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EXPERT SYSTEM FOR DIAGNOSING ALZHEIMER'S USING CERTAINTY FACTOR METHOD

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Abstract

This expert system for diagnosing Alzheimer's disease is a computer-based stem system used as a tool to diagnose Alzheimer's disease based on a dynamic knowledge base. This knowledge base contains knowledge obtained from various sources including from the experience of experts who are proficient in their fields and also books related to diagnosis of Alzheimer's disease and then collected into a database system needed for making conclusions. In this system, the certainty factor method will be used using a forward chaining inference engine. The purpose of making this root stem p can be useful for many people and can know clearly about Alzheimer's disease from its symptoms and solutions, which will be displayed in the form of a website using PHP programming with MySQL database.

Keywords : Expert System, *Certainty Factor*, *Alzheimer's*, *PHP*

1. INTRODUCTION

Background of the problem Alzheimer's disease is the most common type of dementia initially characterized by weakened memory, to brain disorders in planning, reasoning, perception, and language. In people with Alzheimer's, symptoms develop slowly over time. A person who has entered old age often experiences memory disorders. Memory disorders in old age are caused by central nerve degeneration in the central nerve. Memory impairment that occurs is called dementia or Alzheimer's. Most Alzheimer's sufferers experience memory impairment, personality changes, mood and behavior, problems in interaction. A person affected by Alzheimer's will experience interference gradually. The average impairment decline will be experienced over three to nine years. (Novitasari et al., 2018)

This situation encourages experts to develop a technology that is able to develop the use of computers and can adopt the processes and ways of thinking of computers like humans. This can be realized by applying an Artificial Intelligence science by creating an Expert System (expert system) One of the studies in artificial intelligence is an expert system using the Certainty Factor (CF) method combined with the forward Chain method.

The forward-chaining algorithm is one of the two main methods of reasoning when using inference engines and can be logically described as a repeatability application of modus ponens (a set of inference rules and valid arguments). The opposite of forwardchaining is backward-chaining. (Akil, 2017)

Certainty Factor is a method used to measure a person's beliefs. The input is in the form of certainty from experts and certainty from users. Certainty Factor (CF) is one of the techniques used to overcome uncertainty in decision making. Certainty Factor (CF) can occur with a variety of conditions. Among the conditions that occur is that there are several antendents (in different rules) with the same consequences. In this case, we must aggregate the overall CF values of each condition. There are two stages of the model that are often used to calculate the confidence level (CF) of a rule are as follows (T. Sutojo, 2011) :

a. Using the calculation method, the certainty factor indicates a measure of certainty of a fact or rule. Certanity factor notation gives the concepts of measure of belief (MB) and measure of disbelief (MD)
b. By digging from the results of interviews with experts. The CF value is obtained from the interpretation of the term from the expert into a certain MD or MB value. Which is used to

calculate the CF value of a rule by several methods. For more details, the trust value rules provided by MYCIN

Hypertext Processor (PHP) is a scripting language that can be embedded or inserted into HTML. PHP is widely used to create dynamic websites. PHP can be used to build a CMS (Content Management System) (Mandala, Eka Praja Wiyata, 2015). PHP is a programming language carries the concept of a script that runs directly from server side (server-side scripting) using HTML (Hypertext Markup Language) on a web page. (Ilahi, 2022)

An expert system is one of the artificial intelligence techniques that seeks to adopt the skills and knowledge of one or more human experts into a computer, so that the computer can solve problems as experts usually do. A good expert system is designed to solve a particular problem by imitating the work of experts. With this expert system, even ordinary people can solve problems that can only be solved with the help of experts. For experts, this expert system will also help his activities as a very experienced assistant(Umar & ., 2023)

2. RESEARCH METHOD

The research method is a sequence of activities that output a study in the form of charts that illustrate stages of the research process in making expert system applications to diagnose Alzheimer's disease. So that the steps taken by the author in this design do not deviate from the subject and are easier to understand. So the author formed a research method as shown in figure 1:

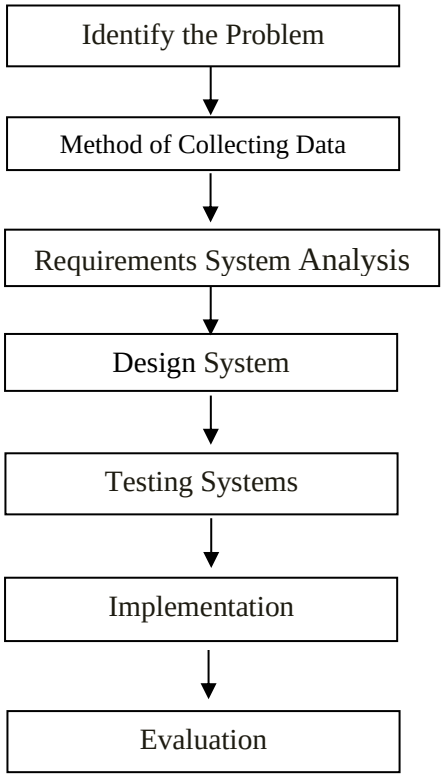


Figure 1 Research Method

2.1. Identify the Problem

This stage author will to identify the existing problems. This stage initial stage in the preparation of this research. The results of this identification are the background in formulating problems that will be an object of research. In the implementation of this study, data collection was carried out by interviewing experts or neurospecialists people who are competent in the field of human neuroscience. To get the right data or information about Alzheimer's disease, these data are grouped into several important points, including:

1. Classification or grade in *Alzheimer's* disease.
2. Symptoms of each stage of *Alzheimer's* disease.

3. Assess the likelihood of each symptom.
4. Solutions and their handling.
5. Other data related to *Alzheimer's disease.*

2.2. Method of Collecting Data

Data collection methods used in this study with Interview method:
Research conducted directly in the field to obtain primary data with data collection techniques needed for research. One of them is by way of an interview (interview). Interview is a way of collecting data using direct questions and answers with the parties concerned in the field under study to obtain the information needed.

2.3. System Requirements Analysis

After the data is collected, then this analysis is carried out to find out what is needed in designing an expert system application for diagnosing Alzheimer's disease using certainty factor web methods, applications designed can make it easier for people to recognize Alzheimer's disease and its symptoms and solutions.

2.4. Design System

This stage is facts are collected that support the design of the system by consulting with experts and comparing the results of research in the guidebook.

2.5. System Testing

It is a stage of research carried out to practice directly the results of the analysis which aims to test the correctness of the designed system. This implementation also explains how to use the expert system in diagnosing Alzheimer's disease. For more details about this implementation will be explained in Chapter V in this research report.

2.6. Implementation

This implementation is done to find out that this program can function properly according to the needs and steps that have been done before.

2.7. Evaluation

Evaluation is carried out to see whether the design results with the system test process that has been made are in accordance with user requests. The purpose of the evaluation is to see how far the system is functioning and to identify problems that occur.

3. RESULTS AND ANALYSIS

In this discussion, several steps are taken to analyze and design a system that aims to determine the diagnosis of Alzheimer's disease using the Certainty Factor method. The analysis carried out is applying the forward chaining method and calculations related to the research objectives.

3.1. Data Collection

The problem discussed in this study is about the types of Alzheimer's disease. The following is a description of the types present in Alzheimer's which can be seen in Table 1:

Tabel 1 Data on Types of Alzheimer's

Alzheimer's Disease Code	Name Alzheimer's Type
P 0 01	*Alzheimer's Dimensia (mild)*
P 0 02	*Alzheimer's ataxia (moderate)*
P003	*Acute Alzheimer's*

a. Symptom Data

There are several symptoms causedby each type of Alzheimer's, which can be explained in Table 2:

Tabel 2 Natural the Symptoms of Alzheimer's

Gejala Code	Symptomatic Name
G001	Memory Decline
G002	Looks confused even though it is in a place that is usually visited
G003	Requires a long time to make decisions
G004	Daily activities are slower than usual
G005	Loss of initiative from within
G006	Changes in personality begin to appear
G007	Memory is getting worse
G008	Difficult to think logically
G009	Has difficulty reading, writing and working with numbers
G010	Start easily forgetting your own family members
G011	Can't learn new things
G012	Restless, anxious, and easily sad, especially when it is approaching night
G013	Talk the same thing over and over again
G014	Perform the same movement over and over again
G015	Difficulty controlling behavior and emotions
G016	Hallucinations arise
G017	Convulsions arise
G018	Difficult to swallow food
G019	Being depressed to losing weight
G020	Can't communicate well, can only make up
G021	Unable to recognize the people closest to you

b. Data Solutions

Each disease has a way of handling or solutions so that a person does not have Alzheimer's disease. It can be explained in Table 3:

Table 3 Solution Data

NO	Solution Code	Solution Name
1	S001	Teneat non pharmacologically
2	S002	Pharmacological Therapy
3	S 003	Need a caregiver because all the work done by the patientcan not be doneproperly
4	S004	Kconsultation to doctors and health practitioners

c. Table of Relations of Disease and Symptoms

The following relationship between disease and symptoms is described in Table 4:

Table 4 Relation of Disease and Symptoms

Gejala Code	Symptomatic Name	Disease Name
G001	Memory Decline	Alzheimer's Dimensia (mild)
G002	Looks confused even though it is in a place that is usually visited	
G003	Requires a long time to make decisions	Alzheimer's Dimensia (mild)
G004	Daily activities are slower than usual	
G005	Loss of initiative from within	
G006	Changes in personality begin to appear	
G007	Memory is getting worse	Alzheimer's ataxia (moderate)
G008	Difficult to think logically	
G009	Has difficulty reading, writing and working with numbers	

Gejala Code	Symptomatic Name	Disease Name
G010	Start easily forgetting your own family members	
G011	Can't learn new things	
G012	Restless, anxious, and easily sad, especially when it is approaching night	
G013	Talk the same thing over and over again	
G014	Perform the same movement over and over again	
G015	Difficulty controlling behavior and emotions	Alzheimer's ataxia (moderate)
G016	Hallucinations arise	
G017	Convulsions arise	Acute Alzheimer's
G018	Difficult to swallow food	
G019	Being depressed to losing weight	
G020	Can't communicate well, can only make up	Acute Alzheimer's
G021	Unable to recognize the people closest to you	

Source: dr. H.Hadril Busudin, Sp.S. MHA

d. Table of Disease Relations and Solutions

Thesolution can be described in Tabel 5:

Table 5 Disease Relations and Solutions

No	Solution Code	Name Alzheimer's Disease
1	S001	*Alzheimer's Dimensia (mild)*
2	S002	*Alzheimer's ataxia (moderate)*
3	S003	*Acute Alzheimer's*
4	S004	

Source: dr. H.Hadril Busudin, Sp.S. MHA

3.2. Certainty Factor Method Analysis

This knowledge will be represented in the form of rules that are useful for finding conclusions about the types of mental disorders and their solutions. Basically, the rule consists of two main parts, namely the premise or condition part and the conclution part or conclusion. Inference procedure in this case the method follows if-then logic to search for rules until one of the IF conditions is true. If true, the system executes THEN clause to make a decision. This process will be repeated until the desired goal is achieved. (Hafizal et al., 2023)

The way to get the level of confidence (CF) from a rule that researchers use, namely by interviewing an expert. The CF value (Rule) is obtained from the interpretation of the "term" from the expert which is converted into a CF value. For more details can beexplained in Table 6:

Table 6 *Certainty Factor* Value Table

Uncertain Term	**CF**
Definitely not	0.1
Almost certainly not	0.2
Probably not	0.3
Maybe not	0.4
Small probability	0.5
Maybe	0.6
Probably	0.7
Almost certainly	0.8
Definitely	1

3.2.1. Rule Based on CF value

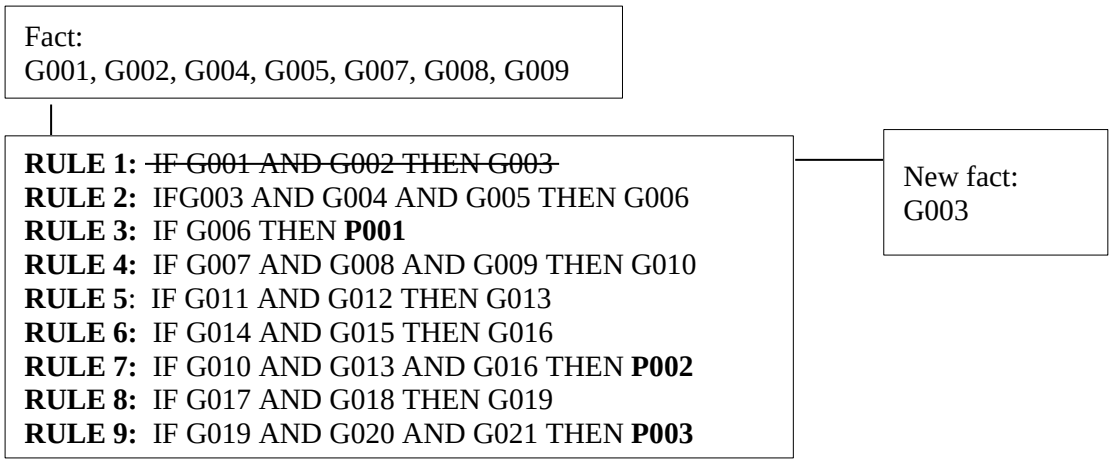
Rule a knowledge respentation technique sintax rule IF E Then H. Evidence (existing facts) and hypotheses or conclusions generated.

RULE 1: IF G001 and G002 then G003 (CF=0.85)
RULE 2: IF G003 and G004 and G005 then G006 (CF=0.75)
RULE 3: IF G006 then P001(CF=0.90)
RULE 4: IF G007 and G008 and G009 then G010(CF=0.70)
RULE 5: IF G011 and G012 then G013(CF=0.80)
RULE 6: IF G014 and G015 then G16(CF=0.60)
RULE 7: IF G010 and G013 and G016 then P002(CF=0.70)
RULE 8: IF G017 and G018 then G019(CF=0.80)
RULE 9: IF G019 and G020 and G021 P003(CF=0.80)

3.2.2. Iteration

The search technique that starts with facts then matches those facts with the IF part of the fact rule that matches the IF part, then the rule is executed. Once executed, a new fact (the THEN part) is added to the new fact.

This Alzheimer's expert system uses 9 rules. User selected facts G001, G002, G00 4, G005, G007, G008, G009. Determining the iteration of the disease P001. The iteration can bedescribed as Figure 2, Figure 3, Figure 4:



Gambar 2 *Iterasi* 1

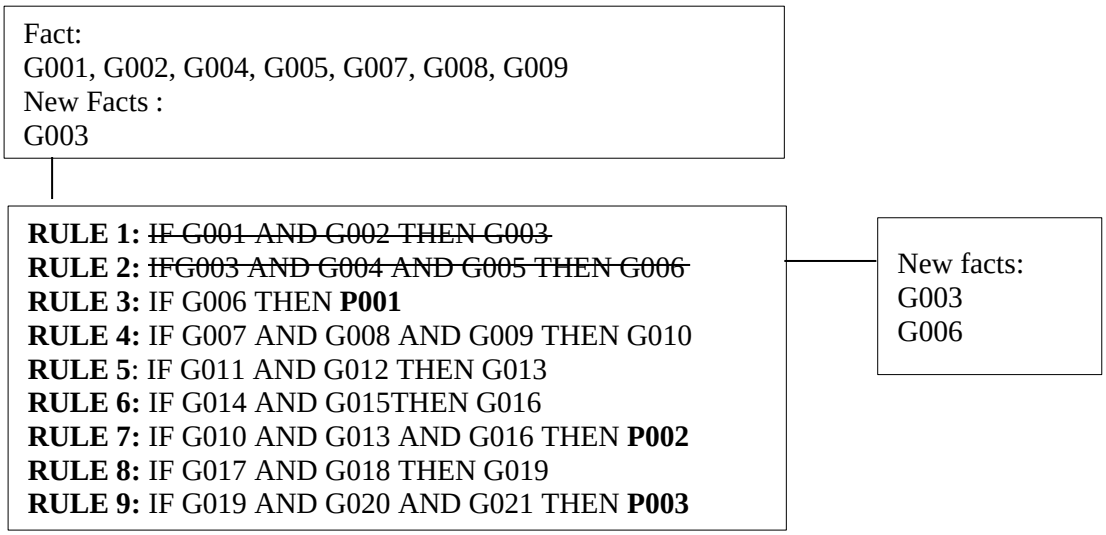


Figure 3 *Iteration* 2

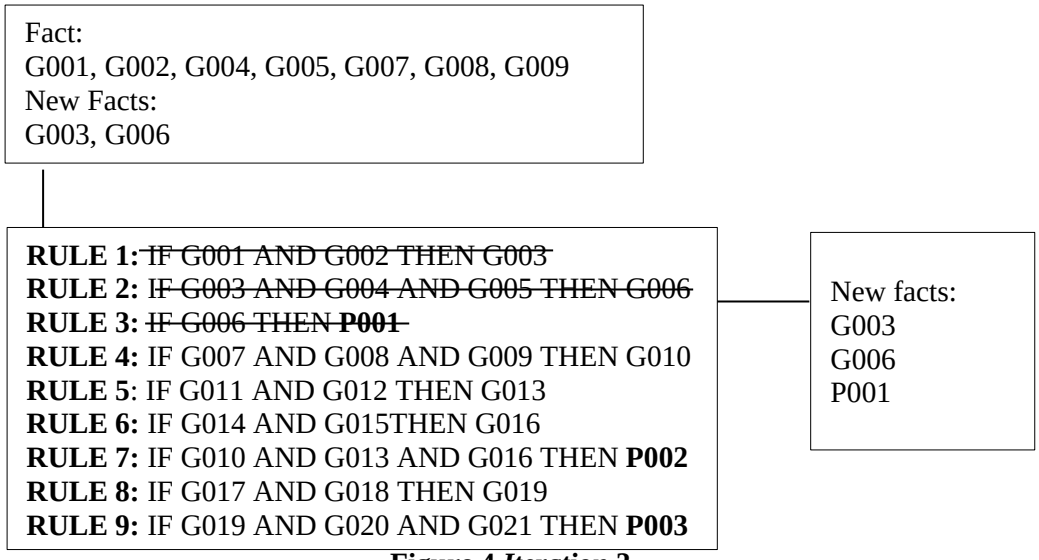


Figure 4 *Iteration* 3

Until here the process was stopped because the search for the disease was already P001 had been found. So we get Alzheimer's disease Dimensia in this iteration.

3.3. CF Value From Alzheimer's Disease Symptom Facts

The facts of the symptoms of Alzheimer's disease can be explained in Table 7

Table 7 Symptom Fact Table

Fact	Value *of Evidence*	CF value
G001	*Evidence*	CF = 0. 80
G002	*Evidence*	CF = 0. 80
G003	*Evidence*	CF = 0. 70
G004	*Evidence*	CF = 0. 70
G005	*Evidence*	CF = 0. 80
G006	*Evidence*	CF = 0. 60
G007	*Evidence*	CF = 0. 60
G008	*Evidence*	CF = 0. 50
G009	*Evidence*	CF = 0. 60
G010	*Evidence*	CF = 0. 70

While the value of the CF rule can be explained in Table 8:

Tabel 8 Tabel Nilai CF Rule

No	Rule	CF Value
1	IF G001 AND G002 THEN G003	0.85
2	IF G003 AND G004 AND G005 THEN G006	0.85
3	IF G006 THEN **P001**	0.90
4	IF G007 AND G008 AND G009 THEN G010	0.70

Description of each rule of new facts:
Rule 1 = G001 (CF=0.80) AND G002 (CF= 80) THEN G003 (CF=0.70)
CF1 (G001.G002 ∩ G003)
= Min [0.85;0.85] * 0.85
= 0.72
New Facts:
G003 Hypothesis CF = 0.72

Rule 2 = IFG003 (CF=0.70) AND G004 (CF=0.70) AND G005 (CF=0. 80) THEN G006(CF=0. 60)
CF2 (G003.G004.G005 ∩ G006)
= Min[0.72;0.75;0.80]*0.85
= 0.61
New Facts :
G006 Hypothesis CF = 0.61

Rule 3 = IF G006 (0. 60) THEN P001(CF=0. 90)
CF2 (G006 ∩ P001)
= Min [0.61]*0.90
= 0.54
New Facts :
P001 Hypothesis CF = 0.54

Rule 4 = IF G007 (0.64) AND G008 (0.6) AND G009 (0.6) THEN G010 (CF=0.90)
CF2 (G007.G008.G009. ∩ G010)
= Min [0.60;0.50;0.6 0]*0.70
= 0.35
New Facts :
G010 Hypothesis CF = 0. 35

Rule 5 = Not executed because Envidence is Not a Fact
Rule 6 = Not executed because Envidence is Not a Fact
Rule 7 = Not executed because Envidence is Not a Fact
Rule 8 = Not executed because Envidence is Not a Fact

From the description above can be concluded as in Table 9

Table 9 New Fact Table Types

New Facts	Result Value Based	CF value
G003	*Hypothesis*	0.72
G006	*Hypothesis*	0.61
P001	*Hypothesis*	0.54
G010	*Hypothesis*	0.35

CF Combined Rule:
From the rule that runs obtained Rule 4 as a hypothesis, namely with the type of Alzheimer's disease Dimensia (Mild).
New Facts :
P001Hypothesis CF = 0. 54*100=54%
Conclusion:
The type of Alzheimer's suffered by youser is: type of Alzheimer's Dimensia (mild) with a degree of certainty = 0.54 or 54%

3.4. System Design

System design is the process of planning and building structures, components, and interactions between the various elements involved in the system. In designing an expert system to detect Alzheimer's symptoms, it is compiled using the design requirements of the Use Case Diagram which can be seen in Figure 5.

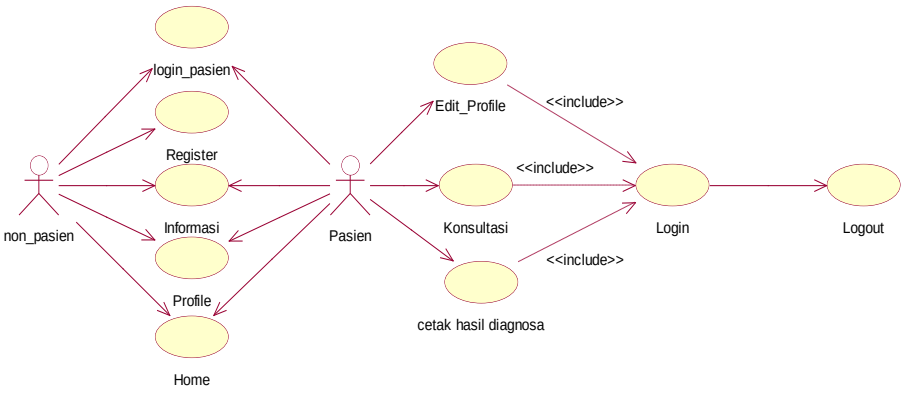


Figure 5 Use Case Diagram

Overview of the system that runs on the expert system application to diagnose symptoms of Alzheimer's disease using the Certainty Factor method. Login to the application to be able to access the system, verify user access rights, log in to the system. The process of examining symptoms using the certainty factor method, starting from determining symptoms to the final process produces the type of Alzheimer's disease. The resulting output is the determination of the type of Alzheimer's disease suffered along with the solution of the disease.

3.5. Implementation

System implementation is carried out after designing an expert system. Interface design is done for user interaction with the system that has been created. To carry out a system implementation, a program and script are needed according to the expert system designed.

a. Home Page View

On this page a page is displayed to select a menu from several options found on the home page. On this page there are several menus that can be obtained, including the top menu and side menu. On the top menu there are several menus including: Home menu, Information, Registration and Login. The home page appears after performing commands on the expert system, so it looks like Figure 6:

Figure 6 Home Page Layout

b. Display of Patient Registration Page

On this page patients can register to be able to log in as patients, as Figure 7:

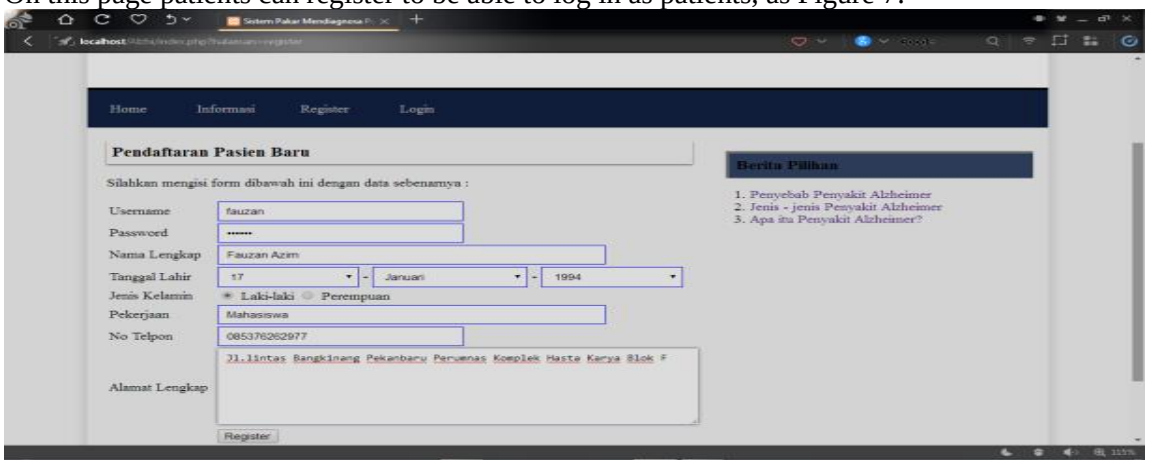


Figure 7 Registration Page Layout

c. Patient Login Page Display

After registering as a patient, the user can log in as a user on the login page, by filling in the username, password and level chosen by the patient as shown in Figure 8:

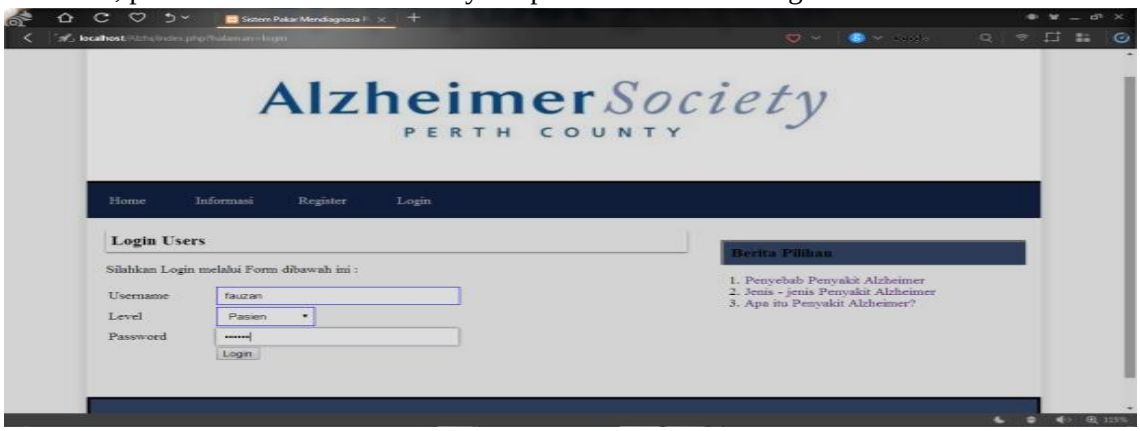


Figure 8 Patient Login Page Layout

d. Consultation Page View

In this consultation menu display, patients will be faced with several questions related to Alzheimer's disease, so that patients can know clearly about the disease they suffer, and after answering the questions, the system will issue results in the form of the final results of all these questions as shown in Figure 9:

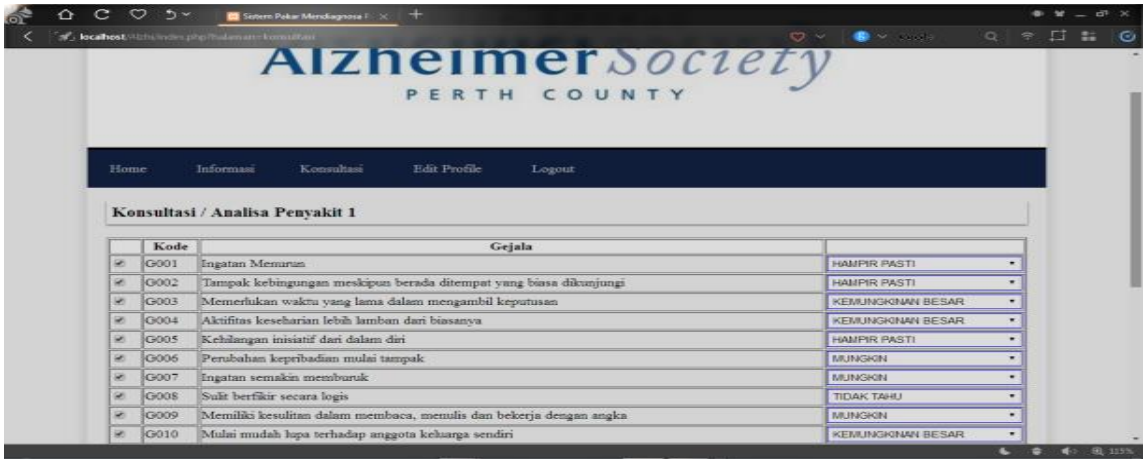


Figure 9 Consultation Page Layout

e. Consultation Results Page View

This page is a continuation of the question page. On this page will be presented the results of questions that have beenanswered oleh user before. For more details can be seen Figure 10 :

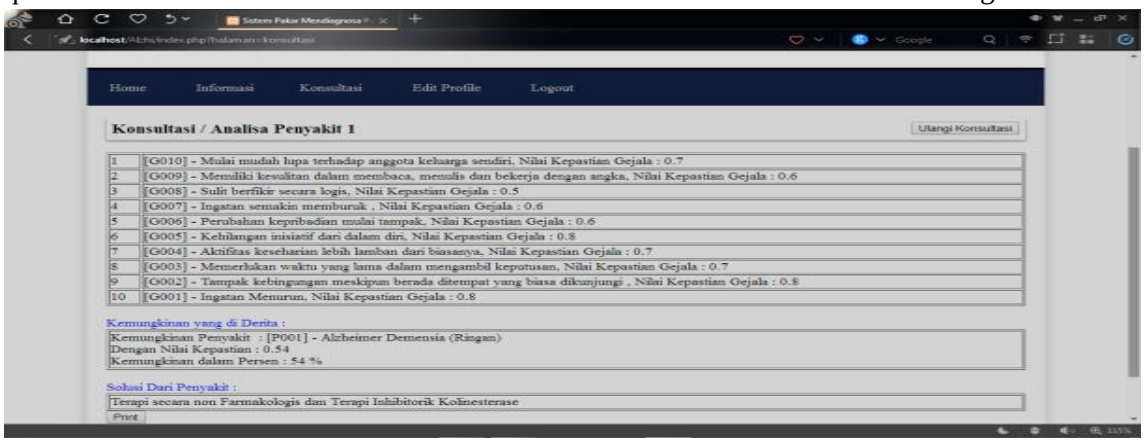


Figure 10 Consultation Results Page Layout

f. Print Page Display of Consultation Results

This page User patients can print or print the results of consultations that have been carried out on the system, as shown in figure 11:

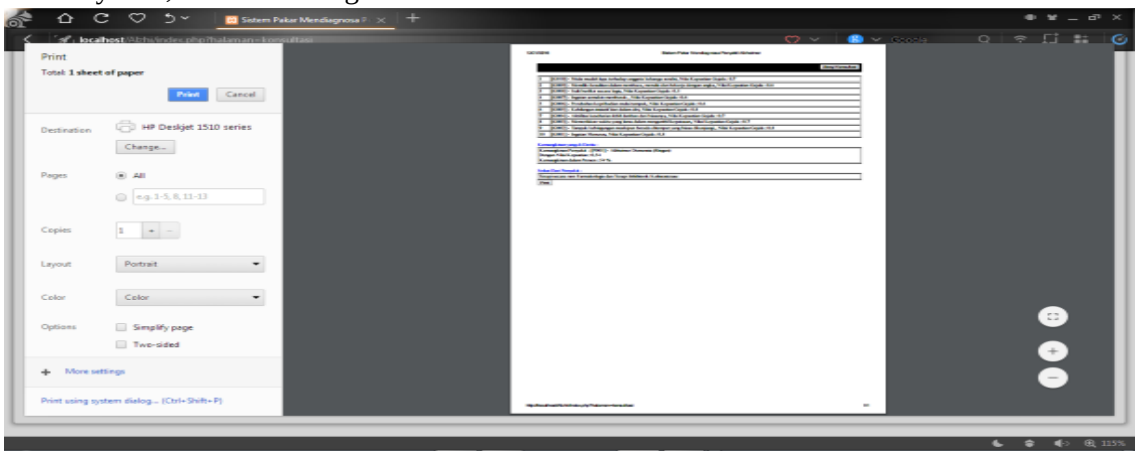


Figure 11 Print Page Layout of Consultation Results

4. CONCLUSION

From the discussion above, conclusions can be drawn, namely:

1. By building and designing an expert system can help the public to update information and knowledge about Alzheimer's disease.
2. By implementing the certainty factor method with a forward chaining inference engine, it can determine the certainty value based on the symptoms that have been selected by the user. The expert system designed is straightforward, easy to understand, and by reading the instructions for use people can already understand and use it.
3. By designing a website-based expert system that is created, it can be accessed by people in need without having to cost a lot of money.

The system is designed to provide information related to Alzheimer's. However, it has not yet reached perfection, where this system still has several limitations including:

1. This expert system only discusses the diagnosis of Alzheimer's disease and treatment efforts.
2. The information available in this expert system is still limited. This is closely related to the availability of information obtained by the author.
3. The process of displaying the results of the diagnosis still has many shortcomings.
4. The system created cannot consult directly with experts but only on systems that have been made based on symptoms that have been inputted and obtained from the experts themselves.

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