Journal of Computer System and Informatics (JoSYC)
ISSN 2714-8912 (media online), ISSN 2714-7150 (media cetak)
Volume 6, No. 3, May 2025, Page 572-580
https://ejurnal.seminar-id.com/index.php/josyc
DOI 10.47065/josyc.v6i3.7355

Implementation of Apriori Algorithms to Analyze and Determine Consumer Purchase Patterns in Gadget Stores as Sales Increase Strategy

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Submitted: 15/05/2025; Accepted: 31/05/2025; Published: 31/05/2025

Abstract–This study aims to identify the pattern of product purchases that often occur simultaneously at a gadget store in order to develop a more effective sales strategy. The research problem focuses on how to find associations between products based on sales transaction data. The proposed solution is to apply data mining techniques, specifically a priori algorithms, to analyze transaction data and find significant association rules. The A priori algorithm is used through several stages, including the calculation of support for each item, the elimination of items with support below the minimum threshold, the formation of itemset combinations, and the calculation of confidence to generate association rules. The results showed two association rules that met the minimum confidence threshold (60%), namely: (1) If customers buy USB-C, they tend to buy Powerbank (confidence: 67%), and (2) If customers buy Smartwatches, they tend to buy Screen Protectors (confidence: 67%), and (3) If customers buy Screen Protectors, they tend to buy Smartwatches (confidence: 100%). These patterns can be used by the store for strategic product placement and bundling promotions.

Keywords: Data Mining; Apriori Algorithms; Consumer Purchasing Patterns; Increased Sales

1. INTRODUCTION

The development of information technology in Indonesia is currently more advanced, this can be seen from the use of existing technology. Increasingly advanced technology makes humans must be able to keep up with existing developments. The increasingly attached nature of humans to information technology makes humans must be ready to adapt to face all possibilities that occur. The role of information technology has a significant impact in various areas of life, one of which is in the trade sector [1].

Increasingly fierce business competition makes retail companies have to look for new breakthroughs to determine the right strategy in running a business. Transaction data needs to be used by the company's management to find new information or knowledge that is useful as support in decision-making. New information or knowledge can be found by using data mining techniques. Data mining is the process of extracting or excavating knowledge from large amounts of data [2].

Entrepreneurs can develop a business strategy by studying consumer behavior patterns when shopping. The process of finding consumer spending patterns requires a concept called Data Mining. There are many methods in data mining. One of the methods that is often used is the a priori algorithm method. The data generated from the sales process or transaction data is processed by the a priori algorithm method to find out information related to product purchases made by buyers [3].

Relevant research has been carried out and a priori algorithms have also been used to find out patterns related to customers, including customer purchase patterns obtained from sales at gadget stores. This study aims to investigate the implementation of data mining with a priori algorithm in determining purchasing patterns in gadget stores [4].

Based on related research researched by Mutia Khanza et al in 2021 which discusses a priori algorithms in determining order goods for HP sales transactions. In the study, they concluded that the advantage of this algorithm is that it has greater computing capabilities and the weakness must always be carried out in the scanning stage which is repeated in each iteration takes a long time [1].

Furthermore, in the research researched by Kevin Brighton et al in 2024 which discusses the application of the basketball market analysis method with an A priori algorithm in Electronic Retail stores. The study concluded that the identification of associations between products can be realized by utilizing the advantages of the Apriori algorithm by meeting the conditions set by the Apriori algorithm, namely determining the minimum support value

In order to find the frequency between goods purchased together in the dataset as well as the minimum confidence value as a determinant of the certainty of the relationship between items in the association rules, the Shopping Cart Analysis Method and a priori algorithm have been applied using a web-based application [2].

Furthermore, the third research researched by Reza Nur et al. in 2024 discusses the application of a priori algorithms for the analysis of consumer purchasing patterns. The study concluded that the analysis process can help store owners in anticipating the availability of the most sold products. The testing process results in a high

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frequency value for each product item sold. From the association rules found, a pattern of purchasing goods can be obtained, where customers buy Mineral Water goods more often [3].

Based on the background that has been explained, this study aims to find patterns in the form of products that are often purchased at the same time, this is done so that the resulting patterns can be used for sales strategies. Based on the rules of association obtained from the output, data processing using a priori algorithm can predict which goods will be provided in the same quantity and placed close to each other [5].

2. RESEARCH METHODOLOGY

2.1 Research Stages

The research framework describes the sequence of steps required in the research process. Each stage is interconnected in a structured and systematic manner. The preparation of these stages aims to facilitate the implementation of research effectively and efficiently

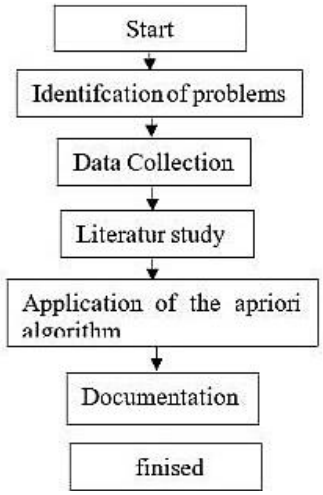

Figure 1. Research Framework

Based on the research structure that has been explained earlier, the author will explain the steps taken in this study as follows:

a. Problem Identification
   The first step in this study is to identify problems related to consumer purchasing patterns at gadget stores. The main focus is on finding patterns or associations of products that are often bought together, which can provide insights for stores in determining more effective sales strategies. Using a priori algorithm, this study aims to explore purchasing patterns that can improve marketing and sales strategies.
b. Data Collection
   At this stage, data on consumer purchase transactions at gadget stores is collected. The data collected includes information about the products purchased, the frequency of purchases, and the timing of the transaction. This data is used as an input in the analysis process to find associations between products that are often purchased together using a priori algorithm.
c. Studi Literature
   The author conducted a literature review by reading various references such as journals, books, and scientific articles relevant to data mining, a priori algorithms, and the application of algorithms in the analysis of consumer purchasing patterns. The study covers basic theories about the A priori algorithm, how it works, as well as examples of its application in the analysis of purchasing patterns in various industries, including retail and gadget stores.
d. Application of Apriori algorithm
   At this stage, an Apriori algorithm is applied to analyze consumer purchase transaction data. Through this algorithm, the author looks for associations between products that are often purchased simultaneously by consumers. Based on the results of the associations found, the author can provide recommendations related to products that should be promoted together to increase sales.
e. Documentation
   The final stage includes recording the entire research process, including the stages of data collection, the application of a priori algorithm, and the analysis of the results of the associations found. The documentation is systematically compiled to provide a clear understanding for readers or other researchers who want to develop further research, as well as provide practical recommendations for gadget stores in their sales improvement strategies.

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2.2 Data Mining

Data mining is the process of finding hidden patterns, relationships, and important information from large data sets using statistical techniques, mathematics, and artificial intelligence technology[4][5]. Data mining is a data analysis step that aims to extract previously unknown, predictable, and useful information from a large database[6][3]. The data mining process is not only about displaying data, but also involves collecting, processing, analyzing, and presenting results in the form of patterns or relationships that can be used to support decision-making. Some of the methods commonly used in data mining include classification, clustering, prediction, and association rule mining[7]. In this study, data mining was used to analyze consumer purchase transaction data at a gadget store. By applying the association rule mining method using an A priori algorithm, it is hoped that patterns of purchasing goods that often occur simultaneously can be found. This pattern can be used by the store as a reference in developing effective promotional strategies, product placement, and bundling offers to increase sales [3][8].

2.3 Algotitma Apriori

Apriori algorithm is one of the methods in data mining that is used to find patterns of relationships between items in transaction data[9][10]. The A priori algorithm operates on the basic principle that any subset of itemsets that frequently appear in the data must also appear frequently in the larger dataset. This means that if a combination of products is often purchased together in a number of transactions, then all subsets of those combinations must also appear frequently in other transactions [11]. This principle allows the algorithm to efficiently look for strong purchasing patterns or product associations by examining smaller itemset first and then expanding the search to larger itemsets. This approach helps in finding patterns that are useful for market analysis[12][13]. By applying these principles, a priori can efficiently identify combinations of items that have a tendency to appear simultaneously in a transaction. The patterns resulting from this process can be used for various analysis purposes, such as product recommendations, promotional strategies, or grouping of goods in the sales system.

The stages of an Apriori algorithm consist of several main processes, which are carried out gradually and systematically to generate relevant association patterns[14]:

a. Support: Measures how often item combinations appear in a dataset.

$$Support(A \rightarrow B) = \frac{The\ number\ of\ transactions\ containing\ A \cup B}{Total\ number\ of\ transactions} \quad (1)$$

b. Confidence: Measures how often item B appears in a transaction that contains item A.

$$Confidance(A \rightarrow B) = \frac{The\ number\ of\ transactions\ containing\ A \cup B}{The\ number\ of\ transactions\ containing\ A} \quad (2)$$

c. Lift: Measures how much increased the likelihood of item B appearing when item A appears, compared to when items A and B appear independently.

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

The Support formula (A → B) calculates the ratio of the number of transactions containing the item combination A and B to the total number of transactions, to determine how often the combination appears in the dataset; Confidence (A → B) measures the likelihood of item B appearing in a transaction that already contains item A, by dividing the number of transactions that contain A ∪ B by the number of transactions that contain A; while Lift (A → B) evaluates the strength of the relationship between A and B by comparing the confidence value (A → B) to the support (B), thereby indicating how likely B is to occur together with A compared to its random occurrence.

2.4 Consumer Purchasing Patterns

Consumer purchasing patterns refer to the tendency or habits that consumers have in purchasing products or services, both individually and in groups. This pattern appears repeatedly over a period of time and is influenced by various factors, including needs, preferences, price, product quality, and promotional strategies implemented by the seller. By understanding these purchasing patterns, companies can devise more effective marketing strategies, offer products that match consumer preferences, and improve customer satisfaction. Analysis of consumer purchasing patterns also helps in designing the right promotional programs to increase sales[15], [16], [17]. Consumer purchasing patterns refer to the relationship or relationship between one product and another that are often purchased simultaneously in a single transaction. This pattern can describe the tendency of consumers to choose related products, whether functionally, aesthetically, or for other needs. Identifying these purchasing patterns is important for businesses, especially in marketing strategies and sales planning, as it can help in product structuring, bundling promotions, and offers that are more in line with consumer preferences[3][18].

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2.5 Increased Sales

Increasing sales is one of the main goals in any business activity. The company strives to increase the sales volume of products or services within a certain period of time. Strategies to achieve these goals involve a variety of efforts, such as a deep understanding of consumer needs and preferences, as well as the implementation of effective marketing tactics. By designing the right offerings and tailoring the product or service to market demand, a company can maximize its sales potential. Effective sales increase focuses not only on transaction volume, but also on increasing consumer satisfaction and building long-term mutually beneficial relationships between companies and consumers[19]. Sales can increase if the company is able to understand consumer needs well, devise the right marketing strategy, and offer products that match market preferences. A deep understanding of what consumers want allows companies to design more relevant and engaging offerings. With effective marketing strategies, such as market segmentation, proper promotion, and strategic product placement, companies can increase the attractiveness of their products. In addition, offering products that suit the tastes and needs of the market will increase consumer satisfaction, encourage them to make more purchases and ultimately increase the company's total sales[20].

3. RESULTS AND DISCUSSION

3.1 Analyzes

Purchase pattern analysis, or often called market basket analysis, is a technique in data mining that aims to identify associative relationships or patterns of relationships between items that are often purchased simultaneously by consumers in a transaction. In the context of the GADGET store, this analysis allows us to uncover combinations of gadget products or accessories that customers tend to buy simultaneously. The main goal of purchasing pattern analysis is to find strong association rules, which can provide valuable insights into consumer behavior. This association rule is usually in the form of "If item A is purchased, then item B is also likely to be purchased." The strength of this rule is measured based on metrics such as support, which shows how often a combination of items appears in the entire transaction, and confidence, which shows how likely item B is to be purchased when item A has already been purchased. The following Table 1 shows the transaction data that will be used.

Table 1. Transaction Data

Transaction No.	Transaction Items
1	Keyboard Wireless, Powerbank, USB-C, Adapter
2	Headset, Powerbank, Smartphone Case, USB-C
3	Gaming Mouse, Mouse Pad, Monitor Stand
4	Smartwatch, Wireless Earbuds, Charging Dock
5	Keyboard Mechanical, RGB Lights, Gaming Chair
6	USB-C, HDMI Cable, Laptop Stand
7	Wireless Mouse, Powerbank, HDMI Cable
8	Smartphone, Smartwatch, Screen Protector
9	External SSD, USB-C Hub, Monitor Stand
10	Headset, Gaming Chair, RGB Lights
11	Laptop Cooling Pad, Powerbank, Wireless Mouse
12	Smartphone, Charging Dock, HDMI Cable
13	Keyboard Wireless, Wireless Earbuds, Mouse Pad
14	External SSD, Smartwatch, Screen Protector

3.2 Application of a priori algorithm

In the process of a priori algorithm consists of several steps which are:

1. The initial step Calculating the support value of the support level is the Single Item Support Level (support 1-itemset for each single item) is a fundamental step in the analysis of transaction data. By measuring how often a product appears in transaction records, we can understand the level of popularity or demand for that product. These support values form the basis in an A-priori algorithm to identify relevant purchasing patterns, which will further guide strategic decision-making regarding product offerings and stock management. The following in Table 2 represents the Formation of Support from 1 item set.

Table 2. Formation of Support from 1 set item

Gadget Item Name	Occurrence	Support
Keyboard Wireless	2	14%
Power Bank	4	29%
USB-C	3	21%

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Gadget Item Name	Occurrence	Support
Adapter	1	7%
Headset	2	14%
Smartphone Case	1	7%
Gaming Mouse	1	7%
Mouse Pad	2	14%
Monitor Stand	2	14%
Smartwatch	3	21%
Wireless Earbuds	2	14%
Charging Dock	2	14%
Keyboard Mechanical	1	7%
RGB Lights	2	14%
Gaming Chair	2	14%
HDMI Cable	3	21%
Laptop Stand	1	7%
Wireless Mouse	2	14%
Smartphone	2	14%
Screen Protector	2	14%
External SSD	2	14%
USB-C Hub	1	7%
Laptop Cooling Pad	1	7%

2. Step two Eliminate the 1-itemset Support Result with Minimum Support.
   With a Minimum Support value of 14%. In accordance with Table 2 which shows items that do not meet the minimum Support value of less than 14% are eliminated. The process of eliminating the 1-itemset support result with a minimum support value of 14% will result in more 1-itemset frequencies. The following can be seen in Table 3 below:

Table 3. 1-itemset value meets minimum support

Gadget Item Name	Occurrence	Support
Keyboard Wireless	2	14%
Power Bank	4	29%
USB-C	3	21%
Headset	2	14%
Mouse Pad	2	14%
Monitor Stand	2	14%
Smartwatch	3	21%
Wireless Earbuds	2	14%
Charging Dock	2	14%
RGB Lights	2	14%
Gaming Chair	2	14%
HDMI Cable	3	21%
Wireless Mouse	2	14%
Smartphone	2	14%
Screen Protector	2	14%
External SSD	2	14%

3. Third step Formation of a 2-itemset Combination Pattern
   The 2-itemset frequency pattern is formed by combining all the gadget items that meet the support minimum value of Table 3, and then calculating the Support value by generating the 2-itemset combinations in the Table 4 below.

Table 4. *Support* of 2 itemset

Nama Item Gadjet	Occurrence	Support
Keyboard Wireless, Powerbank	1	7%
Keyboard Wireless, USB-C	1	7%
Keyboard Wireless, Headset	0	0%
Keyboard Wireless, Mouse Pad	1	7%
Keyboard Wireless, Monitor Stand	0	0%
Keyboard Wireless, Smartwatch	0	0%
Keyboard Wireless, Wireless Earbuds	1	7%
Keyboard Wireless, Charging Dock	0	0%

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Nama Item Gadjet	Occurrence	Support
Keyboard Wireless, RGB Lights	0	0%
Keyboard Wireless, Gaming Chair	0	0%
Keyboard Wireless, HDMI Cable	0	0%
Keyboard Wireless, Wireless Mouse	1	7%
Keyboard Wireless, Smartphone	0	0%
Keyboard Wireless, Screen Protector	0	0%
Keyboard Wireless, External SSD	0	0%
Powerbank, USB-C	2	14%
Powerbank, Headset	1	7%
Powerbank, Mouse Pad	0	0%
Powerbank, Monitor Stand	0	0%
Powerbank, Smartwatch	0	0%
Powerbank, Wireless Earbuds	0	0%
Powerbank, Charging Dock	0	0%
Powerbank, RGB Lights	0	0%
Powerbank, Gaming Chair	0	0%
Powerbank, HDMI Cable	1	7%
Powerbank, Wireless Mouse	1	7%
Power Bank, Smartphone	0	0%
Powerbank, Screen Protector	0	0%
Powerbank, External SSD	0	0%
USB-C, Headset	1	7%
USB-C, Mouse Pad	0	0%
USB-C, Monitor Stand	1	7%
USB-C, Smartwatch	0	0%
USB-C, Wireless Earbuds	0	0%
USB-C, Charging Dock	0	0%
USB-C, RGB Lights	0	0%
USB-C, Gaming Chair	0	0%
USB-C, HDMI Cable	1	7%
USB-C, Wireless Mouse	0	0%
USB-C, Smartphone	0	0%
USB-C, Screen Protector	0	0%
USB-C, External SSD	0	0%
Headset, Mouse Pad	0	0%
Headset, Monitor Stand	0	0%
Headset, Smartwatch	0	0%
Headset, Wireless Earbuds	0	0%
Headset, Charging Dock	0	0%
Headset, RGB Lights	1	7%
Headset, Gaming Chair	1	7%
Headset, HDMI Cable	0	0%
Headset, Wireless Mouse	0	0%
Headset, Smartphone	0	0%
Headset, Screen Protector	0	0%
Headset, External SSD	0	0%
Mouse Pad, Monitor Stand	1	7%
Mouse Pad, Smartwatch	0	0%
Mouse Pad, Wireless Earbuds	1	7%
Mouse Pad, Charging Dock	0	0%
Mouse Pad, RGB Lights	0	0%
Mouse Pad, Gaming Chair	0	0%
Mouse Pad, HDMI Cable	0	0%
Mouse Pad, Wireless Mouse	0	0%
Mouse Pad, Smartphone	0	0%
Mouse Pad, Screen Protector	0	0%
Mouse Pad, External SSD	0	0%
Monitor Stand, Smartwatch	0	0%
Monitor Stand, Wireless Earbuds	0	0%
Monitor Stand, Charging Dock	0	0%

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Nama Item Gadjet	Occurrence	Support
Monitor Stand, RGB Lights	0	0%
Monitor Stand, Gaming Chair	0	0%
Monitor Stand, HDMI Cable	0	0%
Monitor Stand, Wireless Mouse	0	0%
Monitor Stand, Smartphone	0	0%
Monitor Stand, Screen Protector	0	0%
Monitor Stand, External SSD	1	7%
Smartwatch, Wireless Earbuds	1	7%
Smartwatch, Charging Dock	1	7%
Smartwatch, RGB Lights	0	0%
Smartwatch, Gaming Chair	0	0%
Smartwatch, HDMI Cable	1	7%
Smartwatch, Wireless Mouse	0	0%
Smartwatch, Smartphone	1	7%
Smartwatch, Screen Protector	2	14%
Smartwatch, External SSD	1	7%
Wireless Earbuds, Charging Dock	0	0%
Wireless Earbuds, RGB Lights	0	0%
Wireless Earbuds, Gaming Chair	0	0%
Wireless Earbuds, HDMI Cable	0	0%
Wireless Earbuds, Wireless Mouse	1	7%
Wireless Earbuds, Smartphone	0	0%
Wireless Earbuds, Screen Protector	0	0%
Wireless Earbuds, External SSD	0	0%
Charging Dock, RGB Lights	0	0%
Charging Dock, Gaming Chair	0	0%
Charging Dock, HDMI Cable	1	7%
Charging Dock, Wireless Mouse	0	0%
Charging Dock, Smartphone	1	7%
Charging Dock, Screen Protector	0	0%
Charging Dock, External SSD	0	0%
RGB Lights, Gaming Chair	1	7%
RGB Lights, HDMI Cable	0	0%
RGB Lights, Wireless Mouse	0	0%
RGB Lights, Smartphone	0	0%
RGB Lights, Screen Protector	0	0%
RGB Lights, External SSD	0	0%
Gaming Chair, HDMI Cable	0	0%
Gaming Chair, Wireless Mouse	0	0%
Gaming Chair, Smartphone	0	0%
Gaming Chair, Screen Protector	0	0%
Gaming Chair, External SSD	0	0%
HDMI Cable, Wireless Mouse	1	7%
HDMI Cable, Smartphone	1	7%
HDMI Cable, Screen Protector	0	0%
HDMI Cable, External SSD	0	0%
Wireless Mouse, Smartphone	1	7%
Wireless Mouse, Screen Protector	0	0%
Wireless Mouse, External SSD	0	0%
Smartphone, Screen Protector	1	7%
Smartphone, External SSD	0	0%
Screen Protector, External SSD	1	7%

Furthermore, eliminate the 2-itemset Support Result with Minimum Support with a Minimum Support value of 14%. The following can be seen in Table 5, which shows the values of 2 itemsets that meet the minimum support.

Table 5. 2-itemet values meet minimum support

Gadget Item Name	Occurrence	Support
Powerbank, USB-C2	2	14%
Smartwatch, Screen Protector	2	14%

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4. The fourth step is the formation of a 3-itemset combination pattern.
   The 3-itemset frequency pattern is formed by combining all the gadget items that meet the support minimum value of Table 5, and then calculating the Support value by resulting in a combination of 3-itemset. Berikut dapat dilihat pada Tabel 6 yaitu support dari 3 itemset

Table 6. *Support* of 3-itemet

Gadget Item Name	Occurrence	Support
Powerbank, USB-C, Smartwatch	0	0%
Powerbank, USB-C, Screen Protector	0	0%
Powerbank, Smartwatch, Screen Protector	0	0%
USB-C, Smartwatch, Screen Protector	0	0%

   Based on Table 6 above shows that no 3-itemset combination meets the minimum support of 14%. Therefore, the highest frequent itemset we get is 2-itemset: {Powerbank, USB-C} and {Smartwatch, Screen Protector}.
5. Fifth Step Establishment of Association Rules
   Once the frequent itemset is found, it then looks for association rules that meet the minimum requirements for confidence. Suppose we set a minimum confidence value of 60% (you can adjust this value), Here are the Association Rules of {Powerbank, USB-C}:
   a. If you buy a Powerbank, then buy USB-C.

      $Confidence = \frac{Support\ (Powerbank, USB-C)}{Support\ (Powerbank)} = \frac{2}{14} / \frac{4}{14} = \frac{2}{4} = 50\%$ (Not meeting the minimum confidence)

   b. If you buy USB-C, then buy a Powerbank.

      (Memenuhi minimum confidence)$Confidence = \frac{Support(Powerbank, USB-C)}{Support(USB-C)} = \frac{2}{14} / \frac{3}{14} = \frac{2}{3} = 67\%$

   Association Rules of (Smartwatch, Screen Protector) :
   a. If you buy a Smartwatch, then buy a Screen Protector.

      $Confidence = \frac{\text{Support (Smartwatch,Screen Protector)}}{\text{Support (Smartwatch)}} = \frac{2}{14} / \frac{3}{14} = \frac{2}{3} = 67\%$ (meet minimum trust)

   b. If you buy a Screen Protector, then buy a Smartwatch.

      $\frac{\text{Support (Smartwatch,Screen Protector)}}{\text{Support (Smartwatch)}} = \frac{2}{14} / \frac{2}{14} = \frac{2}{2} = 100\%$ (meet minimum trust)

Table 6. Association Rules

Rule	Confidence
If you buy USB-C, then buy a Powerbank	67%
If you buy a Smartwatch, then buy a Screen Protector	67%
If you buy a Screen Protector, then buy a Smartwatch	100%

4. CONCLUSION

Based on the analysis of the A priori algorithm with a minimum support of 14% on the transaction data of the GADGET Store, two groups of two items that are often purchased at the same time were identified: Powerbank and USB-C, as well as Smartwatch and Screen Protector. An evaluation of the relationship rule with a minimum of 60% confidence revealed a tendency for consumers who buy USB-C to also buy Powerbanks (about 67% trust), as well as a strong relationship between Smartwatch and Screen Protector purchases (about 67% trust for Smartwatches leads to Screen Protector and 100% for Screen Protector leads to Smartwatches). These findings indicate strategic opportunities for cross-promotion, more effective product placement, and the development of a more personalized recommendation system, particularly in offering Powerbank to USB-C buyers and Screen Protector to Smartwatch buyers, and vice versa, to increase sales potential and customer satisfaction.

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ISSN 2714-8912 (media online), ISSN 2714-7150 (media cetak)
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