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Analysis of Computer Product Purchasing Patterns Using Association Rules with the Apriori Algorithm at F3I Store

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Abstract: The sales transaction data at F3I Store, which grows daily, has not been optimally utilized and has merely become piles of archived monthly reports. This study aims to extract valuable information from the data by analyzing consumer purchasing patterns using *Data Mining* techniques. The method used is *Association Rule Mining* with the Apriori Algorithm to identify associations among products that are frequently purchased together. Based on an analysis of 15 transaction records with the parameters of *minimum support* of 20% and *minimum confidence* of 60%, three valid association rules were found. The results show that the strongest association pattern is found in the purchase of a Computer followed by a Monitor, with a *confidence* value of 80%, as well as the purchasing patterns of Laptop with Mouse and Mouse with Keyboard, each at 62.5%. These findings can be used by the management of F3I Store as a basis for decision-making for *product bundling* (value bundle) strategies and the optimization of the store *layout* to increase sales volume.

Keywords: Data Mining, Association Rule, Apriori Algorithm, Purchasing Patterns, Computer Sales.

Abstract: The daily growth in sales transaction data at F3I Store has not been optimally utilized and has merely accumulated as a pile of monthly reports. This study aims to extract valuable information from this data by analyzing consumer purchasing patterns using data mining techniques. The method used is Association Rule Mining with the Apriori algorithm to identify associations between products that are frequently purchased together. Based on an analysis of 15 transaction records with a minimum support of 20% and a minimum confidence of 60%, three valid association rules were identified. The results show that the strongest association is between the purchase of a computer and a monitor, with a confidence level of 80%, followed by the purchase of a laptop with a mouse and a mouse with a keyboard, each with a confidence level of 62.5%. These findings can be used by F3I Store management as a basis for decision-making regarding product bundling strategies and store layout optimization to increase sales volume.

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1. INTRODUCTION

Increasingly intense business competition requires business actors to have appropriate sales strategies, one of which is by utilizing sales transaction data processed using data mining techniques to discover consumer purchasing patterns of strategic value[1]. Data mining is an effective method for processing large amounts of data with the aim of discovering relationships among items through the association rule technique, which is measured using support and confidence values [2]. The large volume of sales transaction data that is merely stored as archives causes the potential for important information to remain underutilized, whereas the application of the Apriori algorithm is able to reveal consumer shopping patterns that are useful for stock management and arrangement[3]. The continuously growing sales transaction data needs to be analyzed systematically so that it can assist management in determining more effective promotion and sales strategies based on the association

rules produced[4]. The application of association rules with the Apriori algorithm has also been proven capable of supporting business decision-making through the identification of purchasing patterns among items that frequently appear together, so that companies can plan sales strategies and inventory control more precisely[5].

F3I Store, as a computer store, has daily transaction data that continues to grow, yet the consumer purchasing patterns within it have not been explored in depth. Based on this background, our study, entitled "Analysis of Computer Product Purchasing Patterns Using Association Rules with the Apriori Algorithm at F3I Store", aims to discover the combination patterns of computer product items that are most frequently sold in order to support the store management's decision-making.

2. THEORETICAL FRAMEWORK

2.1 Data Mining

Data mining is a data analysis process that aims to extract valuable information from a large set of data. *Data Mining* is a series of processes to extract added value from a set of data in the form of knowledge that was previously unknown manually [4]. *Data Mining* as the mining or discovery of new information by searching for certain patterns or rules from a very large amount of data [5]. This process is often associated with *Knowledge Discovery in Database* (KDD), which transforms raw data into information that is useful for decision-making.

2.2 Association Rule Mining

One of the popular techniques in *Data Mining* is *Association Rule Mining*. This method focuses on searching for relationship patterns among data in a transaction database. *Association Rule Mining* is a method that can identify similarity relationships among items [1]. Its main purpose is to find associative rules or associations between different item combinations [2]. This analysis is often used to understand consumer behavior, for example, which items are frequently purchased together.

2.3 Apriori Algorithm

To carry out the *Association Rule* function, an efficient algorithm is required, one of which is the Apriori Algorithm. This algorithm is designed to learn association rules and search for relationship patterns among items in a dataset [4]. The Apriori algorithm works by searching for association rules that meet the predetermined minimum *support* (frequency of occurrence) and minimum *confidence* (level of certainty/accuracy) thresholds [5]. With an iterative mechanism, this algorithm is able to filter the most frequently occurring item combinations (itemsets).

2.4 Support

In association rules, support is the percentage of combined items in the database; if the database contains items A and B, then support is the proportion of transactions in the database that contain A and B. The following is the formula for finding the support value of two items.

$$\text{Support}\ (A, B) = P(A \cap B)$$

Itemsets whose support value is below the minimum support threshold will be eliminated from the association rule formation process.

2.5 Confidence

Confidence is a measure used to indicate the level of confidence of an association rule. Confidence describes the likelihood of item B occurring when item A appears in a transaction. The

confidence value is used to assess the strength of the relationship among items that have met the support criteria.

Association rules with a high confidence value indicate a strong relationship among items and can be used as a basis for decision-making related to sales strategies.

3. RESEARCH METHOD

This study is quantitative research with a data mining approach. This approach is used to analyze computer product sales transaction data at F3I Store in order to find consumer purchasing patterns based on associations among products. The following is an overview of the research flow:

Table 1. Research Flow

START
↓
Collection of Sales Transaction Data
↓
Data Selection
↓
Data Preprocessing
↓
Data Transformation
↓
Determination of Minimum Support & Confidence
↓
Apriori Algorithm Process
• Calculate Itemset Support
• Form Frequent Itemsets
• Formation of Association Rules
↓
Evaluation of Purchasing Patterns
↓
Conclusions & Recommendations
↓
END

3.1 Data Selection

The data used in this study consist of computer product sales transaction data at F3I Store stored in the store database. These data are secondary data obtained over a certain period of time. Each transaction record contains information about the products purchased by consumers in a single transaction and is used as the basis for the process of applying the Apriori algorithm to find purchasing patterns. The following is the data table:

Table 2. Transaction Data

Transaction	List of Purchased Items

ID	
T1	Laptop, Mouse, Keyboard, Mousepad
T2	Laptop, Mouse, Flash Drive
T3	Laptop, Mouse, Keyboard, Headset
T4	Laptop, Mouse, Mousepad
T5	Laptop, Mouse, Keyboard
T6	Laptop, Headset
T7	Laptop, Flash Drive, External HDD
T8	Laptop, Mousepad
T9	Mouse, Keyboard, Mousepad
T10	Mouse, Keyboard, Headset
T11	Computer, Monitor, Keyboard
T12	Computer, Monitor, Mouse
T13	Computer, Monitor, UPS
T14	Computer, Keyboard
T15	Computer, Monitor, Mousepad

At the data selection stage, computer product sales transaction data at F3I Store were obtained in the form of a list of items purchased in each transaction. These data are used as the initial data before the preprocessing and transformation stages are carried out.

3.2 Data Preprocessing

The data preprocessing stage is carried out to ensure the quality of the transaction data before the analysis process using the Apriori algorithm. At this stage, the computer product sales transaction data at F3I Store were examined to avoid duplicate data, empty data, and recording errors. Each transaction already had complete product information, so no data deletion was necessary.

In addition, the consistency of product name writing was checked so that no naming differences occur that could affect the analysis process. The results of the preprocessing stage show that the transaction data are clean, consistent, and ready to be used in the data transformation stage and the subsequent data mining process.

3.3 Data Transformation

Data transformation is the stage carried out to convert sales transaction data into a form suitable for the needs of the data mining process using the Apriori algorithm. In this study, the transaction data, which originally took the form of a list of products purchased in each transaction, were converted into a binary table form.

Table 3. Data Transformation Results

Transaction ID	Laptop	Computer	Monitor	Mouse	Keyboard	Mousepad	Headset
T1	1	0	0	1	1	1	0
T2	1	0	0	1	0	0	0
T3	1	0	0	1	1	0	1
T4	1	0	0	1	0	1	0
T5	1	0	0	1	1	0	0
T6	1	0	0	0	0	0	1

T7	1	0	0	0	0	0	0
T8	1	0	0	0	0	1	0
T9	0	0	0	1	1	1	0
T10	0	0	0	1	1	0	1
T11	0	1	1	0	1	0	0
T12	0	1	1	1	0	0	0
T13	0	1	1	0	0	0	0
T14	0	1	0	0	1	0	0
T15	0	1	1	0	0	1	0

In the binary table, each row represents one sales transaction, while each column represents the type of computer product sold at F3I Store. A value of 1 indicates that a product was purchased in that transaction, while a value of 0 indicates that the product was not purchased. This form of data is used to facilitate the process of calculating item occurrence frequencies, forming itemsets, and calculating support and confidence values.

The results of this data transformation stage produce structured data that are ready to be used as input in the application of the Apriori algorithm to find computer product purchasing patterns at F3I Store.

4. RESULTS

4.1 Determination of Minimum Support and Minimum Confidence

Based on the number of computer product sales transactions at F3I Store, namely 15 transactions, the following were determined in this study:

a. Minimum Support = 20%
   This means that an item or item combination must appear in at least 3 transactions (20% × 15 = 3).
b. Minimum Confidence = 60%
   This means that the minimum confidence level of an association rule is 60%. This value was chosen so that the purchasing patterns produced are sufficiently significant and relevant to be analyzed further.

4.2 Formation 1-Itemset and Support Calculation

Support formula:

Table 4. Support 1-Itemset

1-Itemset	Number of Transactions	Support (%)	Remarks
Laptop	8	53.33%	Passed
Computer	5	33.33%	Passed
Monitor	4	26.67%	Passed
Mouse	8	53.33%	Passed
Keyboard	6	40.00%	Passed

Mousepad	5	33.33%	Passed
Headset	3	20.00%	Passed
Flash Drive	2	13.33%	Did Not Pass
External HDD	1	6.67%	Did Not Pass
UPS	1	6.67%	Did Not Pass

Items That Meet the Minimum Support (≥20%)

Laptop, Computer, Monitor, Mouse, Keyboard, Mousepad, Headset.

The items **Flash Drive, External HDD, and UPS** were eliminated because they did not meet the minimum support.

4.3 Formation of 2-Itemsets

2-itemsets are formed from the items that passed the 1-itemset stage.

Example of a 2-Itemset Support Calculation

Table 5. 2-Itemset Support Table

2-Itemset	Number of Transactions	Support (%)
Laptop – Mouse	5	33.33%
Laptop – Keyboard	3	20.00%
Laptop – Mousepad	3	20.00%
Mouse – Keyboard	5	33.33%
Mouse – Mousepad	3	20.00%
Computer – Monitor	4	26.67%

All of the combinations above meet the minimum support of ≥20%.

4.4 Formation of Association Rules and Confidence Calculation

After the itemset combinations that meet the minimum support value have been obtained, the next stage is to form association rules and calculate the confidence value of each rule produced. The confidence value is used to measure the level of confidence in the relationship among products in an association rule. The confidence formula used is as follows:

In this study, a minimum confidence of 60% was set.

Confidence Calculation of the Association Rules

a. Rule 1: Laptop → Mouse

   Number of transactions containing Laptop = 8

   Number of transactions containing Laptop and Mouse = 5

This rule meets the minimum confidence so it can be accepted as an association rule.

b. Rule 2: Mouse → Keyboard

Number of transactions containing Mouse = 8

Number of transactions containing Mouse and Keyboard = 5

This rule meets the minimum confidence and shows an association between the purchase of a Mouse and a Keyboard.

c. Rule 3: Computer → Monitor

Number of transactions containing Computer = 5

Number of transactions containing Computer and Monitor = 4

This rule meets the minimum confidence and has the highest confidence level compared with the other rules.

Table 6. Results of Association Rules

Association Rule (A → B):	Support $A \cup B$:	Confidence:	Remarks:
Laptop → Mouse	33.33%	62.50%	Meets the Criteria
Mouse → Keyboard	33.33%	62.50%	Meets the Criteria
Computer → Monitor	26.67%	80.00%	Meets the Criteria

Based on the association rules produced, the computer product purchasing patterns at F3I Store show associations among products that are relevant to consumer needs. The Computer → Monitor rule has the highest confidence level, while the Laptop → Mouse and Mouse → Keyboard rules show fairly strong and consistent purchasing patterns. These patterns can be used as a basis for consideration in formulating sales strategies at F3I Store.

4.5 Discussion

Based on the results of data processing using the Apriori algorithm with a minimum support of 20% and a minimum confidence of 60%, three valid association rules were formed. The rule with the highest confidence level is Computer → Monitor with a confidence value of 80%. This shows that consumers who purchase a CPU unit (Computer) have a very strong tendency to purchase a Monitor at the same time as the main output component. In addition, the patterns Laptop → Mouse and Mouse → Keyboard, each with a confidence value of 62.5%, were also found. The high level of this association indicates that although laptops already have a touchpad, consumers at F3I Store still prioritize navigation comfort by adding additional peripheral devices.

The implications of these patterns can be applied directly in F3I Store's marketing strategy to increase sales. Management can apply a *product bundling* (value bundle) strategy specifically for Computers and Monitors to speed up consumers' purchasing decisions. In addition, the store layout (*store layout*) can be optimized by placing the Mouse and Keyboard shelves side by side to trigger impulsive purchases. Sales assistants can also be instructed to carry out *cross-selling* by actively offering a Mouse to every customer who purchases a Laptop, given that the likelihood of the offer being accepted by consumers is quite high.

Overall, the use of the *minimum support* parameter of 20% and the *minimum confidence* parameter of 60% on 15 transaction records proved to be effective. These parameters successfully filtered out infrequently sold items such as Flash Drives and UPS devices, so that the association

rules produced truly represent the habits of the majority of consumers and are relevant to be used as a basis for business decision-making.

5. CONCLUSION

Based on the analysis of transaction data at F3I Store, the Apriori algorithm proved effective in identifying consumer purchasing patterns using the *minimum support* parameter of 20% and the *minimum confidence* parameter of 60%. This study successfully found three dominant association rules, in which the strongest relationship is seen in the purchase of a Computer followed by a Monitor with a confidence level of 80%, as well as the purchasing patterns of Laptop with Mouse and Mouse with Keyboard, each with a confidence level of 62.5%. These findings can be directly utilized by store management to formulate *product bundling* strategies and optimize the arrangement of goods to significantly increase sales volume.

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