

## Article

# Implementation of the FP-Growth Algorithm in Sales Transactions for Menu Package Recommendations at *Warung Oemah Tani*

Latifah Adi Triana<sup>1</sup>, Nur Isnaeni Khoerida<sup>2</sup>, Neta Tri Widiawati<sup>3</sup>, Imam Tahyudin<sup>4\*</sup>

<sup>1,2,3,4</sup>Department of Informatics, Faculty of Computer Science, Amikom Purwokerto University, Indonesia

\* Corresponding Author: [imam.tahyudin@amikompurwokerto.ac.id](mailto:imam.tahyudin@amikompurwokerto.ac.id)

## Abstract:

Along with the rapid development of the culinary industry, business competition is getting tougher. *Warung Oemah Tani* serves a variety of menus and drinks, but to provide satisfying service to customers, business people must try to develop new products. Under these circumstances, the menu recommendations for *Warung Oemah Tani* need to be analyzed so that the suggestions are right on target. This study aims to explore the sales of *Warung Oemah Tani* using the FP Growth algorithm. This algorithm identifies the data set with the highest frequency of concurrent sales (frequent itemset). The results of the association rules show that the highest support value is 0.520 and the highest confidence value is 0.929, with a minimum support of 30% and a minimum confidence of 80%. Obtained 14 rule associations that meet the minimum support and minimum confidence.

**Keywords:** FP-Growth, Data Mining, Menu Recommendations, Customers, sales



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## 1. INTRODUCTION

Rapid industrial development has resulted in increasingly fierce competition in the food and beverage industry. To maximize sales, many business actors, especially those engaged in the food and beverage industry, are making improvements through product or menu innovation. When starting a business, it's about products that attract customer attention and maximize sales and how to provide the best customer service. Companies must use the best business strategy to provide customer service. However, several factors may make it difficult for companies to choose a design. One of the contributing factors is the difficulty of producing analysis related to existing customer sales data.

We will formulate the problems at *Warung Oemah Tani* by analyzing sales data. *Warung Oemah Tani* is a culinary stall in the Bobosan area, North Purwokerto, Banyumas Regency. The promotion of *Warung Oemah Tani* menus made in one package has not been promoted optimally at *Warung Oemah Tani*. *Warung Oemah Tani* sells the food or drink menu separately. Still, if further research is done, sales could be increased by offering new options, such as buying the menu in cost-effective packages that include a combination of heavy food and drink or light food and drink.

Therefore, the results of this study will provide solutions regarding product sales data analysis methods to maximize marketing and business strategies. It is hoped that the results of our research can help *Warung Oemah Tani's* business maximize business process efficiency and provide an overview of innovations that can be used for menu combination recommendations. In addition, our research findings will assist *Warung Oemah Tani* in determining which menus can be developed and minimize spending on raw materials for menus that are less desirable so that raw materials are not stored in the warehouse for too long. One approach that can be taken to solve this problem is to use data mining, a method that uses statistics, mathematics, artificial intelligence, and machine learning methods to extract and identify useful information and related knowledge from large databases [1].

The application of data mining can be made with the FP-Growth Algorithm. Frequent Pattern Growth (FP-Growth) is an alternative algorithm that can be used to determine the most frequently occurring data set (frequent itemset) in a data set [2]. Previous studies used FP-Growth to find patterns in items purchased together [1]. Another study was conducted with the aim of looking at the buying patterns of customers from restaurants in buying side dishes so that restaurants can arrange side dishes to be sold every day [3]. Other studies also use FP Growth for various calculations to analyze spare part sales data at Shoorum PT. Alpha Scorpi [4]. Another study used FP-Growth to obtain a frequency pattern in each cluster divided after dividing all the data [5]. FP-Growth is also used to analyze fish sales as a reference in fish stock inventory at fish shops at PT Trans Retail Indonesia [6]. Then research using FP-Growth can also be used to find out the pattern of relationships in data transaction sales of outdoor products in the West Nusa Tenggara region [7]. Subsequent research aims to apply data mining association data mining methods to create new sales strategies for cross-selling [8]

From the studies discussed previously, this study uses sales transactions to recommend food and beverage menus to be ordered by consumers. This research utilizes the Rapidminer application for data analysis. In this study, the association rule mining method was used with the FP-Growth algorithm, which functions to form possible item combination candidates, and then tested whether the combination meets the specified minimum support and minimum confidence parameters.

## 2. THEORY

### A. Data Mining

Data mining is a term used to describe the disclosure of information in data sets. Data mining is extracting and identifying helpful information and related knowledge from large databases using statistical, mathematical, artificial intelligence, and machine learning techniques [9].

There are methods to fulfill data mining requirements, one of which is the requirement for extensive information. We can decide our choices or their quality from this information [10].

### *B. Association Rule*

In the scientific field of data mining, there is a method called the association rule. One technique that can help find patterns or associative relationships is the association rule technique. The widely used association rules are based on meeting the minimum support and confidence requirements [11]. This method is often also called market basket analysis. The data processing method known as Association Rule or ARM (Association Rule Mining) is a single subprocess-based system or technique [12]. Association rule mining is a procedure for looking for relationships between items in a specified data set. The Association rule is a technique used in data management. Association rule includes two stages [13]:

1. We are looking for the most frequent combination of an itemset.
2. Define condition and result (conditional association rule)

In this study, to get the percentage of total transactions, each transaction in the FP-Growth Algorithm association rules method must apply a support value and a confidence value [14]. Association rules have various uses, such as assisting in finding sales correlations in transactional, medical, and retail data sets [15].

### *C. FP Growth*

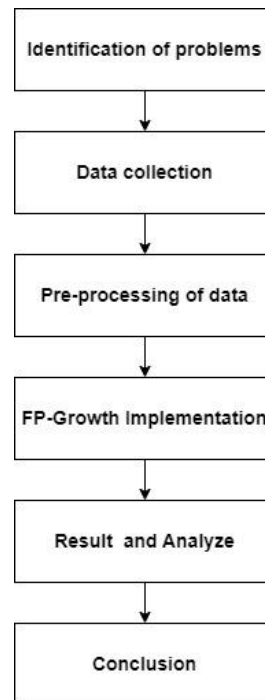
The FP-growth algorithm is a well-known algorithm based on the FP-growth tree proposed by Han Jiawei et [16]. The FP-Growth algorithm attracts attention because it can analyze frequent patterns with just two database scans without generating a pool of candidates [5]. The FP-Growth algorithm is an alternative algorithm that is quite effective for finding the most frequently occurring data set (frequent itemset) in large data sets [17]. The FP-Growth algorithm is a development of the Apriori algorithm [18]. Association analysis is mainly done with the help of the Apriori growth method and Frequent Pattern (FP) [19]. Therefore, the shortcomings of the Apriori algorithm are corrected by the FP-Growth algorithm. The characteristic of the FP-Growth algorithm is that the data structure used is in the form of a tree called the FP-Tree. Using the FP-Tree, the FP-Growth algorithm can directly extract the frequent itemset from the FP-Tree [20]. The FP-Growth algorithm has the main advantage of not generating candidate sets and only traversing the data set twice, thereby increasing the efficiency of frequent itemset mining [21]. Excavation of frequent itemsets using the FP-Growth algorithm will be carried out by generating a tree data structure known as FP-Tree. FP-Tree is used with the FP-Growth algorithm to determine the frequent itemset from the database, in contrast to the a priori paradigm which scans the database repeatedly to select the frequent itemset [22].

Moreover, the FP-Growth method can be divided into three main stages as follows [23]:

1. In the conditional pattern base generation stage,
2. FP-Tree dependent generation stage, and
3. The frequent itemset search stage.

### 3. RESEARCH METHOD

This research was conducted at *Warung Oemah Tani*, located in Bobosan Village, Banyumas, Central Java. *Warung Oemah Tani* sells various types of drinks as well as light and heavy meals. Moreover, the research was carried out following the predetermined research stages. The stages of the research can be seen in Figure 1.



**Fig 1.** Research Stages

Figure 1 illustrates several steps taken in this study, starting from identifying the problems found in *Warung Oemah Tani* to concluding the entire examination. The problem identification and data collection process begin with directly meeting workers who work at *Warung Oemah Tani*. Then conducted, interviews and the results of the discussions found problems in *Warung Oemah Tani*. The problem that arises is that there is a menu that runs out more quickly, there is no innovation in the package menu that contains food and drinks, and there are raw materials left every day. Therefore, it can make a loss for the business. So that we can help solve these problems, we need transaction data as material for analysis. After the data is obtained, the data analysis process is carried out. The processed data is sales transaction data that has been inputted by researchers with the help of Microsoft Excel [24]. After the data has been processed, searching for frequency patterns is carried out using the FP-Growth algorithm, which produces FP-Tree and interesting rules (strong association rules) so that combinations of side dishes from the restaurant will be found. Then testing was carried out using data analysis software, namely Rapid Miner.

#### 4. RESULT AND DISCUSSION

##### A. Problem Identification

From the results of interviews conducted by researchers at *Warung Oemah Tani*, it was found that the problems being faced by *Warung Oemah Tani* are that there is a menu that runs out more quickly, *Warung Oemah Tani* offers no package menu. There are raw materials left in the warehouse that, if not used, will spoil or be unconsumable, which can make the business lose money.

##### B. Data Collection

The data collection process was carried out directly at the *Oemah Tani Warung*. The results of data collection obtained transaction data for *Warung Oemah Tani* in Bobosan Village, Banyumas. The dataset is taken from the most purchased products, and 14 food and beverage menus are obtained in Table 1. And they Obtained 50 sales transaction sample data which can be seen in table 2.

**Table 1.** Most Preferred Menu

No	Items	Frequency
1	Hot Sweet Tea	19
2	Sweet iced tea	31
3	Orange juice	24
4	Black coffee	24
5	Coffee milk	18
6	Ginger Milk	20
7	Grilled fish cake	29
8	Nuggets	28
9	French fries	33
10	<i>Mendoan</i>	33
11	Chicken fried rice	16
12	Boiled noodles	15
13	Fried noodles	22

**Table 1.** Sales Transaction Data

No	Transaction Data
1	Sweet Ice Tea, <i>Mendoan</i> , Chicken Fried Rice
2	Sweet Ice Tea, Grilled fish cake, Nugget, French Fries
3	Sweet Ice Tea, Orange Ice, Black Coffee, Ginger Milk, Grilled fish cake, <i>Mendoan</i> , Fried Noodles
4	Sweet Ice Tea, Orange Ice, Milk Coffee, Grilled fish cake, Nugget, French Fries, <i>Mendoan</i>
5	Hot Sweet Tea, Orange Ice, Milk Coffee, Milk Ginger, Brains, French Fries, Boiled Noodles, Fried Noodles
..	.....
..	.....
48	Iced Tea, Black Coffee, Ginger Milk, Grilled fish cake, Nugget, French Fries, <i>Mendoan</i>

No	Transaction Data
49	Hot Sweet Tea, Black Coffee, Milk Coffee, Milk Ginger, Fried Noodles
50	Sweet Ice Tea, Black Coffee, Milk Coffee, <i>Mendoan</i> , Chicken Fried Rice

Table 3. Sales Transaction Data Itemset

No	Hot Sweet Tea	Sweet iced tea	Orange juice	Black coffee	Coffee milk	Milk Ginger	Grilled fish cake	Nuggets	French fries	<i>Mendoan</i>	Chicken fried rice	Boiled noodles	Fried noodles
1	0	1	1	0	0	0	1	0	0	1	1	0	0
2	0	1	0	1	0	0	1	1	1	0	0	0	0
3	0	1	1	1	0	1	1	0	0	1	0	0	1
4	0	1	1	0	1	0	1	1	1	1	0	0	0
5	1	0	1	0	1	1	1	0	1	0	0	1	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...
45	0	0	0	1	0	0	0	1	1	1	1	0	0
46	0	1	0	0	0	1	0	1	1	1	0	1	1
47	1	0	0	1	1	0	1	0	0	1	1	0	0
48	0	1	0	1	0	1	1	1	1	1	0	0	0
49	1	0	0	1	1	1	0	0	0	0	0	0	1
50	0	1	0	1	1	0	0	0	0	1	1	0	0

### C. Data pre-processing

In the pre-processing data stage, the previously created dataset (Table 3) is entered into the Rapid Miner Software; then, because the dataset's data type is an integer, it needs to be changed to binomial. Here's a look at the process design:

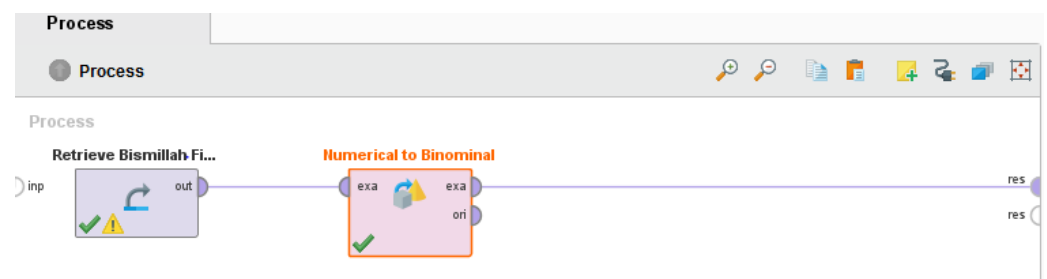


Fig 2. Design Pre-processing

### D. Implementation of the FP-Growth Algorithm

Research testing was carried out with the FP-Growth algorithm. The data type that was originally changed from integer to binomial is then carried out to determine the appropriate minimum support and minimum confidence values to obtain the best frequent itemset. From Figure 3, the minimum support used is 30% or 0.3. and From Figure 4, the minimum confidence used is 80% or 0.8.

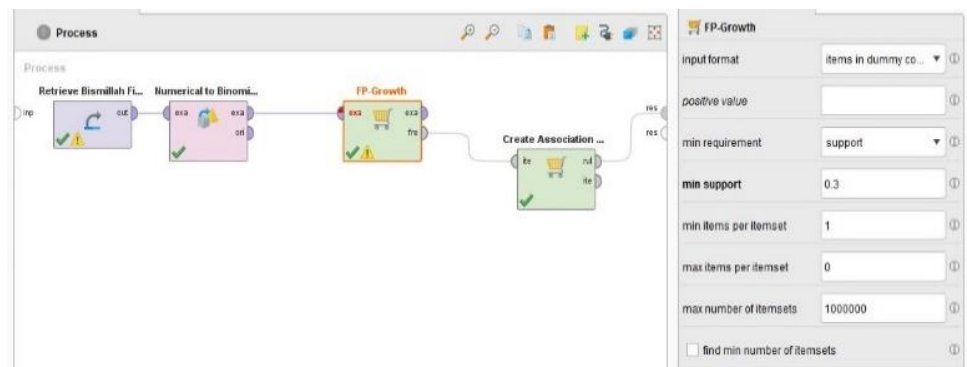


Fig 3. Determining Minimum Support

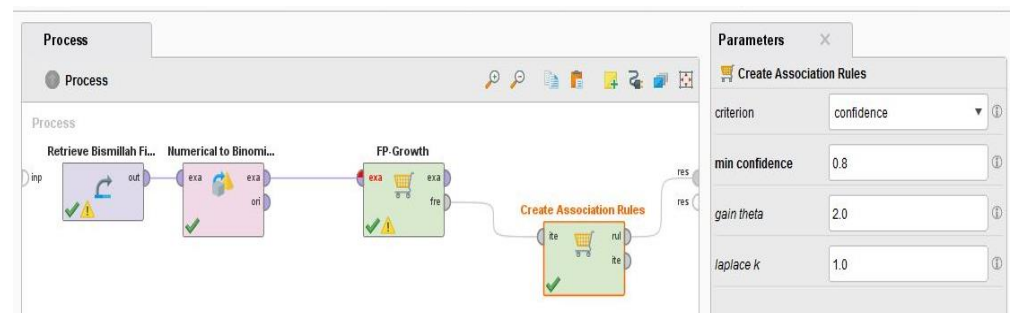


Fig 4. Determine Minimum Confidence

### E. Results

The results of the implementation of the FP-Growth algorithm that meet the minimum support and minimum confidence values are the following itemset results:

No.	Premises	Conclusion	Support	Confide...	LaPlace	Gain	p-s	Lift	Convict
4	Es Teh Manis, Nugel	Mendoan	0.360	0.818	0.944	-0.520	0.070	1.240	1.870
5	Kentang Goreng, Es Teh Manis	Nugel	0.400	0.833	0.946	-0.550	0.131	1.488	2.640
6	Kentang Goreng, Mendoan	Es Teh Manis	0.360	0.857	0.958	-0.480	0.100	1.382	2.660
7	Kentang Goreng, Mendoan	Nugel	0.360	0.857	0.958	-0.480	0.125	1.531	3.080
8	Kentang Goreng, Mendoan, Es Teh Manis	Nugel	0.320	0.889	0.971	-0.400	0.118	1.587	3.960
9	Kentang Goreng, Mendoan, Nugel	Es Teh Manis	0.320	0.889	0.971	-0.400	0.097	1.434	3.420
10	Mendoan, Es Teh Manis, Nugel	Kentang Goreng	0.320	0.889	0.971	-0.400	0.082	1.347	3.060
11	Mendoan, Nugel	Kentang Goreng	0.360	0.900	0.971	-0.440	0.096	1.364	3.400
12	Mendoan, Nugel	Es Teh Manis	0.360	0.900	0.971	-0.440	0.112	1.452	3.800
13	Es Teh Manis, Nugel	Kentang Goreng	0.400	0.909	0.972	-0.480	0.110	1.377	3.740
14	Nugel	Kentang Goreng	0.520	0.929	0.974	-0.600	0.150	1.407	4.760

Fig 5. Eligible Itemset Results

Moreover, the following shown in Figure 6 is a graphical display of the rules obtained from the implementation of the FP-Growth algorithm on the *Warung Oemah Tani* sales transaction dataset:

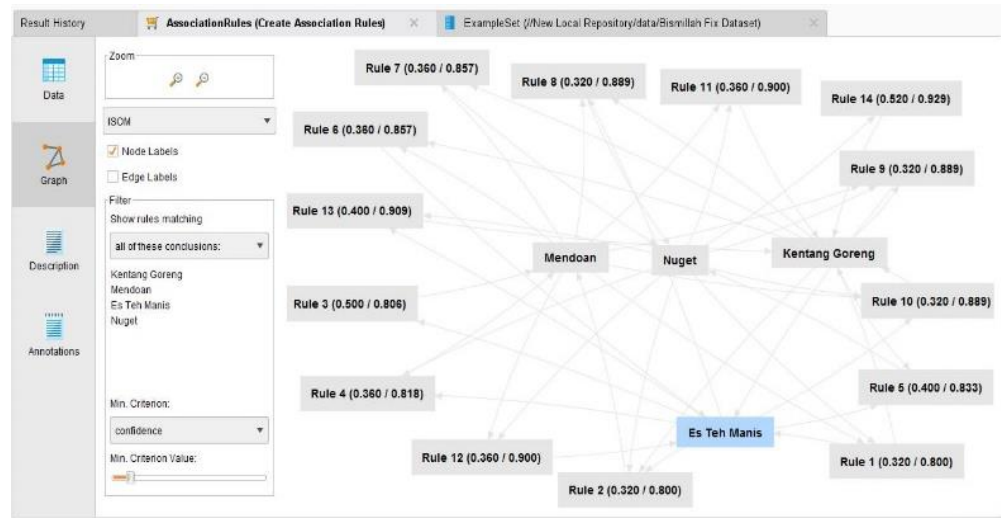


Fig 6. Graph Rules

Then the association rules are obtained from the application of the FP-Growth algorithm to the *Warung Oemah Tani* sales transaction dataset:



Fig 7. Association Rules

The results of the implementation of the FP-Growth algorithm resulted in four correlated rules or items, namely french fries, mendoan, sweet iced tea and nuggets. Then from the results of the association rules in Figure 7 and in Figure 5 it is obtained an itemset that meets a minimum support of 30% and a minimum confidence of 80%. The following is the order of support and confidence values, i.e., Nugget, Fried Potatoes 0.520 and 0.929 , Sweet Ice Tea, Nugget, Fried Potatoes 0.400 and 0.909 , Mendoan, Nugget, Sweet Ice Tea 0.360 and 0.900 , Mendoan,



Nuget, Fried Potatoes 0.360 and 0.900, Mendoan, Sweet Ice Tea, Nuget, Fried Potatoes 0.320 and 0.889, Fried Potatoes, Mendoan, Nuget, Sweet Ice Tea 0.320 and 0.889, Fried Potatoes, Mendoan, Sweet Ice Tea, Nuget 0.320 and 0.889, Fried Potatoes, Mendoan, Nuget 0.360 and 0.857, French Fries, Mendoan, Sweet Ice Tea 0.360 and 0.857, Fried Potatoes, Sweet Ice Tea, Nuget 0.400 and 0.833, Sweet Ice Tea, Nuget, Mendoan 0.366 and 0.818. The results of the association rules can be used as a benchmark for Warung Oemah Tani business owners in determining menu packages that are frugal according to consumer tastes, which consist of food and drinks.

## 5. CONCLUSIONS

Based on the results and calculations described, it can be concluded that the study's results used FP-Growth to find out what menus could be used as recommendations at *Warung Oemah Tani*. With minimum support of 30%, the highest support value was 0.520, and with a minimum confidence of 80%, the highest confidence value was 0.929. Then, from 50 sales transaction sample data for *Warung Oemah Tani* and 13 menus that are most in demand at *Warung Oemah Tani*, such as Hot Sweet Tea, Sweet Ice Tea, Orange Ice, Black Coffee, Coffee Milk, Ginger Milk, Grilled fish cake, Nuget, French Fries, Mendoan, Chicken Fried Rice, Boiled Noodles and Fried Noodles. Obtained 14 rule associations that meet the minimum support and minimum confidence. The rule association results can be used as a reference for the recommendation menu package at *Warung Oemah Tani*.

## AUTHOR CONTRIBUTIONS

Conceptualization; Latifah Adi Triana [L.A.T], Nur Isnaeni Khoerida [N.I.K], Neta Tri Widiawati [N.T.W], Imam Tahyudin [I.T], methodology; [L.A.T],[N.I.K],[N.T.W],[I.T]; validation; [L.A.T],[N.I.K],[N.T.W],[I.T], formal analysis; [L.A.T],[N.I.K],[N.T.W],[I.T]; investigation; [L.A.T],[N.I.K],[N.T.W],[I.T]; data curation; [L.A.T],[N.I.K],[N.T.W],[I.T], writing—original draft preparation; [L.A.T],[N.I.K],[N.T.W],[I.T], writing—review and editing; [L.A.T],[N.I.K],[N.T.W],[I.T], visualization; [L.A.T],[N.I.K],[N.T.W],[I.T], supervision project administration; [L.A.T],[N.I.K],[N.T.W],[I.T], funding acquisition; [I.T], have read and agreed to the published version of the manuscript.

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## CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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