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Using Apriori Algorithm to Analyze Library Borrowing Patterns at SMK Negeri 1 Cirebon

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ABSTRACT

This study aims to identify book borrowing patterns in the SMKN 1 Cirebon City library using the association rule method with the apriori algorithm. The apriori algorithm is a data mining method that finds association relationships between items in an extensive database. In this study, book borrowing transaction data is processed to determine the combination of books often borrowed together. The analysis begins with processing book borrowing transaction data, followed by applying the apriori algorithm to find frequent itemsets and association rules with high support and confidence values. The analysis results show that students often carry specific book borrowing patterns, such as those who borrow Python programming books borrow data science with Python books. This pattern is expected to be a recommendation for the library in managing book inventory, arranging bookshelves, and developing more effective and efficient borrowing strategies so that the library can rearrange the bookshelves by placing books that are often borrowed together in the nearest location. Also, the library can determine the types of books that need to be added based on the connected borrowing pattern. Thus, applying the association rule method using the apriori algorithm can help libraries understand students' book-borrowing habits and improve the quality of library services.

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1. INTRODUCTION

The library is one of the places where we can get various information. Every school has at least one library that aims to provide facilities and infrastructure for students to gain knowledge. In this regard, the library is essential to support the continuity of education, as it serves as a source of learning for students or school residents, including teachers, who can access various references to enhance their knowledge [1]. Few students also borrow books to read on-site or take home, allowing them more time to read the book, including at SMK Negeri 1 Kota Cirebon. However, managing book borrowing data becomes challenging with

the increasing number of book collections and borrowing activities. Data that continues to grow from borrowing activities is often only stored as an archive without being used further to obtain valuable information.

Various obstacles often occur in library management, such as the frequent occurrence of similar books scattered around, making it difficult for librarians to maintain order. As a result, librarians sometimes have to rearrange the existing books, which can be time-consuming. This issue becomes more significant if visitors want to borrow books that are still of one type. This often happens when visitors want to borrow more than one book from the same category or subject. Therefore, a system must support the relationship between these books to overcome these challenges. One method that can identify book borrowing patterns is the Association Rule method with the Apriori algorithm. This algorithm can find relationships or connections between items in large data sets. In the context of libraries, applying the Apriori algorithm can reveal patterns of book borrowing where students frequently borrow certain books together. This information can be used to improve the management of book collections and library services to ensure better organization and accessibility.

Several previous studies have shown the effectiveness of the Apriori algorithm in analyzing library book borrowing patterns. Research by Riyanti Puspasari [2] shows that applying the Data Mining concept can help officers plan and predict books currently popular among visitors based on book borrowing patterns [3]. This finding is supported by another study by Suryati [3], which proved that the Apriori Algorithm is used to explore association rules. This method is a form of association analysis in data mining techniques that helps to find associative rules between different combinations of items [2]. Furthermore, research conducted by Amsury [4] revealed that libraries can gain insights into book borrowing transaction patterns by using the association rule mining approach with the Apriori algorithm. This analysis serves as a basis for providing book recommendations that align with the reading interests of library members, which can also aid in determining the layout of books on the shelves to enhance accessibility and efficiency in book retrieval [4]

This study aims to apply the Association Rule method using the Apriori algorithm to identify book borrowing patterns in the SMK Negeri 1 Kota Cirebon library. By implementing this algorithm, it is hoped that the library can gain better insight into student preferences for book collections so that decision-making related to library management can be carried out more precisely and efficiently. Ultimately, this approach is expected to optimize library services, making accessing relevant learning resources easier for students and educators.

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2. METHOD

Data mining is a method for finding specific patterns from large data sets [5], [6]. In data mining, clustering is one of the techniques that is useful for data analysis. Data mining is a stage of time spent finding examples of information in very large data sets, also called knowledge discovery in a database (KDD) [7], [8]. The following is the flow of this research:

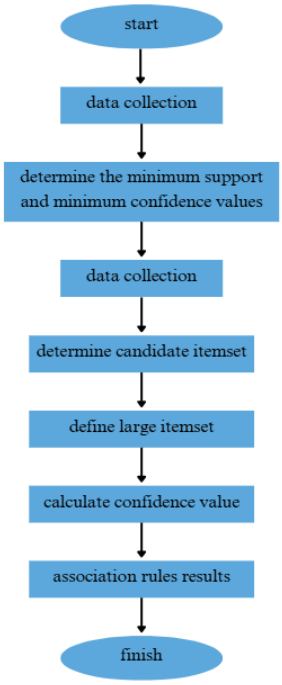

Figure 1 Research flow [9], [10]

Association rule mining is a method for finding patterns of relationships between one or more itemsets in a dataset [11], [12]. The association rule consists of two stages, namely finding a combination of the most frequently occurring item sets and the second is defining Conditions and Results. One of the techniques used to find patterns that can be used in association rules is market basket analysis (MBA) [13]. The importance of an associative rule can be known by two parameters support: the percentage of item combinations in the database and confidence, namely the strength of the relationship between items in the associative rule. Support and confidence can be written as Equation 1 and Equation 2 [14], [15].

$$support\ (A \Longrightarrow B) = P(A \cap B) \quad (1)$$

$$confidence\ (A \Longrightarrow B) = P(B \mid A) \quad (2)$$

If the support item of data itemset 1 meets the minimum support threshold determined, then 1 is a frequent k-itemset. Lk denotes frequent k-itemset. The equation obtained is as follows [16].

$$support\ (A \Longrightarrow B) = P(A \cap B) \quad (3)$$

$$confidence\ (A \Longrightarrow B) = P(B \mid A) \quad (4)$$

The apriori algorithm is an algorithm from the Association Rules Mining (ARM) technique and is included in the data mining method section to determine high-frequency patterns. Using the apriori algorithm will produce a combination of goods output where if the minimum confidence value is greater, the combination of goods will be more valid. If the support value is higher, the selection of combinations of each item set will be more specific [17].

The apriori algorithm is one of the association algorithms in data mining, where the association rules contained in it are often referred to as Market Based Analysis (MBA) [17], [18]. The apriori algorithm is often used. The disadvantage of the apriori algorithm is that it must perform repeated scanning of the entire database at each time iteration [19]. A priori algorithm is a data retrieval algorithm with association rules that meet the support and confidence limits by forming association rules with parameters to determine the relationship of a combination of items that meet the minimum requirements of the support and confidence values.

The Apriori algorithm can implement marketing analysis by finding each rule on associations that have met the conditions, namely the support and confidence limits. Each association rule is found by using parameters so that the formation of the rules obtained produces accurate predictive values. Association rules are expressed by several attributes, which are usually referred to as (affinity analysis) or (market basket analysis) [20]. Association analysis or association rule in data mining is one of the data mining techniques to find a rule on a combination of items. What is interesting about this analysis is that one of its stages is to produce an efficient algorithm by analyzing high-frequency patterns (frequent pattern mining). This algorithm works by examining the development of candidate item sets from the results of the frequency of item sets with support-based pruning, which aims to remove item sets that are not influential by selecting the minimum support.

The Apriori algorithm is a method for finding patterns of relationships between one or more items from a dataset, which functions to form candidate combinations of items and then tests whether the combination meets the minimum support and confidence parameters, which are threshold values given by the user [21]. The disadvantage of the apriori algorithm is that it must perform repeated scanning of the entire database at each iteration. The more transaction data to be processed, the longer it will take [19]. One of the stages of association analysis that has attracted the attention of many researchers to produce efficient algorithms is high-frequency pattern analysis (frequent pattern mining). The importance of an association can be known by two benchmarks: support and confidence. Support (supporting value) is the percentage of the combination of items in the database, while confidence (certainty value) is the strength of the relationship between items in the association rules [22]. Support is a parameter that proves the level of dominance of an item/itemset from the total borrowing that occurs. This parameter ensures whether an item/item set is worthy of looking for its confidence value; for example, from the total borrowing, how much dominance proves that items A and B are likely to be purchased simultaneously. The following stages are carried out in the application of calculations using the apriori algorithm: (1) Find the three most borrowed books, Determine the list of books in the library, and Determine book borrowing data in the library; (2) Grouping three books that are often borrowed; (3) Represent data from available borrowing; (4) Create a tabular format based on borrowing data; (5) Analyzing the highest frequency pattern. To find items that meet the minimum requirements of the support value, you can use the formula [23], [24]:

$$support\ (A)\ =\ \frac{number\ of\ transactions\ containing\ A}{Total\ Transactions} \quad (5)$$

Meanwhile, to find the value of 2 itemsets can be obtained by the formula:

$$support\ (A,B)\ =\ \frac{number\ of\ transactions\ containing\ A\ and\ B}{Total\ Transactions} \quad (6)$$

Meanwhile, to calculate the confidence value of the rule value A → B can use the following formula [25], [26]:

$$confidence\ (A \rightarrow B)\ =\ \frac{number\ of\ transactions\ containing\ A\ and\ B}{Total\ transactions\ containing\ A} \quad (7)$$

To find associations that meet the minimum requirements for confidence by calculating the associative confidence A∪B is obtained by the formula:

$$confidence\ P(B|A)\ =\ \frac{\Sigma\ Transaksi\ Untuk\ A\ dan\ B}{\Sigma\ Transactions\ for\ A\ and\ B} \quad (8)$$

3. RESULTS AND DISCUSSION

The following is an example of applying the Association Rule Method Using the Apriori Algorithm to Identify Book Borrowing Patterns in Libraries at SMK Negeri 1 Cirebon City. The data required is book loan data for 2023. Table 1 shows some of the books students often borrowed in 2023.

Table 1. Book Borrowing Data January 2023

No	Titel	Category	Total
1	Atlas	IPS	64
2	Sherlock Holmes	Novel	32
3	Ande Ande Lumut	Novel	48
4	Komunikasi Digital	Komputer	35
5	Matematika Untuk Smk	Matematika	4
6	Geografi	IPS	45
7	Dasar Pengukuran Listrik	Elektronika	3
8	Bahasa Indonesia 2	Bahasa	0
9	Fiqih	Agama	1
10	Surgamu Dari Sang Nabi	Agama	19
11	Rangkaian Listrik	Elektronika	13
12	Teknik Perawatan Dan Perbaikan Otomotif	Otomotif	7
13	Pemeliharaan Sasis Sepeda Motor 2	Otomotif	3

After that, data tabulation is made zero means not often borrowed in that month, and 1 (one) means books that often appear/are borrowed in that month (taken three books that are often borrowed), then the tabulation of book data is obtained as in table 2 as follows:

Table 2. Tabulation of Book Data for 2023

Month	Name Book Titel				
	Atlas	Electricity	Electrical Circuits	Geography	Ande Lumut
1	1	0	0	1	1
2	1	1	0	0	1
3	0	1	1	0	1
4	1	1	0	1	0
5	1	0	0	1	1
6	1	0	1	0	1
7	1	1	0	1	1
8	1	1	1	0	0
9	0	1	1	1	0
10	1	0	1	1	0
11	1	0	0	1	1
12	0	1	1	1	0
Total Itemset	**9**	**7**	**6**	**8**	**7**

The number of itemsets is obtained from the formula Itemset (Number of transactions), a total of the number 1 value (frequently borrowed book transactions):

a) Atlas = month 1 + month 2 + month 4 + month 5 + month 6 + month 7 + month 8 + month 10 + month 11 = 9
b) Electricity = month 2 + month 3 + month 4 + month 7 + month 8 + month 9 + month 12 = 7
c) Electrical Circuit = month 3 + month 6 + month 8 + month 9 + month 10 + month 12 = 6
d) Geography = month 1 + month 4 + month 5 + month 7 + month 9 + month 10 + month 11 + month 12 = 8
e) Ande-ande moss = month 1 + month 2 + month 3 + month 5 + month 6 + month 7 + month 11 = 7

After that, a reference to one item (1 item) is made with a percentage of support.

Table 3. Support 1 itemset result

No	Book Title	Number of Transactions	Support	Support %
1	Atlas	9	0,75	75
2	Kelistrikan	7	0,58333333	58
3	Rangkaian Listrik	6	0,5	50
4	Geografi	8	0,66666667	67
5	Ande Lumut	7	0,58333333	58

Table 3 explains the results of obtaining the support value of the number of transactions multiplied by the number of months (Support = number/number of months) then obtained:

a) Atlas = 9/12 = 0.75 (75%)
b) Electrical = 7/12 = 0.58 (58%)
c) Electrical Circuit = 6/12 = 0.5 (50%)
d) Geography = 8/12 = 0.67 (67%)
e) Ande-ande moss = 7/12 = 0.58 (58%)

If the minimum support is 30%, then the five books are true that the level of frequent borrowing each month is appropriate because > 30% minimum support.
Next is the 2 Itemset step, which compares the books that pass on 1 item set. If the value that often appears the same is the same, given the value Y, if no or one of the books often appears, then the value is 0. See the following table:

Table 4. Itemset

1. ATLAS , KELISTRIKAN			
Bulan	Nama Judul Buku		TRX 2 ITEM
	ATLAS	KELISTRIKAN	
1	1	0	N
2	1	1	Y
3	0	1	N
4	1	1	Y
5	1	0	N
6	1	0	N
7	1	1	Y
8	1	1	Y
9	0	1	N
10	1	0	N
11	1	0	N
12	0	1	N
jumlah 2 itemset			4
Support (%)			33,3333

2. ATLAS ,RANGKAIAN LISTRIK			
Bulan	Nama Judul Buku		TRX 2 ITEM
	ATLAS	RANGKAIAN LISTRIK	
1	1	0	N
2	1	0	N
3	0	1	N
4	1	0	N
5	1	0	N
6	1	1	Y
7	1	0	N
8	1	1	Y
9	0	1	N
10	1	1	Y
11	1	0	N
12	0	1	N
jumlah 2 itemset			3
Support (%)			25

3. ATLAS , GEOGRAFI			
Bulan	Nama Judul Buku		TRX 2 ITEM
	ATLAS	GEOGRAFI	
1	1	1	Y
2	1	0	N
3	0	0	N
4	1	1	Y
5	1	1	Y
6	1	0	N
7	1	0	N
8	1	0	N
9	0	1	N
10	1	1	Y
11	1	1	Y
12	0	1	N
jumlah 2 itemset			5
Support (%)			41,6667

4. ATLAS , ANDE ANDE LUMUT			
Bulan	Nama Judul Buku		TRX 2 ITEM
	ATLAS	ANDE LUMUT	
1	1	1	Y
2	1	1	Y
3	0	1	N
4	1	0	N
5	1	1	Y
6	1	1	Y
7	1	1	Y
8	1	0	N
9	0	0	N
10	1	0	N
11	1	1	Y
12	0	0	N
jumlah 2 itemset			6
Support (%)			50

5. KELISTRIKAN, RANGKAIAN LISTRIK			
Bulan	Nama Judul Buku		TRX 2 ITEM
	KELISTRIKAN	RANGKAIAN LISTRIK	
1	0	0	N
2	1	0	N
3	1	1	Y
4	1	0	N
5	0	0	N
6	0	1	N
7	1	0	N
8	1	1	Y
9	1	1	Y
10	0	1	N
11	0	0	N
12	1	1	Y
jumlah 2 itemset			4
Support (%)			33,33333

6. KELISTRIKAN ,GEOGRAFI			
Bulan	Nama Judul Buku		TRX 2 ITEM
	KELISTRIKAN	GEOGRAFI	
1	0	1	N
2	1	0	N
3	1	0	N
4	1	1	Y
5	0	1	N
6	0	0	N
7	1	0	N
8	1	0	N
9	1	1	Y
10	0	1	N
11	0	1	N
12	1	1	Y
jumlah 2 itemset			3
Support (%)			25

7. KELISTRIKAN, ANDE LUMUT			
Bulan	Nama Judul Buku		TRX 2 ITEM
	KELISTRIKAN	ANDE LUMUT	
1	0	1	N
2	1	1	Y
3	1	1	Y
4	1	0	N
5	0	1	N
6	0	1	N
7	1	1	Y
8	1	0	N
9	1	0	N
10	0	0	N
11	0	1	N
12	1	0	N
jumlah 2 itemset			3
Support (%)			25

8. RANGKAIAN LISTRIK, GEOGRAFI			
Bulan	Nama Judul Buku		TRX 2 ITEM
	RANGKAIAN LISTRIK	GEOGRAFI	
1	0	1	N
2	0	0	N
3	1	0	N
4	0	1	N
5	0	1	N
6	1	0	N
7	0	1	Y
8	1	0	N
9	1	1	Y
10	1	1	Y
11	0	1	N
12	1	1	Y
jumlah 2 itemset			3
Support (%)			25

9. RANGKAIAN LISTRIK, ANDE LUMUT			
Bulan	Nama Judul Buku		TRX 2 ITEM
	RANGKAIAN LISTRIK	ANDE LUMUT	
1	0	1	N
2	0	1	N
3	1	1	Y
4	0	0	N
5	0	1	N
6	1	1	Y
7	0	1	N
8	1	0	N
9	1	0	N
10	1	0	N
11	0	1	N
12	1	0	N
jumlah 2 itemset			2
Support (%)			16,66667

10. KELISTRIKAN ,GEOGRAFI			
Bulan	Nama Judul Buku		TRX 2 ITEM
	ANDE LUMUT	GEOGRAFI	
1	1	1	Y
2	1	0	N
3	1	0	N
4	0	1	N
5	1	1	Y
6	1	0	N
7	1	1	Y
8	0	0	N
9	0	1	N
10	0	1	N
11	1	1	Y
12	0	1	N
jumlah 2 itemset			4
Support (%)			33,33333

Table 4 above explains the number of item sets obtained by adding up the books that appear simultaneously, then giving a value of Y or one, which is then added up. The support value is obtained from the number of 2 itemsets divided by the number of months multiplied

by 100 (per cent). Then, we obtained 10 equations for two itemset. The calculation is as follows:

a) Atlas, Electrical = (4/12) * 100 = 33.33%
b) Atlas, Electrical circuit = (3/12) * 100 = 25%
c) Atlas, Geography = (5/12) * 100 = 41.67%
d) Atlas, Ande-ande moss = (6/12) * 100 = 50%
e) Electricity, Electrical Circuit = (4/12) *100 = 33.33%
f) Electricity, Geography = (3/12) *100 = 25%
g) Electricity, Ande-ande moss = (3/12) *100 = 25%
h) Electrical Circuit, Geography = (3/12) *100 = 25%
i) Electricity, Ande Moss = (2/12) *100 = 16.67%
j) Ande Moss, Geography = (4/12) *100 = 33.33% 10.

If the support value meets the 30% standard, it is used as a reference for the next association. Otherwise, it is deleted. Example Atlas-electrical = (4/12)*100 = 33.33%. The values are collected and obtained according to the minimum support as follows:

Table 5. Result 2 Itemset

No	Item	Number Of Transactions	Support %
1	Atlas, Kelistrikan	4	33.3333333
2	Atlas, Geografi	5	41.6666667
3	Atlas, Ande Lumut	5	S0
4	Kelistrikan, R. Listrik	4	33.3333333
5	Ande Lumut, Geografi	4	33.3333333

From Table 5 above, the most dominant minimum support limit is if the atlas book is borrowed, then the ande-ande moss book is likely to be borrowed, or if the Atlas is borrowed, then geography and ande-ande moss are borrowed at the same time. Next, we create three item sets with the same steps as the 2 item set, except that we add one book and then compare them.

From Table 6 below, the support value can be set at 30%. Those that do not reach the support figure are ignored, and the following analysis is carried out.:

a) Atlas, electrical, electricity = (1/12)*100 = 8.33 (does not meet the minimum support)
b) Atlas, electricity, Geography = (2/12)*100 = 16.67 (does not meet the minimum support)
c) Atlas, electrical, Ande moss = (2/12)*100 = 16.67 (does not meet the minimum support) 3.
d) electricity, R.Listrik, Geografi = (2/12)*100 = 16.67 (does not meet the minimum support)
e) electrical, R. Electricity, Ande moss = (2/12)*100 = 16.67 (does not meet the minimum support)
f) R. Electricity, Geography, Ande moss = (0/12)*100 = 0 (does not meet the minimum support) 6.
g) Geography, Ande moss, Atlas = (4/12)*100 = 33.3 (meets the minimum support) 7.

Table 6. Three Itemsets

1. ATLAS , KELISTRIKAN, R. LISTRIK				
Bulan	Nama Judul Buku			TRX 2 ITEM
	ATLAS	KELISTRIKAN	R. LISTRIK	
1	1	0	0	N
2	1	1	0	N
3	0	1	1	N
4	1	1	0	N
5	1	0	0	N
6	1	0	1	N
7	1	1	0	N
8	1	1	1	Y
9	0	1	1	N
10	1	0	1	N
11	1	0	0	N
12	0	1	1	N
jumlah 3 itemset				1
Support (%)				8,33333

2. ATLAS , KELISTRIKAN, GEOGRAFI				
Bulan	Nama Judul Buku			TRX 2 ITEM
	ATLAS	KELISTRIKAN	GEOGRAFI	
1	1	0	1	N
2	1	1	0	N
3	0	1	0	N
4	1	1	1	Y
5	1	0	1	N
6	1	0	0	N
7	1	1	1	Y
8	1	1	0	N
9	0	1	1	N
10	1	0	1	N
11	1	0	1	N
12	0	1	1	N
jumlah 3 itemset				2
Support (%)				16,6667

3. ATLAS , KELISTRIKAN, ANDE LUMUT				
Bulan	Nama Judul Buku			TRX 2 ITEM
	ATLAS	KELISTRIKAN	ANDE LUMUT	
1	1	0	1	N
2	1	1	1	Y
3	0	1	1	N
4	1	1	0	N
5	1	0	1	N
6	1	0	1	N
7	1	1	1	Y
8	1	1	0	N
9	0	1	0	N
10	1	0	0	N
11	1	0	1	N
12	0	1	0	N
jumlah 3 itemset				2
Support (%)				16,6667

1. ATLAS , KELISTRIKAN, R. LISTRIK				
Bulan	Nama Judul Buku			TRX 2 ITEM
	ATLAS	KELISTRIKAN	R. LISTRIK	
1	1	0	0	N
2	1	1	0	N
3	0	1	1	N
4	1	1	0	N
5	1	0	0	N
6	1	0	1	N
7	1	1	0	N
8	1	1	1	Y
9	0	1	1	N
10	1	0	1	N
11	1	0	0	N
12	0	1	1	N
jumlah 3 itemset				1
Support (%)				8,33333

2. ATLAS , KELISTRIKAN, GEOGRAFI				
Bulan	Nama Judul Buku			TRX 2 ITEM
	ATLAS	KELISTRIKAN	GEOGRAFI	
1	1	0	1	N
2	1	1	0	N
3	0	1	0	N
4	1	1	1	Y
5	1	0	1	N
6	1	0	0	N
7	1	1	1	Y
8	1	1	0	N
9	0	1	1	N
10	1	0	1	N
11	1	0	1	N
12	0	1	1	N
jumlah 3 itemset				2
Support (%)				16,6667

3. ATLAS , KELISTRIKAN, ANDE LUMUT				
Bulan	Nama Judul Buku			TRX 2 ITEM
	ATLAS	KELISTRIKAN	ANDE LUMUT	
1	1	0	1	N
2	1	1	1	Y
3	0	1	1	N
4	1	1	0	N
5	1	0	1	N
6	1	0	1	N
7	1	1	1	Y
8	1	1	0	N
9	0	1	0	N
10	1	0	0	N
11	1	0	1	N
12	0	1	0	N
jumlah 3 itemset				2
Support (%)				16,6667

7. GEOGRAFI, ANDE LUMUT, ATLAS				
Bulan	Nama Judul Buku			TRX 2 ITEM
	GEOGRAFI	ANDE LUMUT	ATLAS	
1	1	1	1	Y
2	0	1	1	N
3	0	1	0	N
4	1	0	1	N
5	1	1	1	Y
6	0	1	1	N
7	1	1	1	Y
8	0	0	1	N
9	1	0	0	N
10	1	0	1	N
11	1	1	1	Y
12	1	0	0	N
jumlah 3 itemset				4
Support (%)				33,3333

Then, in the decision, three itemset are as follows:

Table 7. Decision Three itemset

7. Geografi, Ande Lumut, Atlas				
	Book Title			
Month	Geografi	Ande Lumut	Atlas	Trx 2 Item
1	1	1	1	Y
2	0	1	1	N
3	0	1	0	N
4	1	0	1	N
5	1	1	1	Y
6	0	1	1	N
7	1	1	1	Y
8	0	0	1	N
9	1	0	0	N
10	1	0	1	N
11	1	1	1	Y
12	1	0	0	N
Total Three Itemsets				**4**
Support (%)				**33,3333**

No	Item	Support Calculation	Support % Limit
1	Geografi, Ande Lumut, Atlas	33,33	30

Table 7 shows that three itemsets are sure to have one decision: if students borrow geography books, ande ande moss eats borrow atlas books. Again, in addition to the minimum support, the confidence level is ensured by measuring the confidence level of 60% and the reference support of 30%. The results are as follows:

Table 8a. Confidence Level

No	Rule	Confidence	
1	if borrowing an atlas, then borrowing electricity	4/7	57.14286
2	if borrow electricity, then borrow Atlas	4/9	44.44444
3	if borrow Atlas, then borrow geographic	5/8	62.5
4	if borrow geographic, then borrow Atlas	5/7	71.42857
5	if borrow Atlas, then borrow ande ande lumut	6/7	85.71429
6	if borrow ande ande lumut, then borrow Atlas	6/9	66.66667
7	if borrow electricity, then borrow an electrical Circuit	4/6	66.66667
8	if borrow an electrical Circuit, then borrow an electrical	4/7	57.14286
9	if borrow ande ande lumut, then borrow geographic	4/8	50
10	if borrow geographic, then borrow ande ande lumut	4/7	57.14286

Table 8b. Confidence Level: 2 Item Set

No	Item	Number Of Transactions	Support %
1	Atlas, Kelistrikan	4	33
2	Atlas, Geografi	5	42
3	Atlas, Ande Ande Lumut	6	33
4	Kelistrikan, R. Listrik	4	33
5	Ande Ande Lumut, Geografi	4	33

Table 8c. Confidence Level: 1 Item Set

No	Item	Number Of Transactions	Support %
1	Atlas	9	75
2	Kelistrikan, R. Listrik	7	58
3	Rangkaian Listrik	6	50
4	Geografi	8	67
5	Ande Ande Lumut	7	58

From the table 8a, table 8b, and table 8c above, the confidence is obtained from the following calculations:

a) If borrow an atlas then borrow an electrical book = 2 itemset (atlas, electrical) / 1itemset (electrical) * 100 = (4/7)*100 = 57%
b) If borrow Electrical then borrow Atlas book = 2 itemset (atlas, electrical) / 1itemset (atlas) * 100 = (4/9)*100 = 44%
c) If borrow atlas then borrow Geography book = 2 itemset (atlas, Geography) / 1itemset (Geography) * 100 = (5/8)*100 = 62.5%
d) If borrow Geography then borrow atlas book = 2 itemset (atlas, Geography) / 1itemset (atlas) * 100 = (5/7)*100 = 71.4%
e) If borrow atlas then borrow Ande moss book = 2 itemset (atlas, Ande moss) / 1itemset (ande moss) * 100 = (6/7)*100 = 85.7%
f) If borrow Ande moss then borrow atlas book = 2 itemset (atlas, Ande Lumut) / 1itemset (atlas) * 100 = (6/9)*100 = 66.67%

And so on, it is obtained as in the following table 9:

Table 9. Confident Result Rule

NO	RULE	CONFIDENCE	
1	if borrowing an atlas, then borrowing electricity	4/7	57.14286
2	if borrow electricity then borrow Atlas	4/9	44.44444
3	if borrow Atlas then borrow geographic	5/8	62.5
4	if borrow geographic then borrow Atlas	5/7	71.42857
5	if borrow Atlas then borrow ande ande lumut	6/7	85.71429
6	if borrow ande ande lumut, then borrow Atlas	6/9	66.66667
7	if borrow electricity then borrow an electrical Circuit	4/6	66.66667
8	if borrow an electrical Circuit, then borrow an electrical	4/7	57.14286
9	if borrow ande ande lumut then borrow geographic	4/8	50
10	if borrow geographic then borrow ande ande lumut	4/7	57.14286

Comparing the support value on one itemset. With the level of confidence value. Provided that the confidence value is greater than the support value. Then, the results are obtained as in Table 10

Table 10. Comparison Confident Result Rule

NO	RULE	CONFIDENCE		SUPPORT
1	if borrow Atlas then borrow ande ande rumput	6/7	85.714	58
2	if borrow electricity then borrow an electrical Circuit	4/6	66.667	50

The display of the results in the application is shown in Figure 2 below.

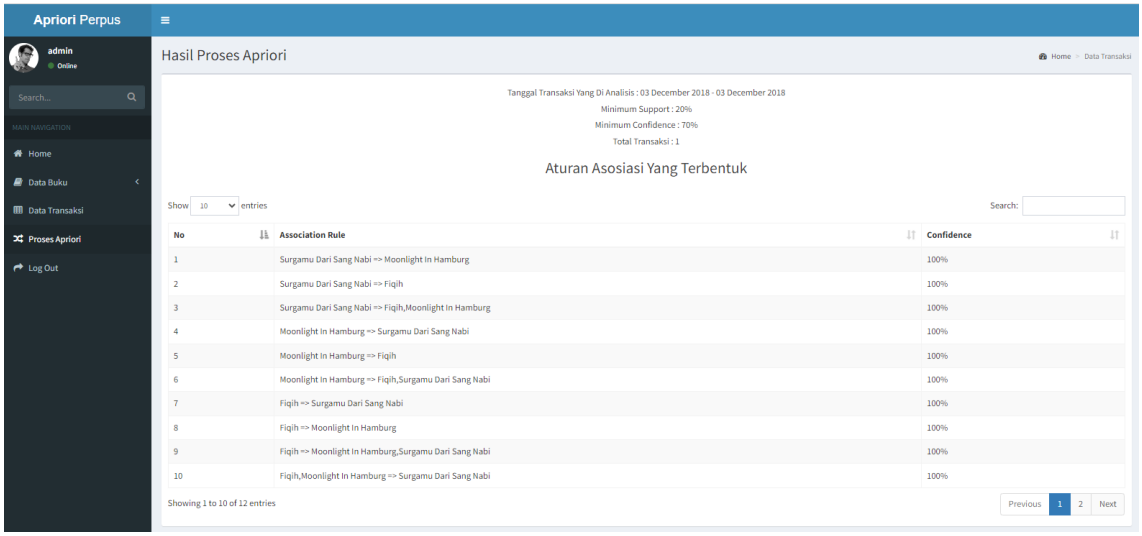

Figure 2. The result of the apriori process in the application

The application of this method has several main benefits:

- Increased Efficiency of Collection Arrangement: Books often borrowed together can be placed close together to increase accessibility.
- More Accurate Book Recommendations: The system can provide book recommendations based on previous borrowing patterns, similar to the recommendation system in online bookstores.
- Optimization of Book Procurement: Libraries can prioritize the procurement of books that have strong associations with other books that are often borrowed.
- User Behavior Analysis: Librarians can understand readers' preferences based on detected borrowing patterns.

Although the Apriori algorithm has many advantages, some challenges must be considered:

- Scalability and Performance: The Apriori algorithm can be slow when the number of borrowing transactions is very large, especially if the minimum support value is low.
- Data Quality: Borrowing data must be complete and clean for more accurate analysis results.
- Interpretation of Results: Not all association rules found have practical value; it is necessary to select truly relevant rules.

Several studies have shown the effectiveness of this method in libraries. Case studies at various universities show that the Apriori algorithm can find relationships between books with high confidence. For example, if many students who borrow the book "Atlas" also borrow "Ande-ande Lumut," then the system can recommend Ande-ande Lumut to students looking for books about Atlas. This algorithm can be integrated with a digital library system based on machine learning to be more effective. With continuous learning from new

borrowing data, the system can continuously update the recommendation pattern to remain relevant.

4. CONCLUSION

The author makes the following conclusions based on evaluating and testing the book loan transaction pattern system application at SMKN 1 Cirebon City using the Apriori method.

a. The results of testing with book borrowing transaction data in the library with a minimum support limit experiment of 30% and a minimum confidence of 60% obtained 10 rules each year.
b. One of the rules formed is if you borrow an atlas, then borrow a lumut with a support value of 58% and a confidence value of 85.7%, and if you borrow electricity then borrow an electrical circuit, these rules can be recommendations for the library to arrange the layout of the books.

This clustering system still needs to be continuously improved in performance. Suggestions for further development are:

a. It is necessary to compare several methods, and the aim is to get good recommendations
b. Increasing the number of association rules between items. This can be obtained by obtaining a larger dataset so that the number of support and confidence variations will also be greater.
c. Increasing the increasingly varied mining pattern. This can be achieved by increasing the number of books analyzed.

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