Expert System for Chili Plants Disease Detection using Certainty Factor Method

Rafi Akbar Widyatama, Seng Hansun

Abstract*: This paper describes the creation of an expert system that is used to diagnose diseases in chili plants using a web-based certainty factor method. This expert system is made based on the weight of symptoms by experts so that users can find out the disease suffered by chili plants based on symptoms that arise. The symptom weight was calculated using the certainty factor method. This method is used to accommodate uncertainties that are often expressed by experts when detecting a disease. The design and manufacture of this expert system are done using the PHP programming language, MySQL database, CSS and the CodeIgniter framework. The results of the analysis between expert and expert systems have 87.09% compatibility level, and based on the calculation of the feasibility of the system with the Delone and McLean model shows that 77.58% of respondents agree Pakarcabaiku.com is a successful system for detecting chili disease.

***Index Terms*: Certainty Factor, Chili Plants, Delone and McLean Model, Disease, Expert System.**

I. INTRODUCTION

Computers today have experienced very rapid development. Technological advances that occur in computers make computers more reliable to simplify human work. One example of technological advances in computers is the increasingly massive use of artificial intelligence that is implemented into computers. Artificial intelligence, making computers can do the job as well as a human being [1]. The development of artificial intelligence technology is predicted to bring significant changes to human life and will be predicted to replace human position [2].

The development of artificial intelligence can be done through several methods, one of which is the expert system. According to [3], an expert system is a computer-based system that uses knowledge, facts, and reasoning techniques in solving problems that usually can only be solved by experts in the field. The implementation of expert systems, in this case, will be applied through agriculture. Then one type of plant that will be implemented into an expert system is a chili plant. Based on data compiled from katadata.co.id in its report entitled "What is the Production of Domestic Chilies?" which was published in 2017, the national production of large chili and cayenne pepper continues to increase every year. Therefore, it is necessary to maintain the quantity of chili supply so that the price of chili in the market remains stable.

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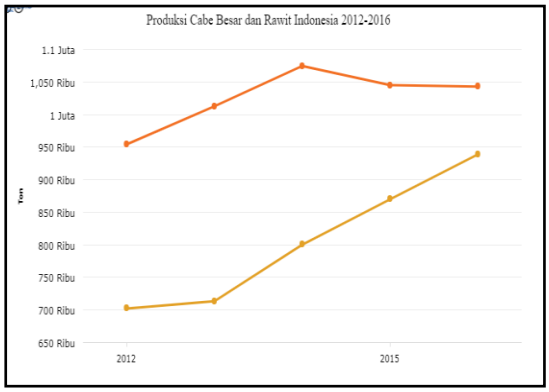

Figure 1. Chili Production Data 2012-2016

It is important for both large and small scale farmers in the household to maintain the quality of chili production because chili is a plant that is vulnerable to weather and pests [4]. There are 12 types of diseases and seven types of pests that can attack chili plants. If not anticipated, there will be losses such as crop failure that can be felt by farmers [5].

The cause of crop failure caused by several factors can be anticipated by looking at the symptoms and structure of the chili plant. Then find solutions to the media that can help these problems with an expert system.

In this study, the author uses the certainty factor method which receives input in the form of expert confidence which often issues expressions such as "maybe", "most likely" and "almost certain" which can then provide an output in the form of a percentage of the value of confidence in the disease that attacks and solutions overcome these problems.

The certainty factor method was chosen because, according to [6], certainty factor is a suitable method used for expert systems that measure certain or uncertain things such as disease diagnosis. Some studies that have used certainty factors such as the expert system for diagnosing tuberculosis used by [7] have an accuracy rate of 81.25%. Meanwhile [8] made an expert system for detecting the risk of osteoporosis and osteoarthritis, having an accuracy rate of up to 80%.

In addition, this study will explain some previous studies that have links to this research. The first study was conducted by [9], a student of STMIK Sinar Nusantara Surakarta with the title "Expert System for Diagnosing Pests and Diseases of Large Chili Plants Using the Certainty Factor Method." Research carried out has a focus on large chili plants and identify disturbances to pests and diseases and does not explain how many types of diseases and pests that can be diagnosed, then the researcher conducts the validation process only by interviewing experts, not jumping directly into the community.

The second study was conducted by Helmi

Kurniawan and Iwan Fitrianto Rahmad, a lecturer of STMIK Utama Potential in 2011 with the title "Expert System Design to Detect Disease in Chilies Using Certainty Factor Method." Research conducted only uses six types of diseases and is less relevant to the current conditions that have 12 types of diseases.

The research that will be conducted by researchers is carried out using 12 types of diseases and is focused only on the types of disorders caused by diseases and doing sampling from students of the Faculty of Agriculture IPB as respondents.

II. CERTAINTY FACTOR

Certainty factor (CF) is a clinical parameter value given by MYCIN to show the amount of trust [10]. MYCIN is an expert system that can help and facilitate doctors who have no experience in handling a particular disease [11]. In dealing with a problem, we often found answers that do not have full certainty. This uncertainty can be a probability or chance of an event that depends on the outcome of an event. Uncertain results are caused by two factors, namely uncertain rules and uncertain user answers to questions raised by the system. This is very easy to see in the disease diagnosis system, where experts cannot define the relationship between symptoms and their causes with certainty, and patients can not feel a symptom with certainty as well. Eventually there are many possible diagnoses [12]. To get the confidence level of a rule, use the formula as below [6].

$$CF\ (H,E)\ =\ MB(H,E) - MD(H,E) \quad (1)$$

where:

$CF\ (H,E)$ = Certainty factor

$MB(H,E)$ = The confidence level of the hypothesis (h), if given the evidence (e) between 0 and 1.

$MD(H,E)$ = The level of uncertainty about the hypothesis (h), if given evidence (e) between 0 and 1

H = Hypothesis

E = Evidence

Meanwhile, according to Halim and Hansun [13], on the same facts there is a combination of CF when more than one.

1. If the CF(e1) and CF(e2) > 0

$$CF(H,E)\ =\ CF(H,E)1\ +\ CF(H,E)2\ *\ (1 - CF(H,E)1) \quad (2)$$

2. If the CF(e1) and CF(e2) < 0

$$CF(H,E)\ =\ CF(H,E)1\ +\ CF(H,E)2\ *\ (1 + CF(H,E)1) \quad (3)$$

3. If the mark CF(e1) ≠ sign CF (e2)

$$CF(H,E)\ =\ (CF(H,E)1 + CF(H,E)2)/\ (1 - min(|CF(H,E)1|, |CF(H,E)2|)) \quad (4)$$

Representation of CF values is explained in Table 1

Table 1. Value Representation [14]

Uncertainty Term	CF
Definitely not	-1.0
Almost certainly not	-0.8
Unlikely	-0.6
Probably not	-0.4
Do not know	-0.2 to 0.2
Maybe	0.4
Most likely	0.6
Almost certainly	0.8
Certainly	1.0

III. DESIGN PHASE

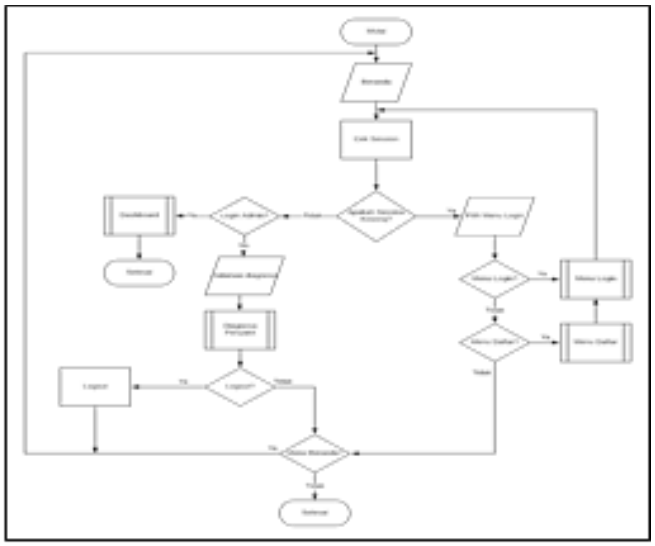

Figure 2. Main Menu Flowchart

Based on the flowchart illustrated in Figure 2. Users who access the Pakarcabaiku.com page will be displayed first on the start page. This home page is called the homepage which displays general information with headers and navbar. Besides that session checking is done, if the session is empty then the user cannot access the diagnosis menu and it is recommended to log in first. If the user does not have an account, the user is required to register an account first.

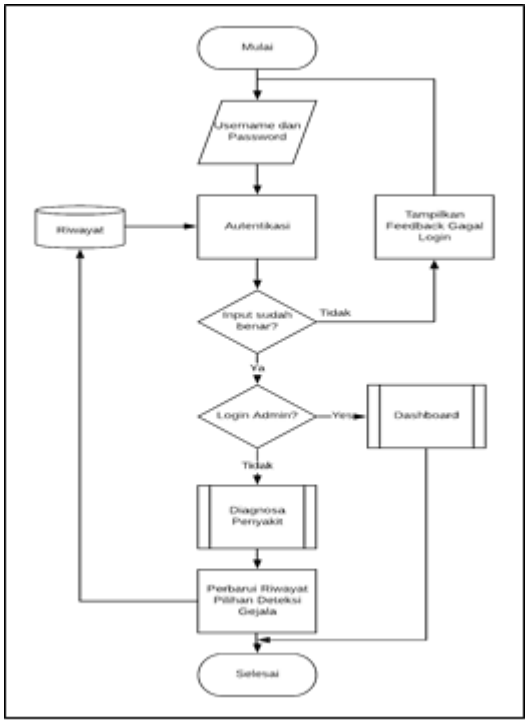

Figure 3. Sub Menu Login Flowchart

Figure 3 explains the flow of the login sub-menu where the username and password entered by the user first check whether the username and password match what is in the database. If it matches, the user will immediately be directed to the diagnostic page. If they do not match, the user will be shown a warning message that the username or password is incorrect.

IV. RESULTS AND DISCUSSION

Figure 4. Main Menu

As can be seen in Figure 4, it is the main page of the expert system website diagnosis of diseases in chili plants. This main page is applied as close as possible to the initial sketch. The main page has a predominance of white in the background.

On the main page, there are five menu choices on the navbar that are placed next to the logo, namely the homepage, expert information, diagnostics, contacts, and entry. Through the menus above, the user can find out the current page with color changes that occur in the navbar menu on the current page.

Next on the main page is inserted a banner that contains a picture of a collection of chilies and is placed behind the welcome text. A diagnostic button is also provided, which will lead to the symptom diagnosis page.

Then there are three steps that are displayed in the form of a container, which is a recommendation for farmers to be able to do when they encounter problems with chili plants. Next, that is available at a glance information about the disease displayed in the form of a card. There are currently 12 diseases displayed on the main page.

Followed by a footer section that is dominated by black with information about the developer, contact persons, and bulletin subscriptions.

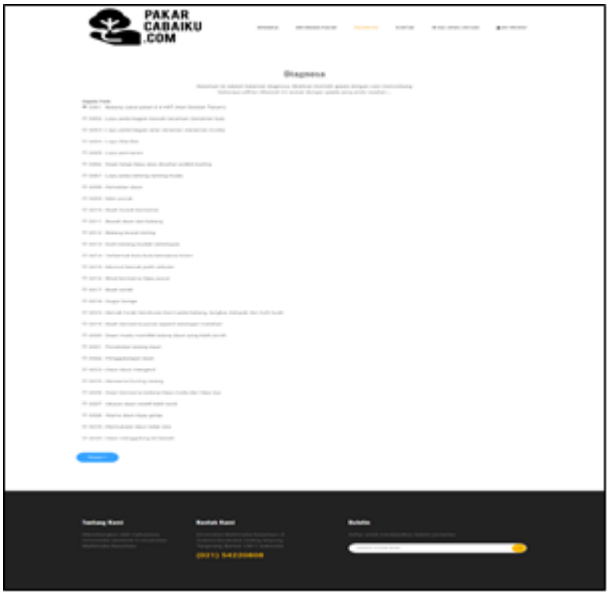

Figure 5. Diagnose Menu

As shown in Figure 5, the image is a diagnostic page display. This page is the page that the user must pass first after logging in. This page displays the types of symptoms that have been identified and verified by experts.

The types of symptoms are displayed sequentially and arranged according to the symptom code and symptom name. The user only needs to select a few of the symptoms that appear in plants and carry out the counting process through the system by pressing the process button. After the user presses the process button it will be redirected to the results analysis page as shown in Figure 6.

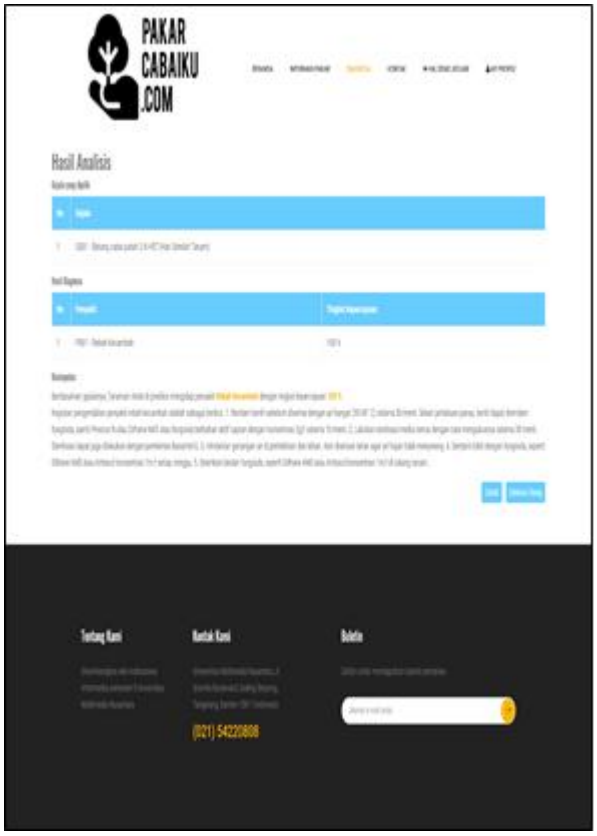

Figure 6. Result Menu

In Figure 6. the results of an analysis of the possibility of illnesses suffered by chili plants based on the symptoms that have been selected are accompanied by a percentage of the level of confidence in the disease and the solution to deal with the disease. Furthermore, users can print the diagnosis page or re-diagnose.

Then an expert system test is carried out by comparing the results of the system output with the results of the expert analysis. The trial was conducted using 31 cases given by experts by Abdul Hakim, S.P., M.Sc. The following is an expert system trial table.

Table 2. Expert and System Results

No	Symptom	Expert system result	Expert observations
1	Withered suddenly Withered on young branches	Fusarium wilt, bacterial wilt	Bacterial wilt
2	Dwarf fruit The leaves remain green or are accompanied by a slight yellow Colored rotten fruit	Anthrax, bacterial wilt, cercospora leaf spot	Anthrax, begomovirus
3	The leaves curl down Small leaves Bright yellow	Begomovirus	Begomovirus
4	Colored rotten fruit Dark green leaf color The leaves remain green or are accompanied by a slight yellow	Anthrax	Anthrax
5	Colored rotten fruit Withered suddenly The leaves curl down	Anthrax, bacterial wilt, crackers	Anthrax, bacterial wilt, crackers
6	The leaves remain green or are accompanied by a slight yellow Dry rot	Bacterial wilt, choanephora leaf rot	Bacterial wilt, choanephora leaf rot
7	Rotten leaves and stems Bark is easy to peel off Withered suddenly	Bacterial wilt, choanephora leaf rot	Choanephora leaf rot
8	Shoot off The leaves curl down Dwarf fruit	Crackers	Crackers
9	Dwarf fruit Deciduous flower	Cercospora leaf spot	Cercospora leaf spot
10	Broken chili stems 2-4 days after planting Withered at the bottom of the plant	Sprout	Sprout
11	Withered on the top of the plant Withered suddenly Permanent wilt	Bacterial wilt	Bacterial wilt
12	The leaves remain green or are accompanied by a slight yellow Permanent wilt	Bacterial wilt	Bacterial wilt
13	Withered on young branches Death leaves	Fusarium wilt	Fusarium wilt
14	Shoot off Colored rotten fruit Rotten leaves and stems	Anthrax	Anthrax
15	Dry rot Bark is easy to peel off	Choanephora leaf rot	Choanephora leaf rot
16	Rotten leaves and stems Bark is easy to peel off	Choanephora leaf rot	Choanephora leaf rot
17	Circular white patches appear Pale green boils	Bacterial wilt, Phytophthora blight	Phytophthora blight
18	Small soft patches on the stem, petals and rind Pale colored fruit like a sun attack	Soft rot of bacteria	Soft rot of bacteria
19	Thickening of the leaf bone	Begomovirus	Begomovirus

	Leaf rolling		
20	Thickening of the leaf bone Leaf rolling Small leaves	Begomovirus	Begomovirus
21	Leaf rolling Small leaves Bright yellow	Begomovirus	Begomovirus
22	Leaves are light green and dark green The size of the leaf is relatively smaller	Virus mosaic	Virus mosaic
23	Dark green leaf color Uneven leaf surface	Crackers	Crackers
24	Uneven leaf surface The leaves curl down	Crackers	Crackers
25	Young leaves have clearer leaf bones Thickening of the leaf bone Leaf rolling	Begomovirus	Begomovirus
26	Thickening of the leaf bone Small leaves	Begomovirus	Begomovirus
27	Withered on the top of the plant Withered at the bottom of the plant	Bacterial wilt	Bacterial wilt
28	Withered on the top of the plant Permanent wilt	Bacterial wilt	Bacterial wilt
29	Broken chili stems 2-4 days after planting Withered suddenly	Sprout	Sprout
30	Shoot off Rotten leaves and stems	Anthrax	Anthrax
31	Death leaves Shoot off	Fusarium wilt	Fusarium wilt

Then the system feasibility test was calculated by giving questionnaires to 31 people who were students of the Faculty of Agriculture IPB. The questionnaire was made based on the Delone and McLean model.

Table 3. Questionnaires Results

No	Answer Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
1	0	2	4	21	4
2	0	1	5	22	3
3	1	1	7	18	4
4	0	2	4	23	2
5	0	2	7	20	2
6	0	1	8	20	2
7	0	1	4	23	3
8	0	1	5	19	6
9	0	1	2	23	5

Next, calculate the percentage score of each variable.

1. System Quality

Measurement of the quality of the system is measured through the following two questions.

a. Pakarcabaiku.com is easy to use and user-friendly. Here is the percentage score of the question above.

Score percentage

$$= \frac{(4*5)+(21*4)+(4*3)+(2*2)+(0*1)}{5*31} * 100\%$$

= 77.42%

b. Pakarcabaiku.com fulfills the need to detect chili disease. Here is the percentage score of the question above.

Score percentage

$$= \frac{(3*5)+(22*4)+(5*3)+(1*2)+(0*1)}{5*31} * 100\%$$

= 77.42%

So as to determine the percentage score of the system quality variable, i.e.

(77,42% + 77,42%)/2 = 77.42%%.

2. Information Quality

Measurement of information quality is measured through the following two questions.

a. Information about chili is contained in Pakarcabaiku.com complete. Here is the percentage score of the question above.

Score percentage

$$= \frac{(4*5)+(18*4)+(7*3)+(1*2)+(1*1)}{5*31} * 100\%$$

= 74.84%

b. The detection results from Pakarcabaiku.com are easy to understand. Here is the percentage score of the question above.

Score percentage

$$= \frac{(2*5)+(23*4)+(4*3)+(2*2)+(0*1)}{5*31} * 100\%$$

= 76.13%

So as to determine the percentage score of the information quality variable, i.e. (74,84%+76,13%)/2 = 75.48%.

3. Service Quality

Measurement of service quality is measured through two questions as follows.

a. Pakarcabaiku.com provides clear guidelines for using the system. Here is the percentage score of the question above.

Score percentage

$$= \frac{(2*5)+(20*4)+(7*3)+(2*2)+(0*1)}{5*31} * 100\%$$

= 74.19%

b. Pakarcabaiku.com is able to handle user errors when using the system. Here is the percentage score of the question above.

Score percentage

$$= \frac{(2*5)+(20*4)+(8*3)+(1*2)+(0*1)}{5*31} * 100\%$$

= 74.84%

So as to determine the percentage score of the service quality variable, i.e. (74,19%+74,84%)/2 = 74.51%.

4. User Satisfaction

User satisfaction is measured by the question "Pakarcabaiku.com provides satisfactory detection results". Here is the percentage score of the question above.

Score percentage

$$= \frac{(3*5)+(23*4)+(4*3)+(1*2)+(0*1)}{5*31} * 100\%$$

= 78.06%

5. Use

The usefulness of the system is measured by the question, "Pakarcabaiku.com saves time in detecting or searching for articles about chili disease." Here is the percentage score of the question above.

Score percentage

$$= \frac{(6*5)+(19*4)+(5*3)+(1*2)+(0*1)}{5*31} * 100\%$$

= 79.35%

6. Net Benefits

The impact of the system or profit is measured by the question, "Pakarcabaiku.com helps in the detection of chili disease." Here is the percentage score.

Score percentage

$$= \frac{(5*5)+(23*4)+(2*3)+(1*2)+(0*1)}{5*31} * 100\%$$

= 80.65%

7. Criticism and suggestions

Then in the final question, the respondent is given a form that can be used to convey criticism and suggestions from the expert system that has been made. Criticism and suggestions are needed to develop the system so that it can be even better.

Then the percentage of the final score is calculated which is the sum of each variable by calculating the average to get the percentage of system success.

Percentage of the final score

$$= \frac{77,42\% + 75,48\% + 74,51\% + 78,06\% + 79,35\% + 80,65\%}{6}$$

= 77.58%

The final score percentage is at 77.58%, so it can be concluded that the respondents agree that Pakarcabaiku.com site is a successful system for detecting chili.

V. CONCLUSION

An expert system of chili plant disease detection which was built using a web-based certainty factor method has been successfully designed and built. Detection of disease is carried out using existing symptoms, and then a calculation is done using the certainty factor method so that the results of the analysis are released. This system trial is carried out by comparing the results of expert analysis and the results of system analysis. The trial shows that the expert system has a level of 87.09% compatibility with the results of expert analysis. Furthermore, calculations using the Delone and McLean model based on a questionnaire distributed to students of the Faculty of Agriculture IPB showed that 77.58% of respondents agreed that the system was successful in detecting chili. In the future, other research to build an expert system in detecting chili disease can be done using different algorithms, such as C4.5 [15] and Forward Chaining method [16].

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AUTHORS PROFILE

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