

Determining and Managing Stock of Goods Based on Purchasing Patterns Using The Frequent Pattern Growth Algorithm

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ABSTRACT

Stock inventory is one of the important work activities because stock inventory is the main element in the field of commerce. Mistakes regarding stock inventory will result in fatal problems, especially when stock inventory management is still done manually, or improper stock inventory planning can cause the amount of stock to pile up due to the small amount of demand from consumers, resulting in the stock being damaged, especially those contains elements of expiration because it is not sold. On the other hand, if the stock of goods is low while consumer demand is high, consumers will turn to other supermarkets to look for the goods they want. This can make supermarkets lose money because they cannot meet consumer needs. Therefore, **the association method** in determining and managing stock is needed to look for combination patterns of product items in the form of a system. **This research aimed** to look for product item combination patterns in previous period transaction data based on purchasing patterns in determining and managing supermarket inventory using the FP-Growth method with Min. Support 30% and Min. Confidence 70% produced 12 rules then with Min. Support 45% and Min. Confidence of 60% produced 6 rules. **The results of this research** show that the FP-Growth method, the Min. limit was chosen in this study. Support 30% and Min. Confidence was 70% due to generating 12 association rules. **The conclusion of the research** is that the results of this research provide information for supermarkets in making decisions in determining and managing the stock of goods based on purchasing patterns.

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1. INTRODUCTION

The current development of information technology has a huge impact on all aspects of life, including the business world. Information technology has become a necessity for the business world to increase effectiveness, productivity, and competitiveness. With information technology, the flow of information becomes faster, more accurate, and more reliable [1]. Inventory of goods is one of the important work activities for trading companies because inventory of goods is the main element in the field of trade. A small mistake regarding inventory will result in fatal problems, whether it is buildup in the warehouse or empty goods. Companies need technological support in the form of information systems that can make it easier and faster to provide information about inventory state [2]. Every supermarket business definitely has its own marketing strategy to boost sales and manage stock inventory. The important factor in sales is knowing consumer demand for products much sought after so that stock supplies are not excessive or short. Supermarkets need to know the number of product sales for the next period by analyzing the number of sales based on previous period data. Supermarkets also need to know what types of products or goods consumers need because of the various types of products that consumers often buy and do not buy.

When stock inventory management is still done manually or improperly planned, it can cause the amount of stock to pile up due to the small amount of demand from consumers, so that the stock of goods experiences damage, especially those that contain expired elements because they are not sold. On the other hand, if the stock of goods is low while consumer demand is high, consumers will turn to other supermarkets to look for the goods they want. This can make supermarkets lose money because they cannot meet consumer needs. So, sales forecasting is needed to decide which stock items require more inventory than other items to plan the next steps to increase sales quantity. Accuracy in predicting future product sales is necessary to minimize losses and gain profits. Therefore, a system is needed to look for product item combination patterns using association techniques in determining and managing stock inventory. Several previous studies used various association methods, such as research [3] using the FP-Growth and Apriori method to determine purchasing patterns for motorbike spare parts to know which spare parts are purchased a lot and assist in ordering spare parts at the head office. Research [4] has researched finding book borrowing patterns in libraries by applying the FP-Growth method. Research [5] conducted research to find similarities in goods based on purchased items used as a reference in the layout of goods using the Apriori and FP-Growth algorithms.

Research [6] conducts research related to determining product layout in ATK shop sales using the FP-Growth algorithm. Research [7] analyzes sales transaction patterns at the KGS Rizky Motor store to determine the emergence of patterns of items often purchased simultaneously to promote the best product items using the FP-Growth method. Research [8] performs research to determine Converse shoe stock inventory based on customer demand by applying the a priori method to make Converse shoe stock inventory data more accurate. Research [9] applies the FP-growth method in determining purchasing patterns for raw material goods so that a tendency emerged as to which goods were frequently purchased in research conducted at PT. Global Warna Indonesia produces the best purchase recommendations by looking at the highest support and confidence values. The purchasing pattern is purchasing BC (Retarder) and Methanol with a support value of 0.167 or 16.7% and confidence of 0.855 or 85%.

This research focuses on analyzing PT HERON supermarket sales transaction data to look for patterns of combinations or relationships between purchased product items to solve the problem of accumulation and emptiness in stock inventory using the FP-Growth method. An information system for determining and managing stock of goods will make it easier for supermarkets to stock each item of goods needed by consumers and increase efficiency and benefits for supermarkets. **This research aimed** to look for product item combination patterns in previous period transaction data based on purchasing patterns in determining and managing supermarket inventory using the FP-Growth method. **This research contributes** to understanding and improving inventory management in supermarkets by emphasizing the application of association techniques in stock management based on consumer purchasing patterns at PT HERON supermarkets.

2. RESEARCH METHOD

This research has several strands. The initial stage is collecting sales transaction data, followed by data preprocessing, implementing the FP-Growth method, and finally, the analysis results. The following is the flow as in Figure 1.

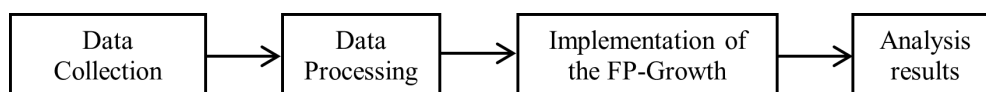


Figure 1. Research Flow

2.1. Data Collection

The method used in collecting data in this research used literature studies, interviews, and sales transaction data. Data collection was carried out to obtain information regarding the description of the existing system and what was implemented in the system to be created and to obtain the necessary data.

1. Literature Studies

The literature study was carried out by searching various written sources in the form of books, archives, magazines, articles, journals, and documents that were relevant to the problem under study so that the information obtained from this literature study was used as a reference or reference in preparing this thesis.

2. Interview

The author conducted the interview here by discussing questions directly with PT. HERON, which is located at Jl. Panca Usaha No.18, Cakranegara, Mataram City. The results of the interview were obtained in the form of raw data on sales of goods transactions in the period January 2020 to July 2020.

2.2. Data Preprocessing

This stage is the process of processing raw data so that it can be processed into quality data so that it can be analyzed further using the association method. Here, data attributes were selected for data processing purposes and eliminating unnecessary attributes, finally eliminating redundant or duplicate data. The following data has been preprocessed in Table 1.

Table 1. Preprocessed Sales Transaction Data

No	Date	Product Items
1	2/1/2020	Diapers, Liquid Cleanser, Detergent, Milk, Soap, Telon Oil, Toothpaste, Cologne, Breast Pad, Hair Lotion
2	3/1/2020	Diapers, Liquid Cleanser, Detergent, Milk, Telon Oil
3	4/1/2020	Diapers, Shampoo, Eucalyptus Oil, Telon Oil, Milk
4	5/1/2020	Diapers, Milk, Soap, Detergent, Liquid Cleanser, Porridge, Shampoo, Cologne, Breast Pad, Tissue
5	6/1/2020	Milk, Diapers, Biscuits, Porridge, Toothpaste, Eucalyptus Oil, Telon Oil, Cologne, Cotton Ball, Cotton Buds, Tissue, Powder, Cream, Soap
...
178	27/07/2020	Milk, Eucalyptus Oil, Liquid Cleanser, Breast Pad
179	28/07/2020	Diapers, Biscuits, Cologne, Soap, Shampoo, Tissue, Milk, Eucalyptus Oil, Telon Oil
180	29/07/2020	Milk, Diapers, Powder, Shampoo, Eucalyptus Oil, Biscuits, Soap, Porridge, Cologne, Tissue, Telon Oil
181	30/07/2020	Diapers, Tissue, Milk, Liquid Cleanser, Soap
182	31/07/2020	Tissue, Detergent, Liquid Cleanser, Cotton Buds, Milk, Diapers, Telon Oil

2.3. Implementation of the FP-Growth Method

At this stage, implement the FP-Growth method to look for combination patterns or relationships between product items in determining and managing stock inventory. The following is a flow diagram of the FP-Growth method, as in Figure 2.

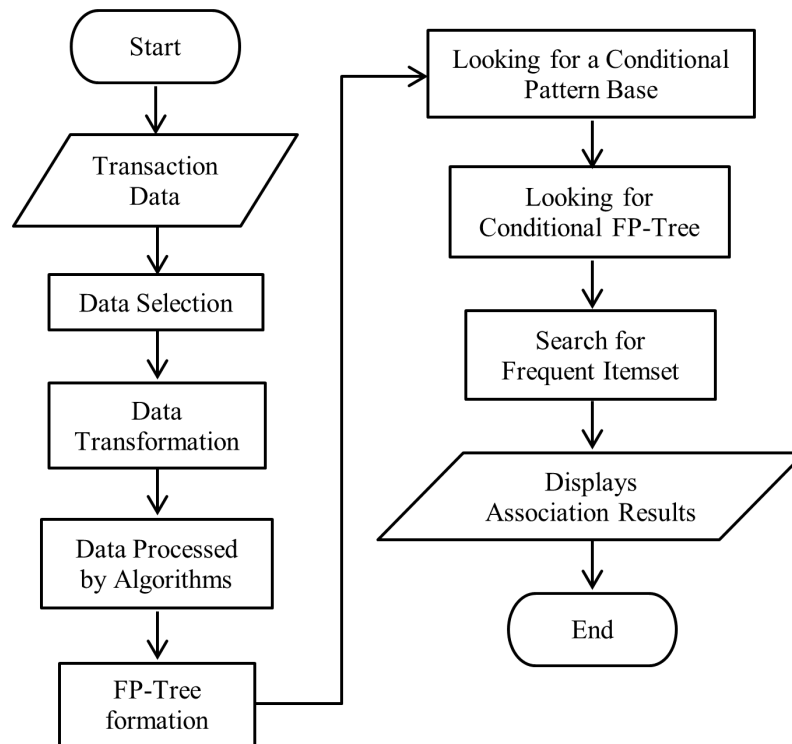


Figure 2. Flow Diagram of the FP-Growth Method

The FP-Growth algorithm is a development of the Apriori algorithm. So, the shortcomings of the Apriori algorithm are corrected by the FP-Growth algorithm [3, 5]. According to [10], The FP-Growth algorithm is divided into three main steps, namely:

1. Conditional Pattern Base Generation Stage

Conditional Pattern Base is a subdatabase that contains prefix paths and suffix patterns. The conditional pattern base generation is obtained through the FP-tree that has been built previously.

2. Conditional FP-Tree Generation Stage

At this stage, the support count of each item in each conditional pattern base is added up, then each item that has a support count greater than or equal to the minimum support count will be generated with a conditional FP-tree.

3. Frequent Itemset Search Stage

If the Conditional FP-tree is a single path, then a frequent itemset is obtained by combining items for each conditional FP-Tree. If it is not a single path, then FP-growth is generated recursively. The following formula for finding support, confidence, and lift ratio in associations can be seen as follows. The formula for finding support items is like Equation (1). The formula for finding support for a combination of two items is like Equation (2). The formula for finding confidence is like Equation (3). The formula for finding the lift ratio is like Equation (4).

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

$$Support(A, B) = \frac{\Sigma \text{ Number of Transaction } A \text{ and } B}{\text{Total Transactions}} \times 100\% \quad (2)$$

$$Confidence(A|B) = \frac{\Sigma \text{ Number of Transactions Contains } A \text{ and } B}{\Sigma \text{ Transaction Containing } A} \times 100\% \quad (3)$$

$$Lift \text{ Ratio} = \frac{Support}{Support(A) \times Support(B)} \quad (4)$$

2.4. Analysis Results

The final stage is the analysis of the results where association rules are generated and obtained from combination patterns between items in transaction data for the period January 2020 to July 2020 using the FP-Growth method. Where valid association rules have strong and valid links between items, these valid association rules were used as reference information for supermarkets in making decisions in determining and managing stock inventory.

3. RESULT AND ANALYSIS

In this research, several data must be prepared. The dataset used for this research is PT HERON sales transaction data has been preprocessed for the period January 2020 to July 2020 with a total of 182 transactions and 28 product items. For testing here, use the rapidminer tool with a Min. limit to test the dataset. Support 30% and Min. Confidence 70%. Previously, the dataset that had been preprocessed had to be converted into binomial form and saved in Excel format to be processed by the Rapidminer tool, as in Figure 3.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
18	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
21	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
22	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
23	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
24	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Figure 3. Transaction Dataset in Binomial Form

After the dataset has been prepared and saved in Excel, the next step is to add the dataset to the Rapidminer tool by selecting import data. The following is the display of the data that has been added, as in Figure 4.

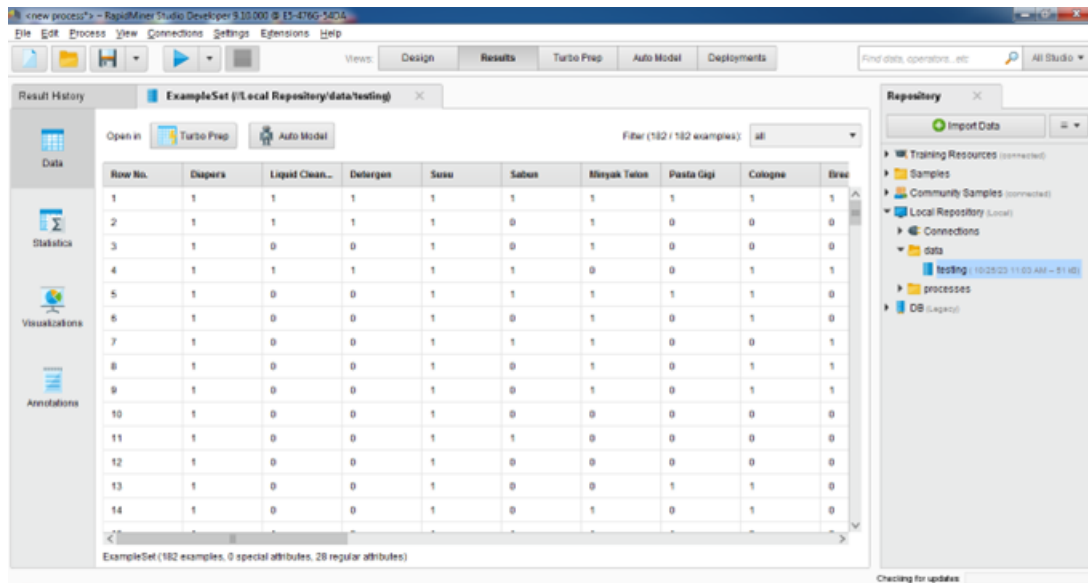


Figure 4. Dataset Successfully Added to Rapidminer Tools

The next step is to select the design menu in the view, add the dataset by drag and drop to the process page, and add several operators such as Numerical to Binomial, the FP-Growth operator, and the Create Association Rules operator. Finally, connect all the operators, as in Figure 5.

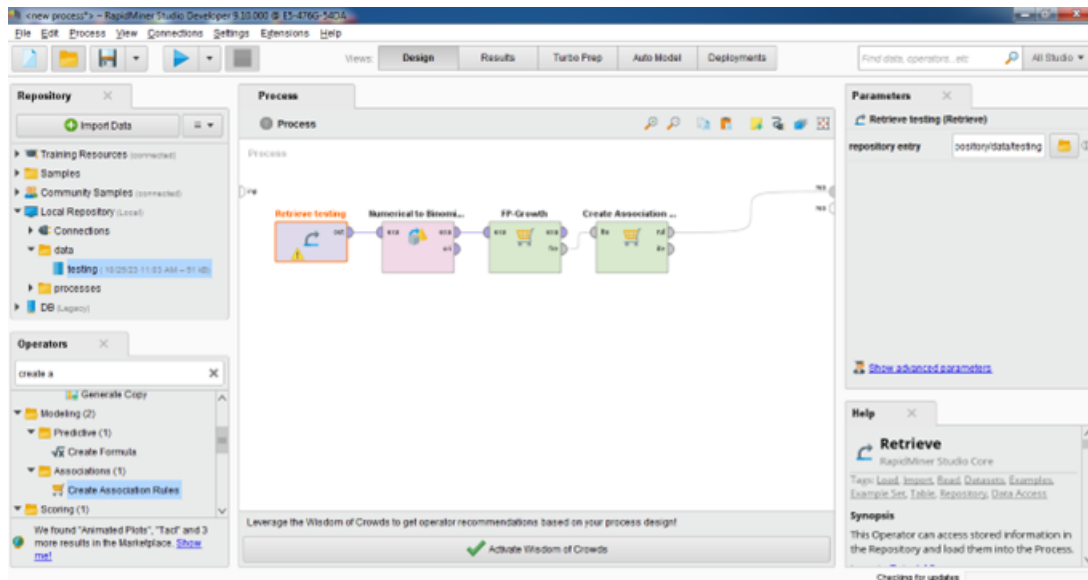


Figure 5. The Addition of Several Operators to Process the Dataset

The next step is to determine the Min. limit support by selecting the FP-Growth operator by filling in the value 0.3 or 30%, as in Figure 6.

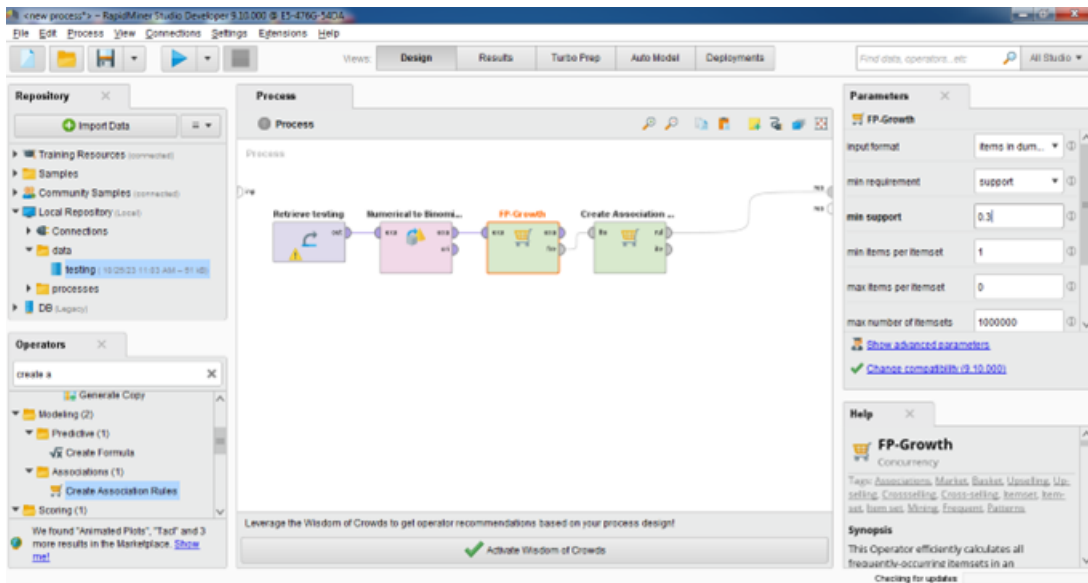


Figure 6. Giving Min Value. 30% Support for FP-Growth Operators

The final step determines the Min. limit. Confidence by selecting the Create Association Rules operator by filling in the value 0.7 or 70%, then selecting the play menu to process the dataset, as in Figure 7.

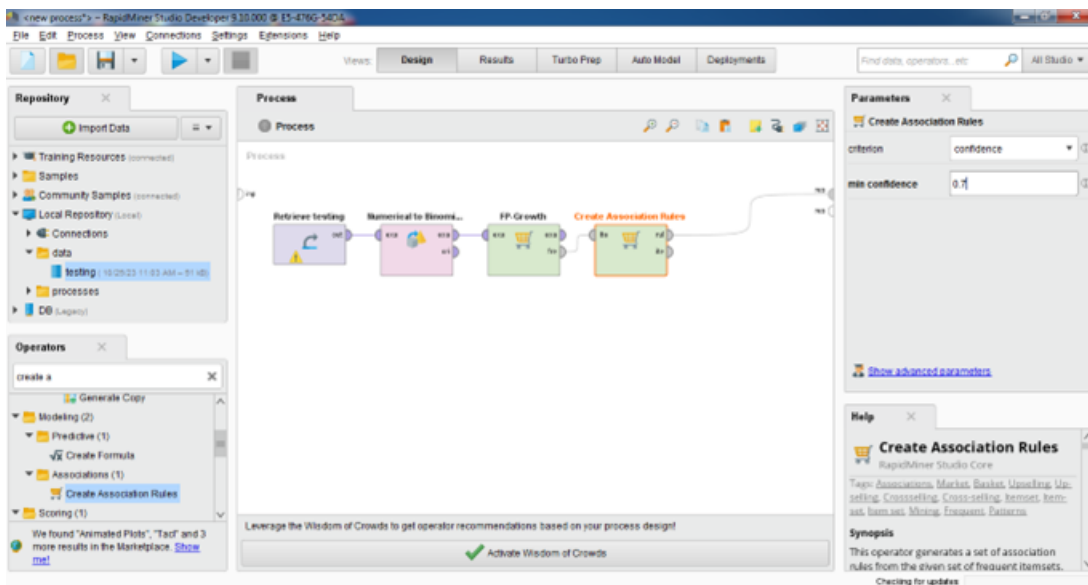


Figure 7. Giving Min Value. 30% Support for FP-Growth Operators

The final results and 13 association rules obtained from PT sales transaction data are the following. HERON for the period January 2020 to July 2020, with a total of 182 transactions and 28 product items, can be seen in Figure 8.

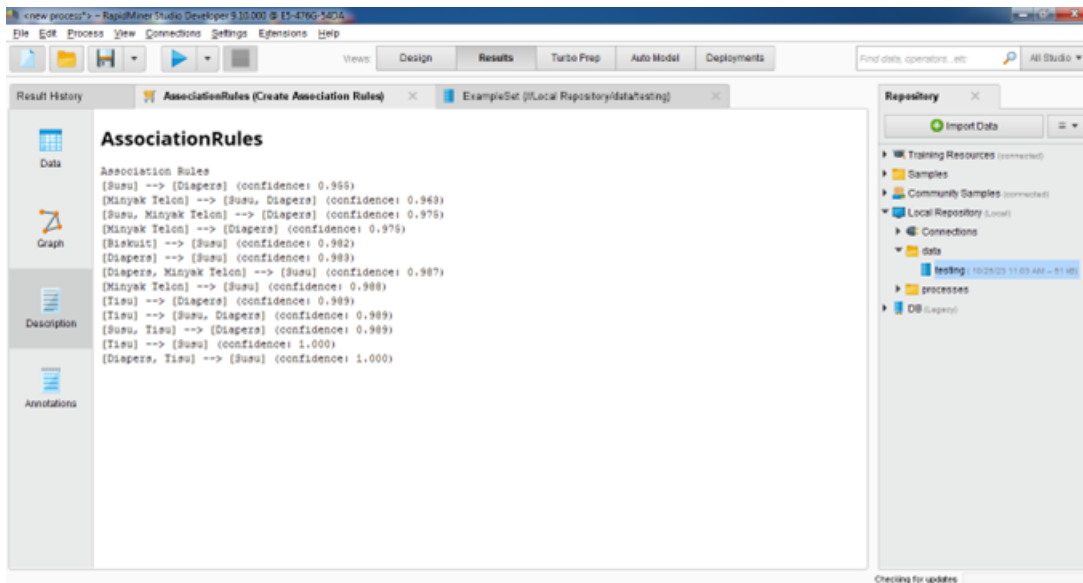


Figure 8. Association Results Obtained

Based on testing of several Min values. Support and Min. Confidence with rapidminer tools, resulting in more rules and providing recommendations for determining and managing stock of product or goods items. The first test uses the Min value. Support 30% and Min. Confidence 70%. The second test uses the Min value. Support 45% and Min. Confidence 60%. The results of the second test of support and confidence or rules produced using the FP-Growth method are presented in Table 2 Min value. **The findings of this research are** the use of a minimum support 30% and Min. Support 70% produces the most valid rules, namely 12 rules so that these rules are used to provide information for making decisions to determine and manage product items to be re-stocked.

Table 2. Comparison Results of Association Rules

No	Min. Support	Min. Confidence	Lift Ratio	Average of Generated Rules	Legal Association Rules
1	30%	70%	1,05	13	12
2	45%	60%	1,05	7	6

In Table 3, there are the association results that were used to determine and manage product items or goods to be re-stocked.

Table 3. Association Results that Were Recommended in Determining and Managing Stock Items

No	Association Results
1	The tendency to buy Telon Oil is to buy Milk and Diapers, these stocks need to be increased and managed
2	The tendency to buy Milk and Telon Oil then buy Diapers, this stock needs to be increased and managed
3	The tendency is to buy Telon Oil and then buy Diapers, this stock needs to be increased and managed
4	The tendency to buy biscuits is to buy milk, this stock needs to be increased and managed
5	The tendency to buy Diapers is to buy Milk, this stock needs to be increased and managed
6	The tendency to buy Diapers and Telon Oil is to buy milk stock, this needs to be increased and managed
7	The tendency to buy Telon Oil is to buy Milk, this stock needs to be increased and managed
8	The tendency to buy tissue then buy diapers, this stock needs to be increased and managed
9	The tendency to buy tissue then buy milk and diapers, this stock needs to be increased and managed
10	The tendency to buy Milk and Tissue then buy Diapers, this stock needs to be increased and managed
11	The tendency to buy tissue then buy milk, this stock needs to be increased and managed
12	The tendency to buy Diapers and Tissue then buy Milk, this stock needs to be increased and managed

So, referring to Table 3, the model to be selected is the model with a Min. Support value of 30% and Min. Support is 70% because it is an association model that produces the most and most valid rules, namely around twelve. This is also the reason for the Min value. Support 30% and Min. Confidence 70% is used as information to make decisions to determine and manage stock items at the PT. HERON supermarket, **where the results of this study are supported by research [5].**

4. CONCLUSION

The conclusion in this research is from the analysis results obtained using the FP-Growth method with Min limits. Support 30% and Min. 70% confidence obtained from 12 valid association rules. Where valid association rules have a strong and valid link between items, these valid association rules will be used as reference information for supermarkets in making decisions in determining and managing inventory of stock items. Suggestions for further research include combining the FP-Growth method with Clustering methods such as K-Means to group similar product items so that the results can be more accurate.

5. DECLARATIONS

AUTHOR CONTRIBUTION

All authors contributed to the writing of this article.

FUNDING STATEMENT

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COMPETING INTEREST

The authors declare no conflict of interest in this article.

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