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Implementation of Data Mining of Organic Vegetable Sales With Apriori Algorithm

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ABSTRACT

In the modern organic vegetable sector, the author observes that there is very tight business competition. Therefore, an effective approach is essential to attract buyers, although restricted sources of new information are one of the hurdles in establishing this business.Association rules are expressed with numerous features that are commonly referred to as (affinity analysis) or (market basket analysis. It was discovered that if consumers buy curly red chilies, they are also inclined to buy cayenne pepper with a 100% confidence level. Likewise, if people buy kale and red curly chiles, they are more likely to buy cayenne pepper with a 100% confidence level. This also applies if consumers buy tomatoes and curly red chilies with a 100% confidence level. In addition, other associations were also observed, such as if consumers buy curly red chilies, they prefer to buy tomatoes with a confidence level of 86%, or if they buy tomatoes and bird's eye chilies, they tend to buy curly red chiles with an 86% confidence level.Likewise, if people buy both cayenne pepper and red curly chili, they are more likely to buy tomatoes with an 86% confidence level. Finally, if customers buy kale and cayenne pepper, they are also likely to buy red curly chilies at an 83% confidence level. Based on the data acquired from this study, it is intended to obtain information about combinations of organic veggies that consumers typically buy together in each transaction, with the intention of improving organic vegetable yields and devising appropriate sales tactics.

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1. Introduction

The number of businesses in the field of organic vegetables has experienced a significant increase in recent years. This growth was due to increased consumer awareness of the importance of a healthy lifestyle and concern for the environment. However, along with this growth, there has also been intense business

competition in the organic vegetable market. Organic Vegetables are vegetables that are cultivated without the use of any chemicals, either during the fertilization process or by spraying pesticides. Organic vegetables are considered safe for consumption because they do not contain pesticides like most vegetables in the community. Vegetables are included in perishable products, where products that are easily damaged have a short shelf life, and their selling value will decrease if they are stored for a long time. To survive and thrive in this competitive industry, companies need to adopt effective and innovative strategies. One of the main challenges in the organic vegetable industry is attracting and retaining buyers. In addition, limited sources of information are also an obstacle to developing this business. Therefore, this research also involves risk management by identifying risks to minimize the risk of losses that will occur. This risk management is carried out by knowing the sources of risk and designing strategies to reduce or even eliminate the risk of losses that will occur.

The method used in this study is the Apriori algorithm, which is one of the best-known methods in data mining. The Apriori algorithm is used to find significant patterns in organic vegetable sales transactions and to build association rules that are useful for business people. By leveraging these patterns, businesses can make better decisions about the combination of organic vegetables offered to consumers, improve operational efficiency, and maximize profits.

This research has a clear objective, namely to identify which organic vegetables are often purchased simultaneously by consumers in every transaction. The results of this research will provide valuable insights for business people in planning the right sales strategy, optimizing organic vegetable yields, and increasing consumer satisfaction.

In this research, we will discuss the process of implementing the Apriori algorithm for analyzing organic vegetable sales data. We will also present our findings in the form of significant buying patterns, along with the confidence level of each association found. In addition, we will discuss the practical implications of the results of this research and provide recommendations for developing a better organic vegetable business. It is hoped that this research can provide a valuable contribution to the organic vegetable industry and encourage the use of data mining techniques in optimizing sales and business development strategies.

2. Research Method

A. Data Mining

Data mining is a term used to describe the discovery of knowledge in databases. Data mining is a process that uses statistical techniques such as mathematics, artificial intelligence, and machine learning to extract and identify useful information and related knowledge from large databases[1].

B. Algoritma Apriori

The a priori algorithm is a data retrieval algorithm with association rules that meet the support and confidence limits by forming association rules with parameters to determine the relationship of a combination of items that meet the minimum requirements of the support and confidence values [2].The Apriori algorithm is also one of the algorithms that can be used in the implementation of marketing analysis by finding every rule in the association that meets the requirements, namely its support and confidence limits. Each association rule is found by using parameters, so that the formation of the rules obtained produces an accurate predictive value. Association rules are expressed with several attributes, which are usually referred to as (affinity analysis) or (market basket analysis. Association analysis, or association rule in data mining, is one of the data mining techniques to find a rule in a combination of items. What's interesting about this analysis is that one of the stages is producing an efficient algorithm by analyzing high-frequency patterns (frequent pattern mining). The way this algorithm works is by examining the development of the itemset candidates from the results of the frequency of the itemsets with support-based pruning, which aims to remove itemsets that have no effect by selecting minimal support. While the principle of the a priori algorithm itself is that if an item is categorized as having an item frequency that has more support than previously determined, then each subset also includes an item frequency group, and vice versa. Support is a parameter that proves the level of dominance of an item or item set in the total transactions that occur. This parameter determines whether an item or itemset is feasible to find its confidence value; for example, from the total number of transactions that exist, how big is the level of dominance that proves that items A and B can be purchased simultaneously [2].

High Frequency Pattern Analysis with Appriori Algorithm looks for item combinations that meet the minimum requirements of the support value in the database. The support value of an item is obtained by using the following formula[1]:

1. **Support (A) = Transaction Amount for A / Total Transactions** (1)

The support value of the two items is obtained by using the formula [1]:

2. **Support (A,B) = Number of Transactions for A and B / Total Transactions** (2)

After all the high-frequency patterns are found, we look for association rules that meet the minimum requirements for confidence by calculating the confidence of the A-U-B associative rules. The confidence value of the A U B rules is obtained by the following formula:[1]:

3. **Confidence P (B │A = Number of Transactions for A and B / Total Transactions for A** (3)

To determine the association rules to be selected, they must be sorted based on support X confidence, the rules are taken as many as N rules that have the greatest results [1].

C. Previous Research

Based on research in a journal entitled "Data Mining Implementation for Sales Data Analysis Using the Apriori Algorithm (DAPOERIN'S Case Study)," it was concluded that the study of the a priori algorithm can help develop marketing strategies for marketing other snack foods by examining the advantages of the selling value of snack foods as best sellers. [3].

Based on research in a journal entitled "Data Mining Using the Apriori Algorithm for Product Recommendations for Customers," it concludes that The Apriori algorithm can produce association rules as a reference in product promotion and decision support in providing product recommendations to consumers based on predetermined minimum support and confidence values [4].

Based on research in a journal entitled "Data Mining Method for Copier Spare Parts Sales Data Using the Apriori Algorithm," it is concluded that: By using the Apriori algorithm calculations, it can be determined that a lot of photocopier spare parts products are sold simultaneously, which is useful in completing marketing strategies in order to further increase the level of sales [5].

Based on research in a journal entitled "Application of Shoe Sales Data Mining Using the Apriori Algorithm Method," it concludes that: Data mining and the Apriori algorithm are very useful for knowing the relationship between the frequency of selling shoes that are most in demand by consumers, so that they can be used as very valuable information by decision makers to prepare stocks of what types of shoes are needed in the future, and the Apriori Algorithm helps develop a shoe sales Based on research in a journal entitled "Application of Shoe Sales Data Mining Using the Apriori Algorithm Method," it concludes that: "Data mining and the Apriori algorithm are very useful for knowing the relationship between the frequency of selling shoes that are most in demand by consumers, so that they can be used as very valuable information by decision makers to prepare stocks of what types of shoes are needed in the future, and the Apriori algorithm helps develop a shoe sales strategy" [6].

Based on research in a journal entitled "Application of Data Mining Using the Apriori Algorithm on Transaction Data as a Support for Sales Strategy Information," the results show that the Apriori algorithm can be used to process sales transaction data into new information in the form of linkages between products based on testing Orange tools. The associative rules formed are tested using a lift ratio in order to know which association rules between products are the strongest [7].

Based on research in a journal entitled "Implementation of the Apriori Algorithm to Determine Compressor Spare Part Inventory," it concludes that The application of data mining using the Apriori algorithm technique is quite effective in assisting the process of determining spare part inventory in companies [8].

Based on research in a journal entitled "Application of the Apriori Algorithm in Data Mining to Predict Visitor Patterns at Karo Regency Tourism Objects," it is concluded that: The Apriori algorithm is one of the algorithms that searches for frequent itemsets using the association rule technique. Using the a priori algorithm can generate patterns of visitors from the years 2015 and 2016 at Karo district attractions. With the Apriori algorithm, it can be concluded that in 2015 the number of visitors was lower [9].

Based on research in a journal entitled "Implementation of Data Mining Sales of Oppo Store SDC Tanggerang Mobile Phones with Appriori Algorithms," it concludes that: The process of determining sales patterns

Handphone can be done by applying data mining with the appriori algorithm method. With this method, it can be seen that the most popular items are [1]. Based on research in a journal entitled "Application of the Market Basket Data Mining Method Analysis of Book Product Sales Data Using the Apriori Algorithm and Frequent Pattern Growth (FP-Growth): A Case Study of Printing at Pt. Gramedia" concludes that: The Apriori algorithm and frequent pattern growth (FP-growth) are two very popular algorithms for finding a number of frequent itemsets from transaction data stored in databases [2].

Based on research in a journal entitled "Implementation of Data Mining in Sales at GOC Cosmetics Stores Using the Apriori Algorithm Method," it is concluded that the application of the a priori algorithm as a procedure for achieving evaluation targets in creating a strategy of relevance of interaction between components, which sees the achievement of item set connections on transaction processing, is the first algorithm association process used [10].
Based on research in a journal entitled "Data Mining Application of Item Associations Using the Apriori-TID Algorithm," it concludes that The Apriori-TID algorithm can be applied in the process of finding frequent itemsets in association analysis. Apriori-TID pruned the item pair search dataset, starting with searching for two items in pairs. The development of data mining applications with CRISP-DM includes the business understanding phase, the data understanding phase, the data processing phase, the modeling phase, the evaluation phase, and the deployment phase. The data mining application that is built can produce association rules based on the minimum support and minimum confidence specified by the user according to company policy. The number of transactions, minimum support, and minimum confidence affect the number of rules generated by the application [11]. Based on research in a journal entitled "Application of the Apriori Algorithm in Sales Transaction Data Processing at Priyo Minimarket, Lubuklinggau City," it was concluded that The application of the Apriori algorithm in processing sales transaction data results at Priyo Minimarket can form several patterns of combinations of result itemsets, and the resulting information can be used in making a catalog of products to be sold [12]. Based on research in a journal entitled "Application of the Apriori Algorithm on Sales Data at Bappenas Cooperative Supermarkets, Central Jakarta," it concludes that: Using the a priori algorithm is very useful to find out the relationship between the frequency pattern of sales of basic needs that are most frequently purchased simultaneously [13]. Based on research in a journal entitled "Data Mining Analysis of Product Purchase Patterns Using the Apriori Algorithm Method," it concludes that: Based on the problem, a system is needed to process goods data based on their tendencies that appear together in a transaction using the Apriori algorithm. The application of the a priori algorithm is expected to find patterns in the form of products that are often purchased together. This pattern is used to place products that are frequently purchased together in an adjacent area. The results achieved are in the form of a report on the results of data mining on the purchasing patterns of goods that are often purchased together for the development of marketing strategies for selling goods [14].

Based on research in a journal entitled "Apriori Algorithm Analysis to Support Higher Education Promotion Strategies," it concludes that: The a priori algorithm is one of the classic data mining algorithms. The a priori algorithm is used so that computers can learn association rules and look for patterns of relationships between one or more items in a dataset. This research was conducted by observing several research variables that are often considered by tertiary institutions in determining their promotion targets, namely the origin of the school, major, and study program chosen. The results of this study are in the form of interesting patterns of data mining results, which are important information to support the right promotion strategy in getting prospective new students [15].
Based on research in a journal entitled "Application of the Apriori Algorithm on Barbar Warehouse Sales Data," it was concluded that The Apriori algorithm has a positive influence on Barbar Warehouse sales reports because the owner can find out which products need to be increased or reduced in stock to increase sales turnover [16].

Based on research in a journal entitled "Apriori Data Mining Application in Sales Implementation at Alfamart," it was concluded that: Based on the results of calculations and analysis of consumer research using Data Mining with the Apriori Algorithm method, as a whole, from the sales sample data, 142 association rules fulfilled the support above 10% and 50% confidence [17].
Based on research in a journal entitled "Analysis of Drug Sales Transactions using the Apriori Algorithm," it was concluded that Data mining using the Apriori algorithm method can be applied to the data processing of drug sales transactions. Testing data on drug sales transactions with a minimum support value of 30% resulted in the 2 types of drugs most frequently purchased, namely fasidol, ifarsyl[18].Based on research in a journal entitled "Implementation of data mining to determine used book sales strategies with consumer purchasing patterns using the Apriori method (case study: Medan City), it was concluded that the most frequently purchased types of books are psychology books, with three times the number of transactions, and

the maximum support is 33.33, which is included in the pass category so that the application of the Apriori algorithm can be properly applied in the case of selling this type of used books, making it easier to sort the layout of used books from the most in demand to those that are rarely purchased by customers [19].Based on research in a journal entitled "Application of Car Spare Part Sales Correlation Data Mining Using the Apriori Algorithm Method (Case Study: CV. Citra Kencana Mobil)," it concludes that: From the data testing that has been done, the application of data mining association rules using the a priori algorithm can be used to find correlations for car spare parts sales using the a priori algorithm (case study: CV. Citra Kencana Mobil) [20].
Based on research in a journal entitled "Implementation of Data Mining Sales of Cosmetics at Zahrani Stores Using the Apriori Algorithm," it concludes that Apriori is a very well-known algorithm for finding high-frequency patterns. High-frequency patterns are item patterns in a database that have a frequency or support above a certain threshold, which is known as minimum support. Using an a priori algorithm can help develop marketing strategies [21].

Based on research in a journal entitled "Application of Data Mining in Determining Stock Availability Patterns Based on Consumer Demand at Chykes Minimarket Using the Apriori Algorithm," it concludes that The problems that occur with regard to the availability of goods, which are frequent itemsets in the Apriori Algorithm, are very appropriate in their application in data mining using the Association Rule technique [22].
Based on research in a journal entitled "Implementation of the Association Rule Mining Method with the Apriori Algorithm for Goods Promo Recommendations," it was concluded that: From the results of the research in the form of information, consumers tend to buy two product combinations where the level of linkage of one item with another item reaches 80%, so that the information that appears can be used in making product promotions with product combinations that are in accordance with consumer transaction patterns [23].

Based on research in a journal entitled "Implementation of Data Mining on Order Predictions Using the Apriori Algorithm (Case Study: Kimia Farma)," it was concluded that The Apriori Algorithm can help develop marketing strategies by providing advice to consumers [24].Based on research in a journal entitled "Application of Data Mining to Determine Shoe Sales Patterns Using the Apriori Algorithm Method," it concludes that: Data mining and the Apriori algorithm are very useful for knowing the relationship between the frequency of selling shoes that are most in demand by consumers, so that they can be used as very valuable information in making decisions to prepare stocks of what types of shoes are needed in the future, and the Apriori Algorithm helps develop shoe sales strategies. Based on the research results, the most popular shoes are New Balance (91.67%), Adidas (75%), Geox (50%%), Nike (41.67%), and Palladium (41.67%)[25].

3. Result and Discussion

At this stage, we form an item set to apply the a priori algorithm with the following list:

Table 1. Data on Organic Vegetable Items

No	Name of Organic Vegetables
1	Kale
2	Kailan
3	Curly Red Chilies
4	Caisim
5	Spinach
6	Pakcoy
7	Tomatoes
8	Lettuce
9	Cucumbers
10	Broccoli
11	Pare
12	Purple Eggplant
13	Cayenne Pepper

Based on organic vegetable sales transactions in March 2023, consumer purchase items can be seen in the following table :

Table 2. Pattern of Organic Vegetable Sales Transactions

No	Transaction Item
1	Cayenne Pepper, Tomato, Spinach
2	Kale, Pakcoy, Tomato
3	Curly Red Chili, Broccoli, Kale
4	Lettuce, Spinach, Curly Red Chili
5	Caisim, Kale, Tomato
6	Kailan, Cayenne Pepper, Pakcoi
7	Cayenne Pepper, Curly Red Chili, Tomato
8	Lettuce, Cucumber, Pare
9	Purple Eggplant, Tomato, Kale
10	Kale, tomatoes, curly red chilies
11	Cayenne Pepper, Tomato, Curly Red Chili
12	Lettuce, Cucumber, Tomato
13	Kale, spinach, lettuce
14	cayenne pepper, bitter gourd, tomatoes
15	spinach, pare, caisim

In the organic vegetable sales transaction data, a tabular table is formed, which makes it easier to find out how many items were purchased in each transaction as follows:

Table 3. Transaction Data Tabular Format

Transaction	Kale	Kailan	Curly Red Chilies	Caisim	Spinach	Pakcoy	Tomatoes	Lettuce	Cucumbers	Broccoli	Pare	Purple Eggplant	Cayenne Pepper
TR1	1	0	1	0	1	0	1	0	0	0	0	0	1
TR2	1	0	0	0	0	1	1	0	0	0	0	0	0
TR3	1	0	1	0	0	0	0	0	0	1	0	0	1
TR4	0	0	0	0	1	0	0	1	1	0	0	0	0
TR5	1	0	0	1	0	0	1	0	0	0	0	0	1
TR6	0	1	0	0	0	1	0	0	0	0	0	0	1
TR7	1	0	1	0	0	0	1	0	0	0	1	0	1
TR8	0	0	0	0	0	0	0	1	1	0	1	0	0
TR9	1	0	0	0	0	0	1	0	0	0	0	1	0
TR10	1	0	1	0	0	0	1	0	0	0	0	0	1
TR11	0	0	1	0	0	0	1	0	0	1	0	0	1
TR12	0	0	0	0	0	0	1	1	1	0	0	0	0
TR13	1	0	1	0	1	1	1	1	0	0	0	0	1
TR14	0	0	1	0	0	0	1	0	0	0	1	0	1
TR15	1	1	0	1	1	0	0	0	0	0	1	0	0
Jumlah	9	2	7	2	4	3	10	4	3	2	4	1	9

The next stage is the analysis of frequency patterns and the process of forming item sets (C1) with a minimum amount of support of 30%, with the following formula::

Support (A) = Number of Transactions for A / Total Transactions (4)

Table 4. One Itemset Support

No	Items	∑ Transaction	Support
1	Kale	9	60%
2	Kailan	2	13%
3	Curly Red Chilies	7	47%
4	Caisim	2	13%
5	Spinach	4	27%
6	Pakcoy	3	20%
7	Tomatoes	10	67%
8	Lettuce	4	27%
9	Cucumbers	3	20%
10	Broccoli	2	13%
11	Pare	4	27%
12	Purple Eggplant	1	7%
13	Cayenne Pepper	9	60%

The results of one item set must meet the minimum support requirement of 30%, so an item that does not meet the minimum support will be deleted, as shown in the following table. :

Table 5. Support for One Selected Itemset

No	Items	∑ Transaction	Support
1	Spinach	9	**60%**
2	Curly Red Chili	7	**47%**
3	Tomato	10	**67%**
4	Cayenne pepper	9	**60%**

The next stage is the formation of C2, or with two itemsets and a minimum amount of support of 30%, with the following formula:

Support (A,B) = P (A∩B) (5)

1. **Support (A,B) = Transaction Amount for A / Total Transactions**

Table 6. Support for 2 Selected Itemsets

No.	Combination	∑Transaksi	Support
1	Kale, Curly Red Chili	5	33%
2	Kale, Tomato	6	40%
3	Kale, Cayenne Pepper	6	40%
4	Curly Red Chili, Tomato	6	40%
5	Curly Red Chili, Cayenne Pepper	7	47%
6	Tomatoes, Cayenne Pepper	7	47%

The results of the 2-item support must meet the minimum requirement of 30%, so that 2-items that do not meet will be deleted.
The next stage is the formation of C3, or 3 item sets with a minimum amount of 30% support, as follows::

Table 7. Support for 3 Selected Itemsets

No.	Combination	∑ Transaction	Support
1	Kale, Curly Red Chili, Tomato	4	27%
2	Kale, Curly Red Chili, Cayenne Pepper	5	33%
3	Tomatoes, Curly Red Chilies, Cayenne Peppers	6	40%

The next stage is the formation of C4 or 4 itemsets, and because there are no combinations that meet the minimum requirements in the 4 itemsets, it is continued by making associations from the selected C2 and selected C3.

Table 8. Association of selected C2

No	Association Rule 2 Itemset			
	Rule	∑ A & B	∑A	Confidence
1	If you buy kale, then buy curly red chilies.	5	9	56%
2	If you buy curly red chili, then buy kale.	5	7	71%
3	If you buy kale, then buy tomatoes.	6	9	67%
4	If you're buying tomatoes, then buy kale.	6	10	60%
5	If you buy kale, then buy cayenne pepper.	6	9	67%
6	If you buy cayenne pepper, then buy kale.	6	9	67%
7	If you buy curly red chilies, then buy tomatoes.	6	7	86%
8	If buying tomatoes, then buy curly red chilies.	6	10	60%
9	If you buy curly red chili, then buy cayenne pepper.	7	7	100%
10	If you buy cayenne pepper, then buy curly red chili.	7	9	78%
11	If you buy tomatoes, then buy cayenne pepper.	7	10	70%
12	If you buy cayenne pepper, then buy tomatoes.	7	9	78%

Table 9. Association of selected C3

No	Association Rule 3 Itemset			
	Rule	∑ A & B & C	∑A&B	Confidence
1	If you buy kale and curly red chili, then buy cayenne pepper.	5	5	100%
2	If you buy kale and cayenne pepper, then buy curly red chili.	5	6	83%
3	If you buy cayenne pepper and curly red chili, then buy kale.	5	7	71%
4	If you buy curly tomatoes and red chili, then buy cayenne pepper.	6	6	100%
5	If you buy tomatoes and cayenne pepper, then buy curly red chili.	6	7	86%
6	If you buy cayenne pepper and curly red chili, then buy tomatoes.	6	7	86%

The final association rules are ordered based on the predetermined minimum support and minimum confidence, which can be seen in the table below :

Table 10. Final Association

Final Association		
Rule	Support	Confidence
If you buy curly red chilies, then buy tomatoes.	40%	86%
If you buy curly red chili, then buy cayenne pepper.	47%	100%
If you buy kale and curly red chili, then buy cayenne pepper.	33%	100%
If you buy kale and cayenne pepper, then buy curly red chili.	33%	83%

If you buy curly tomatoes and red chili, then buy cayenne pepper.	40%	100%
If you buy tomatoes and cayenne pepper, then buy curly red chili.If you buy cayenne pepper and curly red chili, then buy tomatoes.	40%	86%
If you buy tomatoes and cayenne pepper, then buy curly red chili.If you buy cayenne pepper and curly red chili, then buy tomatoes.	40%	86%

Based on the association rules above, the most popular products can be identified, as seen in the graph below.:

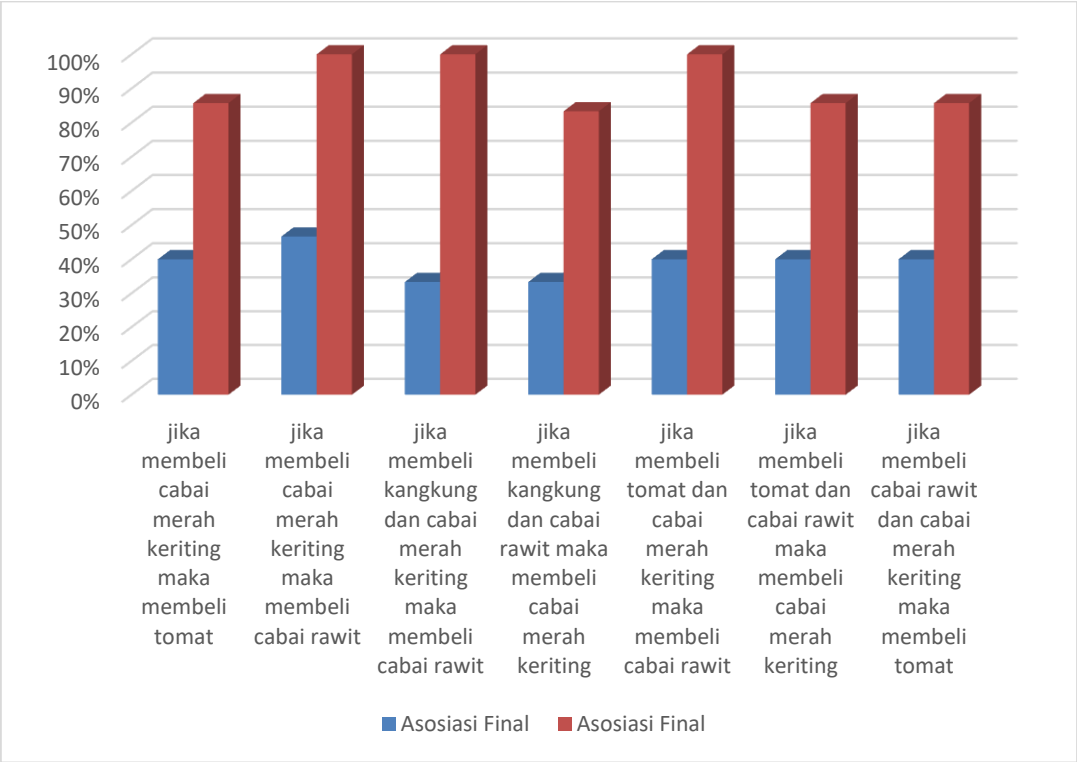

Figure 1. Graph of Most Final Sales Associations

4. Conclusion

From the process of determining data mining patterns using the a priori method, it is known that the items that sell the most, if you buy curly red chilies, then buy cayenne pepper with a 100% confidence value, if you buy kale and curly red chilies, then buy cayenne peppers with a 100% confidence value, if you buy

tomatoes and curly red chili then buy cayenne pepper with a confidence value of 100%, if buying curly red chili then buy tomatoes with a confidence value of 86%, if buying tomatoes and cayenne pepper then buy curly red chili with a confidence value of 86%, if buying cayenne pepper and curly red chili then buy tomatoes with a confidence value of 86%, and if you buy kale and cayenne pepper then buy curly red chilies with a confidence value of 83%.The results obtained are summarized as follows:

1. The Apriori algorithm is very useful for knowing the relationships and combinations of organic vegetables that are in great demand by consumers, so that they can be used as good information in selling organic vegetables and determining sales strategies.
2. Based on the results of the study, it was found that the supply value was 47% and the confidence was 100%, and the items that were sold were tomatoes, curly chilies, and cayenne peppers.

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