Forward Chaining Method in a Web-Based Bipolar Disorder Expert System
(Case Study: Pinilih, Argodadi Village, Sedayu District)

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Article Info	ABSTRACT
	Bipolar disorder is a psychiatric disorder. At Argodadi Pinilih Disability Secretariat, Sedayu District, Yogyakarta Region, around 60% of people with disabilities are affected by psychiatric disorders and one of them is bipolar, one of them is depression, and suicide if initial treatment is not given to the sufferer. In addition, the cost of doing consultation with the medical specialist is not cheap. An expert system is an artificial intelligence system that is useful for diagnosing an error and as a decision-maker with the knowledge rules applied by an intelligent system that can solve problems like an expert. In making an expert system, the forward chaining method is used which aims to be able to diagnose bipolar disorder with accurate results and its utilization can be used by experts and laypeople to make an initial diagnosis of bipolar disorder. The results of this study are in the form of an expert system program that is used to diagnose bipolar disorder which can provide information related to the disease and can provide information on initial treatment of the disease. The information obtained by the consultant from the expert system is in the form of a percentage.

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1. INTRODUCTION

Bipolar disorder is a mental disorder that causes extreme mood swings from mania episodes to depression. During a depressive episode, sufferers may feel very sad, lethargic, and lose interest in activities they normally enjoy. Although the exact cause of bipolar disorder is not known with certainty, genetic, environmental, and chemical changes in the brain may play a role in the cause.

The Secretariat of the Disabled Village of Argodadi Pinilih is a place for disabled people to socialize in all fields. There are around 60% of people with disabilities experience psychiatric disorders, one of them is bipolar. At the secretariat for the disabled, Argodadi Pinilih Village has a head of service who is assigned as a companion for the disabled to take care of all people affected by psychiatric disorders. However, the head of the secretariat service does not know with certainty the information related to bipolar disorder itself. Besides, there is no psychiatric poly doctor who deals specifically with the village, so the lack of knowledge and the absence of special handlers cause many cases, one of which is depression, cutting, and suicide. Technological developments are currently very rapid, especially in the field of mental health which treats bipolar disorder. The disabled people in Argodadi Pinilih Village need an information system that can diagnose bipolar disorder with a level of accuracy comparable to an expert.

The problems above can be overcome by one of the information technologies that can help users is an expert system. An expert system is an artificial intelligence that is often used to diagnose system errors and as a solution to a problem in making decisions with basic knowledge and having rules that have been applied by intelligent systems [3] . Web-based expert systems can diagnose mental disorders so that patients can carry out digital consultations about their illnesses. This application can certainly help people recognize the disease they

are suffering so that they are aware of referring them to a medical specialist [5] . The purpose of making this expert system is to build an expert system that serves to diagnose early [7] . Impementation of the Forward Chaining method in expert systems can produce the benefits of accuracy, speed, and can be accessed anytime and anywhere, so that it can ease the task of experts who handle their fields. The purpose of using the forward chaining method is to identify mental disorders by examining the symptoms they are experiencing [8] . The aim of this expert system application is to make it easier for experts to diagnose types of bipolar disorder and speed up the consultation process [9] . The forward chaining method is used to obtain a conclusion from the schizophrenia symptoms possessed by the patient and the Bayesian network to calculate how accurately an expert system identifies a problem. This study uses the forward chaining method to determine the results of the expert system. The forward chaining method is a method that uses IF and THEN reasoning, starting with gathering the facts of the problem and then hypothesizing it to find conclusions [11] . Forward chaining is an inference method that does reasoning from a problem to its solution, so it is very suitable to be applied in this study [12] . Thus, the researchers took research entitled: "Implementation of the Forward Chaining Method in Web-Based Bipolar Disorder Expert System Diagnoses". This system can be used as a psychiatrist's assistant in the village of Argodadi, Sedayu sub-district. With this system, it is hoped that it can assist in diagnosing and providing early treatment to people affected by bipolar disorder.

Several research journals on this related matter have been carried out by previous studies, there are several reference journals used as references. The first research journal is "Web-Based ISPA Disease Diagnostic System Using the Forward Chaining Method." This study used the forward chaining method as a problem-solving method. The results of this study showed that the validity of the system's accuracy level of 94% using 100 trial data. The next study is "Expert System for Diagnosing Osteoporosis in the Elderly Using the Web-Based Forward Chaining Method ". This study applied the forward chaining method which was implemented on the disease diagnosis page and was used by users to conduct consultations.

2. RESEARCH METHODS

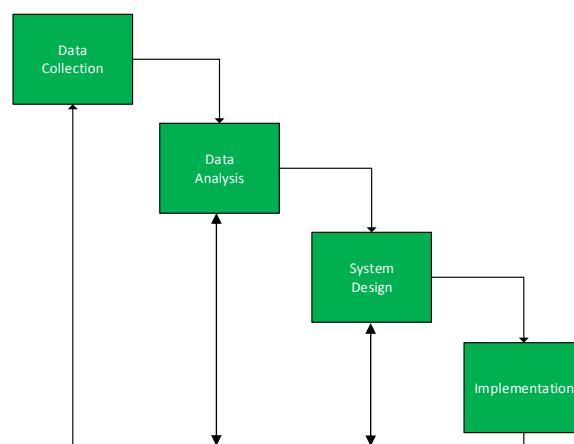The research method is a procedure used to collect data with specific purposes and uses.

Figure 1. Waterfall method

2.1 Data collection

Data collection at this stage was carried out to obtain the data needed to complete the research. The data collection stages carried out in this study were:

1. Interview

The question-and-answer process carried out by researchers with informants was a process of collecting data face-to-face.

2. Literature review

In this stage, the researchers were collecting data by studying reference books, online journals, as well as sources related to the research needed.

3. Primary data

Primary data was data obtained directly from the first party, namely the Head of Pinilih Secretariat Service in Argodadi Village, Sedayu District, which became a source of information during this research.

2.2 Data analysis

The analysis phase was carried out to process data into information. Researchers analyzed what data used in making an expert system for diagnosing bipolar disorder. All data related to symptoms and diseases that had

been obtained from experts was calculated for restatements using the forward chaining method. The following is the workflow of the expert system for diagnosing bipolar disorder:

1. Design a disease and symptom table by providing the code of each disease and symptom.
2. The system performs reasoning from facts as a representation of knowledge using the forward chaining method so that it produced a conclusion in the form of disease information from the symptoms experienced.

2.3 Study of Literature

The literature study was using journals and books from official institutions that were used as reference sources that helped to complete this research.

1. Expert system

An expert system is a computer-based system that is used to solve problems that can mimic the abilities of an expert. The meaning of the expert is someone who has special abilities to be able to solve problems that cannot be solved by ordinary people. One of the advantages of using an expert system in bipolar disorder is it can increase productivity because an expert system can work faster than humans, so it can assist in diagnosing and providing fairly accurate treatment information.

2. Bipolar Disorder

Bipolar disorder is a periodic mood change that can be shown by every individual who experiences manic episodes (first pole), major depressive episodes (second pole), and normal behavior that occurs between the two episodes [16].

3. Forward Chaining

Forward chaining method is an inference method whose procedural level uses the thoughts and inference patterns used in the system to make a good decision. If a premise is applied according to the situation, the resulting value is true and the process will state a conclusion. Forward chaining operates starting by inputting a set of known facts into working memory, then new facts are derived based on rules where the premises match the known facts. The forward chaining process can be seen in Figure 2 as follows.
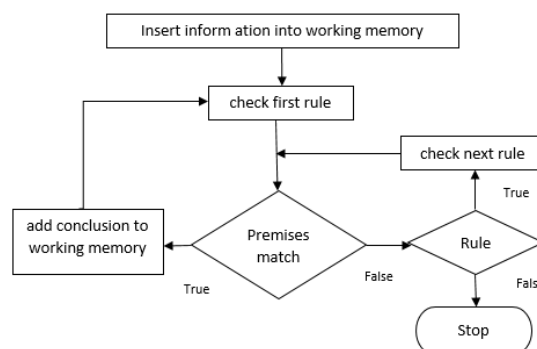
Figure 2. Forward Chaining Process

4. PHP

PHP or the abbreviation of Hypertext Preprocessor is a computer language or computer programming language with standard instructions for governing computers. Web programming is server-side, which is intended to produce a script that will be generated in HTML code which is the web standard language.

2.4 System Design

This system design stage describes the path of a system in the form of an overview that is used in designing the main menu page in the expert system for diagnosing bipolar disorder using the forward chaining method. The purpose of this system design is to facilitate implementation and testing. This design stage develops using UML (Unified Modeling Language), namely flowchart diagrams, use case diagrams, activity diagrams, sequence diagrams, class diagrams, and system interface designs.

2.4.1 Flowcharts

The flowchart diagram is described as a general process algorithm in the Bipolar Disorder Diagnostic Expert System. The expert system architectural design using the forward chaining method describes the process from start to finish so that it can produce conclusions that have been determined by experts. The flowchart diagram can be seen in Figure 3 below:
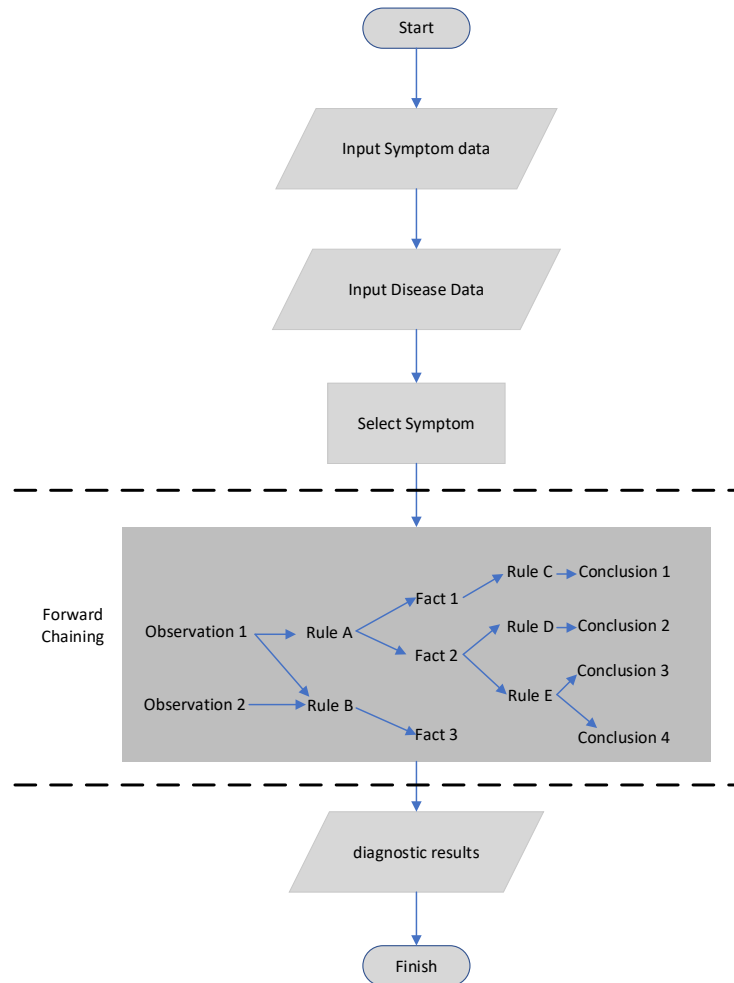
Figure 3. Flowchart Diagram

3. RESULTS AND ANALYSIS
3.1 Input Symptom Data

The symptom data contains symptom information along with symptom codes obtained from the expert psychologist Doctor Mirza Adi Prabowo who is willing to assist in providing symptom information as well as information data obtained from Pinilih Argodadi Village which has been summarized. The following is data on the symptoms of bipolar disorder.

Table 1. Symptom Data

No.	Symptom Code	Symptom Name
1.	G01	Have more energy and are very excited to do activities for at least 7 days to 2 weeks in a row
2.	G02	Feeling Easily Offended
3.	G03	Inflated or exaggerated self-esteem
4.	G04	Reduced need for sleep (eg feeling rested after only 3 hours of sleep)
5.	G05	More talkative than usual or pressured to keep talking
6.	G06	Often hallucinating
7.	G07	Experiencing distractibility (i.e. easily distracted from outside stimuli that are not related)
8.	G08	Increased intentional or undirected strenuous activities that may interfere with daily activities
9.	G09	Inability to control inappropriate activities (for example sexual immorality, or foolish business investments)
10.	G10	If you are having a relapse, you can injure yourself
11.	G11	Have you ever felt that you have more energy and are very excited to do activities for at least 4 days in a row?
12.	G12	The idea of flight or the subjective experience that the mind is racing
13.	G13	Loss of interest or pleasure in almost all activities all day or every day
14.	G14	Depressed mood most days (e.g. feeling sad, empty, or hopeless every day)
15.	G15	Significant weight loss when not on a diet or drastic weight gain
16.	G16	Insomnia or hypersomnia nearly every day
17.	G17	Feeling excessively restless
18.	G18	Feeling tired or low on energy most days

No.	Code	Symptom
19.	G19	Feelings of worthlessness or excessive guilt nearly every day
20.	G20	Blaming yourself or feeling guilty for being sick (having delusions)
21.	G21	Reduced ability to think or concentrate, or doubt most days
22.	G22	Repeated suicide attempts without a specific plan
23.	G23	Feeling easily hurt
24.	G24	Experiencing easily carried away
25.	G25	Decreased or increased appetite
26.	G26	Have a low sex drive
27.	G27	More aggressive
28.	G28	Often irritable almost every day
29.	G29	Mood changes that change every day
30.	G30	Likes to take drugs
31.	G31	Easy cry
32.	G32	Symptoms are barely noticeable, but has a messy mood and fluctuates most days

3.2 Disease Data

The disease data contains information on the type of disease along with the disease code obtained from the psychologist Doctor Mirza Adi Prabowo who is willing to assist in providing information on the number of illnesses from bipolar disorder. The following is data on types of bipolar disorder.

Table 2. Disease Data

No.	Disease Code	Disease Name
1.	P 01	Bipolar I
2.	P02	Bipolar II
3.	P03	Unipolar
4.	P04	Cyclomatia
5.	P05	RapidCycle

3.3 Select Symptoms

The select symptom table contains the compatibility of the disease and symptoms accompanied by a symptom code. The total of the symptoms possessed by the 5 diseases is 32 symptoms. Select symptoms can be seen from this table below.

Table 3. Table of Select Symptoms

Symptom Code	Symptom Name	Bipolar I	Bipolar II	Unipolar	Cyclomatia	RapidCycle
G01	Have more energy and are very excited to do activities for at least 7 days to 2 weeks in a row	✓				
G02	Feeling Easily Offended	✓	✓			
G03	Inflated or exaggerated self-esteem	✓	✓			
G04	Reduced need for sleep (eg feeling rested after only 3 hours of sleep)	✓	✓	✓		✓
G05	More talkative than usual or pressured to keep talking	✓	✓			
G06	Often hallucinating	✓				
G07	Experiencing distractibility (i.e. easily distracted from outside stimuli that are not related)	✓	✓			
G08	Increased intentional or undirected strenuous activities that may interfere with daily activities	✓	✓			
G09	Inability to control inappropriate activities (for example: sexual immorality, or foolish business investments)	✓	✓			
G10	If you are having a relapse, you can injure yourself	✓				
G11	Have you ever felt that you have more energy and are very excited to do activities for at least 4 days in a row?		✓			
G12	The idea of flight or the subjective experience that the mind is racing	✓	✓			
G13	Loss of interest or pleasure in almost all activities all day or every day	✓	✓			
G14	Depressed mood most days (e.g. feeling sad, empty, or hopeless every day)	✓	✓			
G15	Significant weight loss when not on a diet or drastic weight gain	✓	✓	✓		

G16	Insomnia or hypersomnia nearly every day	✓	✓			
G17	Feeling excessively restless	✓	✓			
G18	Feeling tired or low on energy most days	✓	✓	✓		
G19	Feelings of worthlessness or excessive guilt nearly every day	✓	✓	✓	✓	
G20	Blaming yourself or feeling guilty for being sick (having delusions)	✓	✓			
G21	Reduced ability to think or concentrate, or doubt most days	✓	✓	✓	✓	✓
G22	Repeated suicide attempts without a specific plan	✓	✓			
G23	Feeling easily hurt				✓	
G24	Experiencing easily carried away				✓	
G25	Decreased or increased appetite			✓	✓	
G26	Have a low sex drive				✓	
G27	More aggressive				✓	
G28	Often irritable almost every day					✓
G29	Mood changes that change every day					✓
G30	Likes to take drugs					✓
G31	Easy cry					✓
G32	Symptoms are barely noticeable, but has a messy mood and fluctuates most days			✓		

3.4 Rule Base Forward Chaining Rules

Rule base forward chaining shows the relationship rules to determine the diagnosis results from the symptoms that have been inputed by the user. The results of the decision representation are usually written in IF-THEN form. The rule is an implication relationship of two parts, namely the premise part (if) and the conclusion part (then) where if the premise is fulfilled then the conclusion part will also be true. The following are the forward chaining rule base shown in Table 4.

Table 4. Rule Base Forward Chaining Rules
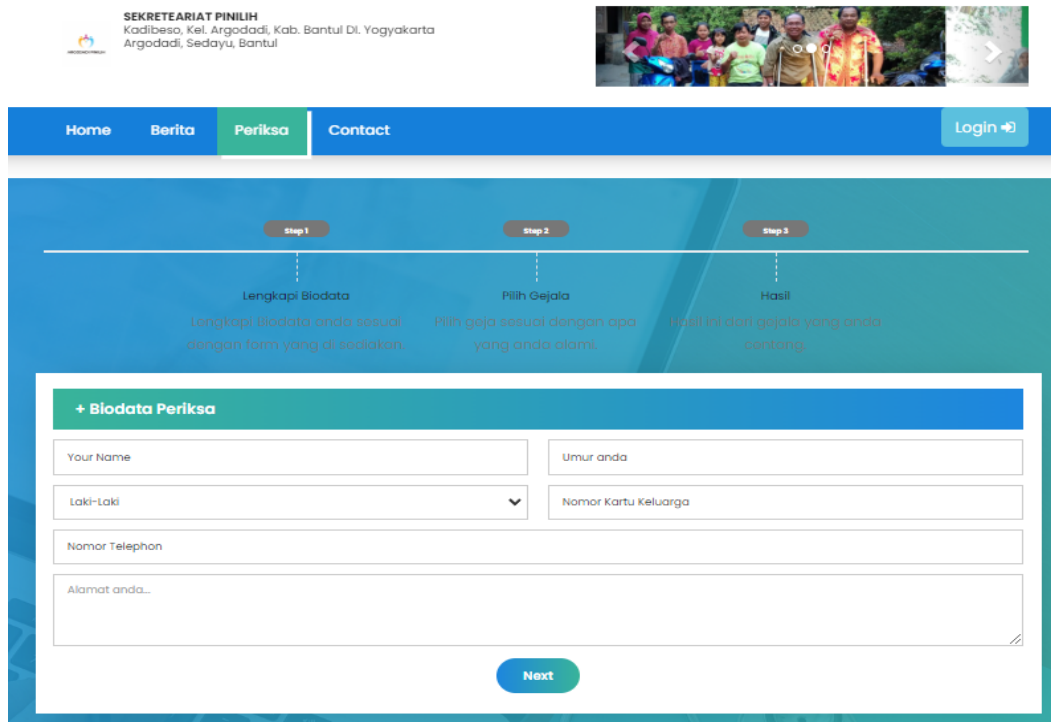
IF>AND>THEN(RULE)	THE TYPE OF DISEASE
IF	
G01, G02, G03, G04, G05, G06, G07, G08, G09, G10, G12, G13, G14, G15, G16, G17, G18, G19, G20, G21, G22	BIPOLAR I
THEN	
IF	
G02, G03, G04, G05, G07, G08, G09, G11, G12, G13, G14, G15, G16, G17, G18, G19, G20, G21, G22	BIPOLAR II
THEN	
IF	
G04, G15, G18, G19, G21, G25, G32	UNIPOLAR
THEN	
IF	
G27, G26, G25, G24, G23, G21, G19	CYCLOMATIA
THEN	
IF	
G31, G30, G29, G28, G21, G04	RAPID CYCLE
THEN	

3.5 Results of System Implementation

System implementation contains a system that has been successfully tested and produced output that is as expected, where the results of the system that has been designed are the results of the initial diagnosis and treatment of bipolar disorder. The following results of the implementation of the system can be seen in the image below.

1. View Consultation and Select Symptoms

The consultation page (check) is filled in by the system user where the user must first fill in the biodata and then select the symptoms experienced by the patient, the patient selects the symptoms by clicking a tick in the system. Consultation images and select symptoms can be seen in Figure 4 and Figure 5.

Figure 4. Display of Consultation and Select Symptoms

Figure 5. Display Select Symptoms

2. Diagnostics result page display

This display contains the results of the diagnosis based on the symptoms selected by the patient. The display of the diagnostic results can be seen in Figure 6 below:

Figure 6. Diagnostic Results Page

3.6 Result Validation

From the results of the analysis and testing of the system with the implementation of the forward chaining method on a web-based expert system for diagnosing bipolar disorder, the results of testing the system can run according to the results obtained by an expert. The following are the results of system testing that has been carried out.

Table 5. Validation Results

No.	Name	Gender	Age	Symptom	System Results	Expert	Validation
1.	PSN1	L	53	G04, G21, G28, G29, G30, G31	RapidCycle	RapidCycle	In accordance
2.	PSN2	L	58	G02, G03, G04, G05, G07, G08, G09, G11, G12, G13, G14, G15, G16, G17, G18, G19, G20, G21, G22	Bipolar II	Bipolar II	In accordance
3.	PSN3	L	41	G01, G02, G03, G04, G05, G06, G07, G08, G09, G10, G12, G13, G14, G15, G16, G17, G18, G19, G20, G21, G22	Bipolar I	Bipolar I	In accordance
4.	PSN4	P	47	G19, G21, G23, G24, G25, G26, G27	Cyclomatia	Cyclomatia	In accordance
5.	PSN6	P	46	G04, G21, G28, G29, G30, G31	Unipolar	Unipolar	In accordance

Based on the validation results of 20 patient testing data with a system entitled Implementation of the Forward Chaining Method in Web-Based Bipolar Disorder Expert System, it is stated that it is by expert data and the average level of accuracy reaches 100%.

$$\text{acy Value} \frac{\text{total of appropriate data}}{\text{total of all data}} \times 100\%$$

$$\text{Accuracy Value} \frac{20}{20} \times 100\% = 100\%$$

So that the system obtains results that are by the expert validation of 20 patient data who carry out consultations with an accuracy rate of 100%.

4. CONCLUSION

Based on the results of research with the title Implementation of the forward chaining method on a web-based expert system for diagnosing bipolar disorder, there are several conclusions, namely:
1. The expert system for diagnosing bipolar disorder is designed with the implementation of the forward chaining method to assist heads of offices in providing maximum care to people affected by bipolar

disorder, as well as assisting the community in making an initial diagnosis of people affected by bipolar disorder.
2. The results of the acquisition of expert knowledge obtained 5 disease variables with 32 symptoms.
3. Based on the results of the analysis, the use of the forward chaining method can be applied to diagnose bipolar disorder.
4. Based on the validation results of medical record consultation patient data testing with a system entitled Implementation of the Forward Chaining Method in Web-Based Bipolar Disorder Expert System, from 20 test data obtained results that correspond to an average value of 100% accuracy.

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