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# PROCEEDING 9<sup>th</sup> EECSI 2022

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Engineering, Computer Science and Informatics

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## **PROCEEDINGS**

### **9<sup>th</sup> International Conference on Electrical Engineering, Computer Science and Informatics (EECSI) 2022**

October 6 – 7, 2022, Jakarta – Indonesia

Editors:

Mochammad Facta, Ph.D

Mohammad Syafrullah, Ph. D

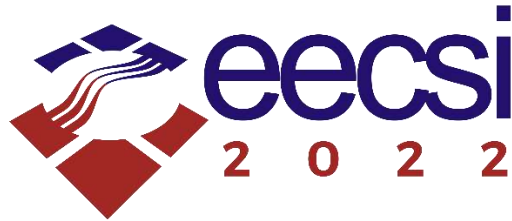
Munawar Agus Riyadi, Ph. D

Imam Much Ibnu Subroto, Ph. D

Irawan, M.Kom

# PROCEEDINGS

## 9<sup>th</sup> International Conference on Electrical Engineering, Computer Science and Informatics (EECSI) 2022



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Universitas Budi Luhur

Jl. Ciledug Raya, Petukangan Utara, Jakarta Selatan, 12260.

DKI Jakarta, Indonesia.

Telp: 021-585 3753

## **Foreword from General Chair EECSI 2022**

In the name of Allah, Most Gracious, Most Merciful.

Welcome to the ninth International Conference on Electrical Engineering, Computer Science and Informatics (EECSI 2022) in Jakarta, Indonesia.

The 9th EECSI 2022 provides platform for researchers, academicians, professionals, and students from various engineering fields and with cross-disciplinary working or interested in the field of Electrical Engineering, Computer Science, and Informatics to share and to show their works and findings to the world.

I would like to express my hearty gratitude to all participants for coming, sharing and presenting your experiences in this vast conference. Only high-quality selected papers are accepted to be presented in this event, so we are also thankful to all the international reviewers and steering committee for their valuable work. I would like to give a compliment to all partners in publications and sponsorships for their valuable supports.

Organizing such an prestigious conference was incredibly challenging and would have been impossible without our outstanding committee, so I would like to extend my sincere appreciation to all committees and volunteers from Universitas Budi Luhur as a host and all colleagues from Universitas Islam Sultan Agung, Universitas Diponegoro, Universitas Sriwijaya, Universitas Ahmad Dahlan, Universitas Muhammadiyah Malang, Universiti Colleg TATI, Universiti Teknikal Malaysia Melaka (UTeM) and IAES Indonesia Section for providing me with much needed support, advice, and assistance on all aspects of the conference. A special thanks for IEEE Indonesia Section for the technical co-sponsorship during the conference. We do hope that this event will encourage the collaboration among us now and in the future.

We wish you all find opportunity to get rewarding technical program, intellectual inspiration, renew friendships and forge innovation, and that everyone enjoys this conference.



**Mohammad Syafrullah, Ph. D**  
**General Chair EECSI 2022**

## Foreword from IAES Indonesia Section

Bismillahirrohmannirrahim,  
Assalamualaykum warohmatullahi wabarakatuh and Good Day,  
Ladies and Gentlemen,

We would like to welcome our colleagues to attend the 6<sup>th</sup> International Conference on Electrical Engineering, Computer Science and Informatics (EECSI 2022) held virtually in Jakarta on October 6<sup>th</sup> - 7<sup>th</sup>, 2022.

I hope this event will become a great event for researchers, engineers and professionals to strengthen ties and partnerships and their findings and development to the world in the field of electrical, computer, and informatics.

Institute Advanced Engineering and Science (IAES) collaborating with Universitas Budi Luhur, Universitas Diponegoro, Universitas Ahmad Dahlan, Universitas Gajah Mada, Universitas Islam Sultan Agung, Universitas Sriwijaya, Universitas Muhammadiyah Malang, and Universiti Teknologi Malaysia as several top universities have successfully organized the conference nine times since year 2014. This achievement is due to valuable contributions also from our colleagues from Universitas Budi Luhur. I would like to put my sincere gratitude and appreciation for all partners, friends, organizing committee, reviewers, keynote speakers, and participants who have made this event as a key stage to show great progress to the world as today.

I would also like to extend my gratitude to Rector of Universitas Budi Luhur, academia and supporting staffs from Universitas Budi Luhur who become a main host and IEEE Indonesia section as a technical co-sponsor for EECSI 2022.

We wish you a happy conference and success always.

Thank you.



Assoc.Prof. Mochammad Facta, Ph.D  
IAES – Indonesia Chapter

## Foreword from Rector Universitas Budi Luhur

Distinguished Guests and Participants, Excellencies,  
Ladies and Gentlemen

On behalf of the EECSI 2022 conference organizers, I would like to express my gratitude to all of you, who have come together here from various countries, for your cooperation which has enabled us to conduct a highly fruitful conference.

In this year's EECSI Conference which main theme was "Bridge Toward Industrial Revolution 4.0 and Its Applications on Electrical, Electronics, Computer Science and Informatics for Humanity", I expected that every participant to make contribution to this related field and promote mutual understanding among the participants through this event.

It is good for Budi Luhur University to learn about the excellent research done from different country regarding the conference topic. We also learned new ideas from each other, which we could adopt to further improve our work in this important area. I would like to pay my deep respect to all the participants for your positive participation.

We greatly appreciate the support we have from the EECSI conference organizing committee, to the Program Chairs, to the Program Committee for their extremely hard work for the details of important aspects of the conference programs and social activities. They have made this a very pleasant experience.

Finally, on behalf of the Conference Committee, I would like to express my appreciation to all the participants for taking time out of your busy duties to attend the event and to all your organizations for sending excellent participants to the event.



Assoc. Prof. Dr. Ir. Wendi Usino, M.Sc, MM  
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# Market Basket Analysis Using FP-Growth Algorithm On Retail Sales Data

Muhammad Raihan Pradana  
Department of Informatics  
Universitas Budi Luhur  
Jakarta, Indonesia

[1811503240@student.budiluhur.ac.id](mailto:1811503240@student.budiluhur.ac.id)

Mohammad Syafrullah  
Department of Computer Science  
Universitas Budi Luhur  
Jakarta, Indonesia

[mohammad.syafrullah@budiluhur.ac.id](mailto:mohammad.syafrullah@budiluhur.ac.id)

Hendri Irawan  
Department of Information System  
Universitas Budi Luhur  
Jakarta, Indonesia

[hendri.irawan@budiluhur.ac.id](mailto:hendri.irawan@budiluhur.ac.id)

Irawan  
Department of Computer Engineering  
Universitas Budi Luhur  
Jakarta, Indonesia

[irawan@budiluhur.ac.id](mailto:irawan@budiluhur.ac.id)

Joko Christian Chandra  
Department of Informatics  
Universitas Budi Luhur  
Jakarta, Indonesia

[joko.christian@budiluhur.ac.id](mailto:joko.christian@budiluhur.ac.id)

Achmad Solichin  
Department of Computer Science  
Universitas Budi Luhur  
Jakarta, Indonesia

[achmad.solichin@budiluhur.ac.id](mailto:achmad.solichin@budiluhur.ac.id)

**Abstract**—Technological developments make industrial competition increasingly fierce, especially in lifestyle-related industries. In the store where we do our case study, the buyer's interest in buying fashion products has decreased significantly. It has implemented many marketing strategies such as offering discounts, events, or product bundling, but sales still have not reached the target. Therefore, the store needs a system that can predict the pattern of habits and desires of buyers for an item. This system can be based on sales transaction data, which is processed using data mining techniques. In this case, the most suitable method is the association or commonly called market basket analysis. This method works by analyzing the behavior patterns of buyers when buying a product simultaneously at a given time. We choose the FP-Growth algorithm because the process is faster and more efficient. This research output is a system that can count the product association value in transactional data. When we tested 571 transaction data items with minimum support of 4% and a minimum of 50% confidence, four rules were obtained with a lift ratio test value above 1.

**Keywords**—Association Rule, FP-Growth, Data mining, Market Basket Analysis

## I. INTRODUCTION

Hoyjakarta is a retail store that resells various lifestyle products and accessories brands. The market target is the younger generation. In running its business, it sells through online stores and physical stores. For its online store, it uses a marketplace platform and social media. Hoyjakarta has two outlets in Jakarta and Bandar Lampung for its physical store. In the last few months, sales of several products have decreased significantly, as evidenced by the decline in sales value, both for a product intended for the lower middle class and a product aimed at the upper middle class. It has implemented many marketing strategies, including creating promotional content on Instagram and online and offline events. However, the sales have not reached the monthly target and compared to last year is still very far from achieving the target.

The sales transaction data owned by the store is fairly structured in terms of details, synchronization of stock items, and the sales report itself, but they don't use the data they have properly enough to increase product sales figures. In making discounted or promotional events, the store only refers to the summary of transaction data for four months, then, for its parameters, focuses on products that are often sold out.

Because of this, we believe that the results obtained in promotions are usually less than optimal, such as promotional mismatches in the form of discounts on product purchases or discounts for product bundling. Therefore, it needs a system that can predict the pattern of habits and desires of buyers for an item.

This system is based on sales transaction data, which is processed using data mining techniques. Data mining is a field intersection of computer science and statistics used to discover patterns in information repositories. The main goal of data mining is to extract useful information from a dossier of data and convert it into an understandable structure for future use. [1]. Data mining can be used in various fields, including healthcare, telecommunications, banking, manufacturing, education, service delivery, retail marketing, and bioinformatics [2]. In this case, the most suitable method is the association or commonly called market basket analysis. This method works by analyzing the behavior patterns of buyers in buying a product simultaneously at the same time. Market-based analytics analyze all data and create models for each data [3]. The result of this market basket analysis takes the form of an association rule. This association rule discovery can be used to identify a pattern in the discovered rules [4] and find a linkage of an item that often appears in a database.

In the literature study, we refer to regarding the association method. The algorithms often used are Apriori and Frequent Pattern-Growth (FP-Growth). We choose the FP-Growth algorithm because the process is faster and more efficient. Unlike the Apriori algorithm, which must scan data continuously so that it requires a more significant memory allocation, the FP-growth algorithm only performs two data scans where the data will be stored periodically from the original database in a simplified form or commonly called FP-Tree. The FP-Growth algorithm does not need to make candidate generation [5]. FP-Growth algorithm is used in data mining with large data because it is faster [6] and can combine it into statistics [7].

Previous studies have involved association rules and sales, for example, integrating product records of each purchase and analyzing association rules. The commodity combinations with associated consumption connections are attained, and the analysis model of commodity portfolio association rules is established [8].

Another previous study used FP-Growth and Apriori algorithms using 300 data transactions to help make decisions

regarding marketing activities such as promotional support, inventory control, and cross-selling campaigns at retail stores in Mumbai [9].

And finally, research to predict the novel and forecast hypermarket sales during the festive season. 484 sample data sets for FP-Growth and Apriori algorithms are used. Both algorithms were run and compared for their accuracy. The applied Apriori algorithm has higher accuracy than the FP-Growth algorithm. Also, the FP-Growth calculation takes longer than the Apriori calculation to produce a new result. [10].

## II. RESEARCH METHOD

In developing a market basket analysis system, we use association rules to find a relationship between 2 items in a dataset using the FP-Growth algorithm. There are several stages which can be seen in the following figure. Figure 1 is the transaction data processing process which will be converted into useful information for business strategy, along with a description of each stage.

### A. Data Collection and Selection

This research gets data from transaction data through the store transaction recording application. The amount of data to be analyzed is 571 transaction data items from January 8 to April 30, 2022. We only use transaction data on Saturdays and Sundays because transactions' intensity is higher than on regular days. Sample data can be seen in Table 1.

TABLE I. SAMPLE DATA FROM TRANSACTION

Order No	DateTr ans	Article Code	Type	ArticleN ame	Si ze	Price
OPK220108001	1/8/2022	HY.FX X-TJ001	Apparel	Fxxing Rabbit Smoking Kills	M	950000
OPK220108001	1/8/2022	HY.NBC-VA001	Sneakers	New Balance 574	38	1799000
OPK220108002	1/8/2022	HY.VAN-TI011	Sneakers	Vans Old Skool	42	800000
OPK220108002	1/8/2022	HY.VAN-TL067	Socks	Vans Socks	U	50000
OPK220108003	1/8/2022	HY.HER-TJ004	Accessories	Sixteen Hip Pack Watercolor	U	500000
...	...	...	...	...	...	...
NAY220430034	4/30/2022	HY.VAN-TL067	Socks	Vans Socks	U	50000

### B. Data Pre-Processing

After knowing which data can be used, the next step is data pre-processing with the initial stages of combining several data files into one master data into a workbook file. In this case, we only take the data that will be used at the processing stage and then reformats such as labeling the table header, discarding incorrect or incomplete data, to rearranging the date format so that it is easier to read. The pre-processing data stage is still done manually with the help of a few formulas in

the excel workbook application because the raw data format and naming are still messy. The results of sample data pre-processing and transformation are shown in Table II.

TABLE II. SAMPLE DATA PRE-PROCESSING AND TRANSFORMATION

OrderNo	Date	ArticleCode	ArticleName
OPK220108001	2022-01-08	HY.FXX-TJ001	Fxxing Rabbit Smoking Kills
OPK220108001	2022-01-08	HY.NBC-VA001	New Balance 574
OPK220108002	2022-01-08	HY.VAN-TI011	Vans Old Skool
OPK220108002	2022-01-08	HY.VAN-TL067	Vans Socks
OPK220108003	2022-01-08	HY.HER-TJ004	Sixteen Hip Pack Watercolor
...	...	...	...
NAY220430034	2022-04-30	HY.VAN-TL067	Vans Socks

### C. FP-Growth Stages

#### 1) Frequent Itemset Search

The following process is to find the frequent itemset. The dataset imported into the database is used to find the frequent itemset by calculating the frequency value of each customer transaction attribute.

#### 2) Sort data by priority

[The frequent itemset calculated in the previous step is sorted based on the items with the frequency, from the most to the least (priority).

#### 3) FP-Tree Creation

The next step is to create an FP-Tree based on the items sorted in the previous step based on the transactions made.

#### 4) Generate Conditional Pattern Base

After the creation of the FP-Tree, the conditional pattern base generation process is carried out regarding the previous process. First, determine the conditional pattern by looking at the suffix/bottom part of the FP-Tree and then sort the data list.

#### 5) FP-Tree Conditional Generation

In the conditional FP-Tree generation process, it is done by outlining the item results from the conditional pattern base generation process one by one. At this stage, the items will be grouped based on the frequency of transactions for each item based on certain items.

#### 6) Frequent Pattern Generation

The frequent pattern generation process refers to the conditional pattern base generation process. At this stage, processed items will be grouped again and combined into sub-frequencies for an item in the transaction.

FP-Growth algorithm mines frequent itemsets using an FP-Tree by pattern fragment growth [11]. The FP-Tree is mined by calling FP-Growth (FP-tree, null), which is implemented as follows.

```

procedure FP-Growth (Tree,  $\alpha$ )
(1) if Tree contains a single path P then
(2) for each combination (denoted as B) of the
    nodes in the path P
(3) generate pattern BU $\alpha$  with support count =
    minimum support count of nodes in B
(4) else for each a, in the header of Tree {
(5) generate pattern  $\beta$ =aUa with support count =
    a..support.count; (6) construct B's conditional
    pattern base and then  $\beta$ 's conditional FP tree
    Trees:
(6) if Trees 0 then
(7) call FP-Growth(Trees, B); }

```

#### D. Association Rules Search

The FP-Growth algorithm is used to find the support and confidence values of sorted data based on a pattern that often occurs in the data set so that it can be known which elements may appear (support) or elements that exactly appear (confidence) [12]. It aims to search for association rules from previously processed data at this stage. When data has been related to that, several processes are needed as follows:

##### 1) Calculate Support Value

After knowing the frequent itemset value, the next step is to find the support value in both frequent itemset. The support value from two item set is obtained using Equation 1. This support value calculation determines how often a combination of items appears in transactions. The greater the percentage of support value in a combination of items, the more frequent combinations appear. There are two stages of calculating support values in its application: sorting data based on priority to selecting data that often appear. After the frequent pattern generation process, it aims to find combinations of items that often appear.

$$Supp(A, B) = \frac{\text{Number of transactions contains A and B}}{\text{total of transactions}} \quad (1)$$

##### 2) Calculate Confident Value

Confident value aims to discover the possibility between products to be purchased simultaneously. The resulting value in the itemset is obtained using Equation 2.

$$Conf(A \rightarrow B) = \frac{\text{Number of transactions contains A and B}}{\text{Number of transactions contains A}} \quad (2)$$

##### 3) Calculate Lift Ratio

Lift Ratio is carried out as an addition to find out whether a rule is valid or not using Equations 3 and 4.

$$Lift\ ratio = \frac{Confident(A,B)}{Benchmark\ confidence(A,B)} \quad (3)$$

To get the value of the benchmark confidence using the formula:

$$Benchmark\ Confidence = \frac{Nc}{N} \quad (4)$$

$Nc$ : the number of transactions with consequent items and variable

$N$ : the number of database transactions

#### 4) Association rule results

After the whole process is done, the final result of the calculation will form the sentence "If... Then...". This process will be used as a consideration to help sales strategy.

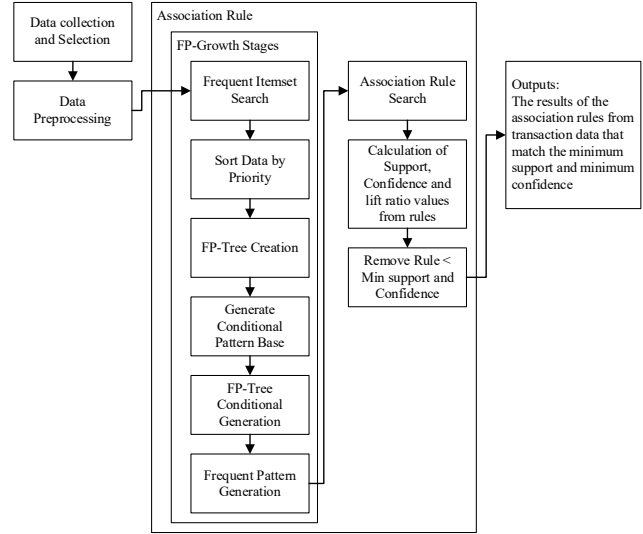


Fig. 1. Application System Process Stages

### III. RESULT AND DISCUSSION

#### A. Experimental Environment

A device with certain specifications is needed for the system that has been developed to work properly. This study uses device specifications, namely a code editor with Visual Studio Code, then connected to a local Apache Database Server that runs through localhost with the Opera browser, described on the deployment diagram in Figure 2.

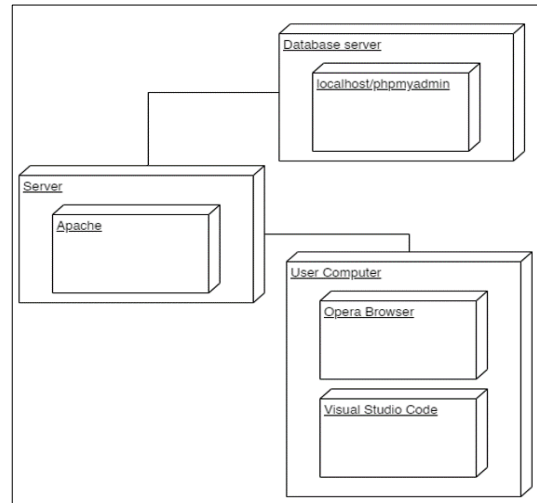


Fig. 2. Deployment Diagram

##### 1) Hardware Specification

The hardware that supports this application runs properly as follows:

- Processor : Intel(R) i5-8300H CPU @2.30GHz

- RAM : 16 GB DDR4
- Hardisk : 1000 GB
- VGA : Nvidia GTX 1050

## 2) Software Specification

The software that supports this application runs properly as follows:

- OS : Windows 11 Pro 64-bit (10.0)
- IDE : Visual Studio Code
- DBMS : Mysql Database
- Web Server: Apache (XAMPP version 3.3.0)
- Browser : Opera

## B. Output Rule

This test uses 571 total data items sold or 428 total sales transactions from January 8 to April 30, 2022. In this study, we set a minimum support value of 4%, considering sales data is quite varied. Then for the minimum confidence value of 50%, with consideration, because confidence is related to the confidence of 2 or more items, if the value is less than 50%, it is certain that the relationship between the itemset is more unrelated.

Rule validation testing tests the accuracy and accuracy of support and confidence in a rule using the Lift Ratio calculation. The following are the results of the Lift Ratio calculation on the rules tested using the system, as seen in Table III.

TABLE III. RULE LIFT RATIO VALIDATION TESTS ON THE SYSTEM

No	Rule	Support	Confidence	Lift Ratio
Rule #1	If there is a purchase of nike airforce one then there is a purchase of nike socks	5.84%	89.29%	11.58
Rule #2	If there is a purchase of Nike socks, then there is a purchase of nike airforce 1	5.84%	75.76%	11.58
Rule #3	If there is a champion short purchase, then there is a champion tees purchase	4.44%	57.58%	5.24
Rule #4	If there is a purchase of vans old skool, then there is a purchase of vansocks	5.37%	53.49%	4.02

The results of this study are the produce implication for the store in the form of product recommendations that can be packaged in sales offers to customers. The store can offer purchase packages of Nike Airforce 1 shoes with Nike socks at a slightly lower price. Likewise, Vans Old Skool shoes can be bundled with Vans socks. Moreover, Champion shorts can also be bundled with Champion tees.

## IV. CONCLUSION

This system can perform association calculations on transaction data to determine the pattern of products often purchased simultaneously and help the sales strategy. In

testing 571 total data with minimum support of 4% and a minimum of 50% confidence, four rules were obtained with a lift ratio test value above 1 with details. The support value of the first rule is 5.84% and confidence 89.29%, with a lift ratio value of 11.58. Then the second rule, with a 5.84% support value, 75.76% confidence value, and a lift ratio value of 11.58. Furthermore, the third rule has a support value of 4.44%, a confidence value of 57.58%, and a lift ratio value of 5.24. Finally, the support value of the fourth rule is 5.37% and a confidence value of 53.49% with a lift ratio value of 4.02.

For further development of this system to have a better function, use other methods such as EFP (Expand FP-Growth) to get better and more accurate results.

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