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EXPERT SYSTEM FOR DIAGNOSING RESPIRATORY DISEASES FOR CATS

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Abstract

Cats are the most common pet in Indonesia, and there is a cat ownership rate of 47% (Rakuten Insight, 2021). Cat owners need to know and recognize the signs and symptoms of the diseases that often occur in cats, especially respiratory problems and diseases. Although vaccines in cats can significantly reduce the incidence of respiratory diseases, they do not eliminate infectious disease pathogens. During the COVID-19 pandemic, it was necessary to adjust health consultations that could reduce the transmission of COVID-19, which is the contactless method. In animal health, there is an online consultation between veterinarians and cat owners through the WhatsApp platform. Cat owners manually type every symptom experienced by the cat. However, there are several shortcomings in the online consultation, including the fact that the symptoms described by the cat owner are unclear, so the diagnosis data is lacking, and the consultation fee is quite expensive. Based on the problems that have been mentioned, the purpose of this study is to create an expert system for diagnosing respiratory diseases in cats using the Certainty Factor method. The result of this study is the availability of an expert system that can be used to diagnose respiratory diseases in cats.

Keywords: Cat; Respiratory Disease; Certainty Factor; Expert System

Abstrak

Kucing merupakan hewan yang banyak dipelihara di Indonesia dengan tingkat kepemilikan hewan kucing sebesar 47% (Rakuten Insight, 2021)*. Pemilik kucing perlu mengetahui dan mengenal tanda dan gejala dari penyakit yang seringkali terjadi pada kucing, terutama masalah dan penyakit pernapasan pada kucing. Meskipun vaksin pada kucing dapat menurunkan insiden penyakit pernapasan secara signifikan, namun tidak menghapuskan patogen penyakit menular tersebut. Dimasa pandemik COVID-19, dibutuhkan penyesuaian konsultasi kesehatan yang dapat mengurangi transmisi COVID-19 yaitu dengan metode contactless. Pada dunia kesehatan hewan, terdapat konsultasi daring melalui platform whatsapp antara dokter hewan dan pemilik kucing. Pemilik kucing mengetik manual setiap gejala yang dialami oleh kucing. Namun, terdapat beberapa kekurangan pada konsultasi daring tersebut di antaranya gejala yang dijelaskan oleh pemilik kucing kurang jelas sehingga data diagnosis kurang dan biaya konsultasi cukup mahal. Berdasarkan masalah yang telah disebutkan, tujuan penelitian ini adalah pembuatan sebuah sistem pakar diagnosis penyakit pernapasan pada kucing dengan menggunakan metode certainty factor. Hasil dari penelitian ini adalah tersedianya sistem pakar yang dapat digunakan untuk melakukan diagnosis penyakit pernapasan pada kucing.*

Kata kunci: Kucing; Penyakit Pernapasan; Certainty Factor; Sistem Pakar

INTRODUCTION

Cats are the most common pet in Indonesia, and there is a cat ownership rate of 47% (Rakuten Insight, 2021). Cat owners need to know and recognize the signs and symptoms of the diseases that often occur in cats, especially respiratory problems and diseases. Respiratory diseases in cats that often occur include Feline Herpes Virus and Feline Viral Rhinotracheitis, with a 97% incidence in cats exposed to this virus during their lifetime, Feline Calicivirus, with a 90% incidence in high population areas, and Feline Panleukopenia Virus or Feline Distemper with a mortality rate of 90% in kittens and 50% in adult cats (Cornell Feline Health Center, 2018).

During the COVID-19 pandemic, it was necessary to adjust health consultations that could reduce the transmission of COVID-19, which is the contactless method. In animal health, there is an online consultation through the WhatsApp platform between veterinarians and cat owners (Suryadiningrat, 2022). Cat owners manually type every symptom experienced by the cat. However,

there are several shortcomings in the online consultation, including the fact that the symptoms described by the cat owner are unclear, so the diagnosis data is lacking, and the consultation fee is quite expensive.

Previous research was conducted by Fitri Rahmawati et al. by creating an expert system for cat skin diseases using Naive Bayes and Certainty Factor (Rahmawati, Via, & Puspaningrum, 2020). This research provides an accuracy rate of 100%. The second research created an expert system using the certainty factor method to accurately identify panleukopenia in cats Putra and Nurcahyo (2020) (Putra & Nurcahyo, 2020). This research provides an accuracy rate of 100%. Further research was conducted by Muhammad Afdhal et al. (2021) (Afdhal, Mandala, & Zulfikri, 2021), who created an expert system for diagnosing Feline Infectious Peritonitis Virus in cats using a web-based Naive Bayes method. This research provides an accuracy rate of 87,37%.

Based on a literature study of previous research and the identified problems, researchers propose to create an expert system for diagnosing animal diseases, especially respiratory diseases in cats. This research is limited to respiratory diseases in cats, specifically Feline Herpes Virus (FHV), Feline Calicivirus (FC), Feline Panleukopenia Virus (FPV), and Feline Rhinotracheitis (FR), and the data for this research was obtained from experts (veterinarians) at the Kevin Petshop clinic in Bekasi. Researchers hope that this research can help provide an expert system that can help cat owners temporarily diagnose respiratory diseases experienced by cats.

RESEARCH METHODS

The research stages that serve as a guide for researchers to solve problems are shown in Figure 1.

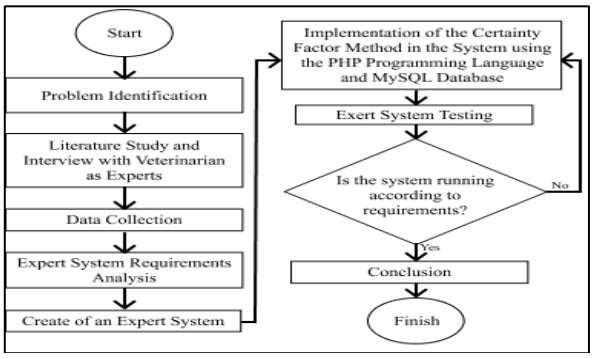

Figure 1. Research Stages

Problem Identification

This stage explains the problem that will be researched by the researcher, which is to create an Expert System for Respiratory Disease Diagnosis in Cats.

Literature Study and Interview with Veterinarians as Experts

This stage is the process of processing research materials. Find out about theories related to research.

1) Respiratory Diseases in Cats

Respiratory disease in cats is something that often occurs in high-population areas (Ucdavis Koret Shelter Medicine Program, 2015). Various varieties of viruses, bacteria, fungi, and protozoa can cause infections, which negatively affect a cat's health. Infection can occur in the upper and lower respiratory tract. The upper respiratory tract includes the nasal passages, sinuses, oral cavity, pharynx, and larynx. The lower respiratory tract includes the trachea, bronchi, and lungs (Cornell Feline Health Center, 2018).

2) Symptoms of Respiratory Disease in Cats

Table 1 shows the disease list table, and Table 2 shows the symptom list table.

Table 1. Diseases List (Cornell Feline Health Center, 2018)

No.	Diseases Name	Diseases Code
1.	*Feline Herpes Virus*	F1
2.	*Feline Calici Virus*	F2
3.	*Feline Rhinotracheitis*	F3
4.	*Feline Panleukopenia Virus*	F4

Table 2. Tabel Symptoms List (Cornell Feline Health Center, 2018)

No.	Symptom Name	Symptom Code
1.	Anorexia or loss of appetite	G01
2.	Sneeze	G02
3.	Dehydration	G03
4.	Diarrhea	G04
5.	Gingivitis or inflammation of the gums	G05
6.	Nasal congestion	G06
7.	Convulsions	G07
8.	Jaundice or yellowness of the mouth and ears	G08
9.	Discharge from the nose	G09
10.	Discharge from the eyes	G10
11.	Lethargy or fatigue	G11
12.	Vomit	G12
13.	Fast breathing	G13
14.	Bleeding in the digestive tract	G14
15.	Drastic weight loss	G15

3) Certainty Factor Algorithm

The certainty factor is usually used to calculate the level of confidence in information

(Wirasbawa, Widjaja, Wenji, & Hansun, 2022). This algorithm uses 2 variables, namely evidence (symptoms), which is symbolized by the letter E and Hypothesis, which is symbolized by the letter H (Wirawan, 2023). The result of the calculation typically falls within the range of -1 to 1, where -1 indicates disbelief or lack of confidence, and 1 indicates complete confidence or belief (Hartati, 2021). The basic equation of the certainty factor is the equation that if E, then H, as shown in equation (1).

$$CF(H,e) = CF(E,e) \times CF(H,E) \quad \text{.....(1)}$$

Then, there is the final CF value, namely the certainty value of a final hypothesis. The final CF is calculated using CF Combine (CFC), which is a combination of CF from each evidence or symptom. Equations (2) and (3) are ways of combining each certainty factor value (Pasaribu, Sihombing, & Suherman, 2020).

CF Combine:

$$CFC\ 1{,}2 = CF(H,e)1 + CF(H,e)2 \times [1 - CF(H,e)1] \quad \text{.....(2)}$$

$$CFC\ old, 3 = CFC\ old + CF(H,e)3 \times [1 - CFC\ old] \quad \text{.....(3)}$$

The CF value in percentage form is shown by the equation (4).

$$CF = CFC\ final \times 100\% \quad \text{.....(4)}$$

Information:

CF (H, e)	=	CF hypothesis that is influenced by evidence e (cf each symptom).
CF (E, e)	=	CF evidence E, which is influenced by evidence e (the certainty value given by the user).
CF (H, E)	=	CF of a hypothesis with the assumption that evidence is known with certainty, which is when the value of CF (E, e) = 1 (the certainty value provided by the expert).
CFC (1, 2)	=	CF Combine Symptoms 1 and 2.
CFC *old*, 3	=	CF Combine old dan Symptom 3.

4) Expert System

An Expert System is a computerized system that uses facts, reasoning, and human knowledge to help solve problems as an expert or specialist in a particular field would (Pratiwi, 2019). Expert systems have architecture as their main part. The architecture is divided into two parts, namely the development environment, which is used to transfer knowledge from experts into the expert system, and the consultation environment, which users use to obtain information or knowledge from experts through this system (Jauhari, Anamisa, & Mufarroha, 2020). Figure 2 shows the expert system architecture (Winarsih, 2023):

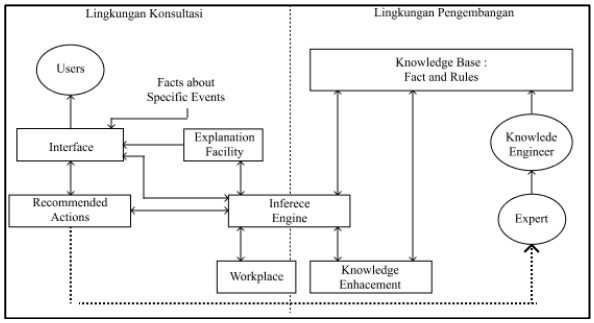

Figure 2. Expert System Architecture (Winarsih, 2023)

Data Collection

This stage is the collection of data needed for this research. At this stage, researchers conducted interviews with experts, namely veterinarians, regarding all the necessary data requirements.

Expert System Requirements Analysis

This stage contains an analysis of system requirements such as hardware, software, and system architecture by researchers, which is needed in this research. At this stage, an interview is also conducted with the veterinarian regarding what is needed to carry out a diagnosis so that it can be implemented into the system.

Creation of an Expert System

Create an expert system using the certainty factor method by the expert system architecture.

Implementation of the Certainty Factor Method

This stage implements an expert system with the PHP programming language and MySQL database. Figure 3 shows the flowchart of the certainty factor method.

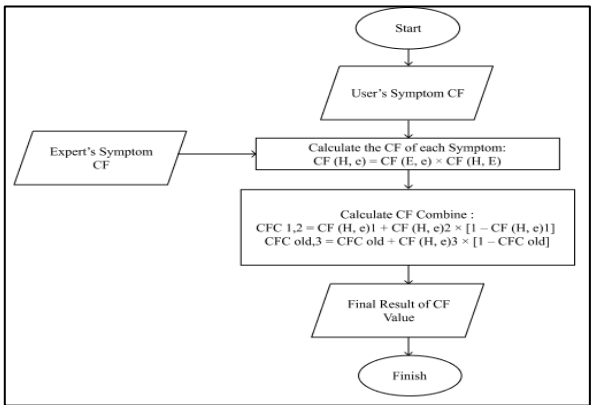

Figure 3. Certainty Factor Method Flowchart

The explanation of Figure 3 is as follows:

7. **CF User Symptoms.**

User symptom CF is the certainty factor value that the expert has determined for the user. The user selects CF values based on the symptoms observed in their cat. In this research, the CF value for users, according to experts, is now referred to as the user's CF value.

b. CF Expert Symptoms.

CF of symptoms by experts is the certainty value of each symptom given by the expert.

c. Calculate CF for Each Symptom.

This is the process of calculating the user's CF value multiplied by the expert's CF value.

d. Calculate CF Combine.

Calculating CF Combine is the process of combining the certainty factor values of each symptom to determine the disease.

e. Final Result CF.

The final result of the CF is the certainty value of the disease diagnosed.

Expert System Testing

This stage is tested on the expert system that has been created to find out whether the system is appropriate and functioning well and efficiently. In the test, researchers used data from experts on respiratory disease cases. Then, testing is carried out between real data and the system, and the level of accuracy is calculated using equation (5) (Mulyani, Sulindawati, & Wahyuni, 2018).

$$Level\ of\ Accuracy = \frac{Number\ of\ Correct\ Predictions}{Number\ of\ Sampels} x100\% \quad \text{.....(5)}$$

Conclusion

In this stage, the researcher will conclude or summarize what has been done from start to finish in this research.

RESULTS AND DISCUSSION

Literature Study and Interview with Veterinarians as Experts

In this research, researchers conducted interviews with a veterinarian, Dr. Wahyu, at the Kevin Pet Shop Clinic in East Bekasi, who was the expert for this research. Researchers conducted 4 times with the following dates and interview agendas:

1) October 15, 2022

Respiratory diseases in cats and the symptoms of each disease.

2) November 27, 2022

The Expert's Certainty Factor values for each symptom; The influence of cat type, gender, and age on disease diagnosis; Recommended actions for each disease.

3) January 20, 2023

Conditioning each symptom for the user within the range of 0.2 – 1.0.

4) June 17, 2023

Real data collection by the expert.

Data Collection

The results of interviews conducted by researchers produced data, namely Table 3, which shows an explanation of each disease based on the results of expert interviews.

Table 3. The Explanations for Each Disease

No.	Disease	Explanation
1.	Feline Herpes Virus	Feline Herpes Virus (FHV) is a disease in cats that attacks the upper respiratory tract and is caused by a decrease in the body's immune system. This disease is usually called Cat Flu. FHV can be transmitted through saliva and blood.
2.	Feline Calici Virus	Feline Calici Virus (FCV) is a disease in cats that attacks the upper respiratory system. FCV can be transmitted through fluids from the nose and mouth. FCV can also be transmitted through air contamination (but rarely).
3.	Feline Rhino-tracheitis	Feline Rhinotracheitis is a disease in cats that attacks the lower respiratory tract (lungs) due to contaminated air. This disease is similar to Feline Herpes Virus and is often called Influenza in cats.

No.	Disease	Explanation
4.	Feline Panleukopenia Virus	Feline Panleukopenia Virus (FPV) is a disease in cats that attacks white blood cells, resulting in a decrease in the body's immunity, and the virus damages the digestive tract. This disease is usually called Distemper in cats. FPV can be transmitted through cat faeces.

No.	Diseases	Recommended Action
4.	Feline Panleukopenia Virus	Immediately take him to the nearest veterinarian for further examination. If it is at a time when the vet is not yet open, you can give brown sugar water to prevent the cat from getting weak. Feed the cat wet food.

Table 4 shows the recommended actions for each disease based on the results of expert interviews.

Table 4. Recommended Actions for Each Disease

No.	Diseases	Recommended Action
1.	Feline Herpes Virus	Immediately take him to the nearest veterinarian for further examination. If it is at a time when the vet is not yet open, you can give brown sugar water to prevent the cat from getting weak. Frequently clean the fluid from the cat's nose so that the cat can breathe well.
2.	Feline Calici Virus	Immediately take him to the nearest veterinarian for further examination. If it is at a time when the vet is not yet open, you can give brown sugar water to prevent the cat from getting weak. Provide a heat lamp in the cat's enclosure.
3.	Feline Rhino-tracheitis	Immediately take him to the nearest veterinarian for further examination. If it is at a time when the vet is not yet open, you can give brown sugar water to prevent the cat from getting weak. Provide a heat lamp in the cat's cage. Frequently clean the fluid from the cat's nose & mouth.

Table 5 shows the symptom code (KG) for each disease, and Figure 4 shows the decision tree for respiratory diseases in cats. For example, F1 is the disease code (KP) for Feline Herpes Virus disease, and G1 is the symptom code for anorexia symptoms.

Table 5. The Symptom Codes for Each Disease

KP	KG			KP	KG		
F1	G01	G09	G13	F2	G01	G08	G15
	G02	G10	G14		G03	G10	
	G06	G11	G15		G05	G11	
KP	KG			KP	KG		
F3	G01	G06	G13	F4	G01	G07	G13
	G02	G09	G15		G03	G11	G14
	G03	G11			G04	G12	G15

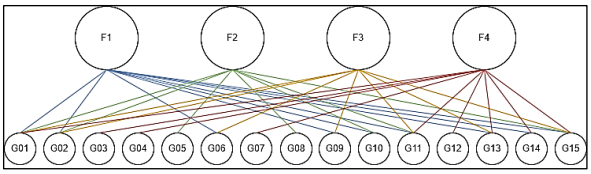

Figure 4. Decision Tree for Respiratory Diseases in Cats

Table 6 shows the conditions for each user's CF value. The user's CF value is based on the results of interviews with experts. Experts gave a range of 0.2 – 1.0 according to the condition of each symptom.

Table 6. The Condition of Each Symptom Based on The User's CF Value

No.	Symp-tom	User's CF Value	Condition
1.	Anorex-ia	0.2	Still want to eat but am not hungry
		0.4	Just sniffing but not eating
		0.6	Doesn't want to eat but isn't weak yet
		0.8	Doesn't want to eat and starts to feel weak
		1.0	No longer has any remaining energy (Critical)
2.	Sneeze	0.2	2x a day
		0.4	5x – 6x a day
		0.6	Almost every hour
		0.8	Almost every 30 minutes
		1.0	Intense more than 1 time in 30 minutes
3.	Dehydration	0.2	Still want to drink
		0.4	Still want to drink, but starting to feel weak
		0.6	Drinks a little and starts vomiting
		0.8	Doesn't want to drink and vomits
		1.0	Vomiting is yellow and has no energy (Critical)
4.	Diarr-hea	0.2	Stools are formed but not hard.
		0.4	The stool begins to liquefy, but there are dregs

No.	Symp-tom	User's CF Value	Condition
		0.6	Stools are loose but somewhat thick.
		0.8	Stools are very liquid
		1.0	Stools are mucusy
5.	Gingivi-tis	0.2	The oral mucosa is red
		0.4	The oral mucosa has white dots
		0.6	Drooling mouth
		0.8	The mouth smells bad
		1.0	Doesn't want to eat or drink and feels weak
6.	Nasal congestion	0.2	Still sniffing food and eating.
		0.4	Started to sniff the food and eat, but not ravenously, rarely
		0.6	Can't smell food and don't eat
		0.8	Breathing through the mouth.
		1.0	Already weak and lethargic.
7.	Convulsions	0.2	1x a day
		0.4	2x – 3x a day
		0.6	every 2 hours
		0.8	once every 1 hour
		1.0	Intense more than 1 time in 1 hour (Critical)
8.	Jaundice or yellowness of the mouth and ears	0.2	The yellowness is not very visible
		0.4	Yellowing in the mucous membrane area
		0.6	Followed by yellowing of the eyeballs
		0.8	Followed by yellow skin
		1.0	Areas other than those mentioned are also yellowing (Critical)
9.	Discharge from the nose	0.2	The nose is only wet.
		0.4	Clear discharge.
		0.6	The discharge is becoming thicker or greenish.
		0.8	Thick green discharge.
		1.0	Discharge is blocking the airway (Critical).
10.	Discharge from the eyes	0.2	Clear discharge.
		0.4	The discharge is becoming reddish.
		0.6	Thick red discharge.
		0.8	Discharge is like blood.
		1.0	The discharge makes it impossible to open the eyes (Critical)
11.	Lethargy	0.2	Still walking actively.
		0.4	Sleeping a lot.
		0.6	Eyes are squinting and only moving the tail.
		0.8	Unable to lift the head.
		1.0	No longer has the strength to move (Critical).
12.	Vomit	0.2	1x a day
		0.4	2x – 3x a day
		0.6	Every 2 hours
		0.8	Vomit is yellow
		1.0	Vomiting is yellow and intense every 1 hour (Critical)
13.	Fast breathing	0.2	110 – 120 per minute
		0.4	120 -140 per minute
		0.6	140 – 160 per minute
		0.8	More than 200 per minute
		1.0	More than 300 per minute (Critical)
14.	Bleeding in the digestive tract	0.2	There are red spots in the stool but no fresh blood
		0.4	Red spots begin to appear in the stool
		0.6	Stools are mixed with fresh blood
		0.8	Only bleeds when defecating
		1.0	Clotted, thick, and profuse blood comes out when defecating (Critical)
15.	Drastic weight loss	0.2	Weighs 3kg, and the spine is visible
		0.4	Ribs are visible
		0.6	Other bones have started to stick out
		0.8	The body only has bones
		1.0	Remaining skin and unable to move (Critical)

Table 7 shows the expert's CF values for each symptom. This expert's CF value is based on the results of interviews with experts. Experts give a range from 0 to 1, with the conditions for each range as follows:

0 = Never 0.6 = Slightly Often
0.2 = Very Rare 0.8 = Often

0.4 = Rarely 1.0 = Very Often

Table 7. Expert's CF Value for Each Symptom According to The Expert

No.	Symptom Code	Symptom	Expert's CF
1.	G01	Anorexia or loss of appetite	1.0
2.	G02	Sneeze	0.4
3.	G03	Dehydration	1.0
4.	G04	Diarrhea	0.4
5.	G05	Gingivitis or inflammation of the gums	0.4
6.	G06	Nasal congestion	0.4
7.	G07	Convulsions	0.6
8.	G08	Jaundice or yellowness of the mouth and ears	0.6
9.	G09	Discharge from the nose	0.6
10.	G10	Discharge from the eyes	0.4
11.	G11	Lethargy or fatigue	1.0
12.	G12	Vomit	0.8
13.	G13	Fast breathing	0.6
14.	G14	Bleeding in the digestive tract	0.6
15.	G15	Drastic weight loss	0.8

Analysis of The Expert System's Requirements

7. **Hardware Requirements**

1) Laptop HP AMD Athlon Gold 3150U
2) RAM 8 GB
3) Solid State Drive 500 GB

b. Software Requirements

1) Windows 10 Operating System (64-bit)
2) Visual Studio Code
3) Database MySQL
4) Microsoft Office
5) Figma

Creation of an Expert System

The expert system is created according to the architecture of the expert system, as shown in Figure 2.

a. Consultation Environment

1) Users

This application is used by users (cat owners) and admins.

2) Facts about Specific Events

The user or cat owner will fill in these facts according to the cat they own. This fact contains the symptoms experienced by the cat along with the condition level of the symptoms, according to Table 6.

3) Interface

This application has a user interface and an admin interface. Some interfaces that are general or can be accessed by users and admins are the account registration interface and the account login interface. Figure 5 shows the user flow diagram for carrying out the diagnosis stage, Figure 6 shows the admin flow diagram for managing symptom data, and Figure 7 shows one of the user page wireframe interfaces for the homepage.

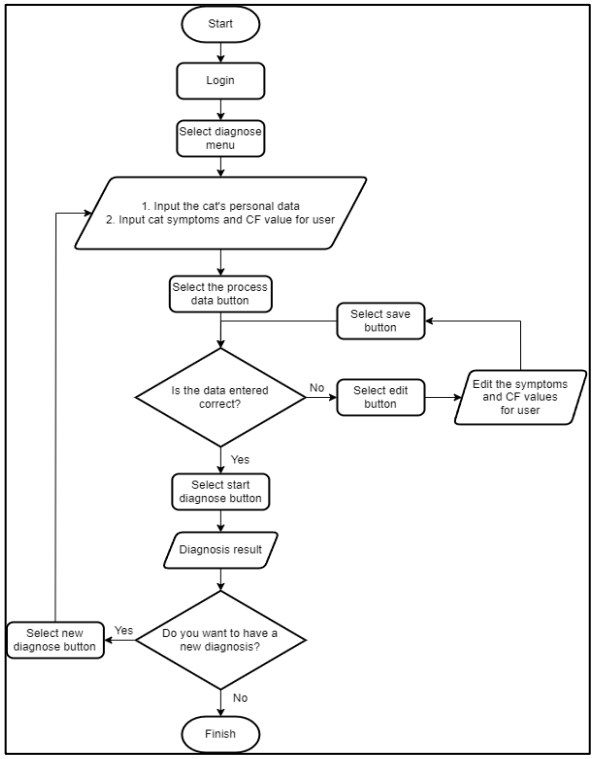

Figure 5. User Flowchart for Carrying Out the Diagnosis Stage

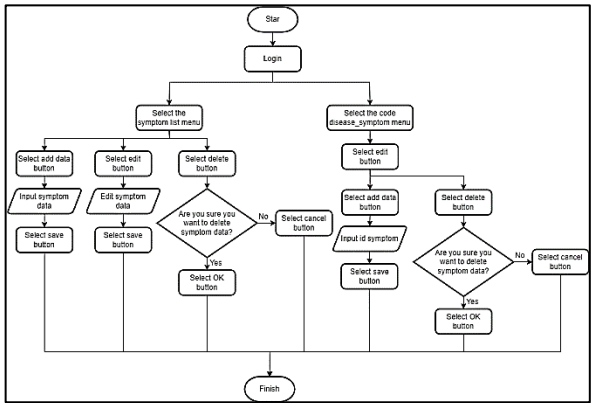

Figure 6. Admin Flowchart for Managing Symptom Data

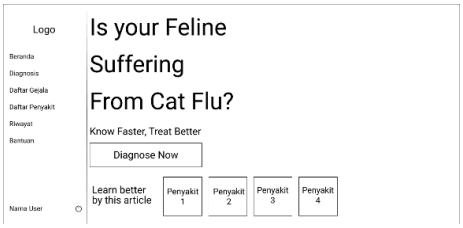

Figure 7. User Page Wireframe for Home

4) Explanation Facility

Explanations about diseases resulting from the diagnosis based on the explanations provided by Drh. Wahyu (the expert), which can be seen in Table 3.

5) Recommended Action

Are based on the diagnosis results. These actions are based on Drh's direction. Wahyu's (the expert), which can be seen in Table 4.

6) Workplace

Stores the history of diagnosis results for each user, containing the cat's name, age, gender, diagnosis results (disease and certainty level), date of diagnosis, and symptoms input by the user.

b. Development Environment

1) The Expert

The expert whose knowledge and expertise are applied in this system to solve problems is Drh. Wahyu, who works at Kevin Petshop.

2) Knowledge Engineer

The acquisition of expert knowledge is done through interviewing the expert. The interview results are found in point 4.3.

3) Knowledge Base

After interviewing Drh, Wahyu, the data obtained is translated into the knowledge base. There are two basic elements in the knowledge base, which are facts and rules. Table 8 displays the facts and rules obtained.

Table 8. Fact and Rules

Rules	Fact	Conclusion
Rules 1	If G01 and G02 and G06 and G09 and G10 and G11 and G13 and G14 and G15	F1
Rules 2	If G01 and G03 and G05 and G08 and G10 and G11 and G15	F2
Rules 3	If G01 and G02 and G03 and G06 and G09 and G11 and G13 and G15	F3
Rules 4	If G01 and G03 and G04 and G07 and G11 and G12 and G13 and G14 and G15	F4

4) Knowledge Enhancement

The knowledge in this system can be improved as needed in the future. If any improvements need to be made, they will be carried out by the researcher based on developments or changes directed by Drh. Wahyu (the expert).

5) Inference Engine

The inference engine used in this research is the certainty factor. This method processes and understands how the rules and facts provided by the expert can solve problems. Below is the calculation for one of the real data provided by the expert. Table 9 displays cat symptoms and the user's CF in real data 1.

Table 9. Cat Symptoms and User's CF in Real Data1

No.	Symptom	KG	User's CF
1.	Sneeze	G02	0,6
2.	Dehydration	G03	0,2
3.	Jaundice or yellowness of the mouth and ears	G08	0,2
4.	Discharge from the nose	G09	0,4
5.	Lethargy or fatigue	G11	0,4
6.	Drastic weight loss	G15	0,4

The CF method calculation process for real data 1 is as follows:

1) The expert CF value for symptoms in real data 1, according to Table 7, is shown in Table 10.

Table 10. Expert CF Value for Symptoms on Real Data 1

No.	Symptom	KG	Expert's CF
1.	Sneeze	G02	0,4
2.	Dehydration	G03	1
3.	Jaundice or yellowness of the mouth and ears	G08	0,6
4.	Discharge from the nose	G09	0,6
5.	Lethargy or fatigue	G11	1
6.	Drastic weight loss	G15	0,8

2) Calculate the CF value for each symptom (CF(H,e)) using equation (1). The user's CF value in real data 1 is obtained from Table 9, and the expert CF value is obtained from Table 10. The CF value results for each symptom are shown in Table 11.

Table 11. CF Value for Each Symptom in Real Data 1

No.	KG	Symptom	User's CF × Expert's CF
1.	G02	Sneeze	0,6 × 0,4 = 0,24
2.	G03	Dehydration	0,2 × 1 = 0,2
3.	G08	Jaundice or yellowness of the mouth and ears	0,2 × 0,6 = 0,12
4.	G09	Discharge from the nose	0,4 × 0,6 = 0,24
5.	G11	Lethargy	0,4 × 1 = 0,4
6.	G15	Drastic weight loss	0,4 × 0,8 = 0,32

3) Calculate CF Combine for disease code F1 (refer to Table 5) using equations (2) and (3).

a. Select any symptoms in real data 1 which are included in the disease code F1 (refer to Table 5). Obtain symptoms with codes G02, G09, G11, and G15, which are included in the disease code F1.

b. Equation (2) is used to calculate the CF combined with the CF value of the symptoms included in the disease code F1. The first calculation is to calculate the CF combined from

the symptom CF values with codes G02 and G09 obtained in Table 11.

$$CFC1,2 = CF(H,e)1 + CF(H,e)2 \times [1 - CF(H,e)1]$$
$$CFC1,2 = CF(G02) + CF(G09) \times [1 - CF(G02)]$$
$$CFC1,2 = 0{,}24 + 0{,}24 \times [1 - 0{,}24]$$
$$CFC1,2 = 0{,}24 + 0{,}24 \times 0{,}76$$
$$CFC1,2 = 0{,}24 + 0{,}1824$$
$$CFC1,2 = 0{,}4224$$

c. The CFC1,2 value that has been obtained is saved as the old CFC value. Then, calculate the combined CF value from the old CF value with the symptom CF value with code G11, which is in Table 11, using equation (3).

$$CFC\ old,3 = CFC\ old + CF(H,e)3 \times [1 - CFC\ old]$$
$$CFC\ old,3 = CFC\ old + CF(G11) \times [1 - CFC\ old]$$
$$CFC\ old,3 = 0{,}4224 + 0{,}4 \times [1 - 0{,}4224]$$
$$CFC\ old,3 = 0{,}4224 + 0{,}4 \times 0{,}5776$$
$$CFC\ old,3 = 0{,}4224 + 0{,}23104$$
$$CFC\ old,3 = 0{,}65344$$

d. Do the same steps for the next symptom that is included in the F1 disease code to get the final combined CF value.
e. After getting the final combined CF value, it is then converted into percent form, namely using equation (4).

$$Percentage = CFC\ final \times 100\%$$
$$Percentage = CFC\ old,4 \times 100\%$$
$$Percentage = 0{,}7643392 \times 100\%$$
$$Percentage = 76{,}43\%$$

4) Carry out the same calculation process as step number 3 to get the percentage of the CF value combining other disease codes. In real data 1, the final result of the combined CF value, along with the percentage for each disease code, is obtained, as shown in Table 12.

Table 12. CFC Values for All Disease Codes in Real Data 1

No.	KP	CFC Value	Percentage
1.	F1	0,764339	76,43%
2.	F2	0,712768	71,28%
3.	F3	0,811471	81,15%
4.	F4	0,6736	67,36%

5) Conclusion: The highest CF Combine value is owned by disease code F3, which is Feline Rhinotracheitis. So, the diagnosis result for real data 1 is Feline Rhinotracheitis with a CFC value percentage of 81.15%.

Implementation of the Certainty Factor Method

a. MySQL Database.

The database in this application uses 5 tables there is the user table, penyakit table, gejala table, gejala_penyakit table, and diagnosis table.

b. Certainty Factor Method Program Code and Application Interface

This application uses the Certainty Factor method for its inference engine. This Certainty Factor method is implemented using the Visual Studio Code code editor, PHP programming language, Laravel framework, and MySQL database. This application has two roles: the admin role and the user role. The following is one of the program codes for calculating diagnosis results, shown in Figure 11, and one of the applications displays a user interface display of the diagnosis results page, shown in Figure 12.

```
public function analisis($id)
    {
        $diagnose = Diagnose::where('id_diagnose', $id)->first();
        $filteringF1  =  DB::table('gejala_penyakit')->where('id_penyakit',
'F01')->select('id_gejala')->get();
.
.
.
            'max' => $max, 'nama' => $nama,
                    'kucing' => $data_kucing,
                    'p' => $p,
                    'a' => $a
                ]); }}
```

Figure 8. Diagnosis Result Calculation Program Code

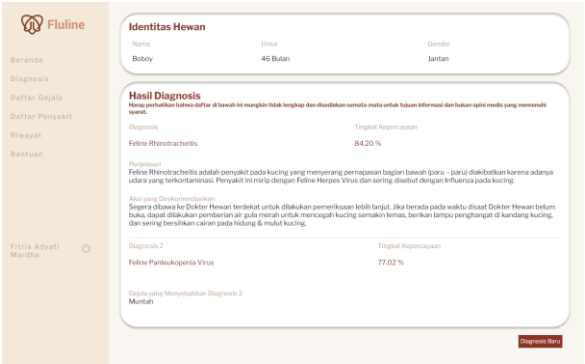

Figure 9. User Interface Display for the Diagnosis Page

Expert System Testing

Testing was carried out using real data provided by experts. There are 5 real cat medical record data provided, along with expert diagnosis results. Then, the five real data were tested with an expert system. Table 13 shows the test results from real data with the system being built.

Table 13. The result is the testing of real data by the system.

Cat's Name	Symptom	Real Diagnosis	System Diagnosis	Prediction Result
Miki	Sneeze Dehydration Jaundice Discharge from the nose Lethargy Drastic weight loss	Feline Herpes Virus	Feline Herpes Virus	True
Suna	Anorexia Diarrhea Gingivitis Discharge from the eyes Lethargy Drastic weight loss	Feline Panleu-kopenia Virus	Feline Panleu-kopenia Virus	True
Cali	Sneeze Nasal congestion Convulsions Discharge from the nose Discharge from the eyes Lethargy Fast Breathing	Feline Rhino-trache-itis	Feline Rhino-trache-itis	True
Roa	Anorexia Diarrhea Gingivitis Vomit Fast Breathing Drastic weight loss	Feline Panleu-kopenia Virus	Feline Panleu-kopenia Virus	True
Boboy	Sneeze Dehydration Jaundice Discharge from the nose Lethargy Drastic weight loss -	Feline Rhino-trache-itis	Feline Rhino-trache-itis	True

From Table 13, it can be concluded that the real data provided resulted in the same diagnosis between the expert and expert systems. Then, the prediction results are calculated using equation (5) to obtain the accuracy level.

$$Level\ of\ Accuracy = \frac{Number\ of\ Correct\ Predictions}{Number\ of\ Sampels} x100\% \quad \text{.....(5)}$$

$$Level\ of\ Accuracy = \frac{5}{5} \times 100\% = 100\%$$

The accuracy level of real data testing results provided by experts with the system is 100%.

CONCLUSIONS AND SUGGESTIONS

Conclusion

Based on research that has been carried out by researchers, namely creating an expert system for diagnosing respiratory diseases in cats, testing has been carried out using real data from an expert (Drh. Wahyu). There are 5 cat medical record data along with Drh's diagnosis results. Revelation. Then, the data is tested using the built-in expert system. This test expects the diagnosis results from the system to be the same as the diagnosis results from Drh. Revelation. After testing, the system produces the same diagnosis as the expert. So, the level of accuracy of real data test results provided by experts with the system is 100%. Thus, the following conclusions can be drawn: The factor certainty method can be used as an expert system method for diagnosing respiratory diseases in cats. Furthermore, this expert system for diagnosing respiratory diseases in cats can help cat owners temporarily diagnose respiratory diseases experienced by cats. Based on testing 5 real data provided by experts with the system, results were obtained with an accuracy level of 100%.

Suggestion

Based on the results and discussion above, the suggestions from this research are as follows: this research can be developed with additional datasets. Then, features can be developed that can provide further information about respiratory diseases in cats, which can also be developed further using other methods. So that later, this development will produce a more complete and accurate system than it is at present.

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