Ann PUBLISHER
Journal Engineering Sciences (Improsci)
e-ISSN 3031-7088
p-ISSN 3032-3452

Herbal Treatment Expert System For Ent Disease Diagnosis Using The Certainty Factor Method Based On Android

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Abstract:
Background. Public understanding of ENT (ear, nose, and throat) diseases remains low. Many people still rely on experts manually, resulting in high costs for the general public.
Aims. This research was conducted to develop a tool to assist users in diagnosing ENT (ear, nose, and throat) diseases in humans. This tool, an expert system, is designed to diagnose and provide herbal treatment recommendations.
Result. This expert system application produces an application program or tool that can be used to diagnose possible ENT diseases in humans based on user-entered symptoms.
Conclusion. System testing demonstrated that the system can diagnose ENT diseases based on patient symptoms, despite the uncertainty of those symptoms.
Implementation. The diagnostic results are accompanied by a Certainty Factor value, which indicates the level of accuracy and predictability of the possible ENT disease in humans, along with the corresponding herbal treatment.

Keywords: Expert System, Certainty Factor, the Otolaryngology disease

INTRODUCTION

The recent development and advancement of science have been matched by rapid advances in technology, particularly in information technology. This can be felt in everyday life, for example, through the use of technology in education, telecommunications, business, medicine, and other fields.

This has also influenced the development of smartphones, which are now increasingly popular. Android, the smartphone software launched by Google Inc., has seen a surge in usage, as we know, due to support from many smartphone vendors who have adopted the software in various forms across their products. With this technological advancement, virtual technologies have also developed, one of which is Artificial Intelligence, often referred to as AI.

On the other hand, herbal medicine for treating ENT (ear, nose, and throat) conditions remains quite challenging. This is the author's own experience: when a family member contracted an ENT disease, they were unable to treat it at the first signs. Herbal medicine utilizes natural ingredients such as plants and herbs found around us.

The problem is that we cannot identify the symptoms and the location of the disease, and there is also a lack of knowledge about herbal medicine. Consequently, considerable costs must be incurred for treatment by visiting an ENT specialist. However, the disease may not be severe enough to be self-treated.

Therefore, it is necessary to develop an application that helps treat ENT diseases with locally available herbal remedies. The application must be able to provide appropriate and efficient solutions before further treatment is initiated.

An expert system is a system that attempts to adapt human knowledge to computers, enabling them to solve problems similar to those performed by experts (Sri Kusumadewi, 2003). A good expert system is designed to solve a specific problem by mimicking the work of experts [1]. In this case, the problem is treating ENT diseases with herbal remedies.

The application in question is an Android-based expert system that draws on knowledge from an expert in diagnosing and treating ENT diseases and in herbal remedies. The development of this expert system application is expected to provide free, anywhere access to help patients or users determine the diagnosis of ENT diseases based on identified symptoms, eliminating the need for expensive or time-consuming visits to experts or specialists.

LITERATURE REVIEW

Expert Systems

The AI community first developed expert systems in the mid-1960s. The first expert system to emerge was the General-Purpose Problem Solver (GPS), developed by Newell and Simon. When we need to make a complex decision or solve a problem, we often seek advice by consulting an expert.

1. Definition of Expert Systems

   According to Ahmad Syatibi (2012), an expert system is a branch of AI (Artificial Intelligence) that extends the specialized knowledge of human experts to solve problems. A human expert is someone who is an expert in a specific field of knowledge. This means an expert possesses specialized knowledge or skills that others do not. Experts can solve problems that others cannot solve efficiently.

   Thus, an expert system is a system designed to mimic the abilities or knowledge of humans, in this case, experts, as if the system's creator were the expert. In other words,

an expert system is a system designed and implemented using a specific programming language to solve problems like experts, in this case, doctors.

2. Basic Concepts of Expert Systems

In general, an expert system is a system that attempts to adopt human knowledge into a computer, so that the computer can solve problems as experts typically do (Sri Kusumadewi, 2003). A sound expert system is designed to solve a specific problem by mimicking expert behavior.

According to Efrain Turban (1995), the basic concepts of an expert system include expertise, transfer of expertise, inferencing, rules, and explanation capability.

3. Characteristics of an Expert System

A system is considered an expert system if it has the following characteristics:

a. It can provide reasoning for uncertain data.
b. It is limited to a specific domain of expertise.
c. It is based on specific rules.
d. It is designed to be developed incrementally.
e. Its output is advisory.
f. Can present a series of reasons in a way that can be understood.

4. Advantages of Expert Systems

Expert systems as programs have advantages compared to conventional systems, including:

a. Collecting large amounts of data.
b. Storing this data for long periods of time in a specific format.
c. Performing calculations quickly and accurately, without the hassle of retrieval of stored data at high speed.

5. Advantages of Expert Systems

The following are the advantages of using expert systems, including:

1. Making knowledge and advice more accessible.
2. Increasing output and productivity.
3. Storing the skills and expertise of an expert.
4. Improving specific problem-solving.
5. Increasing reliability.
6. Providing rapid responses.
7. Serving as an intelligent guide.

8. Able to work with incomplete and uncertain information.

6. Weaknesses of Expert Systems

In addition to several advantages, expert systems also have several weaknesses, including (Sri Kusumadewi, 2003):

a. The costs required to create and maintain them are very high.
b. They are challenging to develop, which is closely related to the availability of experts in the field.
c. Expert systems are not 100% accurate.

7. Expert System Structure

Expert systems consist of two main parts (Sri Kusumadewi, 2003): the development environment and the consultation environment.

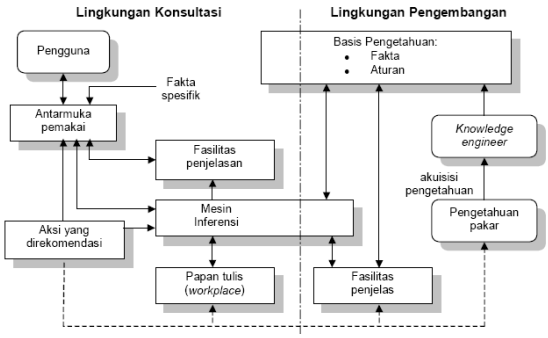

Figure 1. Expert System Structure (Turban, 1995)

8. Inference Methods in Expert Systems

According to Ahmad Syatibi (2012), inference is the process of generating information from known or assumed facts. Inference is a logical conclusion or implication based on available information. In expert systems, the inference process is carried out in a module called the inference engine.

There are two approaches to controlling inference in rule-based expert systems: backward chaining and forward chaining.

9. Knowledge Engineering

Knowledge engineering is defined as the process of creating an expert system by collecting data from a human expert or other sources, which is then processed into an expert system (Giarrratano and Riley, 1994). The primary goal of knowledge

engineering is to build modular software so that changes can be made to one module without affecting the performance of other modules.

Certainty Factor (CF)

The certainty factor expresses confidence in an event (fact, or hypothesis) based on evidence or expert judgment (Turban, 2005). The certainty factor uses a value to assume an expert's degree of confidence in a given data. The certainty factor introduces the concepts of confidence and uncertainty, which are then formulated into the following basic formula [3]:

$$CF(H,E) = MB(H,E) – MD(H,E)$$

$$CF[H, E] = MB[H, E] - MD[H, E]. \quad (1)$$

$$MB[h, e_1 \wedge e_2] = \begin{cases} 0 & MD[h, e_1 \wedge e_2] = 1 \\ MB[h, e_1] + MB[h, e_2].(1 - MB[h, e_1]) & lainnya \end{cases} \quad (2)$$

$$MD[h, e_1 \wedge e_2] = \begin{cases} 0 & MB[h, e_1 \wedge e_2] = 1 \\ MD[h, e_1] + MD[h, e_2].(1 - MD[h, e_1]) & Lainnya \end{cases} \quad (3)$$

Foto by:

Muhammad Ali Fajri

Description:

CF = Certainty Factor in hypothesis H, which is influenced by fact E.

MB = Meansure of Belief, which is the increase in confidence in hypothesis H, which is influenced by fact E.

MD = Meansure of Disbelief, which is the increase in distrust in hypothesis H, which is influenced by fact E.

E = Evidence (Event or fact).

H = Hypothesis (Suspect).

Case Example:

With confidence values referring to data on knowledge of symptoms and diseases, for example, as in the table below:

Table 2. Example of Knowledge Data

Penyakit / Gejala	Contract Ulcers		Barotitis Media		Deviasi Septum		Laringitis		Osteoskl erosis	
	MB	MD	MB	MD	MB	MD	MB	MD	MB	MD
Demam	0.95	0.2	0.15	0.93	0.04	0.27	0.26	0.16	0.72	0.22
Sakit kepala	0.23	0.67	0.19	0.33	0.57	0.62	0.53	0.03	0.84	0.32
Batuk	0.48	0.01	0.85	0.39	0.96	0.05	0.21	0.97	0.95	0.31
Hidung tersumbat	0.89	0.68	0.49	0.62	0.75	0.08	0.21	0.95	0.65	0.25
Letih dan lesu	0.82	0.7	0.45	0.65	0.8	0.9	0.66	0.05	0.34	0.5
Hidung meler	0.01	0.5	0.45	0.41	0.63	0.47	0.31	0.59	0.88	0.18
Nyeri Leher	0.92	0.19	0.29	0.59	0.6	0.59	0.95	0.18	0.15	0.88
Suara serak	0.4	0.54	0.65	0.51	0.51	0.95	0.12	0.78	0.44	0.45
Dahi sakit	0.91	0.69	0.55	0.48	0.42	0.02	0.91	0.87	0.39	0.13
Sakit gigi	0.44	0.72	0.19	0.96	0.89	0.44	0.72	0.31	0.78	0.85

There was a case where Nini experienced symptoms of fever and neck pain. The expert system predicted that Nini had an ENT disease, with a confidence value as indicated in the table above! It is known that five diseases have symptoms of fever and neck pain, namely:

a. Contract Ulcers
b. Barotitis Media
c. Deviated Septum
d. Laryngitis
e. Osteosclerosis

Therefore, using manual calculations:

MB (Contract Ulcers | fever, neck pain) =

0.95 + 0.92 x (1 - 0.95) = 0.996

MD (Contract Ulcers | fever, neck pain) =

0.2 + 0.19 x (1 - 0.2) = 0.352

CF (Contract Ulcers | fever, neck pain) = 0.996 – 0.352 = 0.644

MB (Barotitis Media | fever, neck pain) = 0.15 + 0.29 x (1 - 0.15) = 0.3965

MD (Barotitis Media | fever, neck pain) = 0.93 +0.59 x (1-0.93) = 0.9713

CF (Barotitis Media|fever, neck pain) = 0.3965 –0.9713 = -0.5748

MB (Septal Deviation|fever, neck pain) = 0.04 +0.6 x (1-0.04) = 0.616

MD (Septal Deviation|fever, neck pain) = 0.27 +0.59 x (1-0.27) = 0.7007

CF (Septal Deviation|fever, neck pain) = 0.616 –0.7007 = -0.0847

MB (Laryngitis|fever, neck pain) = 0.26 + 0.95 x(1-0.26) = 0.963

MD (Laryngitis|fever, neck pain) = 0.16 + 0.18 x(1-0.16) = 0.3112

CF ((Laryngitis|fever, neck pain) = 0.963 –0.3112 = 0.6518

MB (Osteosclerosis|fever, neck pain) = 0.72 +0.15 x (1-0.72) = 0.762

MD (Osteosclerosis|fever, neck pain) = 0.22 +0.88 x (1-0.22) = 0.9064

CF (Osteosclerosis|fever, neck pain) = 0.762 –0.9064 = -0.1444

From the CF of each disease, the highest CF value for Laryngitis is 0.6518, so Nini is most likely to have Laryngitis.

Herbal Medicine

Herbal medicine (herbalism) is a traditional or folk medicine practice based on the use of plants and Plant extracts. Herbalism is the practice of using plants for medicinal purposes, including herbal medicine, herbology, and phytotherapy [5].

To treat illnesses with herbal remedies, we must first understand the benefits and contents of the herbs, as well as the type of illness being treated, to ensure the treatment is tailored to our needs.

Diagnosis of ENT Diseases

1. ENT (Ear, Nose, Throat) Diseases

ENT diseases are among the most common diseases. The branch of medicine that specifically examines the diagnosis and treatment of ear, nose, throat, and head and neck diseases is called otolaryngology [2]. An ENT (ear, nose, and throat) examination must be integrated because all three are interconnected. If one part of these organs is affected, the other two will be affected. The following are types of ENT diseases: contract ulcers, parapharyngeal abscess, peritonsillar abscess, barotitis media, septal deviation, pharyngitis, laryngeal cancer, head and neck cancer, metastatic neck cancer, and cancer Nasopharyngeal disease, tonsil cancer, laryngitis, vestibular neuronitis, osteosclerosis, acute otitis media, Meniere's disease, tonsillitis, auditory nerve tumors, postural vertigo, maxillary sinusitis, frontal sinusitis, ethmoidal sinusitis, and sphenoidal sinusitis [8].

2. Diagnosing ENT Diseases

By carefully observing the symptoms of ENT diseases and the extent of their causes, or by defining the objectives, steps or activities can be carried out to determine the causes or failure of a system in complex situations based on observations of the observed symptoms.

Because other disorders can cause many symptoms, clinical tests can be performed to confirm the possibility of these other causes.

Android

According to Arif Akbarul Huda (2012), Android is an open-source smart device that has resulted in a continuous and significant increase in the number of users and application developers. Android is a mobile operating system based on a modified version of Linux (Wahana Komputer, 2012). Android was first developed by Android, Inc., a company based in Palo Alto, California, USA. Its developer was Andy Rubin.

Google Inc. later acquired Android. After Google acquired it, Android was developed into a mobile device platform.

METHOD

The research method used to develop this herbal medicine expert system application for ear, nose, and throat (ENT) diseases is the R&D (Research & Development) method. Research and development (R&D) is a research method used to produce specific products and test their effectiveness [20]. These products are not always in the form of objects or hardware, such as books, modules, classroom or laboratory learning aids, but can also be software, such as computer programs for data processing, classroom learning, libraries or laboratories, or models for education, learning, training, guidance, evaluation, management, and others (Wahana Komputer, 2013).

Descriptive analysis is a method that describes the data obtained in accordance with the data to be collected, examines the data conditions, and then groups them through tabulation to illustrate the actual conditions observed at the empirical level (Ade Johar Maturidi, 2012). In writing this thesis, the author used the research and development (R&D) method because the author developed a new application and collected data by directly observing field conditions, which can be used as a consideration in decision-making.

DISCUSSION

Functional Requirements Analysis

A functional requirements analysis is conducted to provide an overview of the problems and procedures that will be implemented in the system. The following are some of the planned functional requirements for this application:

1. Display information about herbal plants and their benefits, as well as the treatment of various types of ENT diseases using herbal plants.
2. Display diagnoses for ENT patients based on their symptoms.

3. Simplify and provide users with knowledge about the use of herbal plants as ENT treatment.

The following is an analysis of the old system based on the ENT treatment examination in the previous system.

Table 3. System Procedure Diagram (Flowmap) of the Old System

1. Problem Analysis

   Based on the problem analysis above, the author developed an alternative way to present information and provide consultations on herbal treatments for ENT diseases and on solutions for diagnosing symptoms. This system is designed as an expert system to diagnose ENT diseases, and the problem being analyzed is the various symptoms experienced by ENT patients.

2. Non-Functional Requirements Analysis

   A non-functional requirements analysis was conducted to determine the system's requirements specifications. Based on the functional requirements above, the function for displaying information and images has been around since API Level 1. However, the author used the minimum requirement of API Level 9 (Gingerbread). This was considered because the majority of Android users already use Android versions 2.3 (Gingerbread) or later. The selection of these minimum requirements also took into account the more varied user interfaces available in this Android version.

   To build this application, the following software is also required:

   a. Java Programming Language

   b. Eclipse Software

   c. Operating System

   d. Android SDK

e. Android Development Tools

System Design

1. UML

UML (Unified Modeling Language) is a graphical/image-based language for visualizing, specifying, constructing, and documenting object-oriented (OO) software development systems. UML also provides a standard for writing a system blueprint, which includes business process concepts, classes written in a specific programming language, database schemas, and components required for the software system.

a. Use Case Diagram

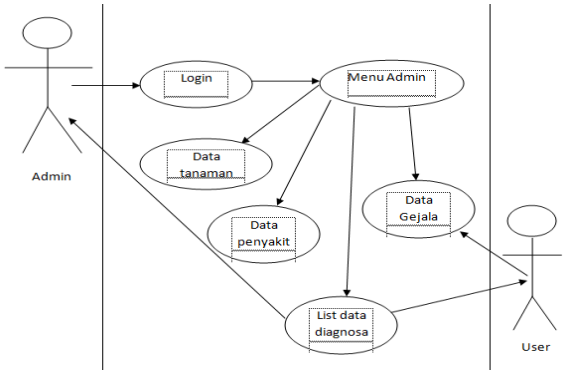

Figure 2. Application Use Case Diagram

Description:

The use case diagram above illustrates that users can simply view (read) and directly select the symptoms they are experiencing, which will then provide a diagnostic result in the form of a list of diagnostic data based on the symptoms input. Meanwhile, the admin can create, read, update, and delete plant, disease, symptom, and diagnosis data when logging in to the admin menu.

b. Activity Diagram

Activity diagrams illustrate the process flow of a system. The main components in an activity diagram are state and message.

At this stage, activity diagrams are used to model the behavior of use case objects in this expert system application. Two activity diagrams are created for the user and the admin.

2. Activity Diagram for the Expert System for Diagnosing ENT Diseases

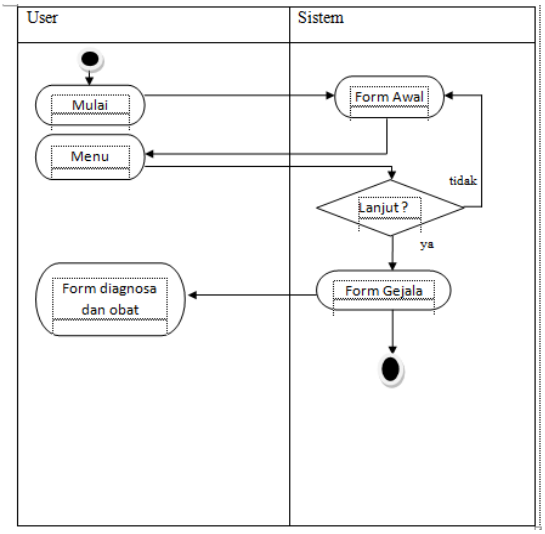

Figure 3. User Activity Diagram

Description:

The image above explains that when users start using the program, they will immediately go to the initial form, which will then display a menu containing a list of diagnoses. The condition will be continued until the diagnosis results are obtained, but the condition will return to the initial form if they choose not to continue or return.

3. Admin Activity Diagram for the ENT Disease Diagnosis Expert System

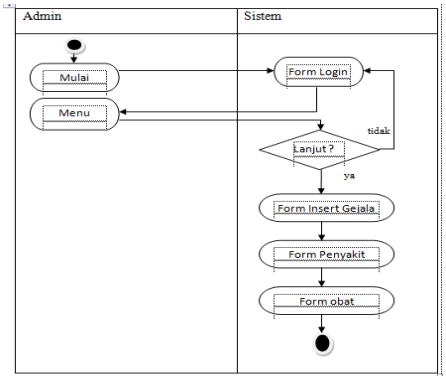

Figure 4. Activity Diagram (Admin)

Description:

The image above explains that when the admin enters the login form, a menu of options appears. If the condition persists, the admin will be able to create, read, update, and delete data in the symptom, disease, and medication insertion form.

4. Sequence Diagram for the ENT Disease Diagnosis Expert System

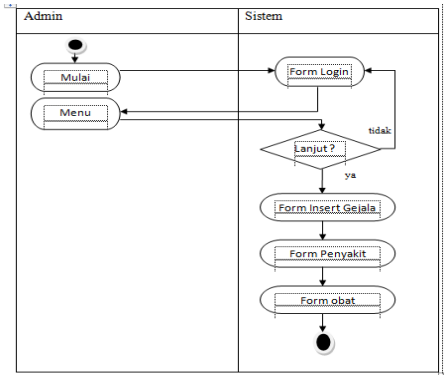

Figure 5. Sequence Diagram for the Herbal Medicine Expert System

5. Sequence Diagram of an Expert System for Diagnosing ENT Diseases

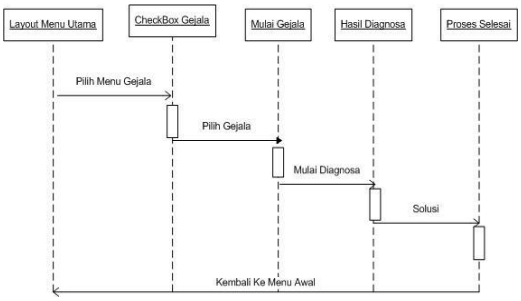

Figure 6. Sequence Diagram of an Expert System for Herbal Medicine

6. ERD of an Expert System for Diagnosing ENT Diseases

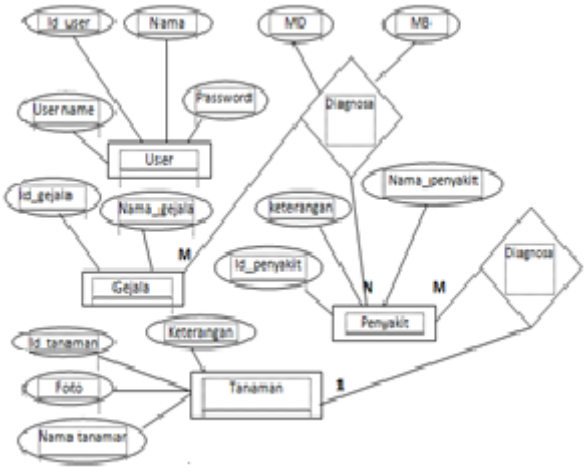

Figure 7. ERD Herbal Medicine Expert System

Server Implementation

1. Main Page

Figure 8. Main Page

2. Treatment Plant Input

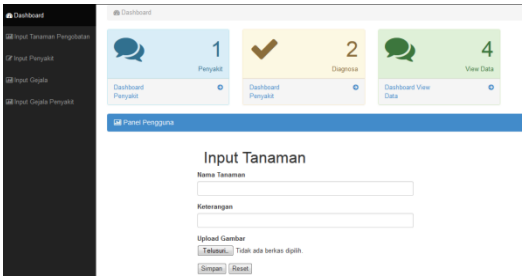

Figure 9. Treatment Plant Input Page

3. Disease Input

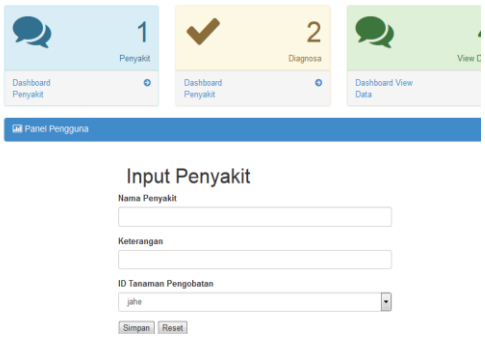

Figure 10. Disease Input Page

4. Symptom Input

Figure 11. Symptom Input Page

5. Database Program Code

Figure 11. Database Program Code Snippet

6. Display Implementation

a. Main Display

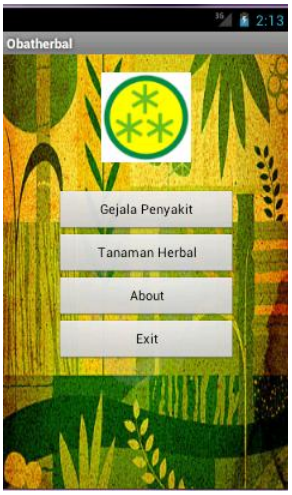

Figure 12. Main Program Display

b. Test Plan

Table 3. Test Plan

Kelas Uji	Butir Uji	Jenis Pengujian
Main Menu	Symptoms of the disease	*Black Box*
	Herbal Plants	*Black Box*
	About	*Black Box*
	Exit	*Black Box*
Disease Symptoms Menu	CheckBox select symptoms	*Black Box*
	Analysis Results Button	*Black Box*
Herbal Plant Menu	A list of herbal plants	*Black Box*
	Herbal Plant Yield	*Black Box*

CONCLUSION

Obtain relevant information on ENT diseases and their associated herbal remedies that are not widely known. Produce diagnostic conclusions for ENT diseases based on symptom certainty and uncertainty. Provide a selection of symptoms appropriate to the patient's condition to determine the type of ENT disease.

Implication

In practice, the developed system can provide relevant information on various Ear, Nose, and Throat (ENT) diseases, along with alternative herbal treatments that are still largely unknown to the general public. This has the potential to increase public knowledge and awareness of the use of herbal medicines as an adjunct to the initial management of ENT diseases.

Furthermore, this system demonstrates that the ENT disease diagnosis process can be conducted using a symptom certainty and uncertainty assessment approach, resulting in more measurable and systematic diagnostic results. This approach helps users understand the likelihood of a disease based on the symptoms they experience, resulting in more informed decision-making.

Another implication is the system's ability to provide symptom options tailored to the user's condition, simplifying the process of identifying the type of ENT disease. With this feature, users can conduct an initial diagnosis independently before consulting a medical professional.

Overall, this research has implications for the development of a health diagnostic support system that can serve as an educational tool and support initial decision-making, particularly in the field of ENT diseases. At the same time, emphasizing that the system's results are recommendations and do not replace direct medical diagnosis.

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