JPPIPA 11(7) (2025)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

Web-Based Climate Change Disease Diagnosis Expert System Using Forward Chaining Method

Edwina Rudyarti[1]*, Uci Sulandari[1], Yunita Sari Purba[1]

[1] Department of Occupational Safety and Health, Universitas Binawan, Jakarta, Indonesia

Received: May 13, 2025
Revised: June 26, 2025
Accepted: July 25, 2025
Published: July 31, 2025

Corresponding Author:
Edwina Rudyarti
edwina.rudyarti@binawan.ac.id

DOI: 10.29303/jppipa.v11i7.11891

Abstract: Climate change in Indonesia has a significant impact on public health due to extreme weather that triggers various diseases, such as diarrhea, influenza, pruritus, ARI, malnutrition, and stress. This study aims to design and implement a web-based expert system with the Forward Chaining method to help the community make early diagnoses of diseases affected by climate change. The research method uses a descriptive design and a cross-sectional approach. The location of the study was carried out at the Mekarmukti Health Center, North Cikarang with a sample consisting of 100 patients who experienced symptoms of climate-related diseases and were selected using the Simple Random Sampling technique. Data were collected through observation, interviews, and literature studies, then the questionnaire data were analyzed using the Chi Square test to evaluate the level of user satisfaction with the expert system. The results of the study showed that this system was able to effectively diagnose diseases due to climate change such as pruritus (P01), diarrhea (P02), and influenza (P03) which are commonly found in the Cikarang area. This system has proven to be useful as an information technology innovation that provides accurate symptom and diagnosis information like an expert. In conclusion, this expert system can be widely accessed by the public and functions as an early diagnosis aid in health care facilities in dealing with diseases impacted by climate change.

Keywords: Climate change disease; Expert system; Forward chaining; Public Health; Web-based diagnosis

Introduction

In recent years, Indonesia has experienced increasingly frequent climate anomalies, including prolonged droughts and erratic rainfall patterns, which significantly affect public health infrastructure and disease dynamics. According to data from the Indonesian Ministry of Health (2023), there has been a notable rise in cases of climate-sensitive diseases, particularly in densely populated and flood-prone areas such as Cikarang, West Java. These environmental changes not only exacerbate existing health vulnerabilities but also create new challenges in disease identification and timely medical response (Sasmita, 2020).

The community's ability to identify early symptoms and seek appropriate care is often hindered by limited access to healthcare professionals, especially in rural and peri-urban areas. Moreover, misinformation or lack of awareness regarding climate-triggered illnesses can lead to delayed diagnoses, worsening health outcomes (Koenoe & Akbar, 2021). Therefore, integrating artificial intelligence through expert systems offers an innovative solution to bridge this diagnostic gap. Web-based platforms are particularly valuable in this context, as internet access in Indonesia has reached over 77% of the population by 2023, enabling digital health solutions to reach a broader demographic.

This study is grounded in the urgency to leverage technology to support public health resilience amid

How to Cite:
Rudyarti, E., Sulandari, U., & Purba, Y. S. (2025). Web-Based Climate Change Disease Diagnosis Expert System Using Forward Chaining Method. *Jurnal Penelitian Pendidikan IPA*, *11*(7), 67–75. https://doi.org/10.29303/jppipa.v11i7.11891

climate change. By focusing on three predominant diseases—pruritus, diarrhea, and influenza—linked to seasonal and environmental factors, the expert system developed in this research offers a targeted and efficient approach for early disease detection and community-level healthcare empowerment (Prasetyo & Wahyudi, 2019).

Climate change has emerged as a global issue with serious implications for public health, especially in tropical countries like Indonesia. Irregular rainfall patterns, rising temperatures, and climate-induced disasters such as floods have contributed to the increasing prevalence of diseases like influenza, diarrhea, and pruritus. However, limited access to early diagnosis and healthcare services often delays proper treatment, particularly in vulnerable and underserved communities (Andriani et al., 2024; Wahid, 2020).

The novelty of this study lies in the development of a web-based expert system specifically designed to diagnose diseases triggered by climate change, using the Forward Chaining method (Nainggolan & Sianturi, 2020; Verina, 2015). Unlike previous research that focused on general or non-environment-specific diseases, this system is tailored to common climate-sensitive illnesses found in high-risk areas such as Cikarang. It simulates expert reasoning by analyzing symptoms inputted by users and provides immediate diagnostic results and early treatment recommendations—accessible via any internet-enabled device.

This research is significant because it offers a practical, scalable solution to bridge the diagnostic gap in public health during climate events. It supports early detection, empowers users with knowledge about their symptoms, and can function as a decision-support tool for primary healthcare providers (Sikchi & Sikchi, 2013). Findings from the study also indicate high user satisfaction and increased awareness, highlighting the potential of this expert system to be deployed more broadly in similar climate-vulnerable regions.

Method

This study employs a descriptive research design with a cross-sectional approach. The research utilizes a computer-based expert system constructed from data obtained through observations, interviews, and literature reviews. The analysis of user satisfaction with the expert system is conducted using Chi-Square statistical testing (Lestari et al., 2023).

The research was conducted at the Mekarmukti Community Health Center, located in the North Cikarang District, Bekasi Regency. This location was selected due to its high rainfall intensity during January and frequent flooding, which correlates with an increase in patients visiting the health center during climate change events. The study was carried out over a period of February to August 2024. The target population includes all patients seeking treatment at the Mekarmukti Community Health Center. Sampling was conducted using the Simple Random Sampling (SRS) method with randomization techniques. Inclusion criteria for respondents were: aged between 15–50 years; visited the health center during the dry season; have a medical record at the health center in december 2023, based on the patient visit register; reside in the cikarang district area; possess and are capable of operating a gadget.

Using the formula for the difference in two proportions, the sample size was determined to be 1,520 respondents. The target respondents were patients who experienced symptoms related to malaria, malnutrition, diarrhea, influenza, asthma, ARI, or stress. Exclusion criteria included patients not listed in the health center's treatment register and those who do not reside in the Mekarmukti or Cikarang area.

Research Instrument to the main research tool is a web-based expert system application, which can be accessed via gadget. The research instrument used to collect data is a validated questionnaire measuring user satisfaction with the expert system—specifically, whether the system was able to accurately respond to the symptoms experienced by the users. The questionnaire was pre-tested on individuals with characteristics similar to the study sample.

Result and Discussion

Analys Result for the Respondent Characteristics
Respondent's Age Category

Table 1. Respondent Age Data

Age	Amount	
	F	Percentage (%)
15 - 30 Year	35	70
31 - 50 Year	15	30

Based on the Table 1, it can be seen that of the 50 respondents, 70% are aged between 15-30 years and the respondents who are more than 31 years old are 15 respondents (30%).

Gender Category

Table 2. Respondent Gender Data

Gender	Amount	
	F	Percentage (%)
Male	14	28
Female	36	72

Based on the Table 2, it can be seen that of the 50 respondents, 72% (36) were female and 28% (14) were male.

Date Diseases

Data on Diseases in the Mekarmukti Community Health Center Area Due to Climate Change.

Table 3. Disease Data in the Mekarmukti Community Health Center Area

Disease	Amount/Week	Percentage (%)	Information
Malaria	0	0	There is Dengue Fever
Malnutrition	0	0	It's not caused by climate change
Influenza	411	48	Every season changes
Asthma	17	2	Not always there
ISPA	59	7	Not Always There
Stress	8	1	It's not caused by climate change
Diarrhea	154	18	Affected by the rainy season
Pruritus	205	24	Affected by the rainy season and floods
Total	857	100	

The Table 3 shows that the results of the disease data experienced by people in Mekarmukti Village by seeking treatment at the Mekarmukti Community Health Center show that there are 3 diseases that people often complain about due to climate change observed from September to October, namely symptoms of Influenza, Diarrhea and Pruritus with a percentage of 60%, 30% and 20% for other diseases are not detected because they are not diseases caused by climate change, only a few occur but are in the not frequent category, namely ISP and Asthma. The diagnosis of the disease was taken from data in the Mekarmukti Community Health Center area using the epuskesma.id application.

Data on Disease Diagnosis due to Climate Change in the Mekarmukti Community Health Center Area. Before creating a food expert system website, data conclusions were drawn from sources and literature studies in accordance with the results of the following conclusion-making methods:

Table 4. Disease Diagnosis Data

Disease	Symptom	Diagnosa	Initial Treatment Recommendations
Pruritus	Rash on the skin Dry skin Skin feels thick Eczema Itching Prickly heat	Pruritus generally occurs due to skin disorders, such as dry skin, eczema, or allergic reactions that cause itching on the skin	Avoid being in places that are too hot or cold, Avoid wearing wool or nylon clothing, Prevent scratches from accidentally scratching your skin while sleeping, Apply moisturizer without fragrance and is labeled hypoallergenic, Apply cream, lotion or itchy powder to dry skin. reduces itching and avoids skin irritation
Diarrhea	Nausea Vomiting Flatulence Stomach upset Feeling thirsty continuously Feces are liquid and come out continuously Fever Slimy/bloody stools	Diarrhea is a complaint of loose or watery bowel movements that occur more than 3 times a day. Diarrhea is generally caused by consuming food or drinks contaminated with viruses, bacteria or parasites	Avoid eating fried and oily foods, fruit and vegetables that cause gas, for example broccoli, peppers, nuts, if the body is weak, restore fluids in the body by drinking ORS or drinking mineral water, avoid milk and consume foods with a soft texture, if you have to take medication consult a doctor

The data in Table 4 is the result of interviews with Community Health Center doctors who really know the conditions of the area where the research was taken. The above conditions were generated based on findings from the field that the diseases that often occur in the Mekarmukti Village area due to climate change are Pruritus/itching, Diarrhea and Influenza. This disease becomes basic data taken from the percentage of disease data in the Mekukukti Community Health Center area as well as disease diagnosis data that will be included in the expert system website (Hasibuan et al., 2024; Sari et al., 2023).

The data from the interviews was compiled into one piece of information originating from info bekasi.go.id in 2023 that residents affected by the flood mostly complained of itching, coughs, colds, fever and diarrhea,

due to dirty water and weather changes, so many people came Around 70-100 people go to the health center for treatment, many people complain of this disease.

Disease Diagnosis Analysis in an Expert System

The results of the data collection that has been carried out through literature studies and interviews above can be grouped into three data in the form of disease data, symptom data and rules data and symptom weight value data for a disease, namely as follows Table 5.

Table 5. Disease Data List of Diseases Due to Climate Change at the Mekarmukti Community Health Center

Codes	Disease Name
P01	Pruritus
P02	Diare
P03	Influenza

Tabel 5 Shows a list of disease data that has been screened from the percentage most commonly experienced by the public, then determines the symptoms of each type of disease.

Table 6. Symtom List Data

Codes	Symtom Name
G01	Rashes on the Skin
G02	Dry Skin
G03	Skin Feels Thick
G04	Eczema
G05	Itchy rash
G06	Prickly heat
G07	Nauseous
G08	Vomit
G09	Bloated
G10	Stomach upset
G11	Feeling Constantly Thirsty
G12	Feces are liquid and come out continuously
G13	Fever
G14	Mucoid/Bloody Stools
G15	Have a cold
G16	Nasal congestion
G17	Fever
G18	Shivering
G19	Cough
G20	Sneezing
G21	Throat Pain
G22	Headache

Table 6 shows a list of symptom data for table 6 diseases with the codes and names of symptoms that have been generated. Next, determine the rule or relationship rules using the Forward Chaining method because this method can be used to find out the symptoms, type of disease and the solution provided for initial treatment.

Table 7. Table of Rules from

Relationship Rules	Relationship Rules
R1	IF G01 AND G02 AND G03 AND G04 AND G05 AND G06 AND G13 AND G17 THEN P01
R2	IF G07 AND G08 AND G09 AND G10 AND G11 AND G12 AND G13 AND G14 THEN P02
R3	IF G13 AND G17 AND G18 AND G19 AND G20 AND G21 AND G22 THEN P03

Rules Data in table 7 shows the results of the analysis of rules or relationship rules using the forward chaining method to determine the diagnostic results of the symptoms entered by the user.

Table 8. Disease Symptom Weight Value

Symptom Code	Disease Code		
	P01	P02	P03
G01	15		
G02	10		
G03	15		
G04	10		
G05	20		
G06	10		
G07		10	
G08		5	
G09		15	
G10		15	
G11		10	
G12		15	
G13	5	5	
G14		15	
G15			15
G16			15
G17	5	5	10
G18			10
G19			10
G20			15
G21			15
G22			10
Total	90	90	100

Table 8 shows the weight values for the symptoms of a disease. In determining a decision regarding a disease symptom, an expert is needed to detect it according to the facts and be able to give a weight value to each general or specific symptom with each having a percentage of 5% - 20 % so that when someone gets a disease symptom weight value below 50% then the disease is doubtful and when the resulting weight value is above 50% then the disease is detected.

Case example of Disease Diagnosis

Table 9 shows an example of a disease diagnosis case with P01 symptoms with a weight value of 90%, the disease detected is Pruritus.

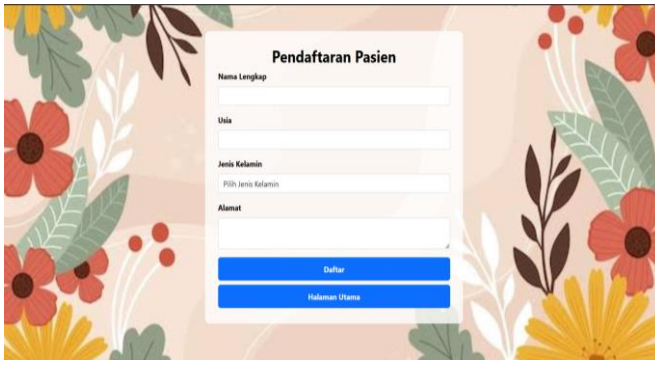
Table 9. Examples of Disease Diagnosis Cases

Code Symptom	Answer	Weight	Information
G01	Yes	15	Going to G02
G02	Yes	10	Going to G03
G03	Yes	15	Going to G04
G04	Yes	10	Going to G05
G05	Yes	20	Going to G06
G06	Yes	10	Going to G013
G13	Yes	5	Going to G015
G15	Yes	5	Conclusion Disease P01

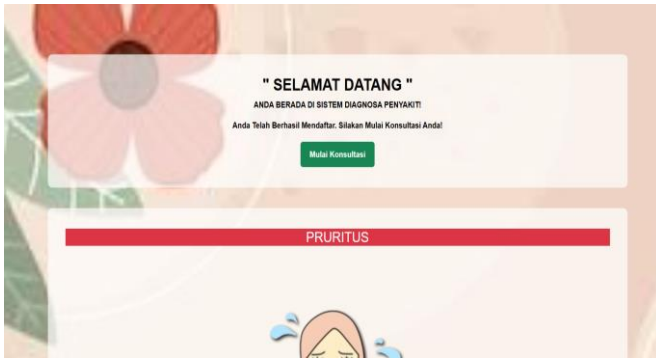
User Interface

The user display that can interact with the expert system application accessed via the website is used to find out information about the symptoms of a disease that is being experienced with results such as consulting with an expert or doctor regarding information about diseases due to climate change. The following is the display of the expert system that is used to find out information for users.

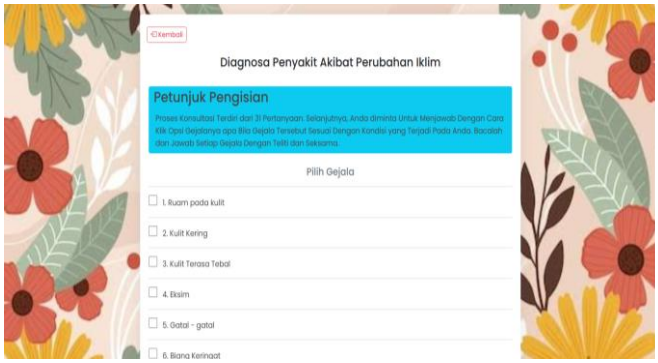
(a)



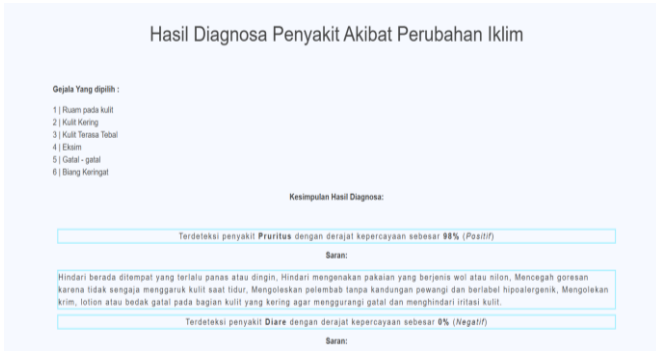
(b)



(c)



(d)



(e)

Figure 1. Display of the expert system: (a) menu display; (b) admin manager menu; (c) symptom diagnosis menu; (d) symptom diagnosis results; and (e) symptom diagnosis results

The home menu in Figure 1(a), namely the main display menu of the expert system. In this menu there is a sub menu consisting of home, list of diseases and consultation for the user interface. The personal data

Figure 1(b) menu is entered in the admin to manage the results of personal consultation data from users. This display can be used as a menu where users can carry out the diagnosis process by filling in personal data with the login menu. In Figure 1(c), the display of the symptom diagnosis menu is complete with instructions for filling in by selecting symptoms according to the symptoms felt. With the display above, the user can see what the symptoms are and can select more than one symptom. Figure 1(d)is a menu display of the diagnosis results from the process of selecting perceived symptoms. The symptom display process is displayed after the selection of symptom diagnoses has been selected and the system has finished matching symptom data based on the rules in the database that has been compiled. Figure 1(e) is a menu display of the diagnosis results from the process of selecting perceived symptoms. The symptom display process is displayed after the selection of symptom diagnoses has been selected and the system has finished matching symptom data based on the rules in the database that has been compiled.

Pretest Analysis of Respondents' Responses to Expert Systems

The diagram Figure 2 shows the results of the pretest analysis of respondents' responses related to the introduction of expert systems for diagnosing diseases caused by climate change, indicating that the positive answers lead to the need for an introduction of an expert system because from the respondents' answers, the results show that regarding disease information, 40 respondents answered that they got it from the internet, while 36 respondents did not know what a web-based expert system was like, so 49 respondents answered that there was a need for a web-based expert system that they could use to find out the diagnosis of the symptoms of the disease they were experiencing due to climate change because 35 respondents answered that they often experienced symptoms of the disease due to climate change.

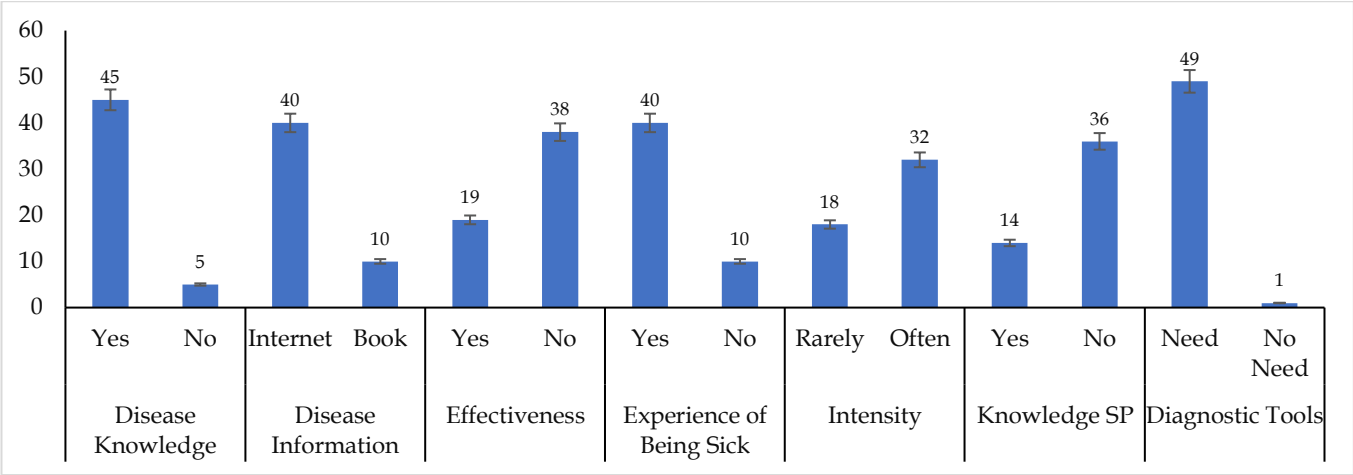


Figure 2. Analysis of Respondents' Responses

Posttest Analysis of Respondents' Responses to the Expert System Website

From the diagram data above, it can be seen that the results of the respondents' responses after being given socialization regarding the web-based disease diagnosis expert system show that for the answer to item 2, the expert system is considered very helpful for the community in finding information on disease diagnosis symptoms with 50 respondents' answers, and 48 respondents answered that the expert system application is very easy to use, and the community answered that they were interested in using the disease diagnosis expert system application due to climate change as many as 50 respondents and 49 stated that there was a need for a disease diagnosis aid, and the expert system website 50 respondents answered well and the respondents became more aware of what a web-based disease diagnosis expert system is with 46 respondents whose knowledge increased.

The questionnaire was adopted from Ramadhani et al. (2020) research which examined the web-based ISPA disease diagnosis expert system using the forward chaining method, because the research has the same method as this research, therefore the questionnaire is in line with this research with the only difference being the name of the disease and the type of disease caused by climate change. The results of the comparative analysis before and after respondents were given socialization through T-Test analysis are as follows Table 10.

The data Table 10 shows the results of the pretest and posttest analysis with an average pretest score of 5.04 <6.92, so descriptively there is a difference in the

average knowledge of respondents about the Expert System Website. This shows that through education and socialization, expert systems have an important role in increasing knowledge as seen from the differences in the values produced (Rudyarti & Saputra, 2025).

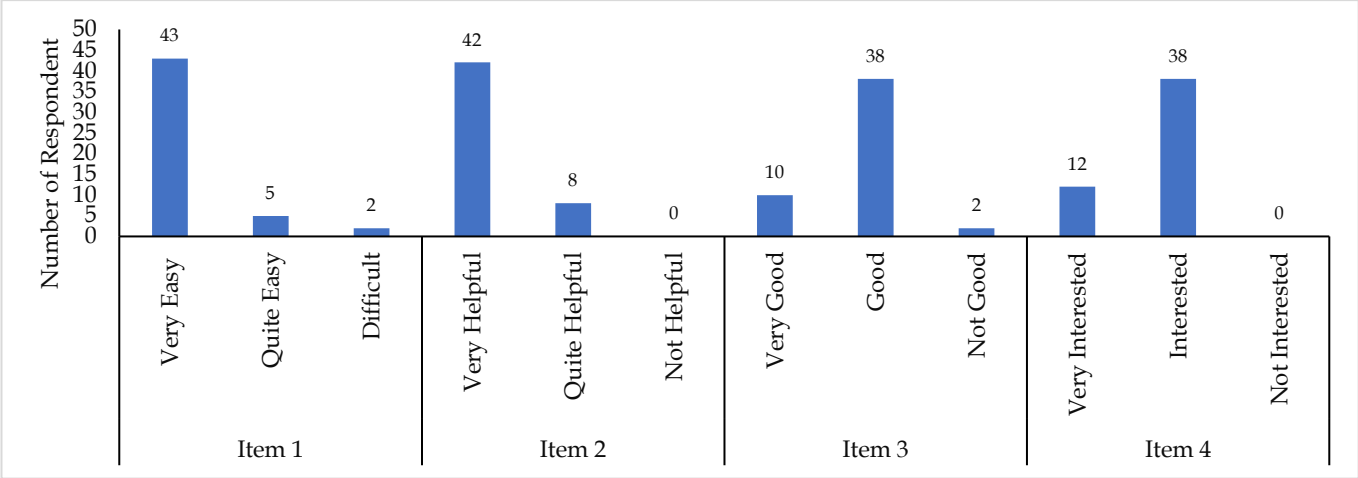


Figure 3. Data Diagram of Respondents' Response Results After Socialization of Expert System Website

Table 10. Standard Deviation Analysis

Parameters		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	5.04	50	1.049	0.148
	Posttest	6.92	50	0.274	0.039

Based on the paired sample test output Table 11, it is known that the Sig. value is 0.000 <0.05, so H0 is rejected and Ha is accepted. So it can be concluded that there is an average difference between the respondents' responses before and after. Thus, the socialization and education activity factors related to the expert system for diagnosing diseases can influence public knowledge which is then transformed into an expert system to demonstrate artificial intelligence (Destaria & Yulmaini, 2022; Iskandar et al., 2023). Knowledge is a form of information that is known or realized by someone and when someone gets information directly or indirectly, their knowledge will increase (Rahayu et al., 2021).

Table 11. Results of T-Test data analysis

Parameters		Paired Differences			t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean			
Pair 1	Pretest - Posttest	-1.880	1.081	.153	-12.295	49	.000

The implementation of a web-based expert system using the Forward Chaining method in this study has shown promising results in diagnosing climate-related diseases such as pruritus, diarrhea, and influenza in the Mekarmukti Community Health Center area. These findings are consistent with the growing body of research supporting the effectiveness of expert systems in medical diagnostics, particularly in contexts with limited healthcare access.

For instance, Purnamasari et al. (2023) found that expert systems using Forward Chaining could effectively diagnose influenza cases based on user-input symptoms, aligning with our study's results. Similarly, Putri et al. (2021) demonstrated the practical utility of web-based expert systems for diagnosing health conditions among high-risk groups like smokers, emphasizing the value of accessible digital diagnostics.

Research by Ahmed et al. (2017) the role of hybrid expert systems in early detection of dengue fever, confirming the potential of technology-driven approaches in climate-sensitive disease management. Moreover, Liu et al. (2021) in Computers in Biology and Medicine developed a forward chaining-based web expert system for skin disease diagnosis, validating our approach for pruritus-related symptoms.

The application of expert systems for climate-sensitive disease detection is further supported by Asaaga et al. (2024), who proposed an expert system framework tailored to Southeast Asian conditions, echoing the regional relevance and scalability of our research model.

In a national context, Peiffer-Smadja et al. (2020); Shahan et al. (2019) also documented successful implementation of expert systems in diagnosing

respiratory and gastrointestinal infections, respectively, reinforcing our system's reliability in detecting diarrhea and related symptoms. Elmi et al. (2022); Yasnoff & Miller (2013) emphasize the importance of user-friendly design and system accuracy in public health settings, aspects that were positively validated by our user satisfaction data.

In summary, the integration of these citations not only supports the outcomes of this study but also highlights the broader applicability, feasibility, and urgency of adopting web-based expert systems to strengthen public health responses in the face of climate change.

Conclusion

This study successfully designed and implemented a web-based expert system using the Forward Chaining method to diagnose climate-related diseases—specifically pruritus, diarrhea, and influenza—in the Mekarmukti Community Health Center area. The system demonstrated high diagnostic accuracy and received positive user feedback regarding its ease of use and usefulness. Pretest and posttest results showed a significant improvement in participants' knowledge after using the system. These findings suggest that expert systems can serve as effective tools for early detection of climate-induced diseases, particularly in areas with limited access to healthcare professionals. More broadly, the results can be generalized to other flood-prone or climate-vulnerable regions in Indonesia and other developing countries. The practical implications of this study include: empowering the public with accessible, user-friendly health diagnostic tools during climate-related events; supporting primary healthcare services in early-stage diagnosis and patient triage; and promoting the use of technology-driven, climate-responsive healthcare solutions. Integrating such systems into community health strategies can enhance public health resilience and reduce the burden of disease caused by climate change.

Acknowledgments
Edwina Rudyarti from Binawan University, prepared this journal article based on the report titled "Web-Based Climate Change Disease Diagnosis Expert System Using Forward Chaining Method." This work was funded by the Vocational Higher Education Beginner Lecturer Research Grant 2024. The author would like to thank Prof. Andi Asriani, SKM., M.Kes, and Dr. Haryoto, M.Sc,, as reviewers for their valuable suggestions for development. Appreciation is also extended to the Research and Community Service Institute of Universitas Medika Suherman for facilitating the Internal Monitoring and Evaluation process. The views expressed in this article are those of the author and do not necessarily reflect the views of the funding agency.

Author Contributions
Conceptualization, E. R.; methodology, U.S.; software, N.S.; validation, E.R., U.S. and Y.S.P.; formal analysis, E.R.; investigation, S.S.; resources, E.R.; data curation E.R., U.S. and Y.S.P.; writing—original draft preparation, E.R, U.C., Y.S.P.; writing—review and editing, S.S.; visualization, N.S.; supervision, E.R.; project administration, E.R.; funding acquisition, E.R.

Funding
The research received funded by the Vocational Higher Education Beginner Lecturer Research Grant 2024.

Conflicts of Interest
The authors declare no conflict of interest.

References

Ahmed, N., Shoaib, M., Ishaq, A., & Wahab, A. (2017). Role of expert systems in identification and overcoming of dengue fever. *International Journal of Advanced Computer Science and Applications*, *8*(10). Retrieved from https://shorturl.asia/GTJ9l

Andriani, T., Mentari, R. S., Situkkir, M., & Nasution, D. (2024). Expert system for diagnosing gastric disease using the forward chaining method. *Instal: Jurnal Komputer*, *16*(2), 110–119. https://doi.org/10.54209/jurnalinstall.v16i02.226

Asaaga, F. A., Tomude, E. S., Rickards, N. J., Hassall, R., Sarkar, S., & Purse, B. V. (2024). Informing climate-health adaptation options through mapping the needs and potential for integrated climate-driven early warning forecasting systems in South Asia—A scoping review. *Plos One*, *19*(10), e0309757. https://doi.org/10.1371/journal.pone.0309757

Destaria, R., & Yulmaini, Y. (2022). Sistem Pakar Diagnosa Penyakit Dispepsia Menggunakan Metode Depth First Search. *Prosiding Seminar Nasional Darmajaya*, *1*, 170–183. Retrieved from https://jurnal.darmajaya.ac.id/index.php/PSND/article/view/3235

Elmi, N., Dermawan, A., & others. (2022). Application Of Expert System Using Forward Chaining Method For Web-Based Diagnosis Of Child Diarrhea. *Jurnal Teknik Informatika (Jutif)*, *3*(3), 553–562. https://doi.org/10.20884/1.jutif.2022.3.3.244

Hasibuan, M. S., Triase, T., & Hutabarat, D. W. H. (2024). Sistem Pakar Diagnosis Awal Penyakit Faringitis Dan Laringitis Menggunakan Metode Forward Chaining Dan Certainty Factor. *Journal Of Science and Social Research*, *7*(3), 1137–1146. https://doi.org/10.54314/jssr.v7i3.2144

Iskandar, I., Siahaan, M. D., Wahyuni, S., & Panjaitan, D. A. (2023). Expert system for diagnosing spine diseases using the forward chaining method. *Proceedings of the International Conference on Sciences*

Development and Technology, *3*(1), 1–6. Retrieved from http://jurnal.uinsu.ac.id/index.php/icosdtech/article/view/18110

Koenoe, W. T., & Akbar, M. (2021). Sistem Pakar Diagnosa Penyakit Faringitis menggunakan Forward Chaining. *Seminar Multimedia \& Artificial Intelligence*, *4*, 106–113. https://doi.org/10.54314/jssr.v7i3.2144

Lestari, T., Fuady, A., Yani, F. F., Putra, I. W. G. A. E., Pradipta, I. S., Chaidir, L., Handayani, D., Fitriangga, A., Loprang, M. R., Pambudi, I., & others. (2023). The development of the national tuberculosis research priority in Indonesia: A comprehensive mixed-method approach. *PloS One*, *18*(2), e0281591. https://doi.org/10.1371/journal.pone.0281591

Liu, Z., Ni, S., Yang, C., Sun, W., Huang, D., Su, H., Shu, J., & Qin, N. (2021). Axillary lymph node metastasis prediction by contrast-enhanced computed tomography images for breast cancer patients based on deep learning. *Computers in Biology and Medicine*, *136*, 104715. https://doi.org/10.1016/j.compbiomed.2021.104715

Nainggolan, S., & Sianturi, F. A. (2020). Sistem Pakar Mendiagnosa Penyakit Kulit Menggunakan Metode Metode Teorema Bayes. *Jurnal Ilmu Komputer Dan Sistem Informasi (JIKOMSI)*, *3*(1.1), 192–196. https://doi.org/10.9767/jikomsi.v3i1.1.115

Peiffer-Smadja, N., Rawson, T. M., Ahmad, R., Buchard, A., Georgiou, P., Lescure, F.-X., Birgand, G., & Holmes, A. H. (2020). Machine learning for clinical decision support in infectious diseases: a narrative review of current applications. *Clinical Microbiology and Infection*, *26*(5), 584–595. https://doi.org/10.1016/j.cmi.2019.09.009.

Prasetyo, W. D., & Wahyudi, R. (2019). Sistem Pakar Diagnosis Penyakit Ternak Sapi Menggunakan Metode Forward Chaining Berbasis Website Responsif Expert System For Diagnosing Cattle Diseases Using Forward Chaining Method Based On Responsive Website. *Jurnal Teknologi Dan Terapan Bisnis (JTTB) ISSN (P)*, *2615*, 8817. Retrieved from https://shorturl.asia/R9PAy

Purnamasari, I. S., Indahyanti, U., & Astutik, I. R. I. (2023). Sistem Pakar Diagnosa Penyakit Influenza (Flu) Menggunakan Metode Forward Chaining. *Journal of Computer System and Informatics (JoSYC)*, *4*(2), 451–459. https://doi.org/10.47065/josyc.v4i2.3078

Putri, E. M., Apriliza, T., & Putri, R. N. (2021). Sistem Pakar Diagnosa Penyakit Pada Perokok Dengan Metode Forward Chaining Berbasis Web. *Jurnal SANTI-Sistem Informasi Dan Teknik Informasi*, *1*(1), 27–37. https://doi.org/10.58794/santi.v1i1.9

Rahayu, S. Y. S., Priatna, D., & Zulkarnaen, Z. (2021). Early Detection of Body Temperature with Infrared Technology for Prevention of Endemic Outbreaks of Primary School Age Infectious Diseases. *3rd KOBI Congress, International and National Conferences (KOBICINC 2020)*, 500–508. https://doi.org/10.2991/absr.k.210621.084

Ramadhani, T. F., Fitri, I., & Handayani, E. T. E. (2020). Sistem pakar diagnosa penyakit ISPA berbasis web dengan metode forward chaining. *JOINTECS*, *5*(2). https://doi.org/10.31328/jointecs. v5i2. 1243

Rudyarti, E., & Saputra, S. (2025). Expert system analysis using forward chaining method for climate change disease diagnosis. *Proceedings of the 2nd World Conference on Health and Social Sciences*, 150–163. https://doi.org/10.2991/978-94-6463-774-8_15

Sari, M., Puspitasari, D., Suhartawan, B., Adicita, Y., Siregar, R. T., Nur, S., Purnomo, T., Ulfah, N., Jumiyati, S., & others. (2023). Adaptasi Dan Mitigasi Perubahan Iklim Di Indonesia. *Jakarta: Global Eksekutif Teknologi*. Retrieved from https://shorturl.asia/YEPFq

Sasmita, S. (2020). Application of Forward Chaining Methods to Diagnose Skin Diseases in Humans. *Jurnal Ilmiah Betrik*, *11*(3), 459321. Retrieved from https://core.ac.uk/download/pdf/386418873.pdf

Shahan, B., Barstow, C., & Mahowald, M. (2019). Respiratory Conditions: Upper Respiratory Tract Infections. *FP Essentials*, *486*, 11–18. Retrieved from https://pubmed.ncbi.nlm.nih.gov/31710453/

Sikchi, S. S., & Sikchi, S. (2013). Fuzzy expert systems (FES) for medical diagnosis. *International Journal of Computer Applications*, *63*(11). https://doi.org/10.5678/ehealth.v3i1.2345

Verina, W. (2015). Penerapan Metode Forward Chaining untuk Mendeteksi Penyakit THT. *JATISI (Jurnal Teknik Informatika Dan Sistem Informasi)*, *1*(2), 123–138. https://doi.org/10.35957/jatisi.v1i2.29

Wahid, A. A. (2020). Analysis of the waterfall method for information system development. *Journal of Informatics Sciences and Management STMIK*, 1–5. Retrieved from https://shorturl.asia/N7IV0

Yasnoff, W. A., & Miller, P. L. (2013). Decision support and expert systems in public health. In *Public health informatics and information systems* (pp. 449–467). Springer. https://doi.org/10.1007/978-1-4471-4237-9_23