

# **Analysis Of Consumer Purchase Patterns Using Frequent Pattern Growth Algorithm (FP-Growth)**

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## **Abstract**

This study aims to carry out purchase patterns using the Frequent Pattern Growth Algorithm at 212 Mart Pekanbaru. As modern retail, 212 mart offers a wide selection of everyday things. Due to its proximity to other stores, 212 Mart is under pressure to maximize its chances of attracting and keeping customers. Every day, there are many transactions at 212 Mart. Data mining turns mountains of incompletely processed sales transaction data into knowledge that can be considered when making decisions. FP-Growth uses Association Rules and its algorithm to identify the data set that frequently co-occurs from the data set that generates consumer buying patterns. RapidMiner software is used to process the data, and 28 rules with more than 20% support and confidence more significant than 90% are produced. The outcomes of the association rules are utilized to choose which product proposals, product layouts, and promotional brochures should be replenished simultaneously.

## **Keywords**

Association rules, Data mining, Frequent pattern growth, RapidMiner, Retail

## **Introduction**

Due to the competitive environment, businesses must work harder to improve their talents and potential to choose the best approach for attracting and keeping customers (Aziza 2022; R. J. Kuo, Lin, and Shih 2007; Nazaruddin and Sarbaini 2022; Purba, Hamzah, and Rizki 2022; Sarbaini, Saputri, and Muttakin 2022). One method is to take advantage of information technology. Existing data can be processed effectively to provide valuable information businesses can consider when making decisions. 212 Mart has numerous locations all around Indonesia. This store sells various food items, drinks, and other essentials. Products sold have guaranteed quality, reasonable prices with attractive promotional offers, kind customer service, and a welcoming environment for customers.

Data mining is an innovative method of learning knowledge from massive data sets, and it may be used to guide decisions (Muhammad Rizki et al. 2020; Thurachon and Kreesuradej 2021; Wibowo and Jananto 2020). One of the techniques in data mining is FP-Growth for mining association rules in sizable data sets. Frequent Pattern Growth (FP-Growth) is used to identify datasets in a data collection that frequently occur together. When looking for often occurring item sets, the FP-Growth algorithm employs the idea of tree building. (Chailes and Hermawan 2020; R.-J. Kuo, Gosumolo, and Zulvia 2019; R. Kuo et al. 2018).

Finding the necessary rules and patterns requires using the data mining concept in the large-scale data processing. This study will use data mining to analyse consumer purchasing trends at the Store utilizing transaction data and the FP-Growth Algorithm. Finding datasets that frequently exist in large data sets is the goal of data processing.

Users can consider the study's findings when choosing inventory and marketing tactics to boost sales, draw in new customers, and keep existing ones.

## **Literature Review**

In 1993, Agrawal et al. (Agrawal, Imieliński, and Swami 1993) published the original theory of association rule mining. They provided a useful technique for identifying significant correlations between items in retail transactions. Apriori algorithm (Agrawal and Srikant 1994), which has gained widespread acceptance, was introduced a year later and is a straightforward method for identifying common itemsets and association rules. Level by level, this system generated and evaluated candidate itemsets to determine whether they were frequent or infrequent itemsets. The production of several candidate itemsets, which required numerous database scans, a sizable amount of storage space, and lengthy computation, was a shortcoming of this concept.

To avoid this problem, the FP-Growth algorithm (Han et al. 2004) and a compact data structure - a frequent pattern tree or FP-tree - that collected all frequent items from a transaction was developed by Han et al. in 2000. With this technique, a database must be scanned only twice—first to find frequent itemsets and second to construct the FP-tree. The algorithm recursively constructed FP-trees to find all frequent itemsets without generating candidate itemsets. However, in finding frequent itemsets, the algorithm needed to construct multiple conditional pattern trees, which still required significant resources and computing time

### **A. Data Mining**

Data mining is collecting valuable information from previously unknown data sets. Data mining is used to identify patterns in data that may then be used to make precise predictions about future data. According to this definition, data mining is a field that researches ways to extract knowledge from enormous data sets or uncover patterns or links among them. (Chailes and Hermawan 2020; M Rizki et al. 2021; Thurachon and Kreesuradej 2021; Yang et al. 2020)

Knowledge Discovery in Databases (KDD) is a process made up of several iterative steps as listed below (Castro R, Espitia P, and Montilla 2018; Hernando 2019): Cleaning data, integrating data, choosing data, transforming data, evaluating patterns, and presenting knowledge

### **B. Association Rules**

One approach to finding patterns that frequently arise between several transactions, when each transaction consists of multiple things, is to use association rules. Therefore, this approach will establish a connection between the objects. It might be necessary to repeatedly read through vast transaction data to uncover various relationship patterns. There are three phases to the fundamental association analysis techniques. (Nasyuha et al. 2020; Simanjuntak and Windarto 2020):

$$\text{Support (A)} = \frac{\text{Transaction Number Containing Item A}}{\text{Total Transactions}} \quad (1)$$

Support is a number that shows how dominant a particular item or group of goods is during the entire transaction.

$$\text{Confidence (A} \rightarrow \text{B)} = \frac{f(\text{AUB})}{f(\text{A})} \quad (2)$$

A measure called confidence illustrates the conditional link between two elements.

### **C. Frequent Pattern Growth**

One of the alternate approaches for identifying the datasets (frequent item sets) that appear the most frequently in a data set is frequent pattern growth (FP-Growth) (Chailes and Hermawan 2020). One of the Data Mining association's techniques, FP-Growth, is used to locate datasets frequently resulting from enormous data sets.

The FP-Growth algorithm has three primary stages: the production of the conditional pattern base, the generation of the FP-Tree conditional, and searching for frequent item sets. The following phases must be completed before the primary staging, though: (Wibowo and Jananto 2020) assembling a dataset (items in each transaction), Forming FP-Tree, Generation Stage Conditional Pattern Base, Generation Stage Conditional FP- Tree, Search Frequent Itemset, Sorting by Priority, Generation Stage Conditional FP- Tree, Generation Stage Frequent Itemset.

## **Methodology:**

This research consists of several stages as follows.

#### D. Data Collection

Data was collected to get the information required for the study. Making observations, conducting interviews, and gathering information from documents are all methods for gathering data. This data collection uses actual data to give information that can be verified as accurate. Secondary data were employed to gather the data for this investigation. Most of the time, secondary data are gathered from existing data. Data from Store's sales transactions from January to March 2022 are used. The product name, the date, and the amount are all included in the sales transaction data.

#### E. Data Processing

Raw data in sales transaction data must first go through data preparation before being processed into the software using a predetermined technique. Data selection, transformation, and pre-cleaning data are the stages of the Knowledge Discovery in Database (KDD) stages. Then, using the program RapidMiner, the data will be analyzed to identify customer purchasing trends across all the data.

## II. DATA COLLECTION

All information or data relevant to the research is gathered as part of data collection. The following information was gathered at the time of data collection.

#### A. Data Of Sales Transaction at 212 Mart January-March in 2022

The process of gathering data involved getting an XLSX format (Microsoft Office Excel) file containing Store Pekanbaru's collection of transactions for the 2022 period, which included transactions for up to 468,485 different products.

Table 1. Data Of Sales Transaction January-March 2022

NO	Attributes				
	Code	Stock Name	Transt No	Date	Quantity
1	920143	Sumtim futh roti tawar panjang	2498602490	1/1/2022	1
2	923098	Sumtim selai kecil	2498602490	1/1/2022	1
3	929472	Indomie mieghetti bolognese 85	2498602490	1/1/2022	2
...	...	...	...	...	36
141628	926066	Thai tea lagimi	5873403100	3/31/2022	1

## Results and Discussions

The data used for processing this data is the last data that the data cleaning process has carried out. In this stage, problem-solving will be carried out on consumer purchase patterns with the Association Rule method using the FP-Growth Algorithm. Data preparation must be done because not all attributes are used in data mining. This process is carried out so that the needs will use the data.

#### B. Data Selection

Data selection is essential so that the data processed later follows the data needs of the algorithm used. When processing data using software, there are no errors, the system cannot run, and the results are not appropriate. Based on the results of data selection carried out on the dataset, data consisting of the Attributes Stock Name and Transaction Number is generated. Attribute selection is based on attributes that influence the process of finding association rules because the Market Basket Analysis (MBA) only focuses on what types of goods are most often purchased together from the entire transaction (Griva et al. 2018; Ilham et al. 2018; Sagin and Ayvaz 2018).

#### C. Data Transformation

Data transformation is carried out by changing the January-March 2022 sales transaction dataset to a data form based on the type of goods. Product grouping is carried out because the number of product variations of 212 mart is vast (7940 products), so it takes grouping to get the association rules. In addition, Microsoft Excel and RapidMiner have limitations in preparing data. Product grouping is carried out based on databases from the company. Next, the data is converted into a tabular format for further processing.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Mineral Water	Office stationery	Cake Ingredients	Laundry's Perfume	Biscuit	Body care	Spice	Cereal	Chocolate	Detergen	Product for Baby	Bread	Canned Food	Body S...
2	1	0	0	0	0	1	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	1	0
4	0	0	0	0	0	1	0	0	0	1	0	0	1	0
5	1	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	1	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	1	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	1	0	0	0
12	0	0	0	0	0	0	1	0	0	0	1	0	0	0
13	0	0	0	0	0	1	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	1
15	1	0	0	0	0	1	0	0	0	0	0	0	0	0
16	0	0	0	0	1	0	1	0	0	0	0	0	0	0
17	0	0	0	0	1	0	1	0	0	0	0	0	0	0
18	0	0	0	0	0	0	1	0	0	0	0	0	0	0
19	0	0	0	0	0	0	1	0	0	0	0	0	0	0
20	0	0	0	0	0	0	1	0	0	0	0	0	1	0
21	1	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	1	0	0	0	1	0	0	0
23	1	0	0	0	1	0	1	0	0	0	1	1	0	0
24	0	0	0	0	0	0	1	0	0	0	0	0	0	0
25	0	0	0	0	0	0	1	0	0	0	0	0	0	0

Figure 1. Data Transformation to Tabular

**D. Pre-Cleaning Data**

This stage helps ensure that the data to be processed is complete and appropriate. Based on the pre-cleaning stage of the data carried out on the data that has been selected, the data is complete and does not contain missing data. It indicates that the data can already be continued at the next stage.

**E. FP-Growth with RapidMiner**

Processing large amounts of data requires an application with the help of software that is commonly used to solve problems. The application is carried out by processing data using Rapid Miner software. It aims to find frequent item set datasets in large data sets. The application with Rapid miner is made by importing data from Microsoft Excel and converting each attribute type into binomial, pulling the dataset FP growth algorithm, and creating association rules parameter into a worksheet and connecting it, then running it. The result will appear as a pattern of sales transaction data in association rules.

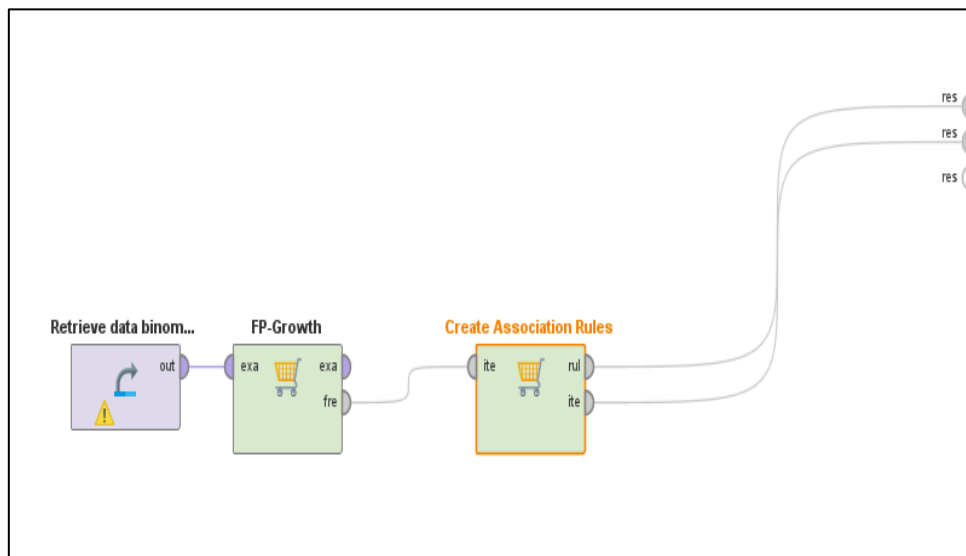


Figure 2. Process with RapidMiner

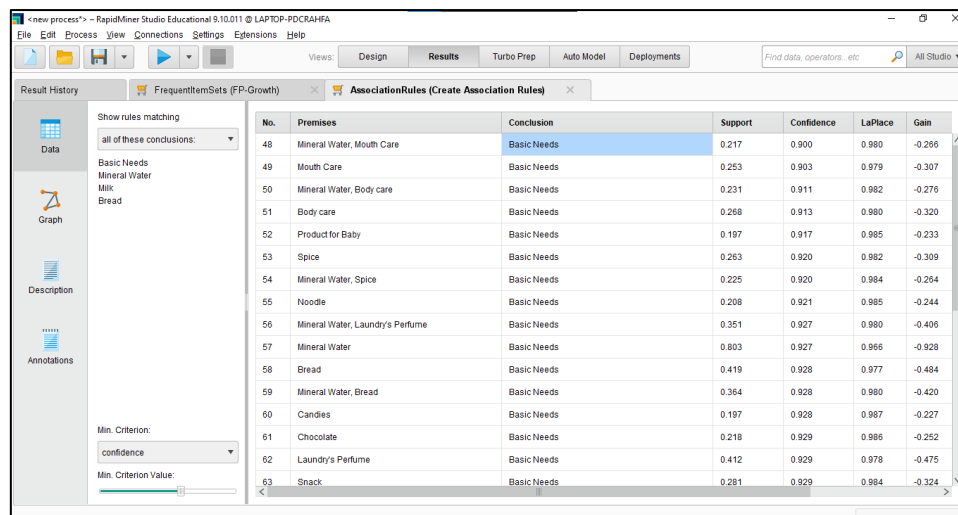


Figure 3. Result

In the data processing results using the FP-Growth Algorithm method in the entire transaction data, 28 rules met the minimum support of 20% and the minimum confidence of 90%. The rules obtained are:

Table 2. Association Rules Result with Min Support 20% and Min Confidence 90%

No	Premises	Conclusion	Support	Confidence
1	Mineral Water, Mouth Care	Basic Needs	0.2172236	0.899711261
2	Mouth Care	Basic Needs	0.2525445	0.902807775
3	Mineral Water, Body care	Basic Needs	0.2307013	0.910992843
4	Body care	Basic Needs	0.2683924	0.912899146
5	Product for Baby	Basic Needs	0.1970535	0.916955017
6	Spice	Basic Needs	0.2629549	0.91970091
7	Mineral Water, Spice	Basic Needs	0.2247525	0.919916302
8	Noodle	Basic Needs	0.2082075	0.921052632
9	Mineral Water, Laundry's Perfume	Basic Needs	0.3510712	0.927212471
10	Mineral Water	Basic Needs	0.8026212	0.927447506
11	Bread	Basic Needs	0.4185992	0.927600412
12	Mineral Water, Bread	Basic Needs	0.3635265	0.927656546
13	Candies	Basic Needs	0.1965887	0.927835052
14	Chocolate	Basic Needs	0.218339	0.928642024
15	Laundry's Perfume	Basic Needs	0.4120928	0.928773437
16	Snack	Basic Needs	0.2809871	0.929010449
17	Mineral Water, Biscuit	Basic Needs	0.5979923	0.929025271
18	Milk, Bread	Basic Needs	0.3421945	0.929789115
19	Mineral Water, Milk, Bread	Basic Needs	0.2987405	0.929842326
20	Mineral Water, Biscuit, Bread	Basic Needs	0.2738765	0.929935301
21	Mineral Water, Milk	Basic Needs	0.3753311	0.929986181
22	Mineral Water, Biscuit, Laundry's Perfume	Basic Needs	0.254357	0.929991504
23	Milk	Basic Needs	0.4300321	0.93004322
24	Mineral Water, Snack	Basic Needs	0.2305619	0.930420105
25	Mineral Water, Biscuit, Milk, Bread	Basic Needs	0.2279128	0.931257121
26	Mineral Water, Biscuit, Milk	Basic Needs	0.2768044	0.931789737
27	Biscuit, Bread	Basic Needs	0.3142167	0.932166
28	Biscuit	Basic Needs	0.6888972	0.932440083
29	Biscuit, Milk, Bread	Basic Needs	0.2605847	0.932945092
30	Biscuit, Laundry's Perfume	Basic Needs	0.2968351	0.93336256
31	Biscuit, Milk	Basic Needs	0.315425	0.933691017

The store can do something in the form of improvements based on the association rules obtained in the form of improvements in the location or position of the products sold. Types of products Mouth care, body care, spice, noodles, mineral water, bread, candies, chocolate, laundry perfumes, snacks, milk, and biscuits are placed close to the basic need products.

Types of products Mouth care, body care, seasoning, noodles, mineral water, bread, sweets, chocolate, fragrance products, snacks, milk, and biscuits are placed close to staple products to make it easier for customers to take the most sold products and increase sales for related products. Furthermore, a promotional brochure is recommended make based on the association rules. The determination of products on brochures is carried out based on the type of products that are most often purchased simultaneously. However, the products promoted are those that are less marketable than the types that are most often purchased simultaneously.

## **1. CONCLUSION**

Data mining can help process sales transaction data in the amount of 33,337 transactions. The Association Rules process using the FP-Growth Algorithm produces association rules, which are combinations of products most often purchased simultaneously. The result of the association rules is in the form of 28 rules using RapidMiner software.

Based on the results of the association rules, a proposal for layout improvement is recommended make, namely the types of products Mouth care, body care, Seasoning, Noodles, Mineral water, Bread, Sweets, chocolate, Fragrance Products, Snacks, Milk, Biscuits are approached with Staple Ingredients. The rules with the highest confidence are Biscuits, Milk, and Bread with Staples, with a confidence value of 93%. So, it is recommended to make a promotional brochure.

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