INCITEST
International Conference on Informatics Engineering, Science & Technology
UNIKOM

Optimizing Product Promotion with Smart Bundling: An FP-Growth and IT-Enabled Analytical Framework

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Abstract. In a business, product promotion is necessary. This is done to increase sales and enhance the competitiveness of the business amid similar market competition. One strategy that can be used in promotion is smart bundling, which combines products into a single package offering that can increase the value of consumer purchases. Problems arise when determining the optimal product combinations is done subjectively without the support of systematic and strong data analysis. The aim of this research is to obtain suitable product bundling based on customer transaction history data, so that the produced products can increase the sales volume itself. In this study, product bundling will be carried out using an information technology-based analytical framework using the Frequent Pattern Growth (FP-Growth) algorithm. This method can identify customers' usual purchasing patterns and generate smart and data-driven product bundling recommendations. The results of the study show that 50% of consumers order Bengawan rice along with signature coffee, indicating that the two products can be sold together at a competitive price. This will impact an increase in sales volume as well as customer loyalty.

Keywords: Promotion, Bundling Product, Frequent Pattern Growth (FP-Growth).

1. Introduction

Technology has been widely utilized in various fields of life, including the business world. The use of technology has increased business competition and effectively increased transaction value, prompting business actors to think more competitively and creatively (Serov & Korol, 2024). Business players continue to innovate to attract customers, increase loyalty, and maximize the value of transactions.

Based on researches, one thing that can be done by business players is to implement product promotion strategies (owusu-ankomah,2024). There are many strategies that companies can apply to promote their products, one of which is product bundling (amalia N, 2025). Product bundling combines two or more products into one package offer. This has proven to be an effective increase in transaction value (Wang & yang, 2022). Product bundling

can also be used to introduce new products to customers and can attract customers' attention to try new products (yin et al., 2023).

However, selecting products to bundle is not an easy task. Businesses typically bundle products based on subjective opinions and intuition derived from managerial experience (Neupane et al., 2023). This results is not promotional strategies because the product bundle determination process does not take real-time customer purchasing behavior into account. This research to address this issue, the Frequent Pattern Growth (FP-Growth) algorithm can be applied when determining product bundles (Ismarmiaty & Rismayati, 2022). FP-Growth is algorithm can identify patterns from customer purchasing patterns based on historical transaction (Hairani & Guterres, 2024). The advantage Fp-Growth is efficiency because this method not require candidate itemsets, this process making it highly suitable for large scale daily transaction data (Xia et al., 2004). The purpose of this research is to determine which products should be bundled based on historical data from customer transactions, so that the resulting product bundles can positively impact sales themselves.

2. Literature Review

2.1 Promotion

Promotion is all communication activities by company to deliver information about a product or service to target market. The objective of promotional activities is (Lauret, 2022) :

1. introduce the product,
2. increase advantages and benefits
3. influence consumer attitudes and behavior to encourage purchases

Promotion is carried out through various media channels to influence the target market. Promotion is not only to increase sales but also serves as a tool to provide detailed information about products, prices, and product advantages (Chaudhuri et al., 2024). This promotion creates competition, as it allows consumers to determine the best choice from the various promotional information they receive. This promotion impacts the awareness of every company to always create products that have high competitiveness (Shivam, 2024).

2.2 Smart Bundling

Bundling is a marketing strategy that combines two or more products into one package at a single price. These products usually have a complementary relationship or are used together, although in some cases, less popular products can be combined with popular products to boost their sales. With a price that is more affordable than purchasing individual products, consumers tend to feel they are getting more value and are encouraged to make a purchase. This strategy is to increase the number of transactions, introduce the new products to customer and reduce the stock slow moving items (Wijaya & Kinder, 2020).
This is some common types of bundling used in various industries (Wijaya & Kinder, 2020) :

1. Mixed Bundling. Mixed bundling is a type of bundling that allows consumers to obtain products separately or in packages that have discounted prices. An example is the offer of products A and B that can be purchased together at a special discount if bundled. This

strategy allows consumers the flexibility to buy products and gain benefits when giving them together.

2. Pure Bundling: In pure packaging, the available products are only sold as a single package and cannot be purchased separately. This strategy prevents consumers from making choices, but it can provide advantages in terms of shipping efficiency.

3. Same Product Bundling The Same Product Bundling Package is a strategy that sells multiple items of the same product in a package that is cheaper than buying one. This strategy is often used for products that are continuously consumed, such as skincare or food ingredients.

4. Buy One Get One (BOGO) Bundling BOGO is a promotional strategy that has the most common form of bundling. In this strategy, consumers receive an additional product as a gift when purchasing a main product at the normal price. This strategy is highly recommended to encourage the sales of a product at the normal price.

5. Cross-Selling Integration Integration is a sales strategy that combines the main product with complementary products that are usually used together.

2.3 Frequent Pattern Growth (FP-Growth)

FP-Growth (Frequent Pattern Growth) is an algorithm used to find frequent itemset patterns in transaction data. In this algorithm, association rule mining is performed; it analyzes the relationships between items, such as products that are frequently purchased together by consumers. In some cases, FP-Growth is used in conjunction with other algorithms like K-Means to analyze consumer behavior and market preferences based on sales data. The results can identify products that are often bought at the same time (Asana et al., 2020).

FP-Growth overcomes the weaknesses of the Apriori algorithm by eliminating the need for candidate generation processes. Instead, FP Growth utilizes a data structure called FP-Tree (Frequent Pattern Tree), which facilitates the direct extraction of frequently occurring data patterns. The FP-Tree is built by analyzing each transaction into specific paths within the tree structure when similar paths and items can be merged. The higher the similarity between transactions, the more efficiently the data flows through the FP-Tree. One of the main advantages of FP-Growth is its efficiency, as it only requires two scans of the existing dataset (Nugroho et al., 2025).

3. Method

This section explains how data is collected and the methods used to analyze the existing transaction data. The first step taken is data preprocessing. Then, analysis is performed using FP Growth, creating an FP Tree, determining frequently occurring itemsets, and generating association rules. Figure 1 shows the steps in this research:

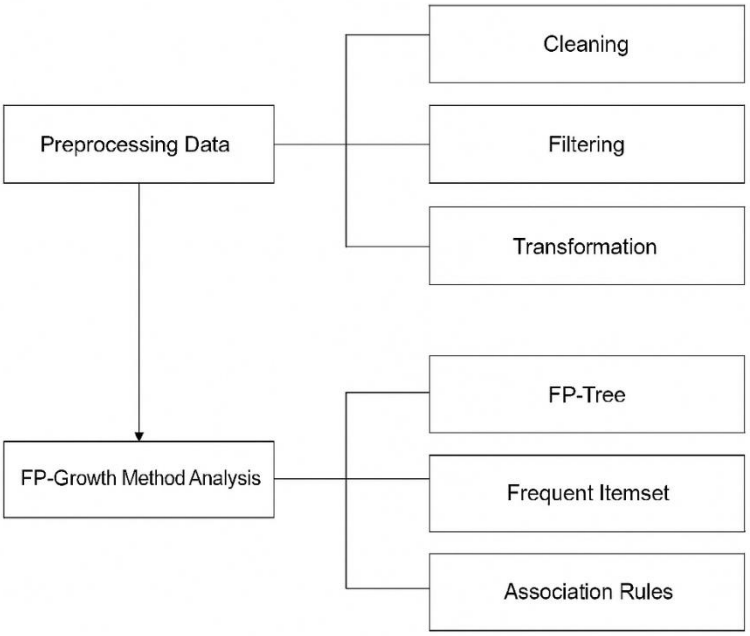

Figure 1. State of the research

4. Results and Discussion

4.1 Prepocessing Data

1. Data Cleaning

   Data cleaning is performed to eliminate data that is perceived as inaccurate, duplicate, or irrelevant. The steps taken are: Removing Duplicate Data: Searching for and removing duplicate transaction data. Handling Missing Values: Dealing with missing or null values. Correcting Errors: Fixing possible typographical errors or other mistakes (Bhattacharjee et al., 2013).

2. Data Filtering

   The filtering stage is the stage that processes data filtering to ensure that the data being analyzed is only relevant data, such as Ref. No, Item Name, and Category, that are used. Unnecessary columns will be removed to simplify data analysis and ensure accurate product groups (Pradhan et al., 2025).

3. Data Transformastion

   transformation process aims to convert transaction data to a format, which involves grouping items based on the reference number (Reff No.) so, transaction contains have a list of products purchased in together. This format necessary for data to be processed by the FP-Growth algorithm for find some purchasing patterns and formulate bundling promotion strategies (Pradhan et al., 2025).

4.2 Prepocessing Data

1. FP-Tree

FP-Tree (Frequent Pattern Tree) is a structure tree which formed based on items frequently appear on data transactions. This tree is used FP-Growth algorithm to find association patterns among products that often purchased together in single transaction (Indrawan & Ariasih, 2021). The data is creating the FP-Tree and make the result of transforming transaction data into a basket format, as shown in Table 1. At this stage, each transaction represented by a row containing of collection of products purchased together.

Table 1. FP-Tree

TID	Item Name
T1	Nasi Bangsawan, EJ Peace Coffee
Signature T2	EJ Peace Coffee Signature
T3	Nasi Bangsawan, Salted Creamy Coffee
T4	Salted Creamy Coffee, Mineral Water, Sweet Cookies
Coffee T5	Red Velvet Latte
T6	Soto Bandung, EJ Peace Coffee
Signature T7	Nasi Bangsawan
T8	EJ Peace Coffee Signature, Nasi Bangsawan

2. Frequent itemset

Frequent itemsets are items that frequently appear together in a single transaction. The purpose to dentifying frequent itemsets is for understand the combinations every product that customers most often buy together, this data can used as a basis for bundling promotion strategies. In this study, the search for frequent itemsets is conducted on the frequency of item occurrence that has been previously calculated. shows in Table 2.

Table 2. Frequent itemset

Item Name	Support Count
Nasi Bangsawan	4
EJ Peace Coffee Signature	4
Salted Creamy Coffee	2

The minimum support value is set at 2, meaning only product combinations that appear in at least 2 transactions will be considered as frequent itemsets. Based on the calculation results, only items or combinations of items that meet the support threshold ≥ 2 are included in the list. This process yields both single itemsets and double combinations that occur most frequently in the data *Association rules*

After obtaining frequent itemsets from Table 3 (combinations of items frequently purchased together and meeting a minimum support of ≥ 2), the next step is to form association rules between items. Association rules aim to describe the probabilistic relationships between products in customer transactions (Ogedengbe et al., 2024).

$$\text{Confidence}\ (A \Rightarrow B) = \frac{Support\ (A \cup B)}{Support\ (A)}$$

Table 3. Association rules

Item Name	Support	Confidence	Interpretation
Nasi Bangsawan, EJ Peace Coffee Signature	2	50%	4 people bought Nasi Bangsawan, 2 people also bought EJ Peace Coffee Signature
EJ Peace Coffee Signature, Nasi Bangsawan	2	50%	Of the 4 people who bought EJ Peace Coffee Signature, 2 people also bought Nasi Bangsawan
Salted Creamy Coffee, Nasi Bangsawan	1	25%	Did not pass because minimum 2

Based on the calculation table above, we can see that 50% of customers purchase the Bengawan rice product together with the signature coffee. According to the product bundling theory (Wijaya & Kinder, 2020), it is stated that products resulting from the analysis process can be combined into a product package, with a price that can be considered by the marketing department. This allows customers to choose to purchase the above products either together or separately.

5. Conclusion

Based on the results of the purchasing pattern analysis, there are 4 customers who purchased Nasi Bangsawan, 2 customers also purchased EJ Peace Coffee Signature, this data indicating 50% confidence. This means 50% of Nasi Bangsawan buyers also purchased EJ Peace Coffee Signature. Out of 4 customers who purchased EJ Peace Coffee Signature, there were 2 customers who also purchased Nasi Bangsawan, so the confidence level is also 50%. So it can be concluded that there is a fairly strong associative relationship between the two products, where half of the buyers of one product also purchased the other. This pattern can be used a consideration for bundling strategies or product promotions.

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