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Implementation of Market Basket Analysis on Sales Transactions of a Computer Store Using the ECLAT Algorithm

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Abstract

Inventory management and product placement practices at Dunia Computer Store are still conducted conventionally, creating the risk of mismatches between inventory availability and customer demand. To address this challenge, a data-driven approach is required to accurately identify customer purchasing patterns. This study implements the Market Basket Analysis (MBA) method using the Equivalence Class Clustering and Bottom-Up Lattice Traversal (ECLAT) algorithm to discover associations among products that are frequently purchased together. The research process includes transaction data collection, data preprocessing, conversion of transaction data into the Vertical TID-list format, frequent itemset mining, and the generation of association rules based on support, confidence, and lift metrics. In addition, a web-based application was developed to facilitate the implementation of the analysis. The dataset consists of 521 sales transactions from Dunia Computer Store covering the period from January 1 to December 30, 2023. The results indicate that McAfee Anti Virus has the highest support value at 23.22%, followed by Mousepad Deskmat at 14.59% and Logitech Mousepad at 11.52%. The generated association rules reveal significant relationships, such as Logitech Mousepad → McAfee Anti Virus with a confidence value of 75.00% and a lift value of 3.23, as well as RAM Corsair DDR4 8 GB → SSD NVME 512 GB Patriot with a confidence value of 70.37% and a lift value of 6.43. These findings demonstrate that the ECLAT algorithm is capable of efficiently identifying customer purchasing patterns. Therefore, the results can be utilized to support cross-selling strategies, product bundling, product placement optimization, and more effective inventory management based on actual transaction data.

Keywords: Market Basket Analysis, ECLAT, Association Rules, Frequent Itemset, Sales Transaction Analysis.

1 INTRODUCTION

Business growth and competition in the information technology era encourage business actors to adopt data-driven strategies in order to survive and maintain their market share. Data mining has emerged as an evolving approach in line with the increasing volume of transaction data stored in various databases, namely the process of extracting valuable information from a collection of data to generate new knowledge that supports decision-making [4]. One data mining technique widely used to formulate sales and marketing strategies is the analysis of relationships between products in relational transaction databases [3].

Market Basket Analysis (MBA) is broadly used to capture association patterns between items in transaction data, particularly when customers' purchasing patterns have not yet been clearly identified. MBA expresses these relationships in the form of association rules, which describe the structure of relationships that exist within a database. Dunia Computer Store, located in Lhokseumawe, Aceh, sells a wide range of computer-related products such as laptops, keyboards, mice, memory modules, and monitors. The store has faced difficulties in determining appropriate stock levels; in 2022, an inaccurate stock procurement decision led to both overstock of certain items and shortages of others. To provide products that better match customer needs, the store requires an approach capable of analyzing historical purchasing patterns recorded in its sales database, allowing it to optimize profit without incurring additional cost.

The Eclat (Equivalence Class Transformation) algorithm was selected for this study because of its proven efficiency in processing large volumes of transaction data through a vertical data representation

(TID-list), which is well suited to the sales volume expected at Dunia Computer Store. This research therefore aims to answer two questions: (1) how can MBA with the Eclat algorithm be implemented to identify customer behavior patterns based on historical sales transactions, and (2) what sales and product-layout strategies can be optimally designed based on the resulting association rules. The study is limited to the analysis of consumer transactions at Dunia Computer Store during the period of January–December 2023 using the Eclat algorithm. The findings are expected to help store management shift from an intuition-based approach toward a data-driven approach in designing sales strategies, improving customer service quality, and optimizing in-store product arrangement.

2 LITERATURE REVIEW

2.1 Previous Research

The application of the ECLAT algorithm across various sales transaction domains has been widely studied. Haristyarini and Yustanti [1] combined MBA-ECLAT with an Artificial Neural Network to predict the purchase quantity of grocery store products. Septiani et al. [2] applied ECLAT to electronic store sales data and found that the number of rules decreases as the confidence threshold increases. Similar approaches have also been applied to various product types, including clothing items [5], general products through comparison of item-relationship patterns [6], minimarket transactions [7], seasonal Ramadan transactions [8], haircare products [9], supermarket products compared with FP-Growth [10], e-commerce product placement [11], comparison of ECLAT and FP-Growth in sales data analysis [12], and the application of MBA using R programming [13]. Other studies have combined ECLAT with the Economic Order Quantity (EOQ) inventory control method [14] and association-rule-based product layout determination [15]. In general, these studies show that ECLAT consistently produces association rules with lift values greater than 1, indicating a positive relationship between products, although few have applied it specifically to a computer retail store with the high product variety examined in this study.

2.2 Data Mining and Market Basket Analysis

Data mining is the process of discovering new patterns or knowledge from a collection of data through the stages of selection, preprocessing, transformation, data mining, and interpretation/evaluation [4]. Market Basket Analysis (MBA) is a technique used to identify customer purchasing patterns based on combinations of products that frequently appear together in the same transaction, making it possible to determine which products tend to be purchased together.

2.3 Association Rule and the Eclat Algorithm

An association rule is a method for identifying relationships between items in a transaction using the statement "if A then B," with support and confidence values determining the strength of the rule. The search process is divided into two stages: frequent itemset generation (finding itemsets that satisfy the minimum support) and rules generation (extracting rules with high confidence from those itemsets).

The ECLAT (Equivalence Class Transformation) algorithm searches for frequent itemsets by grouping items into prefix-based classes (equivalence classes) and representing the dataset in a vertical form as a transaction id-list (TID-list). The support value of an itemset is calculated from the size of the TID-list intersection between its constituent items, making the search process faster since it does not require repeated database scans. Equations (1)–(3) are used to calculate support, confidence, and lift:

$$Support(A) = \left(\frac{Number\ of\ Transactions\ Containing\ A}{Total\ Transactions}\right) \times 100\% \quad (1)$$

$$Confidence(A \rightarrow B) = \left(\frac{Support(A \cap B)}{Support(A)}\right) \times 100\% \quad (2)$$

$$Lift(A \rightarrow B) = \frac{Support(A \cap B)}{(Support(A) \times Support(B))} \quad (3)$$

3 RESEARCH METHODS

The research was conducted at Dunia Computer Store through the following stages: literature study, observation, interviews, transaction data collection, data pre-processing, analysis and modeling using the ECLAT algorithm, implementation into a web application, and system testing. The data used consists of 521 sales transactions from the period of January–December 2023, limited solely to Dunia Computer Store's customer transactions without accounting for other external factors such as price or promotions.

The pre-processing stage converts daily transaction data (horizontal format: id, date, product list) into a vertical TID-list format, in which each product is mapped to the list of transaction IDs that contain it. This format forms the basis for calculating support through intersection operations between TID-lists, in line with the working principle of the ECLAT algorithm.

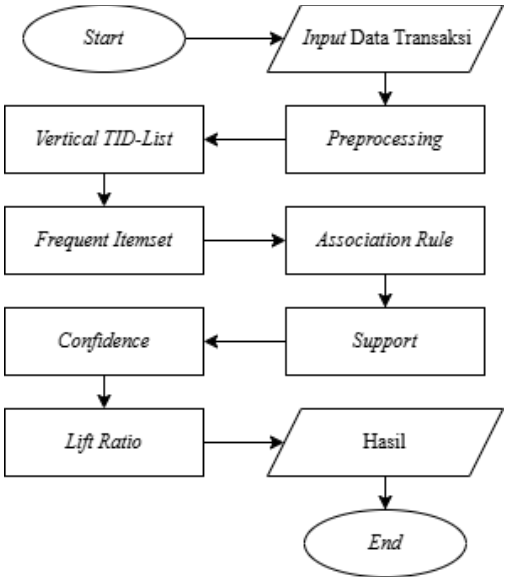

Figure 1. Market Basket Analysis Scheme Using the ECLAT Algorithm

The system was designed with the following functional requirements: (1) input and management of transaction data (add, edit, delete), (2) an ECLAT mining process based on minimum support and minimum confidence parameters that can be adjusted by the user, and (3) presentation of frequent itemset and association rule results in table form, filterable by date range. The database was designed with four main tables: Transactions (daily transaction data), Product_transactions (monthly per-product transaction aggregation), Frequent_itemsets, and Rules (the resulting association rules along with their support and confidence values). System testing was carried out using blackbox testing on all of the application's main functions.

4 RESULTS AND DISCUSSION

4.1 Frequent Itemset Results

The minimum support of 7% and minimum confidence of 70% were selected as the primary experimental parameters to retain recurring product combinations while filtering association rules with relatively high confidence. A second parameter setting of 25% minimum support and 50% minimum confidence was also tested as a comparison. Under this stricter support threshold, no frequent itemsets or association rules were generated, indicating that a higher support threshold was too restrictive for the characteristics of the dataset.

Table 1. Frequent itemsets (scenario 1: support 7%, confidence 70%)

Itemset	Size	Support (%)
McAfee Anti Virus	1 item	23.22
Mousepad Deskmat	1 item	14.59
Logitech Mousepad	1 item	11.52
SSD NVME 512GB Patriot	1 item	10.94
RAM Corsair DDR4 8GB	1 item	10.36
Logitech Mousepad, McAfee Anti Virus	2 item	8.64
RAM Corsair DDR4 8GB, SSD NVME 512GB Patriot	2 item	7.29

Figure 2. Frequent itemset results as displayed in the application (scenario 1: support 7%, confidence 70%)

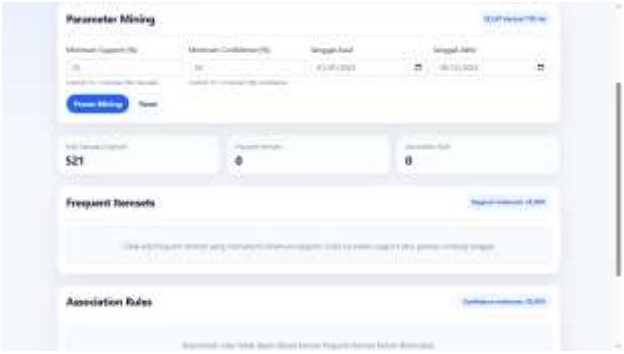

Figure 3. Frequent itemset results as displayed in the application (scenario 2: support 25%, confidence 50%)

4.2 Association Rules Results

Based on the frequent itemsets that passed the threshold, the system formed two association rules shown in Figure 5 and Table 2. The calculation for the first rule, Logitech Mousepad → McAfee Anti Virus: confidence = (8.64% / 11.52%) × 100% = 75.00%, and lift = (45/521) / ((60/521) × (121/521)) = 3.23. The calculation for the second rule, RAM Corsair DDR4 8GB → SSD NVME 512GB Patriot: confidence = (7.29% / 10.36%) × 100% = 70.37%, and lift = (38/521) / ((54/521) × (57/521)) = 6.43.

Table 2. Association rules (scenario 1: support 7%, confidence 70%)

Association Rule	*Support* (%)	*Conf.* (%)	*Lift*
Logitech Mousepad → McAfee Anti Virus	8.64	75.00	3.23
RAM Corsair DDR4 8GB → SSD NVME 512GB Patriot	7.29	70.37	6.43

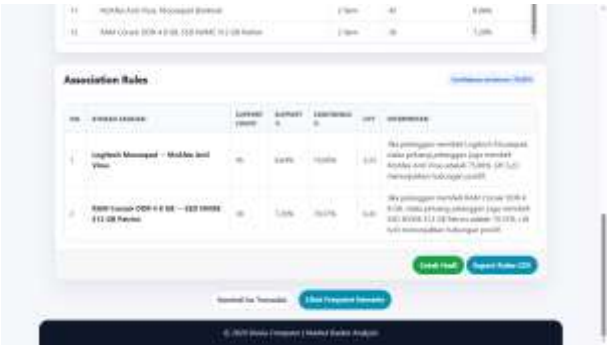

Figure 4. Association rule results as displayed in the application

Both rules have a lift value above 1, indicating a positive relationship between products: customers who purchase Logitech Mousepad have a 75.00% chance of also purchasing McAfee Anti Virus, and customers who purchase RAM Corsair DDR4 8GB have a 70.37% chance of also purchasing SSD NVME 512GB Patriot. These findings are consistent with previous studies that also reported lift values above 1 when applying ECLAT in various retail domains [1], [7], [13], indicating that the product association patterns produced by ECLAT are fairly consistent across business types.

In the second scenario, testing with a minimum support of 25% and a minimum confidence of 50% produced no frequent itemsets or association rules at all, since no product combination in the dataset met such a high threshold. This confirms that the choice of minimum support and confidence values greatly affects the number of rules formed, and needs to be adjusted to the characteristics of the transaction data distribution being analyzed.

4.3 System Implementation and Testing

The results of the ECLAT algorithm were implemented in a web application that provides a transaction data management page, a frequent itemset page, and a mining results page with support, confidence, and date-range parameters that can be adjusted by the user (Figure 4). Blackbox testing of the input/edit/delete transaction data functions, the mining process, inter-page navigation, and system notifications and confirmations showed that all functions ran validly in accordance with the testing hypotheses.

Table 3. Black-box system testing

Function	Test Step	Expected Result	Actual Result	Status
Login	Input username & password	User logs into the system	User successfully logged in.	Valid
Transaction data	Input data	Data saved	Data saved	Valid
ECLAT	Input support & confidence	Mining operations are being carried out.	Frequent itemset/rule displayed	Valid
Mining results	Showing results	Rule displayed	Rule displayed	Valid

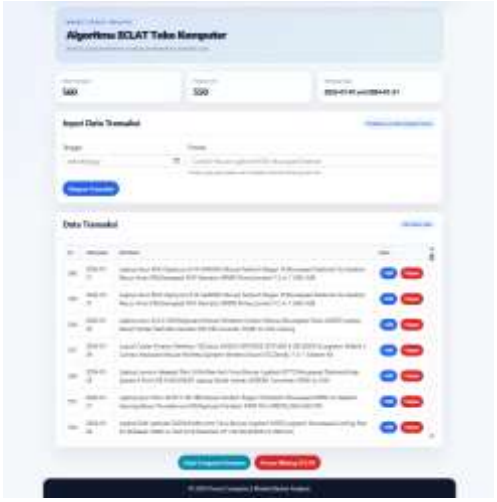

Figure 5. Dashboard page of the Market Basket Analysis application

Overall, the results of this study can be used as a basis for business decision-making, particularly for placing the products contained in the resulting rules close to one another on the store shelf and applying bundling and cross-selling strategies to products with high lift values, thereby addressing the study's second research problem regarding a rule-based product placement strategy.

5 CONCLUSION

This study successfully implemented Market Basket Analysis with the ECLAT algorithm on 521 sales transaction records from Dunia Computer Store for the period of January 1 to December 30, 2023, through a web-based application capable of processing transaction data automatically. The frequent itemset results show McAfee Anti Virus as the product with the

highest support (23.22%), followed by Mousepad Deskmat (14.59%) and Logitech Mousepad (11.52%). At a minimum support of 7% and minimum confidence of 70%, the system generated the rules Logitech Mousepad → McAfee Anti Virus (confidence 75.00%, lift 3.23) and RAM Corsair DDR4 8GB → SSD NVME 512GB Patriot (confidence 70.37%, lift 6.43), both of which have a lift value above 1, indicating a positive relationship between products. In contrast, at a minimum support of 25% and minimum confidence of 50%, no rules were formed, confirming the importance of selecting thresholds that match the characteristics of the data.

Based on these findings, this study has several limitations. First, the dataset was obtained from only one computer store, namely Dunia Computer Store, so the resulting association patterns may not be directly generalizable to other computer stores with different customer characteristics and product distributions. Second, the analysis was conducted using sales transactions from January to December 2023, meaning that changes in purchasing patterns in other periods were not evaluated. Third, the analysis focused on transaction occurrence and did not incorporate external factors such as product prices, discounts, promotions, or seasonal effects. Therefore, the resulting association rules should be interpreted as historical purchasing patterns rather than predictive conclusions. the store can place the products contained in the resulting rules close to one another and apply bundling strategies to products with strong associations. For future research, it is recommended to integrate or compare the ECLAT algorithm with FP-Growth or Apriori on a larger dataset to evaluate the effectiveness and accuracy of each method, as well as to add time-based predictive analysis to examine seasonal or daily purchasing trends as a basis for more adaptive stock management and promotional strategies.

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