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Integration of AHP and certainty factors to optimize chicken disease diagnosis

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Abstract

Chicken farmers, especially beginners, often lose money because they are not aware of the diseases of their livestock. Diagnosis of chicken diseases must be carried out appropriately to increase the productivity of poultry farms. The failure of rapid and precise disease discovery is often due to a lack of diagnostic tools and veterinary expertise. The Analytical Hierarchy Process (AHP) and Certainty Factor (CF) methods are used to build an expert system to optimize the diagnosis of chicken diseases. The Analytical Hierarchy Process (AHP) determines the weight of criteria based on their level of importance, while the Certainty Factor (CF) measures the level of confidence based on the symptoms found. By combining these two approaches, the system is able to produce more structured, measurable, and based diagnoses based on quantitative data and expert expertise. The test results show that the system to be built is very accurate in providing diagnosis recommendations based on symptoms and key criteria. The purpose of this study is that farms and veterinarians will utilize this system to better handle diseases, reduce misdiagnoses, and strengthen the poultry farming sector as a whole.

Keywords

Analytical hierarchy process, Certainty factor, Chicken, Disease, Optimization

Introduction

Indonesian chicken commodities have strong market prospects thanks to their environmentally friendly features. Animal husbandry is the business of developing and raising animals to make a profit [1]. The success of a farm, no matter how big the business, is based on knowledge and understanding of the sources of obstacles and threats from diseases that can spread and cause very detrimental consequences [2]. Raising chickens is a complicated task because you have to pay attention to many things, including diseases that can attack chickens [3]. It is essential to protect chicken livestock from sources of outbreaks and potential obstacles. In poultry farming, disease is one of the main problems [5]. Reduced productivity, increased mortality, and economic losses

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for farmers can occur due to late identification of diseases. If not treated immediately, this disease can harm chickens and harm the farmer. Lack of knowledge of farmers about chicken diseases and treatment is one of the factors causing losses [6] In some cases, certain diseases can be transmitted to humans. One of them is bird flu, or bird flu. As a result, to prevent death, the disease must be treated immediately [7] This condition is dangerous if farmers do not handle and control the disease properly or slowly. This will overwhelm ordinary people or novice farmers in dealing with emerging diseases. In addition, getting experts when needed is difficult and expensive due to time and number of experts. Some large-scale chicken farms choose to consult livestock experts to find treatment solutions in accordance with data and field facts [8] Consultation with specialists in this field is difficult due to their limited number and long diagnosis time, requiring prompt treatment. Expert systems can be used to diagnose chicken diseases based on their symptoms as well as provide appropriate treatment [8] Therefore, information technology is needed to support the livestock sector. This is because technology is very important today. One of the roles of technology is to help treat the symptoms suffered by chickens. An expert system or computer-based artificial intelligence system should be developed to address the previously mentioned problem of chicken disease diagnosis [9]. The AHP and CF methods are used in the application of disease diagnosis in chickens. In the field of poultry farming, this study is one of the first efforts to use the Analytical Hierarchy Process (AHP) as a symptom weighting tool along with the Certainty Factor (CF) to produce a more accurate diagnosis. This expert system allows farmers, the community, and the Livestock and Animal Health Service to diagnose chicken diseases [10] The app can identify diseases based on the symptoms entered by the user and generate disease data [10] Information technology can help users complete the task [11] Therefore, in this study, an expert system was created to diagnose diseases in chickens [12] It is hoped that this system will help farmers identify their livestock diseases more easily [13] thereby reducing losses.

Method

In this study, the diagnosis of disease in chickens was carried out using the Analytical Hierarchy Process (AHP) technique and Certainty Factor (CF). This framework is the steps taken in this study to solve the problem [14], Figure 1 shows the structure.

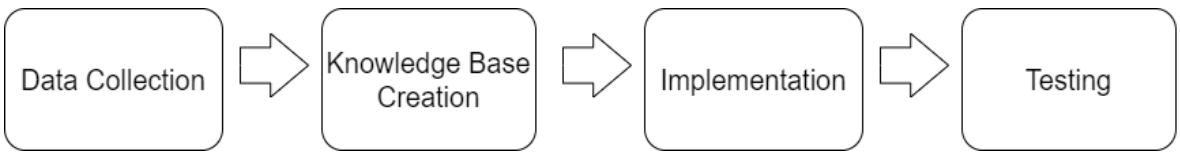

Figure 1. Research structure

Data Collection

Veterinarians are interviewed to collect data. This is because everyone has a different perspective on a disease, the resource person uses one person to facilitate the creation of a knowledge model. Disease and symptom data are two necessary categories.

Experts perform knowledge acquisition through their experience and knowledge [7]. Table 1 shows the disease data, and Table 2 shows the symptom data.

Table 1. Types of Diseases

Code	Name of Disease
P1	Snot or Coryza
P2	Lime or Pullorum Barracks
P3	Cholera
P4	Salmonellosis
P5	*Chronic Respiratory Disease* (CRD)
P6	Avian Influenza

Table 2. Symptom Data

Code	Symptom Name
G1	The poultry looks sleepy and the wings are down.
G2	Mucus coming out of the nose, thick yellowish and smelly.
G3	Swollen face and eyes due to swelling of the infra orbital sinuses.
G4	There is a crust of the nose.
G5	Appetite decreases so that the cache is empty if touched.
G6	Snoring and difficulty breathing.
G7	The dirt is diluted and mixed with white grains such as lime.
G8	Anal hair sticks to one another.
G9	The grayish wings of the chicks become drooping.
G10	The wings drooped.
G11	Difficulty breathing.
G12	Barak experienced diarrhea.
G13	Yellow, brown or green stools are slimy and foul-smelling.
G14	Swollen wings and gobbles and bluish head.
G15	Shaking his head often.
G16	Swollen legs and wings accompanied by paralysis.
G17	The duck droppings are dilute greenish in color.
G18	The color of the fur looks dull.
G19	Coughing cough, especially at night.
G20	Discharge directly from the nose.
G21	Point bleeding (plechie) in the chest, leg and sole area.
G22	Decreased egg production.
G23	Sudden death in large numbers.

Knowledge Base Creation

Knowledge data obtained from experts is modeled into an easy-to-understand form through a knowledge base [15] At this stage, it is carried out with 2 methods, namely the AHP method (Figure 2) and the CF method (Table 3 and Table 4).

Table 3. CF User

Options	CF User
Highly Confident	1
Believe	0.8
Pretty Sure	0.6
A Little Confident	0.4
Do not know	0.2
No	0

Table 4. CF Expert

Symptom Code	Disease Code					
	P1	P2	P3	P4	P5	P6
G01	✓ [0.041]					
G02	✓ [0.416]					
G03	✓ [0.289]					
G04	✓ [0.066]					
G05	✓ [0.029]	✓ [0.122]	✓ [0.04]			
G06	✓ [0.159]				✓ [0.453]	
G07		✓ [0.648]				
G08		✓ [0.098]				
G09		✓ [0.078]				
G10		✓ [0.054]		✓ [0.126]		
G11			✓ [0.27]	✓ [0.097]		
G12			✓ [0.24]			
G13			✓ [0.14]			
G14			✓ [0.12]			
G15			✓ [0.09]		✓ [0.064]	
G16			✓ [0.10]			
G17				✓ [0.715]		
G18				✓ [0.061]		
G19					✓ [0.267]	
G20					✓ [0.217]	
G21						✓ [0.368]
G22						✓ [0.052]
G23						✓ [0.579]

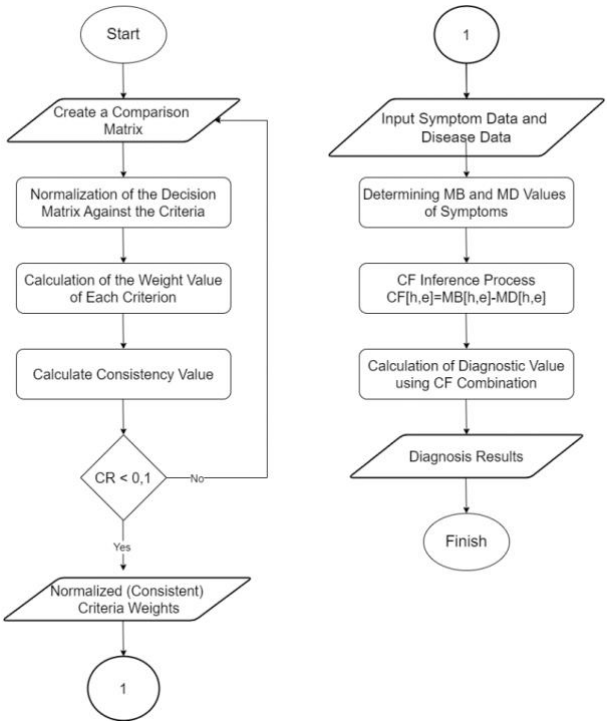

Figure 2. AHP-CF calculation process

Implementation

The following is an example of calculating the combination of the Certainty Factor in cholera disease (Table 5):

1. Certainty Factor for rules with a single premise (single premise rules):

$$CF(h,e) = CF(e) \times CF(rule) = CF(user) \times CF(expert)$$

Table 5. CF(h,e) in Cholera Disease

Symptom code	CF (*user*)	Disease code [CF (expert)]					
		P1	P2	P3	P4	P5	P6
G05	1	0.029	0.122	0.04			
G11	0			0.27	0.097		
G12	0.8			0.24			
G13	0.6			0.14			
G14	0.4			0.12			
G15	0.2			0.09		0.064	
G16	0.4			0.10			
		CF(h,e)					
		0.029	0.122	0.04			
				0	0		
				0.192			
				0.084			
				0.048			
				0.018			
				0.04			

2. Certainty Factor for rules with similar conclusions (similarly concluded rules):

$$CF\ COMBINE\ CF[h,e]_{1,2} = CF[h,e]_1 + CF[h,e]_2(1 - CF[h,e]_1)$$

1) Percentage of Cold Diseases (Snot *or* Coryza)

$$Persentase\ Certainty = CF[h,e]_{G05} \times 100\%$$
$$= 0.029 \times 100\%$$
$$= 2.9\%$$

2) Percentage of Lime Slag Disease or Pullorum

$$Persentase\ Certainty = CF[h,e]_{G05} \times 100\%$$
$$= 0.122 \times 100\%$$
$$= 12.2\%$$

3) Percentage of Cholera Disease

$$\boldsymbol{CF\ COMBINE\ CF[h,e]_{G05,G11} = 0.04 \Leftarrow CF\ Old_1}$$
$$\boldsymbol{CF\ COMBINE\ CF[h,e]_{Old_1,G12}}$$
$$= CF[h,e]_{Old_1} + CF[h,e]_{G12}(1 - CF[h,e]_{Old_1})$$
$$= 0.04 + 0.192(1 - 0.04)$$
$$= 0.04 + 0.192(0.96)$$
$$= 0.04 + 0.18432$$
$$= 0.22432 \approx 0.224 \Leftarrow CF\ Old_2$$
$$\boldsymbol{CF\ COMBINE\ CF[h,e]_{Old_2,G13}}$$
$$= CF[h,e]_{Old_2} + CF[h,e]_{G13}(1 - CF[h,e]_{Old_2})$$
$$= 0.224 + 0.084(1 - 0.224)$$
$$= 0.224 + 0.084(0.776)$$
$$= 0.224 + 0.065184$$
$$= 0.289184 \approx 0.289 \Leftarrow CF\ Old_3$$
$$\boldsymbol{CF\ COMBINE\ CF[h,e]_{Old_3,G14}}$$
$$= CF[h,e]_{Old_3} + CF[h,e]_{G14}(1 - CF[h,e]_{Old_3})$$
$$= 0.289 + 0.048(1 - 0.289)$$
$$= 0.289 + 0.048(0.711)$$
$$= 0.289 + 0.034128$$
$$= 0.323128 \approx 0.323 \Leftarrow CF\ Old_4$$
$$\boldsymbol{CF\ COMBINE\ CF[h,e]_{Old_4,G15}}$$
$$= CF[h,e]_{Old_4} + CF[h,e]_{G15}(1 - CF[h,e]_{Old_4})$$
$$= 0.323 + 0.034(1 - 0.323)$$
$$= 0.323 + 0.034(0.677)$$
$$= 0.323 + 0.023018$$
$$= 0.346018 \approx 0.346 \Leftarrow CF\ Old_5$$

$$\boldsymbol{CF\ COMBINE\ CF[h,e]_{Old_5,G16}}$$
$$= CF[h,e]_{Old_5} + CF[h,e]_{G16}(1 - CF[h,e]_{Old_5})$$
$$= 0.346 + 0.04(1 - 0.346)$$
$$= 0.346 + 0.04(0.654)$$
$$= 0.346 + 0.02616$$
$$= 0.37216 \approx 0.372 \Leftarrow CF\ Old_6$$
$$\boldsymbol{Persentase\ Keyakinan} = \boldsymbol{CF\ COMBINE} \times \mathbf{100\%}$$
$$= 0.372 \times 100\%$$
$$= 37.2\%$$

Result and Discussion

The system developed can accurately diagnose diseases based on user-provided symptoms through a combination of techniques. The diagnosis page of the chicken disease diagnosis expert system uses the following Analytical Hierarchy Process (AHP) and Certainty Factor methods. Figure 3 is the first page of the chicken diagnosis expert system.

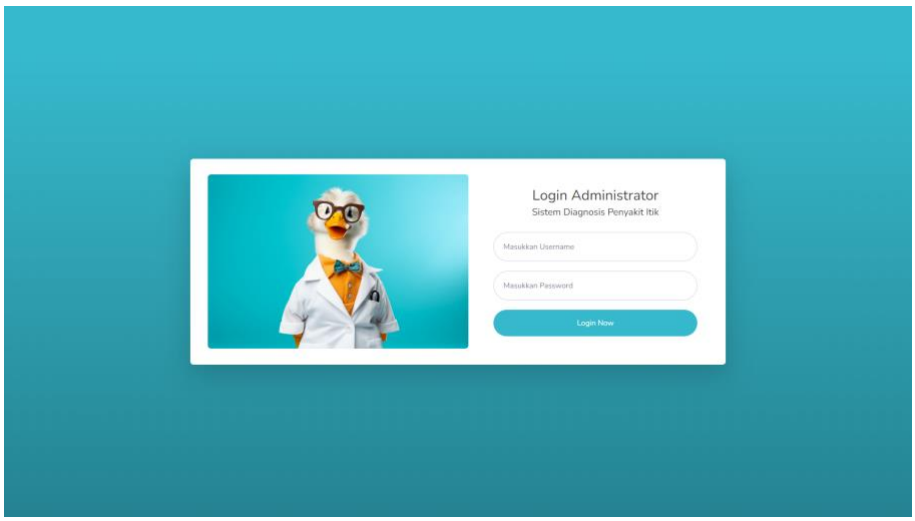

Figure 3. Home page

Figure 4 Explain comparative analysis based on correlation and symptoms using the AHP-Certainty Factor method

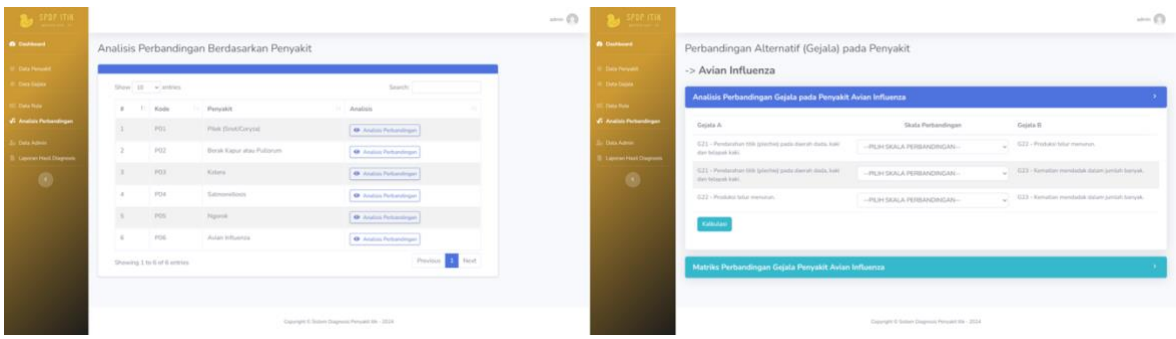

Figure 4. Comparative Analysis

Figure 5. Explain the results of the calculation using the AHP-CF method. AHP can be used to determine the weight of factors that affect the likelihood of a disease, such as symptoms, environmental conditions, or disease history. While the CF method allows

the system to provide a confidence value (certainty) based on data provided by experts or observation results.

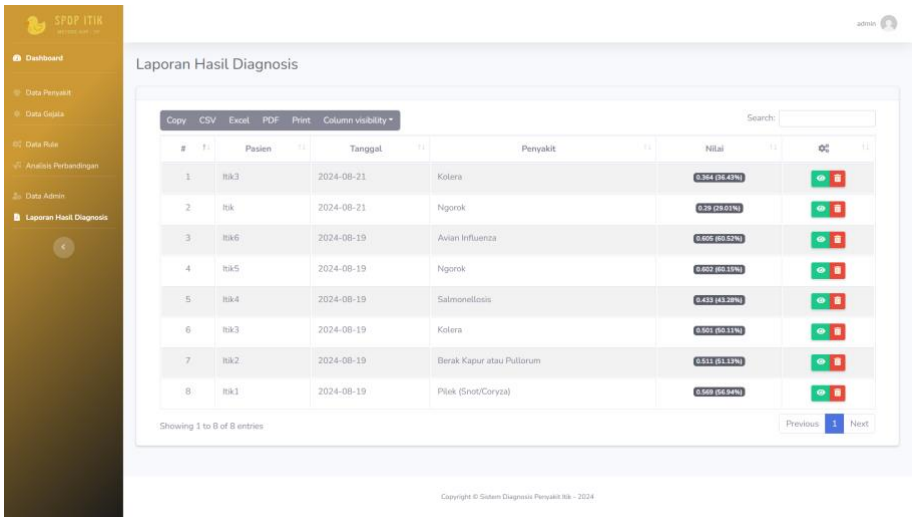

Figure 5. Diagnosis Results

Conclusion

The Analytical Hierarchy Process (AHP) and Certainty Factor methods proved to be very effective in the diagnosis of chicken diseases. An expert system has been built to diagnose symptoms and diseases in chickens, with results displayed based on predefined rules using the Analytical Hierarchy Process (AHP) and CF methods. This method enables the expert system to quickly and accurately diagnose while also indicating the certainty level for each diagnosis. But incomplete symptom data and varying field conditions require further validation from animal experts. This research contributes not only to technological advances in the field of animal husbandry, but also to become a practical solution that can be widely applied to improve the quality of chicken health management.

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