fiction Books, Comics	7	50%	77.78%	70%	1.17
Fiction Books, Educational Books	10	71.43%	100%	90%	1.40
Non-fiction books, comics	7	50%	77.78%	70%	1.17
Non-Fiction Books, Educational Books	9	64.29%	88.89%	80%	1.50
Comics, Educational Books	8	57.14%	100%	75%	1.33
Fiction Books, Children's Books	6	42.86%	66.67%	60%	1.11
Non-fiction books, children's books	5	35.71%	71.43%	55.56%	1.28
Educational Books, Children's Books	9	64.29%	100%	90%	1.40
Fiction Books, Notebooks	7	50%	77.78%	70%	1.17

The table presented illustrates the results of the calculation of Support, Confidence, and Lift values for various combinations of items that are often purchased together in the book sales transaction data at the Rony Jaya Bookstore.In the Frequency column, it is displayed the number of times a certain combination of items appears in the transaction during the analyzed period. For example, the combination {Fiction Book, Educational Book} appears as many as 10 times in the total transaction, indicating that the two items are often purchased together. The Support column (%) shows the percentage of occurrence frequency of each itemset compared to the total transactions. For example, the combination of {Fiction Books, Education Books} has a Support value of 71.43%, which means that about 71.43% of the transactions analyzed involve the two books. This Support value gives an idea of how significant the itemset is in the overall data. The Confidence column (A → B) describes the probability that item B will be purchased if item A has already been purchased. For example, in the combination of {Fiction Book, Education Book}, there is 100% Confidence (A → B), which means that every time a Fiction Book is purchased, the Education Book is always purchased as well. In contrast, the Confidence column (B → A) shows the inverse probability, which is how likely item A is to be purchased if item B has already been purchased. For this combination, the purchased Educational Books are followed by the Fiction Books 90% of the time.

The last column, Elevator, shows how strong the relationship between two items in the itemset is. A Lift value greater than 1 indicates that the two items are more likely to be purchased together than would be expected

if purchased separately. For example, the combination {Fiction Book, Educational Book} has a Lift of 1.40, which means that these two books are purchased together more often compared to the chances of them being purchased separately. Overall, the values in this table provide useful insights in identifying strong relationships between products in the store and can be used to formulate more effective sales or promotional strategies.

4. CONCLUSION

Based on the results of this study, it can be concluded that the application of the Apriori algorithm in transaction analysis at Rony Jaya Bookstore has succeeded in identifying significant customer purchase patterns. The combined use of data mining and business intelligence allows store owners to gain deeper insights into customer preferences. The results of the analysis showed that the combination of certain books, such as Fiction Books and Educational Books, had a high confidence value, namely 87.5%, and 88.89% for the combination of Non-Fiction Books and Educational Books. In addition, there are several other combinations that also show a significant relationship, such as Fiction Books and Non-Fiction Books (confidence 77.78%), and Comics and Educational Books (confidence 71.43%). This information can be used to design more appropriate marketing strategies, such as offering promotional packages and arranging product layouts in stores. This research also emphasizes the importance of ensuring the quality of the data used, because clean and relevant data will result in more accurate and reliable analysis. Thus, this research not only provides practical guidance for Rony Jaya Bookstore in implementing data mining and business intelligence methods, but also serves as an inspiration for other businesses that want to utilize information technology to improve operational efficiency and customer satisfaction. Further research is suggested to explore other data mining techniques and expand the scope of analysis to obtain more comprehensive insights into customer behavior.

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