Development Of A Web-Based Expert System For Healthy Diet Menu Recommendations Using The Certainty Factor Method

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Abstract
Diabetes mellitus and heart disease are two non-communicable diseases with a high prevalence rate in Indonesia. The increasing number of patients suffering from these diseases is influenced by unhealthy lifestyles, such as consuming foods high in sugar and fat, lack of physical activity, and low public awareness regarding healthy eating patterns. This condition causes many patients to experience difficulties in determining appropriate food menus according to their health conditions. Therefore, a system is needed to assist the community in determining healthy diet menus quickly, accurately, and practically. This study aims to design and develop a web-based expert system capable of providing healthy diet menu recommendations for patients with heart disease and diabetes using the Certainty Factor method. The research employed a quantitative method with data collection techniques including literature studies, observations, interviews, and library research. The system was developed using the PHP programming language and MySQL database. The Certainty Factor method was applied to calculate the level of confidence in food recommendations based on users' health conditions such as blood pressure, blood sugar levels, cholesterol, body mass index, and family medical history. The results showed that the system was able to provide healthy food menu recommendations according to the user's health condition with a certain level of confidence. This system is expected to help the public implement healthy lifestyles and serve as an initial consultation medium related to diet management based on information technology.

I. INTRODUCTION

In the modern era, maintaining a healthy diet is very important for preserving health, especially for individuals suffering from diseases such as heart disease and diabetes. However, many people experience difficulties in selecting appropriate foods due to a lack of knowledge regarding nutritional content and its effects on medical conditions. Poor dietary habits can worsen diseases. Unhealthy eating patterns, such as high consumption of fast food, salt, sugar, and unhealthy fats, combined with low intake of fruits, vegetables, fiber, and fish, along with inactive lifestyles, stress, smoking, and excessive alcohol consumption, increase the risk of cardiovascular diseases (Ardiana & Widjaja, 2022).

The DASH Diet (Dietary Approaches to Stop Hypertension) has proven effective in reducing blood pressure in hypertension patients by focusing on the consumption of fruits, vegetables, and low-fat dairy products while limiting saturated fats. Clinical trials such as the OmniHeart RCT demonstrated that the DASH diet can reduce blood pressure, LDL-C levels, and cardiovascular risk (Ardiana & Widjaja, 2022). Meanwhile, the Mediterranean Diet emphasizes the consumption of plant-based foods such as fruits, vegetables, nuts, and olive oil, with limited intake of red meat and moderate portions of red wine. Both diets are effective in reducing the risk of cardiovascular diseases.

Technological advancements allow nutritionists and patients to interact virtually through expert systems. An expert system is essentially a computer program containing knowledge from one or more experts in a particular field. The most commonly used expert system methods are Forward Chaining, Backward Chaining, and Certainty Factor. This

system uses the Certainty Factor (CF) method, which is a method used to combine levels of confidence and uncertainty into a single numerical value. This method is applied to determine healthy diet menus for heart disease and diabetes patients.

Parameters are variables used to input values into a function, procedure, or model. In the context of Artificial Intelligence (AI), parameters may refer to several aspects, such as model parameters, which are values used to regulate the behavior of an AI model, including learning rate, batch size, or the number of neural network layers. Function parameters refer to inputs provided to a function to produce specific outputs, while search parameters are criteria used to filter or sort search results.

II. RESEARCH METHODS

This study employed a quantitative research method. Quantitative research is a method that emphasizes numerical data collection and statistical analysis to produce objective and systematic results (Sugiyono, 2020). This method was chosen because the research focused on implementing the Certainty Factor method to determine the confidence level of healthy diet menu recommendations based on users' health conditions.

The research was conducted at Mitra Medika General Hospital Bandar Klippa, located in Deli Serdang Regency, North Sumatra. The study was carried out for three months, from March to May 2025. In this study, several data collection techniques were applied to obtain accurate and relevant information. These techniques included library research, literature studies, observations, and interviews.

Library research was conducted by collecting various references such as books, scientific journals, articles, and previous studies related to expert systems, the Certainty Factor method, healthy diets, diabetes mellitus, and heart disease. Literature studies were carried out to strengthen the theoretical foundation used in this research and to understand concepts related to website-based system development.

Furthermore, observations were conducted by directly examining problems experienced by heart disease and diabetes patients in determining healthy eating patterns. The researcher also interviewed health professionals and nutrition experts to obtain information regarding suitable foods for patients with certain diseases. Information obtained from interviews was used as the basis for constructing the knowledge base in the expert system.

In the system development process, PHP programming language was used as the coding platform and MySQL as the database management system. The system was developed as a website-based application so that it could be easily accessed by the public through internet-connected devices.

The Certainty Factor method was used in this study to determine the confidence level of healthy food recommendations based on users' health conditions. This method was selected because it is capable of handling uncertainty in decision-making processes. User health data such as age, weight, height, blood pressure, blood sugar level, cholesterol level, and family medical history were processed by the system to generate appropriate food recommendations.

The stages of the research included problem identification, data collection, system requirement analysis, system design, implementation of the Certainty Factor method, system testing, and evaluation of research results. Testing was conducted by comparing manual calculation results with system-generated results to determine the accuracy level of the system in providing healthy diet menu recommendations. Through this structured methodology, the developed system is expected to provide effective, accurate, and beneficial results for society

III. RESULTS AND DISCUSSION

A. Research Result

The results of this study indicate that the web-based expert system developed using the Certainty Factor method was successfully implemented and capable of providing healthy diet menu recommendations according to the

user's health condition. The system was designed to assist patients suffering from heart disease and diabetes in selecting appropriate foods based on medical indicators and nutritional needs.

The system works by processing user health data, including age, gender, body weight, height, blood pressure, blood sugar level, cholesterol level, triglycerides, physical activity level, and family medical history. These data are then analyzed using the Certainty Factor method to determine the level of confidence in the recommended healthy diet menu.

The implementation of the system begins with the user filling out a consultation form containing personal and medical information. After all data are entered, the system automatically calculates the Body Mass Index (BMI) and identifies the user's primary health condition, such as diabetes, heart disease, or a combination of both conditions. Based on these calculations, the system generates healthy food recommendations with a Certainty Factor value above 0.7, indicating that the food is suitable for consumption according to the user's health condition.

The system provides four categories of food recommendations, namely staple foods, side dishes, vegetables, and fruits. Examples of recommended foods for diabetes patients include boiled corn, boiled potatoes, brown rice, spinach soup, guava, apples, and papaya because these foods contain relatively low sugar and high fiber. Meanwhile, foods such as fried rice, coconut milk-based dishes, fried foods, and foods high in sugar received lower Certainty Factor values because they may increase blood sugar and cholesterol levels.

In addition, the system was developed with a simple and user-friendly interface so that users can easily access the consultation features and obtain information regarding healthy diet recommendations. The use of website technology also enables the system to be accessed through various internet-connected devices such as laptops and smartphones.

The testing results showed that the recommendations generated by the system were consistent with manual calculations and expert opinions from nutritionists. This demonstrates that the implementation of the Certainty Factor method in the expert system can effectively assist users in determining healthy diet menus according to their medical conditions.

The increasing prevalence of non-communicable diseases such as heart disease and diabetes indicates the importance of maintaining healthy dietary habits. Unhealthy eating patterns significantly contribute to worsening health conditions and increasing the risk of complications. Therefore, the development of a technology-based system capable of providing healthy diet recommendations is highly relevant to current public health needs.

The application of the Certainty Factor method in this study proved effective in handling uncertainty in decision-making processes. The method allows the system to calculate the confidence level of each food recommendation based on medical indicators provided by users. As a result, the recommendations generated are more specific and adjusted to the users' conditions.

The implementation of the expert system also demonstrates that information technology can play an important role in improving healthcare services. Through this system, users can access healthy diet recommendations quickly and practically without directly visiting healthcare facilities. This is particularly beneficial for communities with limited access to healthcare services.

Furthermore, the system contributes to increasing public awareness regarding the importance of healthy eating patterns. By providing detailed information about food categories and nutritional values, users are encouraged to make healthier food choices and adopt better lifestyles.

However, this study still has several limitations. The system currently focuses only on heart disease and diabetes, so additional disease categories are needed to make the system more comprehensive. Moreover, validation involving more nutrition experts and medical professionals

is necessary to improve the accuracy and reliability of the recommendations provided by the system.

Overall, the research results indicate that the web-based expert system using the Certainty Factor method can serve as an effective technological solution in assisting the public to maintain healthy dietary habits and improve their quality of life.

B. Discussion

1. Indonesi's Health Condition

Indonesia's health condition is still facing various challenges, particularly regarding non-communicable diseases such as diabetes, hypertension, obesity, and heart disease, which continue to increase due to changes in people's lifestyles and eating habits. High consumption of foods containing excessive sugar, salt, and fat, combined with low physical activity, has become the main factor contributing to the increase in these diseases. In addition, unequal access to healthcare services in several regions causes delays in diagnosis and treatment, resulting in increased morbidity and mortality rates. Through various health programs, such as the Healthy Living Community Movement (GERMAS) and balanced nutrition campaigns, the government continues to improve public awareness regarding the importance of healthy lifestyles. However, individual participation in implementing healthy eating habits and regularly conducting health check-ups is also a key factor in improving the quality of public health in Indonesia.

Non-Communicable Diseases (NCDs) are a group of diseases that are not caused by infections from microorganisms such as bacteria, viruses, fungi, or protozoa. Unlike communicable diseases that can spread from one individual to another, Non-Communicable Diseases cannot be transmitted through direct human contact or through animals. Nevertheless, although non-infectious, these diseases have a significant impact on public health, with high mortality rates. According to reports from the World Health Organization (WHO), Non-Communicable Diseases account for at least 70% of total deaths worldwide (Ministry of Health of the Republic of Indonesia, 2021).

According to the World Health Organization (WHO), the increasing prevalence of Non-Communicable Diseases is influenced by four major risk factors, namely unhealthy diets, lack of physical activity, tobacco use, and excessive alcohol consumption. These factors not only directly affect individuals but also influence families, communities, and even healthcare systems as a whole. The health consequences caused by Non-Communicable Diseases can lead to decreased productivity, increased economic burdens, and high medical treatment costs for both individuals and governments (Ministry of Health of the Republic of Indonesia, 2021).

The types of diseases categorized as chronic diseases that cause the highest mortality rates and healthcare expenditures include asthma, cancer in general, diabetes mellitus, heart disease, hypertension, stroke, and chronic kidney disease. Data regarding asthma, cancer, diabetes mellitus, and heart disease are intended for respondents of all ages, while data regarding hypertension, stroke, and chronic kidney disease are intended for respondents aged over 15 years (Ministry of Health of the Republic of Indonesia, 2023).

Heart disease is one of the non-communicable diseases that requires serious attention because it has become a global health threat. This disease plays a major role as one of the leading causes of death worldwide, making it a highly crucial issue in the health sector. Based on data from the World Health Organization (WHO), more than 17 million people worldwide die every year due to diseases related to the heart and blood vessels. In Indonesia, the mortality rate caused by cardiovascular diseases is relatively high. According to data from the Ministry of Health of the Republic of Indonesia in 2024, the number of deaths caused by cardiovascular diseases reached 651,481 people annually. Of this figure, stroke became the leading cause with 331,349 deaths, followed by coronary heart disease which caused 245,343 deaths. In addition, hypertensive heart disease contributed to 50,620 deaths, while

the remaining cases originated from various other cardiovascular diseases (Ministry of Health of the Republic of Indonesia, 2024).

Diabetes is one of the non-communicable diseases that has a serious impact on global health, not only causing long-term complications but also contributing to premature mortality worldwide. Based on available data, the Southeast Asian region ranks third in diabetes prevalence with a rate of 11.3%. The International Diabetes Federation (IDF) also estimated the number of diabetes sufferers among individuals aged 20–79 years in various countries around the world. Among the top 10 countries with the highest number of diabetes patients, Indonesia ranks seventh with approximately 10.7 million people suffering from diabetes (Infodatin, 2020).

2. Healthy Diet Menu

Dietary patterns play an important role in influencing blood pressure. An unbalanced diet can worsen hypertension, while an appropriate dietary pattern can serve as a non-pharmacological strategy to reduce blood pressure (Ardiana & Widjaja, 2022). Vegetarian diets, which are rich in vegetables, fruits, legumes, and whole grains, have become increasingly popular because of their benefits in preventing chronic diseases such as cardiovascular disease, hypertension, and type 2 diabetes (Wendy MJ et al., 2020). In addition, a controlled diet can effectively help reduce body fat (Ardiana & Widjaja, 2022).

Two major dietary patterns widely recommended are the Dietary Approaches to Stop Hypertension (DASH) diet and the Mediterranean diet. The DASH diet emphasizes the consumption of fruits, vegetables, and low-fat dairy products while limiting saturated fats and cholesterol. This diet has been proven to reduce systolic blood pressure by up to 11.4 mmHg and diastolic blood pressure by 5.5 mmHg in patients with hypertension. Meanwhile, the Mediterranean diet, which is rich in fruits, vegetables, legumes, and olive oil, can reduce systolic blood pressure by 5.5 mmHg and diastolic blood pressure by 1.7 mmHg (Ardiana & Widjaja, 2022).

The DASH diet has been tested in various controlled trials, including the OmniHeart Randomized Controlled Trial (RCT), which demonstrated its effectiveness in reducing blood pressure, LDL-C levels, and cardiovascular risk (Ardiana & Widjaja, 2022). The Mediterranean diet, introduced by Ancel Keys in the 1960s, emphasizes the consumption of minimally processed plant-based foods, olive oil, and moderate amounts of red wine. This dietary pattern is associated with a lower risk of chronic diseases and higher life expectancy (Becerra-Tomás N et al., 2020).

Low-carbohydrate diets, which have been used since the 1860s, are also effective in reducing body weight and cardiovascular risk factors. Studies have shown reductions in body weight, blood pressure, triglycerides, and improvements in HDL-C levels among obese individuals (Ardiana & Widjaja, 2022). The DIRECT study proved that low-carbohydrate diets are more effective than low-fat or Mediterranean diets in reducing body weight and increasing HDL-C levels (Rychter AM et al., 2020).

Vegetarian and vegan diets have also been proven to significantly reduce body weight and Body Mass Index (BMI), with vegan diets being more effective than lacto-ovo-vegetarian diets (Wendy MJ et al., 2020). Meanwhile, the Paleo diet, which imitates the dietary patterns of ancient humans, is claimed to improve health, reduce the risk of chronic diseases, and promote weight loss. This diet is high in protein, fiber, and antioxidants while being low in sodium (Ardiana & Widjaja, 2022).

Calorie restriction is effective for weight loss, but food quality also plays an important role. The Eco-Atkins diet, which combines plant-based proteins and healthy fats, has been shown to reduce body weight, LDL-C, and total cholesterol levels (Mooradian AD, 2020). Complex carbohydrates, such as whole grains and vegetables, are considered healthier because they are rich in fiber and nutrients, whereas

simple carbohydrates, such as refined sugar and white flour, can cause spikes in blood sugar levels and insulin resistance (Puddu PE & Menotti A, 2021).

3. Cardiovascular

Cardiovascular diseases, including heart attacks, angina, and stroke, occur due to the narrowing or blockage of blood vessels, which disrupts the heart's function in pumping blood throughout the body. These diseases pose a serious threat to individual health (Ministry of Health of the Republic of Indonesia, 2024). Globally, heart disease is the leading cause of death, accounting for approximately 17.8 million deaths each year. In Indonesia, the prevalence of doctor-diagnosed heart disease reached 1.5% in 2018, while coronary heart disease (CHD) was recorded at 0.5% in 2013. The Indonesian Health Survey (SKI) 2023 showed a slight decrease in heart disease prevalence to 0.85% (Ministry of Health of the Republic of Indonesia, 2024).

The high number of cardiovascular cases in Indonesia is triggered by unhealthy lifestyles, such as smoking, unbalanced diets, hypertension, obesity, diabetes, and lack of physical activity. Other major risk factors include high blood pressure, elevated LDL cholesterol levels, and impaired kidney function. Cardiovascular diseases account for more than 30% of deaths across various age groups, with more than half of the patients dying before reaching the hospital (Ministry of Health of the Republic of Indonesia, 2024). Delays in pre-hospital treatment are caused by limited public education regarding early symptoms, lack of knowledge about access to healthcare services, financial constraints, and low medication adherence (Ministry of Health of the Republic of Indonesia, 2024).

Hypertension, as one of the leading causes of global morbidity and mortality, significantly increases the risk of heart disease, stroke, and kidney failure. In 2019, the global prevalence of hypertension reached 33.1%, while in Southeast Asia it reached 32.4%. In Indonesia, the prevalence of hypertension was 34.1% in 2018 and decreased to 30.8% in 2023 (Ministry of Health of the Republic of Indonesia, 2024). However, gaps in hypertension management remain substantial, particularly in medication adherence and routine health monitoring. Among individuals aged 18–59 years, only 2.53% regularly consumed medication, while among those aged 60 years and above, only 11.9% adhered to treatment recommendations (Ministry of Health of the Republic of Indonesia, 2024).

Hypertension also contributes significantly to disability, with 22.2% of disability cases among individuals aged 15 years and above caused by hypertension, which is higher than stroke (20.2%) and diabetes (10.5%) (Ministry of Health of the Republic of Indonesia, 2024). Risk factors for hypertension include central obesity and lack of physical activity. Among individuals aged 18–59 years, hypertension patients with central obesity had a 3.4 times higher risk, while lack of physical activity increased the risk by 1.9 times. Among individuals aged 60 years and above, insufficient physical activity increased the risk by 1.3 times (Ministry of Health of the Republic of Indonesia, 2024).

Based on these data, it can be concluded that maintaining a healthy lifestyle, including balanced dietary patterns and adequate physical activity, is essential in controlling hypertension and reducing the burden of cardiovascular diseases within society (Ministry of Health of the Republic of Indonesia, 2024).

4. Diabetes Mellitus

Diabetes Mellitus is a chronic disease characterized by increased blood sugar levels due to metabolic disorders. There are three main types of Diabetes Mellitus: Type 1 Diabetes occurs when the immune system destroys the pancreatic beta cells responsible for producing insulin, requiring patients to undergo external insulin therapy. Type 2 Diabetes is caused by insulin resistance and decreased insulin secretion, often associated with obesity and unhealthy lifestyles. Gestational Diabetes occurs during pregnancy and increases the risk of developing Type 2 Diabetes later in life (Infodatin, 2020).

The diagnosis of Diabetes Mellitus is conducted through blood glucose examinations, including: HbA1c, where levels ≥6.5% indicate diabetes, while levels between 5.7%–6.4% are categorized as prediabetes. Fasting Blood Glucose (FBG), where levels ≥126 mg/dL indicate diabetes and levels between 100–125 mg/dL are categorized as prediabetes. Oral Glucose Tolerance Test (OGTT), where blood glucose levels ≥200 mg/dL after 2 hours indicate diabetes, while levels between 140–199 mg/dL are categorized as prediabetes (Infodatin, 2020).

Prediabetes, which includes Impaired Fasting Glucose (IFG) and Impaired Glucose Tolerance (IGT), must be carefully monitored because it can develop into Type 2 Diabetes if not properly managed (Infodatin, 2020). Diabetes management aims to control blood sugar levels, prevent acute complications such as hypoglycemia, and reduce the risk of long-term complications such as kidney and heart damage. Management includes healthy dietary patterns, physical activity, medication, and routine monitoring (Infodatin, 2020).

Globally, diabetes is considered a significant health problem. In 2019, approximately 463 million people (9.3% of the global population) suffered from diabetes, with the highest prevalence found in the North Africa and Middle East region (12.2%) and Southeast Asia (11.3%). Indonesia ranked seventh in the world with approximately 10.7 million diabetes patients (Infodatin, 2020).

In Indonesia, the prevalence of diabetes increased from 6.9% in 2013 to 8.5% in 2018. However, only 25% of patients were aware of their condition. Provinces with the highest prevalence were Special Region of Yogyakarta, DKI Jakarta, and North Sulawesi (each 2%), while East Nusa Tenggara had the lowest prevalence (0.8%) (Infodatin, 2020). The major risk factors for diabetes in Indonesia include unhealthy dietary patterns, lack of physical activity, obesity, and genetic factors. The Indonesian Health Survey (SKI) 2023 showed an increase in diabetes prevalence from 10.9% in 2018 to 11.7% in 2023. In addition, only 1.46% of patients aged 18–59 years and 6.06% of patients aged 60 years and above routinely underwent treatment, indicating challenges in continuity of care (Ministry of Health of the Republic of Indonesia, 2024).

Diabetes also contributes to disability, with 10.5% of disability cases among individuals aged 15 years and above caused by diabetes. Risk factors such as central obesity and lack of physical activity increase the risk of diabetes by up to three times (Ministry of Health of the Republic of Indonesia, 2024). With the increasing prevalence of diabetes, a holistic approach is required, including education, healthy lifestyles, and the utilization of technology such as website-based expert systems to support effective diabetes management (Infodatin, 2020).

5. Expert Systems

Expert systems were first developed in the 1960s through the General Purpose Problem Solver (GPPS), which was created by Newell and Simon. An expert system is a computer-based system designed to imitate the decision-making process of an expert in a specific field. Although this system cannot completely replace the role of a human expert, it adopts the knowledge and experience of experts into a rule-based system capable of providing solutions or recommendations for particular problems.

In its development, an expert system consists of two main components, namely the development environment and the consultation environment (Yuliardi, 2023). The development environment is used to build and update the knowledge base as well as the rules applied within the system. Meanwhile, the consultation environment is the part used by users to obtain information or solutions to specific problems based on the knowledge that has been entered into the system.

Basically, an expert system is a computer program that contains knowledge from one or more experts in a particular field. The system operates using analytical methods and a knowledge base that have previously been defined by experts who possess expertise in that field. For experts, the existence of this system can

serve as a highly useful assistant because it is capable of providing recommendations or diagnoses based on established inference rules. The system combines various logical rules with a knowledge base designed by experts to produce conclusions or solutions that closely resemble human reasoning processes (Zufria, 2021).

Expert systems consist of two main elements that form the basis of their development, namely the development environment and the consultation environment. The development environment serves as the place for designing and building the expert system, including the management of the knowledge base and other supporting components within the system. Meanwhile, the consultation environment functions as a medium for non-expert users to interact with the system in obtaining the information or solutions they need (Syaifuddin, 2020).

In the architecture of an expert system, there are several main components that have specific functions to ensure the system operates effectively. These components include:

1) User Interface

The user interface is the part of the expert system that functions as a communication medium between the user and the system. This interface is responsible for receiving information input from users, converting it into a format that can be processed by the system, and presenting the analysis results in a form that is easy for users to understand. An effective interface makes the interaction between the system and users more intuitive and efficient.

2) Knowledge Base

The knowledge base in an expert system contains a collection of information and rules used to understand, formulate, and solve specific problems. This knowledge is obtained from experts in a particular field and becomes the primary foundation for the system in providing recommendations or solutions.

3) Inference Engine

The inference engine is the component responsible for the reasoning and decision-making mechanism within the expert system. This component functions to select relevant rules from the knowledge base, integrate information, and draw conclusions based on the available facts.

6. Certainty Factor

Certainty Factor (CF) is a method used to combine levels of confidence and uncertainty into a single numerical value. In Certainty Factor theory, qualitative data are represented in the form of degrees of belief. There are two main stages in representing qualitative data using this method. First, the system must be able to express the degree of confidence according to the method being used. Second, the system must be able to integrate these degrees of confidence into the decision-making process within the expert system. The Certainty Factor method is formulated in the form of a basic formula to calculate the CF value of a rule obtained from various expert sources. The Certainty Factor value of a rule is acquired through the interpretation of data converted into specific CF values according to the available expert knowledge sources (Harahap, 2023).

The Certainty Factor method has several advantages that make it suitable for implementation in expert systems dealing with uncertainty, including:

1) Suitable for expert systems that handle uncertainty.
   This method is capable of processing information that is not completely certain and producing values that reflect the degree of confidence in a conclusion.
2) Maintains data accuracy.
   In a single calculation process, this method only processes two data points, allowing the accuracy of the results to be maintained.

However, the Certainty Factor method also has several weaknesses, including:

1) There are still debates regarding uncertainty modeling. Although this method is widely used, some experts still debate the accuracy and appropriateness of the uncertainty model applied.

2) Requires multiple processing steps for more than two data inputs. If more than two data points need to be analyzed, the method must perform several processing stages, which may increase computational complexity.

IV. CONCLUSION AND SUGGESTIONS

A. Conclusion

Based on the results of the research, it can be concluded that the web-based expert system was successfully designed to determine healthy diet menus based on diseases. The Certainty Factor method was effectively applied to determine the confidence level of healthy food recommendations according to users' health conditions.

The system is capable of assisting users in obtaining information regarding healthy eating patterns quickly, practically, and accurately. Furthermore, the implementation of the website-based expert system provides convenience for the public because it can be accessed anytime and anywhere through internet-connected devices.

The application of the Certainty Factor method also proved capable of handling uncertainty in decision-making processes and generating more accurate recommendations. Therefore, the developed system can serve as an initial consultation medium for heart disease and diabetes patients in managing healthy dietary patterns.

B. Suggestion

Based on the research results, several suggestions can be proposed for future development. First, the system should be expanded by adding more types of diseases and a wider variety of food menus so that the recommendations become more comprehensive and specific.

Second, the system can be further developed into a mobile application to improve accessibility and convenience for users. Third, validation from nutritionists and medical experts is necessary to improve the accuracy and reliability of the recommendations provided by the system.

In addition, future researchers are encouraged to compare the Certainty Factor method with other methods to determine which method provides better accuracy in healthy diet recommendation systems. Finally, the system is expected to include direct consultation features with health professionals to enhance the quality of services provided to users.

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