The Utilization of Expert System for Diagnosing Diseases Cocoa Plants Based on Android Using the Forward Chaining Method

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Abstract— Cacao plants originated from South America, then spread to North America, Africa and Asia. In Indonesia, cocoa has been known since 1560, but has become an important commodity since 1951. Cacao commodity plays an important role in the national economy and is a national mainstay commodity. This shows that cocoa is one of the results of plantation commodities that have a high economic value and play an important role as a source of foreign exchange through exports, as well as encouraging the regional economy, especially in rural areas. But behind the high value of cocoa production, there are problems faced, including the low quality of cocoa in Indonesia because cocoa plantations in Indonesia are threatened by pests and plant diseases. Lack of information that is known by the plantation and cocoa farmers about the types of diseases that attack cocoa plants, causing many cocoa plants that are not handled properly. If this is allowed to continue it will impact on the declining quality and production of cocoa plants. Current advances in information technology, especially cellular phones, can be used as a means to improve public services, one of the results of the development of cellular technology is the birth of cellular phones with the android operating system. In this research produced if the symptoms data entered could not find the type of cocoa plant disease because the input data did not match any disease data in the database, the system would display the word "Can not find the disease you are looking for because it is not related to fruit rot disease, stem cancer, vascular antraknosem, streak dieback, upas fungus and root fungus ". From the data of symptoms, diseases and relations above, the algorithm is depicted using a decision tree. Decision tree is a picture of tracking symptoms, determining the disease and concluding results in the form of a solution. In this application, using the Forward Chaining method so that tracking begins with the selection of symptoms experienced then the results of the diagnosis in the form of cocoa plant diseases.

Keywords— Expert System, Diagnosis, Cocoa Plant Disease, Android, Forward Chaining Method

I. INTRODUCTION

At this time there is a development rapid in the field of science and technology, especially computer and communication technology or often referred to as the information age and communication technology (ICT). If in the beginning the computer was only used as a calculator, now the computer has been able to replace the role or complex tasks performed by humans, even being able to imitate human biological processes in decision making called artificial intelligence (Listiyono, 2008).

Cocoa is the third most important commodity after rubber and palm oil, cocoa is one of the main sources of income for farmers in 31 provinces with the involvement of farmers totaling 1,539,401 heads

of household. Increasing cocoa production in Indonesia is very rapid. In 1967 new production was 1,233 tons, in 2003 it reached 698,816 tons and in 2010 it reached 837,918 tons cultivated by smallholder plantations (94.19%) with cocoa plant area reaching 1,650,621 Ha (Direktorat Jenderal Perkebunan, 2011).

Quality improvements and yields to support increased production and development of cocoa in Indonesia can be undertaken by using superior cocoa plant technology, information on land suitability for cocoa, plant propagation technology, pest and disease control major technologies, cloning technology, product processing technology, and technology cocoa industry development (Rubiyo & Siswanto, 2012).

Identifying the plant disease is not easy task, it needs experience and knowledge of plants and their diseases. Moreover, it requires accuracy in describing the symptoms of plant disesases. A person can depend on a system that posses experience and knowledge (expert systems) to enable him/or her identifying any type of disease. The methods that expert system uses differ from one system to another because that depends on the user's primary knowledge of the case. Decision making depends mainly on the way of receiving that knowledge (Abu-Naser, Kashkash, & Fayyad, 2008).

Current technological developments have shown a lot of progress and provide benefits in various aspects of life, the use of technology is very helpful in various agencies such as government and private institutions, education in fulfilling the need to complete work. One of the technological developments that can be done is an expert system. Expert systems designed by utilizing information technology can assist in presenting accurate information. In addition, this technology has touched almost all mobile technology circles can be easily obtained. This is what underlies the need for an application regarding the disease diagnosis system in addition to overcoming obstacles and limitations in the world of health above. So that it is expected that this application can improve the performance of health services, and can reduce the emergence of hazards caused by symptoms of the disease because it can be detected more quickly (Tambunan, Siringoringo, Aruan, Aisyah, & Sitanggang, 2019).

In this case an important role of an expert is very relied upon to diagnose and determine the type of disease and provide examples of ways to overcome them to get the best solution. If there is a new disease found, an expert must conduct research to obtain information from the new disease and immediately provide information to farmers or farmer groups about the disease and how to overcome it (Koten, 2014).

Expert systems can help the activities of experts as experienced assistants and have the required knowledge. In its preparation, the expert system combines inference rules with certain knowledge bases provided by one or more experts in a particular field. The combination of these two things is stored in a computer, which is then used in the decision making process for solving certain problems (Arifin, Slamin, & Retnani, 2017).

Today's technology has experienced very high progress, especially on smartphones today. The latest breakthrough in smartphones is marked by the emergence of an operating system, namely android (Sugiharja, Pahlevi, & Widyastuti, 2019). This can be supported by advances in existing information technology, especially mobile phones, can be used as a means to improve public services, one of the results of the development of cellular technology is the birth of cellular phones with the Android operating system. Android has various advantages as software that uses a computer code base that can be distributed openly (open source) so that users can create new applications in it. Therefore Android has a large community for application developers who expand functionality with the Android system (Kurniawan, 2015).

Android is an operating system for smartphones developed by Google. Android is opensource, so many android developers develop applications such as games, multimedia, file explorer, GPS, etc. including one of them in the development of expert systems (Susanti & Suhendri, 2017).

This research is related to previous research conducted by (Ariandi, Kurnia, Heriyanto, & Marry, 2019) with the title Expert System For Disease Diagnosis In Cocoa Plant Using Android-Based Forward Chaining Method. This research discusses about various types of pests and diseases that attack cocoa plants can cause losses especially for cocoa farmers. Identification of pests and diseases of cocoa plants must be done quickly and accurately, because these pests and diseases can quickly spread and attack cocoa plants in all plantation areas. The expert system of identifying cocoa pests and diseases with the forward chaining method is developed based on android or mobile that can be freely accessed by cocoa farmers or other users and is expected to help cocoa farmers in identifying and providing solutions to cacao pests and diseases so as to minimize losses which will be caused.

Then research conducted by (David Liauw, 2014) with the title Application of Forward Chaining in Expert Systems to Diagnose Corn Pests and Diseases. In the study explained that the expert system in general is a system that seeks to adopt human knowledge to the computer, so that computers can solve problems as is usually done by experts. Expert

systems can collect and store the knowledge of an expert or several experts in a computer. Expert system software can help the work of an expert and can be used by farmers, laypeople to meet information about pests and diseases and as additional information for farmers who are just starting to grow corn but still lack knowledge about corn plants in this study create an expert system that using forward chaining method inference engine.

Next in the research conducted by (Qisty, 2018) with the research title Expert System for Identifying Pests and Diseases of Android-Based Cocoa Plants Using Forward Chaining and Certainty Factor Methods. In this study an expert system was built using the Forward Chaining inference method and the Certainty Factor calculation method. This expert system is made for Android device users. This study consisted of 70 symptom data, 6 pest data, 9 disease data, and 24 rules. When consulting, the user can answer Yes or No from the questions given by the system. User answers are then processed according to rules and are calculated using the certainty factor method. Testing is done to see whether the system can run well as expected. Testing consists of 3 aspects, namely system compatibility, the ability of the system to identify pests and diseases, and the benefits of the system according to targeted users. Based on these 3 tests, the cocoa expert system that has been developed has compatibility with the Android version of KitKat and Lollipop.

The algorithmic method used in this study is the same as the research conducted by (Hawa, Abdullah, & Usman, 2015) with the research title Expert System for Disease Diagnosis in Cocoa Plants Using the Forward Chaining Method (Case Study of the Indragiri Hilir Plantation Office). In this study describes a system that can provide information on several types and characteristics of diseases that interfere with cocoa. So that it can make it easy for farmers / users to find out how to diagnose diseases in cocoa plants. Of course this is expected to indirectly facilitate the diagnosis of farmers or users. In developing this system using the Forward Chaining method. From the results of the study it can be concluded that with the Expert System for Diagnosing Diseases of the Cocoa Plant, the Farmers can find out the disease that there are cocoa plants and the Farmers get a way to diagnose diseases in the cocoa plant.

After reviewing these studies, researcher made a study of expert systems for diagnosing diseases in the Android-based cocoa plant by using the Forward Chaining method. This application contains the introduction of the application and explanation of diseases and pests in cocoa plants. Disease in cocoa plants, how the application works and the features that are in the application.

II. LITERATURE REVIEW

A. Expert System

According to Durkin (1994) in (Sumpala & Rasyid, 2019) defines expert system is one part of artificial intelligence which has experienced rapid development. In general, expert systems are systems that try to adopt human knowledge to computers, so that computers can solve problems like experts. Expert system is a computer program designed to model the ability to solve problems carried out by an expert.

B. Cocoa Plants

According to (Layli, 2015) concluded that Cocoa (Theobroma cacao L.) is one of the mainstay commodity estates that has an important role for the national economy, especially as a provider of employment, a source of income, and the country's foreign exchange.

C. Android

According to (Yosef, 2014) explained that Android is a Linux-based operating system that is used for cellular (mobile) phones such as shortcuts (smartphones) and tablet computers (PDAs).

D. Forward Chaining Method

According to (Akil, 2017) The forward-chaining algorithm is one of the two main methods of reasoning when using an inference engine and can be logically described as a repetition application from the ponens mode (a set of valid inference rules and arguments). The opposite of forward-chaining is backward-chaining.

Then according to (Prambudi, Widodo, & Widodo, 2018) in (Rusdiansyah, Setiawan, & Badrul, 2019) an inference that connects a multiplication problem with solution called chain. A chain is sought or is bypassed or crossed from a problem to obtain the solution referred to as Forward Chaining. Another way of describing the forward chaining this is by reasoning from facts leading to the conclusion that there is from the facts. In the advanced rules of reasoning are tested one by one in a specific order. The sequence may be either a sequence of rules of incorporation into the base rules or also other sequence determined by the user. Each time a rule is tested, the expert system will evaluate whether conditions are true or false. If the condition is true, then the rule is kept then the next rule is tested. Conversely, if conditions are wrong, it is not stored and the next rule is tested. This process would be repeated until the entire base of the rules tested with a variety of conditions. Advanced reasoning work with problems that started with the recording of the initial information and the final settlement to be

achieved, then the whole process will be done sequentially.

III.   PROPOSED METHOD

3.1.   Object Research

This research was conducted by collecting data through the results of data that have been collected through official data available on the page https://www.bps.go.id/

3.2.   Systems Analysis and Design

The design process in this research includes the design of the main systems and algorithms that will be used in software performance. The knowledge representation process is based on the rules that have been obtained. Then translated into a decision table. The data obtained is used to form a decision tree. The symptoms of cocoa plant disease in this study were brownish black spots, cocoa fruit felt soft and wet when touched by a finger, skin of the bark was slightly curved, often there was a reddish liquid, red inner layer, brown spots on leaf bones, on the stem will appear black binntik in the form of fungus thorns, young Leaves Will Show Symptoms of Spots, brown Necrosis, young fruit becomes wilted, dry, and wrinkled, essence of the second or third leaf from the point of growing yellow with spots green patches, deciduous leaves so that there are symptoms of toothless twigs, the presence of thin threads of fungus such as silk on twigs, similar to spider nests, there is a pink fungus crust, many leaves that remain attached to the twigs even though it is dry, leaves turn yellow withered and fall off, bald branches. The process of gathering facts starts when the user enters the consultation page which will display consultation questions regarding the details of the disease. In this menu the user can choose the answer yes or no to the consultation question. After the user chooses, the consultation answer will be processed.
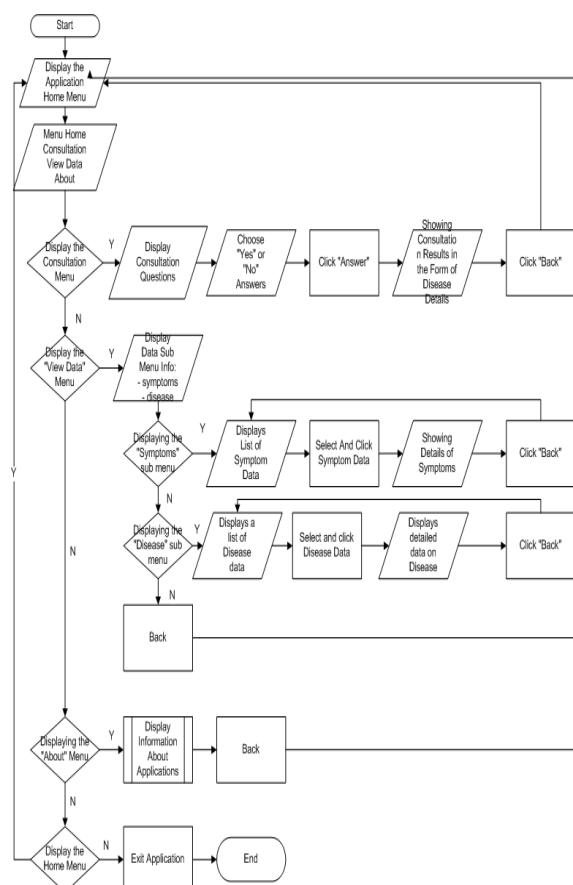

Figure 1   Application Flowchart

3.3.   Implementation

The expert system for diagnosing cocoa diseases is implemented in the form of an android-based software. The system was developed using the forward chaining method by collecting symptom data from users to find disease conclusions.

The main view of the system consists of user pages and administrator pages. The main display for the user consists of the main diagnosis features pages and some additional features. The main view for administrators consists of pages to update knowledge in the system.

Figure 2   Home Page Display

Figure 5   Display of Consultation Results

Figure 3   Menu Display
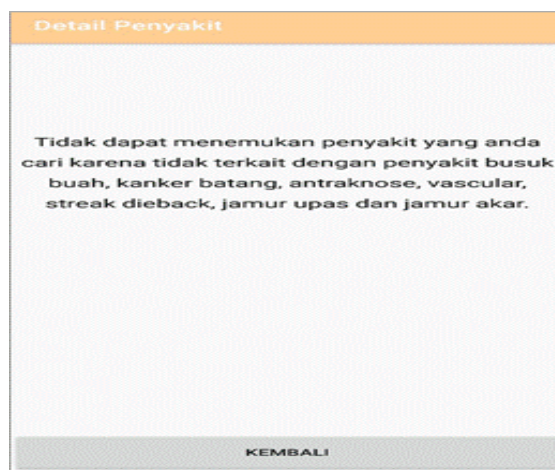

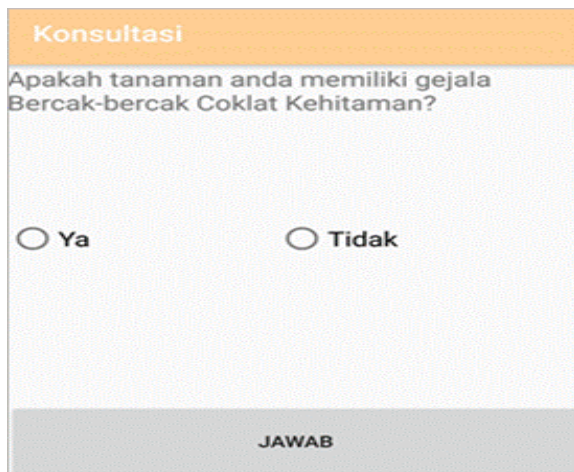Figure 6   Display Consultation Results If Not Found
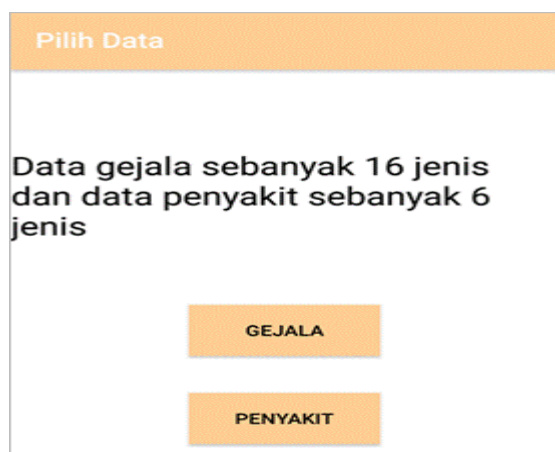

Figure 4   Consultation Page Views

Figure 7   Display of View Menu

Figure 8   Display Symptom List

Figure 11   Disease Detailed Data Display

IV.   RESULT AND DISCUSSION

In designing this application, researcher used the Forward Chaining algorithm. Where Forward Chaining is a search method or tracking technique that starts with information that is merging rules to produce a conclusion or goal. This forward tracking is very good if it works with problems that start with recording the initial information and want to achieve a final solution, because the whole process will be done sequentially going forward.

The following table is a disease in cocoa plants and their symptoms and their relationships that are used as a comparison in designing applications in research:

TABLE 1 Cocoa Plant Disease

Disease Code	Remarks
P001	Fruit Rot Disease
P002	Stem Cancer
P003	Antraknose Disease
P004	Vascular Streak Dieback Disease
P005	Upas Fungus Disease
P006	Root Fungus Disease

TABLE 2 Symptoms of Cocoa Plant Disease

Disease Code	Remarks
G001	Blackish Brown spots
G002	Cocoa fruit feels soft and wet if touched by a finger
G003	Curved Bark

Figure 9   Display Detailed Data Symptoms

Figure 10   Disease List Display

G004	Often there is a reddish liquid
G005	Red Inner Layer
G006	Brown spots on the leaf bone
G007	Black stems appear on the stems in the form of mushroom spines
G008	Young Leaves Will Show Symptoms of Brown-colored Necrosis Spots
G009	Young fruit withers, dries, and wrinkles
G010	The second or third leaf extract from the spot grows yellow with green patches
G011	The leaves fall so that the symptoms appear toothless twigs
G012	The presence of thin threads of silk like fungus on a branch, similar to a cobweb
G013	There is a pink mushroom crust
G014	Many leaves remain attached to the branches even though they are dry
G015	The leaves turn wilted and fall
G016	Bare branches

TABLE 3 Relationship Rules

Relationship	IF (Disease Code)	THEN (Code)
1	G001,G002	P001
2	G003,G004,G005	P002
3	G006,G007,G008,G009	P003
4	G010,G011	P004
5	G012,G013,G014	P005
6	G015,G016	P006

If the entered symptom data cannot find the type of cocoa plant disease because the data input does not match any disease data in the database, the system will display the word "Cannot find the disease you are looking for because it is not related to fruit rot disease, stem cancer, anthraxemic vascular, streak dieback, upas fungus and root fungus. From the data of symptoms, diseases and relations above, the algorithm is depicted using a decision tree. The decision tree is a picture tracking the symptoms, determining the disease and concluding the results in the form of a solution. In this application, using the Forward Chaining method so that tracking begins with the selection of symptoms experienced then the results of the diagnosis in the form of types. Here is a decision tree diagram on the application in this research:
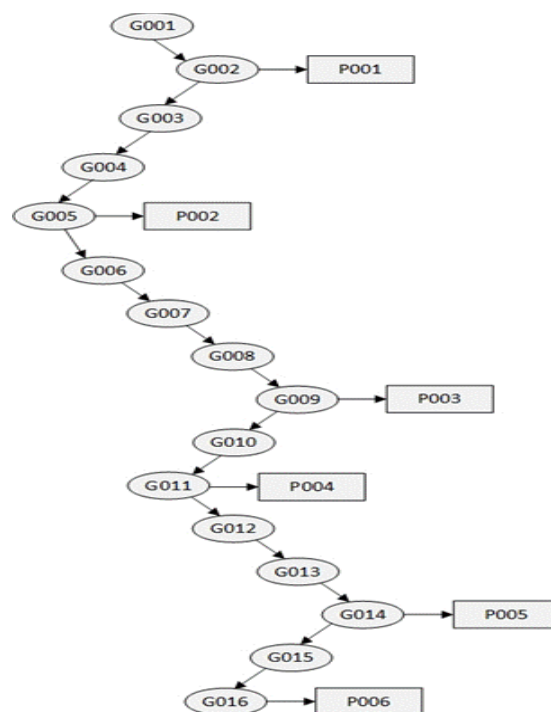

Figure 12   Decision Tree Diagram

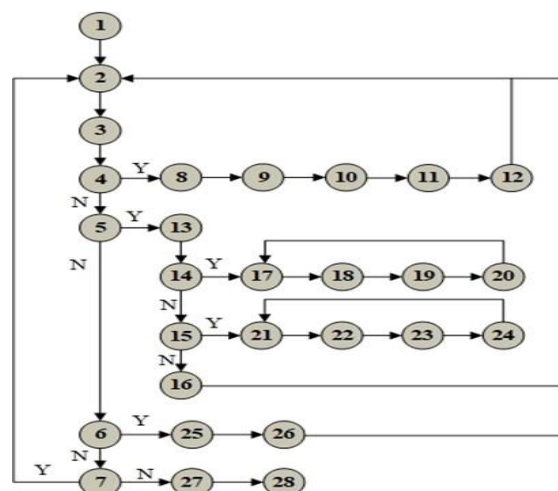This research uses cyclomatic white box testing.

Figure 13 Cyclomatic White Box Testing

To provide a quantitative measurement of the logical complex of the program the writer uses cyclomatic complexity to guarantee that the number of trials done is at least once done. The cyclomatic complexity of the white box flow diagram can be obtained by calculation : $V(G) = E - N + 2$.

Where :

E = The number of edges specified by the arrow image

N = The number of node flowcharts is determined by drawing a circle

So the results obtained are $V(G) = 33 - 28 + 2 = 7$.

Based on the above calculation, the number of independent lines is 7. Below this is an independent path that results from cyclomatic complexity:

1. 1-2-3-4-8-9-10-11-12-2
2. 1-2-3-4-5-13-14-17-18-19-20-17
3. 1-2-3-4-5-13-14-15-21-22-23-24-21
4. 1-2-3-4-5-13-14-15-16-2
5. 1-2-3-4-5-6-25-26-2
6. 1-2-3-4-5-6-7-2
7. 1-2-3-4-5-6-7-27-28

V. CONCLUSION AND SUGGESTION

5.1. Conclusion

Based on the design and implementation of an application diagnosing android-based cocoa plant diseases using the forward chaining algorithm method in the previous chapters, the conclusion can be drawn:

1. This application can help provide information about diseases that attack cocoa plants and provide controls to deal with these diseases.
2. This application is designed using the forward chaining algorithm method in addition to diagnosing cocoa plants, it also aims to find out the symptoms of diseases in cocoa plants.
3. With this application many cocoa plants can be saved and improve the quality of cocoa plants.
4. Adding insight for cocoa farmers to the development of science and technology.

5.2. Suggestion

For further development of this research, suggestions can be given as follows:

1. Add more data on types of diseases in cocoa plants.
2. Display more pictures in each symptom question.
3. Add clearer and more detailed information about cocoa plants.
4. Applications can later be developed on platforms other than Android, such as iOS and Windows Phone.

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