Bulletin of Data Science
ISSN 2745-7966 (Media Online)
Vol 5, No 3, June 2026 | Page 138−145
DOI: 10.47065/bulletinds.v5i3.10061
https://ejurnal.seminar-id.com/index.php/bulletinds

Implementation of the Certainty Factor Method in Determining the Type of Treatment for Dry Facial Skin

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Abstract−Facial skin is one of the most sensitive parts of the body and is vulnerable to various disorders, one of which is dry skin. Dry facial skin is characterized by a dull appearance, a tendency to experience irritation, and the emergence of fine lines or wrinkles. This condition not only affects physical appearance but can also reduce the skin's protective function against infections and exposure to free radicals. This study aims to identify dry facial skin conditions based on symptoms experienced by users by applying the Certainty Factor (CF) method. The CF method is selected because it is capable of handling uncertainty in decision-making processes, particularly in Expert System applications. In its implementation, the system calculates the certainty value from a combination of symptoms entered by the user to determine the probability level of dry facial skin conditions. The results of the study indicate that the system produces a certainty value of 22.32%, suggesting that the user has a 22.32% probability of experiencing dry facial skin. These findings demonstrate that a CF-based expert system can be utilized as an initial supporting tool for identifying skin conditions, although further validation by experts in the field of Dermatology is still required.

Keywords: Expert System; *Certainty Factor*; Face Skin; Skin Care; Treatment

1. INTRODUCTION

Facial skin beauty and health have become major concerns in modern society, particularly among women. In the rapidly growing beauty industry, various types of skincare treatments are offered to address different skin problems, one of which is dry facial skin. Dry skin is a condition in which the skin loses its natural moisture, causing it to appear dull, feel rough, peel easily, and become more susceptible to irritation. If not treated properly, this condition can lead to more serious skin problems such as dermatitis or premature aging [1][2]. Therefore, determining the appropriate type of treatment based on the skin condition is very important to ensure that the treatment provided is effective and does not cause adverse effects.

However, in practice, not everyone has sufficient knowledge about their own skin condition. Many individuals choose skincare products based on recommendations from friends, advertisements, or social media trends without understanding whether these products are suitable for their skin type. This situation may lead to inappropriate treatments that could potentially worsen skin conditions. Consequently, a system is required to assist the public in identifying the appropriate type of skincare treatment based on the skin conditions they experience, particularly for dry skin types.

On the other hand, the development of information technology has brought significant advancements in the fields of health and beauty, one of which is the emergence of Expert System technology. An expert system is a computer-based system designed to simulate the reasoning process of human experts in solving specific problems [3][4]. This system is capable of providing solutions or recommendations based on previously embedded knowledge and can also explain the reasoning behind each conclusion generated [5][6][7]. One of the commonly used approaches in expert systems is the Certainty Factor (CF) method.

The Certainty Factor method is an approach used to handle uncertainty in decision-making processes. CF enables a system to evaluate the degree of confidence in a particular fact or conclusion based on a combination of expert knowledge and symptoms experienced by users [8][9]. By applying this method, an expert system can generate more flexible and realistic results, particularly in medical or aesthetic contexts where symptoms do not always have absolute certainty.

Several previous studies have successfully applied the Certainty Factor method in developing expert systems for various diagnostic cases in both medical and non-medical fields. A study conducted by Mikael Tarigan et al. (2024) demonstrated that this method is capable of producing very high diagnostic accuracy. The testing results showed an accuracy rate of 99.89% in diagnosing anxiety disorders, indicating that the Certainty Factor method can effectively support psychological diagnosis with high precision and efficiency [10]. Another study by Andini et al. (2024) revealed that the developed system could analyze symptoms and determine types of nasal hypertrophy based on certainty values. The results indicated that patients had probabilities of suffering from Septal Deviation at 100%, Rhinitis at 94.24%, and Sinusitis at 85.60%. These findings further strengthen the reliability of the Certainty Factor method in producing diagnostic outcomes based on the severity and clinical symptoms [11].

Similarly, research conducted by Chairul Indra Angkat et al. (2024) applied the Certainty Factor algorithm in diagnosing Guillain-Barré Syndrome. The developed system was able to identify diseases based on symptoms entered by patients with a confidence level of 99.7%. This study confirms that the Certainty Factor method can accelerate the diagnostic process efficiently and reduce dependence on direct interaction between patients and medical experts. Furthermore, the application of the Certainty Factor method is not limited to human medical diagnosis but has also been implemented in the livestock sector [12]. A study by Septa Ardian Prayogi et al. (2024) showed that the developed system could calculate the confidence level in diagnosing goat diseases, such as tetany, with an accuracy rate of 86%. This

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research demonstrates that the Certainty Factor method can be effectively applied across different domains beyond human health [13].

The four previous studies demonstrate the successful implementation of the Certainty Factor (CF) method in various diagnostic contexts. These findings indicate that the method can produce accurate results in supporting decision-making processes based on available symptoms and data. However, to date, there has been limited research specifically implementing the Certainty Factor method for determining appropriate treatments for dry facial skin. Therefore, this study aims to fill this gap by developing an Expert System based on the Certainty Factor approach to provide systematic recommendations for dry facial skin treatment based on measurable confidence levels.

This research focuses on developing an expert system that assists users in identifying suitable treatments for dry facial skin using the Certainty Factor method. The system is designed to receive input in the form of symptoms or characteristics of the user's skin condition, process the information based on a knowledge base obtained from beauty experts or specialists in Dermatology, and generate recommendations for the most appropriate type of treatment along with a corresponding certainty value.

The primary objective of this study is to design and implement a decision support system based on the Certainty Factor method that can address the problem of selecting appropriate treatments for dry facial skin. With the development of this system, it is expected that users without specialized knowledge will be able to obtain accurate and reliable information regarding their skin conditions and recommended treatments without necessarily consulting directly with a beauty clinic, which may require additional time and cost.

The main contribution of this research lies in the application of the Certainty Factor method within the domain of facial skincare, an area that has received relatively limited exploration. In addition, the proposed system is expected to serve as a practical, efficient, and accessible digital solution for the public, particularly in supporting independent decision-making related to skincare treatments. Consequently, this study contributes not only to the field of information technology but also to the domains of beauty and skin health.

2. RESEARCH METHODOLOGY

2.1 Expert System

An Expert System is a computer program designed to simulate the decision-making process of a human expert in solving specific problems. This system utilizes expert knowledge in the form of a knowledge base and an inference engine to generate conclusions based on data and symptoms provided by users [14][15]. The primary objective of an expert system is to assist non-expert users in solving complex problems without relying directly on specialists [16]. In the context of this study, the expert system is used to analyze symptoms of dry facial skin and provide recommendations for the most appropriate type of treatment based on those symptoms. In general, an expert system consists of several main components, including a knowledge base that contains expert information related to symptoms of dry skin and appropriate treatment types, an inference engine that performs reasoning using the Certainty Factor method to produce recommendations, and a user interface that functions as the medium of interaction between the user and the system [17].

2.2 *Certainty Factor Method*

The Certainty Factor (CF) method is an approach used in Expert System applications to handle uncertainty in the decision-making process. The Certainty Factor concept was first developed in the medical expert system MYCIN. CF is used to express the level of confidence in a fact or hypothesis based on symptom information provided by the user [18][19]. The CF value ranges from −1 to 1, where a value of 1 indicates complete confidence in a fact, a value of 0 indicates no certainty, and a value of −1 indicates complete disbelief in a fact [20]. In general, the Certainty Factor formula is used to calculate the confidence level of a hypothesis based on the symptoms identified in the system.

$$CF(H,E) = MB(H,E) * MD(H,E) \quad (1)$$

The explanation of the formula variables is as follows. MB(H, E) represents the Measure of Belief, which indicates the level of confidence in a hypothesis H based on the evidence E provided. Meanwhile, MD(H, E) represents the Measure of Disbelief, which reflects the level of uncertainty or disbelief in the hypothesis H based on the same evidence E. In the Certainty Factor method, these two values are used to determine the overall certainty of a hypothesis within an Expert System. When more than one symptom or piece of evidence is present, the overall CF value can be calculated by applying a combination formula to integrate the certainty values obtained from each symptom.

$$CF_{combine} = CF_1 + CF_2 * (1 - CF_1) \quad (2)$$

This formula is applied repeatedly for each relevant symptom until a final value is obtained that represents the level of certainty regarding the diagnosis or recommendation generated by the system.

2.3 Dry Facial Skin

Dry facial skin is a condition in which the skin lacks sufficient water content or natural moisture, causing the skin surface to become rough, scaly, itchy, and potentially irritated [21]. This condition is generally influenced by several factors, such

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as extreme weather conditions (either cold or hot), the use of inappropriate skincare products, inadequate fluid intake, and genetic factors. If not treated properly, dry skin can accelerate the process of premature aging and lead to other skin-related problems. In the fields of beauty and Dermatology, various types of treatments are recommended to address dry facial skin conditions. The selection of appropriate treatment largely depends on the symptoms experienced and the severity level of the skin condition [22].

2.4 Stage Research

This study was conducted through several systematic stages to develop an Expert System capable of providing recommendations for appropriate treatments for dry facial skin using the Certainty Factor method. Each stage was designed to support the system development process in a logical and sequential manner. Figure 1 illustrates the research stages carried out in this study.

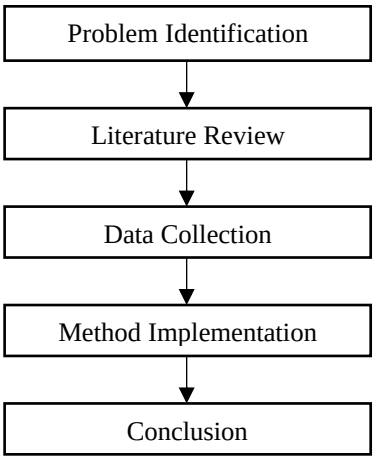

Figure 1. Research Stages

The explanation of Figure 1, which illustrates the research stages in this study, is described as follows.

a) Problem Identification
   This stage aims to identify and formulate the main problem faced by users, namely the difficulty in determining the appropriate type of treatment for dry facial skin conditions. The problem was identified through preliminary observations and interviews with potential users, as well as consultations with beauty experts or specialists in Dermatology.
b) Literature Review
   At this stage, various relevant scientific sources such as journals, books, and previous research reports were reviewed. The focus of the review includes the concept of Expert System, the Certainty Factor method, and the characteristics of dry facial skin along with its treatment methods. This literature review aims to strengthen the theoretical foundation and assist in designing the system based on an appropriate approach.
c) Data Collection
   Data were collected through interviews and direct consultations with beauty experts or dermatologists. The information gathered includes a list of symptoms associated with dry facial skin, common types of treatments provided, and the experts' confidence levels regarding the relationship between symptoms and treatment recommendations. These data serve as the basis for constructing the knowledge base and inference rules in the expert system.
d) Method Implementation
   The Certainty Factor method is implemented in the expert system to calculate the confidence level of each treatment recommendation generated based on the combination of symptoms entered by users. This process includes designing IF–THEN rule-based reasoning, assigning CF values to each rule, and combining the CF values to obtain the final confidence level of the system's recommendation.
e) Conclusion
   After the system has been tested and analyzed, conclusions are drawn regarding the effectiveness of the developed expert system. The evaluation is carried out by comparing the system's recommendations with expert opinions and assessing user satisfaction levels. The conclusions also highlight the strengths, limitations, and suggestions for future system development.

3. RESULT AND DISCUSSION

In this section, the problems related to dry facial skin are described and integrated with the Certainty Factor (CF) method to generate a certainty value for the identified skin condition.

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The analysis focuses on several common symptoms of dry facial skin, including dull skin appearance, skin that is easily irritated, and the rapid formation of wrinkles. These symptoms are processed using the Certainty Factor method to determine the level of confidence and provide solutions for dry facial skin problems.

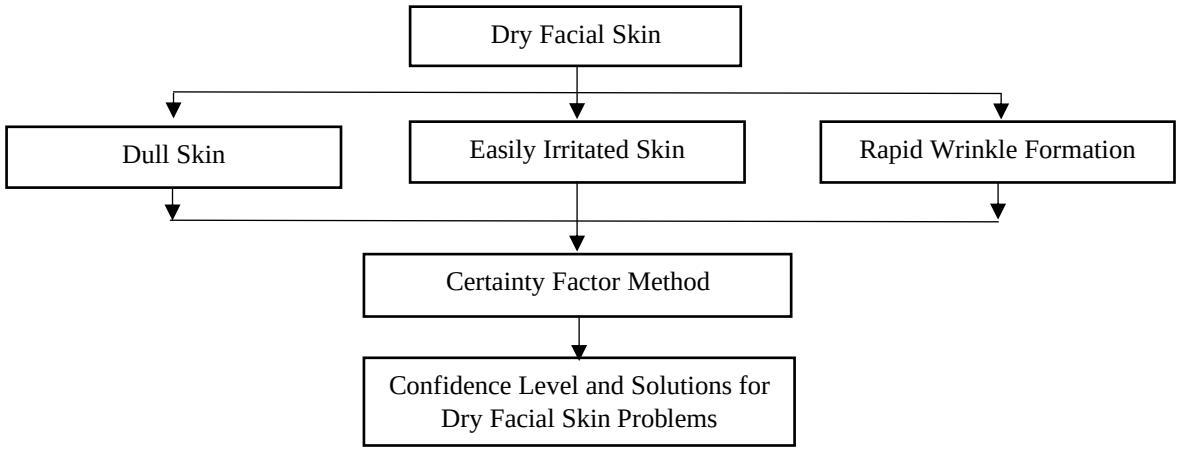

Figure 2. The stages of problem solving

To classify the level of facial skin dryness, criteria are used based on the percentage of certainty obtained from the Certainty Factor calculation results. These criteria are divided into four main categories representing skin conditions ranging from very dry to not dry, as presented in Table 1.

Table 1. Criteria of Dry Facial Skin

Skin Type	Condition	Percentage
Dry Facial Skin	Very Dry	1 – 25%
	Dry	26 – 50%
	Slightly Dry	51 – 75%
	Not Dry	76 – 100%

Table 1 shows the classification of dry facial skin conditions based on the percentage value of certainty generated by the expert system. A lower percentage indicates that the skin condition is categorized as drier, while a higher percentage suggests that the skin condition is closer to normal or not dry.

As a complement to the classification of dryness levels, a detailed description of the physical characteristics for each category is also provided. This explanation helps the expert system identify common symptoms found in each type of dry facial skin. The details are presented in Table 2.

Table 2. Characteristics of Dry Facial Skin

Skin Type	Condition	Description
Dry Facial Skin	Very Dry 1 – 25%	The facial skin appears very dull The skin shows many wrinkles Pores are extremely small and hardly visible The skin feels very rough Skin irritation occurs
	Dry 26 – 50%	The facial skin appears dull Irritation occurs in certain areas of the face Wrinkles appear in specific areas of the face Small pores Rough facial skin texture
	Slightly Dry 51 – 75%	The facial skin is not excessively dull Pores are not very visible, though some may appear Fine wrinkles are visible on the face The skin texture is not too rough
	Not Dry 76 – 100%	Pores are visible but not too large The facial skin does not appear dull and looks fresh No wrinkles are visible The skin texture is smooth and elastic

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Table 2 provides a detailed explanation of the physical characteristics found in each category of dry facial skin. This information was obtained through interviews with beauty experts and is used as the basis for diagnosis in the Expert System based on the Certainty Factor method.

3.2 Implementation of Certainty Factor Method

Several symptoms used as input are processed using the Certainty Factor method to determine the level of confidence in the diagnosed condition. The Certainty Factor method uses numerical values to represent the level of belief held by an expert regarding specific data. The first step in determining the certainty factor is for the expert to assign CF values to each symptom.

To represent the user's confidence in the symptoms experienced, the expert system uses a certainty scale. This value is an important parameter in the inference process because it influences the accuracy of the diagnostic results generated by the system. The certainty scale was obtained through interviews with experts and adjusted to match the understanding of general users, as shown in Table 3.

Table 3. Certainty Values

No	Description	Value
1	Very confident	1.0
2	Confident	0,8
3	Fairly confident	0,6
4	Less confident	0,4
5	Do not know	0,2
6	No	0

Table 3 presents the weight values that represent the user's level of confidence in the presence of certain symptoms. This scale helps the system determine the level of trust in the diagnostic results generated.

In addition to user input, the expert system also relies on knowledge provided by domain experts. Expert knowledge is represented by Certainty Factor values that indicate how strongly the expert believes a symptom is related to a particular skin condition. The detailed expert certainty values are presented in Table 4.

Table 4. Expert Certainty Values

No	Code	Symptom	CF Value
1	GK01	Dull skin appearance	0,8
2	GK02	Small pores	0,8
3	GK03	Rough facial skin	0,8
4	GK04	Many wrinkles on facial skin	0,8
5	GK05	Skin irritation	0,8
6	GK06	Peeling skin	0,8

Table 4 shows the symptoms identified by experts as indicators of dry facial skin, along with their Certainty Factor values representing the expert's confidence in the relationship between the symptom and the condition. All symptoms listed have a CF value of 0.8, indicating that the expert is fairly confident about their relevance.

To capture the user's subjective perception, the system also asks users to assess their level of confidence regarding each symptom they experience. These values are then combined with the expert's values to produce the final inference. The user's certainty values are presented in Table 5.

Table 5. User Certainty Values

No	Code	User Certainty Value
1	GK01	0,8
2	GK02	0,8
3	GK03	0,4
4	GK04	0,4
5	GK05	0,2
6	GK06	0

Table 5 shows the user's level of confidence regarding the symptoms experienced on their facial skin. These values are obtained based on the previously defined certainty scale (see Table 3) and are used in the combined Certainty Factor calculation between expert and user values.

The second step is calculating the CF for each symptom by multiplying the expert CF value with the user CF value.

$$\mathrm{CF[H,E]} = \mathrm{CF[H]1} * \mathrm{CF[E]1}$$

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$CF[H,E] = 0{,}8 * 0{,}8$

$CF[H,E] = 0{,}64$

$CF[H,E] = CF[H]2 * CF[E]2$

$CF[H,E] = 0{,}8 * 0{,}8$

$CF[H,E] = 0{,}64$

$CF[H,E] = CF[H]3 * CF[E]3$

$CF[H,E] = 0{,}8 * 0{,}4$

$CF[H,E] = 0{,}32$

$CF[H,E] = CF[H]4 * CF[E]4$

$CF[H,E] = 0{,}8 * 0{,}4$

$CF[H,E] = 0{,}32$

$CF[H,E] = CF[H]5 * CF[E]5$

$CF[H,E] = 0{,}8 * 0{,}2$

$CF[H,E] = 0{,}16$

$CF[H,E] = CF[H]6 * CF[E]6$

$CF[H,E] = 0{,}8 * 0$

$CF[H,E] = 0$

The third step is combining the CF values from each rule using the formula:

CFcombine CF[H,E]1,2 = CF[H,E]1 + CF[H,E]2 * (1 - CF[H,E]1).

$CFcombine = CF[H,E]1,2$

$CFcombine = CF[H,E]1 + CF[H,E]2 * (1 - CF[H,E]1)$

$CFcombine = 0{,}64 + 0{,}64 * (1 - 0{,}64)$

$CFcombine = 1{,}28 * 0{,}36$

$CFcombine = 0{,}4608$

$CFcombine = CF[H,E]old1,3$

$CFcombine = CF[H,E]old1 + CF[H,E]3 * (1 - CF[H,E]old1)$

$CFcombine = 0{,}4608 + 0{,}64 * (1 - 0{,}4608)$

$CFcombine = 0{,}7808 * 0{,}5392$

$CFcombine = 0{,}42100736$

$CFcombine = CF[H,E]old2,4$

$CFcombine = CF[H,E]old2 + CF[H,E]4 * (1 - CF[H,E]old2)$

$CFcombine = 0{,}42100736 + 0{,}32 * (1 - 0{,}42100736)$

$CFcombine = 0{,}74100736 * 0{,}57899264$

$CFcombine = 0{,}429037778$

$CFcombine = CF[H,E]old3,5$

$CFcombine = CF[H,E]old3 + CF[H,E]5 * (1 - CF[H,E]old3)$

$CFcombine = 0{,}429037778 + 0{,}32 * (1 - 0{,}429037778)$

$CFcombine = 0{,}589037778 * 0{,}570962222$

$CFcombine = 0{,}33631831$

$CFcombine = CF[H,E]old4,6$

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$$\text{CFcombine} = \text{CF[H,E]old4} + \text{CF[H,E]6} * (1 - \text{CF[H,E]old4})$$

$$\text{CFcombine} = 0{,}336318319 + 0 * (1 - 0{,}336318319)$$

$$\text{CFcombine} = 0{,}336318319 * 0{,}6636811$$

$$\text{CFcombine} = 0{,}223208112$$

The fourth step is calculating the percentage value of the combined CF using the formula:

CFpersentase = CFcombine * 100%.

$$\text{CFpersentase} = \text{CFcombine} * 100\%$$

$$\text{CFpersentase} = 0{,}223208112 * 100\%$$

$$\text{CFpersentase} = 22{,}32\%$$

Based on the calculated percentage, the level of confidence that the user has a very dry facial skin condition is 22.32%.

4. CONCLUSION

This study demonstrates that the Certainty Factor (CF) method can be effectively applied in an Expert System to determine appropriate treatments for dry facial skin. The system was designed based on rules obtained from beauty experts and implemented through a CF-based inference approach to address uncertainty in symptom assessment. The testing results indicate that the system produced a confidence level of 22.32% for a very dry skin condition based on the symptoms provided by the user. Although the percentage is relatively low, the system was able to generate results that are consistent with the actual condition and demonstrates potential in providing initial treatment recommendations. The CF method is capable of measuring the level of certainty flexibly, allowing the recommendations generated by the system to be more personalized and aligned with individual conditions. This system can be utilized as a decision-support tool for users experiencing dry skin problems, particularly for those who have not yet consulted directly with specialists in Dermatology. Overall, this research contributes to the development of expert systems in the field of skincare treatment and can serve as a foundation for further development within a broader scope.

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ISSN 2745-7966 (Media Online)
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