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Using the Apriori Algorithm to Identify Purchase Patterns for Enhancing Sales in Personal Shopper Services

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Abstract

This research aims to explore the application of the Apriori algorithm in identifying purchasing patterns in the drop-off service industry in order to increase sales. Drop-off services often face challenges in designing effective marketing strategies due to limited understanding of customer purchasing behavior. In this study, the Apriori algorithm is applied to uncover recurring purchase patterns among customers, which are then used to develop more efficient marketing strategies. Customer transaction data is analyzed to find associations that reflect their purchasing preferences. The results show that the application of the Apriori algorithm successfully identifies patterns that can improve marketing strategies and, ultimately, increase sales. This research emphasizes the importance of applying data mining techniques to improve the performance of delivery services.

Keywords: *Apriori Algorithm, Purchasing Patterns, Delivery Service, Data Mining, Marketing Strategy.*

1. Introduction

The rapid development of information technology has had a major impact on various sectors, including business and public services. One of the innovations that has emerged in this digital era is delivery services, which facilitate the transaction process between consumers and service providers. This service is increasingly in demand because it offers convenience, speed, and comfort for its users. However, in the midst of increasingly fierce competition, the biggest challenge for service providers is how to optimize sales and services. One aspect that needs to be considered is the utilization of transaction data, which is increasingly abundant, but often poorly managed.

A major problem faced by many companies, including checkout providers, is how to manage and analyze data to find patterns that can help increase sales. As technology develops, data mining algorithms, such as *Apriori*, are becoming increasingly important in analyzing large and complex transaction data. However, while these algorithms are widely used in various sectors, their application in trust services is still limited. Many service providers have yet to fully utilize their data to formulate more effective business strategies, so the potential for increased sales is often not maximized. The development of technology can be seen from the various forms of retail that have used the system in carrying out the buying and selling process. For example, in making buying and selling transactions, data on purchased goods is stored in one database. So that if data processing is not done properly, it will cause data accumulation and uselessness [1]

This research aims to implement the Apriori algorithm in finding purchase patterns in the transaction data of deposit service. By using the Apriori algorithm, it is expected to find associations between products that are often purchased together, which can then be used to formulate strategies to increase sales. This approach aims to identify hidden patterns in transaction data that can help service providers in designing more efficient and data-driven marketing strategies. With the existence of data mining, knowledge will be obtained in a large collection of data according to [2] The application of Apriori Algorithm, in general, requires a data structure to store candidate frequent itemsets for a kth iteration and to store the resulting frequent itemsets by [3] Application of Apriori Algorithm in Data Mining to Predict Visitor Patterns at Karo Regency Tourism Objects to [4]

2. Reseach Methods

The process of completing this research involves several stages, which include the following:

1. Prepation for Research; The initial stage of this research includes determining the background, identifying problems, and determining the boundaries of problems related to deposit services, which aims to provide a clear direction in the further research process.
2. Literature Review; This method is carried out by the author by reading and or citing books, journals and other sources related to modeling using data mining techniques and the Apriori algorithm [5].
3. Research Problem; This stage aims to understand the main problems in the delivery service by identifying purchasing patterns. The information obtained will be used to formulate relevant solutions to optimize service performance.
4. KDD (Knowledge Discovery in Databases) is a structured process for extracting useful information for decision-making, starting from data selection to result evaluation:
    a. Selection; In this stage, the relevant dataset is selected using an Excel file with 4,999 records of secondary data from a transaction database. The "Reactive" operator is used to ensure that the selected dataset aligns with the research objectives and contains the necessary information for further analysis. The data selection process is the selection of relevant data for research. In the initial database, there are many attributes in the table that are not needed because they are not used in the data mining process[6]
    b. Preprocessing; The pre-processing stage is the initial step in dataset processing, where transaction data from the service delivery system is cleaned to ensure its quality. This process includes removing irrelevant data, correcting errors, and reducing noise. Attribute transformation, especially for Customer ID and Product, is also an important part of this stage.
    c. Transformation; To process the dataset with the Apriori algorithm, the data must be transformed into a binomial format. This is done using the Numerical to Binominal operator to enable the algorithm to accurately identify association patterns. In this case, identifying the delivery service is also crucial, as the attributes related to the service need to be adjusted to match the binomial format. This stage is the process of transforming the selected data as a result of synchronizing the previous data for the data mining process[7].
    d. Data Mining; The FP-Growth operator is used to analyze transaction data by identifying association patterns between items that are frequently purchased together. This algorithm optimizes the search for frequent itemsets using the FP (Frequent Pattern) tree structure, enabling efficient processing of large datasets. In the context of delivery services, FP-Growth helps identify items that frequently appear together in delivery transactions, which can be used for targeted promotional strategies or more accurate product recommendations.
    e. Evaluation; The patterns discovered from the Apriori algorithm are analyzed to identify associations between products that are frequently purchased together. Evaluation is carried out by observing the support, confidence, and lift values to ensure the significance of the identified patterns. The results are translated into sales strategies, such as product bundle recommendations or promotions

2.1. Data Mining

Data Mining, The process of extracting and searching for useful information in selected data using specific techniques or methods depending on the knowledge-seeking process and the purpose of the research by [8]. Data mining is a term used to describe the discovery of knowledge in databases. The process involves analysis to discover unexpected relationships and summarize data in a way that is more understandable and useful to the data owner. In this study, the researchers used a quantitative approach by applying the Knowledge Discovery in Databases (KDD) process, which focuses on extracting knowledge from large datasets. This process was combined with the Apriori algorithm, which is known to be effective in identifying association patterns between items in transaction data. Using the KDD approach, researchers explored relevant purchase patterns, which can provide important insights into consumer behavior in delivery services. The results of applying this algorithm are expected to help service providers to optimize marketing strategies and improve service efficiency based on customer preferences and habits. The association data mining method can identify relationships or rules related to customer purchasing behavior and assist companies in making decisions regarding sales and marketing strategies[9] Association data mining methods can identify relationships or rules related to customer purchasing behavior buying behavior and help companies to make decisions regarding sales and marketing strategies[10]. Data mining is not an entirely new field. One of the difficulties in defining data mining is the fact that it inherits many aspects and techniques from established fields[11].

2.2. Apriori algorithm

The Apriori algorithm is an algorithm used to identify association patterns and relationships between items in a dataset. Its application can be used to find items that are often purchased together, which can then be used as the basis for promotional strategies, in the hope of increasing the purchase of additional items that were not previously planned. The a priori algorithm is a basic algorithm that was proposed by Agrawal & Srikant in 1994 to determine Frequent itemsets for Boolean association rules. Apriori algorithm is a type of association rule in data mining by[12]

One of the stages of association analysis that has attracted the attention of many researchers in developing efficient algorithms is frequent pattern mining. The significance of an association can be measured by two criteria: support and confidence. Support is the percentage of occurrences of an item combination in the database, while confidence is the strength of the relationship between items in the association rule[13]

The most commonly used data mining method is the Apriori technique by crosschecking the frequency of data sets using the apriori method. The Apriori method uses the concept of frequencies with symbols that are already understood beforehand to process the next information[14]. Association rule is a technique used to identify relationships or interesting patterns between elements in a dataset, as well as to understand how the presence of one item can influence the occurrence of another item. This technique is commonly used to discover associations between items in data. The Apriori algorithm, as one of the algorithms in association analysis, is used to find relationships between two or more attributes or objects in a dataset. In this context, the Apriori algorithm plays a key role in implementing association rules in data mining. Generally, the process of association analysis consists of two main stages, which are:

At this stage, the search for item combinations that meet the minimum support value in the transaction database is carried out. Support measures how often an item or itemset appears in transactions. The support value is calculated using the formula:

$$Support\ (A) = \frac{Number\ of\ Transactions\ Containing\ Items\ A}{Total\ Transactions}\ X\ 100\% \tag{1}$$

The formula above explains that the support value for item A is calculated by dividing the number of transactions containing item A by the total number of transactions. For two items, the support value is obtained by dividing the number of transactions containing both items by the total transactions. The support value indicates how often the combination of items appears in the dataset.

$$Support\ (A \cap B) = \frac{Transactions\ containing\ A\ and\ B}{Total\ Transactions}\ X\ 100\% \tag{2}$$

The formula above explains that the support value is obtained by dividing the number of transactions containing items A and B by the total number of transactions. After high-frequency patterns are found, association rules are generated by calculating the confidence between A and B. Confidence measures the conditional relationship between two items, and its value is calculated using the following formula.

$$Confidence = P(B|A) = \frac{Transaction\ data\ containing\ A\ and\ B}{Transaction}\ X\ 100\% \tag{3}$$

3. Results And Discussion

3.1. Supporting Data

Here is the data from recorded transaction services, used to analyze purchasing patterns and the relationships between frequently selected items. This data is presented in a structured format to facilitate further evaluation and analysis.

Table 1: Data Respresentation

Customer ID	Product	Quantity	Total Amount	Created_At
1	Zara Dress	3	981534	23/03/2024 03:48
2	Faber Castell Sketchbook	3	1145463	27/01/2024 05:42
3	Wardah Lipstick	3	1022547	05/11/2023 20:46
4	Adidas Sneakers	3	1024503	11/04/2024 03:25
5	Funko Pop Batman	4	775984	31/12/2023 07:25
6	Uniqlo T-shirt	1	295646	29/03/2024 01:23
7	Pilot G2 Pen Set	3	956223	24/05/2024 18:17
8	Loreal Foundation	2	908946	10/02/2024 05:18
9	Zara Dress	5	2049385	31/07/2024 00:40
10	Barbie Doll	2	928748	28/01/2024 23:49
11	Faber Castell Sketchbook	4	1164432	05/10/2023 07:10
12	The Body Shop Lotion	1	96995	18/04/2024 02:22
13	Pilot G2 Pen Set	5	1679420	07/03/2024 14:38
14	The Body Shop Lotion	4	360876	27/12/2023 19:44
15	Barbie Doll	4	1990472	09/09/2024 10:41
16	Funko Pop Batman	3	1118388	06/07/2024 04:35
17	Loreal Foundation	4	616824	26/10/2023 23:20
18	Faber Castell Sketchbook	2	984736	17/07/2024 23:52
19	Harry Potter Book Set	4	1315232	11/02/2024 09:30
20	Pilot G2 Pen Set	2	340698	02/01/2024 12:57
….	….	….	….	…..
4999	LEGO City Set	5	255045	28/02/2024 04:28

Table 2: Items Respresentation in Binominal

Customer ID	adidas sneakers	barbie doll	faber castell sketchbook	funko pop batman	harry potter book set	la roche-posay cleanser	lego city set	levi's jeans	loreal foundation	maybelline mascara	pilot g2 pen set	the body shop lotion	uniqlo t-shirt	wardah lipstick	zara dress
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0
3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0

4	0	1	0	0	0	0	0	0	1	0	1	0	1	0	1
5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
8	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
9	0	0	1	0	1	0	1	0	1	0	1	0	0	0	0
10	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
11	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
12	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0
14	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
15	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0
16	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0
18	0	0	0	1	0	0	1	1	0	1	1	0	0	0	0
19	0	1	1	1	0	0	0	0	0	0	0	0	1	0	1
20	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
4998	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0
Jumlah	1026	1038	970	1056	1041	1014	1023	988	983	1001	1001	947	1013	956	918

To identify purchase patterns in delivery services, the apriori calculation is used, which includes data selection and cleaning, as well as transformation into the appropriate format. The apriori algorithm searches for frequently bought item combinations based on support and calculates confidence to find relationships between items. The results can be used for product recommendations or promotional strategies.

To identify purchasing patterns in delivery services to increase sales, the Apriori calculation is used. This Apriori calculation involves several processes, namely:

1. Itemset Arrangement

   This solution begins with the formation of 1 itemset, which consists of items that appear significantly in the transactions, using the concept of minimum support. In this study, the minimum support value is set at 30%, meaning only itemsets that appear in at least 30% of the transactions will be considered. Itemsets that meet this criterion will be used for further analysis, such as discovering association rules using the Apriori algorithm. Itemsets with support below 30% will be excluded from further processing.

Table 3: Result Itemset Arrangement

Name *Items*	Amount	*Support (dalam persen)*
Adidas Sneakers	1026	20.5
Barbie doll	1038	20.8
Faber Castell Sketchbook	970	19.4
Funko Pop Batman	1056	21.1
Harry Potter book set	1041	20.8
La Roche-Posay Cleanser	1014	20.3
Lego city set	1023	20.5
Levi's Jeans	988	19.8
Loreal Foundation	983	19.7
Maybelline Mascara	1001	20
Pilot G2 Pen Set	1001	20
The Body Shop Lotion	947	18.9
Uniqlo T-Shirt	1013	20.3
Wardah Lipstick	956	19.1
Zara dress	4082	81.6

2. Combination of Two Items

   The process of forming C2, also known as the 2-itemset, is carried out with a minimum support of 30%. Table 4 below shows the 2-itemset combinations calculated using the following formula:

   Combinations of 2 itemsets that do not meet the minimum support threshold will be excluded.

Table 4: Result Combination of Two Items

Name *Items*	Amount	*Support (dalam persen)*
Zara dress, Funko Pop Batman	880	17.6
Zara dress, Harry Potter Book Set	862	17.2
Zara dress, Barbie Doll	870	17.4
Zara dress, Adidas Sneakers	845	16.9
Zara dress, Lego city set	840	16.8
Zara dress, la roche-posay cleanser	830	16.6
Zara dress, Uniqlo T-Shirt	835	16.7

Zara dress, Maybelline Mascara	830	16.6
Zara dress, Pilot G2 Set	820	16.4
Zara dress, Levi's Jeans	810	16.3
Zara dress, Loreal Foundation	800	16.2
Zara dress, Faber Castell Sketchbook	795	15.9
Zara dress, Wardah Lipstick	810	16.3
Zara dress, The body shop lotion	775	15.5

3.2. Flowchart

In analyzing this research, the author did 2 (two) ways, namely the first way, manually by creating several itemset tables in finding association rules according to the rules of the apriori algorithm[15]. The design of the flowchart can be explained as follows:

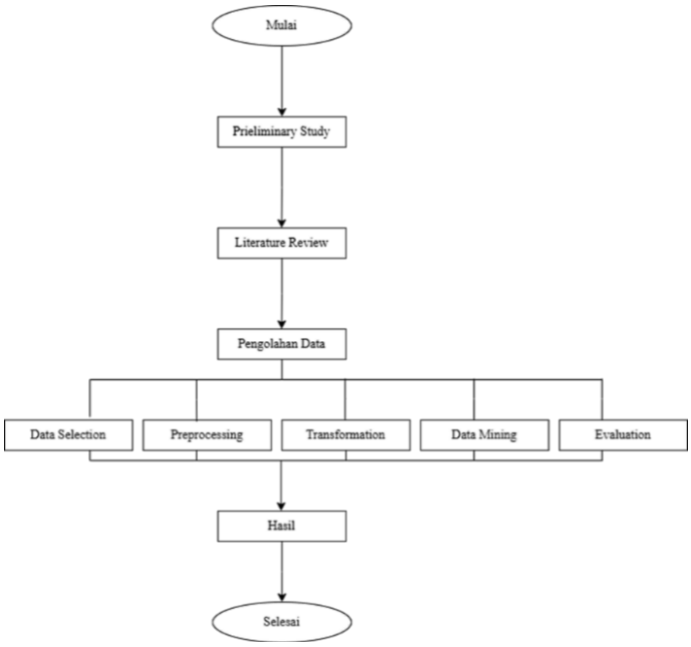

Fig. 1: Flowchart

Process flowchart steps:
1. In the picture above, it is explained that it starts with start,
2. A preliminary study is carried out to obtain a basic understanding, explore the problem being studied and prepare a basis for further research.
3. Then proceed with data processing by applying Knowledge Discovery in Databases; selection, preprocessing, transformation, data mining, and evaluation to find patterns and information from large amounts of data.
5. Analyzing data using Rapid Miner software
6. Furthermore, the results of association rules are created
7. At the end completed

4. Testing

In the testing stage, the researchers used RapidMiner software to analyze the questionnaire data with a minimum support of 30% and minimum confidence of 50%. A 30% support means that only itemsets that appear in at least 30% of the transactions are considered, while a 50% confidence indicates that an association rule is only considered if the likelihood of purchasing the second item is 50% or higher after purchasing the first item.

The results showed that with a 30% minimum support, Zara Dress had the highest results in terms of association, meaning it was frequently purchased together with other products in the transactions. Therefore, this product was selected to proceed to the next step, which is the 2-item combination, to explore further relationships with other products. These findings provide valuable insights for designing more targeted promotional strategies, such as bundling products that are often bought together into one package or special promotion.

No.	Premises	Conclusion	Support	Confidence
3	la roche-posay cleanser	zara dress	0.166	0.819
4	faber castell sketchbook	zara dress	0.159	0.819
5	lego city set	zara dress	0.168	0.820
6	loreal foundation	zara dress	0.162	0.822
7	adidas sneakers	zara dress	0.169	0.823
8	uniqlo t-shirt	zara dress	0.167	0.825
9	harry potter book set	zara dress	0.172	0.828
10	maybelline mascara	zara dress	0.166	0.828
11	levi's jeans	zara dress	0.164	0.831
12	funko pop batman	zara dress	0.176	0.832
13	barbie doll	zara dress	0.174	0.836
14	wardah lipstick	zara dress	0.163	0.850

Fig. 2: Result data Association Rules

4.1. Formation of Association Rules

After successfully identifying all the high-frequency patterns in the dataset, the next step is to perform testing using RapidMiner software to find association rules based on these frequency patterns. This process aims to explore relationships or associations between items that frequently co-occur in transactions, which provides important insights into the purchasing patterns that occur in the dataset. By performing this analysis, we can gain a deeper understanding of how certain items relate to each other in transactions, as well as identify products or items that have a high chance of being purchased together. The results of this association rule mining process will be presented in the form of frequency patterns that describe the combination of related items, as well as the relationship between items based on how often they appear together in various transactions that occur. As a final result, 14 association rules were found that describe important patterns in purchasing, which can be used as a basis for designing more effective and efficient marketing strategies.

AssociationRules

```
Association Rules
[pilot g2 pen set] --> [zara dress] (confidence: 0.814)
[the body shop lotion] --> [zara dress] (confidence: 0.817)
[la roche-posay cleanser] --> [zara dress] (confidence: 0.819)
[faber castell sketchbook] --> [zara dress] (confidence: 0.819)
[lego city set] --> [zara dress] (confidence: 0.820)
[loreal foundation] --> [zara dress] (confidence: 0.822)
[adidas sneakers] --> [zara dress] (confidence: 0.823)
[uniqlo t-shirt] --> [zara dress] (confidence: 0.825)
[harry potter book set] --> [zara dress] (confidence: 0.828)
[maybelline mascara] --> [zara dress] (confidence: 0.828)
[levi's jeans] --> [zara dress] (confidence: 0.831)
[funko pop batman] --> [zara dress] (confidence: 0.832)
[barbie doll] --> [zara dress] (confidence: 0.836)
[wardah lipstick] --> [zara dress] (confidence: 0.850)
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Fig. 3: Result Association Rules

Figure 3 is the result of testing using the rapid miner application application by using a support value of 30% and confidence of 50%. Seen in this figure has the same rules as the previous calculation

Fig. 4: Graph Association Rules

5. Conclusion

This research successfully identifies customer purchasing patterns in a drop-off service using the Apriori algorithm, which can increase sales through data-driven marketing strategies. Apriori algorithm is effective in finding product associations that are often bought together, which provides insights to design more targeted promotions.

The results of the analysis show that products such as Zara Dress have the opportunity to be purchased with other products, such as Pilot G2 Pet Set and The Body Shop Lotion. These findings support the development of promotional strategies, such as product bundling, cross-selling, and data-driven inventory management. With this approach, delivery services can improve customer experience, loyalty, and competitiveness in the market.

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