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An Expert System for Determining Facial Treatments Using the Forward Chaining Method at Azalea Beauty Center

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Abstract

Facial skin problems such as acne, milia, warts, wrinkles, and hyperpigmentation often confuse customers in choosing appropriate treatments at Azalea Beauty Center. Manual consultations are time-consuming and heavily dependent on therapist availability. This study aims to develop an expert system using the forward chaining method to determine suitable facial skin treatments. The system was built using PHP, MySQL, and Bootstrap 5, implementing knowledge bases consisting of symptoms, skin problems, and treatment rules obtained from beauty experts. Black box testing showed all system functions operated correctlyindicating the system is highly acceptable. This expert system successfully provides fast, accurate, and consistent treatment recommendations, improving service efficiency at Azalea Beauty Center.

Keywords: *Expert System, Forward Chaining, Facial Skin Treatment, Azalea Beauty Center*

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1. INTRODUCTION

Facial skin appearance has a significant influence on an individual's self-confidence and social interactions in modern society. Growing public awareness of skin health and beauty has led to an increasing demand for professional skincare services. However, various skin conditions, such as acne, comedonal acne, warts, wrinkles, and hyperpigmentation, often make it difficult for clients to determine the most appropriate treatment [1]. Many individuals have insufficient knowledge of their skin conditions and the available treatment options, which may result in ineffective treatment choices and may even cause further skin damage [2].

Azalea Beauty Center, as a provider of beauty care services, faces challenges in delivering optimal consultation services. The manual consultation process is relatively time-consuming and highly dependent on therapist availability, particularly during peak hours. This situation often results in customer queues and service delays [3]. Furthermore, the quality of consultations may vary depending on the therapists' level of experience, potentially affecting the consistency of treatment recommendations [4].

Expert systems have proven effective across various domains in capturing and replicating human expertise [5]. In the beauty and healthcare sectors, expert systems can assist users in identifying conditions and providing recommendations based on predefined rules and knowledge bases [6]. The forward-chaining inference method is particularly suitable for diagnostic applications because it follows a data-driven reasoning approach, beginning with known facts, such as symptoms, and progressing toward conclusions in the form of diagnoses and recommendations [7].

Several previous studies have demonstrated the effectiveness of expert systems in skin-related applications. Sulindawaty and Fahmi [8] developed an expert system for identifying facial skin types using forward chaining, achieving an accuracy of 83.3%. Syahputri et al. [9] implemented forward chaining to diagnose oily skin conditions and successfully provided accurate information regarding

treatment and prevention. Vratiwi [10] designed an expert system to analyze facial skin problems using forward chaining, incorporating 42 symptoms and nine types of skin problems. Sidhi Pamekas et al. [11] applied forward chaining for the preliminary diagnosis of skin diseases, with an emphasis on accurately representing symptom–disease relationships.

However, existing studies have predominantly focused on identifying skin types or diagnosing skin diseases in general, rather than developing specific treatment recommendation systems integrated into beauty center operations. A research gap remains in addressing the practical implementation of expert systems for treatment recommendations within the context of professional beauty services. In addition, studies examining the integration of expert knowledge from professional beauty practitioners into automated recommendation systems remain limited.

This study aims to address this gap by developing a web-based expert system specifically designed to determine appropriate facial skincare treatments at Azalea Beauty Center. The system employs the forward-chaining methodology to analyze customer-reported symptoms and generate treatment recommendations based on expert knowledge obtained from experienced beauty therapists. The main objectives of this study are: (1) to design and implement an expert system that assists in determining appropriate facial skincare treatments based on customers' skin concerns; (2) to demonstrate how the forward-chaining method traces reported symptoms to generate suitable treatment recommendations; and (3) to evaluate the accuracy and consistency of the system by comparing its recommendations with those provided by experts through validation testing.

The significance of this study lies in its contribution to improving service efficiency in the beauty industry through the implementation of artificial intelligence. By automating the initial consultation process, beauty centers can serve a larger number of customers while maintaining consistent treatment recommendation quality. The system also serves as an educational tool that helps customers better understand their skin conditions and available treatment options. From an informatics perspective, this study demonstrates the practical application of a rule-based expert system in the service industry and provides insights into the implementation of similar AI-based solutions in other domains.

2. RELATED WORK

The study conducted by [1], entitled "Analysis of an Expert System Using the Forward-Chaining Method for Identifying Human Facial Skin Types," addressed the difficulty of determining facial skin types to support the selection of appropriate cosmetic products. The study employed an expert system based on the forward-chaining method. The results showed that the developed system achieved an accuracy of 83.3% in diagnosing facial skin types. These findings indicate that the system was effective in providing relevant information and assisting users in selecting appropriate skincare treatments.

The study conducted by [2], entitled "An Expert System Using the Forward-Chaining Process for Oily Facial Skin," addressed the high prevalence of oily skin problems among users who have limited access to expert consultations. The study applied the forward-chaining method to develop a web-based expert system for diagnosing oily skin conditions and providing appropriate solutions. The developed system successfully provided accurate information regarding the definition, treatment, and prevention of oily skin based on the symptoms reported by users.

3. METHOD

This study employed a quantitative approach with an experimental design to develop and evaluate an expert system for facial skincare treatment recommendations. The system development process followed the waterfall model, comprising the stages of requirements analysis, system design, implementation, and testing [12].

3.1. Data Collection

Data were collected using three complementary methods to ensure comprehensive knowledge acquisition:

1. **Direct Observation**: Direct observations were conducted at Azalea Beauty Center to understand the existing consultation workflow, commonly encountered skin problems, and standard treatment procedures. The observations were carried out during operating hours over

a two-week period, during which consultation patterns and customer interactions were documented.

2. **Expert Interviews**: Semi-structured interviews were conducted with the owner of Azalea Beauty Center, who served as the domain expert, and three professional beauty therapists. The interviews aimed to collect knowledge regarding symptom identification, diagnostic processes, and treatment selection criteria. The interview sessions were recorded and transcribed to facilitate knowledge extraction.
3. **Document Analysis**: Treatment protocols, customer records, and standard operating procedures were reviewed to identify the relationships among symptoms, facial skin problems, and recommended treatments.

3.2. Knowledge Base Development

The knowledge base construction process consisted of the following stages:

1. Symptom Identification: A total of 25 distinct facial skin symptoms obtained from expert interviews and the literature review were catalogued. Each symptom was assigned a unique code ranging from G001 to G025.
2. Problem Classification: Five major categories of facial skin problems were defined: acne (MK001), comedonal acne (MK002), warts (MK003), wrinkles (MK004), and hyperpigmentation (MK005).
3. Treatment Definition: Five types of treatment, coded P001–P005, were established based on the services available at Azalea Beauty Center. These treatments included intense pulsed light (IPL) therapy, high-frequency facial treatment, electrolysis, ultrasound facial lifting, and chemical peeling.
4. Rule Formulation: IF–THEN production rules were developed to associate symptoms with skin problems and subsequently associate the identified problems with appropriate treatments. The rules were validated through expert review to ensure their accuracy and completeness.

The rule structure followed the pattern below:

IF (Symptom1 AND Symptom2 AND ... AND SymptomN) AND (ProblemX)
THEN (TreatmentY)

3.3. Forward-Chaining Implementation

The forward-chaining inference engine operates according to the following algorithm:

1. Initialization: The system presents the user with a list of facial skin symptoms.
2. Data Collection: The user selects the symptoms that correspond to their skin condition from the available options.
3. Rule Matching: The system compares the selected symptoms with the antecedents of the rules stored in the knowledge base.
4. Problem Identification: When a combination of symptoms satisfies the conditions of a rule, the corresponding facial skin problem is identified.
5. Treatment Recommendation: The identified skin problem activates the relevant treatment recommendation rule.
6. Result Presentation: The system displays the identified skin problem and the recommended treatment, accompanied by a detailed explanation.

The inference process continues iteratively until no additional rules can be activated, thereby ensuring that all relevant conclusions are obtained.

3.4. Testing Methodology

The system was evaluated using three complementary testing approaches:

1. **Black-Box Testing**: Black-box testing was conducted to verify the functional requirements of the system using 50 test cases covering user registration, symptom selection, consultation processing, diagnosis generation, and administrative functions. Each function was tested to ensure correct input handling, appropriate output generation, and effective error management.
2. **Accuracy Testing**: Diagnostic accuracy was evaluated by comparing the system-generated recommendations with expert assessments across 15 consultation scenarios. The test cases

represented diverse symptom combinations covering all facial skin problem categories. Accuracy was calculated using the following equation:

Accuracy = (Number of Matching Diagnoses / Total Number of Test Cases) × 100%

3. **User Acceptance Testing (UAT)**: The usability and acceptance of the system were assessed using a structured questionnaire administered to one domain expert, namely the owner of Azalea Beauty Center, and three professional beauty therapists. The respondents evaluated five criteria: diagnostic accuracy, symptom relevance, treatment appropriateness, interface usability, and consultation efficiency. Responses were measured using a five-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The acceptance score was calculated using the following equation:

UAT Score = (Total Weighted Response Score / Maximum Possible Score) × 100%

This study received permission from the management of Azalea Beauty Center. All testing activities involved adult participants who provided informed consent. Personal information collected during the consultation process was anonymized to protect participant privacy. The system also included a disclaimer stating that its outputs constituted preliminary recommendations that required confirmation by a qualified professional

4. RESULT

Knowledge Base Composition

The implemented knowledge base consists of:

- 25 symptoms (G001–G025) encompassing textural changes, visible lesions, discoloration, and signs of aging.
- 5 skin condition categories with detailed clinical descriptions.
- 5 treatment protocols aligned with the services provided by Azalea Beauty Center.
- 5 diagnostic rules encoding expert decision-making logic.
- Treatment recommendation mappings linking each condition to the appropriate intervention.

Table 1 presents a comprehensive catalog of symptoms, along with their unique identifiers and descriptions.

Table 1. Knowledge Base of Symptoms

Code	Symptom Description
G001	Rough skin texture upon palpation
G002	Presence of red or whitish (purulent) bumps
G003	Presence of small pustular lesions
G004	Tenderness or pain upon palpation
G005	Rough texture in acne-prone areas
G006	Lesions induced by pore occlusion and bacterial infection
G007	Presence of small, solid, non-purulent papules
G008	Flesh-colored papules, occasionally presenting a pinkish hue
G009	Papules accompanied by mild pruritus (itching) or occasional slight stinging
G010	Sudden and widespread eruption of papules within a short timeframe
G011	Papules or nodules induced by mild allergic irritation or impurities
G012	Presence of solid, rough nodules, occasionally protruding as flesh-like growths
G013	Lesions matching skin tone or presenting as slightly hyperpigmented
G014	Rough and protruding, feeling indurated (hard) upon palpation
G015	Painless but may cause a sensation of obstruction or mild pruritus

Vol. 6, No. 1, Juni 2026, Page. 53-65
https://jiki.jurnal-id.com
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Code	Symptom Description
G016	Facial skin appears dull despite cleansing
G017	Visible fine lines around the eyes (crow's feet)
G018	Onset of fine lines in the periorbital area
G019	Forehead wrinkles (rhytides), particularly during facial expressions
G020	Presence of fine cutaneous folds around the perioral (mouth) area or cheeks
G021	Decreased skin firmness and elasticity
G022	Appearance of dark brown patches on the cheeks or forehead
G023	Persistent dark spots from acne scars (post-inflammatory hyperpigmentation)
G024	Uneven skin tone
G025	Appearance of small dark spots on the face induced by solar exposure

The structure of the diagnostic rules employs forward chaining logic. For instance, Rule R1 is formulated as follows:

IF (G001 AND G002 AND G003 AND G004 AND G005 AND G006) AND MK001
THEN P001

This rule indicates that in the presence of a rough texture (G001), inflammatory lesions (G002, G003), tenderness (G004), localized roughness (G005), and bacterial etiology (G006), the condition is identified as acne (MK001), which necessitates IPL laser treatment (P001).

Decision Tree

A decision tree can be converted into IF-THEN production rules. This transformation is achieved by mapping each branch and terminal node (leaf node) of the decision tree into a rule that culminates in a specific conclusion. This mechanism is known as Forward Chaining, wherein these rules are applied to derive a conclusion based on the provided initial data.

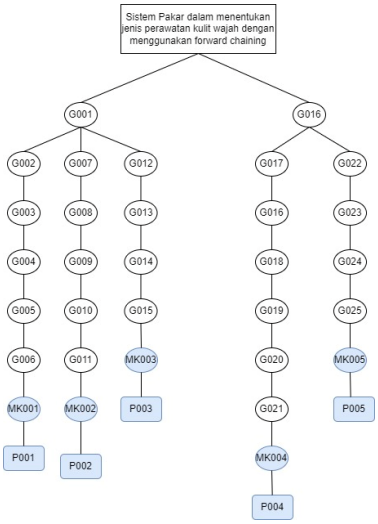

Figure 1. Decision Tree

Use Case Diagram

This Use Case Diagram models the primary functional interactions within the skin expert system, involving two main actors: the User and the Administrator. The User actor interacts with the system to complete personal data registration and conduct consultations to obtain diagnostic outcomes and treatment recommendations. Conversely, the Administrator retains full responsibility for system management. This encompasses authentication procedures (Login and Logout) alongside a suite of

Vol. 6, No. 1, Juni 2026, Page. 53-65
https://jiki.jurnal-id.com
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critical master data management functions—specifically, the management of symptom data, skin condition data, treatment modalities, user profiles, and diagnostic rules—thereby ensuring the system's knowledge base remains accurate and up-to-date.

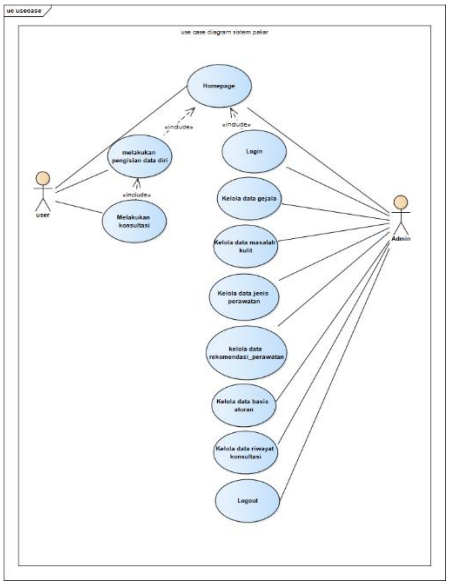

Figure 1. Use Case Diagram

Implementation

The user interface implementation developed for the proposed system is presented as follows:

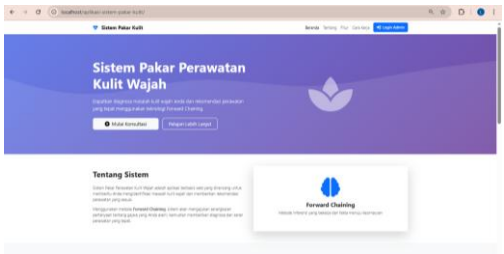

Figure 3. Main Page

Figure 3 illustrates the main page of the Facial Skin Care Expert System. This interface presents essential information regarding the system alongside its core features, notably the automated diagnostic capability driven by the Forward Chaining method. Furthermore, it provides an operational guide designed to facilitate users in conducting consultations and acquiring rapid, accurate skin care recommendations.

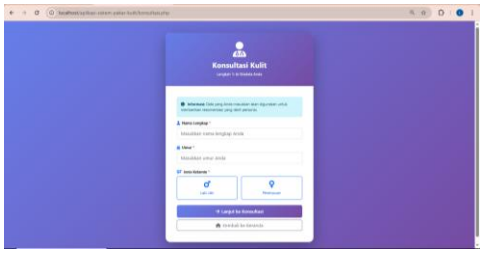

Figure 4. Personal Information Entry Page

Figure 4 illustrates the personal data registration page, which serves as the initial step for users to commence the diagnostic process. Users are required to input fundamental demographic data, such as

Vol. 6, No. 1, Juni 2026, Page. 53-65
https://jiki.jurnal-id.com
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name, age, and gender, enabling the system to generate more accurate and personalized analytical outcomes and skin care recommendations.

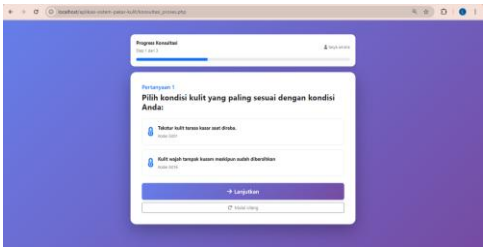

Figure 5. Consultation Process Page

Figure 5 displays the interactive consultation interface, featuring queries designed to assist the system in analyzing the user's skin condition. Users are prompted to select the symptoms that best correspond to their clinical presentation; the system subsequently logs these selections to be processed during the diagnostic phase until an accurate conclusive result is achieved.

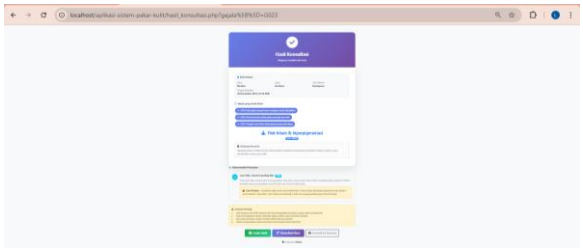

Figure 6. Consultation Results Page

Figure 6 presents the consultation results page, detailing the definitive diagnosis generated by the system based on the symptoms selected by the user. The displayed information encompasses patient demographic data, a description of the identified skin condition, and standard treatment recommendations. Furthermore, the interface provides functional options to print the results, initiate a new consultation session, or return to the homepage.

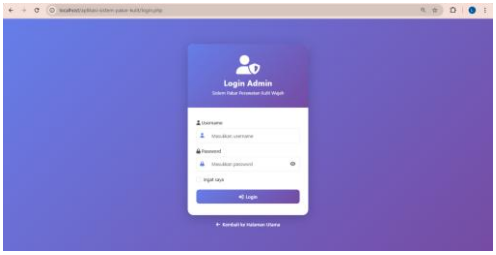

Figure 7. Admin Login Page

Figure 7 depicts the login interface of the Facial Skin Care Expert System, functioning as an access gateway for administrators to manage system data, including symptoms, skin conditions, treatment modalities, and consultation histories. This page incorporates a credential input form for the username and password, alongside a "remember me" functionality to preserve the session state. The system authenticates the submitted credentials against the database. Upon successful validation, the administrator is redirected to the Admin Dashboard; conversely, invalid inputs will trigger an error message. Furthermore, the interface is equipped with a "Return to Homepage" button, allowing users to seamlessly exit the administrative environment.

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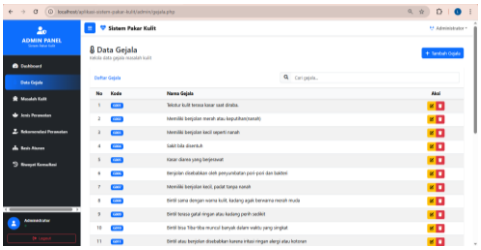

Figure 8. Symptom Data Page

Figure 8 illustrates the symptom management interface, which oversees the foundational data for the expert system's diagnostic capabilities. Within this module, administrators are authorized to execute CRUD (Create, Read, Update, Delete) operations on symptom data, facilitating the addition, modification, or deletion of existing records.

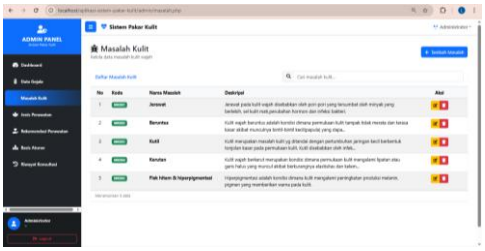

Figure 9. Skin Problem Page

Figure 9 displays the skin condition management interface, which is similarly critical to the system's diagnostic framework. Comparable to the symptom module, administrators can perform CRUD (Create, Read, Update, Delete) operations on skin condition data, enabling them to append, edit, or eliminate existing entries.

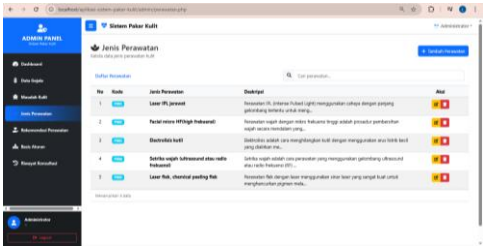

Figure 10. Treatment Types Page

Figure 10 presents the management interface for treatment modalities (treatment types), which constitute a core component of the expert system's therapeutic output. Within this section, administrators are empowered to perform CRUD (Create, Read, Update, Delete) operations on the treatment data, including the insertion, modification, or removal of existing records.

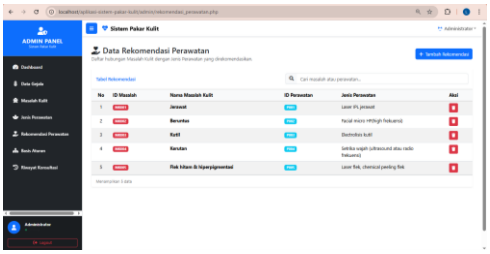

Figure 11. Treatment Recommendation Page

Figure 11 depicts the interface dedicated to managing treatment recommendations, an essential element for mapping diagnoses to appropriate care. Here, administrators can execute CRUD (Create,

Vol. 6, No. 1, Juni 2026, Page. 53-65
https://jiki.jurnal-id.com
DOI: https://doi.org/10.54082/jiki.319

Read, Update, Delete) operations on the recommendation data, specifically allowing for the addition and deletion of existing entries.

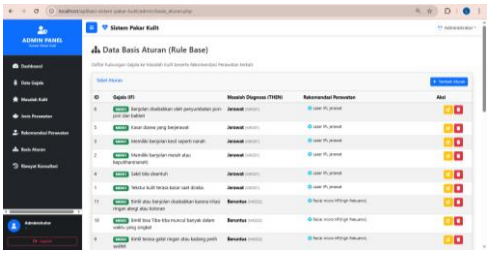

Figure 12. Rule Base Page

Figure 12 illustrates the rule base management interface, which serves as the foundational logic for the expert system's diagnostic inference. Administrators are granted the capability to perform comprehensive CRUD (Create, Read, Update, Delete) operations on the rule base data, encompassing the creation, revision, or erasure of existing rules.

Black-Box Testing Results

The outcomes of the black-box testing are summarized in Table 2, demonstrating that all system functionalities operate in accordance with the specified functional requirements. Furthermore, the accuracy evaluation yielded a diagnostic agreement rate of 86.67%, while the User Acceptance Testing (UAT) results indicated an exceptionally high level of system acceptance among domain experts and therapists.

Table 2. Summary of Black-Box Testing

System Function	Number of Test Cases	Passed	Failed	Success Rate
Login	2	2	0	100%
Symptom Management	8	8	0	100%
Skin Condition Management	9	9	0	100%
Treatment Management	9	9	0	100%
Recommendation Management	6	6	0	100%
Rule Management	9	9	0	100%
Consultation History	2	2	0	100%
User Consultation	5	5	0	100%
Total	**50**	**50**	**0**	**100%**

The testing procedures encompassed a variety of positive and negative scenarios, including:

- Authentication using valid and invalid login credentials;
- Complete and incomplete data submissions;
- Boundary value analysis;
- Duplicate data detection;
- Data modification and deletion operations;
- End-to-end completion of the consultation workflow.

The evaluation results confirm that all system functionalities execute in strict accordance with the design specifications. The system effectively generates appropriate error messages and user feedback. Robust input validation successfully precludes the ingestion of invalid data. Furthermore, database transactions meticulously preserve relational integrity across tables, and the system demonstrates the capability to manage concurrent user access without precipitating data conflicts.

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Accuracy Evaluation Results

The accuracy evaluation was performed by comparing the system's diagnostic outcomes against those of the domain expert across 15 consultation scenarios, which were selected to represent a diverse array of symptom patterns. The detailed findings of this evaluation are delineated in Table 3.

Table 3. Diagnosis Accuracy Test Results

Test Case	Symptom Pattern	Expert Diagnosis	System Diagnosis	Concordance
1	G001, G007	Acne	Milia	No
2	G001–G006	Acne	Acne	Yes
3	G001, G007–G011	Milia	Milia	Yes
4	G001–G006	Acne	Acne	Yes
5	G016, G017	Wrinkles	Hyperpigmentation	No
6	G001, G007, G009, G010	Milia	Milia	Yes
7	G001, G007, G010, G011	Milia	Milia	Yes
8	G016–G021	Wrinkles	Wrinkles	Yes
9	G016–G020	Wrinkles	Wrinkles	Yes
10	G001, G012–G015	Warts	Warts	Yes
11	G001, G012–G015	Warts	Warts	Yes
12	G001, G012, G015	Warts	Warts	Yes
13	G016, G022–G024	Hyperpigmentation	Hyperpigmentation	Yes
14	G016, G022, G024, G025	Hyperpigmentation	Hyperpigmentation	Yes
15	G016, G022, G023	Hyperpigmentation	Hyperpigmentation	Yes

The calculation of the accuracy rate is as follows:

- Total test cases: 15
- Concordant diagnoses (Matches): 13
- Discordant diagnoses (Mismatches): 2

Accuracy = (13 / 15) × 100% = 86.67%

Discrepancies occurred in test cases 1 and 5, attributable to a limited combination of presented symptoms. In Case 1, the manifested symptoms were confined to a rough texture and solid nodules lacking additional distinguishing features, resulting in system ambiguity between acne and milia. In Case 5, the presentation of dull skin and fine lines proved insufficient to differentiate between rhytides (wrinkles) and early-stage hyperpigmentation. These findings demonstrate that the comprehensiveness of symptom data significantly dictates the precision of the system's diagnostic outcomes.

User Acceptance Testing (UAT) Results

User Acceptance Testing (UAT) was executed to assess the system's level of acceptance from the perspectives of domain experts and therapists, employing a structured questionnaire. The findings of this evaluation are presented in Table 4.

The calculation of the UAT scores is detailed as follows:

- **Domain Expert**: (25 / 25) × 100% = 100%
- **Therapists**: (72 / 75) × 100% = 96%

The evaluation results demonstrate that the system's acceptance level falls within the "Strongly Agree" category (80–100%). The domain expert validated that the knowledge base and system rules are highly appropriate and accurate. Concurrently, the therapists indicated that the system effectively expedites the consultation workflow and exhibits high usability, notwithstanding minor feedback suggesting further user interface (UI) enhancements

Vol. 6, No. 1, Juni 2026, Page. 53-65
https://jiki.jurnal-id.com
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Table 4. User Acceptance Testing (UAT) Results

Evaluation Criteria	Expert Response	Therapists' Response	Total Score
Diagnostic accuracy aligns with manual clinical examinations	Strongly Agree (5)	3 × Strongly Agree (15)	20
Symptom parameters reflect real-world clinical conditions	Strongly Agree (5)	3 × Strongly Agree (15)	20
Treatment recommendations are clinically appropriate	Strongly Agree (5)	2 × Strongly Agree + 1 × Agree (14)	19
User interface is intuitive and highly usable	Strongly Agree (5)	3 × Strongly Agree (15)	20
System effectively expedites the consultation workflow	Strongly Agree (5)	1 × Strongly Agree + 2 × Agree (13)	18

5. DISCUSSIONS

Diagnostic Performance Analysis

The experimental results demonstrate a system accuracy of 86.67%, indicating a high degree of concordance between the system's diagnoses and expert assessments. This performance is comparable to previous studies employing the forward chaining method, such as Sulindawaty and Fahmi [8], who achieved an accuracy of 83.3%, and Vratiwi [10], who similarly reported a high diagnostic agreement rate. The primary distinction of the current study lies in the system's scope; it not only identifies dermatological conditions but also generates corresponding treatment recommendations.

Diagnostic discrepancies predominantly occurred in cases presenting with incomplete or ambiguous symptoms. This underscores a fundamental limitation of rule-based expert systems, which are highly contingent upon the comprehensiveness of the inputted symptom data. This finding is consistent with Sidhi Pamekas et al. [11], who emphasized the critical need for unequivocal symptom-disease mappings. In real-world clinical practice, such ambiguous presentations typically require supplementary physical examinations or adaptive follow-up questioning—capabilities that are not yet fully supported by the current system.

When compared to manual consultations, the proposed system demonstrates distinct advantages, including the consistent execution of inference rules, expedited diagnostic processing, and round-the-clock service availability. Nevertheless, the system currently lacks the capacity to emulate the contextual comprehension and adaptive deductive reasoning typically exhibited by experienced therapists.

Effectiveness of the Forward Chaining Method

The forward chaining method proved highly suitable for this system due to its data-driven reasoning approach, which closely emulates the clinical consultation workflow—progressing sequentially from symptom elicitation to the final diagnosis. Furthermore, this approach enables the system to provide transparent explanations for its diagnostic outputs, thereby enhancing user confidence.

Given the relatively concise rule base, the inference process operates efficiently without imposing significant computational overhead. The integration of the forward chaining algorithm within the web-based framework was successfully executed. Additionally, the decoupled architecture—which separates the inference engine from the knowledge base—facilitates seamless updates to the system's medical rules without necessitating modifications to the underlying source code.

User Acceptance and Practical Implications

The results of the User Acceptance Testing (UAT) demonstrated an exceptionally high acceptance rate, achieving 100% agreement among domain experts and 96% among therapists. These findings indicate that the system is evaluated as accurate, intuitive to use, and capable of streamlining the consultation workflow. Minor feedback provided by the therapists primarily concerned user interface (UI) refinements, particularly regarding layout optimization for tablet devices.

From an operational perspective at the Azalea Beauty Center, the system effectively mitigates consultation queues and assists junior therapists in delivering consistent treatment recommendations. Additionally, it provides preliminary educational information to clients prior to face-to-face consultations. Furthermore, the system functions as a strategic medium for both client education and the promotion of clinic services.

Research Contributions

This study contributes to the field of informatics, particularly regarding the application of web-based expert systems within the beauty service industry. The primary contributions encompass the implementation of the forward chaining method for diagnostic and treatment recommendations, the integration of the expert system with modern web technologies, and the provision of a comprehensive system evaluation framework that includes functional testing, accuracy assessments, and user acceptance evaluations.

6. CONCLUSION

This study successfully developed and validated a web-based expert system for determining facial skin treatments at Azalea Beauty Center using the forward chaining method. The system demonstrated a high diagnostic accuracy of 86.67% and excellent user acceptance, achieving 100% agreement from experts and 96% from therapists. Consequently, the proposed system is deemed highly feasible for practical implementation.

The forward chaining method proved highly suitable for this diagnostic application due to its ability to systematically reason from symptoms to treatment recommendations through a transparent, consistent, and efficient process. Furthermore, the knowledge base—comprising 25 symptoms, 5 skin conditions, 5 treatment types, and 5 diagnostic rules—successfully captured the experts' decision-making patterns. As a result, the system can provide automated consultation services that effectively complement the role of human therapists.

This study contributes to the application of expert systems within the beauty service industry by offering a replicable methodology for developing knowledge-based systems. Furthermore, it demonstrates the system's effectiveness through comprehensive functional, accuracy, and user acceptance testing. In practical terms, the implementation of this system aids in reducing consultation wait times, ensuring consistent treatment recommendations, and providing preliminary guidance for clients.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this article.

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