



Expert System for Diagnosing Pests on Oil Palm Seed Plants Using the Certainty Factor Method

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Abstract

Indonesia is one of the largest countries producing palm oil. The problems that often arise in oil palm seedlings are pest attacks. Oil palm seedlings diagnosed with pest attacks can be characterized by existing symptoms. Based on the phenomena that occurred, researchers created a system for diagnosing pests in oil palm seed plants, so that they could diagnose quickly and find solutions to pest problems in oil palm seed plants. This research uses a development method called waterfall. The design of this research is to plan an Expert System for Diagnosing Pests on Oil Palm Seed Plants Using the Certainty Factor Method. Based on the tests that have been carried out, the results are that the community or farmers on oil palm plantations can easily diagnose pests on oil palm seed plants in real time as long as they are connected to the internet to help diagnose pests on oil palm seed plants. Testing of the expert system showed a high level of accuracy in diagnosing pests on oil palm seedlings. The level of suitability accuracy reached more than 90%. With this expert system, oil palm plantation management can be improved significantly. Early detection of pest attacks will reduce the losses incurred and allow more effective preventive measures to be taken.

Introduction

Indonesia is one of the largest countries producing palm oil, and Indonesia produces 59% of the total production of palm oil in the world or 45.5 million tons per year, and palm oil is one of the crops that is much in demand by the public at a price of 2000 per kilo. Pest control on oil palm seedlings also needs to be done quickly and as accurately as possible, because a pest attack is one of the attacks that can quickly spread to all other oil palm seedling plantations, if not immediately controlled it can result in low growth and productivity of coconuts. palm. In oil palm plantations there are pests that attack oil palm seedlings, diagnosing pests on oil palm seedlings must be done as quickly and as accurately as possible (Almahdoni, 2020; Koubaa et al., 2020).

Pests are all types of animals that have the potential to interfere with plant growth, causing the growth of oil palm seedlings to become unfit for planting (Ani Ayu, 2023). As technology develops rapidly, it can be utilized in the plantation sector, such as expert systems. An expert system is a computer-based system that uses knowledge, facts and reasoning techniques to solve problems, which usually can only be solved by an expert in a particular field (Nurrahman Bugis, 2019; Sarker, 2022; Yuliardi et al., 2023).

Because pests on these plants can cause problems faced by farmers as a result of these pest attacks, a system is needed that can help farmers to diagnose pest attacks on oil palm seedlings early, namely in the form of an expert system (Frandian, 2022). Expert system with the Certainty Factor method (Nucahyono et al., 2022).

The problems that often arise in oil palm seedlings are pest attacks. Oil palm seedlings diagnosed with pest attacks can be characterized by existing symptoms. Pest attacks are something that can be fatal if not treated immediately because these attacks are very easily transmitted/spread to other plants so they can very easily cause damage and even lead to death. Pest attacks on oil palm seedlings can be said to be normal because pest attacks can attack living plants (Panunggul et al., 2023; Defitri & Marcelian, 2023). However, the most important thing is how to overcome the problem of controlling the attack.

Based on the phenomenon that occurs, there is no system for diagnosing oil palm seed pests at PTPN II Sawit Across, most PTPN II nursery employees find it very difficult to find out pest attacks that occur on oil palm seedlings at PTPN II Sawit Across, therefore the researchers created a system to Diagnosing pests on oil palm seedlings, with this expert system, it will be easier for students and oil palm farmers who want to learn about procedures for caring for oil palm seedlings, so they can diagnose quickly, and find solutions to pest problems (Zufria et al., 2021). on oil palm seedlings. what differentiates my research from previous research conducted by (Nucahyono et al., 2022). entitled "Android-based expert system for diagnosing pests and diseases of oil palm plants using the certainty factor method" is a research that I made that only focuses on diagnosing pests, not diseases and my research is only for oil palm seed plants which is web-based so that it can be easily accessed while the research previously focused on oil palm plants diagnosed with android-based pests and diseases, this previous research will be used as a benchmark and reference in this research.

The purpose of this writing is to help students and the public, especially farmers, to study oil palm seed plants in order to know the types of pests that attack oil palm seed plants. In designing this system, a method is used, namely the Certification Factor.

Methods

The research framework is a sequence of activities that will be carried out in a research study. So that the steps taken by the author in this design do not deviate from the main topic of discussion and are easier to understand. This stage is the initial stage of research carried out by the author, where this stage refers to the problems that occur especially at PTPN II Sawit Seberang, subdistrict. Sawit Seberang, Langkat Regency. As for the phenomena observed so far, there is no system that can determine the type of pest by examining the symptoms.

Planning

This research uses a development method called waterfall, namely a development method from the approach used in descriptive-qualitative research. This method is a software development process that is carried out sequentially, where progress is seen as water that continues to flow downwards (like a waterfall) through the phases of planning, modeling, implementation (construction) and testing. This research is more focused on observation. in depth by identifying and observing the types of pests on oil palm seedlings carried out in one of the nursery areas belonging to PTPN II Sawit Seberang, kec. Sawit Seberang, Langkat Regency. Qualitative techniques involve subjective opinions that cannot be expressed in the form of numbers or values.

Identification of problems

The problem identified in this research is to identify the questions that will be answered in the research. This identification involves asking clear questions in the context of the research. In

the context of this research, analyzing oil palm plant seeds diagnosed with pests. The problem faced in this research is how to apply the Certainty Factor method in an expert system application to diagnose pests and determine the type of pest attack on oil palm seedlings?

Observation

In this research, observation refers to the process of analyzing data on oil palm seedlings diagnosed with pests, data obtained through interviews. Observations were carried out over several days to obtain accurate and representative data.

Data retrieval

This research requires data about pests taken at one of the nurseries belonging to PTPN II Sawit Seberang, sub-district. Sawit Seberang, Langkat Regency. The author collected this data using the question and answer method from several experts who work as assistant managers at the PTPN II Sawit Seberang nursery and made observations at the nursery location.

Design

At this stage, developers create a system design that can help determine hardware and system requirements and also help in defining the overall system architecture.

Trials

This research trial plan aims to find out whether the method the researcher uses can provide diagnostic results that are relevant to the expert's idea of knowledge.

Implementation

The implementation plan for this research can implement the creation of a diagnosis application to find out the results of a diagnosis in an expert system.

Needs Analysis

At this needs analysis stage, activities will be carried out to identify the needs and specifications of the system to be built. Aims to clearly understand how the system needs to be built so that it fits the problem constraints that will be determined. Then the results obtained are that the researcher obtains documentation of the analysis results which will be used as a reference in subsequent stages.

Planning

This system flowchart design is the process of describing and creating system flows which are carried out as a whole or carried out separately in a particular process and explain the procedures in the system. The following design in this research is to plan an Expert System for Diagnosing Pests on Oil Palm Seed Plants Using the Certainty Factor Method. The testing stage was carried out to test the feasibility of the system that has been built in classifying pests in diagnosing oil palm seedlings using the Certainty Factor method. The application of this system is to apply the system to the pest diagnosis system for oil palm seed plants at PTPN II Sawit Across using the Certainty Factor method. By implementing the system for the pest diagnosis system for oil palm seed plants at PTPN II Sawit Across, you can easily find out what will be a priority in determining the suitability of oil palm seedlings.

Results and Discussion

System planning

This stage is the stage of developing a website-based application by writing programming code so that it can produce an expert system application for diagnosing pests on oil palm seedlings that are diagnosed with pests. The system development is built using the PHP and

MySQL programming languages so that it is able to diagnose pests using the method that will be used. Before building a system, the first step that will be taken first is to design the system flow, database and system interface.

In this design the author creates a use case diagram which is used to describe the activities carried out by actors on the existing system. The actors in this research are users of this expert system. The following is a schematic of the use case diagram in an expert system for diagnosing pests on oil palm seedlings.

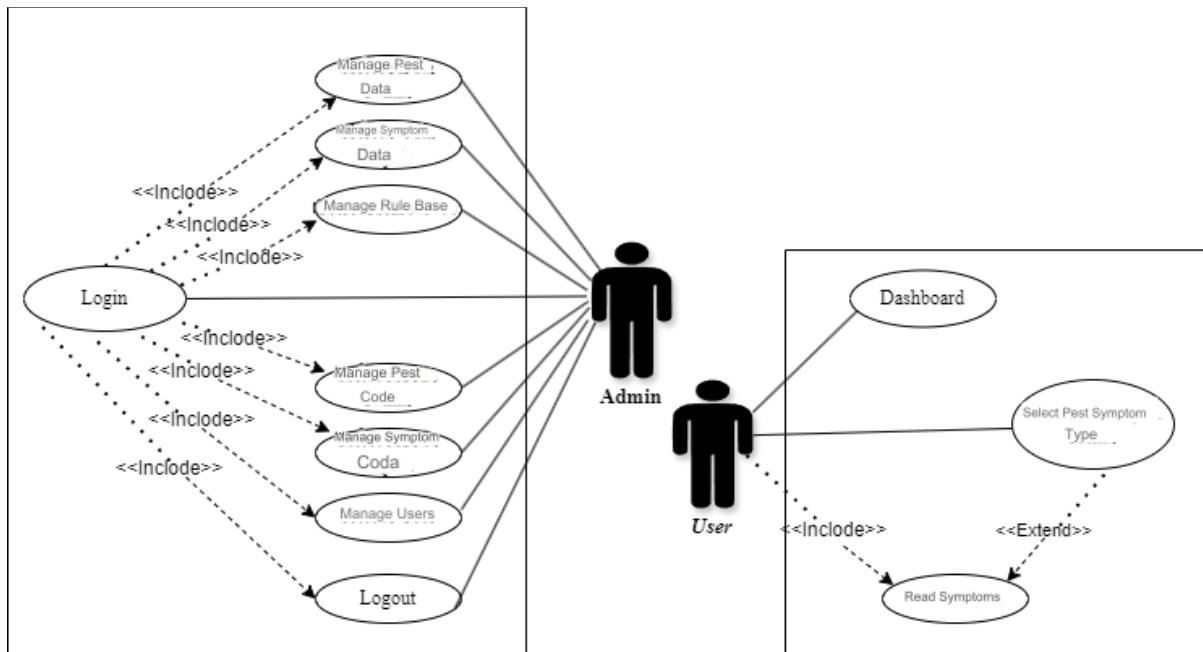


Figure 1. Use Case Diagram Admin Dan User

In a use case diagram, managers are connected by lines to the use cases they work on. The actors in the application in the website-based pest diagnosis expert system for oil palm seedlings are admin and user.

Admin

When the admin wants to manage data, he is required to log in with the account provided. If the logged in account is not registered or does not exist, a login failed display will appear. The admin does not want to carry out the login process, the admin needs to input a valid username and password, so that it can be processed by the system. If the password or username is wrong, the system will automatically display the error message. If the data entered is correct, the system will direct the admin to the main page.

Users

Users can access the dashboard page, diagnosis page and logout application. Users can diagnose pests on oil palm seed plants by selecting the symptoms on oil palm seed plants so that the system can display the diagnosis results and percentage values.

Database Design

A database is a place to store data. In carrying out data processing operations, data storage is very important. Processing in data processing does not only have to be done in a fast process, and there is much more. For example, minimum time for data acquisition, capacity to store and update large amounts of data to update data.

In designing this database the author created a class diagram describing the classes contained in this expert system. These classes have their own attributes. An explanation of the class diagram in this research will be depicted in the class diagram below.

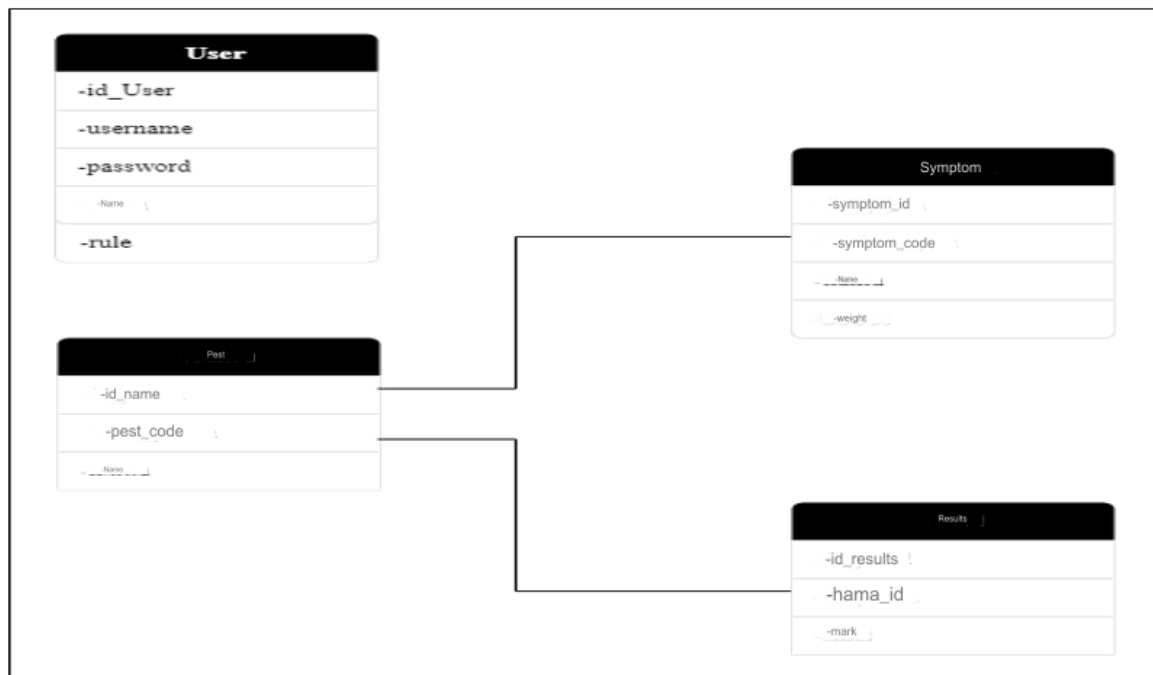


Figure 2. Class Diagram

In creating this system the database used is the MySQL database. The database created in this design is as follows:

User Table

This user table is used to store user data in the database. This table contains user_code, username, password and user level. The pest table is used to store information about relevant pests.

Symptom Table

The symptom table will be used to store information about various symptoms that may appear related to certain pests or conditions in the system.

Results Table

The results table is used to store analysis or prediction results, where each row represents the predicted results of the relationship between a symptom and a disease and has a CF value which shows how strong the correlation is between the symptom and the disease.

Interface Design

This input/output interface design aims to create an application interface that is integrated with the software so that application design is easier to understand. The following is the result of designing the system flowchart and interface, the following is the system for the admin page on the expert system application that was built:

Flowchart Administrator

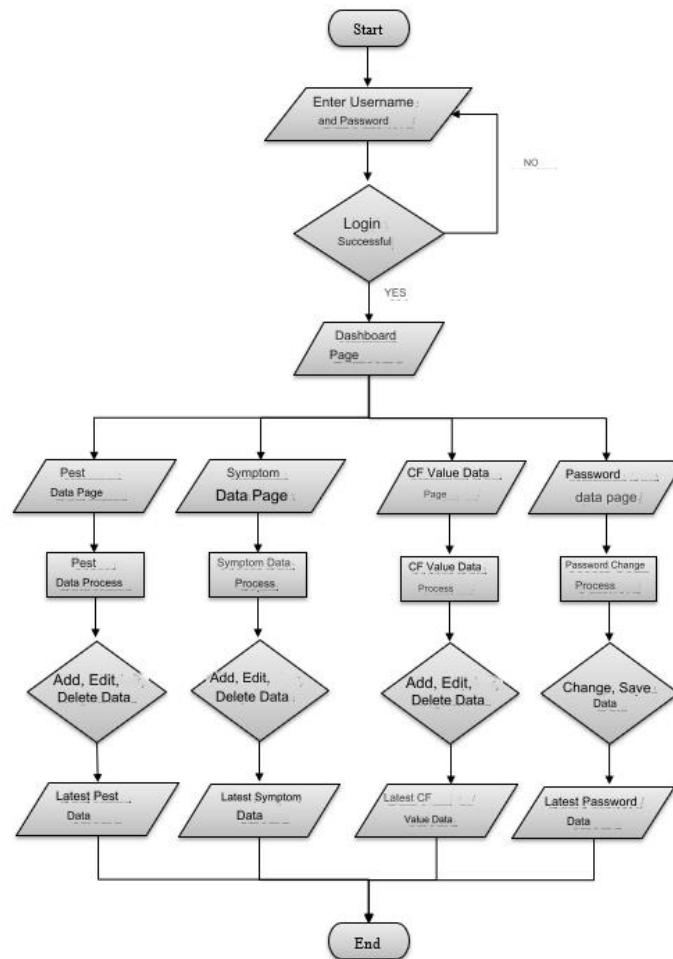


Figure 3. Flowchart Administrator

Administrator Login Display Design

The login display will display a username and password input form which can be used to enter the expert system for diagnosing pests on oil palm seedlings as shown in Figure 4.

The screenshot shows a web browser window titled "Expert System Certainty Factor Method". The browser's address bar is empty. Below the browser window, there is a navigation bar with "Expert system" and "Consultation" tabs, and a "Login" button. The main content area contains a "Username" input field, a "Password" input field, and a "Login" button with a right-pointing arrow icon.

Figure 4. Interface Login

Administrator Main Menu Page Design

This page contains all the menus contained in the expert system for diagnosing pests on oil palm seedlings which has a pest data menu, symptom data, Certainty Factor value data, consultation data and a password change data menu. The design can be seen in Figure 5 below.

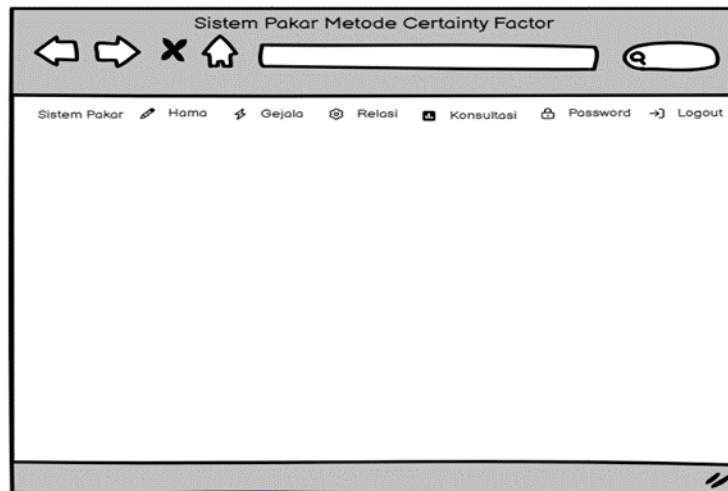


Figure 5. Interface Menu Utama Administator

Flowcahrt User

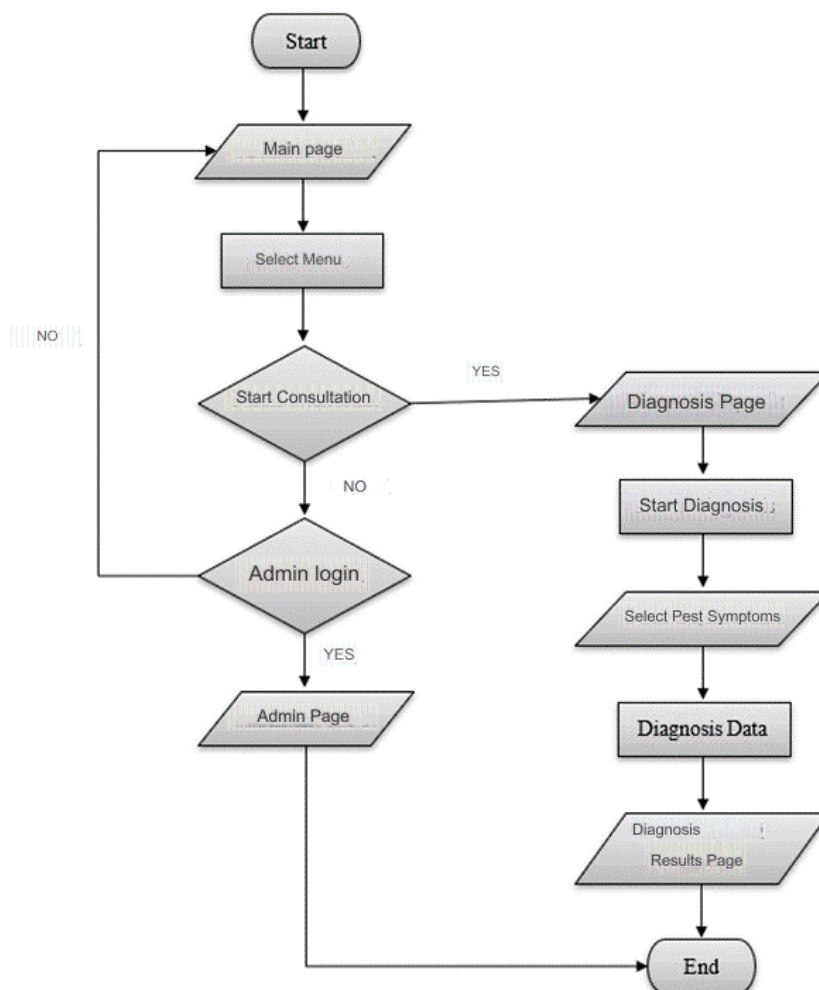


Figure 6. Flowchart User

User Main Menu Page Design

This page functions to display the entire user's main menu page on the system. The following is the design of the user's main menu page.

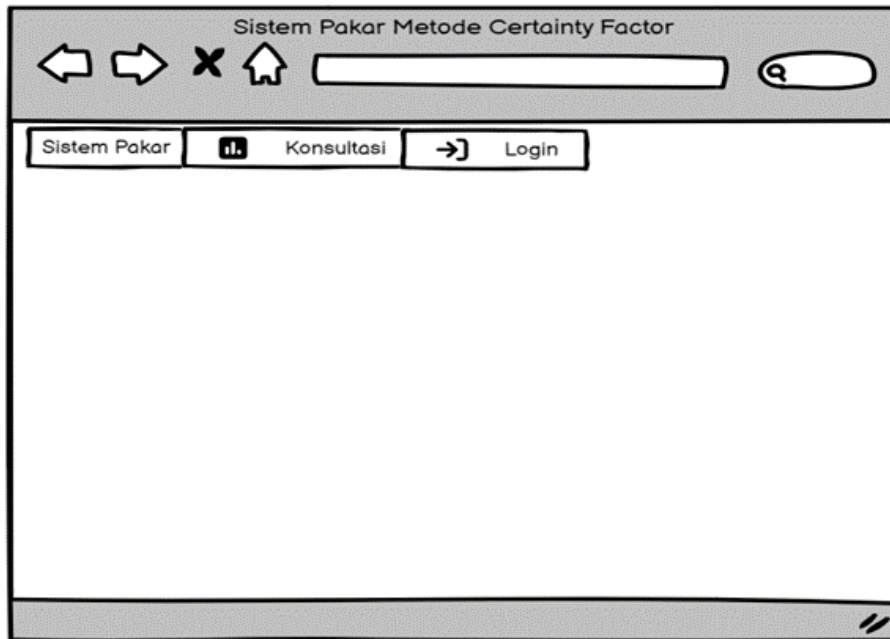


Figure 7. User Main Menu Page

Diagnostic Page Interface Design

The Diagnosis page functions to display all symptom data and user identity data on the system. The following is the design of the diagnosis page menu page.

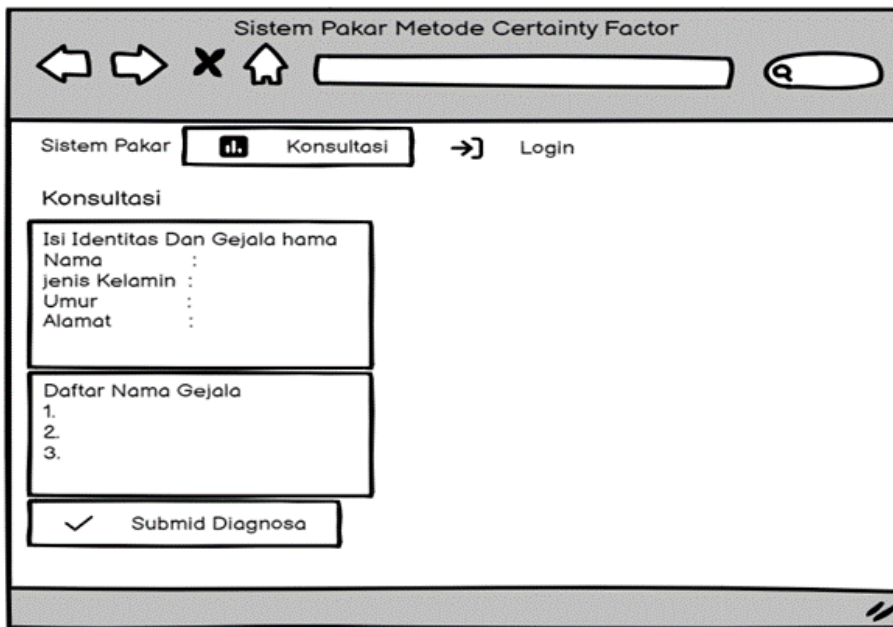


Figure 8. Diagnosis Page Interface

Diagnostic Results Interface Design

The diagnosis results page functions to display all diagnosis results data on the system. The following is the design of the diagnosis results page.

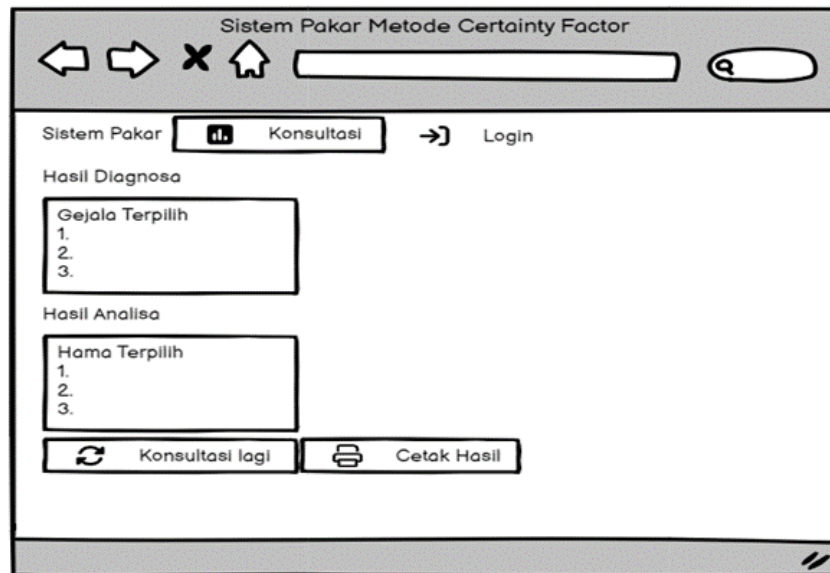


Figure 9. Interface hasil diagnosis

Implementation

After carrying out the interface design stages. Application of the Certainty Factor method in determining the diagnosis results of coconut seedlings based on the data that has been collected. This system was created using the PHP programming language which produces a website-based system. The display that will appear for the first time when running this system is as follows:

Expert System Home Page

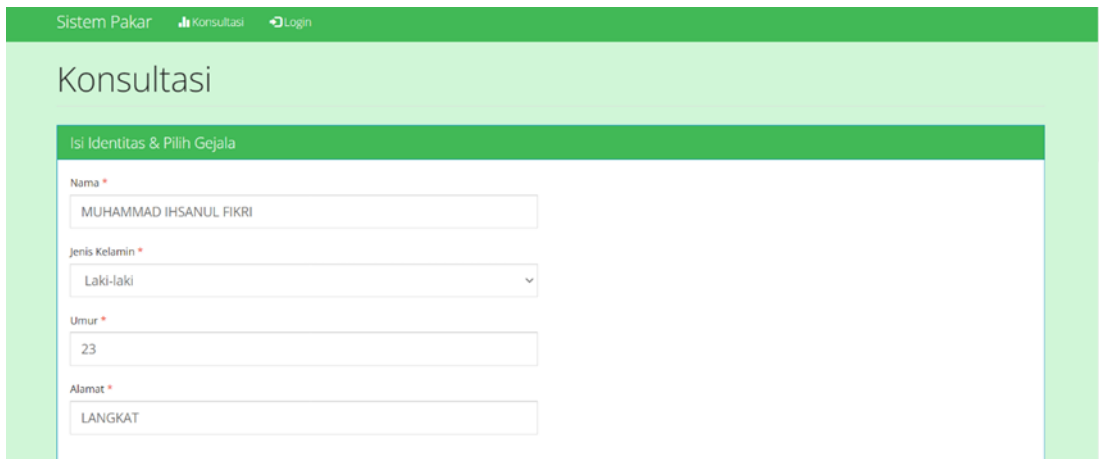
The following is the main page menu for the expert system for diagnosing pests on oil palm seedlings, where all pages can be accessed here.



Figure 10. Main Menu Displays

Diagnostic Page Menu

To start diagnosing the user clicks on the consultation menu on the system. Users will be directed to the diagnosis menu page. On the diagnosis page, users will be asked to fill in their identity and fill in the pest symptoms. The following is a display of the diagnosis page that has been built.



Sistem Pakar Konsultasi Login

Konsultasi

Isi Identitas & Pilih Gejala

Nama *
MUHAMMAD IHSANUL FIKRI

Jenis Kelamin *
Laki-laki

Umur *
23

Alamat *
LANGKAT

Figure 11. Identity Content Menu Display



<input type="checkbox"/>	No	Nama Gejala
<input type="checkbox"/>	1	Tampak Guntingan atau potongan pada daun yang baru terbuka seperti huruf "V"
<input checked="" type="checkbox"/>	2	Terdapat lubang bekas Gerakan
<input type="checkbox"/>	3	Terdapat kotoran berwarna merah kecoklatan bagian pangkal
<input type="checkbox"/>	4	Bagian daun akan terlihat berlubang-lubang
<input checked="" type="checkbox"/>	5	Rusaknya pada bagian pinggir daun
<input type="checkbox"/>	6	Rusak seluruh pelepah jika yang menyerang dalam skala kelompok
<input type="checkbox"/>	7	Pada tahap awal dapat di tandai dengan Daun yang berwarna kuning
<input type="checkbox"/>	8	Daun kering dan mati
<input type="checkbox"/>	9	Daun seperti lidi
<input type="checkbox"/>	10	Menyerang kulit ari daun sehingga daun menjadi berlubang

Figure 12. Menu Display Symptom Contents 1-10



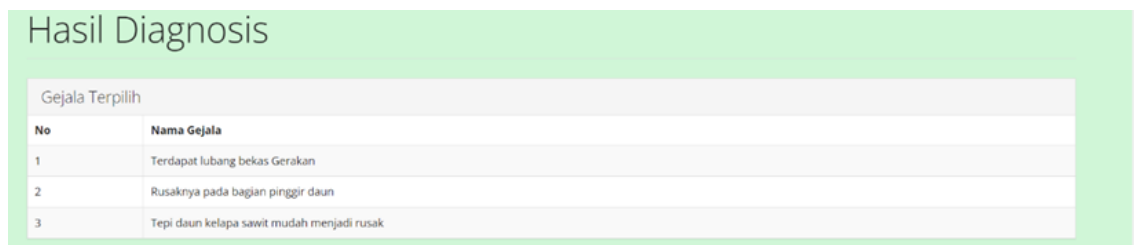
<input type="checkbox"/>	11	Terdapat bercak kotoran dari hama tersebut
<input checked="" type="checkbox"/>	12	Tepi daun kelapa sawit mudah menjadi rusak
<input type="checkbox"/>	13	Robeknya bagian tepian helai dengan ukuran yang cukup besar
<input type="checkbox"/>	14	Bibit menjadi layu pucuknya
<input type="checkbox"/>	15	batang terlihat Lorong anai-anai yang terbuat dari tanah dari bawah menuju keatas

Submit Diagnosis

Figure 13. Display Menu Contents Symptoms 11-15

Diagnostic Results Page Menu

After filling in the identity and symptoms of the pest, the user clicks on the submit diagnosis menu in the bottom left corner. Next, the system will process the data and produce a percentage of possible values. The following is a display of the diagnosis results page.



Hasil Diagnosis

Gejala Terpilih

No	Nama Gejala
1	Terdapat lubang bekas Gerakan
2	Rusaknya pada bagian pinggir daun
3	Tepi daun kelapa sawit mudah menjadi rusak

Figure 14. Selected Symptom Menu Displays



Figure 15. Diagnostic Results Menu Display

Administrator Page

This page is a page that can only be accessed by an admin. To access this page, the admin is asked to log in by entering the existing username and password. The following is the admin page for the expert system application that was built:

Administrator Login Page Display

The administrator menu page will display all the menus on the system as in Figure 16 below.



Figure 16. Administrator Login Display

Dashboard Page View

After successfully logging in, the admin will then be directed to the dashboard page. On this page, the admin can see existing data collections such as pest data, symptom data, Certainty Factor value data, consultation data and the password change data menu (Furqan et al., 2023). Apart from that, the dashboard page can also display all the summary results of the diagnosis that has been carried out by the user.

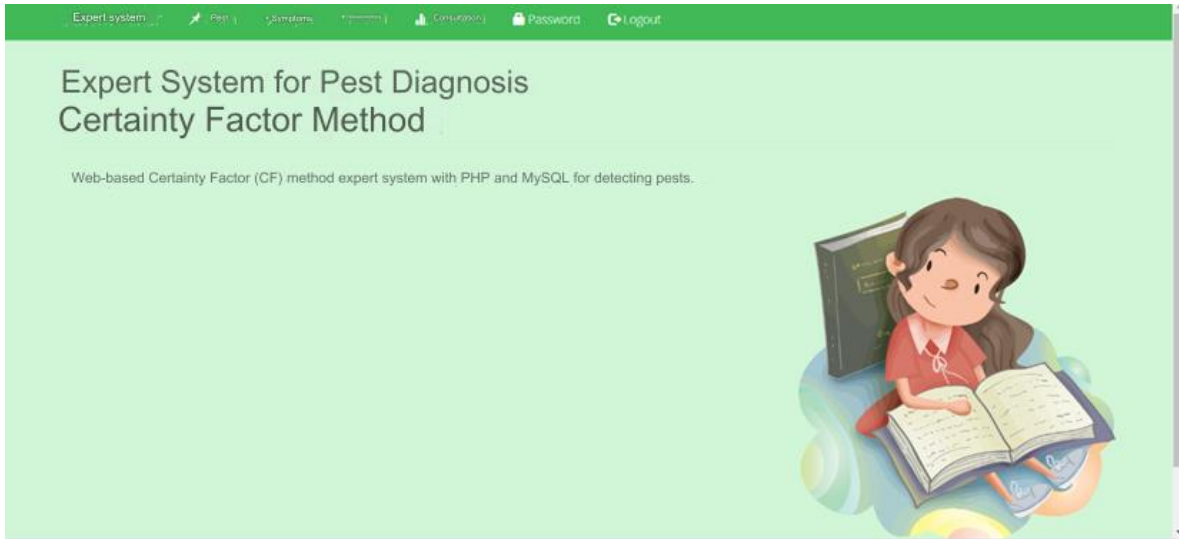


Figure 17. Dashboard Page Views

Pest Page Views

On the pest page, users can add or remove pests. The following is a display of the page that has been built.

Kode	Nama Hama	Keterangan	Aksi
H001	Kumbang Tanduk	(Orytes Rhinoceros)	[Edit] [Delete]
H002	Kumbang Sagu	(Rhynchophorus Ferrugineus)	[Edit] [Delete]
H003	Kumbang Malam	(Adoretus Compresussus)	[Edit] [Delete]
H004	Belalang Kayu	(Valanga Nigricornis)	[Edit] [Delete]
H005	Kutu Perisai	(Aulacaspis Tegelensis)	[Edit] [Delete]

Figure 18. Pest Page Views 1-5

H006	Ulat Api	(Setothosea Asigna)	[Edit] [Delete]
H007	Ulat Grayak	(Spodoptera Litura)	[Edit] [Delete]
H008	Kumbang Debu Emas	(Hypomeces Squamosus)	[Edit] [Delete]
H009	Anai anai Randau	(Coptotermes Curvignatus)	[Edit] [Delete]

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Figure 19. Pest Page View 6-9

Symptom Page View

On the symptoms page, users can add or remove symptoms. The following is a display of the page that has been built.

Sistem Pakar Hama Gejala Relasi Konsultasi Password Logout

Daftar Gejala

Pencarian... Refresh + Tambah Gejala































Kode	Nama Gejala	Keterangan	Aksi
G001	Tampak Guntingan atau potongan pada daun yang baru terbuka seperti huruf "v"	-	 
G002	Terdapat lubang bekas Gerakan	-	 
G003	Terdapat kotoran berwarna merah kecoklatan bagian pangkal	-	 
G004	Bagian daun akan terlihat berlubang-lubang	-	 
G005	Rusaknya pada bagian pinggir daun	-	 
G006	Rusak seluruh pelepah jika yang menyerang dalam skala kelompok	-	 
G007	Pada tahap awal dapat di tandai dengan Daun yang berwarna kuning	-	 

Figure 20. Page Views Symptoms 1-7

G008	Daun kering dan mati	-	 
G009	Daun seperti lidi	-	 
G010	Menyerang kulit ari daun sehingga daun menjadi berlubang	-	 
G011	Terdapat bercak kotoran dari hama tersebut	-	 
G012	Tepi daun kelapa sawit mudah menjadi rusak	-	 
G013	Robeknya bagian tepian helai dengan ukuran yang cukup besar	-	 
G014	Bibit menjadi layu pucuknya	-	 
G015	batang terlihat Lorong anai-anai yang terbuat dari tanah dari bawah menuju keatas	-	 

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Figure 21. Symptom Page Display 8-15

Certainty Factor Value Data Page Display

On the certainty factor value data page, users can add or delete certainty factor value data. The following is a display of the page that has been built.

Sistem Pakar Hama Gejala Relasi Konsultasi Password Logout

Data Relasi

Pencarian... Refresh + AddNew Relasi















No	Hama	Gejala	MB	MD	Aksi
1	[H001] Kumbang Tanduk	[G001] Tampak Guntingan atau potongan pada daun yang baru terbuka seperti huruf "v"	1	0.2	 
2	[H002] Kumbang Sagu	[G002] Terdapat lubang bekas Gerakan	0.6	0.2	 
3	[H002] Kumbang Sagu	[G003] Terdapat kotoran berwarna merah kecoklatan bagian pangkal	0.8	0.1	 
4	[H003] Kumbang Malam	[G004] Bagian daun akan terlihat berlubang-lubang	0.8	0.1	 
5	[H004] Belalang Kayu	[G005] Rusaknya pada bagian pinggir daun	1	0.2	 
6	[H004] Belalang Kayu	[G006] Rusak seluruh pelepah jika yang menyerang dalam skala kelompok	1	0	 
7	[H005] Kutu Perisai	[G007] Pada tahap awal dapat di tandai dengan Daun yang berwarna kuning	0.8	0.2	 

Figure 22. Data Page Display for Certainty Factor Values 1-7

8	[H005] Kutu Perisai	[G008] Daun kering dan mati	1	0.1	 
9	[H006] Ulat Api	[G009] Daun seperti lidi	1	0.1	 
10	[H007] Ulat Grayak	[G010] Menyerang kulit ari daun sehingga daun menjadi berlubang	0.8	0.2	 
11	[H007] Ulat Grayak	[G011] Terdapat bercak kotoran dari hama tersebut	0.8	0.2	 
12	[H008] Kumbang Debu Emas	[G012] Tepi daun kelapa sawit mudah menjadi rusak	0.6	0.1	 
13	[H008] Kumbang Debu Emas	[G013] Robeknya bagian tepian helai dengan ukuran yang cukup besar	1	0.3	 
14	[H009] Anai anai Randau	[G014] Bibit menjadi layu pucuknya	0.8	0.2	 
15	[H009] Anai anai Randau	[G015] batang terlihat Lorong anai-anai yang terbuat dari tanah dari bawah menuju keatas	1	0.1	 

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Figure 23. Data Page Display for Certainty Factor Values 8-15

Password Page Display

On this page, users can change the desired username and password which will be used to log in to the administrator page. The following is a display of the page that has been built.

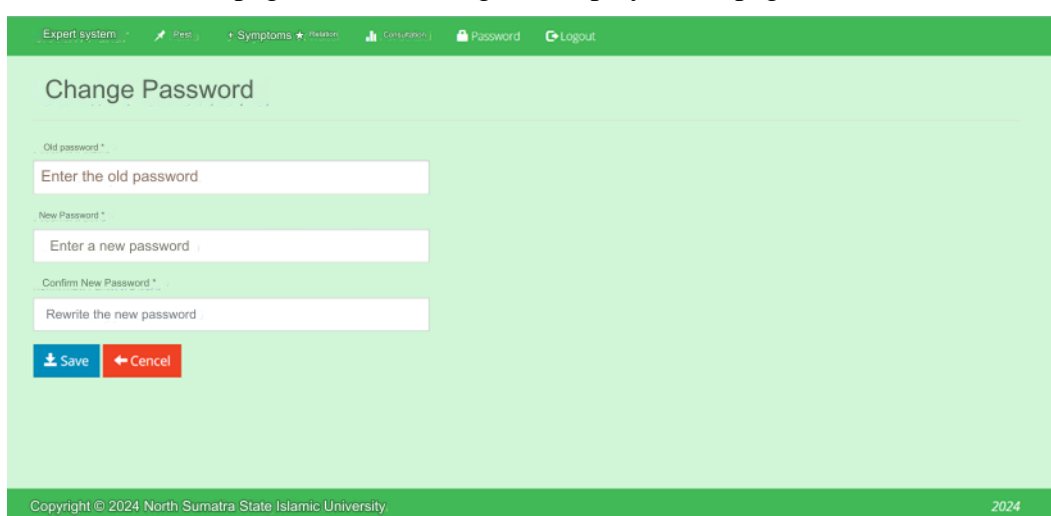


Figure 24. Password Page Displays

Conclusion

The test results also show that the expert system interface is easy for users to use. Farmers or oil palm plantation managers can easily access the system, enter symptoms observed in plants, and obtain accurate diagnosis results. With this expert system, oil palm plantation management can be improved significantly. Early detection of pest attacks will reduce the losses incurred and allow more effective preventive measures to be taken. The application that has been designed has a fairly good page display so that it makes it easy for users to carry out diagnoses.

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