**Journal of Artificial Intelligence and Engineering Applications**

*Website: https://ioinformatic.org/*

*15th October 2025. Vol. 5. No. 1; e-ISSN: 2808-4519*

# Design of a Diagnostic Expert System in Pig Farm Using a Web-Based Bayes Theorem Method

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**Abstract**

Based on data from the East Sumba livestock office from 2021 to 2024, there are three cases of diseases in pigs that have occurred such as *African Swine Fever* (ASF), Cholera *(Hog cholera),* Worms *(Helminthiasi).* Diseases in pig farm animals are generally caused by viruses, bacteria, parasites, which can cause mass deaths and great economic losses for farmers. In addition, the problems faced include the low understanding of farmers about the symptoms and treatment of the disease, the limited number of veterinarians and medical personnel, and the lack of access to animal health services and other supporting information. To address this problem, the research developed a web-based expert system designed to help diagnose swine disease using the Theorem method that can help make early diagnosis independently and provide quick and precise treatment recommendations. In addition, this system is also expected to help veterinarians and medical professionals in expanding the reach of information and education services to the public more efficiently.

***Keywords***: *Bayes' Theorem Method, PHP, Swine Disease, Expert Systems, Web-Based*

## 1. Introduction

The development of information and communication technology today has a big impact in various areas of our lives, including in the world of agriculture and livestock. In today's digital era, technology is not only used to support the process of machine automation, but also used in the form of computer-based information systems to help make faster, more accurate, and more efficient decisions. According to. In the world of livestock, the application of technology is very important to be used to increase productivity, efficiency of livestock management, and support efforts to prevent and control livestock diseases. Technology can be a solution to overcome various obstacles, especially in managing livestock health in an integrated and modern manner, so that it can help farmers in maintaining the stability of their livestock business results.[1]

One of the uses of technology in the field of livestock is through the expert system, which is an artificial intelligence-based system designed to mimic the ability of an expert to analyze and solve certain problems. In the context of animal health, expert systems can be used to help diagnose diseases based on the symptoms that arise in animals. In pig farming, there are various diseases that are common and have the potential to cause mass deaths, such as *African Swine Fever* (ASF), a viral disease that is highly contagious and has not been found a vaccine to date, swine cholera (*Hog Cholera*) is also contagious but has a vaccine, Worm disease (*Helminthiasis)* caused by parasitic infections in the digestive tract.

In East Sumba Regency, East Nusa Tenggara Province, which is one of the areas with a fairly high number of pig livestock populations on the island of Sumba. Based on "data from the livestock office of East Sumba Regency, East Nusa Tenggara", the number of pig deaths due to *African Swine Fever* (ASF) disease in 2021 was recorded at 1,500 heads, and decreased to 500 heads in 2022, then increased to 900 heads in 2023 and jumped sharply to 3,000 heads in 2024. Meanwhile, the number of pig deaths due to cholera (*Hog Cholera*) was recorded at 41 in 2021, 11 in 2022, increasing to 233 in 2023, and 221 in 2024, while for cases of worm disease (*helminthiasis),* the number of deaths was recorded as many as 1,356 in 2021, increasing to 2,209 in 2022, Then it decreased to 1,482 heads in 2023, and 1,457 pads in 2024. This data shows the importance of early detection and rapid treatment of diseases in pigs. The increase in the number of cases from year to year reflects that efforts to handle *African Swine Fever* (ASF*),* Cholera (Hog Cholera) and Worms (*Helminthiasis)* are still not optimal. Some of the factors that contribute to worsening the condition are the limited number of veterinarians and veterinary medical personnel, which causes difficulties for farmers to obtain animal health services quickly and professionally, low knowledge of breeders about the symptoms and handling of *African Swine Fever* (ASF), cholera (Hog Cholera), and worm disease (*Helminthiasis)* causing delays in taking action, in addition to the lack of an easily accessible diagnosis support system that further complicates the process of early identification of diseases, lack of attention to the provision of supplements such as vitamins, drugs, and vaccines which play an important role in increasing the immunity of pigs to infections, in addition, the lack of continuous training and education to farmers about biosecurity and preventive measures also worsens the situation, Low awareness of the importance of cage sanitation and isolation practices for sick animals creates a large gap for the spread of swine disease in East Sumba Regency.

Based on the description described above, an expert system is created consisting of a symptom base and solutions to overcome the problem. This study aims to design and build a web-based expert system to diagnose pig livestock diseases using the *Bayes Theorem* method, which calculates the likelihood of diseases based on the symptoms input by the farmer. With this system, it is hoped that farmers can carry out early detection independently and obtain fast and accurate handling recommendations.

# 2. Literature Review

## 2.1. Expert System

Expert systems are computer-based systems that can solve problems using knowledge, facts, and reasoning that can generally only be solved by experts. Some of the characteristics of an expert system are that it has accurate information, is easy to make changes to its system, has the ability to learn and adapt, and can be used in a variety of existing technologies.[2]

## 2.2. Bayes' Theorem

Bayes' theorem is a system of theoretical methods that has two different interpretations. In Bayesian interpretation, the theorem explains how one's subjective level of belief must change rationally when faced with new evidence. This allows us to assess or revise probabilities based on initial information that has not been corrected, thus obtaining probabilities.[3]

## 2.3. Swine Diseases

Swine disease is an abnormal condition that attacks the health of pigs, caused by various pathogenic agents such as viruses, bacteria, parasites, or non-infectious factors such as nutritional deficiencies and environmental stress. This disease can affect various organ systems of the pig's body, such as the digestive, respiratory, and reproductive systems, and can cause decreased productivity, stunted growth, and even death. Some diseases in pigs are highly contagious and can spread rapidly among livestock populations, such as *African Swine Fever* (ASF), swine cholera (*Hog Cholera)* and Worms (*Helminthiasis).* Therefore, early detection and proper handling are essential to prevent significant economic losses in the pig farming sector. The types of swine diseases are as follows:

a) *African Swine Fever* (ASF)
*African Swine Fever* is a viral disease that is highly contagious in domestic pigs and wild pigs. And the condition causes the death of pigs, diseases can cause considerable economic losses for pig farmers, especially the southwestern community. Livestock health is a condition or condition that causes slow growth, weight loss and reproductive disorders. One of the important parts of handling livestock health is to observe sick livestock through examinations. The following are some types of diseases that are suspected of being sick. *African Swine Fever* (ASF) in pigs. Clinical symptoms of ASF include high fever, lethargy and unwillingness to eat, red or bluish spots on the skin and decreased appetite.[4]

b) Swine Cholera (*Hog Cholera)*
*Hog Cholera* is a highly contagious viral disease in pigs, caused by *Classical Swine Fever Virus* (CSFV) of the genus *Pestivirus*family *Flaviviridae.* This disease can cause huge economic losses in the pig farming industry. The main symptoms include fever, depression, loss of appetite, bloody diarrhea, and death. Clinically, this disease has similarities to ASF, but it can be distinguished from Cholera disease that has a vaccine and can still be overcome.[5]

c) Worms (*Helminthiasis*)
*Helminthiasis* In pigs, it is an infection of the digestive tract caused by worm parasites such as *Ascaris suum* (roundworm), *Trichuris suis* (whipworm), and other species of nematoda, trematoda, and cestoda. This disease is commonly found on traditional farms with poor sanitation, and can cause weight loss, stunted growth, anemia, and overall decreased productivity symptoms that are white, namely: diarrhea, distended stomach, coarse and dull fur, weakness and fatigue, There are internal worms *Anemia* (paleness of the mucous membranes) Mild cough.[6]

## 2.4. Website

A website is a collection of pages that display text, images, sounds, videos, animations, and a combination of all of them, both static and dynamic, which form a series of buildings that are connected to networks of pages (hyperlinks). A website is a set of web pages that are integrated and have relationships between interrelated files

## 2.5. Systems Modeling

Modeling is a theoretical method that has two different interpretations. In the interpretation of an object, with the aim of simplifying complex structures. In system design, the modeling used is UML (Unifiend Modeling Language), which serves as a guide in developing applications. UML is a visual modeling language used to specify, visualize, build, and document the design of a software system.[7]

# 3. Research Methods

## 3.1. Research Object

This research was conducted on pig farms in East Sumba district, East Nusa Tenggara to design an expert system that can diagnose diseases in pigs using the Bayes Theorem method.

## 3.2. Research Flow

The step taken to obtain data in this study is to conduct direct research in the field directly looking for data on diseases in pig farms in East Sumba.

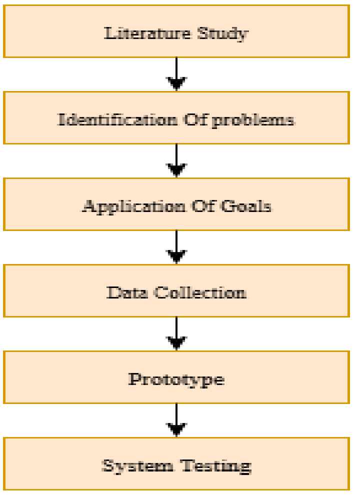


**Fig. 1.** Research Flow

## 3.3. Development Methods

The research method used in the expert system for the identification of peanut plant diseases is the waterfall method because this method is a sequential software development model, where each stage is passed one by one systematically like a waterfall flow, this method is used to conduct system analysis to develop an information system, starting from needs analysis and design.

## 3.4. Needs Analysis

At this stage, the needs of the system are collected based on the problems faced by the farmer that are needed, namely the knowledge base, the list of diseases and symptoms, the symptom code, the disease code, and the symptom code.

1. Knowledge Base

This system has diagnostic rules sourced from experts. Experts will enter their knowledge into the format provided, which can later be added if there are any shortcomings. The list of diagnostic rules in the expert system is as follows.

a. Initialization of Disease and Symptom Data

**Table 1:** List of Diseases

| Yes | Disease Code | Disease Name |
|---|---|---|
| 1 | P01 | *African Swine Fever* (ASF) |
| 2 | P02 | Cholera (*Hog Cholera)* |
| 3 | P03 | Worms (*Helminthiasis)* |

**Table 2:** List of Symptoms

| Yes | Disease Code | Symptom Name |
|---|---|---|
| 1 | G01 | High Fever |
| 2 | G02 | Lethargic and weak |
| 3 | G03 | Not wanting to eat |
| 4 | G04 | Redness of skin on the ears, abdomen, and legs |
| 5 | G05 | Rapid breathing |
| 6 | G06 | Sudden death |
| 7 | G09 | Decreased appetite |
| 10 | G01 | High Fever |
| 11 | G03 | Not wanting to eat |
| 12 | G07 | Diarrhea |
| 13 | G08 | Vomit |

| | | |
|---|---|---|
| 14 | G09 | Decreased appetite |
| 15 | G017 | Pale skin (anemia) |
| 16 | G016 | Limp |
| 17 | G020 | Weight loss |
| 18 | G02 | Lethargic and weak |
| 19 | G03 | Not wanting to eat |
| 20 | G07 | Diarrhea |
| 21 | G09 | Decreased appetite |
| 22 | G017 | Pale skin (anemia) |
| 23 | G018 | Limp |
| 24 | G019 | Weight loss |
| 25 | G020 | The stomach looks distended |
| 26 | G021 | Slow growth compared to other pigs accordingly |

b. Displays the probability value of a symptom

**Table 3:** Probability Value

| Disease Name | Symptom Code | Probability |
|---|---|---|
| P01 | G01 | 0.90 |
| | G02 | 0.83 |
| | G03 | 0.90 |
| | G04 | 0.80 |
| | G05 | 0.80 |
| | G06 | 0.75 |
| | G09 | 0.85 |
| P02 | G01 | 0.70 |
| | G03 | 0.70 |
| | G07 | 0.85 |
| | G08 | 0.60 |
| | G09 | 0.65 |
| | G017 | 0.55 |
| | G016 | 0.65 |
| | G020 | 0.60 |
| P03 | G02 | 0.60 |
| | G03 | 0.60 |
| | G07 | 0.70 |
| | G09 | 0.85 |
| | G017 | 0.70 |
| | G018 | 0.60 |
| | G019 | 0.75 |
| | G020 | 0.85 |

c. **Rule Base**

**Table 4:** Rule Base

| Rule | Symptom |
|---|---|
| Rule 1 | IF Pigs have a high fever (G01)<br>AND Lethargic and weak (G02)<br>AND Won't eat (G03)<br>AND reddish skin on the ears, abdomen, legs (G04)<br>AND Rapid breathing (G05)<br>AND Sudden death (G06)<br>AND decreased appetite(G09) |
| Rule 2 | IF Pigs have a high fever (G01)<br>AND Won't eat (G03)<br>DAN Diarrhea (G07)<br>AND VOMIT (G08)<br>AND Lust is decreasing (G09)<br>AND Pale Skin (G017)<br>DAN Lover (G016)<br>AND Drastic weight loss (G020) |
| Rule 3 | IF Lethargic and weak (G02)<br>AND Won't eat (G03)<br>DAN Diarrhea (G07)<br>AND decreased appetite (G09)<br>AND Pale skin (G017)<br>DAN Drowns (G018)<br>AND Weight loss (G019)<br>AND A Bloated Belly (G020)<br>AND Slow Growth (G021) |

d. Based on the results of the research conducted on new cases of pigs that experienced symptoms as follows:

**Table 5:** Consultation

| Symptom Code | Questions Based on Symptoms | Answer |
|---|---|---|
| G01 | High Fever | Yes |
| G02 | Not wanting to eat | Yes |

| | | |
|---|---|---|
| G03 | Redness of skin in the ears, abdomen, and legs | Yes |
| G04 | Rapid Breathing | Not |
| G05 | Sudden death | Not |
| G06 | Male lust | Yes |
| G07 | High fever | Yes |
| G08 | Not wanting to eat | Yes |
| G09 | Diarrhea | Not |
| G010 | Vomit | Not |
| G011 | Decreased appetite | Yes |
| G012 | Pale skin (anemia) | Not |
| G013 | Drastic weight loss | Yes |
| G014 | Lethargic and weak | Yes |
| G015 | Not wanting to eat | Yes |
| G016 | Diarrhea | Not |
| G017 | Decreased appetite | Yes |
| G018 | Weight loss | Yes |
| G019 | The stomach looks distended | Not |
| G020 | Slow growth compared to other pigs of its age | Yes |

1. Calculation of Bayes' Theorem Method
   a. Summing the Probability Value

Explain the probability value of each *evidence* for each hypothesis based on the data in the case.

1. P01 = *African Swine Fever* (ASF)
   G01 = P(E|H1) = 0.90
   G02 =P(E|H2) = 0.80
   G03 = P(H|H3) = 0.83
   G04 = P(H|H4) = 0.70
   G05 = P(H|H5) = 0.60
   G06 = P(H|H6) = 0.80
   G09 = P(H|H9) = 0.70
   $\sum_{i=n}^{n}$ = 0.90+0.80+0.83+0.70+0.60+0.80+0.70= 5.33
2. P02= Cholera (*Hog Cholera*)
   G01=P(H|H1) = 0.90
   G03 = P(H|H3) = 0.82
   G07 = P(H|H7) = 0.79
   G08 = P(H|H8) = 0.69
   G09 = P(H|H9) = 0.73
   G017 =P(H|H17) = 0.51
   G016 = P(H|H16) = 0.64
   $\sum_{i=n}^{n}$ = 0.90+0.82+0.79+0.69+0.73+0.51+0.64 = 5.08
3. P03= Worm Disease (*Helminthiasis*)
   G02 = P(H|H2) = 0.60
   G03 = P(H|H3) = 0.60
   G07 = P(H|H7) = 0.70
   G09 = P(H|H9) = 0.85
   G017 =P(H|H17) = 0.70
   G018 =P(H|H18)= 0.60
   G019=P(H|H19)= 0.75
   G020=P(H|H20)= 0.85
   G021= P(H|H21) = 0.80
   $\sum_{i=n}^{n}$ = 0.60+0.60+0.70+0.85+0.70+0.60+0.75+0.85+0.80=6.45

b. Looking for the probability value of the hypothesis looking at H regardless *of any other evidence*, each looking for probability by dividing the probability value of the initial evidence with the probability sum result based on the new sample.

$$P(H1) = \frac{p\ (E\backslash Hi)}{\sum_{i=n}^{n}}$$

1. P01 = *African Swine Fever* (ASF)
   (P|H1) = $\frac{0.90}{5,33} = 0.169$
   (P|H2) = $\frac{0.80}{5,33} = 0,150$
   (P|H3) =$\frac{0.83}{5,33} = 0,156$
   (P|H4) = $\frac{0.70}{5,33} = 0,131$
   (P|( H5) = $\frac{0.60}{5,33} = 0.113$
   (P|H6) =$\frac{0.80}{5,33} = 0,150$
   (P|H9) = $\frac{0.70}{5,33} = 0,131$
2. P02 = Cholera (*Hog Cholera)*
   (P|H1) = $\frac{0.90}{5,08} = 0.177$

(P|H3) = $\frac{0.82}{5,08} = 0,161$
(P|H7) = $\frac{0.79}{5,08} = 0.156$
(P|H8) = $\frac{0.69}{5,08} = 0,136$
(P|H9) = $\frac{0.73}{5,08} = 0,144$
(PH17) = $\frac{0.51}{5,08}$ =0,100
(P|H16) = $\frac{0.64}{5,08} = 0,126$

3. P03 = Stinging Disease (*Helminthiasis)*
(PH1) = $\frac{0.60}{6,45} = 0.0930$
(P(H3) = $\frac{0.60}{6,45} = 0.0930$
(P(H7) = $\frac{0.70}{6,45} = 0,1085$
(P(H8) = $\frac{0.85}{6,45} = 0,1318$
(P|H9) = $\frac{0.70}{6,45} = 0.1085$
(P|H17) = $\frac{0.60}{6,45} = 0,0930$
(P|H16) = $\frac{0.75}{6,45} = 0,1163$
(P|H20) = $\frac{0.85}{6,45} = 0.1318$
(P|H21) = $\frac{0.80}{6,45} = 0.1240$

c. Looking for hypothesis probabilities looks at *evidence* by switching the probability value of the initial evidence to the probability value of the hypothesis without looking at the *evidence* and adding the multiplication results for each hypothesis.
$\sum_{i=n}^{n}$ = p(Hi)*p(E\Hi) +...+ p(Hi)*p(E\Hi)

1. P01= African *Swine Fever (*ASF)
$\sum_{k=1}^{1} =$ (0,90*0.169) + (0.80*0.150) + (0.83*0.156) + (0.70+0.131) +(0,60*0,113)+ (0,80*0,150) +(0,70*131
= 0.1521+0.1200+0.1295+0.0917+0.0678+0.1200+0.0917
= 0.7728

2. P02 = Cholera (*Hog Cholera)*
$\sum_{k=1}^{1} =$ (0,90*0.177) +(0.82*0.161) + (0.79*0.156) + (0.69+0.136) +(0.73*0.144) +(0.51*0.100)
=0.1593+0.1320+1232+0.0938+0.1051+0.0510
=0, 6644

3. P03= Worm disease (*Helminthiasis)*
$\sum_{k=1}^{1}$(0, 60*0,0930)+0,60*0,0930)+(0,70*0,1085)+(0,85*0,1318)+(70*0,1085)+(0,60*0,0930+0,75*0,1163)+0,85*0,1318+80 *0,124
=0.0558+0.0558+0.07595+0.11203+0.07595+0.0558+0.08723+0.11203+0.0992
= 0.7298

From the calculation process using the *Bayes Theorem* method above, the following results were obtained:

**Table 6:** Final Results of *Bayes' Theorem Method Calculation*

| Disease codes | Name of the disease | Final score |
|---|---|---|
| P01 | *African Swine Fever* (ASF) | 0,7728 |
| P02 | *Cholera* (*Hog Cholera)* | 0, 6644 |
| P03 | *Worms* **(***Helminthiasis)* | 0,7298 |

# 4. System Implementation

## 4.1. System Implementation

This section describes this stage of the implementation of the system design that has been done before. The implementation process is shown through the interface of the swine disease diagnostic expert system. This aims to visually describe how the system works and provide an overview of the flow of system usage by users. This system has two access rights, namely admin (expert) user (User)

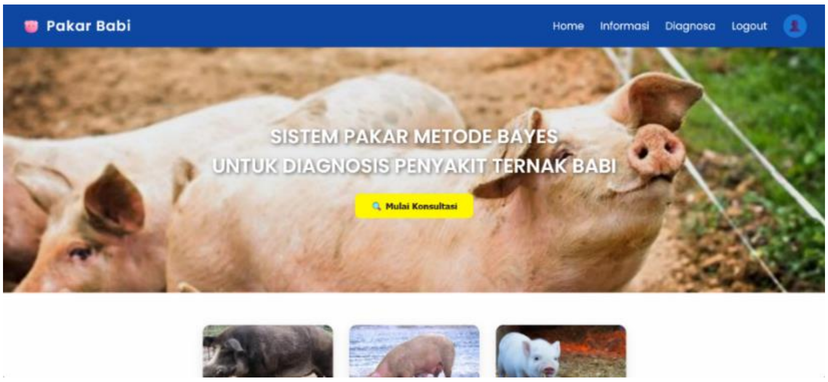


**Fig. 2:** Home Page


**Fig. 3:** Diagnosis Page


**Fig. 4:** Diagnosis Results Page

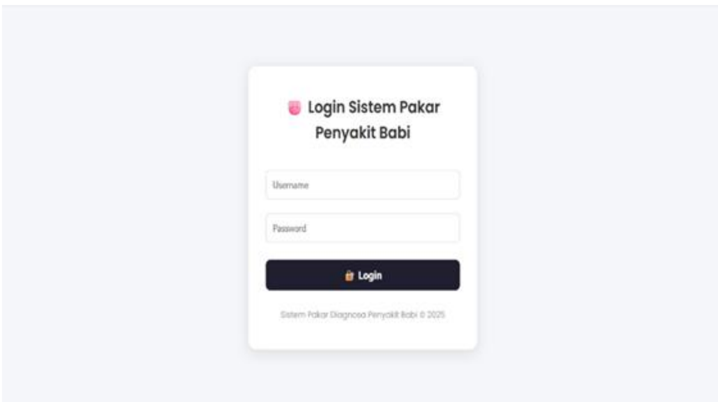


**Fig. 5:** Login Page

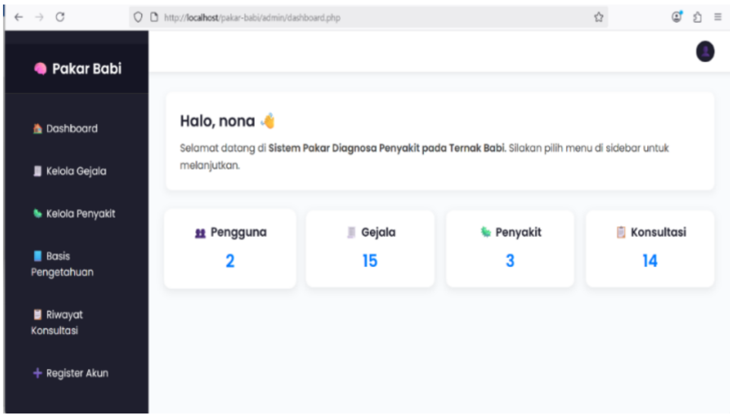


**Fig. 6:** Dashbord Page

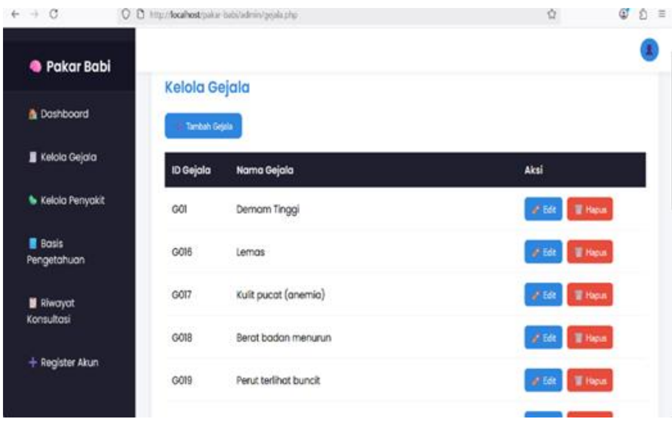


**Fig. 7:** Manage Symptoms Page

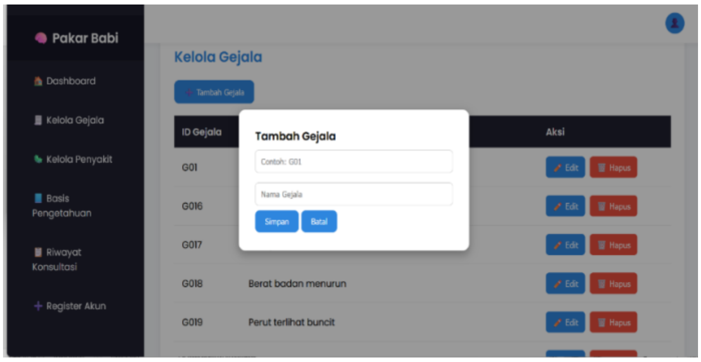


**Fig. 8:** Add Symptoms Page

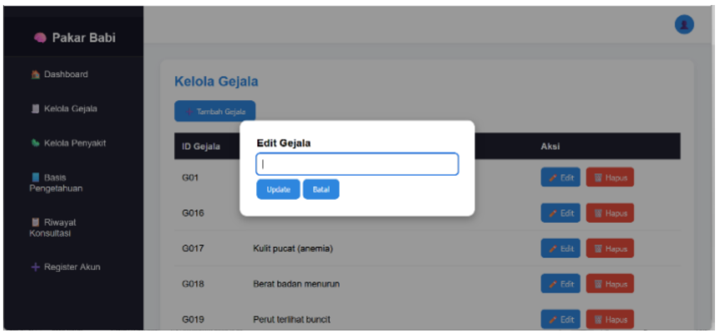


**Fig. 9:** Symptom Edit Page

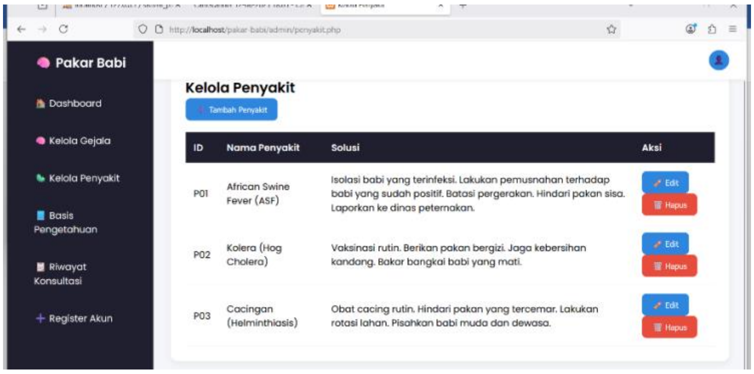


**Fig. 10:** Disease Management Page

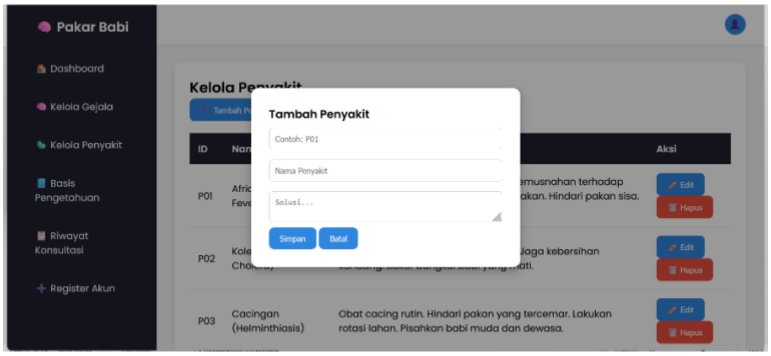


**Fig. 11:** Disease Add Page

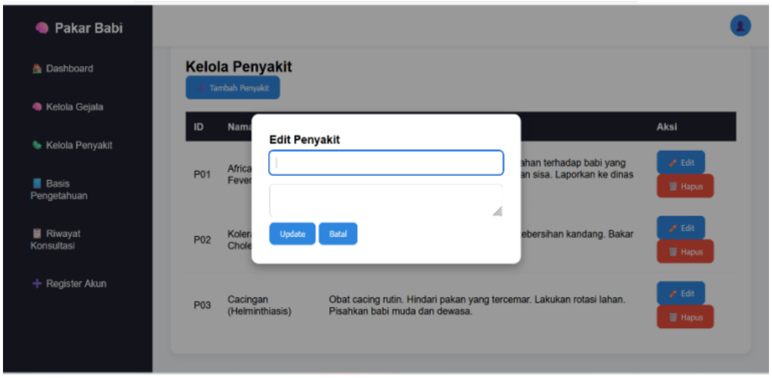


**Fig. 12:** Disease Edit Page

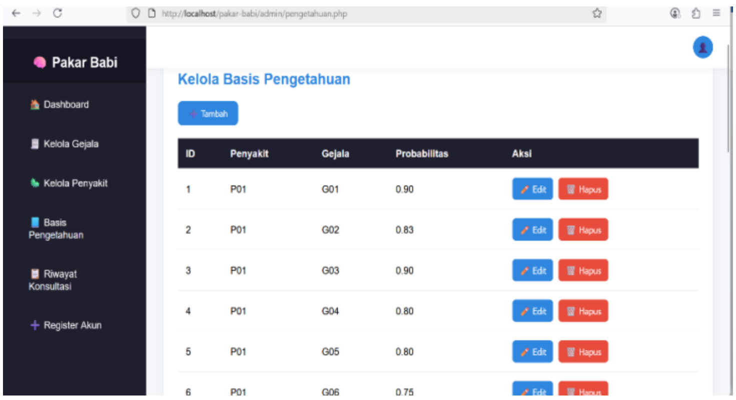


**Fig. 13:** Manage Knowledge Base Page

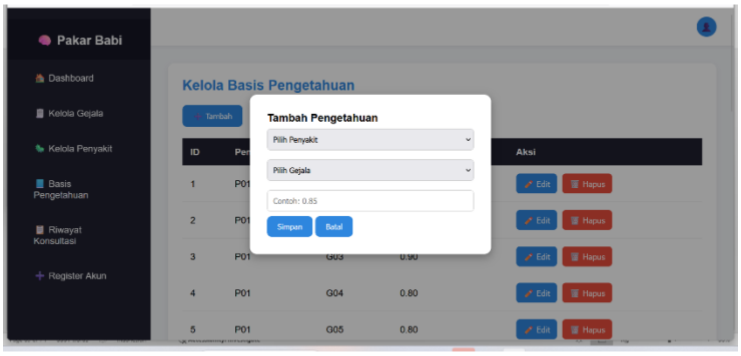


**Fig. 14:** Add Knowledge Base Page

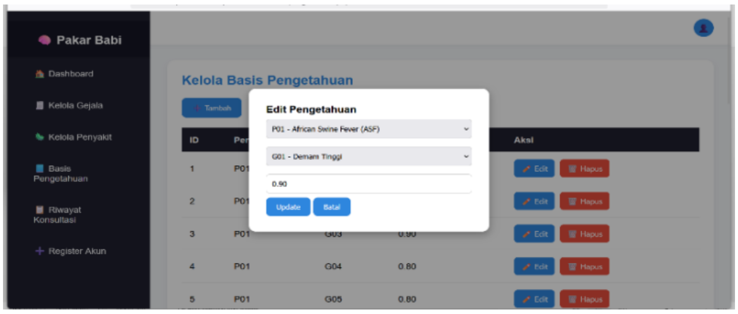


**Fig. 15:** Knowledge Base Edit Page

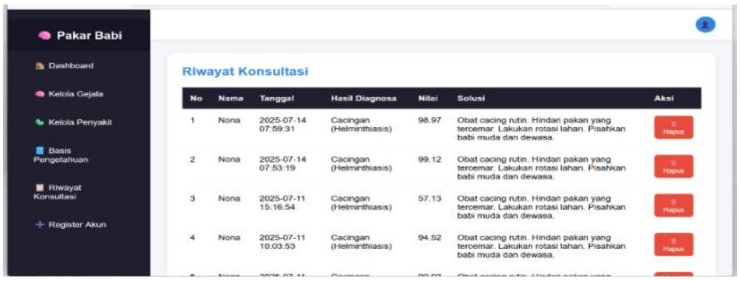


**Fig. 16:** Consultation History Page

## 5. Conclusion

This research produces an expert system for disease diagnosis in pig farms with the aim of assisting farmers and veterinarians in diagnosing pig diseases independently, quickly and accurately. The system is developed using *the Bayes Theorem* method and is designed to provide a diagnosis based on the symptoms chosen by the user. In its implementation, the system includes disease data management features, symptom data, and knowledge base and consultation history all of which can be accessed by farmers through a web-based view. Based on the results of the test using *the black box* technique, all functions in the system can run well and in accordance with what has been designed. Out of a total of 10 test scenarios, the system was able to produce a diagnosis that corresponded to real conditions as much as 70%, which indicates that the system has a fairly high level of accuracy. Therefore, this system has the potential to be used by farmers as an auxiliary medium in diagnosing and handling diseases in pig farms independently. In addition, this system is also expected to expand the horizons of veterinarians and veterinarians, accelerate the diagnosis process, and become an applicable recommendation in supporting the economic resilience of the East Sumba community.

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