Available online at www.coins-indocompt.org

COINS JOURNAL
Computing and Information System Journal

COmputing and INformation Systems Journal

IndoCompt PUBLISHER

E-ISSN: 3109-3248

Vol. 2, No. 1, April, 2026

EARLY DETECTION OF DIABETES MELLITUS TYPE 1, TYPE 2, AND GESTATIONAL DIABETES MELLITUS (GDM) USING WEBSITE-BASED CERTAINTY FACTOR

Rayhan Ibrahim[a*], Guruh Wijaya[b], Dudi Irawan[c]

Muhammadiyah University of Jember, Jember 68121, Indonesia

rayhanibrahim02@gmail.com

Received 27 Pebruary 2026; Revised 03 Mart 2026; Accepted 18 Mart 2026; Published 01 April 2026

Abstract

The development of information technology plays an important role in supporting healthcare services, particularly in assisting the early detection of diseases. One chronic disease that requires early detection is Diabetes Mellitus, which consists of Type 1 Diabetes Mellitus, Type 2 Diabetes Mellitus, and Gestational Diabetes Mellitus (GDM). These three types of diabetes have similar early symptoms, making them difficult to recognize by the general public. Therefore, this study aims to design and develop a web based expert system to detect Type 1 Diabetes Mellitus, Type 2 Diabetes Mellitus, and Gestational Diabetes Mellitus (GDM) using the Certainty Factor method. This method is used to calculate the level of diagnostic confidence based on symptoms selected by users, referring to confidence weights provided by medical experts. The problem-solving process is carried out through Certainty Factor calculations using a weighted average approach to generate the percentage of diagnostic confidence. Based on testing and validation results through manual calculations and expert evaluation, the developed system achieved an accuracy rate of 87.10%. The results indicate that this expert system can be used as a supporting tool for the early detection of Diabetes Mellitus prior to further medical examination.

Keywords: Expert System, Diabetes Mellitus, Certainty Factor, Early Detection, Website, Healthcare, Information Technology

1. Introduction

Diabetes Mellitus (DM) is one of the chronic diseases that continues to increase significantly worldwide, including in Indonesia. This condition is caused by disorders in blood glucose regulation associated with insulin production or function. Diabetes Mellitus consists of several types, namely Type 1 Diabetes Mellitus, Type 2 Diabetes Mellitus, and Gestational Diabetes Mellitus (GDM), each of which has different characteristics but often presents similar early symptoms.

The similarity of early symptoms among these three types of diabetes often causes difficulties for the general public in identifying the type of disease at an early stage. Early detection is essential to prevent severe complications and to provide timely medical treatment. However, limited access to healthcare services and medical experts remains a challenge, especially for initial diagnosis.

Several previous studies have developed expert systems using the Certainty Factor method for disease diagnosis. However, most of these studies focus only on a single disease or do not specifically differentiate between multiple types of Diabetes Mellitus. In addition, some studies lack comprehensive validation using real user data and expert comparison.

Therefore, this study aims to develop a web-based expert system capable of detecting Type 1 Diabetes Mellitus, Type 2 Diabetes Mellitus, and Gestational Diabetes Mellitus simultaneously using the Certainty Factor method. The main contribution of this research lies in integrating multi-type diabetes detection in one system, applying a weighted average approach in Certainty Factor calculations, and validating the system using real respondent data and expert comparison.

It should be emphasized that the developed system is not intended to replace medical professionals. Instead, it serves as a decision-support tool to assist users in identifying potential symptoms at an early stage. Final diagnosis and treatment decisions must remain under the responsibility of qualified healthcare practitioners.

2. Methode

Diabetes Mellitus is a chronic disease with a continuously increasing number of cases, including in Indonesia. It consists of Type 1 Diabetes Mellitus, Type 2 Diabetes Mellitus, and Gestational Diabetes Mellitus, which are often not detected at an early stage because the initial symptoms are not well recognized. Delayed diagnosis can lead to serious complications, further exacerbated by limited public awareness as well as constraints related to time and cost for medical examinations. Therefore, a web-based expert system using the Certainty Factor method was developed to assist in the early detection of diabetes based on the symptoms experienced by users. This system is expected to provide rapid preliminary information and support early prevention efforts. Figure 1 illustrates the stages of the research.

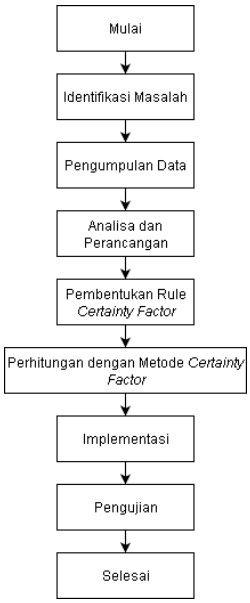

Figure 1. Research Stages

2.1 Data Collection

The data used in this study were obtained from 62 respondents through a questionnaire based on symptoms of Diabetes Mellitus. The respondents consisted of individuals with varying characteristics, including age and health conditions.

In addition, expert knowledge was obtained from medical practitioners to determine the relationship between symptoms and types of Diabetes Mellitus. This expert knowledge serves as the basis for assigning weights in the Certainty Factor method.

2.2 Expert System

An expert system is a type of information system that integrates the knowledge possessed by a human expert into a computer-based system so that it can be utilized as a consultation tool. This knowledge serves as the basis for the system in answering questions or providing solutions to problems submitted by users. An expert system can be considered successful if it is able to produce decision-making processes and conclusions that are consistent with those made by human experts. Knowledge-based reasoning approaches are believed to have the capability to generate disease diagnosis predictions; therefore, an evaluation of the effectiveness level of the diagnostic results produced by such reasoning methods is necessary. Consequently, the most optimal knowledge-based reasoning method in producing diagnostic conclusions can be identified [6].

2.3 Certainty Factor

Certainty Factor (CF) is a method used to represent the degree of confidence of an expert in a particular hypothesis based on identified facts or symptoms. This method is widely applied in the development of expert systems to address uncertainty in the diagnostic process, especially in medical problems that involve multiple symptoms. Through the application of the Certainty Factor approach, the system is able to generate diagnostic decisions that closely reflect the level of confidence held by experts regarding specific conditions [8]. The CF value is calculated using the following formula:

$$CF(H,E) = CF(User) \times CF(Expert) \quad (1)$$

Where:

- CF (H, E): Certainty Factor for hypothesis H given evidence E
- CF(User): User confidence level in experiencing a symptom
- CF(Expert): Expert confidence level for the relationship between symptom and disease

After obtaining the CF (H, E) values for each symptom, the next step is to determine the overall level of confidence for a particular disease using the weighted average method. This approach provides a balanced contribution between the expert's confidence weight and the user's level of certainty, so that the final value more accurately reflects the patient's actual condition. The equation used is as follows:

$$CF_{total} = \frac{\sum CF(H,E)}{\sum CF_{Expert}} \quad (2)$$

2.4 System Design

The design of an Early Detection system to identify Type 1 Diabetes Mellitus, Type 2 Diabetes Mellitus, and Gestational Diabetes Mellitus was carried out by analyzing individual behavior using a UML (Unified Modeling Language) modeling approach.

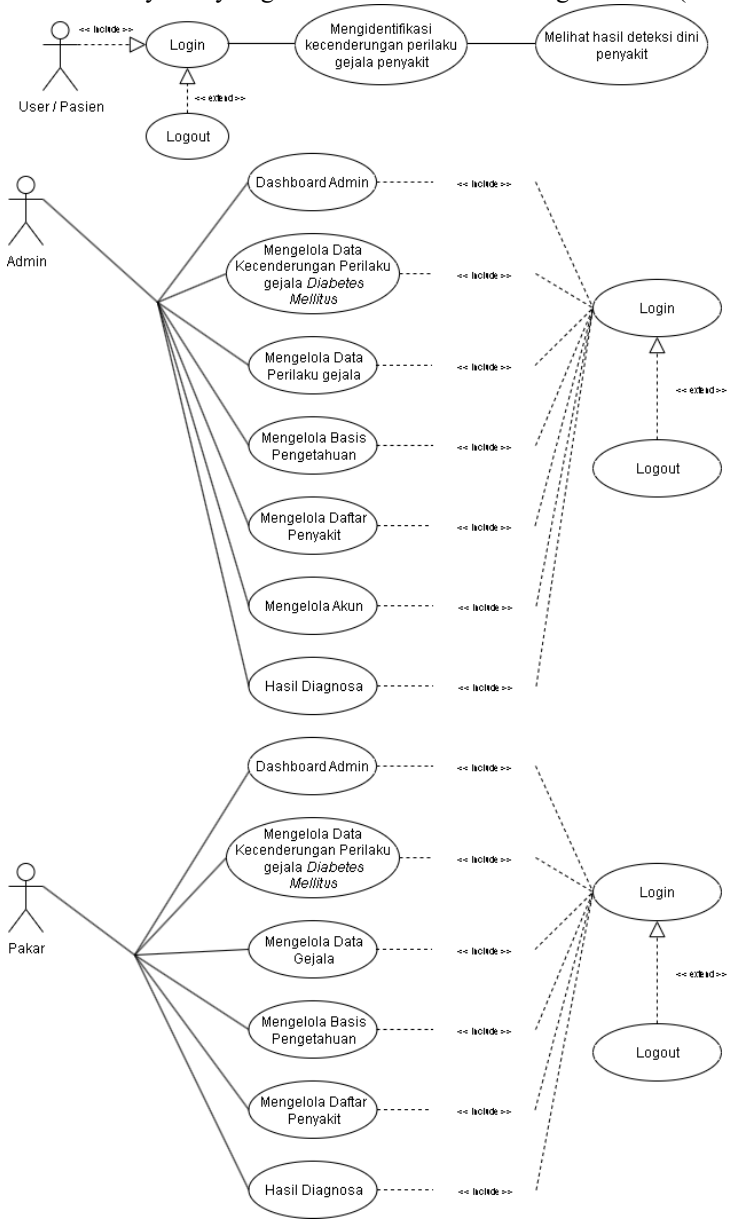

Figure 2. Use Case Diagram

3 Result

3.1 Research Result

Table 1. Tendency Level

Code	*Tendency Level*	*CF Value Range*	*Percentage*
K001	Low Tendency	0.2 – 0.4	20 % – 40 %
K002	Moderate Tendency	0.4 – 0.6	41% – 60 %
K003	High Tendency	0.6 – 0.8	61% – 80 %
K004	Very High Tendency	0.8 – 1.0	81% – 100 %

Table 1 presents several levels of tendency along with their corresponding tendency codes. The system classifies the analysis results into four categories: low tendency with CF values ranging from 0.2 to 0.4 or percentages between 20% and 40%, moderate tendency with CF values from 0.4 to 0.6 or percentages between 41% and 60%, high tendency with CF values from 0.6 to 0.8 or percentages between 61% and 80%, and very high tendency with CF values from 0.8 to 1.0 or percentages between 81% and 100%.

Table 2. Symptom Data and Expert CF Scores

Code	*Symptoms*	*Weight Frequency (Likert 1–10)*	*CF Value*
G001	The patient frequently urinates excessively (polyuria).	10	1.0
G002	The patient feels very thirsty or drinks excessively (polydipsia).	10	1.0
G003	The patient experiences excessive hunger or eats more than usual (polyphagia).	8	0.8
G004	The patient's urine attracts ants or appears sweet.	8	0.8
G005	The patient experiences drastic weight loss without a clear reason.	10	1.0
G006	The patient complains of frequent blurred vision.	10	1.0
G007	The patient easily feels tired even without heavy activity.	6	0.6
G008	The patient's wounds heal slowly within a reasonable time.	8	0.8
G009	The patient frequently experiences itching or recurrent skin infections.	8	0.8
G010	The patient often experiences flu, cough, or respiratory tract infections.	8	0.8
G011	*(For pregnant patients)* The patient feels excessive thirst during pregnancy.	10	1.0
G012	*(For pregnant patients)* The patient urinates excessively during pregnancy.	10	1.0
G013	*(For pregnant patients)* The patient feels easily fatigued during pregnancy.	8	0.8
G014	*(For pregnant patients)* The patient experiences recurrent vaginal or urinary tract infections.	8	0.8
G015	*(For pregnant patients)* The patient complains of blurred vision during pregnancy.	6	0.6
G016	*(For pregnant patients)* The patient experiences excessive weight gain during pregnancy.	8	0.8
G017	The patient has a history of autoimmune diseases (e.g., thyroiditis, vitiligo).	6	0.6
G018	The patient experiences unexplained weight loss (often associated with Type 1 DM).	6	0.6
G019	The patient experiences overweight or obesity (often associated with Type 2 DM).	6	0.6
G020	The patient has family members with a history of Diabetes Mellitus.	8	0.8
G021	The patient has had a viral infection prior to the onset of diabetes symptoms (e.g., high fever, ARI).	8	0.8
G022	Are you under 30 years old?	10	1.0
G023	Are you over 30 years old?	10	1.0
G024	During pregnancy, has the gestational age exceeded 24 weeks?	10	1.0

Table 2 explains the behavior codes, behavior names, and CF values used in the calculation process for determining the certainty factor.

Table 3. User Confidence Level Scale

Code	*Level of Tendency*	*CF Weight Value*
J001	Very Confident (VC)	1.0
J002	Confident (C)	0.8
J003	Fairly Confident (FC)	0.6
J004	Slightly Confident (SC)	0.4
J005	Almost Not Confident (ANC)	0.2
J006	Not Confident / Not Relevant (NC/NR)	0.0

Table 3 explains the mechanism for applying the Certainty Factor method in the consultation process. At this stage, users are asked to select from the provided answer options, each of which is assigned a specific weight value. The lowest weight value of 0.2 indicates that the user does not experience or does not match the statement presented by the system. The higher the level of conformity of the user's response, the greater the resulting level of certainty. The calculation process begins by separating rules that have more than one premise into rules with a single premise. Next, the Certainty Factor value is calculated for each rule, and all resulting values are then combined to obtain the final level of confidence. The system classifies diagnosis results into four categories: low, moderate, high, and very high tendency based on CF values. Based on testing using 62 respondents, the system produced an accuracy rate of 87.10%, indicating that the system is capable of providing reliable early detection results.

3.2 Discussion

An example of a manual Certainty Factor calculation case applied to the category experienced by an individual with the initials NYB.

Table 4. Testing Classification of Diabetes Mellitus Symptoms Tendency

Code	*Symptoms*	*Answer*
G001	The patient urinates excessively (polyuria).	SC
G002	The patient feels extremely thirsty or drinks excessively (polydipsia).	SC
G003	The patient experiences abnormally excessive hunger (polyphagia).	FC
G004	The patient's urine attracts ants or appears sweet.	C
G005	The patient experiences significant and unexplained weight loss.	VC
G006	The patient complains of recurrent blurred vision.	VC
G007	The patient feels easily fatigued despite minimal physical activity.	C
G008	The patient's wounds heal slowly.	SY
G009	The patient frequently experiences recurrent skin or fungal infections.	C
G010	The patient often suffers from colds, flu, or respiratory tract infections.	ANC
G011	(For pregnant patients) The patient experiences excessive thirst during pregnancy.	ANC
G012	(For pregnant patients) The patient urinates excessively during pregnancy.	SC
G013	(For pregnant patients) The patient feels easily fatigued during pregnancy.	SC
G014	(For pregnant patients) The patient experiences recurrent urinary tract infections or vaginal discharge during pregnancy.	ANC
G015	(For pregnant patients) The patient complains of blurred vision during pregnancy.	ANC
G016	(For pregnant patients) The patient experiences excessive weight gain during pregnancy.	NC/NR
G017	The patient has a history of autoimmune diseases (e.g., thyroiditis, vitiligo).	SC
G018	The patient experiences sudden and unexplained weight loss (commonly associated with Type 1 Diabetes Mellitus).	SC
G019	The patient is overweight or obese (commonly associated with Type 2 Diabetes Mellitus).	ANC
G020	The patient has an immediate family member with a history of	SC

	diabetes mellitus.	
G021	The patient experienced a viral infection prior to the onset of diabetes symptoms (e.g., high fever, upper respiratory tract infection).	NC/NR
G022	Are you under 30 years old?	VC
G023	Are you over 30 years old?	NC/NR
G024	Are you currently at or beyond 24 weeks of pregnancy?	NC/NR

In Table 4, the statements along with the user's responses are presented. Before classification is performed, these responses are converted into certainty term values according to Table 1, so that the combined values of the user's CF and the expert's CF can be obtained:

Table 5.1. CF (H,E) type 1 value

Code	*CF Expert*	*CF User*	*CF Expert x CF User*
G022	1.0	1.0	1.00
G001	1.0	0.4	0.40
G002	1.0	0.4	0.40
G003	0.8	0.6	0.48
G004	0.8	0.8	0.64
G005	1.0	1.0	1.00
G006	1.0	1.0	1.00
G007	0.6	0.8	0.48
G010	0.8	0.2	0.16
G017	0.6	0.4	0.24
G018	0.6	0.4	0.24
G021	0.8	0.0	0.00
Σ (CF(H, E))			6.04
Σ CF_expert			10.0

The average value is obtained through the following calculation:

$$\sum CF(H,E) = 1.00 + 0.40 + 0.40 + 0.48 + 0.64 + 1.00 + 1.00 + 0.48 + 0.16 + 0.24 + 0.24 + 0.00 = 6.04$$

$$\sum CF_{expert} = 1.0 + 1.0 + 1.0 + 0.8 + 0.8 + 1.0 + 1.0 + 0.6 + 0.8 + 0.6 + 0.6 + 0.8 = 10.0$$

Furthermore, to obtain the early detection result, the following calculation is performed:

$$CF_{total} = \frac{\sum CF(H,E)}{\sum CF_{expert}} = \frac{6.04}{10.0} = 0.604$$

$$Percentage = CF_{total} \times 100\% = 0.604 \times 100\% = 60.40\%$$

Thus, the calculation result for the early detection of Type 1 Diabetes Mellitus is 60.40%.

Table 5.2. CF (H, E) type 2 value

Code	*CF Expert*	*CF User*	*CF Expert x CF User*
G023	1.0	0.0	0.00
G002	1.0	0.4	0.40
G003	0.8	0.6	0.48
G004	0.6	0.8	0.48
G005	1.0	1.0	1.00
G006	0.6	1.0	0.60
G007	0.6	0.8	0.48
G008	0.8	1.0	0.80
G009	0.8	0.8	0.64
G020	0.8	0.4	0.32
Σ (CF (H, E))			5.20
Σ CF_expert			8.00

The average value obtained is calculated as follows:

$$\sum CF(H,E) = 0.00 + 0.40 + 0.48 + 0.48 + 1.00 + 0.60 + 0.48 + 0.80 + 0.64 + 0.32 = 5.20$$
$$\sum CF_{expert} = 1.0 + 1.0 + 0.8 + 0.6 + 1.0 + 0.6 + 0.6 + 0.8 + 0.8 + 0.8 = 8.0$$

Next, to obtain the early detection result, the calculation is performed:

$$CF_{total} = \frac{\sum CF(H,E)}{\sum CF_{expert}} = \frac{5.20}{8.0} = 0.65$$
$$Percentage = 0.65 \times 100\% = 65.00\%$$

Thus, the calculation result for the early detection of Type 2 Diabetes Mellitus is 65.00%.

Table 5.3. CF (H, E) value of GDM type

Code	*CF Expert*	*CF User*	*CF Expert x CF User*
G024	1.0	0.0	0.00
G011	1.0	0.2	0.20
G012	1.0	0.4	0.40
G013	0.8	0.4	0.32
G014	0.8	0.2	0.16
G015	0.6	0.2	0.12
G016	0.8	0.0	0.00
Σ (CF(H,E))			1.20
Σ CF_expert			6.00

The average value obtained is calculated using the following computation:

$$\sum CF(H,E) = 0.00 + 0.20 + 0.40 + 0.32 + 0.16 + 0.12 + 0.00 = 1.20$$
$$\sum CF_{expert} = 1.0 + 1.0 + 1.0 + 0.8 + 0.8 + 0.6 + 0.8 = 6.0$$

Next, to obtain the early detection result, the calculation is performed as follows:

$$CF_{total} = \frac{\sum CF(H,E)}{\sum CF_{Expert}} = \frac{1.20}{6.0} = 0.20$$
$$Percentage = 0.20 \times 100\% = 20.00\%$$

Thus, the calculation result for the early detection of Gestational Diabetes Mellitus (GDM) is 20.00%.

From the calculations of the three types of Diabetes Mellitus obtained from the respondent with the initials NYB on October 25, 2025, at 15:33:50 PM, the following summary of the calculation results was obtained:

Table 5.4. Recapitulation of User Calculation (Initials NYB)

Type of Diabetes	*Σ CF(H, E)*	*Σ CFexpert*	*CF_total*	*Percentage*
Type 1	6,04	10,0	0,604	60,04%
Type 2	5,20	8,0	0,65	65,00%
GDM	1,20	6,0	0,20	20,00%

Based on the early detection results of Type 1 Diabetes Mellitus, Type 2 Diabetes Mellitus, and Gestational Diabetes Mellitus for the patient with the initials NYB, the system detected Type 2 Diabetes Mellitus with a confidence level of 65.00%.

In addition to accuracy, evaluation metrics such as precision, recall, and F1-score are important for assessing system performance, especially in healthcare applications. Although this study focuses on accuracy, future work will include confusion matrix analysis to provide a more comprehensive evaluation of system performance.

3.3 Implementation

The following is the implementation of the Early Detection of Type 1 Diabetes Mellitus, Type 2 Diabetes Mellitus, and Gestational Diabetes Mellitus using a web-based Certainty Factor approach.

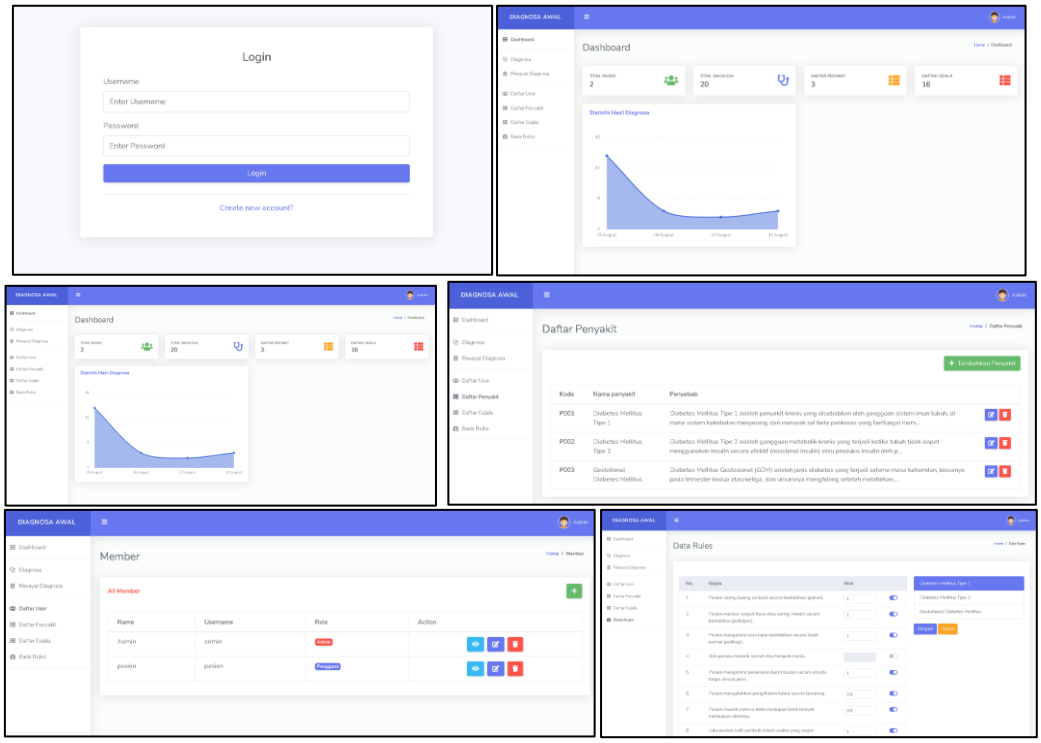

Figure 4. Web System Implementation

4 Conclusion

Based on the conducted research and discussion, this study successfully designed and implemented a web-based early detection system for Diabetes Mellitus using the Certainty Factor method, covering Type 1 Diabetes Mellitus, Type 2 Diabetes Mellitus, and Gestational Diabetes Mellitus (GDM). The system functions as an initial screening tool to assist users before undergoing further medical examinations by utilizing symptom data and expert knowledge.

The system is capable of identifying the tendency of Diabetes Mellitus based on both patient input and expert-defined rules. Among 62 respondents, the distribution of confidence levels indicates 35.48% low, 20.97% moderate, 30.65% high, and 12.90% very high tendency. Furthermore, the identification results show that 14.52% of respondents were detected with Type 1 Diabetes Mellitus, 64.52% with Type 2 Diabetes Mellitus, 6.45% with GDM, and 14.51% were not detected as having diabetes, indicating that Type 2 Diabetes Mellitus is the most dominant type among the respondents.

The evaluation results, obtained by comparing the system's diagnosis with expert diagnosis, show that 54 out of 62 cases were consistent, resulting in an accuracy rate of 87.10%. This indicates that the system has a relatively high level of accuracy and can be utilized as a supporting tool for early detection. However, several limitations were identified in this study, including the relatively limited number of respondents and the reliance on user-input symptoms, which may introduce subjectivity in the diagnostic process. In addition, overlapping symptoms among different types of Diabetes Mellitus may affect classification accuracy. Therefore, future research is recommended to involve a larger dataset, incorporate additional evaluation metrics such as precision, recall, and F1-score, and explore the integration of other intelligent methods to improve diagnostic performance and system reliability. However, it is important to emphasize that this system is intended only as an initial screening tool and should not be used as a substitute for professional medical diagnosis. Users are strongly advised to consult healthcare professionals for accurate diagnosis and appropriate treatment.

5 References

[1] Oktora, S. I., & Butar, D. (2022). Determinants of Diabetes Mellitus Prevalence in Indonesia. Jurnal Kesehatan Masyarakat, 18(2)..

[2] Goyal, R. (2023). *Type 2 diabetes*. In StatPearls. StatPearls Publishing.https://www.ncbi.nlm.nih.gov/books/NBK513253/

[3] Atkinson, M. A., Eisenbarth, G. S., & Michels, A. W. (2022). Type 1 diabetes mellitus. In J. F. Strauss, R. L. Barbieri, &

D. P. Mishell (Eds.), Yen & Jaffe's Reproductive Endocrinology (8th ed.). National Center for Biotechnology Information (NCBI).

[4] Arini H, Anggorowati A, Pujiastuti R. (2022) Dukungan keluarga pada lansia dengan Diabetes Mellitus Tipe II: Literature review. *Jurnal Penelitian dan Pemikiran Ilmiah Keperawatan*, 7(2), 172-180.

[5] Guevara-Ramírez, P., Roldán-Benítez, A., Valverde-Bruffau, A., & López-Tinoco, C. (2023). A Comprehensive Review of *Gestational Diabetes Mellitus*. *International Journal of Molecular Sciences, 24*(22), 16783.

[6] Marbun, E. T., Erwansyah, K., & Hutagalung, J. (2022). *Sistem pakar mendiagnosa penyakit kolesterol pada remaja menggunakan metode certainty factor*. Jurnal Sistem Informasi Triguna Dharma (JURSI TGD), 1(4), 549–556.

[7] Hastutik S., Wayan I., Susanto P. (2022) Information Technology: Konsep dan Implementasinya. *Media Sains Indonesia*, 31-33.

[8] Harbigantara, M. D. (2021). *Sistem pakar berbasis Android untuk diagnosis penyakit pada kulit anjing dengan metode Certainty Factor* (Skripsi, STMIK AKAKOM Yogyakarta). Repositori UTDI.