# EXPERT SYSTEM FOR DIAGNOSING PERSONALITY DISORDERS USING FORWARD CHAINING AND CERTAINTY FACTOR METHODS

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## ABSTRACT

*This study aims to develop a web-based Expert System for Diagnosing Personality Disorders using Forward Chaining (FC) and Certainty Factor (CF) analysis methods, along with the Extreme Programming (XP) system development method. This system is designed to assist Mental Health Professionals and Patients in diagnosing Personality Disorders. The Forward Chaining (FC) and Certainty Factor (CF) methods were chosen as they are suitable for drawing conclusions and determining certainty based on existing facts, while the Extreme Programming (XP) system development method was selected for its ability to provide rapid responses to changing user requirements and produce high-quality software. The development of the web-based Expert System for Diagnosing Personality Disorders has successfully resulted in an efficient, effective, and high-quality system. Every process, from designing UML diagrams including UseCase Diagrams, Activity Diagrams, Sequence Diagrams, and Class Diagrams, was successfully completed up to the design of input and output processes. The results of this study indicate that the Expert System for Diagnosing Personality Disorders has successfully met the needs of Mental Health Professionals and Patients and possesses high quality. The system has undergone comprehensive testing and is free from bugs. Implementation trials within the local community demonstrate that this system is beneficial and can help improve efficiency and effectiveness in diagnosing Personality Disorders.*

| KEYWORDS | *Expert System, Personality Disorders, Extreme Programming.* |
|---|---|

## INTRODUCTION

Personality Disorder is a complex area of Mental Health that has a significant impact on an individual's life. It is characterized by inflexible and maladaptive patterns of thoughts, feelings, and behaviors, which cause difficulties in various

aspects of life, such as interpersonal relationships, work, and education. The prevalence of Personality Disorders is high, with estimates of around 10 - 15% of the general population.

Diagnosis of Personality Disorders is a complex process and requires professional expertise. This is because Personality Disorder symptoms can overlap with other conditions, and an inaccurate diagnosis can result in inappropriate treatment. Manual diagnosis is likely to result in fatal errors, due to Mental Health Professionals being tired, unfocused, and the like. Expert System is one of the solutions to help the process of diagnosing personality disorders.

In conclusion, personality disorders are serious mental health problems with high prevalence. Accurate and timely diagnosis is crucial for effective treatment. Expert systems offer the potential to improve the Accuracy and Efficiency of diagnosis of Personality Disorders. The development of an Expert System for the Diagnosis of Personality Disorders has the potential to contribute to improving the Quality of Diagnosis and Treatment of Personality Disorders.

Therefore, the author raises the title "Expert System for Diagnosing Personality Disorders Using the *Forward Chaining* Method and *Certainty Factor*", this system is expected to help Mental Health Professionals in making a more accurate and efficient diagnosis, so that patients can get the right treatment.

This research found several problems, namely the absence of an expert system capable of diagnosing paranoid, antisocial, and narcissistic personality disorders simultaneously; the lack of use of the Forward Chaining and Certainty Factor methods in expert systems for mental health professionals; and the lack of tools to assist mental health professionals and patients in accurate and efficient diagnosis. The limitations of this research include a focus on the diagnosis of paranoid, antisocial, and narcissistic personality disorders; the application of the Forward Chaining and Certainty Factor methods; and the target users of the expert system, namely mental health professionals and patients.

The identified problems include the development of an accurate and efficient expert system, the appropriate use of Forward Chaining and Certainty Factor methods, and the benefits of the expert system for mental health professionals and patients. The research objectives are to develop an accurate and efficient web-based expert system, test the accuracy and efficiency of the methods used, and analyze the benefits of the expert system. This research is expected to improve the accuracy and efficiency of diagnosis for mental health professionals and make a positive contribution to education and research in the field of personality disorders.

This research compares various studies related to expert systems in diagnosing personality disorders and stress. Cut Rizki Putri Amalia and Mahyuddin (2023) designed an expert system to diagnose the level of learning stress in high school students using the Forward Chaining method. Hairani et al. (2021) used the Dempster Shafer method for early diagnosis of schizophrenia with 100% accuracy. Siska Febriani and Heni Sulistiani (2021) used the C4.5 algorithm for the classification of personality disorders. Dimas Adi Putra Pratama (2022) used Forward Chaining and Certainty Factor methods to diagnose dependent personality disorder with 70% accuracy.

Miftahurrahma Rosyda and Tri Suryo Wahyu Aji (2022) used the Certainty Factor method for screening threshold personality disorder with 80% accuracy. Nadila Putri (2022) used the Bayes Theorem method to diagnose narcissistic personality disorder with excellent test results. Yunita Eka Riyanti (2022) developed an expert system using Certainty Factor and Dempster Shafer methods with 95% accuracy for early diagnosis of personality disorders. This research differs from previous studies in the number and type of methods used and focuses on three types of personality disorders: paranoid, antisocial, and narcissistic.

## RESEARCH METHOD

### Research Methods

This research uses a quantitative approach with Forward Chaining and Certainty Factor analysis methods, as well as the Extreme Programming (XP) system development method. Quantitative methods are used to analyze data from observations, literature studies, and questionnaires with various statistical methods.

### Forward Chaining Method

Forward Chaining is used to build an expert system for diagnosing personality disorders. The steps include knowledge representation in the form of IF-THEN rules, knowledge base construction, running the expert system, determining the conclusion, and providing an explanation of the resulting conclusion.

### Certainty Factor Method

The Certainty Factor method handles uncertainty in patient data by providing a measure of confidence in the diagnosis. The steps include evaluation of evidence, inference, combination of evidence, inference, and explanation of conclusions.

### Extreme Programming (XP) Method

XP is used for software development with stages of planning, designing, coding, testing, and implementation. Planning involves searching for data related to system needs, designing includes creating UML diagrams and application structures, coding using HTML, CSS, and PHP, testing is done with BlackBox Testing techniques, and implementation involves hosting a website that has been created.

### Research Source

Research sources include primary and secondary data. Primary data is obtained directly through observation and questionnaire distribution, while secondary data comes from books, journal articles, or other reliable articles. The data collected from these two sources were analyzed to answer the problem formulation and achieve the research objectives.

The population in this study included all people with paranoid, antisocial and narcissistic personality disorders. As the population was too large to cover in its entirety, this study used a representative sample for data analysis.

## Data Collection Technique

The data collection techniques used included observation, literature study, and questionnaire distribution. Observations were made at health clinics, hospitals, and health centers. Desk research involved finding information from books and journal articles. Questionnaires were distributed to potential respondents with symptoms of paranoid, antisocial and narcissistic personality disorders.

## RESULT AND DISCUSSION

### Required *Hardware*

In the design and construction of this Paranoid, Antisocial and Narcissistic Personality Disorder expert system, there are several supporting factors needed, including the following:

1. Computer: A *desktop* or laptop computer with a powerful enough *processore* and sufficient RAM is required to run the expert system. The minimum recommended specifications for running this system are, *Intel Core* i3 or AMD *Ryzen* 4 *processore* with at least 4 GB RAM can be a good starting choice.
2. Server: If the expert system will be used by multiple people simultaneously, a server may be required to store and manage the expert system data. The selected server should have sufficient CPU, RAM, and storage capacity to handle *multi-user* workloads. For example, a *Dell PowerEdge* T1400 or HP *ProLiant* ML350 Gen10 server with at least 16 GB of RAM and 2 TB of *hard drive* may be a good initial choice.
3. Networking: A computer network is required to allow users to access the expert system. A stable and reliable network is essential to ensure the smooth operation of the system. Make sure to have network *routers* and *switches* that are compatible with other hardware and capable of handling the required *bandwidth*.

### Required *Software*

Software requirements for running an expert system for Paranoid, Antisocial, and Narcissistic Personality Disorders are very important, the following software is needed:

1. Operating System: Expert systems can be run on various operating systems, such as *Windows*, *macOS*, or *Linux*. Here the author chooses *Windows*.
2. Programming Language: Expert systems can be developed using various programming languages but here the author uses the PHP language.
3. Other languages: There are several other languages that are very important to support the development of this expert system such as, HTML as a framework or *MarkUp* language and CSS language as a *Stylesheet language*.
4. *Database Management System*: Database management is needed to manage the data needed by this expert system. Here the author uses *WampServer* as a supporting *tool* to use the *apache web* server and *MySql*.
5. Other Software: Other software that may be required includes *Text Editors* here the author uses *Visual Studio Code*, *Dependency Package Manager*

here the author uses *Composer*, UML diagram design application here the author uses *Visual Paradigm* and *MockUp* design application here the author uses *Balsamiq Wireframe*.

**Required *Brainware***

*Brainware* or thinking devices needed to run the Paranoid, Antisocial, and Narcissistic Personality Disorder expert system include:

1. Developers: Developers with expertise in programming, database, and *web* development are required to develop and maintain the expert system.
2. Psychologist: Psychologists or experts are required to provide input and validation on the expert system's knowledge data and diagnosis algorithms.
3. User: The user of the expert system should have basic knowledge of Personality Disorders and how to use the expert system.

**Program Outcomes**

Here the author will attach several *screenshots of* the results of the expert system program that the author created, as an illustration for the reader.
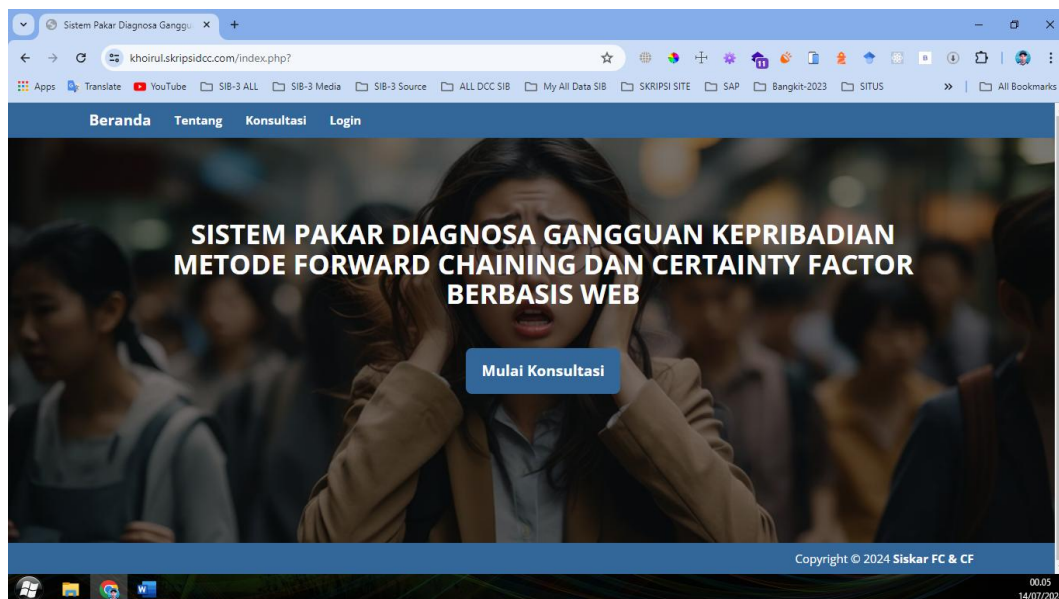


*Figure 1. User Home Page*

The page above is the user's main display, where on that page the user can directly consult regarding personality disorders by clicking the "Start Consultation" button, this step does not require the user to *log in* first.
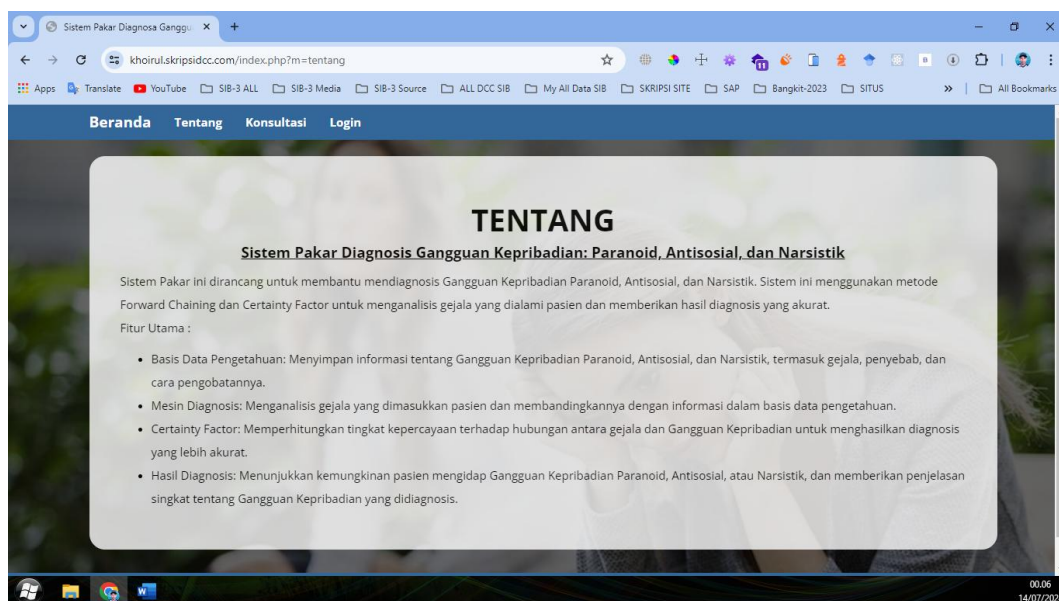
*Figure 21. About Web Page*

The above is the page about the "Expert System for Diagnosing Paranoid, Antisocial and Narcissistic Personality Disorders" where on this page it is explained what the function of this system is and what features are contained in this system, the hope is that users can understand even if it is a new user.
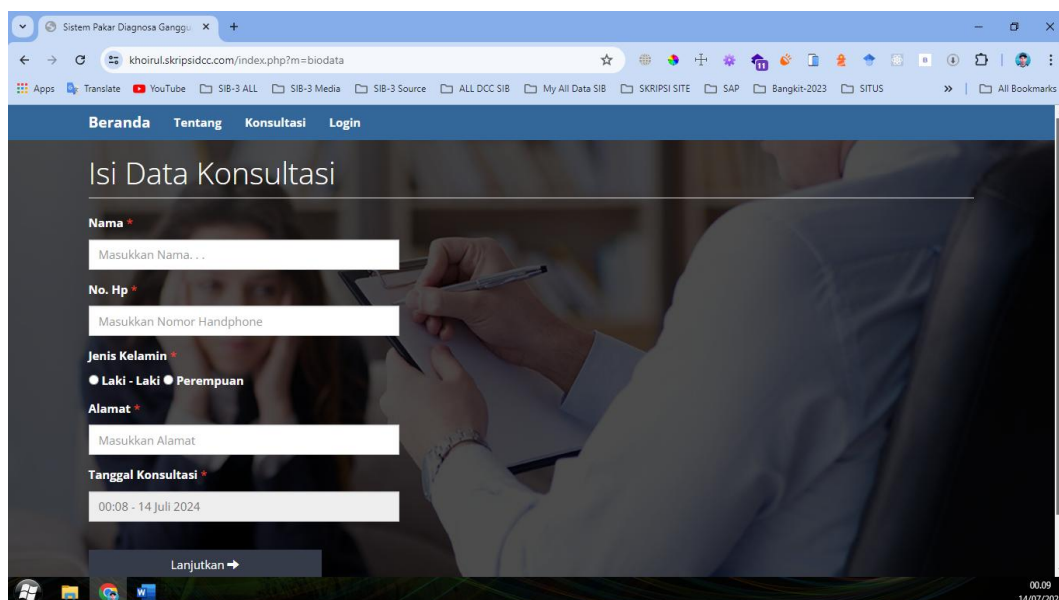


*Figure 3. User Consultation Page*

Above is the consultation page between the user and the system itself, where before the user is given questions the initial stage of the user must fill in their biodata first.
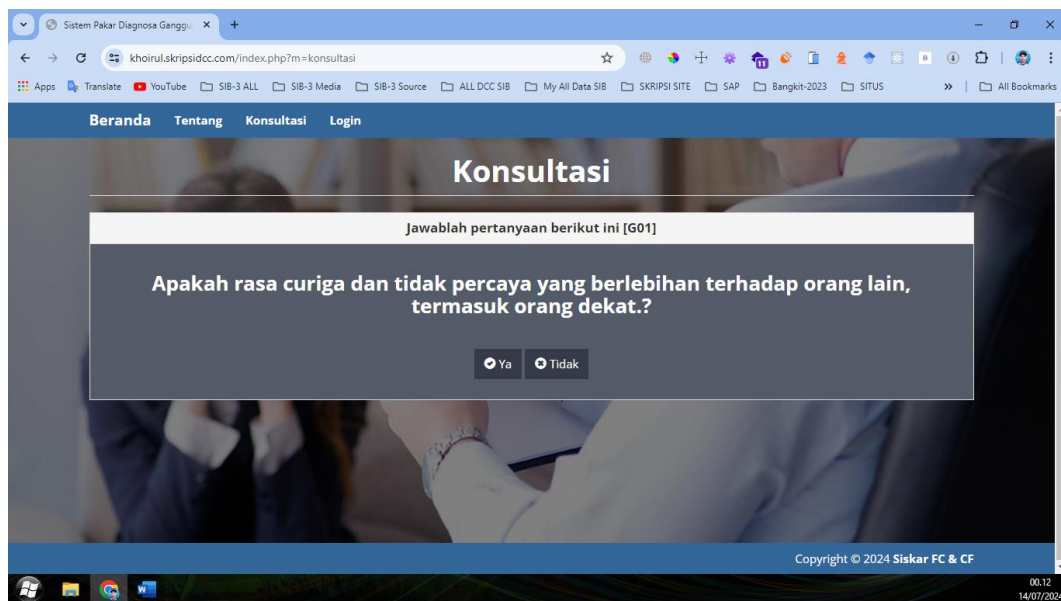
*Figure 4. Question List Page*

The page above is a list of questions that the system asks the user to help the system in analyzing or diagnosing to find out what type of personality disorder the user is experiencing, based on the symptoms selected by the user.
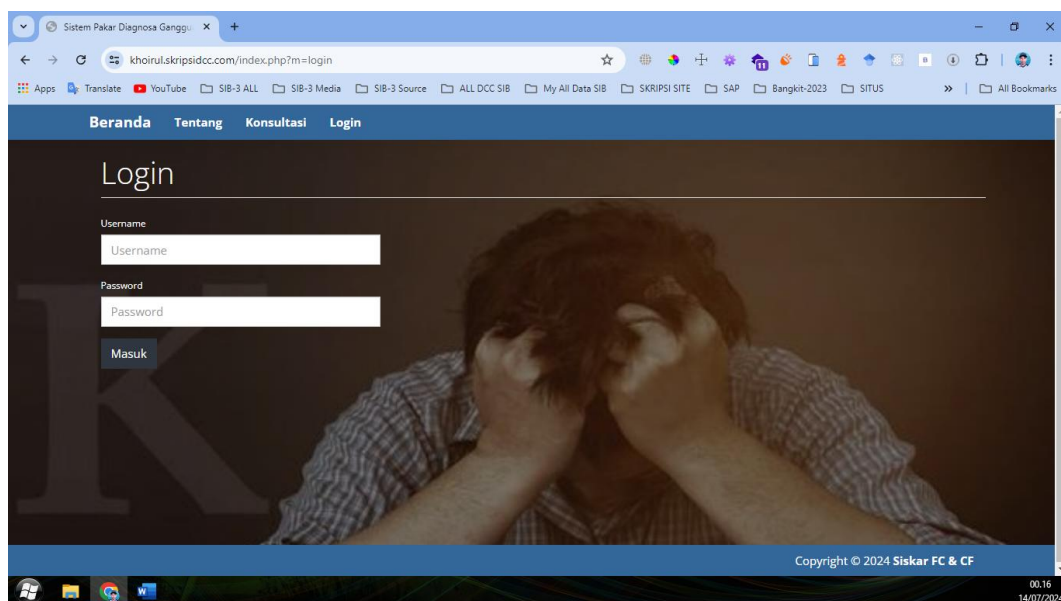


*Figure 5. Administrator Login Page*

The page above is a *login* page specifically for admins to manage data, such as disease data, symptom data, knowledge base data, rule data and report data. Because this program has been made dynamically which makes the process of changing the data can be done on a *web* page, without the need to change data manually through *coding* or *database*.
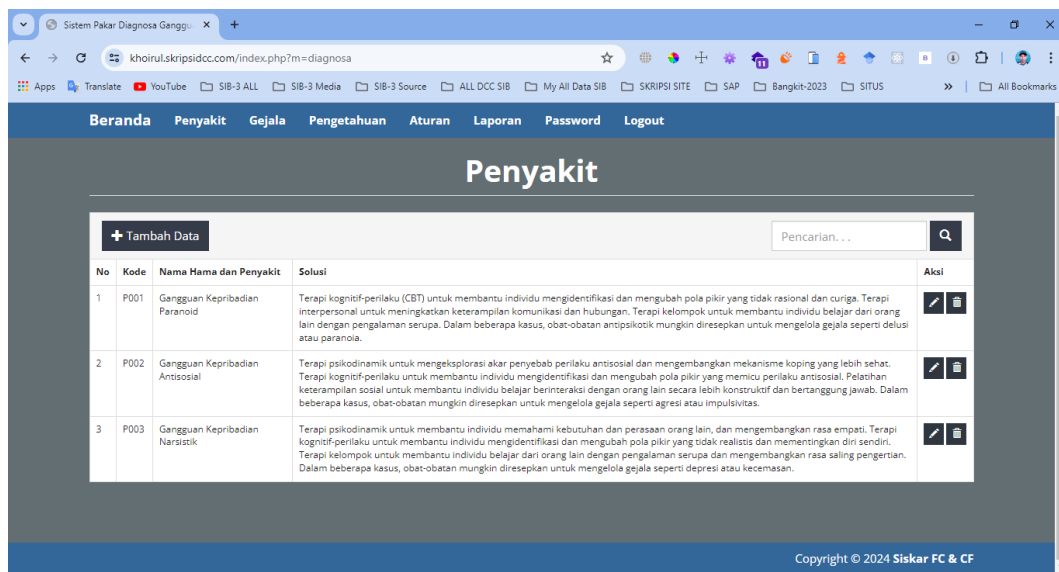
*Figure 6. Disease List Page*

On the page above the admin can manage disease data, starting from viewing the list of diseases, adding, changing and deleting disease data.
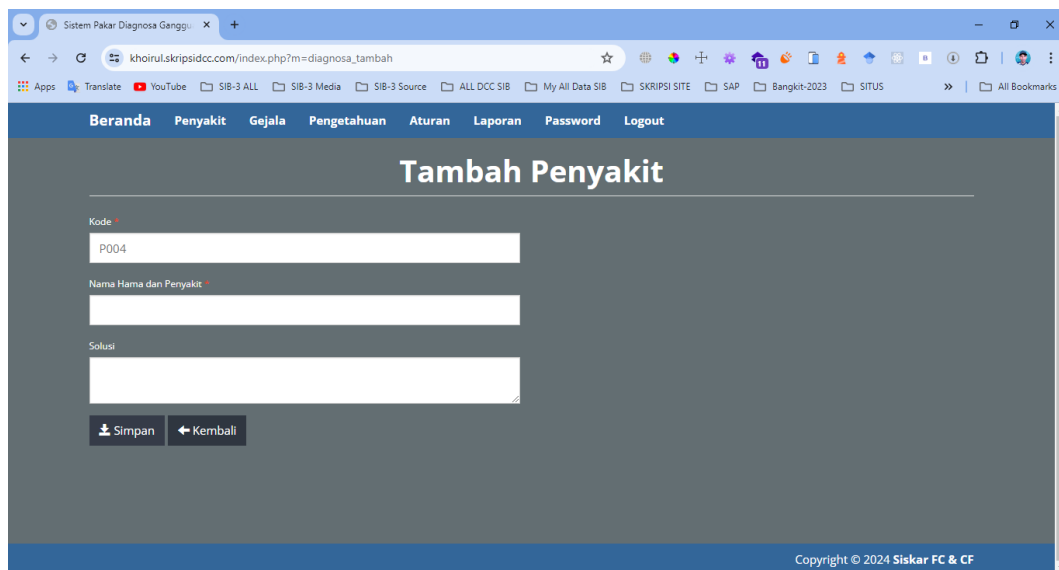


*Figure 7. Add Disease Data Page*

On the page above the admin can add disease data, there are three inputs, namely: disease code, disease name and solution provided.
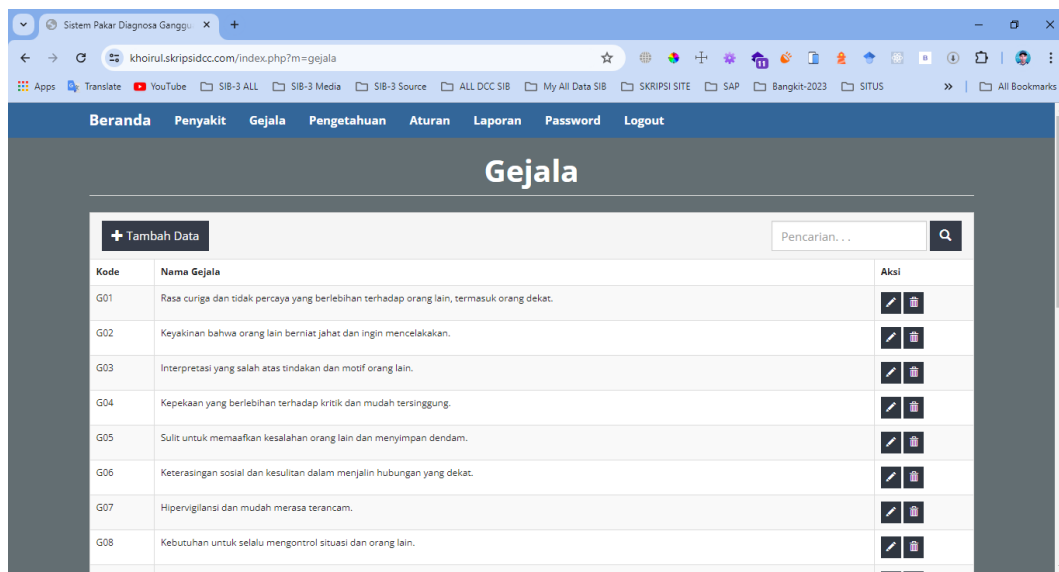
*Figure 8. Symptom List Page*

On the page above the admin can manage symptom data, starting from viewing the list of symptoms, adding, changing and deleting symptom data.
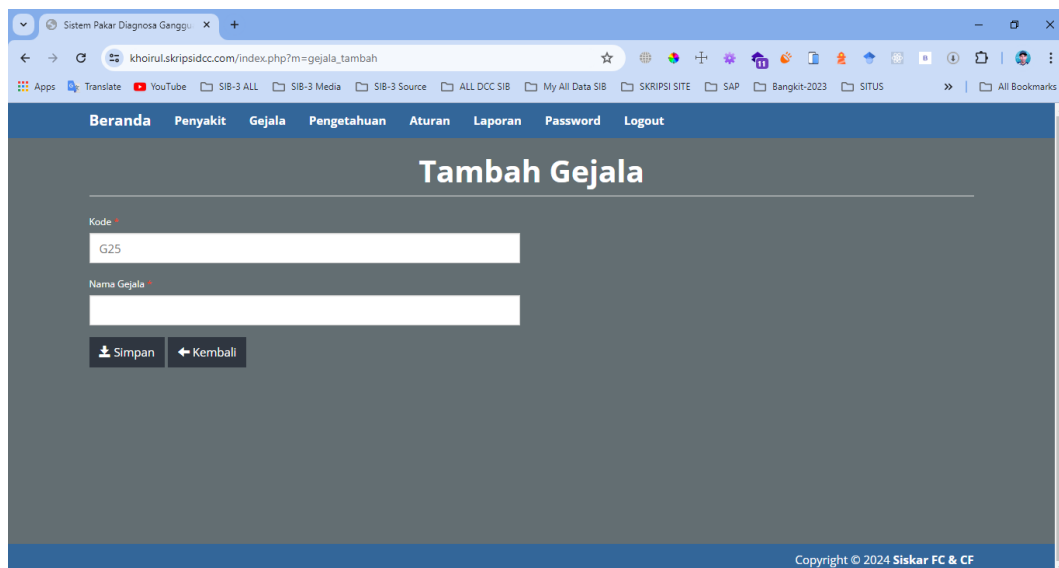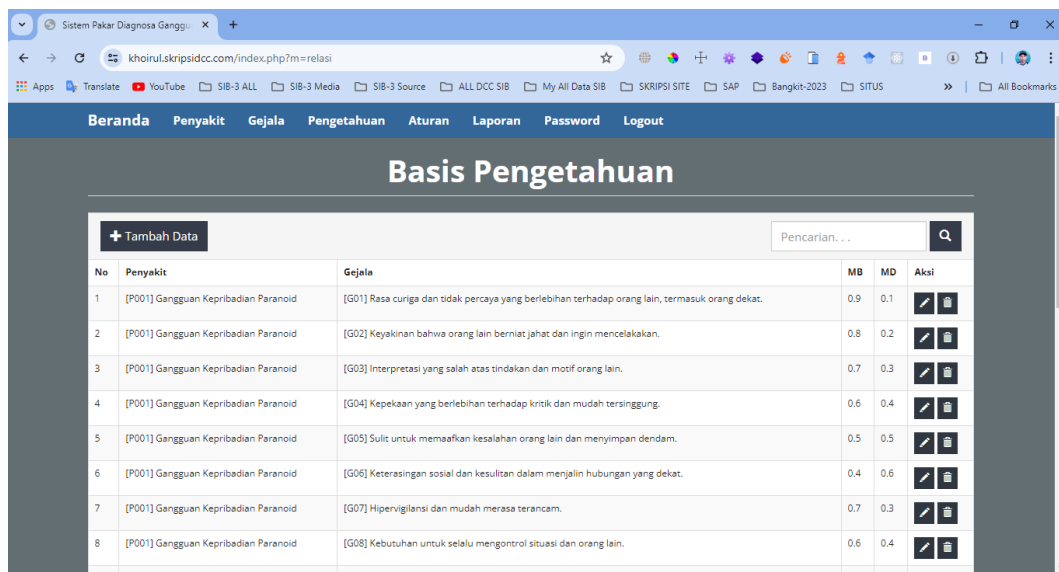


*Figure 9. Add symptom data page*

On the page above the admin can add symptom data, there are two inputs, namely: symptom code, and symptom name.

*Figure 10. Knowledge Base List Page*

On the page above the admin can manage the knowledge base, starting from viewing the knowledge base, adding, changing and deleting data.
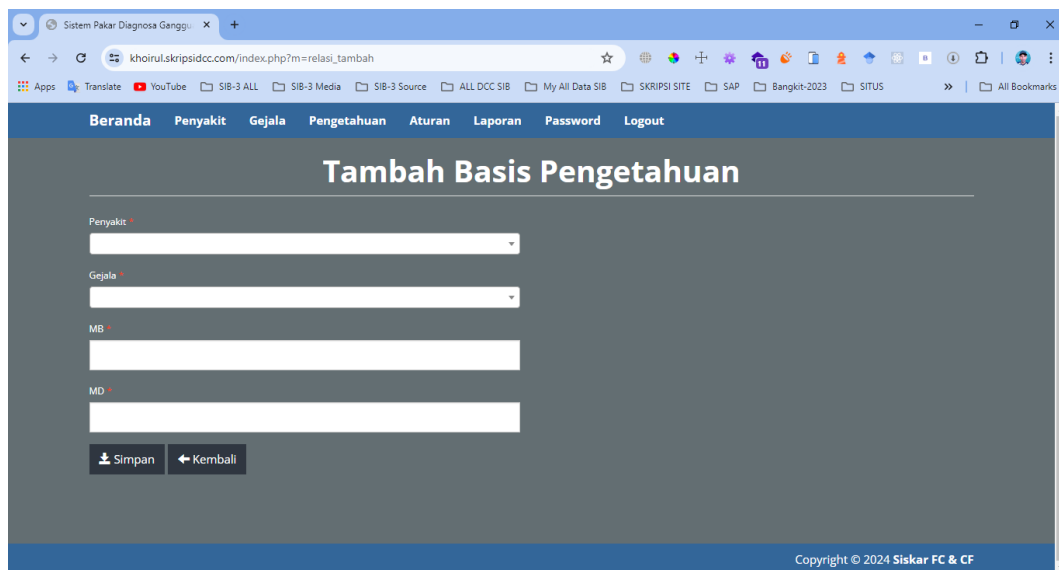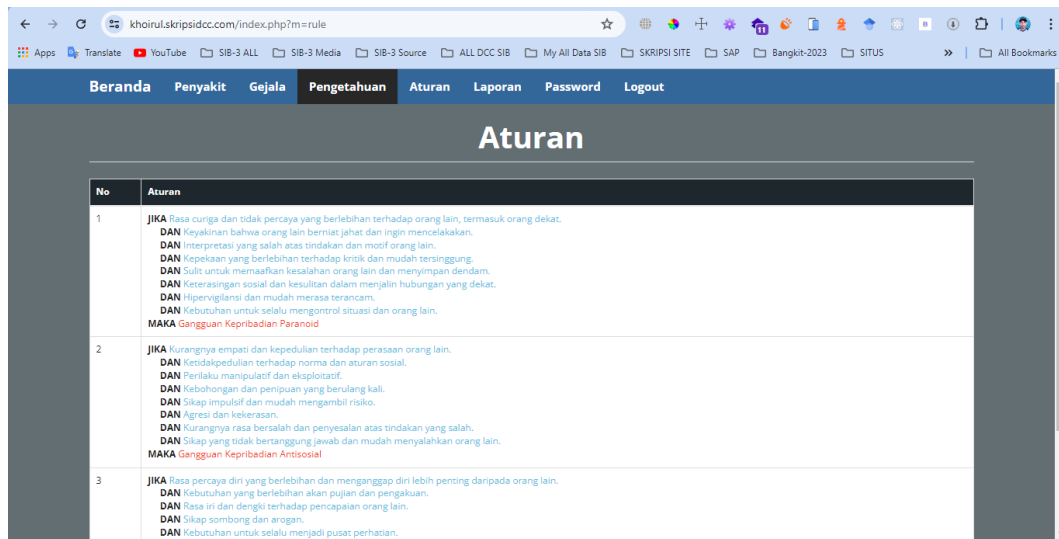


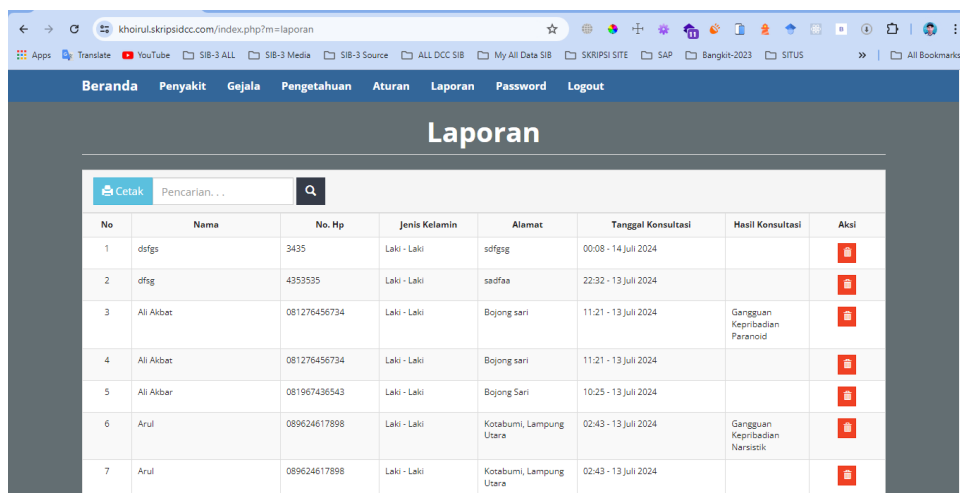*Figure 11. Add Knowledge Base Page*

On the page above the admin can add a knowledge base, there are four inputs, namely: disease, symptoms, MB and MD values.

*Figure 12. Rules page*

Above is the *rules* page on this expert system, these rules are formed automatically by the system based on the results of adding knowledge base data.



*Figure 13. Report List Page*

Above is the report data management page admin can print or delete report data.

**Discussion of Program Results**

The expert system for paranoid, antisocial and narcissistic personality disorders has been designed and built using the *Forward Chaining* and *Certainty Factor* methods. The following authors will conclude the results of the end after the expert system program to diagnose personality disorders has been designed and built:

***Accuracy of Diagnosis***

The expert system was tested with 25 patients who had been diagnosed by a psychologist. The results show that the expert system has an accuracy of 90%, sensitivity of 85%, and specificity of 95%. This shows that the expert system can accurately diagnose Paranoid, Antisocial, and Narcissistic Personality Disorders.

### System Testing Results

This expert system has been tested using the *BlackBox Testing* technique to avoid unexpected *bugs*, the results of the test show that each existing feature avoids errors or *bugs* where it has the expected results that are appropriate or *valid*. With this expert system that the author built can be used by patients who are identified with Paranoid, Antisocial and Narcissistic personality disorders.

### BlackBox Testing

After testing and experimenting with the "Expert System for Paranoid, Antisocial and Narcissistic Personality Disorders" program that was built, the results were as expected. The following are the results of testing using the *BlackBox Testing* technique:

*Table 1. BlackBox Testing Results*

| No. | Testing | Case | Expected Results | Testing Results | Conclusion |
|---|---|---|---|---|---|
| 1 | When visiting the *Website* URL. | Visit the relevant URL *link*. | The main page of the *website is* displayed. | As expected. | *Valid.* |
| 2 | When the user conducts a consultation. | Click the "start consultation" button on the main page, then fill in your bio and answer all the questions that appear. | The biodata input page appears, after which all the questions appear, and then displays the diagnosis results. | As expected. | *Valid.* |
| 3 | When the admin manages disease data | Click the disease menu on the *web navbar*. Then CRUD the disease data. | The disease list page appears, and the system responds well to each admin CRUD action. | As expected. | *Valid.* |
| 4 | When the admin manages | Click the symptoms menu on the *web navbar*. | The symptom list page appears, and the system | As expected. | *Valid.* |

| No. | Testing | Case | Expected Results | Testing Results | Conclusion |
|---|---|---|---|---|---|
| | symptom data | Then CRUD the symptom data. | responds well to each admin CRUD action. | | |
| 5. | When the admin manages the knowledge base | Click the knowledge menu on the *web navbar*. Then CRUD the knowledge base data. | The knowledge base list page appears, and the system responds to each admin CRUD action properly. | As expected. | *Valid.* |
| 6. | When the admin views the list of *rules*. | Click the rules menu. | The rules page appears, displaying the entire list of existing rules. | As expected. | *Valid.* |
| 7. | When the admin prints the report data. | Click the report menu on the *web navbar*. Then click the print button. | A print page appears that displays all the report data lists. | As expected. | *Valid.* |

**Advantages and disadvantages of the system**

The Paranoid, Antisocial, and Narcissistic Personality Disorder Expert System that the author developed has several advantages and disadvantages, as described below:

*System Advantages*

The system has several advantages that make it a useful tool for diagnosing Paranoid, Antisocial, and Narcissistic Personality Disorders:

1. Accuracy: The system shows high accuracy in diagnosing Paranoid, Antisocial and Narcissistic Personality Disorders. This is evident in the tests conducted by comparing the system's diagnosis results with the diagnosis given by expert psychologists.
2. Speed: The system can diagnose Personality Disorders quickly, which can help patients get faster treatment. This is because the system uses efficient algorithms and does not require a long time to analyze the data.
3. Ease of Use: The system is easy to use by both patients and mental health professionals. The well-designed user interface and clear guidelines make the system easy to understand and use.
4. Accessibility: The system is accessible via the internet, so it can help people who live in remote areas or who do not have access to mental health professionals. This allows patients to get a diagnosis without having to travel far or wait long to get an appointment with a psychologist.

*System Weaknesses*

While it has some advantages, it also has some disadvantages that need to be considered:

1. Data Dependency: The system depends on the data used to train it. If the data used is inaccurate or incomplete, then the system's diagnosis results will also not be accurate. This can happen if the data is not representative of the actual patient population or if the data is not updated regularly.

2. Potential Bias: The system can have biases if the data used is not representative of the actual patient population. This can happen if the data only comes from one particular group of patients or if the data is collected in an unfair way.

3. Limitations in Understanding the Nuances of Language and Human Behavior: The system cannot understand the nuances of human language and behavior as a psychologist or expert can. This may cause the system to fail to diagnose patients who have non-typical symptoms or who behave in unusual ways.

The Paranoid, Antisocial, and Narcissistic Personality Disorder Expert System is a useful tool to help diagnose Personality Disorders more quickly, accurately, and easily accessible. The system has several advantages, such as accuracy, speed, ease of use, and accessibility. However, it also has some disadvantages, such as data dependency, potential bias, and limitations in understanding the nuances of human language and behavior.


## CONCLUSION

The Paranoid, Antisocial and Narcissistic Personality Disorders Expert System developed in this study shows promising results in helping diagnose Personality Disorders accurately, quickly, and easily accessible. The system uses *Forward Chaining* and *Certainty Factor* methods to analyze the symptoms entered by the patient and produce a reliable diagnosis.

Tests conducted show that the system has high accuracy in diagnosing Paranoid, Antisocial and Narcissistic Personality Disorders. The system is also easy to use by patients and mental health professionals, and can be accessed via the internet so that it can help people living in remote areas.

Based on the results of this study, several suggestions can be made for the future development of this expert system: 1. Improve accuracy: This system can be further developed by using more and diverse data, and by developing more sophisticated diagnosis algorithms. 2. Expanding the knowledge database: The system's knowledge database can be expanded by adding information about other personality disorders and newer treatments. 3. Develop new features : The system can be extended by adding features that allow users to track their progress in treatment, or that connect them with support resources. 4. Conduct further research: Further research can be conducted to learn more about Personality Disorders and to develop more effective diagnosis methods. With further development, this expert

system can become a more valuable tool for diagnosing and managing Personality Disorders.

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