**Expert System Insemination**

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**Abstract.** Insemination is a method used as a program by injecting sperm directly into the cervix so fertilization can occur. According to world health, the success rate of this program ranges from 20-30%, allowing several couples to choose this alternative. The process of applying artificial insemination requires the right pregnancy results, which require proper identification. System identification technology can be done quickly to assist in the identification of fertility that must be performed by an obstetrician. System development in this research is an expert system to determine the success of insemination programs for pregnancy. This system makes it easier for couples to consult and provide information to couples about insemination activities based on their partner's condition. This expert system is made with a Hybrid method, where reading data from this method is done by forward chaining and certainty factors. The forward chaining method aims to read the cycle of couples who will carry out insemination and certainty factors, namely the method used to determine the level of success in the pregnancy program that will be obtained by the couple.

1. **INTRODUCTION**

Pregnancy is a physiological phenomenon that begins with conception and ends with labor. As long as it the mother and fetus are integral units of function. Even though it can be seen that the condition of a healthy pregnancy does not mean that the mother and fetus are in good condition. However, the lack of information or outreach on pregnancy diseases will cause them to find out about the disease that accompanies pregnancy after an advanced stage. There are many ways that couples do to get pregnant, one of which is an insemination program[1]

Insemination is an assisted return technology procedure to overcome infertility problems[2]. Some couples want to do it is program, but are constrained by the agreement accepted or canceled them to use the program. This Expert System is one of the solutions given to couples to provide knowledge about information that states that the couples are eligible for the insemination program. This program is given to the people of the cloud who cannot be accepted by the medical staff at all and must do an insemination program to get offspring. This system uses the hybrid method in reading the data, namely coupling the method of forward chaining with certainty factors on the grounds that patients can receive information about reporting on the insemination carried out.

Insemination is an assisted reproductive technology procedure to overcome infertility problems [2]. Many of the married couples want to do the program, but are constrained by the possibility of being accepted or rejected by them to use the program. This expert system is one of the solutions given to couples to provide knowledge in the form of information that is feasible and whether or not the couples do the insemination program. This program is given to the cloud community who do not understand the medical at all and want to do an insemination program to get offspring. This system uses the hybrid method in reading the data, which is to join the forward chaining method with
certainty factor on the grounds that patients can receive information on the percentage of possible insemination done.

2. THEORETICAL BASIS

Expert system is a system that adapts one's expertise to a system based on knowleagebase[3]

3. STRUCTURE OF EXPERT SYSTEM

The expert system consists of two main parts, namely: development environment and consultation environment. It is used as an expert system builder both in terms of building components and knowledge bases. The consultation environment is used by someone who is not an expert to consult [4]

![Figure 1. Structure Of expert system](image)

Knowledge-based computer expert systems are computer programs that have knowledge originating from knowledgeable people (experts) in a particular domain, where knowledge here is human knowledge which is very minimal in its spread, expensive and difficult to obtain.

Although it is can solve problems in a limited domain based on the knowledge entered into it, but the expert system cannot solve that cannot be solved by humans. Therefore the reliability of the expert system lies in the knowledge entered into it.

The Conditions of expert systems can help humans solve their problems, including:

1. The need for many experts (experts), but the available experts are very limited in number.
2. Excessive use of experts in making decisions, even in a routine task.
3. Critical considerations must be taken in a short time to avoid undesirable things.
4. Optimal results, such as in digestion or configuration.
5. A large amount of data that experts must examine continuously.

3.1 Inference Engine

An inference engine is the brain of an expert system, this part contains the mechanism of function thinking and patterns of system reasoning used by an expert. This mechanism will analyze a particular problem and then find the best answer or conclusion. From the facts obtained during the question and answer process with the user, as well as the rules stored in the knowledge base, the inference engine can draw a conclusion and provide recommendations or suggestions expected by the user. Some approaches in compiling the inference engine are as follows:
3.2 Forward Chaining

Forward Chaining is a search technique that starts with a known fact, then matches these facts with the IF part of the IF rules –THEN. If there are facts that match the IF section, then the rule is executed. If a rule is executed, a new fact is added to the database. Steps in creating an expert system using the forward chaining method, namely:

a. The definition of the problem begins with the selection of the problem domain and knowledge acquisition.
b. Defining input data to initiate inference because it is required by the forward chaining system.
c. Defining the data control structure to help control the activation of a rule.
d. Writing the initial code in the knowledge domain.
e. System testing in order to know the extent of the system running.
f. Designing the interface with a knowledge base.
g. System development.

3.3 Certainty Factor

The certainty factor method is used when dealing with a problem whose answer is uncertain. This uncertainty can be a probability. This method was introduced by Shortlife Buchanan in the 1970s. The development team of this method noted that, doctors often analyze existing information with expressions such as "maybe", "almost certain". Certainty factor shows a measure of certainty about a fact or rule.

\[ CF[h, e] = MB[h, e] - MD[h, e] \] (1)

Information:
- \( CF[h, e] \) = certainty factor
- \( MB\ [h, e] \) = Measure of belief, measure of trust or level of confidence in the hypothesis (h), if given evidence (e) between 0 and 1.
- \( MD\ [h, e] \) = Measure of disbelief, measure of distrust or level of confidence in the hypothesis (h), if given evidence (e) between 0 and 1. As for some combinations of certainty factor on a certain premise:
  1. Certainty factor with one premise
     \[ CF\ [h, e] = CF\ [e] * CF\ [rule] = CF\ [user] * CF\ [expert] \] (2)
  2. Certainty factor with more than one premise
CF [A \land B] = \text{Min} (CF [a], CF [b]) \times CF \text{[rule]} \ldots (3)

\[
CF [A \lor B] = \text{Max} (CF [a], CF [b]) \times CF \text{[rule]} \ldots (4)
\]

3. Certainty factor with similar conclusions

Combined CF [CF1, CF2] = CF1 + CF2 \times (1 - CF1) \ldots (5)

The advantages of this method are suitable for use in expert systems that measure something that is certain or uncertain such as diagnosing a disease and the calculation of this method only applies to one count, and can only process two data so that accuracy is maintained.

4. METHODOLOGY RESEARCH

Data collection methods, system development methods, and rule design are used in this expert system integration model research. The method used in collecting data is interviews and literature studies. The system development method uses the waterfall model to map basic development activities as shown in the following figure:

![Figure 3. Research Framework](image)

5. ANALYSIS AND DISCUSSION

5.1 Analysis

The application of the Forward Chaining and Certainty Factor method requires several variables, namely the weight of the value given by the user and the expert on each symptom, the scale of the given value is between 0-1, the rule of the symptoms that shows the disorder.

5.2 Knowledge Acquisition

Based on expert assumptions and the application of certainty factor, the range to give a weighted value is 0-1, as well as the value of confidence that can be given by the user. The following are fertility symptoms along with the weight values of experts who determine the decision on the insemination to be followed choose.

| Code | Symptoms                                     | Expert Value |
|------|----------------------------------------------|--------------|
| G001 | The Fallopian tube is clogge up               | 0.9          |
| G002 | Women with ovarian failure (monopose)         | 0.8          |
| G003 | Women with low ovarian reserves              | 0.5          |
| G004 | Decreasing the number of facial hair         | 0.3          |
| G005 | Low sperm count                              | 0.3          |
| G006 | sperm cannot travel too far                   | 0.5          |
| G007 | Ejaculation or erectile disorders            | 0.6          |
| G008 | Hormone abnormalities in women that cause menstruation are not intense | 0.4 |
The presence of endometriosis or other abnormalities in the female reproductive organs

Cervical mucus abnormalities that refuse and prevent sperm from entering the uterus

Women experience sperm allergy

Sexual barriers, physical disabilities or psychological problems such as severe pain during sexual intercourse

The difficulty of pregnancy without reason for obvious infertility

Difficult to achieve ejaculation

Low sperm fluid volume

Lack of desire to have sex

Pain, swelling or lumps around the testicles

Recurrent respiratory infections

Imperfection to smell

| Code | Types of insemination                      |
|------|-------------------------------------------|
| P1   | Intracervical insemination (ICI)          |
| P2   | Intrauterine insemination (IUI)           |
| P3   | Intratubal Insemination (ITI)             |
| P4   | Intravaginal insemination (IVI)           |
| P5   | Intrafollicular insemination              |

| No | Rule                                                                 |
|----|----------------------------------------------------------------------|
| 1  | IF G001 AND G002 AND G003 AND G007 THEN P2                          |
| 2  | IF G003 AND G006 AND G007 THEN P1                                     |
| 3  | IF G006 AND G008 AND G009 AND G012 THEN P5                           |
| 4  | IF G012 AND G013 AND G015 AND G016 THEN P2                           |
|    | Dst                                                                    |

| No | Description | Value |
|----|-------------|-------|
| 1  | Not         | 0     |
| 2  | Do Not Know | 0.2   |
| 3  | A Little Sure| 0.4   |
| 4  | Enough Sure | 0.6   |
| 5  | Sure        | 0.8   |
| 6  | Very Sure   | 1     |
6. DISCUSSION

The steps used by the Certainty Factor method in processing symptoms are based on the provisions of insemination by using the forward chaining method of the process of certainty factor analysis for single premise / symptom rules. The basic formula is used if there is no CF value for each symptom that gives a diagnosis. To get the CF value, the user can choose from 18 symptoms that exist and member the value of the weight according to the symptoms experienced by the user. Then the weight of the value given by the user will be multiplied by the weight of the value given by the expert.

Example of obtaining CF values by using rule table, user weight value and expert weight value:

Table 5. Table Rule

| No | Rule |
|----|------|
| 1  | IF G001 AND G002 AND G003 AND G007 THEN P2 |

Table 6. User Value

| Kode | Symptoms | Value |
|------|----------|-------|
| G001 | The Falopian tube is clogge up | 0.9   |
| G002 | Women with ovarian failure (monopouse) | 0.6   |
| G007 | Ejaculation or erectile disorders | 0.5   |

Table 7. Expert Value

| Kode | Symptoms | Nilai Bobot |
|------|----------|-------------|
| G001 | The Falopian tube is clogge up | 0.7         |
| G002 | Women with ovarian failure (monopouse) | 0.8     |
| G007 | Ejaculation or erectile disorders | 0.6      |

\[
\text{CF sympotms1} = \text{CF(user)} \times \text{CF(expert)} = 0.9 \times 0.7 = 0.63
\]

\[
\text{CF sympotms2} = \text{CF(user)} \times \text{CF(expert)} = 0.6 \times 0.8 = 0.48
\]

\[
\text{CF sympotms3} = \text{CF(user)} \times \text{CF(expert)} = 0.5 \times 0.6 = 0.30
\]

Because there are more than one symptom, then to determine CF then the following equation is used:

\[
\text{CFcombine1(CFsyptoms1, CFsyptoms2)} = \text{CFgejala1} + \text{CFgejala2} \times (1 - \text{CFgejala1})
\]

\[
= 0.63 + 0.48 \times (1 - 0.63) \times \text{CFold1}
\]

\[
= 0.8076
\]

\[
\text{CFcombine2(CFold1, CFsymptoms3)} = \text{CFold1} + \text{CFgejala3} \times (1 - \text{CFold1})
\]

\[
= 0.8076 + 0.30 \times (1 - 0.8076) \times \text{CFold2}
\]

\[
= 0.86532
\]

Information:
The last CFold is CF Diagnosis of fertility, based on the results of the CF calculation above, then CF Diagnosing fertility is 86.532%. Then calculate the percentage of confidence in insemination.

\[
\text{Percentage} = \text{CF disease} \times 100 = 0.86532 \times 100 = 86.532%
\]

Based on the results of the calculation, the description of the confidence level based on the interpretation table of the expert and the final percentage is SURE.

7. IMPLEMENTATION

After testing the method, the next step is to implement the interface. In the interface implementation, all users of the system can enter the Detection Form. To use the system optimally the user must log in first, this is so that the system users can be determined which is only for adults or couples. After logging in, the system will be directed to the following display:

![Figure 4. initial display](image)

Then the user is directed to the consultation subsystem selection for direct consultation. and the user is asked to answer every question raised by the system according to the user's condition as in the following display:

![Figure 5. Consultation](image)

If the user answers no, the system will direct to the next question in accordance with the rule. And if the user enters YES, the system will continue the question as below.
Figure 6. Consultation

After consultation in accordance with the first rule, the results will be given in accordance with the following picture:

Figure 7. Conclusion

8. CONCLUSION

Based on the previous discussion, conclusions can be drawn from research and the making of an expert system of insemination. In an effort to help couples to get offspring, this expert system application can be an alternative problem solving, including:

a. An expert system was created to help couples get information about insemination and not required to consult directly with experts.

b. Hybrid methods (Forward Chaining and Certainty Factor) can provide a diagnosis of insemination based on the symptoms given. Based on the results of calculations, the description of the confidence level based on the interpretation table of experts and the final percentage of 86.532% is sure both of these methods are applied to solve existing problems.

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