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Application of the certainty factor method in an expert system for diagnosing diabetes mellitus based on clinical symptoms

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Abstract

Diabetes Mellitus is a chronic metabolic disease characterized by elevated blood glucose levels due to impaired insulin secretion or function, which can lead to serious complications such as cardiovascular disease, kidney failure, and neuropathy if not detected early. Early detection remains a significant challenge, particularly in regions with limited access to laboratory-based diagnostic facilities, where many cases are only identified after the disease has progressed to a more serious stage. This study applies the Certainty Factor method as an expert system approach to diagnose Diabetes Mellitus based on patients' clinical symptoms. The dataset used was the Early Stage Diabetes Risk Prediction Dataset from the UCI Machine Learning Repository, consisting of 520 patient records with 14 binary clinical symptom attributes. The CF Expert value for each symptom was derived from the proportion of symptom occurrence among positive diabetes cases, and the combined certainty scores were used to classify each patient as diabetic or non-diabetic based on an optimized threshold value. Several threshold values ranging from 0.50 to 0.95 with an interval of 0.05 were systematically tested to determine the optimal decision boundary. The experimental results demonstrate that a threshold of 0.95 yielded the best classification performance, achieving an Accuracy of 79.81%, Precision of 79.61%, Recall of 90.31%, and F1-Score of 84.63%. The high Recall value of 90.31% indicates that the method is highly effective in minimizing undetected positive cases, which is critically important in a medical screening context. Furthermore, the Certainty Factor method demonstrated advantages in interpretability and computational efficiency, as diagnostic decisions can be directly traced to individual symptom contributions without requiring a model training process, making it suitable for implementation in clinical decision support systems for early diagnosis of Diabetes Mellitus.

1. Introduction

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by elevated blood glucose levels due to impaired insulin production, insulin action, or both. Long-term hyperglycemia can damage various organs, including the eyes, kidneys, nerves, heart, and blood vessels, and if left untreated, can lead to serious complications [1]. Diabetes is a significant global health problem, and its prevalence is increasing annually. The high prevalence of diabetes increases the risk of chronic complications, which can impair patients' quality of life and increase mortality from noncommunicable diseases [2].

In Indonesia, the prevalence of diabetes mellitus has increased significantly in recent years. This poses considerable challenges to the health system and necessitates effective early detection measures to reduce the risk of complications and improve treatment outcomes [3]. Early detection of diabetes mellitus is

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crucial, as most affected individuals only become aware of their condition when serious complications have already developed. Therefore, a system is needed that supports the early detection of the disease based on patient symptoms, thus enabling faster and more timely treatment [4].

The development of artificial intelligence (AI) technologies has significantly contributed to healthcare, particularly to the development of decision support systems and expert systems to assist in disease diagnosis. Expert systems allow expert knowledge to be represented in computer systems, thereby contributing to faster and more systematic decision-making [5]. A widely used method in expert systems is the Certainty Factor (CF) method. This method represents an expert's level of confidence in a hypothesis based on available facts or symptoms. Using this confidence level, the system can effectively manage the uncertainty that often arises in the diagnostic process [6].

The Certainty Factor method has been extensively applied in various studies on expert systems, including in the diagnosis of diabetes mellitus. Research shows that this method is capable of generating a confidence level for a diagnosis based on a combination of several symptoms experienced by the patient, thus enabling a more objective decision-making process [7]. In addition, the performance of the Certainty Factor method has also been compared with other methods, such as the Dempster-Shafer method, in several studies on the diagnosis of diabetes mellitus. The comparative results indicate that both methods handle uncertainty well; however, the Certainty Factor method is easier to implement and more readily understood in the diagnostic decision-making process [8]. Research on expert systems for the diagnosis of diabetes mellitus has also been intensively pursued, both in the form of web-based and desktop applications. These systems are intended to support the public and healthcare professionals in the early detection of diabetes risk based on patient symptoms [9].

The basic concept of the Certainty Factor was first introduced by Shortliffe and Buchanan in the development of the medical expert system MYCIN. This approach allows for the measurement of confidence in a hypothesis based on a combination of available evidence, thereby overcoming the limitations of binary logic in the medical decision-making process [10]. According to a report by the International Diabetes Federation (IDF), the number of people with diabetes mellitus worldwide is steadily increasing and is expected to continue rising in the coming decades. This underscores the importance of developing technologies that enable more effective detection and diagnosis of the disease [11]. The World Health Organization (WHO) also states that diabetes mellitus is one of the leading causes of death and disability in many countries, emphasizing the urgent need for prevention measures and early detection systems to identify at-risk patients at the earliest possible stage [12].

The Indonesian government has classified diabetes mellitus as a priority disease within its program to combat noncommunicable diseases through the Ministry of Health. Various screening and public awareness programs are continuously being implemented to reduce the rising number of diabetes cases in the population [13]. Information on clinical symptoms plays a crucial role in the diagnosis of diabetes mellitus, as these can serve as early indicators of the disease. Symptoms such as polyuria, polydipsia, sudden weight loss, weakness, and visual blurring are among the most frequently used indicators in diabetes diagnostics [14]. Furthermore, the development of data-driven research demonstrates that the use of standardized medical datasets can increase objectivity in the development of diagnostic systems. Various artificial intelligence approaches have been applied to process patient data to enable more accurate and consistent predictions [15].

This study uses the Early Stage Diabetes Risk Prediction Dataset, which contains clinical symptom data from patients, to apply the Certainty Factor method to the diagnosis of diabetes mellitus. In contrast to previous research that focused primarily on the development of expert system applications, this study specifically analyzes the capability of the Certainty Factor method to perform diagnosis based on clinical patient symptoms and evaluates its performance using the metrics of Accuracy, Precision, Recall, and F1-Score [16]. Based on this background, the present study aims to apply the Certainty Factor method for diagnosing diabetes mellitus based on clinical symptoms and to evaluate its performance using the Early Stage Diabetes Risk Prediction Dataset. The findings of this study are expected to contribute to the development of a health decision support system that enables faster, more systematic, and more accurate early detection of diabetes mellitus.

2. Research Methodology

This study employs a quantitative, experimental approach, applying the certainty factor method to diagnose diabetes mellitus based on patients' clinical symptoms. This method was chosen because it can represent the degree of certainty of a hypothesis based on available evidence or symptoms, while also addressing the uncertainty often encountered in the diagnostic process. The diagnostic results obtained were then analyzed to determine the accuracy and effectiveness of the certainty factor method in identifying patients with potential diabetes mellitus.

2.1 Research Dataset

The dataset used in this study was obtained from the UCI Machine Learning Repository, namely the Early Stage Diabetes Risk Prediction Dataset. The dataset consists of 520 patient records with 17 attributes, including age, gender, 14 symptom attributes, and one class label. The symptom attributes consist of polyuria, polydipsia, sudden weight loss, weakness, polyphagia, genital thrush, visual blurring, itching, irritability, delayed healing, partial paresis, muscle stiffness, alopecia, and obesity.

Clinically, these attributes represent the following conditions:

1. Age: Patient age (years).
2. Gender: Patient gender.
3. Polyuria: Excessive urination frequency.
4. Polydipsia: Excessive thirst.
5. Sudden Weight Loss: Unintentional and rapid weight loss.
6. Weakness: Physical weakness or fatigue.
7. Polyphagia: Excessive hunger.
8. Genital Thrush: Fungal infection in the genital area.
9. Visual Blurring: Blurred vision.
10. Itching: Persistent itching sensation.
11. Irritability: Increased emotional sensitivity or irritability.
12. Delayed Healing: Slow wound-healing process.
13. Partial Paresis: Weakness affecting certain body parts.
14. Muscle Stiffness: Stiffness in muscles or joints.
15. Alopecia: Hair loss.
16. Obesity: Excessive body weight condition.

The class attribute consists of two categories: 0 represents patients without diabetes mellitus and 1 represents patients with diagnosed diabetes mellitus. This dataset was selected because it contains clinical symptoms directly associated with diabetes mellitus and has been frequently used in previous studies on diabetes prediction and early detection. Furthermore, most symptom attributes are binary, which allows for the straightforward application of the certainty factor method to calculate the confidence level of a diabetes diagnosis based on the observed symptoms.

2.2 Research Stages

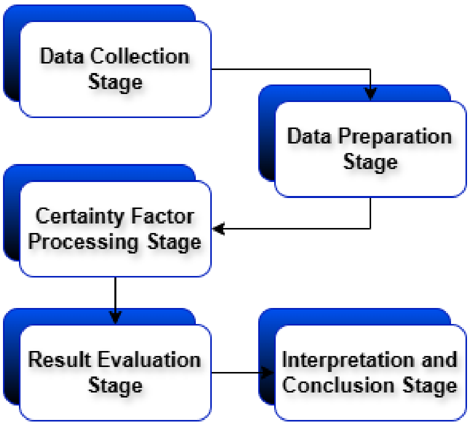

Image 1. Research Method Flowchart

The analysis of diabetes studies comprises several phases. The research methodology is explained below:

- Data Collection: The first step of this study is the creation of the dataset for analysis. This dataset is taken from the diabetes risk early detection dataset available on UCI Machine Learning Repository and comprises 520 patient records. It contains 17 attributes, including age, gender, polyuria, polydipsia, sudden weight loss, weakness, polyphagia, genital thrush, visual blurring, itching, irritability, delayed wound healing, partial paresis, muscle stiffness, alopecia, obesity, and diabetes class. The diabetes class comprises two categories: diabetes-positive and diabetes-negative.
- Data Preparation: Following data collection, data preparation was carried out to ensure data quality before analysis. In this phase, missing values, duplicate records, data types, and the distribution of the individual symptom attributes were checked. Since the symptom variables were already binary (0 and 1), no further transformations or coding were necessary. The prepared dataset then serves as input for calculating the confidence factor.
- Confidence Factor Processing Phase: In this phase, the confidence factor method is applied to determine the degree of confidence in a diabetes diagnosis based on the patient's symptoms. Each symptom is assigned a confidence factor value, derived from the proportion of that symptom's occurrence in positive diabetes cases. The confidence values of multiple symptoms are then combined using the confidence factor combination formula to obtain a final confidence score for each patient's medical record. The resulting confidence score is used to classify whether a patient is likely to have diabetes.
- Outcome Evaluation Phase: After obtaining the classification results, the performance of the confidence factor method is evaluated. The evaluation is performed using a confusion matrix to compare the actual and predicted classifications. Various evaluation metrics are calculated, including accuracy, precision, recall, and F1 score. These metrics are used to measure the effectiveness of the proposed method in diagnosing diabetes based on patient symptoms.
- Interpretation and Conclusion Phase: The final phase of the study involves analyzing and interpreting the results obtained with the Certainty Factor method. Based on the performance indicators, conclusions are drawn regarding the suitability of the method for diagnosing diabetes. This phase also discusses the advantages and limitations of the method and provides recommendations for future research.

2.3 Certainty Factor Method

The certainty factor (CF) method is an inference technique used in expert systems that represents an expert's level of confidence in a hypothesis based on the available evidence. This method accounts for uncertainties in the diagnostic process by assigning a certainty score to each symptom associated with a particular condition.

In this study, the certainty factor method was applied to determine the level of confidence in a diabetes diagnosis based on patient symptoms. Each symptom was assigned a certainty score derived from its proportion of occurrence among the positive diabetes cases in the dataset. The certainty score for each symptom is represented as the expert CF (CFpakar).

The certainty factor for each symptom was calculated using the following equation:

$$CF_{Pakar} = \frac{Jumlah\ Kasus\ Positif\ yang\ Memiliki\ Gejala}{Total\ Kasus\ Positif}$$

Where:

- CFpakar = certainty value of a symptom
- Number of Positive Cases Having the Symptom = frequency of symptom occurrence in positive diabetes cases
- Total Positive Cases = total number of positive diabetes records

After obtaining the certainty value for each symptom, the Certainty Factor values are combined sequentially using the Certainty Factor combination rule:

$$CF_{combine} = CF1 + CF2(1 - CF1)$$

Where:

- CFcombine = combined certainty value
- CF_1 = first certainty value
- CF_2 = second certainty value

The combination process is repeated until all symptoms possessed by a patient are processed. The final Certainty Factor value is then used as the basis for determining whether a patient is classified as diabetic or non-diabetic.

2.4 Determination of Classification Results

After determining the final Certainty Factor, a classification is performed for diagnosis. This classification is based on a threshold. If the final Certainty Factor is greater than or equal to the threshold, the patient is classified as diabetes-positive. Otherwise, they are considered diabetes-negative.

The classification rules are as follows:

$$Prediction = \begin{cases} 1, CF \geq Threshold \\ 0, CF < Threshold \end{cases}$$

Where:

- 1 = Positive Diabetes
- 0 = Negative Diabetes
- Threshold = decision boundary used in the classification process

In this study, various threshold values were tested to achieve the best classification performance. The threshold that yielded the highest accuracy was selected as the optimal threshold for the final classification process.

2.5 Model Evaluation Scenario

To evaluate the performance of the certainty factor method, this study uses a confusion matrix. This matrix provides a comprehensive overview of the distribution of the model-generated prediction results and consists of four main components: True Positives (TP),True Negatives (TN), False Positives (FP),

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and False Negatives (FN).Based on these four components, various evaluation metrics are calculated to measure the effectiveness of the proposed method.

1. Accuracy :

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

2. Precision:

$$Precision = \frac{TP}{TP + FP}$$

3. Recall:

$$Recall = \frac{TP}{TP + FN}$$

4. F1-Score:

$$F1\text{-}Score = 2 \times \frac{Precision \times Recall}{Precision + Recall}$$

Accuracy, precision, recall, and F1 score were used to evaluate the classification performance of the certainty factor method in diagnosing diabetes based on patient symptoms. These evaluation metrics allow for a comprehensive assessment of the model's ability to identify positive and negative diabetes cases.

3. Results and Discussion

3.1 Implementation of the Certainty Factor Method

The dataset used in this study was obtained from the Early Stage Diabetes Risk Prediction Dataset, consisting of 520 patient records with 14 clinical symptom attributes related to Diabetes Mellitus. Each symptom is represented in binary form, where a value of 1 indicates the presence of a symptom and a value of 0 indicates its absence.

In the Certainty Factor method, each symptom is assigned a certainty value (CF Expert) that represents the degree of contribution of that symptom to the hypothesis of Diabetes Mellitus. The CF Expert value was derived from the proportion of symptom occurrence among patients diagnosed with diabetes in the dataset in show Fig 1 below.

	age	gender	polyuria	polydipsia	sudden_weight_loss	weakness	polyphagia	genital_thrush	visual_blurring	itching	irritability	delayed_healing	partial_paresis	muscle_stiffness	alopecia	obesity	class
0	40	Male	0	1	0	1	0	0	0	1	0	1	0	1	1	1	1
1	58	Male	0	0	0	1	0	0	1	0	0	0	1	0	1	0	1
2	41	Male	1	0	0	1	1	0	0	1	0	1	0	1	1	0	1
3	45	Male	0	0	1	1	1	1	0	1	0	1	0	0	0	0	1
4	60	Male	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1

Fig 1. Sample of Early Stage Diabetes Risk Prediction Dataset

Table 1. CF Expert Value of Each Symptom

No	Symptom	CFExpert
0	Poluria	0.759
1	Polydipsia	0.703
2	Sudden_weight	0.588
3	Weakness	0.681
4	Polyphagia	0.591
5	Genitak_thrush	0.259
6	Visual_blurring	0.547
7	Itching	0.481
8	Irritability	0.344
9	Delayed_healing	0.478
10	Partial_paresis	0.600
11	Muscle_stiffness	0.422
12	Alopecia	0.244
13	Obsety	0.191

Table 1 presents a representative sample of five patient records from the Early Stage Diabetes Risk Prediction Dataset used in this study. Each row represents one patient record, and each column represents a clinical symptom attribute in binary form, where a value of 1 indicates the presence of the symptom and 0 indicates its absence. The Class column represents the diagnosis label, where 1 indicates a positive diabetes diagnosis and 0 indicates a negative diagnosis. As shown in the sample, all five records belong to the positive diabetes class, reflecting the slightly dominant proportion of positive cases in the dataset.

Based on Table 1, Polyuria has the highest certainty value of 0.759, followed by Polydipsia at 0.703 and Weakness at 0.681. These values indicate that the three symptoms are the most dominant indicators of Diabetes Mellitus in the dataset used. In contrast, Obesity, Alopecia, and Genital Thrush recorded the lowest certainty values at 0.191, 0.244, and 0.259 respectively, suggesting that these symptoms contribute less significantly to the diagnostic decision compared to the primary symptoms.

Subsequently, the Certainty Factor values of each active symptom in a patient were combined sequentially using the Certainty Factor combination rule until a final certainty score (CF Score) was obtained. This value serves as the basis for classifying patients into diabetic or non-diabetic categories.

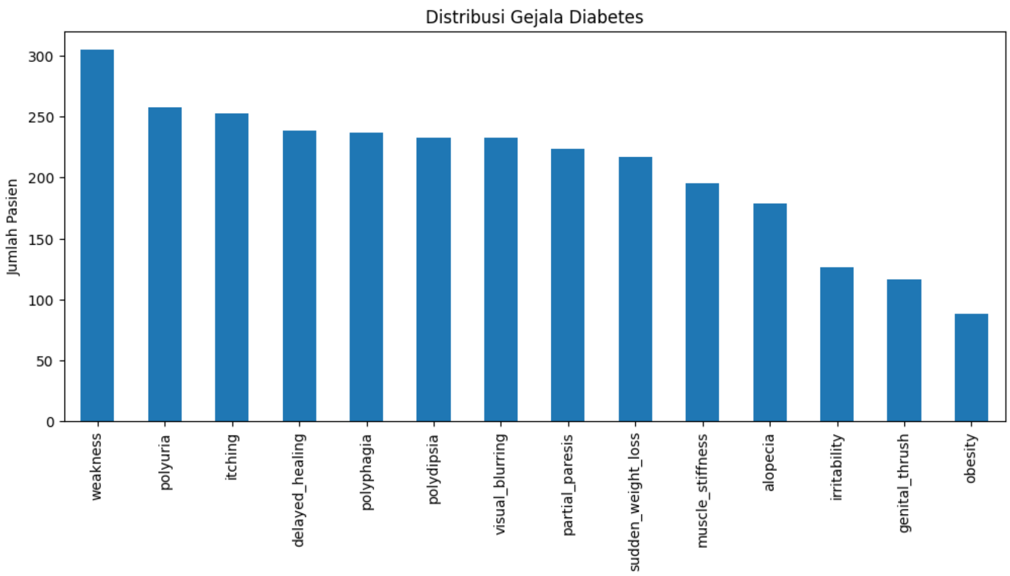

Fig 2. Bar Chart of Diabetes Symptom Distribution

Fig. 2 presents a bar chart illustrating the frequency distribution of each clinical symptom across the entire dataset. As shown in the figure, Weakness recorded the highest overall occurrence with 305 cases, followed by Polyuria with 258 cases and Itching with 253 cases. Meanwhile, Obesity recorded the lowest frequency with only 88 occurrences across 520 patient records. This distribution provides an overview of how frequently each symptom appears in the dataset regardless of class label, complementing the CF Expert values which are derived specifically from positive diabetes cases.

3.2 Classification Model Evaluation Using Confusion Matrix and Classification Metrics

The Certainty Factor method performance evaluation was conducted using a Confusion Matrix consisting of four main components, namely True Positive (TP), True Negative (TN), False Positive (FP), and False Negative (FN). These four components serve as the main foundation for measuring the level of accuracy and error of the system in making predictions. In this study, the division of test result data will be categorized specifically into these four groups based on the suitability between the system results and the real condition of the patient.

The system's prediction accuracy components are represented by True Positive (TP) and True Negative (TN). TP is defined as the number of diabetic patients who are successfully classified accurately by the system as diabetic. Meanwhile, TN is the number of non-diabetic patients who are also successfully identified correctly as the non-diabetic group. The system's success in maximizing the value of these two components indicates a high level of diagnostic reliability.

Conversely, the aspect of misclassification by the system is represented by the False Positive (FP) and False Negative (FN) values. FP indicates the number of non-diabetic patients who are mistakenly diagnosed by the system as diabetic. On the other hand, FN reflects the number of patients who actually have diabetes but are incorrectly classified by the system into the non-diabetic group. Recognizing these two types of errors is crucial for evaluating the weaknesses of the applied method.

Based on these four components, several evaluation metrics are calculated to measure the effectiveness of the Certainty Factor method in diagnosing Diabetes Mellitus based on the patient's clinical symptoms. The use of these multi-source metrics is crucial because accuracy values alone are insufficient to describe the overall performance of the system, especially in medical cases with significant clinical consequences. For example, False Negative errors carry a much more fatal risk than False Positive errors because they can delay emergency medical treatment and trigger more serious disease complications in patients.

3.3 Analysis and Evaluation Result of the Certainty Factor Method

Testing was performed using several threshold values ranging from 0.50 to 0.95 with an interval of 0.05 to determine the optimal decision boundary for diagnosis. Each threshold value was evaluated based on the resulting Accuracy, Precision, Recall, and F1-Score. The complete results of the threshold testing are presented in Table 2.

Table 2. Threshold Testing Results

Threshold	Accuracy	Precision	Recall	F1-Score
0.95	79.81	79.61	90.31	84.63
0.85	76.92	74.27	95.62	83.61
0.90	76.73	75.58	91.88	82.93
0.80	76.54	73.68	96.25	83.47
0.70	75.77	72.56	97.50	83.20
0.75	75.38	72.43	96.88	82.89
0.65	72.50	69.80	97.50	81.36
0.60	71.35	68.87	97.50	80.72
0.55	70.58	68.27	97.50	80.31
0.50	70.58	68.27	97.50	80.31

Based on the experimental results in Table 2, a threshold of 0.95 yielded the best overall performance with the highest Accuracy of 79.81% compared to all other tested values. The Confusion Matrix obtained at the optimal threshold of 0.95 produced the following values: TP = 289, TN = 126, FP = 74, and FN = 31. The complete evaluation results at the optimal threshold are presented in Table 3.

Table 3. Evaluation Results of the Certainty Factor Method

Metric	Performance
Accuracy	79.81%
Precision	79.61%
Recall	90.31%
F1-Score	84.63%

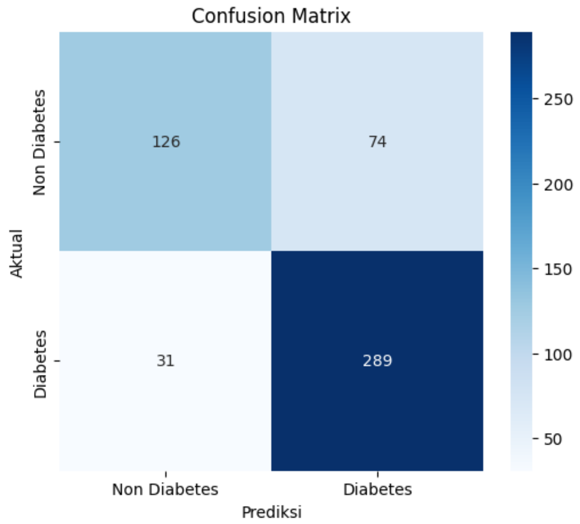

Fig. 3. Confusion Matrix Heatmap at Threshold 0.95

Fig. 3 presents the Confusion Matrix heatmap generated by the Certainty Factor method at the optimal threshold of 0.95. The matrix shows that the model correctly classified 289 diabetic patients as positive (TP) and 126 non-diabetic patients as negative (TN). Meanwhile, 74 non-diabetic patients were incorrectly predicted as diabetic (FP) and 31 diabetic patients were missed by the system (FN). The relatively low FN value confirms the strong capability of the method in detecting true positive cases.

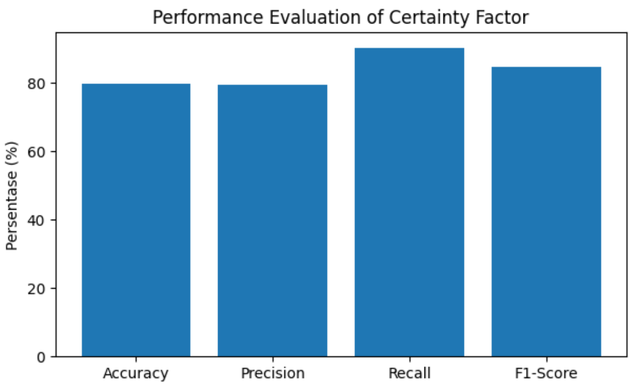

Fig. 4. Bar Chart of Performance Evaluation Metrics

Fig. 4 illustrates the performance of the Certainty Factor method across all four evaluation metrics. As shown in the figure, Recall achieved the highest value at 90.31%, followed by F1-Score at 84.63%, Accuracy at 79.81%, and Precision at 79.61%. The dominance of the Recall value reflects the method's strong capability in identifying positive diabetes cases, which is a desirable characteristic in a medical screening tool.

Based on Table 3, the Certainty Factor method demonstrates reasonably good performance in diagnosing Diabetes Mellitus based on clinical symptoms. A Recall value of 90.31% indicates that the method is capable of identifying the majority of patients who truly have diabetes. In the context of medical diagnosis, this capability is critically important as it reduces the risk of undetected positive cases. Furthermore, a Precision value of 79.61% indicates that the majority of positive predictions generated by the system correspond to actual conditions. An F1-Score of 84.63% reflects a good balance between Precision and Recall, demonstrating that the Certainty Factor method is capable of producing stable classification performance.

3.4 Analysis of Feature Characteristics and Symptom Contribution

The characteristics of the symptoms used in this study have a significant influence on the diagnostic results obtained. Unlike machine learning methods that rely on a learning process from data, the Certainty Factor method utilizes the certainty value of each symptom as the basis for decision-making, making the diagnostic process more transparent and interpretable.

Based on the CF Expert values obtained, Polyuria, Polydipsia, and Weakness make the greatest contributions to the diagnosis of Diabetes Mellitus. These three symptoms are the most frequently occurring symptoms among diabetic patients in the dataset used. This finding is consistent with the clinical literature, which identifies polyuria and polydipsia as two of the three classic symptoms of Diabetes Mellitus, often referred to as the "three Ps" alongside polyphagia.

In contrast, Obesity, Alopecia, and Genital Thrush have relatively lower certainty values. This indicates that these symptoms do not contribute as significantly as the primary symptoms in supporting the diagnostic decision. This characteristic of the Certainty Factor method enables diagnosis to be made based on the degree of contribution of individual symptoms, making the diagnostic process more structured and easy to interpret by medical practitioners.

3.5 Analysis of Computational Complexity and System Efficiency

In addition to classification performance, computational efficiency is also a crucial aspect in implementing AI-based diagnostic systems. The Certainty Factor method differs from machine learning algorithms in that it does not require model training.

The main process of the Certainty Factor method involves simply calculating certainty values and combining patient symptoms using a combination formula. Therefore, this method's computational requirements are relatively low and it does not require extensive hardware resources. With a limited number of symptoms, the calculation process can be performed quickly, making this method highly suitable for implementation in web- or mobile-based decision support systems that require real-time responses.

3.6 Clinical Implication of Diagnostic Result

From a clinical perspective, the Certainty Factor method can be used as an initial screening tool to help identify patients with potential diabetes mellitus based on reported symptoms. A recall value of 90.31% indicates that the system successfully detected most patients with diabetes. This capability is crucial because delayed diagnosis can increase the risk of more serious complications, including cardiovascular disease, kidney failure, and neuropathy.

The diagnostic results generated by this system are not intended to replace a physician's clinical judgment, but rather serve as a supportive tool that provides initial information regarding the likelihood of diabetes mellitus. Patients with a high certainty score may be recommended for further testing, such as a fasting blood glucose test or HbA1c, to confirm a clinical diagnosis.

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3.7 Discussion of Research Findings

The results of this study indicate that the Certainty Factor method has good performance in diagnosing diabetes mellitus based on patient clinical symptoms. Using the Early Stage Diabetes Risk Prediction Dataset consisting of 520 patient records, this method achieved 79.81% accuracy, 79.61% precision, 90.31% recall, and an F1-score of 84.63% at an optimal threshold of 0.95.

The high recall value indicates that the Certainty Factor method is highly effective in detecting patients who truly have diabetes mellitus. This is particularly important in a medical context, as false negatives carry a greater clinical risk than false positives. Furthermore, this method offers advantages in interpretability, as each diagnostic decision can be traced back to the contribution of individual symptoms exhibited by the patient.

The slightly imbalanced class distribution in the dataset, with 320 positive cases (61.5%) and 200 negative cases (38.5%), likely contributed to the relatively high recall value. However, the F1-score of 84.63% confirms that this method maintains a reasonable balance between Precision and Recall, indicating that high Recall is not solely due to class imbalance.

Overall, the results of this study confirm that the Certainty Factor method can be used as an expert system approach to support the early diagnosis of Diabetes Mellitus based on clinical symptoms. This method is capable of producing good classification performance with relatively low computational complexity, thus potentially being applied in various decision support systems in the healthcare field.

Besides diagnostic accuracy, usability also plays an important role in determining the effectiveness of clinical decision support systems. A well-designed user interface can improve user interaction, increase system acceptance, and facilitate faster diagnostic decision-making, particularly for healthcare professionals and the general public [17].

4. Conclusion

This study applies the Certainty Factor method as an expert system approach for diagnosing diabetes mellitus based on clinical symptoms. For this purpose, the Diabetes Risk Early Detection dataset, comprising 520 patient records with 14 clinical symptom attributes, was used. Analysis based on the metrics of accuracy, precision, recall, and F1 score yielded the following key results: The Certainty Factor method achieved the best classification performance at an optimal threshold of 0.95, with an accuracy of 79.81%, a precision of 79.61%, a recall of 90.31%, and an F1 score of 84.63%. Overall, the results demonstrate that the Certainty Factor method provides good classification performance in diagnosing diabetes mellitus based on clinical symptoms.

This performance is particularly reflected in the high recall of 90.31%, which demonstrates the method's strong ability to identify the majority of patients with actual diabetes mellitus. In the context of medical diagnostics, this property is crucial, as it minimizes the risk of undetected positive cases, which can lead to treatment delays and more serious complications. Of the 14 symptoms examined, polyuria, polydipsia, and weakness were identified as the most important diagnostic factors, with expert CF values of 0.759, 0.703, and 0.681, respectively, which are consistent with the clinical features of diabetes mellitus. In addition to its classification performance, the certainty factor method also demonstrated advantages in terms of interpretability and computational efficiency, as each diagnostic decision could be directly attributed to the contribution of individual symptoms without requiring model training.

However, it is important to emphasize that these results are context-dependent and cannot be generalized, as the method's performance can vary depending on data characteristics and the applied threshold. The slightly unbalanced class distribution of the dataset, with 320 positive cases (61.5%) and 200 negative cases (38.5%), may have influenced the relatively high recall rate. Future research is recommended to investigate combining the certainty factor method with feature selection procedures to further improve diagnostic accuracy, as well as to apply class balancing techniques such as SMOTE to correct for the unbalanced data distribution. Furthermore, it is recommended to conduct tests with larger, more diverse, and clinically validated datasets to obtain more representative results that are more readily generalizable to other healthcare settings.

References

[1] M. G. Pradana, B. W. Pamekas, and K. Kusrini, “Perancangan Sistem Pakar Untuk Mendiagnosa Penyakit Diabetes Mellitus Menggunakan Metode Certainty Factor,” *CCIT Journal*, vol. 11, no. 2, pp. 182–191, 2018, doi: https://doi.org/10.33050/ccit.v11i2.586.

[2] A. Ismono, “Penerapan Metode Certainty Factor Pada Sistem Pakar Diagnosa Penyakit Diabetes Melitus,” *Journal of Computer System and Informatics (JoSYC)*, vol. 4, no. 1, pp. 1–6, 2022, doi: https://doi.org/10.47065/josyc.v4i1.2465.

[3] A. P. Putra and C. Rahmad, “Analisa Perbandingan Metode Certainty Factor dan Dempster Shafer pada Sistem Pakar Diagnosa Penyakit Diabetes Melitus,” *Jurnal Informatika Polinema*, vol. 2, no. 1, pp. 7–12, 2015, doi: https://doi.org/10.33795/jip.v2i1.47.

[4] S. L. Mufreni and F. A. Priyatno, “Sistem Pakar Deteksi Dini Diabetes Mellitus Menggunakan Metode Certainty Factor Berbasis Laravel,” *Jurnal Informatika Teknologi dan Sains*, vol. 7, no. 3, 2025, doi: https://doi.org/10.51401/jinteks.v7i3.6052.

[5] A. Idaman, A. R. Selvanda, R. Agustin, V. Rolanda, and Mutiasanita, “Implementasi Certainty Factor Untuk Analisis Akurasi Diagnosa Penyakit Diabetes Tipe 2,” *Jurnal SAINTIKOM*, vol. 24, no. 1, 2024, doi: https://doi.org/10.53513/jis.v24i1.10741.

[6] A. J. Ridwan, V. Atina, D. Hartanti, and D. P. Putri, “Implementasi Algoritma Naïve Bayes dan Certainty Factor pada Sistem Pakar Deteksi Penyakit Diabetes Mellitus Tahap Awal,” *Smart Comp*, vol. 14, no. 2, 2025, doi: https://doi.org/10.30591/smartcomp.v14i2.7327.

[7] N. Husna, A. F. Lubis, and R. A. Putra, “Perbandingan Metode Certainty Factor dan Dempster-Shafer dalam Diagnosis Diabetes Mellitus Tipe 2,” *Anoatik*, vol. 3, no. 2, 2024, doi: https://doi.org/10.33772/anoatik.v3i2.130.

[8] Y. B. Widodo, S. A. Anggraeini, and T. Sutabri, “Perancangan Sistem Pakar Diagnosis Penyakit Diabetes Berbasis Web Menggunakan Algoritma Naive Bayes,” *Jurnal Teknologi Informasi dan Komputer*, vol. 7, no. 1, pp. 112–123, 2021, doi: https://doi.org/10.37012/jtik.v7i1.507.

[9] R. N. Putri and L. Goeirmanto, “Aplikasi Sistem Pakar Untuk Diagnosa Penyakit Diabetes Melitus,” *Jurnal Aplikasi dan Inovasi IPTEKS SOLIDITAS*, vol. 3, no. 2, pp. 106–112, 2020.

[10] E. H. Shortliffe and B. G. Buchanan, “A Model of Inexact Reasoning in Medicine,” *Mathematical Biosciences*, vol. 23, no. 3–4, pp. 351–379, 1975.

[11] International Diabetes Federation, *IDF Diabetes Atlas*, 10th ed., Brussels, Belgium, 2021.

[12] World Health Organization, *Diabetes Fact Sheet*, Geneva, Switzerland, 2023.

[13] Kementerian Kesehatan Republik Indonesia, *Profil Kesehatan Indonesia 2023*, Jakarta, Indonesia, 2024.

[14] Kementerian Kesehatan Republik Indonesia, *Infodatin Diabetes Melitus*, Jakarta, Indonesia, 2023.

[15] M. T. García-Ordás, C. Benavides, J. A. Benítez-Andrades, H. Alaiz-Moretón, and I. García-Rodríguez, “Diabetes Detection Using Deep Learning Techniques With Oversampling and Feature Augmentation,” 2024.

[16] *Early Stage Diabetes Risk Prediction Dataset*, UCI Machine Learning Repository, 2020.

[17] Sobri, M., & Subchi, I. (2025). User Interface Evaluation of the Business Development Center Website at UIN Syarif Hidayatullah Jakarta: A Content, Visual, and Navigation Perspective. Jurnal Teknik Informatika (JUTIF), 6(4), 2681–2692. doi: https://doi.org/10.52436/1.jutif.2025.6.4.5208