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Development of Expert System Application to Detect Chicken Disease using the Forward Chaining Method

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Abstract: Chicken is the most widely kept and consumed poultry in Indonesia. Due to the large population of poultry, a variety of diseases have also emerged, from minor diseases to diseases that can kill chickens and infect humans. As a result of these diseases, there are implications for the losses suffered by chicken farmers. Most farmers find it very difficult to identify chicken diseases due to their lack of knowledge. On the other hand, expecting treatment from a veterinarian or expert is very limited and expensive. Therefore, a system is needed that can easily help chicken farmers detect diseases in their pet chickens. This research aims to build an expert system to detect chicken diseases by applying the forward chaining method. The expert system is implemented as a web-based application. The research stages start with data collection, knowledge acquisition, creating a knowledge base, inference machine, and getting results. The results showed that the forward chaining method provides convenience in detecting chicken diseases. This is proven by only selecting the symptoms of the disease that appear, and then the application will provide conclusions regarding what type of disease is being suffered by chickens. In addition, this application also provides information related to ways of handling and control that can be done to overcome the chicken disease. Hopefully, the results of this research can facilitate chicken farmers in identifying and handling diseases effectively and efficiently.

Keywords: Chicken; Detection; Disease; Expert System; Forward Chaining.

INTRODUCTION

Chicken is the most widely kept type of poultry in the community, both on a small and large scale. Besides being raised, chicken meat is the most consumed food by Indonesians. The high demand for chicken meat is due to its lower price and higher production (Annur, 2022). Due to their large population, chickens have more emerging diseases, from mild ones to those that can be transmitted to humans and cause death. Diseases that affect chickens regularly will lead to death and a decrease in sales volume (Anggrawan, Satuang, & Abdillah, 2020). Chicken diseases often occur due to a lack of biosecurity, low vaccination coverage, unscientific management techniques, and the absence of veterinary care (Degu & Simegn, 2023). Chickens must have symptoms before a disease can be identified. Because they are unfamiliar with illnesses and remedies, many farmers find it challenging to comprehend poultry diseases. Farmers require a professional in chicken farming because a specialist, such as a veterinarian or specialist, must identify poultry diseases (Windarto & Marfuah, 2020). However, from the point of view of finances and expert time, farmers may not be able to use the services of an expert. There is a limit to the number of experts (Aminudin, Taufiq, & Amaliah, 2019) and their time, making it difficult to find an expert when they need one, and the cost of an expert is also high (Yulianto, Idris, Wasiso, &

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Kusrini, 2020). As farmers face difficulties in identifying diseases in their chickens, there is a need for early detection techniques for chicken disease prevention (Cahyaningtyas, Purnomo, & Kristianto, 2019).

Expert system technology can be used to overcome the limitations of doctors and experts (Novaliendry et al., 2020) and able to help farmers and breeders detect diseases. This is evident from several studies that have been conducted previously. In the application of an expert system to diagnose broiler diseases, the results show that the community and extension workers can more easily diagnose chicken diseases (Kusrini, Fathurrahman, & Sayyidati, 2020). Farmers and agricultural engineers assessed the expert system for disease diagnosis, and they were satisfied and accepted its performance quality. The expert system is easy to use by farmers to find and diagnose symptoms of a particular disease (Salman & Abu-Naser, 2019). The expert system also provides satisfactory results on disease detection. Farmers easily use the program because they can select symptoms from the list of symptoms without writing anything down (Al-qumboz & Abu-Naser, 2019).

The most popular method in expert system implementation is the Forward Chaining method (Rupnawar, Jagdale, & Navsupe, 2016). The application of the forward chaining method to the expert system has a constructive impact on the practical side of the system as a whole (Hafizal et al., 2023). Appliedly, the forward chaining method is easy to use and can provide good recommendations to users (Ardiansah, Efatmi, Mardawati, & Putri, 2020). The results of the application of the forward chaining method show the maximum level of accuracy (Susanto, Fadlil, & Yudhana, 2020) (Imamah, Agustiono, Rochman, & Firdaus, 2020) (Wati & Puspitasari, 2020). The forward chaining method is successfully applied to the system being developed to identify users based on their knowledge base. The test results show that the system is able to correctly identify (Atimi & Sartika, 2022). Applications developed using forward chaining can help provide information about diseases based on the symptoms that appear (Pahlevi & Atmojo, 2020). Other research results show that the forward chaining method is superior to the backward chaining method in terms of accuracy of the conclusion by 90%, ease of use by 90%, suitability and satisfaction with the conclusion results by 90%, and usefulness by 95% (Apriliyani, Tyas, & Permatasari, 2022).

Against the problems described earlier, the solution offered in this study is to create an expert system application using the forward chaining method to detect chicken diseases. This research is very important because many chicken farmers experience losses because they do not know what diseases plague their livestock, especially novice farmers who are just learning about animal husbandry. This research also aims to help farmers optimize the results of their farms. The difference between this research and previous research (Anggrawan et al., 2020) lies in the number of diseases to be detected. This study looked at all chicken breeds, not just one. The data used consisted of ten types of diseases: Avian Influenza, Fowl Cholera, Pullorum Disease, Newcastle Disease, Coccidiosis, Infectious Bursal Disease, Infectious Coryza, Infectious Bronchitis, Chronic Respiratory Disease, and Colibacillosis. The purpose of this research is to apply the expert system of the forward chaining method to detect chicken diseases. The formulation of the problem is the process of making the system. Hopefully, the findings of this research can help farmers learn more about chicken diseases. Chicken diseases can be quickly prevented if they are known.

METHOD

In implementing a forward-chaining expert system to detect chicken diseases, systematic and measurable research stages and procedures are needed. These stages and procedures are research methods that are represented in the form of a framework. The selection of this method is based on previous research (Gusman & Hendri, 2019) with some modified treatments. The framework of this study is shown in Figure 1.

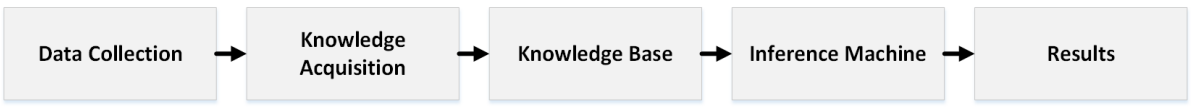

Fig 1. Forward Chaining Stages

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Data Collection

The first step in developing an expert system is to collect data. This is a stage that will be carried out when building an expert system to diagnose diseases in chickens and how to treat them. Collecting data about the symptoms, diseases, and treatment of chicken diseases is part of the application of an expert system to the problem of chicken diseases. Data is obtained from experts Prof. drh. Charles Rangga Tabbu, M.Sc., Ph.D. (Tabbu, 2019). Chicken disease data will detect as many as ten types of diseases, namely: Avian Influenza, Fowl Cholera, Pullorum Disease, Newcastle Disease, Coccidiosis, Infectious Bursal Disease, Infectious Coryza, Infectious Bronchitis, Chronic Respiratory Disease, and Colibacillosis.

Knowledge Acquisition

This stage is needed to enter knowledge, which is disease data, symptoms, and countermeasures obtained from the results of data collection from an expert by engineering knowledge, so that it can be processed by a computer and entered into a knowledge base in a certain format (in the form of knowledge representation).

Knowledge Base

Once knowledge is acquired, the knowledge base stage contains the knowledge needed to understand, formulate, and solve the problem. The knowledge base consists of two basic elements: facts, which are situations of conditions and problems that exist in chicken diseases, and rules, which are correlations between symptoms and diseases to be transformed into production rules.

Inference Machine

Based on the knowledge base in the previous process, the inference engine will guide the reasoning process on a given condition, manipulating and directing the rules, models, and facts stored in the knowledge base to reach solutions and conclusions. At this stage, the machine will provide a conclusion on the type of disease that appears based on the symptoms that have been inputted.

Results

This stage serves to explain to the user how a conclusion can be drawn. The ability to improve the knowledge of an expert is needed to analyze knowledge, learn from past mistakes, and then improve knowledge so that it can be used in the future.

RESULT

After carrying out the process of implementing the research flow, as shown in Figure 1, the results of the research stages are systematically described in the previous Methods section. Expert systems are successful if they have knowledge and a way of processing that knowledge to reach a conclusion. To facilitate the process of finding solutions, information from interviews and book analysis is converted into a table of diseases and symptoms. This table of disease and symptom categories is used to match user data and knowledge bases.

Table 1. Chicken Disease Data and Symptoms

Disease Code	Disease Name	Symptoms
P001	Avian Influenza	decreased appetite, labored breathing, snoring, sneezing, coughing, diarrhea, decreased egg production, blue appearance, foamy discharge from the eyes, swollen head, and sudden death.
P002	Fowl Cholera	reduced appetite, shortness of breath, loose stools, yellow, brown, or green slimy and foul-smelling droppings, swollen comb and wattle, and a bluish head; chickens like to shake their heads; swollen leg and wing joints with paralysis
P003	Pullorum Disease	decreased appetite, whitish watery droppings, white droppings around the anus, grayish cockscomb, drooping wings, closed eyes; chicks will look pale, weak, cold, and like to huddle looking for a warm place. decreased egg productivity, depression, and anemia.

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P004	Newcastle Disease	labored breathing, coughing, sneezing, snoring, lethargic appearance, decreased appetite, decreased egg production, loose stools, watery, slightly greenish feces, bluish comb and head, lowered wings.
P005	Coccidiosis	decreased appetite, decreased egg production, thin body, dull and wrinkled fur, blackish stools containing blood, pale face, and discharge from eyes and nose.
P006	Infectius Bursal Disease	Reduced appetite, lethargic and drowsy appearance, dull feathers, diarrhea—chickens will peck at their rectum, stick their beaks to the floor, tremble, and have difficulty standing up.
P007	Infectious Coryza	Decreased appetite, labored breathing, sleepy appearance and standing hair, stunted growth, puffy face and eyes.
P008	Infectious Bronchitis	coughing, sneezing, difficulty breathing, mucus discharge from the nose, shortness of breath.
P009	Chronic Respiratory Disease	coughing, snoring, discharge from the nostrils, decreased appetite, decreased egg production, chickens like to shake their heads, look lethargic, pale, and have dull feather color.
P010	Colibacillosis	decreased appetite, lethargic and lackluster chickens, rough feathers, shortness of breath, a lot of feces stuck to the anus, diarrhea, cough.

Table 1 displays two categories of data, namely, chicken disease data and symptoms. Each chicken disease is represented with codes P001 to P010. Each disease has its own symptoms. The symptoms of each disease are further codified as shown in Table 2.

Table 2. Chicken Disease Symptom Data

Symptom Code	Symptoms	Symptom Code	Symptoms
G001	Decreased appetite	G020	Whitish-colored loose stools
G002	Shortness of breath/ gasping for air	G021	Sleeping with beak on the floor
G003	Snoring	G022	Sits hunched over
G004	Sneezing	G023	Looks sleepy and feathers stand up
G005	Cough	G024	Cold
G006	Diarrhea	G025	White feces stuck to the anus
G007	Decreased egg production	G026	Clustered in a warm place
G008	Turns blue	G027	Drinks a lot
G009	Foamy discharge from eyes	G028	Likes to shake its head
G010	Swollen head	G029	Coarse coat
G011	Sudden death	G030	Red swollen comb
G012	Lethargic appearance	G031	Legs inflamed/paralyzed
G013	Greenish loose stools	G032	Growth retardation
G014	Staggering	G033	Discharge from eyes and nose
G015	Head spinning	G034	Swollen face and eyes
G016	Thin body	G035	Wings down
G017	Dull and wrinkled fur	G036	Dull and pale feather color
G018	Blackish stools containing blood	G037	Chickens appear lethargic and lackluster
G019	Pale face		

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Table 2 shows the codification of the symptoms of chicken diseases. There are 37 symptoms of ten chicken diseases to be diagnosed. Each symptom is represented by the codes G001 to G037. To achieve the goal, 37 symptoms and 10 disease types are organized as a knowledge base. Table 3 below shows the disease types and symptoms that have been codified into a knowledge base.

Table 3. Knowledge Base

G/P	P001	P002	P003	P004	P005	P006	P007	P008	P009	P010
G001	x	x	x	x	x	x	x	x	x	x
G002	x	x	x	x					x	x
G003	x	x		x			x	x	x	x
G004	x			x				x		
G005	x			x				x		x
G006	x	x	x					x	x	x
G007	x	x	x	x	x			x		
G008	x							x		
G009	x									
G010	x									
G011	x									
G012		x		x				x		
G013		x		x						
G014				x		x				
G015				x						
G016			x		x	x				
G017		x	x		x					
G018					x					
G019					x					
G020			x			x				
G021						x				
G022						x				

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G023		x					x	x		
G024			x					x		
G025			x							
G026			x							
G027		x								
G028									x	
G029										x
G030		x								
G031		x								
G032		x					x			
G033					x					
G034						x	x			
G035						x				
G036						x				
G037									x	x

Table 3 shows the correlation of each symptom to the type of chicken disease. Each chicken disease has its own symptoms. Each disease must have more than one symptom that shows the criteria of the disease. The knowledge base shown in Table 3 is then converted into the form of production rules (IF-THEN) as a form of implication correlation consisting of premises and conclusions. The following are the production rules for detecting chicken diseases, as shown in Table 4.

Table 4. Chicken Disease Production Rules

Rules	Production Rules
Rule 1	IF G001 AND G002 AND G003 AND G004 AND G005 AND G006 AND G007 AND G008 AND G009 AND G010 AND G011 THEN P001
Rule 2	IF G001 AND G002 AND G003 AND G006 AND G007 AND G012 AND G013 AND G017 AND G023 AND G027 AND G030 AND G031 AND G032 THEN P002
Rule 3	IF G001 AND G002 AND G006 AND G007 AND G016 AND G017 AND G020 AND G024 AND G025 AND G026 THEN P003
Rule 4	IF G001 AND G002 AND G003 AND G004 AND G005 AND G007 AND G012 AND G013 AND G014 AND G015 THEN P004
Rule 5	IF G001 AND G007 AND G016 AND G017 AND G018 AND G019 AND G033 THEN P005
Rule 6	IF G001 AND G014 AND G016 AND G020 AND G021 AND G022 AND G034 AND G035 AND G036 THEN P006

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Rule 7	IF G001 AND G003 AND G023 AND G032 AND G034 THEN P007
Rule 8	IF G001 AND G003 AND G004 AND G005 AND G006 AND G007 AND G008 AND G012 AND G023 AND G024 THEN P008
Rule 9	IF G001 AND G002 AND G003 AND G006 AND G028 AND G037 THEN P009
Rule 10	IF G001 AND G002 AND G003 AND G005 AND G006 AND G029 AND G037 THEN P010

The chicken disease production rules, as shown in Table 4, are a set of Rules 1 to 10 in the form of IF-THEN rules. Each rule is a combination of premise (IF) and conclusion (THEN), which is the type of disease.

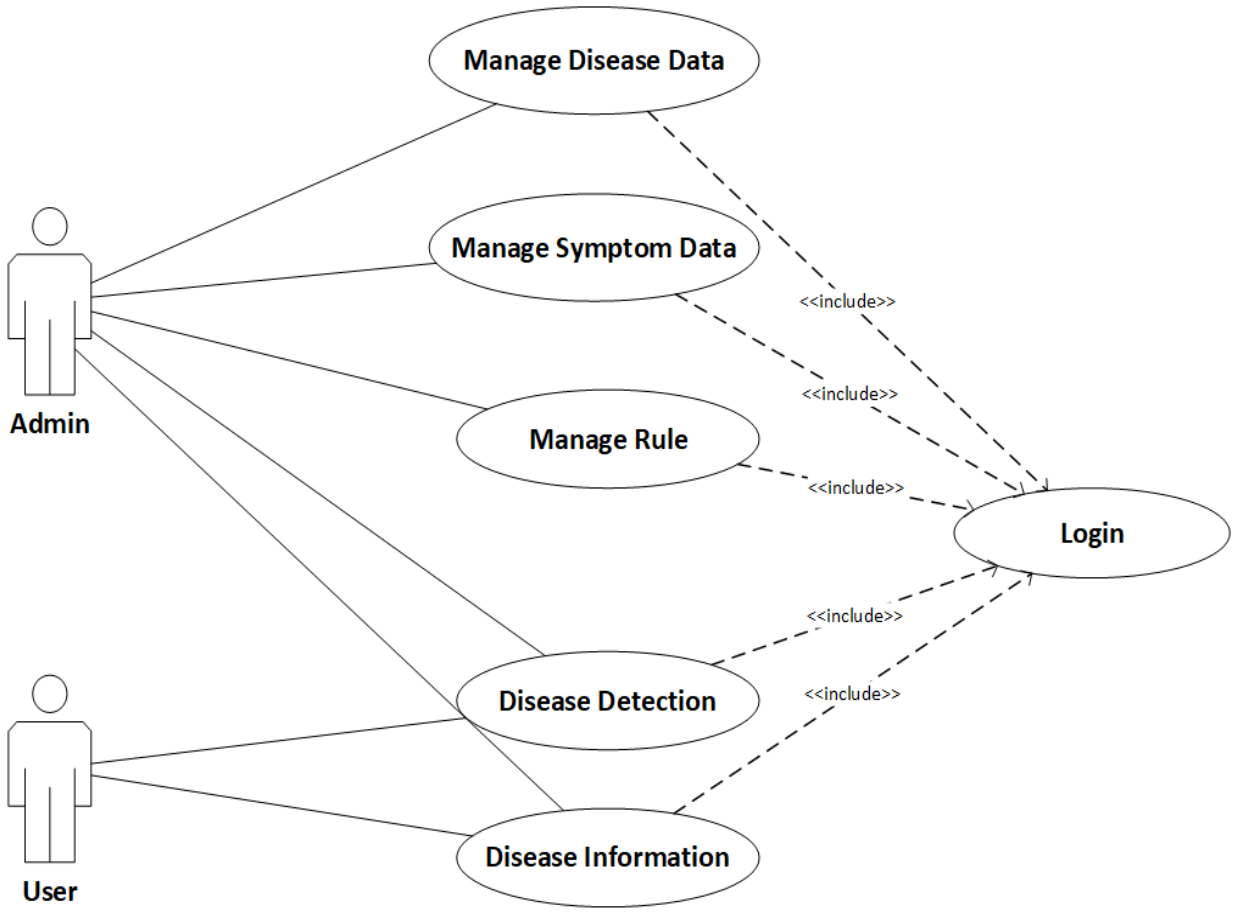

Fig 2. Use Case Diagram

Use cases describe how different parties interact when using the chicken disease expert system. Use cases also describe the functional relationships expected from the system design. In this case, "what" the system does is more important than "how". This use case describes the interaction between actors and the system. Figure 2 shows that the admin is responsible for managing disease data, symptom data, and rule data (knowledge base) in the expert system application, while users can consult diseases and get information about chicken diseases in the application.

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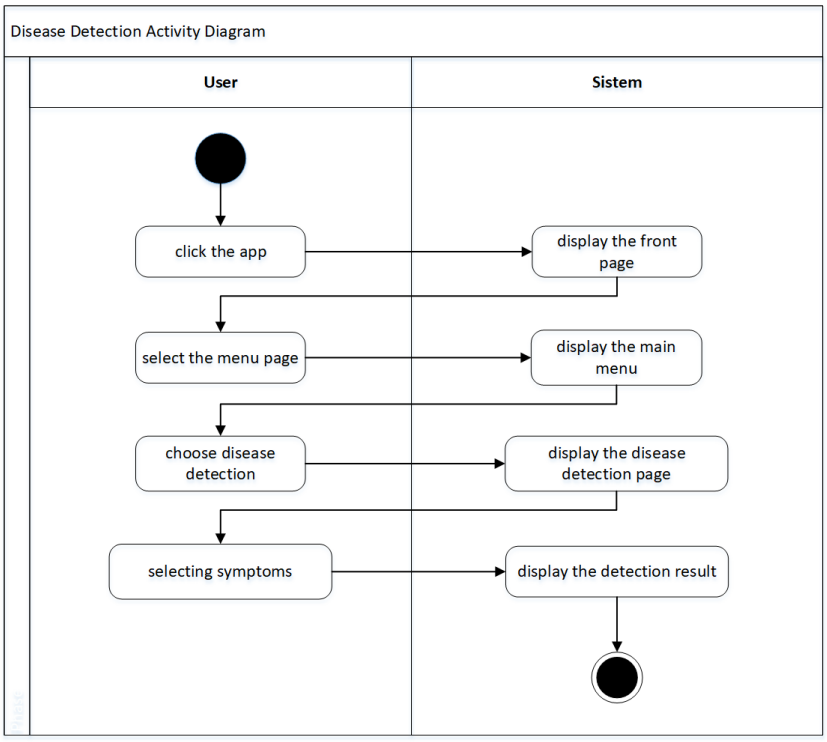

Fig 3. Activity Diagram

In Figure 3, the activity diagram shows the activities that the user performs during the process of detecting chicken diseases. The activity starts with clicking on the application, selecting disease symptoms, and concluding with the disease detection results.

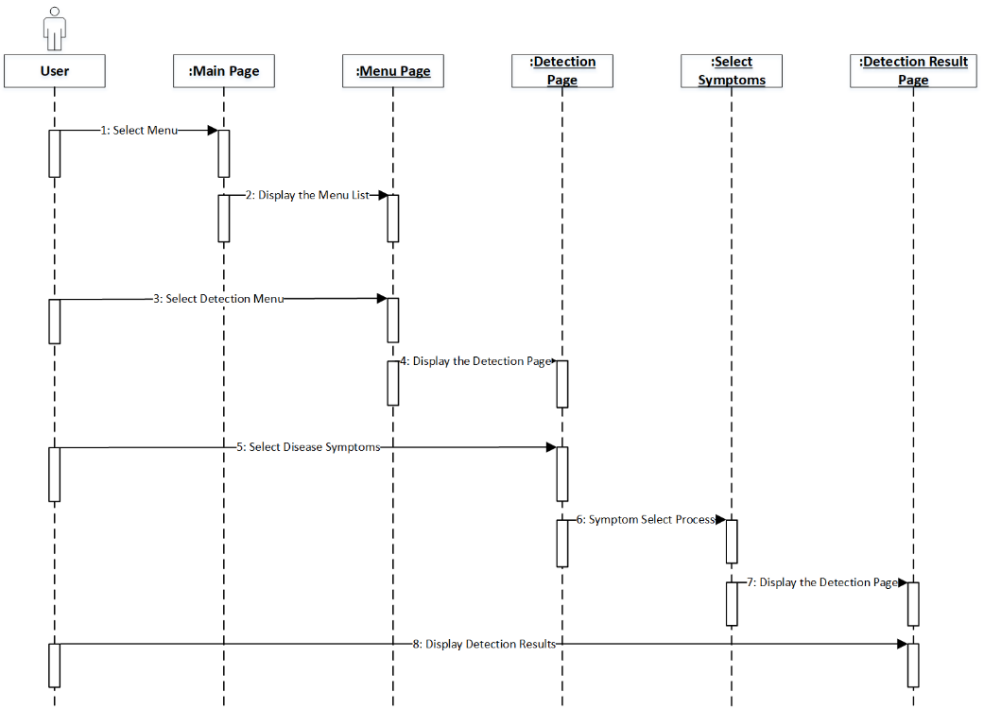

Fig 4. Sequence Diagram

The sequence diagram in Figure 4 shows the process of detecting chicken disease, which has eight stages in sequence.

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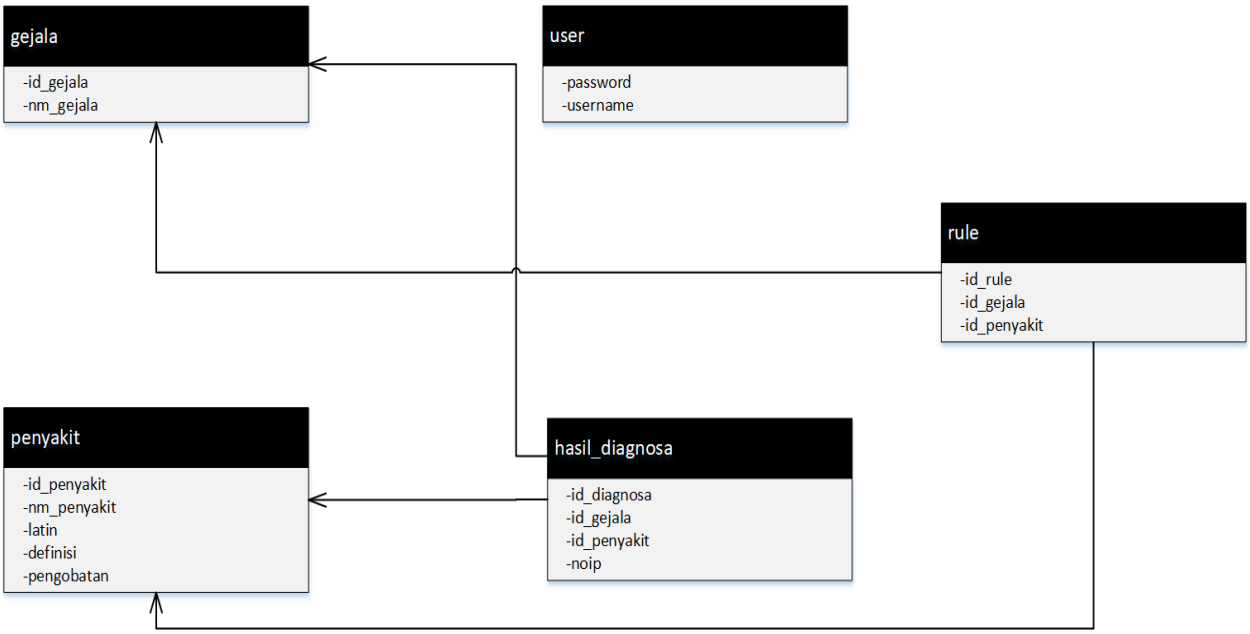

Fig 5. Class Diagram

The link between the various classes of objects that make up the expert system for spotting chicken diseases is depicted in Figure 5. These classes are made up of things with certain traits and purposes. A database is created when the tables created from these classes are linked to other tables. This expert system on chicken disease consists of five interrelated tables.

Table 5. Disease Detection Result

Input Symptoms on the Application	Detection Result	Treatment
The first test: 1. Decreased appetite 2. Labored breathing 3. Snoring 4. Sneezing 5. Coughing 6. Diarrhea 7. Decreased egg production 8. Blue appearance 9. Foamy discharge from the eyes 10. Swollen head 11. Sudden death.	**Avian Influenza**	• Improved biosecurity • Biosecurity is carried out, among others, by isolation, control of livestock, people, equipment, and vehicle traffic, and improved sanitation. • Intensification of environmental security (for smallholder farmers, their livestock should not be allowed to roam but should be penned up). • All dead livestock should be buried to a depth of ± 1 meter and limed or burned. • All unhealthy (sick) animals must be destroyed (stamped out). • Healthy poultry animals should be vaccinated regularly. • Maintain the health of cage workers by wearing N95 masks, goggles, gloves, boots, and washing hands frequently.

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The second test: 1. Decreased appetite 2. Decreased egg production 3. Thin body 4. Dull and wrinkled fur 5. Blackish stools containing blood 6. Pale face 7. Discharge from eyes and nose	**Coccidiosis**	• Before the cage is used, it should be sanitized (cleaned, washed, and disinfected) with an antiseptic. • Litter should always be dry and not lumpy. • Food and drink must be clean, good, and sufficient. • Give Coccidiostat mixed with drinking water or food, given to chickens aged 1-3 months, for 3 consecutive days with an interval of three days, and then give it again for three days. • Vaccination. Only effective for chickens kept in litters and with good litter management. For 12 days after the vaccine, the litter should be sprayed with water to keep it moist but not too wet. • Good drugs given through drinking water for 2-3 days, resting for 2-3 days, and repeating again in a 1-time cycle include: Sulfaquinozalin, Sulfadimetozin, ESB 3, Amaprol (Duocoxine), and Bifuran. • The risk of using quinozalin in layer chickens is decreased egg production. The safest for Leyer is Amparol.
The third test: 1. Decreased appetite 2. Labored breathing 3. Sleepy appearance and standing hair 4. Stunted growth 5. Puffy face and eyes.	**Infectious Coryza**	• Cleaning of the coop before the chickens enter, followed by good sanitation. • Good management • Vaccination is done when the chickens are 8–10 weeks old and then repeated when the chickens are 4 weeks old. • Sulfathiazole or sulfadimethozine via drinking water at a concentration of 0.05% on the first day and 0.025% on the following 4 days. • Erythromycin, Streptomycin, terramycin, or Tylosin, given by injection, can cure individual chickens or small amounts. Re-injections are recommended every day for 2–3 days. • Water sanitization, for example, with Bromosept in drinking water to prevent the spread of germs through drinking water

Table 5 shows the results of using the chicken disease detection expert system application. To perform disease detection, users must select symptoms by checking the available symptom options. Then choose the disease check menu. In a few moments, the system will display the type of disease based on the results of the input of the symptoms given. In the table, testing was carried out by inputting

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the symptoms contained in diseases P001, P005, and P007. After all the symptoms are selected, the user chooses the disease check menu, and the system concludes from the results that the detected diseases are Avian Influenza, Coccidiosis, and Infectious Coryza. These results are in accordance with the knowledge base and production rules that have been determined previously by applying the rules of the forward chaining algorithm, where premises are built to get conclusions. In addition to bringing up the results of disease detection, this expert system application also displays the steps that must be taken to overcome the disease in the treatment column.

DISCUSSIONS

In the forward chaining method, the inference engine uses user-selected symptoms to filter the rules to be tested. This prevents searching for all the rules. The rules that have been selected are stored in working memory in the form of a queue. The queue list in working memory will be used to match the symptom input with the first rule. The disease type is stored in the working memory if the symptom meets that rule. Then check for the next symptom. If the symptom shows a mismatch with the first rule, it is matched with the next rule. If the symptom shows a mismatch with the second rule, the latest disease type is entered into working memory, and so on until the symptom disappears.

The results show that this expert system has advantages and disadvantages. This system has the advantage that users can easily select a list of symptoms as needed. Each symptom identified will show the type of chicken disease and solutions that can help users find chicken diseases. They can also view the list of available diseases. In addition, from the admin side, they can easily enter disease data, symptoms, and knowledge bases without causing significant complexity or difficulty. When compared to previous research (Anggrawan et al., 2020), The disadvantage of this system is that it does not apply the same degree of confidence to the detection results as in the study that used the Certainty Factor method. This happens because this research only focuses on applying the forward chaining method to detect chicken diseases. Another drawback lies in the presentation of disease information that is not accompanied by image or photo captions that might make it easier for users to identify diseases in chickens.

CONCLUSION

There are several points that can be drawn from this research. First, to build a forward chaining expert system for detecting chicken diseases, it is necessary to collect data on diseases and symptoms from sources who are veterinarians, and then the disease data and symptoms are converted into a knowledge base and production rules. Furthermore, web-based system development is carried out. From the application that has been made, the maximum results are obtained, indicating that this system can easily detect chicken diseases based on the input of existing disease symptoms. Hopefully, this research can contribute to making it easier for farmers to detect chicken diseases that are being suffered.

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