

Innovation of an Expert System for Diagnosing Allergic Diseases in Children using the Web-based Certainty Factor Method

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ABSTRACT

In this modern era, the development of computer technology has increased so rapidly. Currently the computer is a tool in helping to overcome all the problems encountered by humans, including in the field of health. With the existence of technology, of course, it will greatly facilitate the community to get health services and consultations. One of the technological developments is an expert system. An expert system is a branch of artificial intelligence (Artificial Intelligence), which is an application designed to use a computer that tries to imitate the reasoning process of an expert or expert in solving specific problems and making decisions or conclusions because to solve a problem and save it. in the knowledge base for processing. This expert system was created to assist experts in deciding diseases based on existing symptoms. The Certainty Factor method is a theory that can be used to solve uncertainty problems. Certainty Factor (CF) is a value to measure expert confidence. Certainty Factor was introduced by Shortliffe Buchanan in making the MYCIN expert system to show the amount of trust. This method can work well when there are problems that start from gathering and then gathering information and then being able to find conclusions that can be drawn from that information. The Certainty Factor method will be applied to accurately determine allergic health in children. If this method is applied, it can minimize the presence of allergic diseases suffered by dangerous children. And when you have an allergy, it can be treated immediately.

INTRODUCTION

An allergy is a reaction that enters a foreign substance into the body and a reaction occurs. Because children's immune systems are very susceptible to allergies. Allergies can be inhaled allergens or flying allergens which enter through the respiratory tract, direct contact with skin or wounds, some also enter through injection (eg drugs). (Junaedi, 2022) (Siregar, 2016). Allergy is a type of common disease that is often encountered and cannot be considered a normal disease, allergies are usually caused by food, dust, animal hair, air, medicines, cow's milk and so on. The general symptoms experienced by everyone are almost the same, such as watery eyes, red eyeballs and itchy skin, body fibers feeling tired, lack of energy and usually accompanied by a runny nose and sneezing. The symptoms that each antibody causes are different, they can be mild or they can also be severe. Severe symptoms can continue to increase and become dangerous. (Wistiani & Notoatmojo, 2016) (Bidang et al., 2017)

Allergies suffered by children recently have become frequent and concerning, because they have a negative impact on children's growth and development. Allergies suffered by children are not only caused by genetic factors, but also nutritional and environmental factors that dominate. The symptoms experienced vary from person to person. Parents' lack of understanding about allergy symptoms in children and limited access to counseling as well as help from health workers can lead to the solution chosen to avoid prolonged suffering in children. (Diani Putri & Yustina Nuke Ardiyan, 2022) (Yolanda et al., 2016) (Susanto et al., 2016)

An expert system is said to be a system that adopts human working methods or knowledge to a computer which is designed to model problem abilities like an expert. With this expert system, people can solve problems or just look for quality information that can only be obtained with the help of experts in their field. Expert systems can also help the activities of experts as experienced assistants and have experienced assistants and the knowledge needed. This expert system can also help activities in the medical field. (Bidang et al., 2017) (Marsa et al., 2022) (Adha et al., 2021)

An expert system is a computer-based system that is able to match or imitate the abilities of an expert. This system is designed to imitate the skills of an expert in answering questions and solving problems in the fields of health or medicine, business, economics and so on. The important role of an expert can be replaced by a computer program whose working principle is to provide solutions such as those carried out by experts. Certainty Factor is one of the techniques used to overcome uncertainty in decision making. When facing a problem, answers are often found that do not have complete certainty (Hartono & Fitriyadi, 2018) (Kusumawardani, 2021). The Certainty Factor method will be



applied to accurately determine the health of allergies in children. If this method is applied, it can minimize the risk of dangerous allergic diseases suffered by children, so that when they experience allergies they can be treated immediately. (Nia Nofia Mitra & Nurcahyo, 2020)

LITERATURE REVIEW

From previous research conducted by (Bidang et al., 2017) (Hartono & Fitriyadi, 2018) who conducted research on allergic diseases in children using the forward chaining method. The forward chaining method is a method that only carries out forward tracking starting from a collection of various facts by tracing rules that are suitable and in accordance with an assumption or hypothesis that leads to a conclusion. Meanwhile, the method I use uses the certainty factor method, this method can measure the level of confidence in a conclusion produced by the expert system. The certainty factor method in the system can carry out calculations accurately. Apart from that, the certainty factor method can also measure diagnoses that are certain or uncertain.

METHOD

Research Method

This research was carried out using the SDLC Waterfall method, which is a method that has the characteristic that each phase must be carried out first before proceeding to the next phase. In this way, the results will focus on each phase so that work is carried out optimally because of parallel work (Steven et al., 2020).

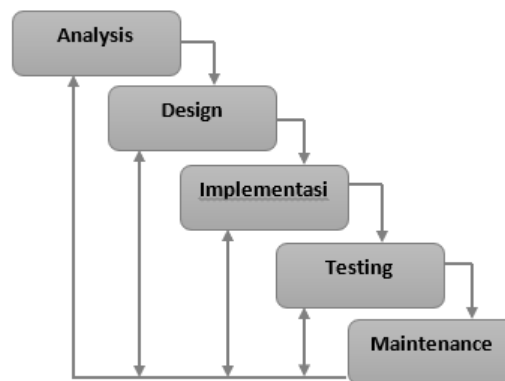


Figure 1. Research method

Data Analysis

In this analysis, diagnosing a disease is done by visiting a doctor or someone who is competent in the health sector. To diagnose allergic disease in children, you need to come directly to the nearest clinic or health center, then consult and explain the symptoms the child is suffering from so you can find out the type of disease. However, usually there are several obstacles in not being able to take him to the clinic immediately and a parent's lack of understanding about the disease. So, with these obstacles in mind, an expert system for diagnosing allergic diseases in children was built by implementing the Certainty Factor method. This application can also be used by medical personnel to make it easier to identify allergic diseases in children by selecting data on the patient's previous symptoms. After obtaining the data, medical personnel can make a diagnosis through the system by entering the patient's symptoms, then the system will carry out a calculation process for each symptom weight that has been input and the output result is that medical personnel can find out what disease the patient is suffering from.

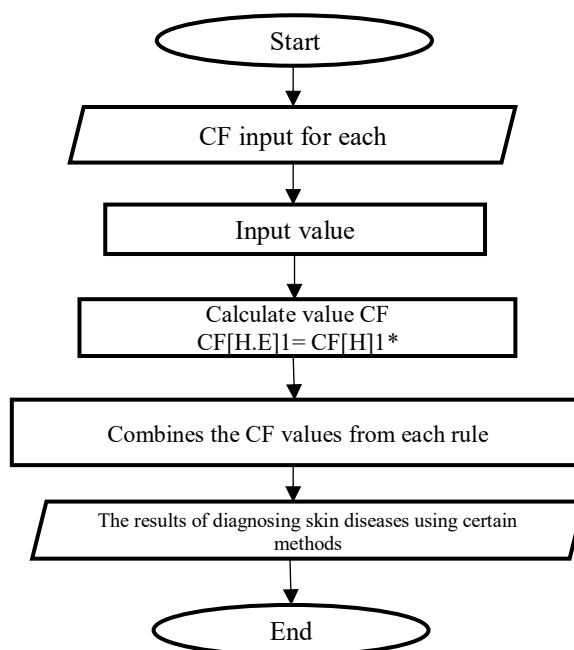


Figure 2. Flowchat Certainty Factor

Certainty Factor

One theory that can be used to solve the problem of uncertainty. Certainty Factor (CF) is a value to measure expert confidence. Certainty Factor was introduced by Shortliffe Buchanan in the creation of the MYCIN expert system to show the amount of trust. Certainty Factor shows a measure of certainty regarding a fact or rule. The highest value in the CF is + 1.0 (definitely true or Definite not) and the lowest value in the CF is - 1.0 (definitely wrong or Definite not) positive values mean the degree of confidence, whereas negative values mean the degree of uncertainty. Certainty Factor is formulated as follows (Girsang & Fahmi, 2019) :

$$CF(h, e) = MB(h, e) * MD(h, e)$$

Keterangan:

CF (h , e) = Certainty factor

MB (h , e) = A measure of confidence/level of confidence in hypothesis H if given/influenced by evidence E (between 0 and 1).

MD (h , e) = A measure of distrust / level of disbelief in hypothesis H, if given / influenced by evidence E (between 0 and 1).

The next calculation is a combination of two or more rules with different evidence but with different evidence but the same hypothesis (Setyaputri & Fadlil, 2018):

$$\text{Rule 1 } CF(h, e_1) = CF_1 = C(e_1) \times CF(\text{Rule1})$$

$$\text{Rule 2 } CF(h, e_2) = CF_2 = C(e_2) \times CF(\text{Rule2})$$

$$CF_{\text{kombinasi}} [CF_1, CF_2] = CF_1 + CF_2(1 - F1)$$

The following is a table of allergic diseases commonly suffered by children:

Table 1. Table of allergic diseases

No	Allergy Code	Allergy Name
1	A001	Cow's Milk Allergy
2	A002	Food Allergies
3	A003	Drug Allergies
4	A004	Dust Allergy
5	A005	Pet Allergies
6	A006	Nummular Dermatitis
7	A007	Atopic Dermatitis (Eczema)
8	A008	Contact Dermatitis

Uncertainty Value:

Table 2. Uncertainty Value

No	Information	Value
1	Very Sure	0,5
2	Certain	0,4
3	Sure enough	0,3
4	Not sure	0,2
5	Don't know	0,1
6	No	0

Allergy symptoms:

Table 3. Allergy symptoms

No	Symptom Code	Name	MB (Confidence)	MD (Uncertainty)
1	G001	itchy skin	0,5	0,1
2	G002	Stomach ache	1	0,2
3	G003	bloated	0,5	0,1
4	G004	nauseous	0,3	0,3
5	G005	vomit	0,8	0,1
6	G006	diarrhea	0,7	0,2
7	G007	swelling (of the lips, face, and neck)	0,9	0,1
8	G008	sneeze	0,4	0,2
9	G009	nasal congestion	0,5	0,3
10	G010	difficulty breathing	0,8	0,4
11	G011	tingling in the mouth	0,9	0,4
12	G012	rash/bumps	1	0,2
13	G013	eyes watery and itchy	0,5	0
14	G014	fever	1	0,3
15	G015	itchy	0,5	0
16	G016	runny nose	0,3	0
17	G017	itchy eyes	0,6	0,2
18	G018	cough	0,2	0
19	G019	itchy nose	0,6	0,2
20	G020	red eye	0,4	0
21	G021	blue on the skin	0,2	0,2
22	G022	flu (allergic rhinitis)	0,5	0,2
23	G023	swollen eyes	0,3	0
24	G024	red spots appear on the skin	0,4	0,2
25	G025	itching appears	0,6	0,2
26	G026	dry skin	0,2	0,1
27	G027	a burning sensation appears	0,3	0,1
28	G028	there is a coin-shaped rash or ulcer	0,5	0
29	G029	prickly heat	0,4	0,1
30	G030	scab-like crusts appear on the cheeks, scalp, hands and feet	0,3	0,2
31	G031	red spots appear on the skin	0,6	0,3
32	G032	swollen	0,2	0,3
33	G033	cracked skin	0,3	0,3
34	G034	warts and lumps appear	0,7	0
35	G035	scaly skin	0,2	0,1

Software Requirements Analysis

In designing an expert system, an analysis of software requirements is also carried out, namely, Functional Requirements and Non-Functional Requirements that must be met. These requirements are shown in the table.

1. User Analysis

In this system, 2 users can be used, namely admin and user. Admin can perform CRUD (Crate, Read, Update, and Delete) on data

2. System Flowchat Design

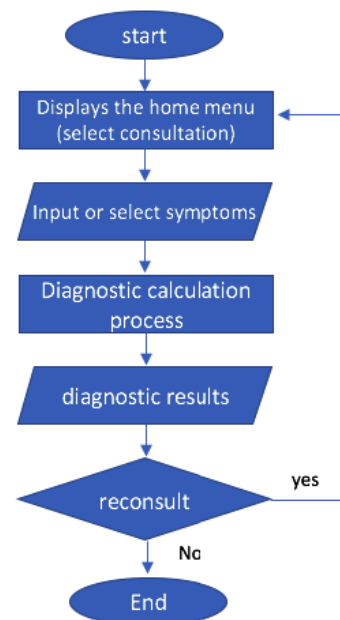


Figure 3. System Flowchat Design

3. Mock-up Application

a. Mock-up Login Menu

Login page, below the admin or employee enters the username and password to start running the application.

b. Mock-up Dashboard Page

The Dashboard page is the main page after logging in.

4. Testing

After completing the preparation of the programming code, the next stage is to test the results of the programming and also determine whether the application is running in accordance with the expected procedures. The testing method used by the author is black box testing.

a. Black box

Table 4. Black Box Test

No	Test Items	Test Scenarios	Test Level	Test Type
1	Application login menu page	Enter the login screen	Unit	Black Box
2	Dashboard menu page	Dashboard page	Unit	Black Box
3	K-nearest neighbor classification menu page	Classification menu page	Unit	Black Box
4	Dataset menu page	Dataset menu page	Unit	Black Box
5	Initial process page	Initial process page	Unit	Black Box
6	Predictions page	Predictions page	Unit	Black Box
7	Performance page	Performance page	Unit	Black Box
8	Dataset page (add data)	Page for adding dataset	Unit	Black Box
9	Logout menu	Select the exit menu	Unit	Black Box

b. Feasibility Test Questionnaire

Table 5. Feasibility Test Questionnaire

Criteria	Value
Not Worth It	1
Decent Enough	2
Worthy	3
Very Worth It	4

The formula used to obtain the percentage is as follows:

$$v = \frac{\sum TSEV}{\sum s - \max} \times 100\%$$

Keterangan:

V = Validation

$\sum TSEV$ = Total questionnaire scores

$\sum s - \max$ = Maximum questionnaire score

100% = Constant

The results of the admin user response validation assessment are used to determine the feasibility of an expert system application for diagnosing allergic diseases in children

RESULT

Login Page Display

The following is the login display in the expert system for diagnosing allergic diseases in children, before the user uses the application. Users are required to log in as one of the security features to validate users in the system. There are two user levels in this application, namely Admin and User, users can enter ID and Password. The login page can be seen in Figure 4.

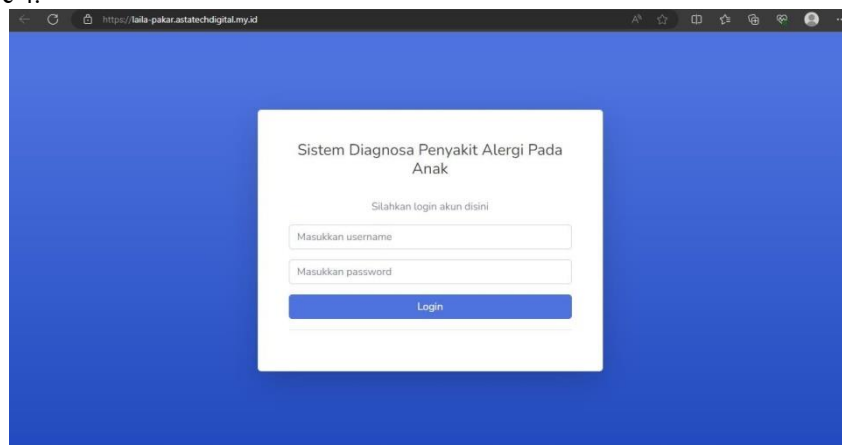


Figure 4. Halaman Login

Dashboard Display

The dashboard page is the first page that will be displayed by the system when the user successfully logs in. The dashboard page functions as a place to display other menus, the admin dashboard display in Figure 4, the user dashboard display 5 as follows:

a. Admin

Users at this level are able to use all application access such as: Diagnosis, Disease list, Symptom list, Rule base, History, Help, User, Logout. The following figure 5 shows what menus are displayed for admin level users.

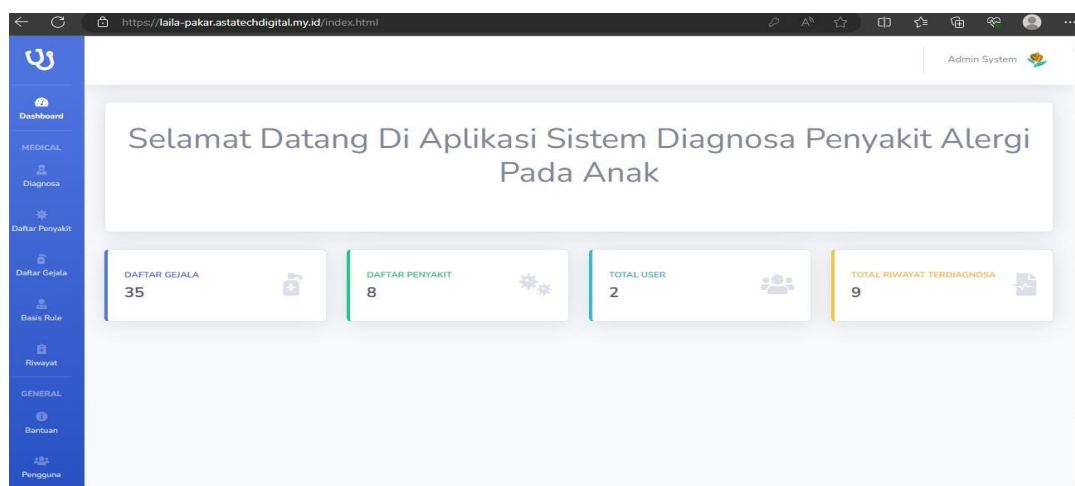


Figure 5. Admin Dashboard Page

b. User

Users with this User level can only carry out the diagnosis process. The access obtained at this level is: diagnosis, history, help and logout. The menus that users can access at user level are as follows:

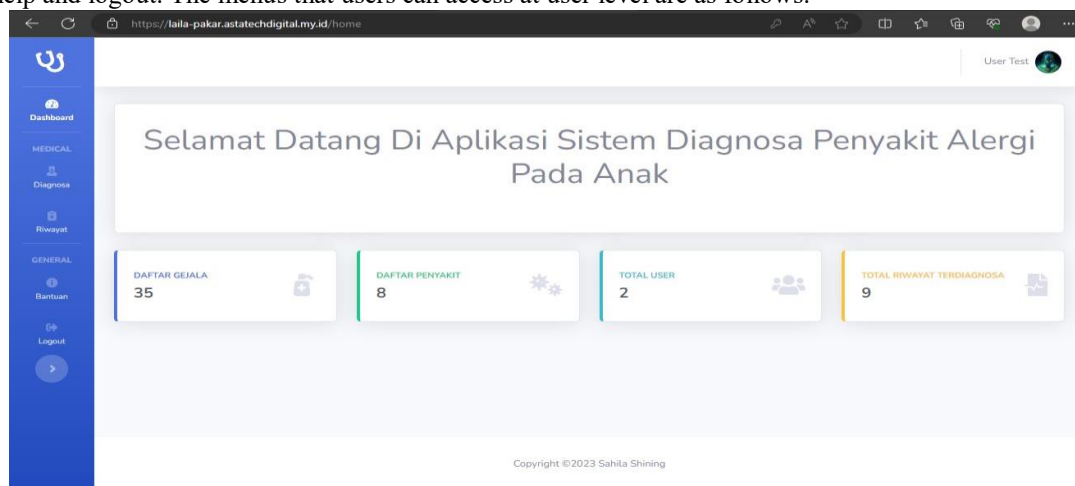


Figure 6. User Dashboard Page

DISCUSSION

System Implementation

The Diagnosis Page is a page that contains data on the symptoms of disease diagnosis that carry out child allergy examinations. The Diagnosis page displays a disease symptom column as well as a level of confidence that can be selected and the name of the patient who made the diagnosis.

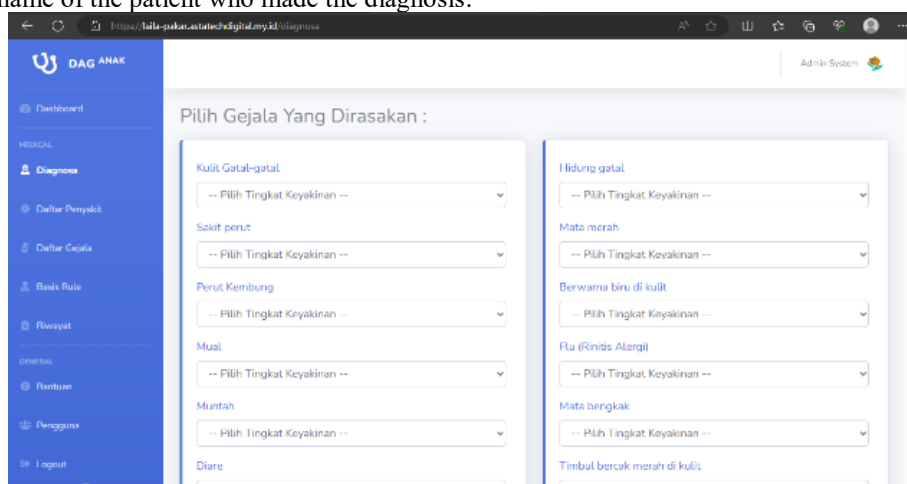


Figure 7. Diagnosis Page

When inputting symptoms, a button is provided here to select the level of confidence in the symptoms experienced which will then display a form including no, don't know, not sure, sure, and very sure.

Figure 8. Inputting symptoms page

When carrying out the symptom input process, a name form is provided to find out the identity of the user who is carrying out the diagnosis process.

Figure 9. Diagnosis process

This page contains a list of diseases that cause allergies in children. The disease page displays the disease code column and disease name, displays the complete disease and the explanation is complete with data add, edit and delete actions. The disease page can be seen in Figure 10 below.

Kode	Nama penyakit	Penyebab
P001	Alergi Susu Sapi	Secara langsung apabila cipratan air dari mulut (droplet) mengenai orang lain—saat bersin, batuk, atau berbicara. Penularan secara tidak langsung terjadi apabila Anda menyentuh permukaan...
P002	Alergi Makanan	Virus dengue masuk ke tubuh manusia melalui gigitan nyamuk Aedes aegypti. Jumlah nyamuk Aedes aegypti biasanya meningkat pada awal musim hujan.
P003	Alergi Obat	Melalui makanan atau minuman yang tidak bersih, misalnya es batu yang proses pembuatannya terkontaminasi virus hepatitis. Penularan virus hepatitis B dan hepatitis C melalui darah...
P004	Alergi Debu	Parasit plasmodium dibawa dan disebarkan oleh nyamuk Anopheles yang kemudian menggigit manusia.
P005	Alergi Hewan	Virus penyebab campak menular melalui percikan air liur penderita saat batuk atau bersin. Selain itu, bisa karena Anda menyentuh benda yang telah terpercik air liur penderita
P006	Dermatis Numaralis	Virus penyebab campak menular melalui percikan air liur penderita saat batuk atau bersin. Selain itu, bisa karena Anda menyentuh benda yang telah terpercik air liur penderita

Figure 10. Symptom List Page

The results of the consultation include a print button to print the patient's consultation results.

Riwayat Diagnosa			
Nama: Kanza Humaira			
Hasil Diagnosa: Tanggal 11-08-2023 12:52:34			
Tabel perhitungan penyakit : Alergi Susu Sapi (P001)			
Gejala	CF User	CF Role	CF(H, E)
Kulit Gatal-gatal (G001)	0.4	0.50	0.2
Sakit perut (G002)	0	1.00	0
Perut Kembung (G003)	0.4	0.50	0.2
Mual (G004)	0.3	0.30	0.09
Muntah (G005)	0.2	0.80	0.16
Nilai CF : 0.511			
Tabel perhitungan penyakit : Alergi Hewan Peliharaan (P006)			
Gejala	CF User	CF Role	CF(H, E)
Kulit Gatal-gatal (G001)	0.4	0.50	0.2
Batuk (G018)	0	0.20	0
Hidung gatal (G019)	0.3	0.60	0.18
Mata merah (G020)	0.3	0.40	0.12
Flu (Rinitis Alergi) (G022)	0.3	0.50	0.15
Mata berair (G023)	0	0.30	0
Nilai CF : 0.509			
Tabel perhitungan penyakit : Alergi Debu (P004)			
Gejala	CF User	CF Role	CF(H, E)
Gatal pada mata (G017)	0	0.60	0
Gejala	CF User	CF Role	CF(H, E)
Batuk (G018)	0	0.20	0
Hidung gatal (G019)	0.3	0.60	0.18
Mata merah (G020)	0.3	0.40	0.12
Berwarna biru di kulit (G021)	0	0.20	0
Nilai CF : 0.278			
Kesimpulan:			
Berdasarkan dari gejala yang baru saja dialami juga berdasarkan RoleBasis dokter yang sudah diberikan oleh seorang pakar penyakit maka perhitungan Algorithm Certainty Factor menggunakan nilai CF yang paling tinggi yaitu 0.511 (0.511%) Alergi Susu Sapi (P001)			

Figure 11. Results of the consultation page

CONCLUSION

From the research that has been carried out, several conclusions can be drawn, including that the application used to diagnose allergic diseases in children using the certainty factor method can be used to determine a disease suffered by the user, which can be done independently. This application makes it easier for users to carry out consultations quickly, effectively and efficiently using expert system applications.

The system built can show the percentage of the user's likelihood of eight allergies in children. The results with the highest percentage indicate the user is most likely to suffer from the disease. The same as in the testing process carried out when the user inputs the symptoms displayed, the results of the symptom input will be obtained by the user showing the following results: cow's milk allergy is 27.8%, food allergy is 44.7%, drug allergy is 44%, disease natural dermatitis allergies 10.8%, atopic dermatitis (eczema) 10.6%, contact dermatitis 11.7%, dust allergies 11.7%, and pet allergies of 14.5%. From this percentage value, it can be explained that, from the symptoms experienced by the user, it shows that the user is likely to suffer from food allergies and has a small possibility of developing atopic dermatitis (eczema).

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