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Implementation of certainty factor method for the diagnosis of tyla fish diseases

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ABSTRACT

Tilapia is one of the most attractive fish for the people of Indonesia because it can be easily found in traditional markets. Obstacles during the fish farming process are disease transmission in tilapia that is farmed so that it can affect sales and will certainly harm fish farmers. Based on this, an expert system was created in order to diagnose diseases in Tilapia. The purpose of the system is to assist fish farmers in diagnosing and treating diseases of tilapia. The method or technique used in this study is the Certainty factor. The results of the study obtained an output in the form of the disease experienced and also a solution for handling tilapia attacked by the disease using the Certainty factor method. The expert system produced by the research, then tested using blackbox testing where all components in the tested system produce the desired results and match their functionality, and the results of accuracy testing with experts obtain an accuracy value of 96% so that the system is declared accurate.

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1. INTRODUCTION

The potential in the freshwater fisheries farming industry has its own charm. Referring to data released by the UN Food Agency, it is estimated that per capita fish consumption globally could reach around 19.6 kg per year by 2021. In Indonesia today, it (CCP, 2015) is difficult to get marine fish because it has reached the level of overfishing. Therefore, increasing freshwater fish production as an alternative to marine fish is important. Freshwater fish farming refers to fishery activities carried out in freshwater waters such as lakes, rivers, swamps and ponds. Freshwater fish are types of fish that live and thrive in freshwater environments, such as lakes and swamps (Windi et al., 2021). Types of freshwater fish such as ikan mas, tilapia, catfish, mujair, catfish, and carp are included in the dominant aquaculture production. Total freshwater fish production reachesmore than 80% contributed by these fish species. Tilapia, as one example, has a considerable level of production and its maintenance is spread in areas throughout Indonesia (CCP, 2015). Tilapia (Oreochromis niloticus) has become one of the choices that is quite high in popularity among the public. This fish has a high appeal and is often used as the main choice for daily dishes. Usually, the fish is produced in a period of about 3.5 to 4 (four) months, and weighs between 120 to 200 grams with a maximum length of about 40 cm (Shoni'ah et al., 2021). The growth rate of tilapia can vary, depending on a number of factors such as water quality, pond depth, feed given, as well as the density of fish populations in it.

In 2010-2013, based on data at the Statistics Centerfor North Sumatra Province, freshwater fish farming was recorded as much as 153,936 tons (Fisheries and Marine Service of North Sumatra Province, 2018) . Haranggaol Floating Net Cage (KJA) Haranggaol Village is one of the freshwater fish farming locations that are part of various fish farming areas in North Sumatra. Production of tilapia from 7,066 bags is 18,856.3 tons/year, carp from 84 bags mixed with tilapia (polyculture) is 145.6 tons/year, and catfish from 9 bags is 14.17 tons/year (Simanjuntak &; Sofyani, 2021). During the process of fish farming, farmers face several obstacles, one of which is the spread and transmission of diseases in fish in farmed fish. Common diseases are Trichodiniasis, Saproligniasis, Epistylis Disease, and red spot (Situmorang, 2020). Common symptoms of the disease in tilapia are similar to physical weakness, excessive fluid increase, wounds, or lumps on the body, which makes it difficult for farmers to diagnose the disease due to limited knowledge in handling the disease in tilapia. Thus, farmers are usually reluctant to handle tilapia infected with the disease and choose to leave it to die. Referring to the problems described earlier, researchers will develop a system that can diagnose tilapia disease accurately.

Artificial Intelligence is a computer discipline that continues to grow. In this field, it is not only aimed at understanding, but also the development of smart entities. The definition of artificial intelligence can be divided into 2 main dimensions, namely dealing with the process of thinking or reasoning thinking (reasoning) and actions or behavior (behavior) (Kurniawan, 2020). An expert system is a type of system that seeks to transfer human knowledge into a computer, with the aim of learning and applying the way of thinking and reasoning of experts in solving problems (Kusumadewi, 2003). In this context, "expert" refers to individuals who have specialized knowledge and the ability to solve problems that are beyond the reach of the general public (Nur et al., 2022). An expert system is also referred to as a duplication of the expertise of one or more experts in their field (Nur et al., 2023). The existence of this root system is applied to support and assist in solving a problem (Permata & Hadi, 2020). Examples of such experts are psychologists and medical personnel.

Some previous studies on the expert system are expert systems on gourami with the Case Based Reasioning method with the results that the system can and is feasible to use to diagnose diseases in these fish from 30 samples getting an accuracy of 93.33%. Furthermore, research on the expert system in koi fish with the (Primary et al., 2018). Bayes method, the results obtained that the identification of koi fish disease can be done with a system that has been made so as to be able to diagnose the disease and provide treatment and treatment suggestions based on symptom input from the user (Saraswati et al., 2020). The next research on the application of the expert system in catfish with the certainty factor method with the result that users are helped by the application, so that they can analyze their own fish diseases based on the information on symptoms provided in the application (Permata & Hadi, 2020). Another study related to an expert system for diagnosing parasites found in fish by applying the certainty factor method, this study resulted in the application of the certainty factor method can diagnose parasites that cause fish to develop diseases with a confidence level of above 95% (R. R. Al Hakim et al., 2021). Research related to the expert system diagnosing diseases in goldfish caused by viruses has resulted that the expert system in this study has proven to make it easier to diagnose diseases in goldfish and how to overcome them without having to come to the fisheries service for consultation (Z. Hakim & Rizky, 2019). The research that will becarried out has differences between previous studies, these differences are the object of research namely tilapia, the subject of research is KJA Haranggaol, the method used, the amount of symptom and disease data, and also the output that will be displayed such as handling of diseases.

Based on the literature above, the expert system uses the Certainty factor method. By using the certainty factor, these problems can be overcome through techniques that allow the search for the value of certainty or uncertainty of a symptom related to the disease (Dewi et al., 2015)(Fersi et al., 2022). The purpose of this study is to apply Certainty Factor to the expert system to diagnose Tilapia disease and provide information to Tilapia farmers to obtain results of disease diagnosis and website-based treatment.

2. RESEARCH METHOD

2.1 Research Flow Chart

This research will go through several stages, namely literature study, data collection, data analysis using the CF method, design analysis, implementation, testing, and making conclusions. These stages can be seen in Figure 1 below:

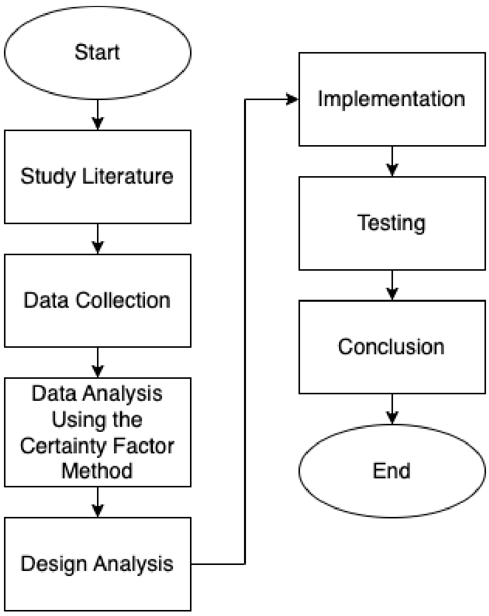


Figure 1. Research Flow Chart

a. Student Literature

Literature search is carried out online as well as, books that are relevant to the research topic. In addition, in this study also used other references such as journals that have been used in previous research.

b. Data Collection

Data was taken from the Banyumas Fisheries and Livestock Service. In the next stage, interviews with relevant experts were conducted to obtain the Certainty factor value of this research object.

c. Data Analysis Using the Certainty Factor Method

In this step, a system flow is drawn which is commonly called a flowchart from the application of the certainty factor method. Flowchart is an illustrative representation of the stages or sequence of activities in a program that is usually used to explain or illustrate every process that occurs in the program (Subrata, 2015)(Fakrurrozi et al., 2022). Basically, the concept of the Certainty Factor method has believe as a belief factor and disbelieve as a factor of uncertainty (Salma Shafira et al., 2022). In Figure 2. Flowchart Certainty factor is shown the CF flowchart.

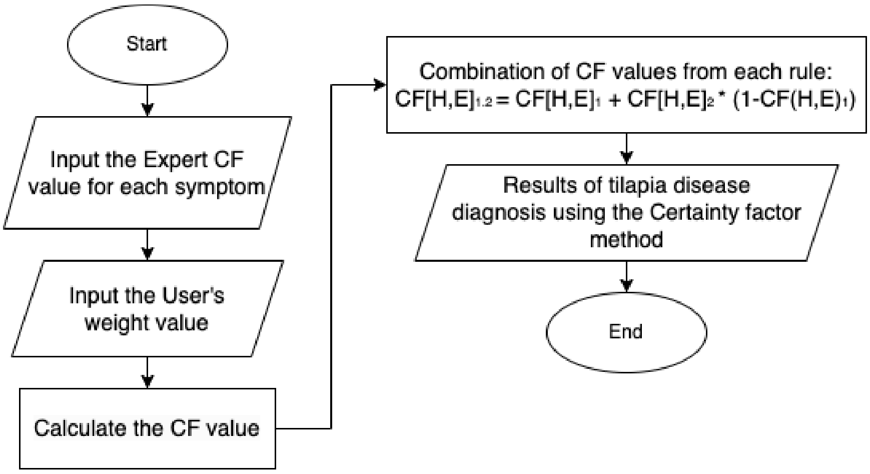


Figure 2. Flowchart Certainty factor

d. Design Analysis

In this step to support the design process and implementationof system entation, researchers utilize Unified Modeling Language and Wireframe. Unified Modelling Language (UML) is a tool for visually describing and documenting the results of analysis and design of a system (Braun et al., 2001). UML includes Use Case Diagrams, Activity Diagrams, and also Sequence Diagrams (Alfathanori & Maslihah, 2021). The wireframe serves as the initial framework before the design of the web page or application interface is created. The elements in a wireframe include text, images, buttons, and content areas that are important components of the design (Hartawan, 2022).

e. Implementation

After the design stage, the next step is implementation. Implementation is the process of creating and running a system. At this stage, the system will be implemented into a program using Hypertext Preprocessor Language (PHP) and get support from other system components.

f. Testing

In this stage, application functionality testing will be carried out to verify the suitabilityof the expert system with the concept that has been set. Testing in this study includes blackbox testing and accuracy testing. Accuracy testing aims to evaluate the extent to which expert systems are able to provide accurate and consistent diagnostic results (NurJumala et al., 2022). Black Box testing focuses on the input issued by the system, according to or not what is expected by users to be ordinary people, so Black Box is suitable because there is no need to understand programming languages (Fadhil et al., 2019) .

g. Conclusion

After completing all steps from literature study to testing, conclusions can be drawn about whether the system performance is in accordance with expectations and is able to provide a clear picture of the methods used as well as the expected results of the research.

3. RESULTS AND DISCUSSIONS

3.1 Research Data

The research data used are in the form of the types of diseases found in tilapia as the object of this study, as well as the symptoms contained in each of these diseases:

a. Symptom Data

The following is the initialization of the symptoms of the disease in Tilapia. The purpose of this symptom initialization stage is to facilitate the creation of a rule base, knowledge base, and implementation of the program. Figure 3 below is a symptom of tilapia disease.

Symptom Code	Symptom
G01	The presence of cotton-like hyphae
G02	Wounds/ulcers on the fish's body
G03	Separate yourself from the group
G04	Appetite goes down
G05	Fish condition is weak
G06	Red spots on the body
G07	Pale skin color
G08	Protruding/bulging eyes
G09	Rubbing the body into the net
G10	Exfoliating skin
G11	Infection of the eyeball such as cataracts
G12	Gasping breathing
G13	White spots on fins/skin/gills
G14	Fish hives
G15	Fin fall out
G16	Gill rot
G17	The edges of the wound appear bright mucus
G18	Sores around the mouth/fins that develop into ulcers
G19	Looks resembling an arrow piercing the body of a fish
G20	Wound/bleeding occurs at the site of attachment
G21	Gill sores/swelling

Figure 3. Symtoms of Tilapia Disesase

b. Disease Data

In the initialization stage of the type of disease in tilapia, the introduction of several types of diseases that have different codes is carried out. The purpose of this symptom initialization stage is to facilitate the creation of a base or rule, knowledge base, and implementation of the program. The following is the result of initializing the type of disease in Tilapia. Figure 4 below is a type of tilapia disease.

Disease Code	Disease Name
P01	Epizootic Ulcerative Syndrome (EUS)
P02	Aeromonas
P03	Streptococciasis
P04	Argulus (Fish Lice)
P05	Tilapia lake virus
P06	Lernaesis (Anchor Worm)
P07	White Spot (White Spot)
P08	Trichodiniasis
P09	Dactylogyriasis
P10	Gyrodactyliasis
P11	Columnaris Desease
P12	Branchiomycosis
P13	Saproligniasis

Figure 4. The type of disease

Based on Figure 3 and Figure 4 above, there are several symptoms caused by each type of pest and disease in tilapia bikan which can be described in Table 1.

Table 1. Relationship between Tilapia Symptoms and Diseases

No.	Symtom Code	Diseases Code												
		P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	P13
1	G01	□												
2	G02	□		□	□				□		□			
3	G03	□												
4	G04	□	□	□				□						
5	G05	□	□	□										
6	G06		□								□			
7	G07		□	□										
8	G08			□		□								
9	G09				□			□			□			□
10	G10					□								
11	G11					□								
12	G12							□		□			□	
13	G13							□						□
14	G14								□					
15	G15											□		
16	G16											□	□	
17	G17											□		
18	G18											□		
19	G19						□							
20	G20						□							
21	G21									□				

Based on the relationship of symptom codes with the type of disease in the table above, it can be concluded that the expert system for diagnosing tilapia disease has many rules. This can be shown by the following Table 2.

Table 2. Rules

No.	Symptom Code	Disease
1	G03 AND G04 AND G01 AND G02 AND G05	P01
2	G07 AND G02 AND G05 AND G06	P02
3	G02 AND G04 AND G05 AND G07 AND G08	P03
4	G02 AND G09	P04
5	G08 AND G10 AND G11	P05
6	G19 AND G20	P06
7	G04 AND G09 AND G12 AND G13	P07
8	G02 AND G14	P08
9	G12 AND G21	P09
10	G02 AND G06 AND G09	P10
11	G18 AND G17 AND G15 AND G16	P11
12	G12 AND G16	P12
13	G09 AND G13	P13

c. Analisis Data dengan Metode CF

The calculation step with the certainty factor testing method is tried to solve the problem of tilapia farmers, the fish experience symptoms seen in fish. Case in point: a tilapia experiences symptoms such as the presence of cotton-like hyphae (G01) with CFUser 0.8 (Almost certain), decreased appetite (GO4) with CFUser 1 (Definitely), and weak fish condition (G05) with CFUser 0.8 (Almost certain). Experts have rated the expert CF/CF values for EUS disease at 0.8 for G01, 0.8 for G04, and 0.6 for G05. What percent is the Certainty Factor value for EUS disease?

CF [H, E]1 = CF User * CF Expert
= 0.8 * 08
= 0.64
CF [H, E]2 = CF User * CF Expert
= 1 * 08
= 0.8
CF [H, E]3 = CF User * CF Expert
= 0.8 * 06
= 0.48
CF1,2 = CF [H, E]1 + CF [H, E]2 * (1 – CF [H, E]1)
= 0.64 + 0.8 * (1 – 0.64)
= 0.64 + 0.288
= 0.928
CF combine = CF1,2 + CF [H, E]3 * (1 - CF1,2)
= 0.928 + 0.48 * (1 – 0.928)
= 0.928 + 0.034
= 0.962

By multiplying 0.962 x 100% then the result is 96%. Thus, based on the calculation of the certainty factor value, the greatest level of confidence found in EUS disease based on these symptoms is 96%. Control of this fungal infectious disease can be done through prevention and treatment. Prevention is done by avoiding stressors both physical, chemical, and biological and replacing with fresh water. The treatment carried out, namely soaking methylene blue 2-5 ppm, soaking formalin 250 mg/L for 1 hour, soaking potassium permanganate 1-2 ppm for 90 minutes, soaking 100-200 ppm for 1-3 hours, and soaking table salt 1,000-2,000 ppm for 24 hours.

d. Design Analysis

The Use Case Diagram will graphically illustrate the various interactions between users and systems in the tilapia disease diagnosis expert system application with the website-based Certainty Factor method. Analysis of randomization in the form of use cases can be seen in
Figure *5* below.

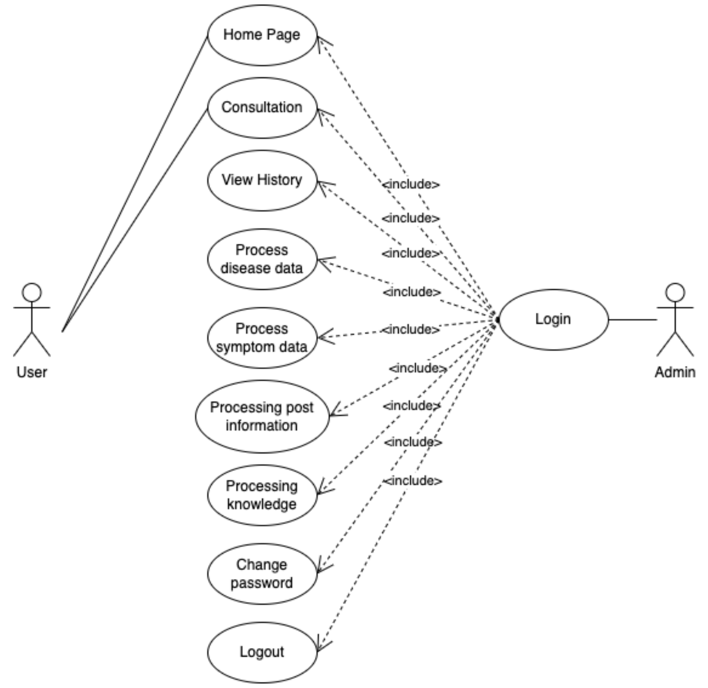
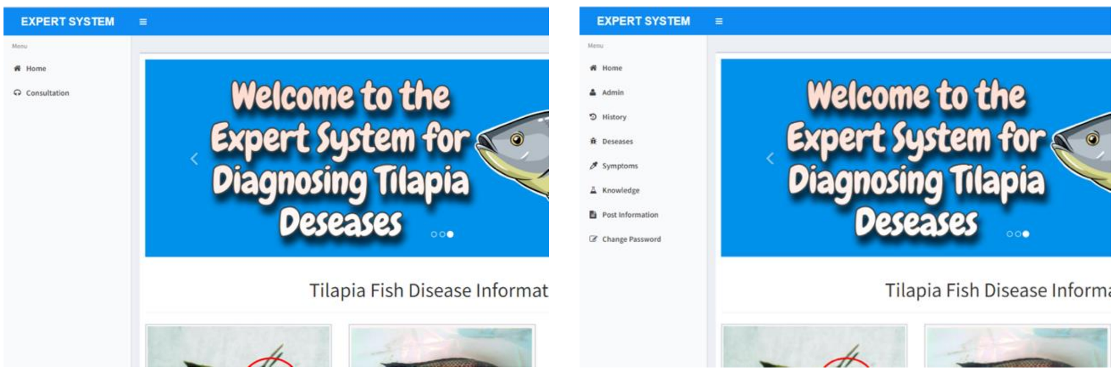


Figure 5. Usecase Diagram

Based on Figure 5 above. Users can open the home page, consult independently, and see the results of the diagnosis from the consultation that has been done. Admins must be logged in to be able to open the home page, view and edit admin data, view consultation history, process disease and symptom data, process information and knowledge posts, change passwords, and log out.

e. Implementation Results

After the calculation is carried out using the Certainty Factor method, it will then be implemented into a website-based system. At this stage, an interface page is generated which is the result of designing an expert system website. This stage shows evidence that the expert system has been designed as well as possible with predetermined expectations. Here is a look at the website of the expert system for diagnosing tilapia disease. The main page of the system can be seen in Figure 6: (a) User Home, (b) Admin Home, consultation main page can be seen in Figure 7.



(a) User Home (b) Admin Home

Figure 6. System Home: (a) User Home, (b) Admin Home

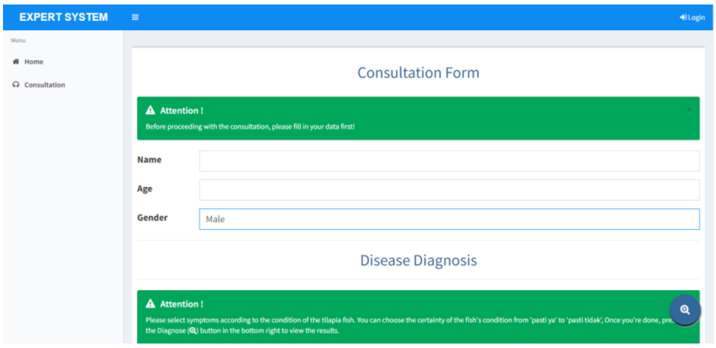


Figure 7. Consultation Page

Based on Figure 6 above. On the homepage the User side has a Home menu feature and a Consultation menu, on the Admin side it has quite complex features, namely the Home menu, Admin, History, Disease, Symptoms, Knowledge, Post Description, Change password. Furthermore, in Figure 7, shows the consultation page containing the symptoms of tilapia disease to be diagnosed.

e. Blackbox Test Results and Accuracy

The system that has been produced in this study will be tested for functionality with the blackbox testing method. The purpose of this test is to find errors or flaws in the system so that it can be corrected. Here is an example of blackbox test results that can be seen in Table 3:

Table 3. Test results User Home

No.	Scenario	Test Case	Expected Results	Results
1	Home Menu	Click Home Menu	The system successfully displays the Home Page	Succeed
2	Image slider	Click the slider navigation	The image slider has been successfully shifted	Succeed
3	Displays Disease Details	Click Details on a disease	The system displays disease details	Succeed
4	Displays Suggestions	Click Suggestions on a disease	The system displays suggestions	Succeed
5	Admin login menu	Click login	The system displays the Admin login form	Succeed
6	Sidebar	Click sidebar	The system displays a navigation menu	Succeed

Based on Table 3 functional features contained in the user home page can be run and there are no problems. To find the accuracy value of the expert system, testing is carried out using a confusion matrix to measure the level of accuracy. The test results showed that out of 50 rules tested, 48 rules were declared correct and 2 rules were declared false. Here is Table 4 showing the results of these tests.

Table 4. True Positive and False Positive Test Results

No.	True Positif	False Positif
1	G5 AND G4 AND G1	G4 AND G5 AND G7 AND G12
2	G4 AND G5 AND G8 AND G3	G4 AND G5
3	G2 AND G4	
4	G5 AND G6	
5	G3 AND G11	

Table 3 above is an example of a true positive test result. True positive data refers to data whose actual value is correct and predicted is also correct, so the data mentioned above can be categorized as true positive, which means that the data inputted is in accordance with the symptoms of fish disease. Furthermore, false positive data occurs when the fact-finding process or symptom rules lead to conclusions that do not match or differ from the conclusions given by experts.

$$\text{Accuracy} = (TN+TP)/(TN+FP+TP+FN)*100\%$$
$$\text{Accuracy} = (0+48)/(0+2+48+0)*100\%$$
$$= 48/50\times 100\%$$
$$= 96\%$$

The calculation results in testing the tested data and the system gets the conclusion that the accuracy rate in this expert system is 96%.

3.2 Discussions

This research brings new elements in science such as methods used in the context of disease diagnosis and risk evaluation, website-based systems that are new and modern approaches in providing access and information for fish farmers and other stakeholders, presenting case studies of Haranggaol Floating Net Cages which are specific contributions that provide insight into how these systems function in real situations, And the research may also provide new insights into understanding the environment of floating net cages and their impact on fish health. The main findings are proven through accuracy testing with experts. Sample testing in this study used 50 randomly selected sample rules, as many as 48 rules were declared successful and 2 rules were declared unsuccessful. From the test results, an accuracy rate of 96% was obtained. After carrying out system testing using the black box method, the expert system that has been designed has proven feasible to use. Test results involving experts and fish farmers show that the tested components produce output that is in line with expectations and works well.

4. CONCLUSION

Based on the findings of this study, it can be concluded that the expert system designed successfully applies the certainty factor method using symptoms inputted by the user. Judging from accuracy testing involving experts, out of 50 randomly selected sample rules, 48 rules managed to give appropriate results and 2 rules did not work. This results in an accuracy rate of 96%. The results of tests involving experts and fish farmers prove that system components produce output that is in line with expectations and functions properly. The limitations in the study are the expert system for diagnosing Tilapia disease with the Certainty Factor method, there are 21 symptom data and 13 Tilapia disease data, data taken from the Banyumas Fisheries and Livestock Service (DINKANNAK), Future research can be developed into an Android application and also future research is expected to add other types of diseases and symptoms to be more comprehensive and able to provide a wider and accurate diagnosis against various types of diseases that may occur in tilapia.

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