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Expert system for diagnosing vaname shrimp disease using forward chaining and case-based reasoning methods

Arini Salsabila [1],Firman Santoso[2], Farihin Lazim[3]
[1]Universitas Ibrahimy, Indonesia, 68374
salsabilaarini03@gmail.com

ABSTRACT

An important part of the fishing industry is the maintenance of shrimp health, especially when it comes to the highly valuable Vannamei shrimp that are cultivated. However, illnesses and other health problems frequently cause productivity problems and result in losses for shrimp growers. The creation of an expert system has been suggested as a potential remedy to these problems. The goal of this research is to create an expert system that can diagnose diseases in shrimp quickly and accurately by analyzing clinical symptoms. This expert system was developed by applying artificial intelligence algorithms for data analysis and diagnosis, recognizing clinical symptoms of shrimp diseases, and learning from fishery professionals. Additionally, the system offers specialized disease control options made to fit the environmental requirements of shrimp farming. This expert system has proven its ability to provide precise diagnoses and suitable treatments for a range of shrimp ailments through testing and evaluation at many Vannamei shrimp farming sites. Improved efficacy and efficiency in managing shrimp health are among the ramifications of this research, which can lower financial losses and promote the expansion of the sustainable fisheries sector.

Keywords:

Expert system; Pond management; Shrimp cultivation; Shrimp disease diagnosis

1. INTRODUCTION

Shrimp ponds are commodities used for the cultivation of various types of shrimp used for the cultivation of various types of shrimp located in coastal areas. Shrimp is one type of fishery product that is in great demand by the public, and has a high export value. There are several types of shrimp that can be cultivated such as galah shrimp, tiger shrimp, and vaname shrimp. Vaname shrimp is one type of shrimp that is often cultivated by many farmers, because vaname shrimp has several advantages, namely more resistant to disease and fluctuations in water quality, fast growth, so it can live in water ponds so that it can be stocked with high density.

The decline in aquaculture water quality is due to increased production of vaname shrimp farming by increasing stocking density with limited land and water resources. Aquaculture waste containing organic matter and nutrients both suspended and dissolved particles result in decreased water quality. The main source of ammonia in aquaculture is the result of shrimp farming waste in the form of organic matter. Water quality plays a role in determining the success of vaname shrimp pond culture because the level of shrimp health, growth, and survival is influenced by environmental interactions, and the condition of vaname shrimp. Not a few vaname shrimp appear several diseases that can cause a decrease in harvest because shrimp are easily exposed to disease and result in mass mortality, so that the benefits obtained are less satisfying, even detrimental.

not a few vaname shrimp appear some diseases that can cause a decrease in harvest because shrimp are easily exposed to disease and cause mass death, so that the benefits obtained are less satisfactory, even detrimental. one alternative is to build an expert system that can diagnose diseases based on the characteristics that have appeared in shrimp. expert systems as artificial intelligence, combining knowledge and facts as well as search techniques and solving problems that normally require the expertise of an expert.

Seeing these problems, a system is needed that can facilitate shrimp farmers to know the shrimp disease that is happening. The creation of the Vaname Shrimp Disease Diagnosis Expert System

application using the Forward Chaining and Case-Based Reasoning Method, aims to help farmers in diagnosing vaname shrimp disease and providing solutions to existing diseases.

2. METHOD

The research method used is Descriptive Method with Qualitative approach method. The Descriptive-Qualitative method is focused on the basic problem of facts carried out by means of observation or observation, and interviews. The descriptive method is research with the intention of making a description (descriptive) of the situations or events that occur.

Interview

Interview is a data collection method with the aim of collecting data in the form of information. This conversation is conducted by two parties, namely the interviewer (interviwer) who asks questions and the interviewee (interview) who provides answers to the questions.

Observation

Observation is a method of collecting data by making direct observations of the object of research up close.

Method Case-Based Reasoning

Case-Based Reasoning is a method to build a system that works by diagnosing new cases based on old cases that have high similarity values. Case-Based Reasoning is the adaptation of solutions that have been used to solve old problems and reuse those solutions for similar new problems. Case-Based relies heavily on SV (Similarity Value) or similarity value. Similarity is a step to recognize similarities between cases stored in the new case base. The Similarity value is determined by a value of I to 1. A value of 0 means not similar and a value of 1 is considered an absolute similar case. The following is the Similarity formula:

Similarity =

$$\frac{\sum ni=0\ f(Ti,Si)xWi}{Wi}$$

keterangan :

T = Target case
S = Case of origin
N = The number of attributes in each case
I = Individual attributes from 1 to n
F = Similarity function for attribute 1 in cases T and S
W = Weight given

Method Forward Chaining

Forward Chaining is the propagation of initial facts or information to reach a final conclusion or goal. Forward Chaining was used to identify initial facts by looking for guidelines that match the conjectures or hypotheses that arise towards a result or conclusion. The Forward Chaining method is used because in this expert system the user first has facts that suit him and then a conclusion or fact that has been selected is made.

Expert System

An expert system is a system that attempts to adopt human knowledge into a computer, so that the computer can solve problems as experts can. Expert systems are designed to mimic the work of experts in order to solve specific problems.

Mysql

MySQL is a SQL database management system software or DBMS Multithread and multi-user. MySQl is actually a derivative of one of the main concepts in databases for selection and data entry that allows data operations to be done easily and automatically.

HTML

HTML is an internet (web) markup language in the form of symbols and codes that are inserted into a file that is designated to be displayed on a website. In short, HTML is a language that is often used to create websites. Websites created with HTML can be seen by everyone connected to the internet. Of

course, by using internet explorer applications (browsers) such as Internet Explorer, Mozilla Firefox and Google Chrome.

RESULTS AND DISCUSSION

Symptoms and types of diseases that often occur in shrimp, the statement was obtained from an expert who used to handle farms and commonly referred to as technicians.

Tabel 1. Symptoms of disease in shrimp

No	Symptom Code	Symptom Name	Expert Value
1	G0001	Pale to white hepatopancreas	0,5
2	G0002	The stomach is pale or white in color and looks empty	0,5
3	G0003	Shrimp skin becomes soft	0,8
4	G0004	There are black nodules on the hepatopancreas	1,5
5	G0005	Mortality starts from the 3rd day after infection	0,7
6	G0006	Shrimp look limp	0,7
7	G0007	Shrimp growth becomes limp	0,7
8	G0008	Shrimp activity decreases	0,2
9	G0009	The release of white feces floating on the surface of the pond	0,3
10	G0010	Pulling over to the edge of the pond	0,5
11	G0011	White color appears as in the meat muscle	0,5
12	G0012	Necrosis at the base of the tail is red	0,6
13	G0013	Decreased appetite and endurance	0,9
14	G0014	Delayed growth	0,3
15	G0015	Death	0,9
16	G0016	Broken antennae	0,9
17	G0017	Incomplete legs	0,9
18	G0018	Broken tail	0,2
19	G0019	Black tail color	1,5
20	G0020	Pale white body	0,5
21	G0021	Black spot on shrimp body area	0,1
22	G0022	Shrimp reddened	1
23	G0023	Yellow skin	0,3
24	G0024	Necrosis or death of shrimp hypodermis (under the skin) tissue	0,1
25	G0025	Necrosis or death of blood cells	0,2
26	G0026	Loss of red blood cells	0,5
27	G0027	Small body size (dwarf)	0,1
28	G0028	Decreased movement activity	0,1
29	G0029	Decreased appetite	0,6
30	G0030	Yellow head	0,1
31	G0031	Paralysis and rapid death	0,9
32	G0032	Breathing difficulty	0,1
33	G0033	Mass death	0,9
34	G0034	Internal organ damage such as liver and intestines	0,2
35	G0035	Yellowish gills	5
36	G0036	Appetite ceases	5
37	G0037	Weakness	3
38	G0038	Visibly faster and irregular breathing	0,5
39	G0039	Swimming always at the edge of the pond	0,5
40	G0040	Gills and body of shrimp are covered with epicomial organisms	0,1
41	G0041	Black spots on antennae body	1,5
42	G0042	White spots in the shape of a circle	0,4
43	G0043	Body dirty with moss	0,5
44	G0044	Increased appetite before disease	0,7
45	G0045	Enlarged hepatopancreas	0,1
46	G0046	Slow response to feed and empty gut	0,2

From the shrimp symptom type data above, a disease can be obtained which is one of the characteristics of the shrimp symptom type. For these symptoms, the system uses the code “P0001” for sequence number one and so on. The diseases can be seen in table 2 as follows :

Tabel 2. types of diseases in shrimp

No	Disease Code	Symptom Code	Description
1	P0001	G0001, G0002, G0003, G0004, G0005,G0006, G0013, G0014, G0015, G0016, G0029, G0037	AHPND
2	P0002	G0009, G0015	WFD

3	P0003	G0010, G0011, G0012, G0013, G0014, G0015, G0016, G0017, G0018, G0019, G0029, G0029, G0031, G0033	IMNV/MYO
4	P0004	G0003, G0004, G0021, G0022	TSV
5	P0005	G0008, G0014, G0020, G0022, G0024, G0025, G0026, G0027, G0028, G0029	IHHNV
6	P0006	G0008, G0020, G0023, G0030, G0031, G0032, G0033, G0034, G0035, G0036	YHV
7	P0007	G0008, G0020, G0022, G0029, G0031, G0034, G0038, G0039, G0040, G0041	MBV
8	P0008	G0017, G0041	Black Spot Disease
9	P0009	G0005, G0006, G0015, G0022, G0034, G0034, G0039, G0042, G0043, G0044, G0045, G0046	WSSV

From the existing shrimp disease type data, it can determine the similarity of new cases with previous cases. Determining similarity can be seen in Table 3 as follows :

Tabel 3. Determining the Similarity of the New Case to the Previous Case

Symptom Code	Symptom Name	New symptoms	AHPND	WFD	MYO	TSV	IHHNV	YHV	MBV	Black spot disease	WSSV
G0001	Pale to white hepatopancreas	✓	✓								
G0002	The stomach is pale or white and looks empty		✓			✓					
G0003	Shrimp skin becomes soft		✓			✓					
G0004	There are black nodules on the hepatopancreas	✓	✓			✓					
G0005	Death occurs starting from the 3rd day after infection		✓								✓
G0006	Shrimp look limp		✓		✓						✓
G0007	Shrimp growth becomes limp		✓								
G0008	Shrimp activity decreases		✓				✓	✓	✓		
G0009	The release of white feces floating on the surface of the pond			✓							
G0010	Pulling over to the edge of the pond				✓						
G0011	White color appears as in the meat muscle				✓						
G0012	Necrosis at the base of the tail is red				✓						
G0013	Decreased appetite and endurance		✓		✓						✓
G0014	Delayed growth		✓		✓		✓				
G0015	Death		✓	✓	✓						✓
G0016	Broken antennae				✓						
G0017	Incomplete legs				✓					✓	
G0018	Broken tail				✓						
G0019	Black tail color				✓						
G0020	Pale white body						✓	✓	✓		
G0021	Black spot on shrimp body area		✓			✓					
G0022	Shrimp reddened					✓	✓		✓		✓
G0023	Yellow skin							✓			
G0024	Necrosis or death of shrimp hypodermis (under the skin) tissue						✓				
G0025	Necrosis or death of						✓				

Symptom Code	Symptom Name	New symptoms	AHPND	WFD	MYO	TSV	IHHNV	YHV	MBV	Black spot disease	WSSV
	blood cells										
G0026	Loss of red blood cells						✓				
G0027	Small body size (dwarf)						✓				
G0028	Decreased movement activity						✓				
G0029	Decreased appetite		✓		✓		✓		✓		✓
G0030	Yellow head							✓			
G0031	Paralysis and rapid death				✓			✓	✓		
G0032	Breathing difficulty							✓			
G0033	Mass death							✓			
G0034	Internal organ damage such as liver and intestines							✓	✓		✓
G0035	Yellowish gills							✓			
G0036	Appetite ceases							✓			✓
G0037	Weakness		✓								
G0038	Visibly faster and irregular breathing								✓		
G0039	Swimming always at the edge of the pond				✓				✓		✓
G0040	Gills and body of shrimp are covered with epicomial organisms	✓							✓		
G0041	Black spots on antennae body								✓	✓	
G0042	White spots in the shape of a circle										✓
G0043	Body dirty with moss										✓
G0044	Increased appetite										✓
G0045	Enlarged hepatopancreas										✓
G0046	Slow feed response and empty gut										✓

To find the similarity value, each belief has the following weight :

- ✓ If there is a match, then the value = 1
- ✓ If there is no match, then the value = 0

Tabel 3. Calculating the Similarity Value of Previous and New Cases

Symptom Code of Previous Case									Symptom Code of a new case	Certainty weight	Answer weight
AHPND	WFD	MYO	TSV	IHHNV	YHV	MBV	Black spot disease	WSSV			
G0001									G0001	0,5	1
G0002										0,5	1
G0003			G0003							0,8	1
G0004			G0004						G0004	1,5	0
G0005								G0005		0,7	1
		G0006						G0006		0,7	1
										0,7	0
				G0008	G0008	G0008				0,2	0
	G0009									0,3	1
		G0010								0,5	1
		G0011								0,5	1
		G0012								0,6	1
G0013		G0013								0,9	1
G0014		G0014		G0014						0,3	1
G0015	G0015	G0015						G0015		0,9	1
		G0016								0,9	1
		G0017					G0017			0,9	1
		G0018								0,2	0
		G0019								1,5	0

					G0020	G0020				0,5	1
			G0021							0,1	0
			G0022	G0022		G0022		G0022		1	1
					G0023					0,3	0
				G0024						0,1	0
				G0025						0,2	0
				G0026						0,5	0
				G0027						0,1	1
				G0028						0,1	0
G0029		G0029		G0029		G0029				0,6	1
					G0030					0,1	0
		G0031			G0031					0,9	1
					G0032					0,1	0
		G0033			G0033					0,9	1
					G0034			G0034		0,2	0
					G0035					5	1
					G0036			G0036		5	1
G0037										3	0
						G0038				0,5	1
						G0039		G0039		0,5	1
						G0040			G0040	0,1	0
						G0041	G0041			1,5	0
								G0042		0,4	0
								G0043		0,5	1
								G0044		0,7	1
								G0045		0,1	0
								G0046		0,2	1

In calculating the similarity value of the previous case with the new case, it is formulated with the formula, as follows :

Case 1

AHPND disease type

$$\frac{(1*0,5)+(1*0,5)+(1*0.8)+(0*1,5)+(1*0,7)+(1*0,9)+(1*0,3)+(1*0,9)+(1*0,6)+(0*0,3)}{0,5+0,5+0,8+1,5+0,7+0,9+0,3+0,9+0,6+0,3}$$

$= 0,7428 * 100 = 74,28\%$

Case 2

WFD disease type

$$\frac{(1*0,3)+(1*0,9)}{0,3+0,9}$$

$= 1 * 100 = 100\%$

Case 3

IMNV/MYO disease type

$$\frac{(1*0,7)+(1*0,5)+(1*0,5)+(1*0,6)+(1*0,9)+(1*0,3)+(1*0,9)+(1*0,9)+(1*0,9)+(0*0,2)+(0*1,5)+(1*0,6)}{0,7+0,5+0,5+0,6+0,9+0,3+0,9+0,9+0,9+0,2+1,5+0,6}$$

$= 1,1176 * 100 = 111,76\%$

Case 4

Types of TSV disease

$$\frac{(1*0,8)+(0*1,5)+(0*0,1)+(1*1)}{0,8+1,5+0,1+1}$$

$= 0,52 * 100 = 0,0052\%$

Case 5

IHHNV disease type

$$\frac{(0*0,2)+(1*0,3)+(1*1)+(0*0,1)+(0*0,2)+(0*0,5)+(0*0,1)+(0*0,1)+(1*0,6)}{0,2+0,3+1+0,1+0,2+0,5+0,1+0,1+0,6}$$

$= 0,6451 * 100 = 64,51\%$

Case 6

YAV Disease Type

$$\frac{(0*0,2)+(1*0,5)+(0*0,3)+(0*0,1)+(0*0,9)+(0*0,1)+(1*0,9)+(0*0,2)+(1*5)+(1*5)}{0,2+0,5+0,3+0,1+0,9+0,1+0,9+0,2+5+5}$$

$= 0,9919 *100 = 99,19\%$

Case 7
MBV disease type

$$\frac{(0*0,2)+(1*0,5)+(1*1)+(1*0,6)+(1*0,5)+(1*0,5)+(0*0,1)+(0*1,5)}{0,2+0,5+1+0,6+0,5+0,5+0,1+1,5}$$

= 1,5510 * 100 = 155%
Case 8
Types of Black Spot Disease

$$\frac{(1*0,7)+(0*1,5)}{0,7+1,5}$$

= 0,375 * 100 = 37,5%
Case 9
WSSV disease type

$$\frac{(1*0,7)+(1*0,7)+(1*0,9)+(1*1)+(0*0,2)+(1*5)+(1*0,5)+(0*0,4)+(1*0,5)+(1*0,7)+(0*0,1)+(1*0,2)}{0,7+0,7+0,9+1+0,2+5+0,5+0,4+0,5+0,7+0,1+0,2}$$

=0,9633 * 100 = 96,33%

System Design

System design for making Shrimp Disease Diagnosis Expert System applications using UML diagrams

1. *Usecase* Diagram

   The activity of designing a design system for the admin can input, edit, delete, view symptom data, and diagnose.

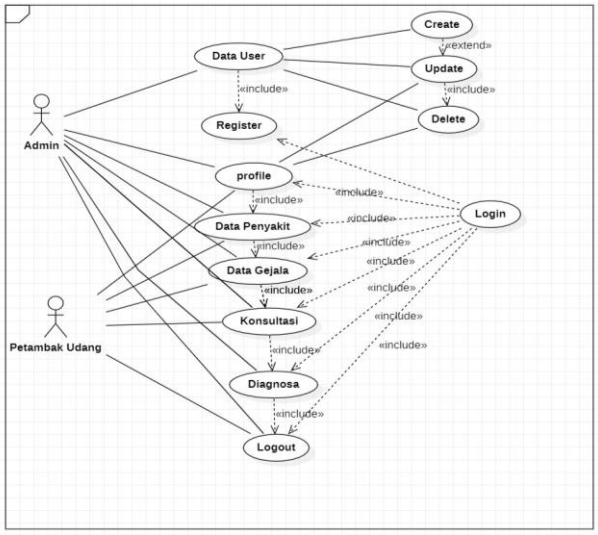

Figure 1. *Usecase* Diagram

2. *Activity* Diagram

Activity diagram describes the activity of diagnosing shrimp disease, starting from the user selecting the diagnosis menu, then the system displays a selection of symptoms, after that select symptoms, and the system displays the diagnosis results.

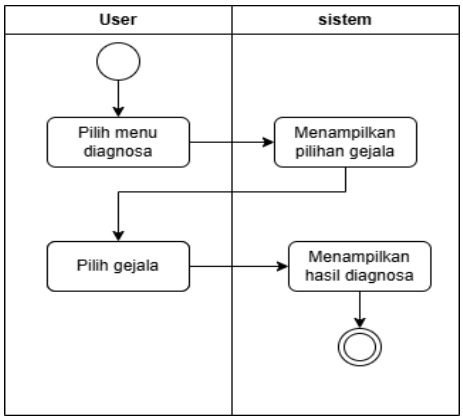

Figure 2. *Activity* Diagram

3. *Class* Diagram

Class diagram is the structure and relationship between classes in a software system. Class diagrams can help in designing data structures to store information about symptoms, diseases, diagnoses, and more.

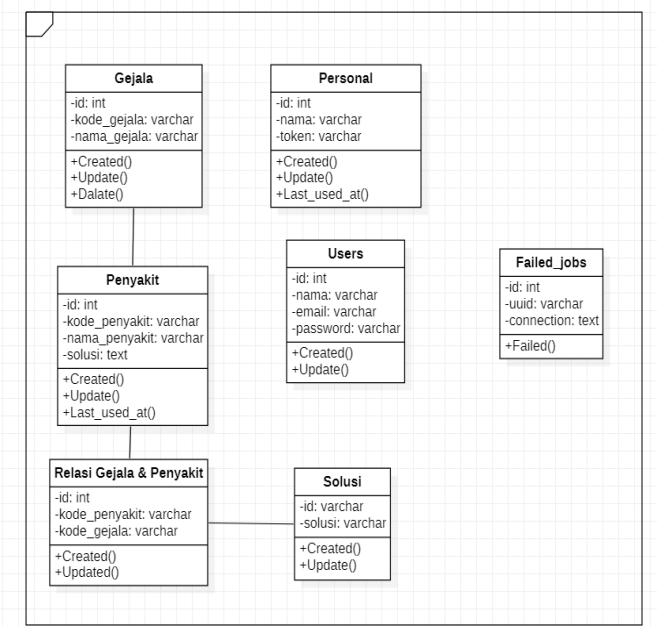

Figure 3. *Class* Diagram

Implementation

Implementation is an extension of the system design process. in this system there are several page views, namely the login form, dashboard menu form, symptom data display, disease data display, diagnosis form, percentage form, and knowledge base. The login form is the main menu where users must log in first, the admin logs in using the account that has been registered.

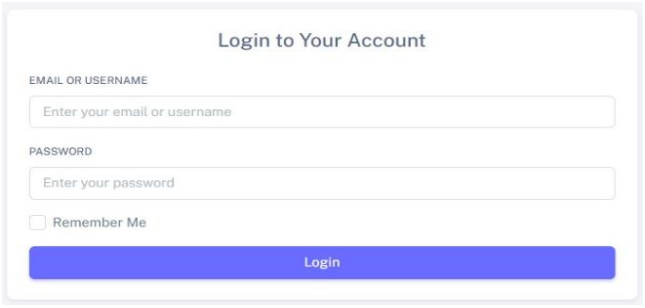

Figure 4. Login form view

Display of symptom data on the admin. Where only admins can add symptom data, edit, delete symptom types, and admins can also import automatic data.

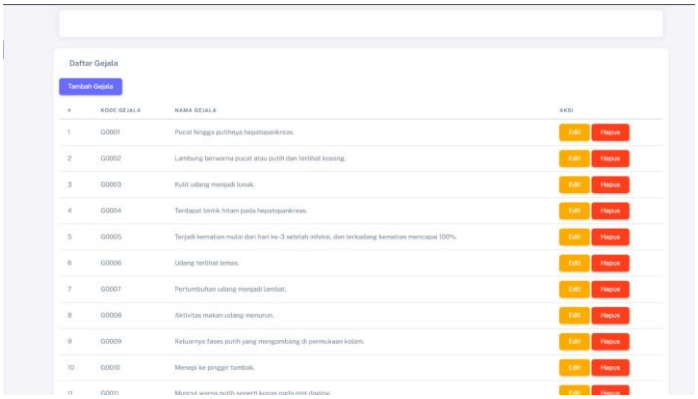

Figure 5. Display of symptom types

Display of disease data on the admin. Where only admins can add disease data, edit, delete symptom types, and admins can also import data automatically.

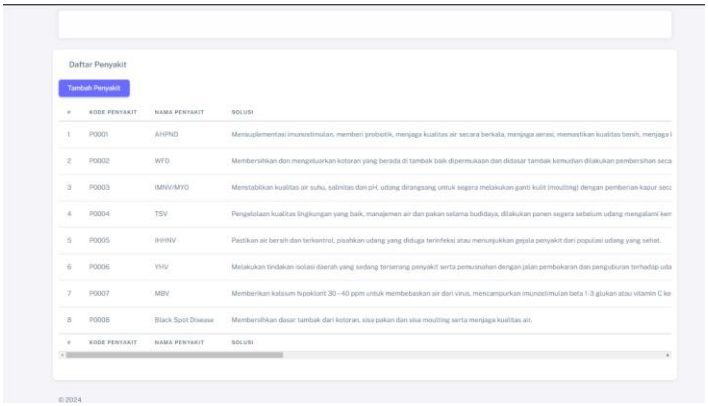

Figure 6. Disease type view

Display form Diagnose disease in shrimp after selecting symptoms.

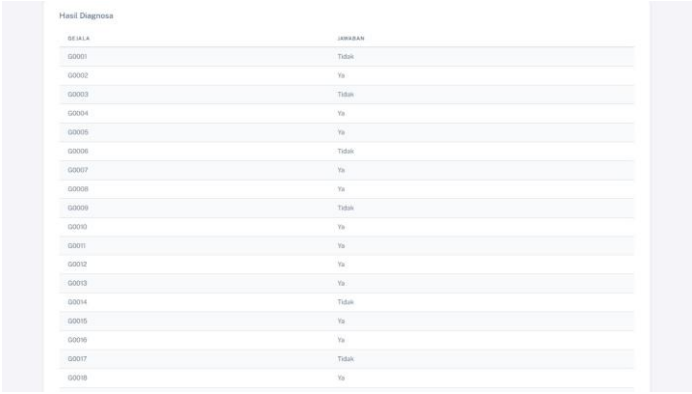

Figure 7. Diagnosis result view

Display of presentation form or results of shrimp disease diagnosis accuracy.

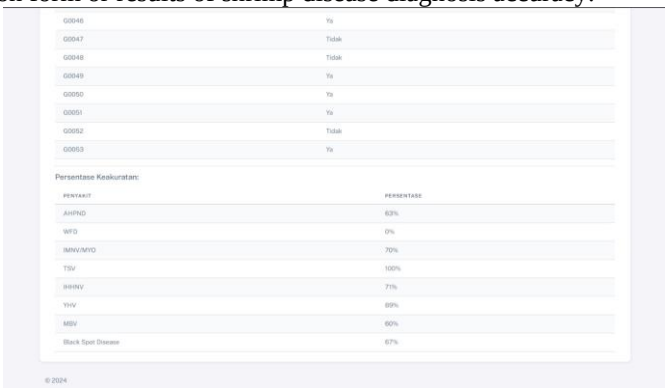

Figure 8. Accuracy view

CONCLUSION

Based on the previous discussion and evaluation, the following conclusions can be drawn:

1. The existence of this shrimp disease diagnosis expert system can assist shrimp farmers in determining diseases without having to meet directly with experts.
2. The implementation of the Case-Based Reasoning (CBR) method is highly suitable for computer-based case reasoning systems.

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BIOGRAPHIES OF AUTHORS

	**Arini Salsabila** is a student of SAINTEK, Ibrahimy University, Information Technology Study Program. I am interested in taking the title of the article Expert System for Diagnosing Shrimp diseases because the research place I took was close to the house where I live. I am interested in exploring the determinants of Vaname shrimp disease in the future.. He can be contacted at email: salsabilaarini03@gmail.com
	**Firman Santoso, M.Kom** is a lecturer at ibrahimy University and Head of Information Technology Department, he is the supervisor in this research. He can be contacted at email: firmandosmik.24@gmail.com

	**Farihin Lazim, M.Tr.T** is a lecturer at Ibrahimi University, Computer Science Study Program, he is the supervisor of the methods that researchers take in this study. He really helped researchers provide excellent input and direction.