eecsi 2022

Organized by : UNIVERSITAS BUDI LUHUR

Sponsored by :

Technical Co-sponsorship : IEEE INDONESIA SECTION

PROCEEDING 9th EECSI 2022

9th International Conference on Electrical Engineering, Computer Science and Informatics

October 06-07, 2022
Jakarta, Indonesia

Co-organizers :

IBSN : 978-623-92135-6-5

PROCEEDINGS

9th 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

9th International Conference on Electrical Engineering, Computer Science and Informatics (EECSI) 2022

ISBN : 978-623-92135-5-8 (PRINT, Part Number : CFP17B51-PRT)
ISBN : 978-623-92135-6-5 (XPLORE COMPLIANT, Part Number : CFP17B51-ART)

Additional copies may be ordered to:
Direktorat Penelitian dan Pengabdian Kepada Masyarakat (DRPM)
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 nineth 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 6th International Conference on Electrical Engineering, Computer Science and Informatics (EECSI 2022) held virtually in Jakarta on October 6th - 7th, 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 tops 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
Rector Universitas Budi Luhur

Organizing Committee of EECSI 2022 Conference

Advisor
- Deni Mahdiana, Universitas Budi Luhur, Jakarta, Indonesia
- Nazori AZ, Universitas Budi Luhur, Jakarta, Indonesia
- Aghus Sofwan, Universitas Diponegoro, Semarang, Indonesia
- Zainudin Nawawi, Universitas Sriwijaya, Palembang, Indonesia
- Rahmat Budiarto, Albaha University, Baha, Saudi Arabia
- Novi Marlyana, Universitas Islam Sultan Agung, Semarang, Indonesia
- Andre Sugiyono, Universitas Islam Sultan Agung, Semarang, Indonesia
- Sunardi, Universitas Ahmad Dahlan, Yogyakarta, Indonesia

General Chair
- Mohammad Syafrullah, Universitas Budi Luhur, Jakarta, Indonesia

General Co-Chair
- Mochammad Facta, Universitas Diponegoro, Semarang, Indonesia

Finance Chairs and Treasurer
- Wiwiek Fatmawati, Universitas Islam Sultan Agung, Semarang, Indonesia
- Widodo MS, Universitas Budi Luhur, Jakarta, Indonesia
- Martini, Universitas Budi Luhur, Jakarta, Indonesia
- Lina Handayani, Universitas Ahmad Dahlan, Yogyakarta, Indonesia

Program Chairs
- Imam Much Ibnu Subroto, Universitas Islam Sultan Agung, Semarang, Indonesia
- Deris Stiawan, Universitas Sriwijaya, Palembang, Indonesia

Publicity Chairs
- Indra Riyanto, Universitas Budi Luhur, Jakarta, Indonesia
- Irawan, Universitas Budi Luhur, Jakarta, Indonesia
- Hendri Irawan, Universitas Budi Luhur, Jakarta, Indonesia

Technical Program Chairs
- Munawar Agus Riyadi, Universitas Diponegoro, Semarang, Indonesia
- Mochammad Facta, Universitas Diponegoro, Semarang, Indonesia
- Tole Sutikno, Universitas Ahmad Dahlan, Yogyakarta, Indonesia

Technical Program Members
- Maxime Leclerc, Thales Research & Technology (TRT), Canada
- Humaira Anwer, National University of Sciences & Technology, Islamabad, Pakistan
- Mahdi Baradarannia, University of Tabriz, Iran
- Deniz Dal, Ataturk University, Turkey
- Tole Sutikno, Universitas Ahmad Dahlan, Yogyakarta, Indonesia
- Zulfatman Has, University of Muhammadiyah Malang, Indonesia
- Noor Suhana Sulaiman, Universiti College TATI, Malaysia
- Chih-Chin Liang, National Formosa University, Taiwan
- Evgeny Markin, Russia

- Agus Minarno, Universitas Muhammadiyah Malang, Indonesia
- Maurice Ntahobari, Institut Teknologi Sepuluh Nopember, Indonesia
- Naveed Sabir, Mehran University Of Engineering & Technology, Jamshoro, Pakistan
- Abdulqawi Saif, Université de Lorraine, France
- Steffen Späthe, Friedrich-Schiller-University Jena, Germany
- Robert Szabolcsi, Óbuda University, Hungary
- Amin Torabi Jahromi, Persian Gulf University, Iran
- Anton Yudhana, Universitas Ahmad Dahlan, Indonesia
- Setiawan Assegaf, Universitas Dinamika Bangsa, Indonesia
- Andi Adriansyah, Universitas Mercubuana, Jakarta Indonesia

Local Arrangement, Exhibits & Registration Chairs

- Wiwin Windihastuty, Universitas Budi Luhur, Jakarta, Indonesia
- Titin Fatimah, Universitas Budi Luhur, Jakarta, Indonesia
- Samsinar, Universitas Budi Luhur, Jakarta, Indonesia
- Suwasti Broto, Universitas Budi Luhur, Jakarta, Indonesia
- Bambang Pujiyono, Universitas Budi Luhur, Jakarta, Indonesia
- Windarto, Universitas Budi Luhur, Jakarta, Indonesia
- Dolly Virgian Shaka Yudha Sakti, Universitas Budi Luhur, Jakarta, Indonesia
- Wasiran, Universitas Budi Luhur, Jakarta, Indonesia
- Anindya Putri Pradiptha, Universitas Budi Luhur, Jakarta, Indonesia

Reviewers

Abdalhossein Rezai	ACECR	Iran
Aditi Sharma	Quantum University	India
Adrian Tam	Clarity Solutions Group	USA
Ahmad Faruq	Universitas Muhammadiyah Malang	Indonesia
Ajay Shankar Shukla	ALL India Intitute of Ayureveda(AIIA)	India
Akhil Gupta	Lovely Professional University	India
Akhyari Nasir	Universiti College TATI	Malaysia
Alexander B. Sergienko	St. Petersburg Electrotechnical University	Russia
Ali Mahdoum	Centre de Developpement des Technologies Avancees	Algeria
Ameur Bennaoui	University of Science and Technology (USTO)	Algeria
Andang Sunarto	Fakultas Ekonomi dan Bisnis Islam, IAIN Bengkulu	Indonesia
Andrews Samraj	Mahendra Engineering College	India
Apdullah Yayik	National Defense University	Turkey
Apriana Toding	Universitas Kristen Indonesia Paulus	Indonesia
Areej M. Abduldaim Al-Alwash	University of Technology	Iraq
Ashish Tanwer	Stony Brook University	USA
Bogdan Cristea	Bogdan Eugen Cristea	Romania
Candid Reig	University of Valencia	Spain
Cesar Cardenas	Tecnologico de Monterrey - Campus Guadalajara	Mexico
Cheruku Sandesh Kumar	Amity University Rajasthan	India
Chuan-Ming Liu	National Taipei University of Technology	Taiwan
Dan Marius Dobrea	Technical University Gh. Asachi	Romania
Deepak Subramanian	AXA	France
Deepti Prakash Theng	G. H. Raisoni College of Engineering	India
Dhananjay Singh	Hankuk University of Foreign Studies	Korea
Dina Fitria Murad	Bina Nusantara University	Indonesia
Donato Impedovo	Universita degli Studi di Bari	Italy
E Hari Krishna	Kakatiya University	India
Eduard Babulak	National Science Foundation	USA
Elias Aboutanios	University of New South Wales	Australia
Ezra Morris A Gnanamuthu	Universiti Tunku Abdul Rahman	Malaysia
Farrukh Arslan	Purdue University	USA
Felix Albu	Valahia University of Targoviste	Romania
Fitri Maya Puspita	University of Sriwijaya	Indonesia
Galandaru Swalaganata	Institut Agama Islam Negeri Tulungagung	Indonesia

Gen Motoyoshi	NEC Corporation	Japan
Gerino P Mappatao	De La Salle University	Philippines
Gnane Swarnadh Satapathi	AJ Institute of Engineering and Technology	India
Grienggrai Rajchakit	Maejo University	Thailand
Haijun Pan	New Jersey Institute of Technology	USA
Haitham Abu Ghazaleh	Tarleton State University	USA
Hamid Alasadi	IRAQ- BASRA	Iraq
Harikumar Rajaguru	Bannari Amman Institute of Technology	India
Hela Elmannai	Princess Nourah University	Tunisia
Henry Novianus Palit	Petra Christian University	Indonesia
Hossein Jafari	Intelligent Fusion Technology	USA
Hussain Saleem	University of Karachi	Pakistan
Idris bin Ismail	Universiti Teknologi PETRONAS	Malaysia
Idris Lim	University of Glasgow	United Kingdom (Great Britain)
Ilesanmi Oluwafemi	Ekiti State University	Nigeria
Indra Riyanto	Universitas Budi Luhur	Indonesia
Isha Suwalka	CTAE	India
Iwan Setiawan	Universitas Diponegoro	Indonesia
Joni W. Simatupang	President University	Indonesia
Joonas Sae	Tampere University	Finland
Josip Music	University of Split	Croatia
Julio Rojas-Mora	Universidad Catolica de Temuco	Chile
Kamarulafizam Ismail	Universiti Teknologi Malaysia	Malaysia
Karim Hashim Al-Saedi	Mustansiriyah University	Iraq
Karthikeyan Ramasamy	Anna University	India
Kesavaraja D	Dr Sivanthi Aditanar College of Engineering	India
Kezhi Li	Imperial College London	United Kingdom (Great Britain)
Kittipong Kan Tripetch	Rajamangala University of Technology Suvarnabhumi	Thailand
Konstantinos Giannakis	Ionian University	Greece
Lateeef Adesola Akinyemi	Lagos State University	Nigeria
Louazani Ahmed	Ahmed ZABANA University Center of Relizane	Algeria
Madhu Ghattamaneni	Sree Vidyanikethan Engineering College	India

Madhur D Upadhayay	Shiv Nadar University	India
Mahmoud Rokaya	Taif University	Saudi Arabia
Manojkumar Somabhai Parmar	Robert Bosch Engineering and Solutions Limited	India
Marwan Nafea	University of Nottingham Malaysia	Malaysia
Md. Moidul Islam	Friedrich Schiller University Jena	Germany
Megat F. Zuhairi	Universiti Kuala Lumpur	Malaysia
Mehran Alidoost Nia	University of Tehran	Iran
Mehtab Fatima	Amity	India
Michael McGuire	University of Victoria	Canada
Miguel Antonio Sovierzoski	Federal University of Technology - Parana	Brazil
Mohamad Fauzi Zakaria	Universiti Tun Hussein Onn Malaysia	Malaysia
Mohammad Abdulrahman Al-Mashhadani	Al-Maarif University College	Iraq
Mohammad Al-Shabi	University of Sharjah	United Arab Emirates
Mohammed I. Younis	University of Baghdad	Iraq
Mohd Ashraf Ahmad	Universiti Malaysia Pahang	Malaysia
Mohd Elias Daud	Politeknik Sultan Salahuddin Abdul Aziz Shah	Malaysia
Mohd Khairul Ikhwan Bin Ahmad	Universiti Tun Hussein Onn Malaysia	Malaysia
Muftah Fraifer	IDC-CSIS-UL	Ireland
Muhammad Sohaib Ayub	Lahore University of Management Sciences	Pakistan
Munawar Riyadi	Diponegoro University	Indonesia
Nadheer A. Shalash	Al-Mamon University College	Iraq
Narendra Kumar Shukla	Shiv Nadar University	India
Narottam K. Das	CQUniversity Australia	Australia
Nasser Najibi	Cornell University	USA
Nibras Abdullah Faqera	Universiti Sains Malaysia	Malaysia
Nicolai Spicher	University of Applied Sciences and Arts Dortmund	Germany
Nidhal Abass	University of Kufa	Iraq
Norashikin M. Thamrin	University Teknologi MARA	Malaysia
Noraziahtulhidayu Kamarudin	University College of Technology Sarawak	Malaysia
Nuno Rodrigues	Instituto Politecnico de Braganca	Portugal
Omar Ibrahim Al saif	Northern Technical University	Iraq

Otavio P. Lavor	UFERSA	Brazil
Paolo Crippa	Universita Politecnica delle Marche	Italy
Parameshachari Bidare Divakarachari	Visvesvaraya Technological University	India
Parmod Kumar	Madda Walabu University	India
Partha Pratim Ray	Sikkim University	India
Pawel Rozga	Lodz University of Technology	Poland
Peter Roessler	University of Applied Sciences Technikum Wien	Austria
Prashant Upadhyaya	Buddha Institute of Technology Gorakhpur	India
Pujianto Yugopuspito	Universitas Pelita Harapan	Indonesia
Qi Zhao	University of California	USA
Raaed Khalid Ibrahim	Foundation of Technical Education	Iraq
Rahul Kala	Indian Institute of Information Technology Allahabad	India
Raid Daoud	Northern Technical University/Al-Hawija Institute	Iraq
Rajeev Mathur	Geetanjali Instt of Tech Studies	India
Rajesh M Pindoriya	Indian Institute of Technology Mandi	India
Ramkumar Jaganathan	VLB Janakiammal College of Arts and Science	India
Rana Khudhair Abbas Ahmed	Al-Rafidain University College	Iraq
Ranjan Kumar Dash	College of Engineering and Technology	India
Ravi Subban	Pondicherry University	India
Renaldi Gondosubroto	GReS Studio	Indonesia
Renliang Gu	Google Inc.	USA
Riko Arlando Saragih	Maranatha Christian University	Indonesia
Rini Nur Hasanah	Brawijaya University	Indonesia
Roberto Carlos Herrera Lara	National Polytechnic School	Ecuador
Rodrigo Campos Bortoletto	Instituto Federal de Sao Paulo	Brazil
Rodrigo Montufar-Chaveznava	Universidad Nacional Autonoma de Mexico	Mexico
Rostyslav Sklyar	Independent Professional	Ukraine
Saifullah Khalid	Civil Aviation Research Organisation	India
Sandeep Kakde	Y C College of Engineering	India
Sarada Prasad Dakua	Hamad Medical Corporation	Qatar
Seng Hansun	Universitas Multimedia Nusantara	Indonesia
Shajith Ali	SSN College of Engineering	India

Shashikant Shantilal Patil	SVKM NMIMS Mumbai India	India
Sherief Hashima	Engineering dept, Nuclear Research Center	Egypt
Shibiao Wan	The Hong Kong Polytechnic University	Hong Kong
Shilpa Mehta	FACULTY	India
Sonali Agarwal	Indian Institute of Information Technology Allahabad	India
Su Fong Chien	MIMOS Berhad	Malaysia
Sumita Mishra	Amity University Lucknow	India
Suneeta Harlapur	Vemana Institute of Technology	India
Sunil Kumar Kopparapu	Tata Consultancy Services	India
Suraya Mohammad	University Kuala Lumpur - British Malaysian Institute	Malaysia
Sutrisno Sutrisno	Diponegoro University	Indonesia
Thaksen Parvat	Sinhgad Institute of Technology	India
Thaweesak Yingthawornsuk	King Mongkut's University of Technology Thonburi	Thailand
Tianhua Xu	University of Warwick	United Kingdom (Great Britain)
Tomoaki Nagaoka	National Institute of Information and Communications Technology	Japan
Tow Leong Tiang	Universiti Malaysia Perlis	Malaysia
Tresna Dewi	Politeknik Negeri Sriwijaya	Indonesia
Tripura Pidikiti	R V R and J C College of Engineering	India
V Jyothsna	JNTUH	India
Victor E Martinez	Universidade Estadual de Campinas	Brazil
Wael A. Salah	Palestine Technical University - Kadoorie	Palestine
Xia Li	Apple	USA
Xiangguo Li	Henan University of Technology	P.R. China
Yogesh S Kale	North Carolina A&T State University	USA
Yong Sun	Schlumberger	USA
Yuchun Guo	Beijing Jiaotong University	P.R. China
Yumnam Jayanta	National Institute of Electronics and Information Technology(Kolkata)	India
YunWu Zhang	Southeast University	P.R. China
Zaher Haddad	Alaqsa University	Palestine
Zahera Mekkioui	University of tlemcen	Algeria

Table Of Content

9th International Conference on Electrical Engineering, Computer Science and Informatics (EECSI 2022)

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

Mohammad Syafrullah
Department of Computer Science
Universitas Budi Luhur
Jakarta, Indonesia
mohammad.syafrullah@budiluhur.ac.id

Hendri Irawan
Department of Information System
Universitas Budi Luhur
Jakarta, Indonesia
hendri.irawan@budiluhur.ac.id

Irawan
Department of Computer Engineering
Universitas Budi Luhur
Jakarta, Indonesia
irawan@budiluhur.ac.id

Joko Christian Chandra
Department of Informatics
Universitas Budi Luhur
Jakarta, Indonesia
joko.christian@budiluhur.ac.id

Achmad Solichin
Department of Computer Science
Universitas Budi Luhur
Jakarta, Indonesia
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. Hoyjakata 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	DateTrans	Article Code	Type	ArticleName	Size	Price
OPK220108001	1/8/2022	HY.FXX-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
...	...	...	...	...	...	...
NAY2204 30034	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, α)
(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 BUα with support count = minimum support count of nodes in B
(4) **else for each** a, in the header of Tree {
(5) generate pattern ß=aUa with support count = a,.support.count; (6) construct B's conditional pattern base and then ß'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.

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

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.

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

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.

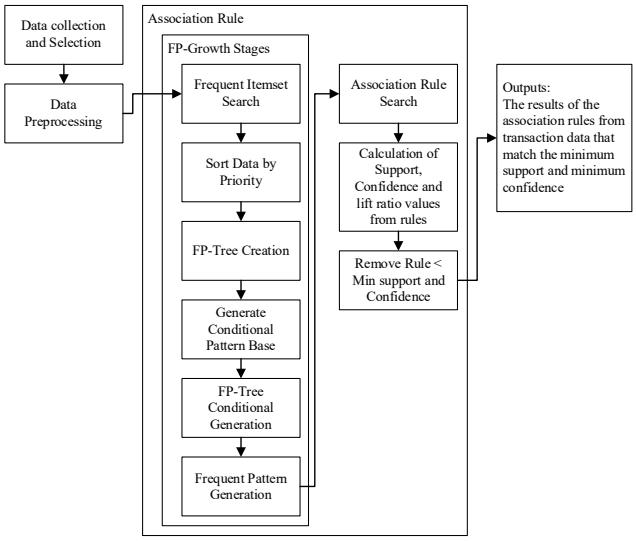

Fig. 1. Application System Process Stages

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.

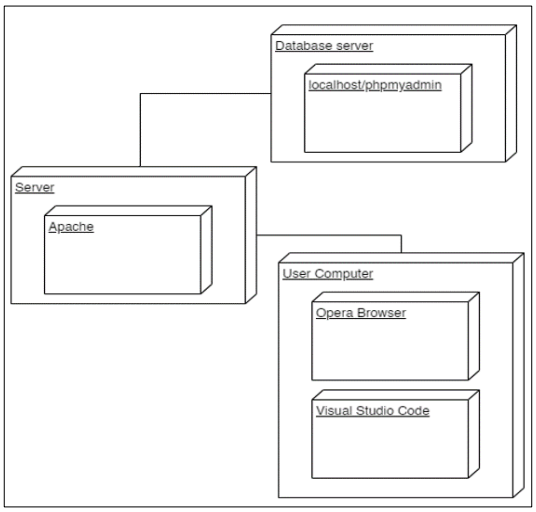

Fig. 2. Deployment Diagram

1) Hardware Spesification

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 vans socks	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.

ACKNOWLEDGMENT

This work was funded by Universitas Budi Luhur, Jakarta, Indonesia.

REFERENCES

[1] S. Agarwal, "Data Mining: Data Mining Concepts and Techniques," in *2013 International Conference on Machine Intelligence and Research Advancement*, Dec. 2013, pp. 203–207. doi: 10.1109/ICMIRA.2013.45.

[2] I. T. J. S, "Survey of Data Mining Algorithm's for Intelligent Computing System," *Journal of Trends in Computer Science and Smart Technology*, vol. 01, no. 01, pp. 14–23, Sep. 2019, doi: 10.36548/jtcsst.2019.1.002.

[3] L. Samboteng, R. Rulinawaty, K. Rachmat, M. Basit, and R. Rahim, "Market basket analysis of administrative patterns data of consumer purchases using data mining technology," *Journal of Applied Engineering Science*, vol. 20, no. 2, pp. 339–345, 2022, doi: 10.5937/jaes0-32019.

[4] M. Tandan, Y. Acharya, S. Pokharel, and M. Timilsina, "Discovering symptom patterns of COVID-19 patients using association rule mining," *Computers in Biology and Medicine*, vol. 131, p. 104249, Apr. 2021, doi: 10.1016/j.compbiomed.2021.104249.

[5] W. P. Nurmayanti *et al.*, "Market Basket Analysis with Apriori Algorithm and Frequent Pattern Growth (Fp-Growth) on Outdoor Product Sales Data," *International Journal of Educational Research & Social Sciences*, vol. 2, no. 1, pp. 132–139, Apr. 2021, doi: 10.51601/ijersc.v2i1.45.

[6] F. Firmansyah and A. Yulianto, "Market Basket Analysis for Books Sales Promotion using FP-Growth Algorithm, Case Study : Gramedia Matraman Jakarta," *Journal of Informatics and Telecommunication Engineering*, vol. 4, no. 2, pp. 383–392, Jan. 2021, doi: 10.31289/jite.v4i2.4539.

[7] M. Szymkowiak, T. Klimanek, and T. Józefowski, "Applying Market Basket Analysis to Official Statistical Data," *Econometrics*, vol. 22, no. 1, pp. 39–57, 2018, doi: 10.15611/eada.2018.1.03.

[8] J. Xu, C. Jiang, Y. Qu, W. Zhong, and Z. Gan, "Analysis and FP-Growth Algorithm Design on Discount Data of Department Store Members," 2022, pp. 797–804. doi: 10.1007/978-981-19-2456-9_80.

[9] K. Venkatachari, Chandrasekaran, and I. Davanbu, "Market Basket Analysis using FP-Growth and Apriori algorithm: a Case Study of Mumbai Retail Store," *BVIMSR's Journal of Management Research*, vol. 8, no. 1, pp. 56–63, 2016.

[10] S. Karthik and V. C.M., "A Novel Prediction of Sales and Purchase Forecasting for Festival Season of Hypermarkets with Customer Dataset Using Apriori Algorithm Instead of FP-Growth Algorithm to Improve the Accuracy," *ECS Transactions*, vol. 107, no. 1, pp. 12647–12659, Apr. 2022, doi: 10.1149/10701.12647ecst.

[11] J. Han, J. Pei, and M. Kamber, *Data Mining, Southeast Asia Edition*. Elsevier Science, 2006.

[12] A. Meida, D. P. Rini, and S. Sukemi, "Pattern of E-marketplace Customer Shopping Behavior using Tabu Search and FP-Growth Algorithm," *Indonesian Journal of Electrical Engineering and Informatics (IJEEI)*, vol. 7, no. 4, Dec. 2019, doi: 10.11591/ijeei.v7i4.1362.