Application Of Fp-Growth And Fp-Tree Algorithms To The Treatment Selection Decision System In Beauty Clinics (Chrisa Aesthetic Clinic Case Study)

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ABSTRACT

The beauty industry faces challenges in understanding consumer preferences for skincare services. This study develops a decision support system based on data mining using the FP-Growth and FP-Tree algorithms to analyze treatment selection patterns at Christa Aesthetic Clinic. Customer transaction data were analyzed to identify service associations based on skin types. Results show that customers with acne-prone skin tend to choose acne exfoliation, acne skinbooster, and acne facial treatments. Dull skin is commonly treated with brightening peels, dermapen derma glow, and brightening facials. Sensitive skin customers prefer facial detox, DNA salmon skinbooster, and moisturizers, while normal skin types tend to choose light exfoliation, sunscreen, moisturizers, and facials. The FP-Growth algorithm effectively identified frequent treatment combinations with a recommendation accuracy of 87%. A satisfaction survey revealed that 95% of customers were satisfied with recommendations tailored to their skin needs. This system enhances operational efficiency and customer experience while providing a data-driven foundation for clinics to formulate more targeted and personalized service strategies.

Introduction

Amidst increasingly fierce business competition, the use of information technology has become a crucial strategy for facilitating decision-making. To gain a more accurate understanding of consumer needs, beauty clinics, which are part of the healthcare and aesthetics industry, must manage transaction data. Christa Aesthetic Clinic is a healthcare service located at No. 66 Medan Resort City Housing Complex, Deli Tua District. The purpose of the Christa Aesthetic Clinic was to offer healthcare services to the local community.

Christa Aesthetic Clinic frequently encounters obstacles when assisting consumers in selecting the appropriate treatment. Consequently, the objective of this investigation is to create a decision support system that generates treatment recommendations based on the transaction history of customers by utilizing a combination of FP-Growth and FP-Tree algorithms. Service quality, post-procedure treatment effects, availability of adequate equipment, and price considerations, which are frequently exhibited on social media, are critical factors to consider when selecting a treatment. A beauty clinic is not only a location where individuals can receive beauty treatments, but also a center where consumers can find solutions that are customized to their health and aesthetic requirements [1]

In the cosmetic industry, especially in aesthetic clinics, choosing the right product is a major challenge for both customers and providers. Despite rapid advances in technology and information, the data clinics collect is often not effectively utilized to help patients choose the right treatment for their health conditions. Many people are concerned about choosing the right treatment due to the wide range of options available and the varying needs of each individual based on their skin type and skin concerns.

FP-Growth is a data mining technique that is effective in identifying patterns that occur frequently. This method employs a divide-and-conquer approach, which recursively divides data into smaller projections to reduce the search space and increase efficacy [2]. The FP-Tree structure can be employed to directly derive frequently occurring patterns in data by this algorithm. An FP-Tree is a data structure that resembles a tree and is constructed from a collection of database objects. The tree's root node is null, and each node in the tree denotes a singular item. Combinations of objects (itemsets) are represented by subsequent nodes. The efficient mining of frequently

occurring patterns is facilitated by the maintenance of relationships between nodes that reflect the associations between items during the tree formation process [3].

The FP-Growth and FP-Tree algorithms have been implemented in a variety of applications, such as the prediction of product demand, the management of transaction data, and the identification of purchasing patterns, in previous research. The algorithm's efficacy in identifying patterns in big data, which is frequently employed for preference analysis and decision-making in the education sector, is demonstrated by research conducted by Muhlis Tahir on the application of FP-Growth in determining students' course selection tendencies. FP-Tree and FP-Growth were also employed in the analysis of drug sales transactions in pharmacies by Yuyun Dwi Lestari. This research yielded patterns that can be used to develop sales strategies.

This study endeavors to resolve this disparity by integrating FP-Growth and FP-Tree into a Decision Support System (DSS) to help beauty clinics make more precise decisions about treatment selection. Clinics will be able to provide more precise and data-driven recommendations by leveraging existing customer data, such as their skin type and skin concerns, as well as frequently selected treatments, through the use of these algorithms.

Furthermore, the purpose of this study is to use the Fp-Growth and Fp-Tree algorithms to analyze data to develop a data mining application that optimizes service sales using Rapidminer 5 software. For customers, this research provides direct benefits in terms of personalized care. Customers will receive treatment recommendations tailored to their skin type, not just based on the experience of the doctor or aesthetician. For clinics, this research offers the potential to increase efficiency in managing treatment decisions and improve customer service.

Research methodology

This investigation implemented a quantitative methodology that was both objective and quantifiable. Quantitative research necessitates the utilization of valid instruments and suitable statistical analysis to guarantee that the findings correspond to actual circumstances[4]. Primary data is employed in this investigation. In general, researchers gather primary data from individuals or primary sources, such as questionnaires or interviewsv[5].

The research variables in this study are divided into two categories: independent variables (independent variables), which include the style of treatment and skin care products. The decision to select a treatment is the dependent variable. In this investigation, the variables are classified into two primary categories. Independent Variables: Type of Treatment: The clinic offers a variety of treatments, including facials, peelings, Dermapen, and Skinbooster, each of which is customized to meet the specific requirements of the skin. Skincare products, including moisturizers, sunscreens, and facial washes, are chosen in accordance with the skin requirements of the consumer. Predicted results in the form of treatments selected by customers based on their skin type and skin problems, as determined by transaction data and pattern analysis, are known as the Dependent Variable Treatment Selection Decision.

An information system that is extensible, adaptive, interactive, and flexible is known as a Decision Support System (DSS). This system generates decisions and alternative solutions to assist management in addressing semi-structured and unstructured problems, where no one is certain of the appropriate course of action, by providing information, modeling, and data manipulation [6]. The objective of a decision support system is to enable a more precise and effective decision-making process by providing reliable and pertinent information [7].

Association Rule Mining Method

M Method of Association Rule Mining One data mining method for identifying links or relationships between elements in a dataset is association rule mining. Finding commonly occurring patterns is its primary objective since they serve as a crucial basis for the creation of more accurate and effective data analysis algorithms[8].

Support: Determine the degree to which different things are present in the data collection using this method. At least 5% of transactions must have the item set, which is the minimum support criterion. Confidence: 80% is the bare minimum required for a social contract. Optional enhancement: To create a high degree of association, raise the degree of association between items by a number larger than 1.

This method uses the K-Fold validation mechanism. By splitting the data into tenfold groups, cross-validation is used to make sure the model doesn't overfit. Accuracy is determined by how frequently the suggestions made correspond with the actual decisions made by the client. 95% of respondents are satisfied with the suggestion system, according to the satisfaction survey.

Method of Association Rule Mining

Association rule mining is a data mining technique that is employed to determine the relationships or connections between entities in a dataset. Its primary objective is to identify patterns that are frequently encountered, as they provide a critical foundation for the development of more precise and efficient data analysis algorithms [8].

At this stage, the database is searched for a combination of items that satisfy the minimal support value requirement. The subsequent equation is employed to determine the support value of an item:

$$Support\ (A) = \frac{Number\ of\ transactions\ containing\ A}{Total\ transactions}$$

$$Support\ (A \cap B) = \frac{Number\ of\ transactions\ containing\ A\ and\ B}{Total\ transactions}$$

Formation of associative rules. After all high-frequency patterns are found, an associative rule that meets the minimum confidence requirement is sought by calculating the confidence of the associative rule A→B. The confidence value of the rule A→B is obtained as follows [9]:

$$Confidence\ (A|B) = \frac{The\ number\ of\ transactions\ containing\ A\ and\ B}{The\ transaction\ amount\ contains\ A}$$

Metode Algoritma Fp-Growth

Based on a preset minimum support value, the FP-Growth algorithm is a pattern mining technique for identifying frequently occurring itemsets in a dataset. Using a divide-and-conquer strategy, this method first looks for single items that appear frequently before creating a conditional database for each pattern. The projected data is then subjected to this procedure in a recursive manner. By doing this, FP-Growth can decrease the search space, circumvent the lengthy Apriori algorithm candidate generation process, and improve scalability and efficiency when working with big amounts of data. Because of this method, it is a well-liked technique for data mining's frequent pattern analysis [10].

A Frequent Pattern Tree is a tree-like structure created with an initial set of items from a database. The goal of a Frequent Pattern Tree is to mine the most frequent patterns. Each node of the Frequent Pattern Tree represents an item in the set. The root node represents null, while the lowest nodes represent itemsets[11].

Research Procedures

The FP-Growth and FP-Tree methodologies were used in this study procedure, as shown in the accompanying figure:
1. Data Collection: Information about customer transactions is input into the system (for instance, by the clinic administrator filling out a form).
2. Data Preprocessing: One-hot encoding is utilised to prepare the gathered data for RapidMiner's use in the mining process.
3. Mining Process: Based on the customer's skin type, the system uses FP-Growth and FP-Tree to extract frequently occurring itemsets from the transaction data in order to identify recurring patterns between chosen treatments.
4. Treatment Recommendations: The system suggests treatments for the clients identified in the data based on the frequent itemsets and association rules that are produced.
5. Evaluation of the Results: A customer satisfaction survey is used to gauge user experience, and cross-validation is used to confirm model accuracy.
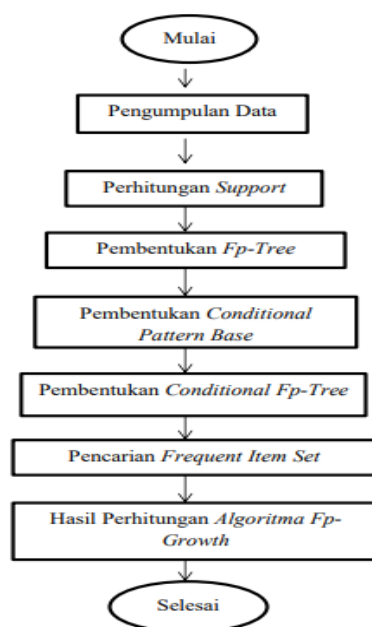

Figure 1. Flowchart

Results and Discussion
Data collection
          This information was obtained from the Christa Aesthetic Clinic, which kept track of patients' treatment preferences from November 2024 to January 2025. 100 clients are included in the data, which is categorised by skin type: normal, dry, sensitive, dull, and acne-prone. Twenty clients in each skin type category selected treatments according to their skin requirements. A facial, peeling, dermapen, and skin booster are among the available treatments; each has a variation depending on the client's skin issues.
FP – Tree Formation
          After classifying the data according to skin type, the frequency of each treatment is determined to create the FP-Tree. Only noteworthy patterns can be examined when treatments with frequencies below a minimal support level are eliminated. Each transaction is ordered by item frequency once the items have been filtered. Transactions are added from the root in that sequence to create the FP-Tree. An item's support is added if it already exists in the tree path; otherwise, a new node is made. To make pattern recognition easier, nodes that have the same item are connected via a header table.The plants are listed here by skin kind.

1. **Skin Prone to Acne**

Table 1. List of Skin Care Products for Acne

NO.	TREATMENT	AMOUNT
1	Peeling Acne	8
2	Skinbooster Acne	10
3	Facial Acne	11
4	Dermapen PRP	7
5	Peeling Eropa Premium (Berjerawat)	10
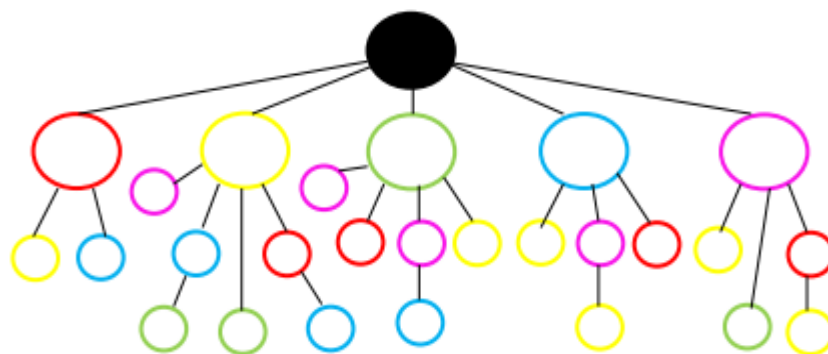
Figure 2. FP: Acne Skin Tree

          One important factor was found by FP-Tree: with an 80% confidence level, clients who bought Peeling Acne also bought Skinbooster Acne. Clinics were able to suggest better service combinations as a result of these findings, which raised client happiness and increased operational effectiveness.
2. **Brightening is needed for dull skin.**

Table 2. List of Skin Care Procedures for Dull and Brightening Skin

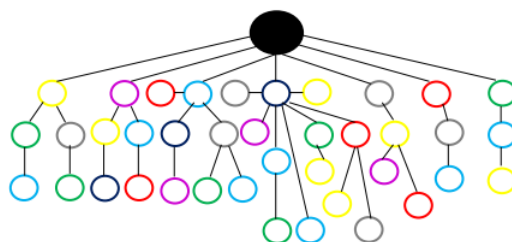| NO.	TREATMENT	AMOUNT
1	Skinbooster Mochi Skin	9
2	Dermapen Derma Glow	6
3	Peeling Eropa Premium (Mencerahkan)	10
4	Facial Brightening	5
5	Peeling Brightening	10
6	Facial Korean Glow	6
7	Skinbooster Glass Skin	6

Figure 3. FP – Tree with Dull Bark Requires Brightening

Customers who bought Facial Brightening were 75% more likely to buy Skinbooster Glass Skin, according to FP-Tree's analysis of important factors. For individuals with acne, this method enables physicians to suggest more suitable treatment combinations, such the Facial Brightening and Skinbooster Glass Skin package. Customer satisfaction and clinic efficiency both increased as a result.

3. Sensitivity and Intuition

Table 3. Treatment of Sensitivity and Aggression

NO.	TREATMENT	AMOUNT
1	Facial Hydra	14
2	Skinbooster DNA Salmon	9
3	Facial Detox	13
4	Moisturizer	6
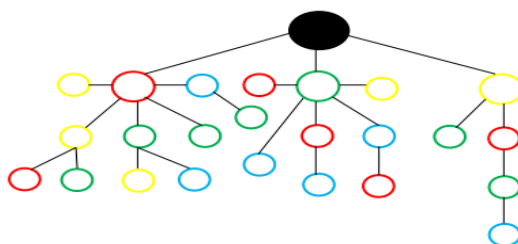
Figure 4. FP – Tree of Sensitive Skin and Requires Hydration

FP-Tree identified a key factor: customers who purchased the Hydra Facial consistently purchased the Salmon DNA Skinbooster with an 85% confidence level. This enabled doctors to recommend product combinations, such as the Hydra Facial and Salmon DNA Skinbooster, for sensitive skin in need of hydration. These results have helped improve the clinic's operational efficiency and customer satisfaction.

4. Dry skin

Table 4. List of Dry Skin Treatments

NO.	TREATMENT	AMOUNT
1	Moisturizer	13
2	Sunscreen	10
3	Facial Diamond Dermabration	12
4	Facial Hydra	8
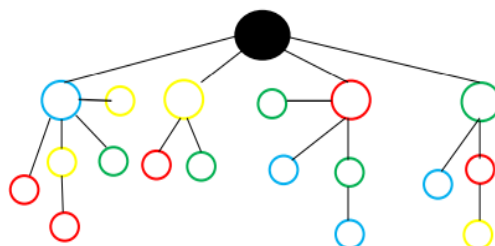
Figure 5. FP – Tree Grown from Dry Bark

FP-Tree identified a key pattern: customers who chose Moisturizer were 70% more likely to choose Facial Diamond Dermabration. This pattern enabled the clinic to recommend a combination of treatments, such as Moisturizer and Facial Diamond Dermabration, for dry skin. These results improved customer satisfaction and clinic efficiency.

5. Typical Skin Care and Routine Maintenance

Table 5. List of Normal Skin Treatments & Routine Care

NO.	TREATMENT	AMOUNT
1	Facial	10
2	Moisturizer	12
3	Peeling Ringan	14
4	Sunscreen	12
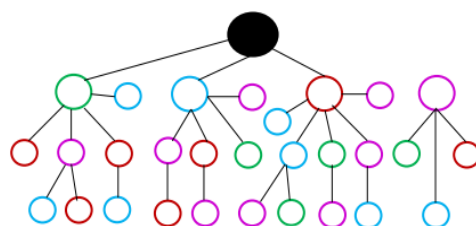
Figure 6. Tree of Normal Height and Rutin Permit

The primary factor identified by FP-Tree is that customers who consistently purchase pelembap buy tabir surya with a high keyakinan of 90%. This enables the doctor to recommend kulit routine products, such as pelembap and tabir surya, to those with normal kulit who require regular kulit routines. As a result, operational efficiency and client satisfaction have increased.

FP – Growth

The FP-Growth algorithm is employed to extract frequent itemsets without the need to investigate all item combinations, as in Apriori, once the FP-Tree has been established. By traversing the FP-Tree and establishing a conditional pattern base to identify frequently occurring patterns, FP-Growth operates more efficiently.

The process of integrating this algorithm into RapidMiner commences with the importation of transaction data in XLS format, which includes the skin varieties and treatments of customers. The user then applies the FP-Growth operator and establishes a minimum support value, such as 0.2, to guarantee that only patterns that appear in at least 20% of transactions are processed. The Create Association Rules operator is subsequently employed to generate association rules, with a confidence parameter of 0.8 to guarantee the reliability of the generated rules. The analysis yields frequently selected treatment combinations and association rules between items. These discoveries have the potential to inform the development of treatment recommendations that are customised to the skin types of clients and to facilitate data-driven business decisions in beauty clinics.
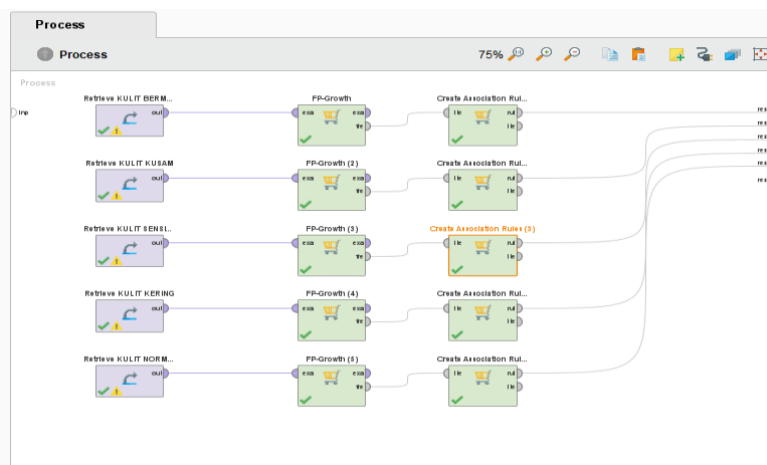

Figure 7. Data Connection Process Utilizing FP Growth

1. **Skin Prone to Acne**

Figure 8. Rules that have been generated

A pattern of relationships between the types of skin care products for acne-prone skin types that customers at the Christa Aesthetic Clinic most frequently select between November 2024 and January 2025 can be found based on the results of the association rules obtained using the FP-Growth algorithm. These association principles explain how different skin care procedures performed by clients with varying degrees of confidence relate to one another.

2. **Brightening is needed for dull skin.**

No.	Premises	Conclusion
6	skinbooster mochi skin, peeling brightening	dermapen derma glow
7	peeling brightening, peeling eropa premium (men…	dermapen derma glow
8	facial korean glow	dermapen derma glow
9	facial brightening	dermapen derma glow
10	skinbooster mochi skin, facial korean glow	dermapen derma glow

Support	Confidence	LaPlace	Gain	p-s	Lift	Convicti...
0.250	0.833	0.962	-0.350	0.040	1.190	1.800
0.300	0.857	0.963	-0.400	0.055	1.224	2.100
0.300	1	1	-0.300	0.090	1.429	∞
0.250	1	1	-0.250	0.075	1.429	∞
0.200	1	1	-0.200	0.060	1.429	∞

Figure 9. Frequent Item Set Results
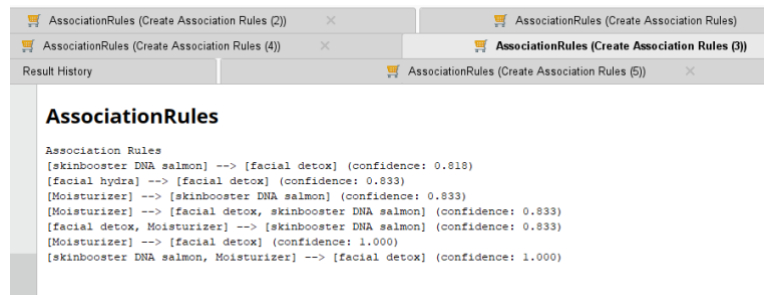

Figure 10. Generated Rules

The association rule results for dull skin indicated a robust correlation between various remedies that are designed to hydrate and brighten the skin.

3. **Sensitivity and Intuiti**

No.	Premises	Conclusion
6	Moisturizer	facial detox
7	skinbooster DNA salmon, Moisturizer	facial detox

Support	Confidence	LaPlace	Gain	p-s	Lift	Convicti...
0.300	1	1	-0.300	0.105	1.538	∞
0.250	1	1	-0.250	0.087	1.538	∞

Figure 11. Frequent Item Set Results
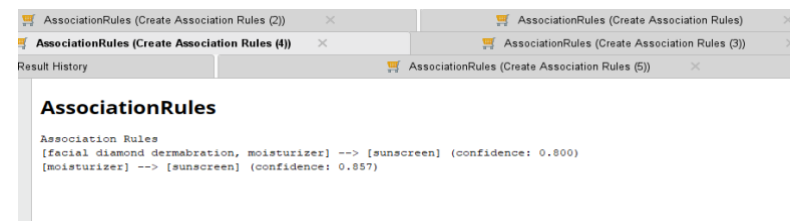
Figure 12. Generated Rules

A pattern of associations was identified between several treatments that are frequently selected by consumers with sensitive skin, as indicated by the results of the FP-Growth analysis. This section provides a comprehensive explanation of each association rule that was identified.

4. Dry skin

No.	Premises	Conclusion
2	moisturizer	sunscreen

Support	Confidence	LaPlace	Gain	p-s	Lift	Convicti...
0.300	0.857	0.963	-0.400	0.125	1.714	3.500

Figure 13. Frequent Item Set Results
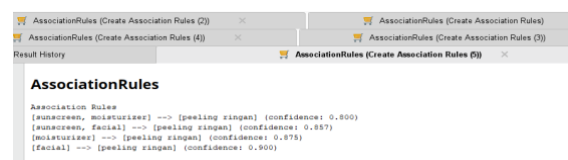

Figure 14. Rules that have been generated

Berdasarkan hasil analisis FP-Growth, ditemukan pola keterkaitan antara beberapa perawatan yang sering dipilih oleh pelanggan dengan **kulit kering**. Berikut adalah penjelasan dari setiap aturan asosiasi yang ditemukan.

5. Typical Skin Care and Routine Maintenance

No.	Premises	Conclusion
2	sunscreen, facial	peeling ringan
3	moisturizer	peeling ringan
4	facial	peeling ringan

Support	Confidence	LaPlace	Gain	p-s	Lift	Convicti...
0.300	0.857	0.963	-0.400	0.055	1.224	2.100
0.350	0.875	0.964	-0.450	0.070	1.250	2.400
0.450	0.900	0.967	-0.550	0.100	1.286	3

Figure 15. Results of the Most Common Item Set

Figure 16. Rules that have been generated

Conclusion

According to the results of an association research using the FP-Growth algorithm, different skin types typically favour different combinations of treatments. Since clients with acne-prone skin are more inclined to mix acne peels, acne skin boosters, and acne facials, acne-control-based treatments are in high demand. On the other hand, customers with dull skin frequently select skin-brightening peels, dermapen derma shine, and skin-brightening facials, suggesting a strong desire for skin-brightening treatments. The increasing use of moisturisers, detox facials, and salmon DNA skin boosters for sensitive skin suggests that customers are becoming more interested in skin-hydrating and soothing treatments. Dry skin responds well to sunscreen and moisturiser, underscoring the significance of skin care and protection.

Customers with average skin, on the other hand, place more value on skincare and prefer a little exfoliation following facials, moisturisers, and sunscreen. Understanding this pattern, beauty clinics can develop more individualised treatment packages, such the "Acne Treatment Package," "Glowing Skin Brightening Package," or "Hydration Treatment Package," to enhance their data-driven marketing tactics and boost client happiness.

The algorithm evaluation and akurasi system results show that 87% of the system's recommendations are in line with user preferences, as indicated by the FP-Growth and FP-Tree evaluation results. It is based on existing historical data. Akurasi ini is determined by comparing the recommendations made by the system with the operations that are carried out by the users in the data. Dukungan dan Keyakinan: The principle of asosiasi keyakinan establishes a strong bond between the perawatan. In the relationship between Peeling Acne and Skinbooster Acne, for example, the 80% keyakinan indicates that consumers who have Peeling Acne have an 80% chance of also having Skinbooster Acne. The prevalence of common skin conditions, such as facial acne and peeling acne, is higher, with more than 10% of all transactions causing it. Pengguna Kepuasan: The recommended system has achieved a 95% user satisfaction rate, as determined by user feedback surveys. Customers understand that the advice given to them is tailored to their health and improves their clinical experience.

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