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Association Rule Mining To Enhance Sata Bottle Sales

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A B S T R A C T

Sales of sata bottles are growing and increasing, However, the results of these sales transactions have not been maximally utilized by shop owners. In fact, by using data mining techniques, the collection of data can generate new information. Association rule mining can find interaction patterns between one or more items in a very large data set. This algorithm is widely used in transaction data for purchasing product items at the same time by customers. research objectives to improve sales strategy, by collecting sales patterns that help related parties make sales strategy decisions, recommend products to customers, and maintain product availability. The research method using apriori algorithm data mining system that aims to determine consumer purchasing patterns. The association rule obtained results in 1 product that is often purchased simultaneously, namely Buy Rabbit Bottle, 420ml Clear Bottle, Buy Rabbit Bottle, Glass Straw, and Buy Rabbit Bottle, Nice Glass with a support value of 10% and a confidence of 80% in three frequent itemset and Rabbit Bottle, 420ml Clear Bottle, Rabbit Bottle, Glass Straw, and Nice Glass, 420ml Clear Bottle with a support value of 15% and a confidence of 83% in two frequent itemset.

1. Introduction

Distributor of Sata Bottles is one of the distributors of glass tumbler bottles and provides screen printing. Sata Bottle as one of the companies engaged in the business of trading drinking bottles, cups and screen printing services to continue to strive to produce superior services and products that meet customer needs and expectations.

Many types of bottles so that there is often a buildup of unsold goods and it is difficult to determine which products are most in demand by consumers. In anticipation of this , Distributor of Sata Bottles needs to process transaction data into useful information that can be utilized as a business strategy[1]. The problem of Sata Bottle Wholesale is that there are many types of bottle products so that there is often a buildup of one type of product and it is difficult to determine which products are of interest to consumers. To solve this problem, Botol Sata needs to process transaction data to find the pattern of consumer purchases, so that the information is useful and can be used as a prediction of sales stock.

This research objectives to improve sales strategy, by collecting sales patterns that help related parties make sales strategy decisions, recommend products to customers, and maintain product availability.[2] Previous studies have been conducted to find consumer purchasing patterns, one of which is research conducted by Sriyanto [3] which aims to find out the sales that consumers are interested in with a minimum support of 30% and a minimum confidence of 60%.

Association Rules formed are if consumers buy NTHN450 products, they also buy NTHN330 with a support value of 47% and a Confidence value of 78% and if consumers buy MTTK330 products, they also buy YOGURT with a support value of 47% and a confidence value of 71%. (2). Riki Winanjaya's research which aims to determine the supply of goods by applying a minimum support of> 30% formed two Association Rules, namely if consumers buy sugar then also buy rice with a confidence value of 56% and if consumers buy eggs then also buy rice with a confidence value of 62%.[4] A priori algorithms produce information, namely consumer purchasing patterns which will be useful for predicting future product availability[5].

In addition, using an a priori algorithm with a minimum support of three and a minimum confidence of seventy percent, Alfie Nur Rahm et al. found one established rule: if customers buy Sedaap fried noodle products, they will buy 250 grams of eggs. After knowing the result, the store owner can use this information to create a stocking strategy, for example, if increasing the stock of Sedaap Mie Goreng, 250 grams of eggs will also be added[6].

In addition, Nola Ritha, et al. showed that the Apriori Algorithm method can be used to determine association rules in the Internal Medicine polyclinic of the Bintan Regional General Hospital with a minimum support of 6% and a minimum confidence of 50%, which can produce association rules that can be used by the hospital and the health department to conduct socialization and health counseling to the community and can be a reference for the health department to make policies in terms of disease prevention.[5]

Based on the background description, the purpose of this research will create an apriori algorithm data mining system that aims to determine consumer purchasing patterns. Association rule mining method is quite efficient because it takes less time than other algorithms. Association rules are also often referred to as market basket analysis.[7] The purpose of this market basket analysis is to determine what items are usually purchased by supermarket customers. Market Basket Analysis (MBA) can be done with several algorithms, but the Apriori algorithm is the most widely used algorithm.[8] This market basket analysis (MBA) is described in figure 1:

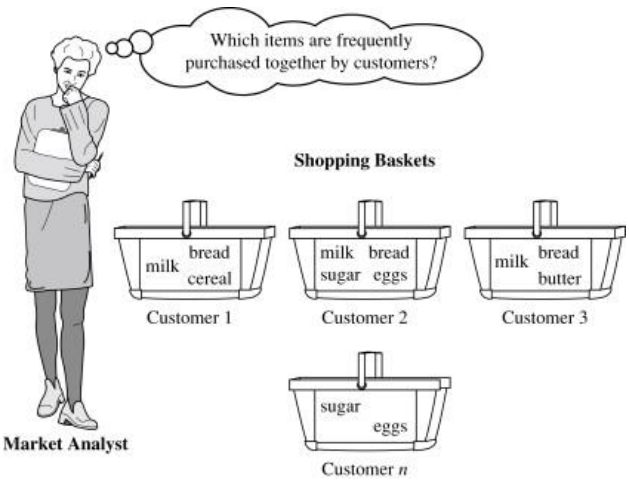

Figure 1. Market Basket Analysis[9]

2. Method

The research method is a scientific way to get data with specific purposes and uses. Based on this, there are four keywords that need to be considered, namely scientific methods, data, goals and uses [11]. The data sample consists of several transaction records totaling 10 purchase transactions. The research steps modeled in this study are illustrated in figure 2.

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Figure 2. Research Steps[10]

Figure 2. shows the research stage that will be carried out by entering the sample data to be analyzed, then the Apriori Algorithm serves to find out the classification of patterns / combinations in a set of itemsets. of itemsets. Then the Association Rule method is used to process data and calculate the results of association rules on a set of items[11].

A. Data Selection

Data that will be used for the data mining process comes from sales transaction data that CV. Sata Bottle Wholesale. The sales data downloaded in excel format consists of 789 sales transactions for four months from February to May 2024. Can be seen in table 1.

Tabel 1. Transaction Data Sales.

No.	Customer Type	Item group	Product	Amount
1	Reseller	Grosir	Crystal Bottle	1500
2	Customer	Grosir	Eko Souvenir Box (9x9x14)	200
3	Customer	Grosir	Crystal Bottle	120
4	Customer	Souvenir	Bubblewarp	1
5	Customer	Souvenir	Wooden Crate	1
6	Customer	Grosir	Lucky day doff bottle	185
7	Reseller	Grosir	Crystal Bottle	400
8	Customer	Grosir	Glass Straws Box	270
9	Customer	Souvenir	Glass Straws Packaging - EKO PACKAGING 9x9x14_9x9x15	240
10	Customer	Grosir	420ml Clear Bottle	200
11	Customer	Grosir	Lucky day bottle doff	500
12	Customer	Grosir	Glass Straws Box	300
13	Customer	Grosir	Glass Straws Box	58
14	Customer	Grosir	Glass Straws Box	116
15	Reseller	Grosir	420ml Clear Bottle	1600
16	Reseller	Grosir	Glass Straw Box	174
17	Customer	Grosir	Lucky day bottle doff	560
---	---	---	---	---
785	Customer	Grosir	Crystal Bottle	100
786	Customer	Souvenir	Wooden Crate	5
787	Customer	Grosir	Straw Cups	285
788	Customer	Grosir	Straw Cups	60
789	Reseller	Grosir	Straw Cups	103

B. Data Preprocessing

The initial data's data reduction and cleansing are included in data processing, in the event that the combined data is not suitable[12]. Data preprocessing is as shown figure 3.

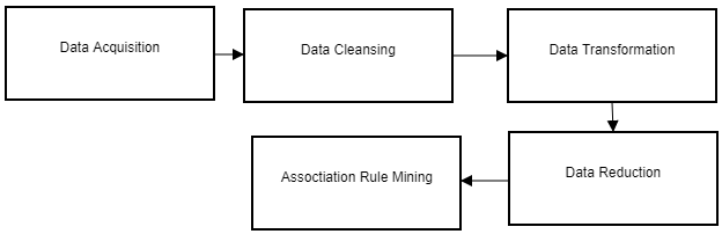

Figure 3. Data Preprocessing

a. Data cleansing
The main purpose of data cleaning is to process data so that it can be accurately analyzed and used to better extract useful information.[12][13] Data cleaning includes removing duplicate data, missing values, outlier values, data format unification, and normalization.

b. Data transformation
Data transformation is the process of combining data from multiple sources into a single data set, includes identifying data sources[14], identifying and resolving schema conflicts.

c. Data reduction
Data reduction purposes to reduce the amount of data by removing redundant information and retaining important information[15], thereby reducing the time and cost of processing, storing data, without reducing the meaning of the data.

3. Results and Discussion

A. Example of Transaction Data Set.
Field observations and surveys provided the sample data for this investigation. Attached is an example of buy transaction data in Table 2.

Tabel 2. Transaction Data Set.

No	Product
1	Rabbit Bottle, Macaron Box Bottle
2	Rabbit Bottle, Nice Glass
3	Rabbit Bottle, Straws Glass
4	Rabbit Bottle, Straws Box
5	Rabbit Bottle, 420ml Clear Bottle
6	Rabbit Bottle, 420ml Doff Bottle
7	Macaron Box Bottle, Nice Glass
8	Macaron Box Bottle, Straws Glass
9	Macaron Box Bottle, Straws Box
10	Macaron Box Bottle, 420ml Clear Bottle
11	Macaron Box Bottle, 420ml Doff Bottle
12	Nice Glass, Straws Glass
13	Nice Glass, Straws Box
14	Nice Glass, 420ml Clear Bottle
15	Nice Glass, 420ml Doff Bottle

B. Data Transformation
The next step, the data is converted to tabular format to make it easier to know how many of each item was sold in the entire transactions. Can be seen in shown in Table 3.

Tabel 3. Tabular Data Set.

No	Rabbit Bottle	Macaron Box Bottle	Nice Glass	Straws Glass	Straws Box	420ml Clear Bottle	420ml Doff Bottle
1	1	1	1	1	1	1	0
2	1	1	1	1	1	1	1
3	0	0	0	0	1	0	0
4	1	0	1	1	1	1	1
5	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1
7	1	0	1	1	1	1	1
JML	6	4	6	6	7	6	5

C. Apriori Algorithm
Analysis of high-frequency patterns, also known as high-frequency pattern mining, is a stage of association analysis that attracts the attention of many researchers to come up with efficient algorithms. Two parameters, support and confidence, can be used to determine the importance of

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association rules. Support, or favorability value, is the percentage of item combinations in the database, while confidence, or certainty value, is the strength of the relationship between items in the association rule[6]. The Apriori algorithm for association rule mining can be used in two steps. Finding all of the item sets from the database that appear frequently is the first stage.

```
Apriori Algorithm [16]
variable:
  Ck is candidate item sets k
  Lk is frequent item sets k
Start:
  Find frequent set Lk-1
  Generate Ck using CP Lk-1, i.e Lk-1 x Lk-1
  Pruning remove any k-1 size itemset are not frequent
  Return frequent set Lk-1
END:
```

Based on the tabular data (Table 3), the number of transactions of each item can be seen in Table 4. number of transaction item sets

Tabel 4. Number of Transaksi Item Set.

No	Product	Amount
1	Rabbit Bottle, Macaron Box Bottle	4
2	Rabbit Bottle, Nice Glass	6
3	Rabbit Bottle, Straws Glass	6
4	Rabbit Bottle, Straws Box	6
5	Rabbit Bottle, 420ml Clear Bottle	6
6	Rabbit Bottle, 420ml Doff Bottle	5
7	Macaron Box Bottle, Nice Glass	4
8	Macaron Box Bottle, Straws Glass	4
9	Macaron Box Bottle, Straws Box	4
10	Macaron Box Bottle, 420ml Clear Bottle	4
11	Macaron Box Bottle, 420ml Doff Bottle	3
12	Nice Glass, Straws Glass	6
13	Nice Glass, Straws Box	6
14	Nice Glass, 420ml Clear Bottle	6
15	Nice Glass, 420ml Doff Bottle	5

D. Analisa Pola Frekuensi Tertinggi

High frequency pattern analysis to find combinations between items that meet the minimum requirements of the support value in the database. The support value is obtained by the equation below :[12]

$$support(A \rightarrow B) = support(A \cup B) = P(AB) \qquad (1)$$

A threshold other than the support value that is used to determine the rule is confidence. According to rule AB, it is the ratio of transactions having items A and B divided by transactions having item A can be calculated by the formula : [12][17][18]

$$confidence(A \rightarrow B) = \frac{support\ (A \cup B)}{support\ (A)} \qquad (2)$$

a result of the data found in Table 3, the next step is to find itemset 1 that meets the minimum requirements to satisfy equation [16]. The pseudocode of the algorithm is summarized in Algorithm:

```
Frequent item sets
variable:
  Ck is candidate item sets k
  Lk is frequent item sets k
Start:
  L1 ← {large 1 – item sets}
  k ← 2
  while Lk-1 ≠ 0
  Ck generate (Lk-1)
For transaction t € T
        Ct ← subset (Ck,t)
For candidate c € Ct
        Count {c}← {count{c}+1}
        Lk ← { c € Ck count|c| ≥ €}
        k=k+1
```

```
  Return Lk-1
END:
```

Combination of each product itemset that meets the minimum support value requirements that have been determined. The formation of the C1 process from the data in table 3 where one itemset with a minimum support equal to 10% is shown in table 5. :

Table 5. Number of One Frequent Item Sets.

No.	Items	Amount	Support
1	Rabbit Bottle	6	15%
2	Macaron Box Bottle	4	10%
3	Nice Glass	6	15%
4	Straws Glass	6	15%
5	Straws Box	7	18%
6	420ml Clear Bottle	6	15%
7	420ml Doff Bottle	5	13%

Table 5 is a table of data on the types of items that have been selected according to the minimum support value that has been determined. The data above is used to determine the combination of items and determine the value of support and confidence. [19]:

E. Formation of two-item Combination Pattern

The formation of a two-item frequent pattern is obtained from each item type that meets the minimum support. by combining all items into two combinations. The results of the combination of the two items are shown in table 6

Table 6. Two-Frequent item sets

No	Items	Amount	Support
1	Rabbit Bottle, Macaron Box Bottle	3	8%
2	Rabbit Bottle, Nice Glass	5	13%
3	Rabbit Bottle, Straws Glass	4	10%
4	Rabbit Bottle, Straws Box	2	5%
5	Rabbit Bottle, 420ml Clear Bottle	5	13%
6	Rabbit Bottle, 420ml Doff Bottle	4	10%
7	Macaron Box Bottle, Nice Glass	2	5%
8	Macaron Box Bottle, Straws Glass	1	3%
9	Macaron Box Bottle, Straws Box	2	5%
10	Macaron Box Bottle, 420ml Clear Bottle	3	8%
11	Macaron Box Bottle, 420ml Doff Bottle	3	8%
12	Nice Glass, Straws Glass	4	10%
13	Nice Glass, Straws Box	5	13%
14	Nice Glass, 420ml Clear Bottle	3	8%
15	Nice Glass, 420ml Doff Bottle	4	10%

The next step is to determine the support value of the minimum support that has been determined can be seen in the table 7

Table 7. Itemset with a predefined minimum value

No	Items	Amount	Support
1	Rabbit Bottle, Nice Glass	5	13%
2	Rabbit Bottle, Straws Glass	4	10%
3	Rabbit Bottle, 420ml Clear Bottle	5	13%
4	Rabbit Bottle, 420ml Doff Bottle	4	10%
5	Nice Glass, Straws Box	4	10%
6	Nice Glass, 420ml Clear Bottle	5	13%

Formation of C2 from two itemsets with a minimum amount of support equal to 10% and a minimum confidence of 60%

Table 8. Confidence Value from Two-Itemset

No	Items	Amount	Support	Confidence
1	Rabbit Bottle, Nice Glass	5/6	15%	83%
2	Rabbit Bottle, Straws Glass	4/6	15%	67%
3	Rabbit Bottle, 420ml Clear Bottle	5/6	15%	83%
4	Rabbit Bottle, 420ml Doff Bottle	4/6	13%	67%

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5	Nice Glass, Straws Box	4/6	15%	67%
6	Nice Glass, 420ml Clear Bottle	5/6	15%	83%

The next step is to identify the association rule (A->B) that satisfies the minimal confidence value criteria after determining all of the high frequency values. satisfies the minimal threshold for confidence value. calculating the Association Rules' value by examining the confidence value. The number of combinations between items serves as the support value, and the strength of the relationship between items is defined by the confidence value is a number that indicates how close certain things are to one another.

Table 9. Association Rule

No	Items	Support	Confidence
1	IF Buy Rabbit Bottle, THEN Buy Nice Glass	15%	83%
2	IF Buy Rabbit Bottle, THEN Buy Straws Glass	15%	67%
3	IF Buy Rabbit Bottle, THEN Buy 420ml Clear Bottle	15%	83%
4	IF Buy Rabbit Bottle, THEN Buy 420ml Doff Bottle	13%	67%
5	Nice Glass, Straws Box	15%	67%
6	Nice Glass, 420ml Clear Bottle	15%	83%

F. Formation of three-item Combination Pattern

The formation of a three-item frequent pattern is obtained from each item type that meets the minimum support. by combining all items into three combinations. The results of the combination of the three frequent items sets are shown in table 10

Table 10. Thre-Frequent item sets

No.	Items	Amount	Support
1	Rabbit Bottle, Macaron Box Bottle, Nice Glass	1	3%
2	Rabbit Bottle, Macaron Box Bottle, Straws Glass	2	5%
3	Rabbit Bottle, Macaron Box Bottle, Straws Box	2	5%
4	Rabbit Bottle, Macaron Box Bottle, 420ml Clear Bottle	1	3%
5	Rabbit Bottle, Macaron Box Bottle, 420ml Doff Bottle	1	3%
6	Rabbit Bottle, Nice Glass, Straws Glass	2	5%
7	Rabbit Bottle, Nice Glass, Straws Box	3	8%
8	Rabbit Bottle, Nice Glass, 420ml Clear Bottle	2	5%
9	Rabbit Bottle, Nice Glass, 420ml Doff Bottle	2	5%
10	Rabbit Bottle, Straws Glass, Straws Box	3	8%
11	Rabbit Bottle, Straws Glass, 420ml Clear Bottle	2	5%
12	Rabbit Bottle, Straws Glass, 420ml Doff Bottle	1	3%
13	Rabbit Bottle, Straws Box, 420ml Clear Bottle	1	3%
14	Rabbit Bottle, Straws Box, 420ml Doff Bottle	2	5%
15	Rabbit Bottle, 420ml Clear Bottle, 420ml Doff Bottle	4	10%

The next step is to determine the minimum support equal to 10% table 11.

Table 11. Three-Frequent item sets

No.	Items	Amount	Support
1	Rabbit Bottle, Macaron Box Bottle, Nice Glass	1	3%
2	Rabbit Bottle, Macaron Box Bottle, Straws Glass	2	5%
3	Rabbit Bottle, Macaron Box Bottle, Straws Box	2	5%
4	Rabbit Bottle, Macaron Box Bottle, 420ml Clear Bottle	1	3%
5	Rabbit Bottle, Macaron Box Bottle,	2	5%

	420ml Doff Bottle		
6	Rabbit Bottle, Nice Glass, Straws Glass	2	5%
7	Rabbit Bottle, Nice Glass, Straws Box	4	10%
No.	**Items**	**Amount**	**Support**
8	Rabbit Bottle, Nice Glass, 420ml Clear Bottle	2	5%
9	Rabbit Bottle, Nice Glass, 420ml Doff Bottle	2	5%
10	Rabbit Bottle, Straws Glass, Straws Box	4	10%
11	Rabbit Bottle, Straws Glass, 420ml Clear Bottle	2	5%
12	Rabbit Bottle, Straws Glass, 420ml Doff Bottle	1	3%
13	Rabbit Bottle, Straws Box, 420ml Clear Bottle	1	3%
14	Rabbit Bottle, Straws Box, 420ml Doff Bottle	2	5%
15	Rabbit Bottle, 420ml Clear Bottle, 420ml Doff Bottle	4	10%

The next step is to determine the support value of the minimum support that has been determined can be seen in the table 12

Table 12. Itemset with a predefined minimum value

No.	Items	Amount	Support
1	Rabbit Bottle, Nice Glass, Straws Box	4	10%
2	Rabbit Bottle, Straws Glass, Straws Box	4	10%
3	Rabbit Bottle, 420ml Clear Bottle, 420ml Doff Bottle	4	10%

The next step is to identify the association rule that satisfies the minimal confidence value criteria after determining all of the high frequent values. the minimal threshold for confidence value. calculating the Association Rules value by examining the confidence value. The number of combinations between items serves as the support value, and the strength of the relationship between items is defined by the confidence value is a number that indicates how close certain things are to one another.

Table 13. Association Rule

No.	Items	Amount	Support	Confidence
1	IF Buy Rabbit Bottle, Nice Glass, THEN Buy Straws Box	4	10%	80%
2	IF Buy Rabbit Bottle, Straws Glass, THEN Buy Straws Box	4	10%	80%
3	IF Buy Rabbit Bottle, 420ml Clear Bottle, THEN Buy 420ml Doff Bottle	4	10%	80%

G. Find the Confidence Value

The table association rule presents the findings from the previous sub-chapter's support and confidence calculations. It yielded 6 association rules where all confidence values were found at two frequent itemset and 3 association rules where all confidence values were found at three frequent itemset to be at least the minimum value. Based on this data, table 9 and table 13 displays the purchasing pattern and product combination rule[8].

Table 14. Final Association Rule Two Frequent Itemset

No	Items	Support	Confidence	Association Rule
1	Rabbit Bottle, Nice Glass	15%	83%	IF Buy Rabbit Bottle, THEN Buy Nice Glass
2	Rabbit Bottle, Straws Glass	15%	67%	IF Buy Rabbit Bottle, THEN Buy Straws Glass

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3	Rabbit Bottle, 420ml Clear Bottle	15%	83%	IF Buy Rabbit Bottle, THEN Buy 420ml Clear Bottle
4	Rabbit Bottle, 420ml Doff Bottle	13%	67%	IF Buy Rabbit Bottle, THEN Buy 420ml Doff Bottle
No	**Items**	**Support**	**Confidence**	**Association Rule**
5	Nice Glass, Straws Box	15%	67%	IF Buy Nice Glass, THEN Buy Straws Box
6	Nice Glass, 420ml Clear Bottle	15%	83%	IF Buy Nice Glass, THEN Buy 420ml Clear Bottle

Table 15 generates final association rule by obtaining 3 Rabbit Bottle, 420ml Clear Bottle, Rabbit Bottle, Glass Straw, and Nice Glass, 420ml Clear Bottle with a value of support of 15% and confidence of 83%

Tabel 15. Final Association Rule Three Frequent Itemset

Item set	Conclusion	Amount	Support	Confident	Association Rule
Buy Rabbit Bottle, Nice Glass	Straws Box	4	10%	80%	IF Buy Rabbit Bottle, Nice Glass, THEN Buy Straws Box
Buy Rabbit Bottle, Straws Glass	Straws Box	4	10%	80%	IF Buy Rabbit Bottle, Straws Glass, THEN Buy Straws Box
Rabbit Bottle, 420ml Clear Bottle	420ml Doff Bottle	4	10%	80%	IF Buy Rabbit Bottle, 420ml Clear Bottle, THEN Buy 420ml Doff Bottle

Table 15 produces the final association rule by obtaining 3 products that are often purchased together, namely Buy Rabbit Bottle, Clear Bottle 420ml, Buy Rabbit Bottle, Glass Straw, and Buy Rabbit Bottle, Nice Glass with a support value of 10% and a confidence of 80%

4. Conclusion

Based on the research and discussion conducted, it can be concluded that the association rule mining method using the apriori algorithm can be applied to find patterns of purchase transactions by combining goods used to increase product sales. The association rule results obtained produce 1 product that is often purchased together, namely Buy Rabbit Bottle, 420ml Clear Bottle, Buy Rabbit Bottle, Glass Straw, and Buy Rabbit Bottle, Nice Glass with a support value of 10% and a confidence of 80% in three frequent itemset and Rabbit Bottle, 420ml Clear Bottle, Rabbit Bottle, Glass Straw, and Nice Glass, 420ml Clear Bottle with a support value of 15% and a confidence of 83% in two frequent itemset.

References

[1] C. B. Sata, "No Title," *CV. Grosir Botol Sata*. [Online]. Available: grosirbotolsata.myolsera.com. [Accessed: 20-Mar-2024].

[2] I. Yanti and D. Idayanti, "Analisis Strategi Pemasaran Untuk Meningkatkan Penjualan Pada Usaha Ibu Bagas di Kecamatan Mamuju," *Forecast. J. Ilm. Ilmu Manaj.*, vol. 1, no. 1, pp. 1–13, 2022.

[3] Sriyanto, Ahmad Fauzi, and Candra Zonyfar, "Data Mining Penerapan Algoritma Apriori untuk Analisis Data Transaksi Sistem Inventory (Studi Kasus PT ABC President Indonesia)," *Sci. Student J. Information, Technol. Sci.*, vol. III, no. 1, p. 143, 2022.

[4] J. Dongga, A. ` Sarungallo, N. Koru, and G. Lante, "Implementasi Data Mining Menggunakan Algoritma Apriori Dalam Menentukan Persediaan Barang (Studi Kasus: Toko Swapen Jaya Manokwari)," *G-Tech J. Teknol. Terap.*, vol. 7, no. 1, pp. 119–126, 2023.

[5] Nola Ritha, E. Suswaini, and W. Pebriadi, "Penerapan Association Rule Menggunakan Algoritma Apriori Pada Poliklinik Penyakit Dalam (Studi Kasus: Rumah Sakit Umum Daerah Bintan)," *J. Sains dan Inform.*, vol. 7, no. 2, pp. 222–230, 2021.

[6] A. N. Rahmi and Y. A. Mikola, "Implementasi Algoritma Apriori Untuk Menentukan Pola Pembelian Pada Customer (Studi Kasus : Toko Bakoel Sembako)," *Inf. Syst. J.*, vol. 4, no. 1, pp. 14–19, 2021.

[7] Sofyan, "Implementation of Data Mining with Association Rule in Decision Making for Product Purchase Correlation using the Apriori Algorithm," *J. Chem. Inf. Model.*, vol. 53, no. 9, pp. 1689–1699, 2019.

[8] E. Umar, D. Manongga, and A. Iriani, "Market Basket Analysis Menggunakan Association Rule dan Algoritma Apriori Pada Produk Penjualan Mitra Swalayan Salatiga," *J. Media Inform. Budidarma*, vol. 6, no. 3, p. 1367, 2022.

[9] "Mining Frequent Patterns, Associations, and Correlations."

[10] S. Edition, *Data Mining Concepts and Techniques*. .

[11] U. Mencari and K. Hubungan, "'penerapan apriori rule generation untuk mencari kedekatan hubungan antar terminologi dalam buku elektronik.'"

[12] X. Zhang and J. Zhang, "Analysis and research on library user behavior based on apriori algorithm," *Meas. Sensors*, vol. 27, no. April, p. 100802, 2023.

[13] F. Ridzuan and W. M. N. Wan Zainon, "A review on data cleansing methods for big data," *Procedia Comput. Sci.*, vol. 161, pp. 731–738, 2019.

[14] "data transformation.pdf." .

[15] M. Goswami, S. Mohanty, and P. K. Pattnaik, "Optimization of Machine Learning Models through Quantization and Data Bit Reduction in Healthcare Datasets," *Franklin Open*, vol. 8, no. July, p. 100136, 2024.

[16] M. H. Santoso, "Application of Association Rule Method Using Apriori Algorithm to Find Sales Patterns Case Study of Indomaret Tanjung Anom," vol. 1, no. 2, pp. 54–66, 2021.

[17] E. Hikmawati, N. U. Maulidevi, and K. Surendro, "Minimum threshold determination method based on dataset characteristics in association rule mining," *J. Big Data*, vol. 8, no. 1, 2021.

[18] B. Mudumba and M. F. Kabir, "Mine-first association rule mining: An integration of independent frequent patterns in distributed environments," *Decis. Anal. J.*, vol. 10, no. February, p. 100434, 2024.

[19] C. Mihaescu, "Mining Frequent Itemsets – Apriori Algorithm," *Lab. Modul. 8*, 2012.