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Naïve bayes on diagnostic expert system for menstrual disorders

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ABSTRACT

Menstrual disorders often occur in women in their active reproductive period. This disorder is caused by various factors such as hormonal, ovarian, hypothalamus, and other factors. Thus, it can be stated that the causes of menstrual disorders are very broad and varied. Lack of public knowledge and awareness about women's reproductive health can have serious consequences for sufferers, such as difficulty getting pregnant, infertility, tumors, and even cancer. To be able to help people with menstrual disorders quickly and efficiently, an expert system is needed to make an initial diagnosis of menstrual disorders. In addition to helping the community, expert systems can assist experts or medical personnel in determining the initial diagnosis/anamnesis so that the evaluation of abnormal uterine bleeding can result in appropriate treatment. In this study, researchers built an expert system with the Naïve Bayes web-based method to get an initial diagnosis in the form of a percentage of possible diseases suffered by users based on the selected symptoms. By testing the system, it can be concluded that the system built by applying the Naïve Bayes method can accurately diagnose types of menstrual disorders with a percentage of 84% based on data and symptoms experienced by patients. Based on other tests, the system functions as it should, and the community considers the system acceptable, good, and proper.

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Introduction

Menstruation is the term used to describe the regular discharge of blood and mucous tissue from the lining of the uterus through the vagina in women who have reached puberty (Wiknjosastro & Prawirohardjo, 2014). The menstrual cycle is characterized by repeated and regular bleeding. This condition is the result of a complex interaction involving the hormonal system and the female organs. Several factors cause menstruation, such as the ovaries, uterus, hypothalamus, pituitary and other factors outside the reproductive organs (Critchley et al., 2020). It can be stated that the causes of menstrual disorders are many and varied. According to dr. I Putu Gde Wardhiana Sp.OG (K), a female hormone expert, said that every day women who came to his clinic quite often complained about menstrual disorders. Complaints of menstrual disorders vary from mild to severe and often cause frustration for both the sufferer and the treating doctor.

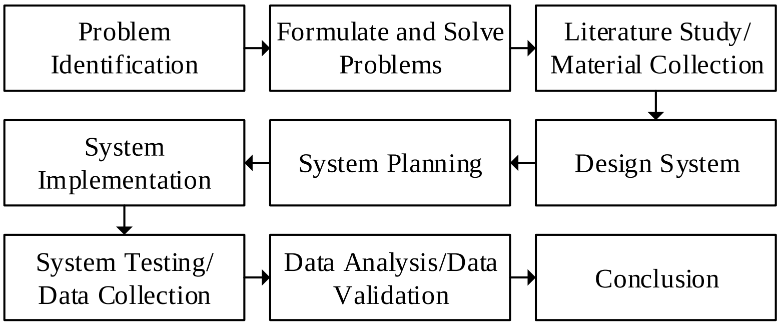
Menstrual disorders are very common in women, especially in their late teens. The prevalence of menstrual disorders worldwide is increasing with age and the busyness of women. The results of

Istika Dwi Kusumaningrum's research (2020) at the Khoirun Nisa Berbah Orphanage in Sleman, stated that 50% of the women in the orphanage experienced menstrual disorders in the first two years after menars (first menstruation) and in the fourth to fifth-year after menars, menstrual disorders are reduced, but 20% of women still experience them (Kusumaningrum, 2020). Another study was conducted by Riris Novita (2018) which stated that 60.20% of respondents experienced menstrual disorders at Al-Azhar Surabaya High School. Most respondents experienced menstrual disorders in the form of Premenstrual Syndrome (PMS) and dysmenorrhea (Novita, 2018). Depending on the type of disorder, this condition can interfere with daily activities and even have serious consequences for sufferers, such as difficulties in pregnancy, infertility, tumors, or cancer (Jewson et al., 2020). Women who are experiencing menstrual disorders really need to get treatment for menstrual disorders quickly, precisely, and efficiently. However, there are still many women who don't know about reproductive health education, sometimes women, especially those in their teens, are still embarrassed and don't feel the need to consult a doctor if they have problems (World Health Organization, 2022). Obstetricians have expertise in the field of female reproduction, but society has been indoctrinated that only pregnant women will go to an obstetrician, thus making women who experience menstrual disorders reluctant to come to the doctor. Women's reproductive health is a component of general health that needs more attention. It should be noted that menstrual disorders are not only carried out with an initial diagnosis but further and thorough examination is needed to get the right and appropriate treatment (Marnach & Laughlin-Tommaso, 2019). An important first step in evaluating and reducing the differential diagnosis is to carry out a careful initial diagnosis. A good diagnosis will lead to more targeted further management. The role of technology that has developed rapidly can help health workers, experts, or sufferers in the process of handling menstrual disorders in making an initial diagnosis quickly, practically, and accurately.

One branch of artificial intelligence reliable for initial diagnosis is an expert system (Yu et al., 2018)(Suminten & Rani, 2018)(Moreira et al., 2019). The expert system aims to support the actions of experts but does not mean replacing the role of the expert because the absolute decision remains with the expert himself/herself (Mohapatra & Anand, 2021)(Gama & Putri, 2017). Besides that, expert systems can help sufferers of menstrual disorders in determining action decisions while giving education about women's reproductive health, especially in menstrual disorders. An expert system requires a relevant inference engine to work like an expert (Istiadi et al., 2021)(Turban, 1995). One reliable method is the Bayes Theorem or often called Naïve Bayes Classifier (Sendari et al., 2020)(Nashiruddin & Hidayat, 2022). Apart from being a popular algorithm for its accuracy in classifying, the Naïve Bayes algorithm has a formula that is quite simple and easy to apply to the system (Berrar, 2018)(Marselena et al., 2018)(Zhang et al., 2021). Several studies with different case studies have used the Naïve Bayes algorithm because it proved to be quite accurate in determining a decision based on probability calculations. One expert system research using the Naïve Bayes method carried out by Yuliana, Paradise, and Kusrini in diagnosing Acute Respiratory Infections, can produce a diagnosis with a low probability of certainty but has a high level of accuracy, namely 90% based on the symptoms experienced by sufferers (Yuliana et al., 2021). Another research conducted by Ridho Handoko M. with case studies of diseases during pregnancy, using the Naïve Bayes method, found the comparison of the accuracy of system diagnosis with an expert diagnosis equals 77% (Handoko, 2021). From the various studies explored, no research studied the development of expert systems on the menstrual cycle, menstrual disorder syndrome, and other menstrual disorders using the Naïve Bayes method. So in this study, researchers tried to apply and test the level of accuracy of the Naïve Bayes method on expert systems with case studies of menstrual disorders.

Method

Research method is a procedure used to conduct research that is useful in collecting data or information to achieve goals through scientific procedures. An overview of the flow of this research is shown in Picture 1.

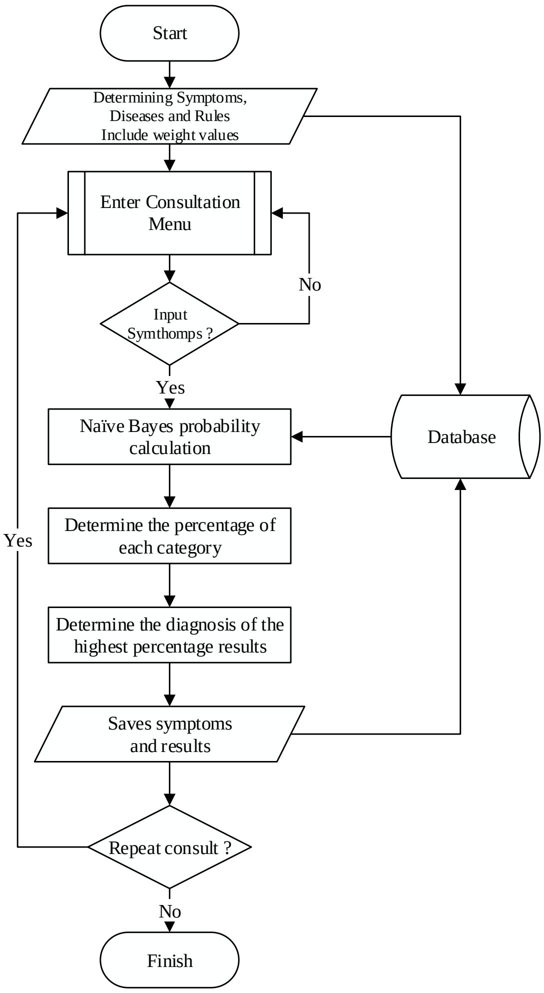


Picture 1. Chart of Research Methods
Source: Research Processed Results

The first research stage began with problem identification. The problems that were obtained came from the obstetrician, dr. I Putu Gde Wardhiana, Sp.OG (K) with the name Sudirman Agung Pharmacy at Jalan Diponegoro Blok A2 No.176-178, Dauh Puri Klod, West Denpasar District, Denpasar City, Bali. The problem being studied is the specialist's (doctor) concern for young women to check if they experience disturbances or abnormalities during menstruation. Identification of problems is also collected through research, official websites, and books. After getting the problem, the formulation of the problem was carried out based on the problems that had been identified. The formulation of the problem was carried out with the aim of limiting the scope of the research so that the scope of the problem is not too broad and widened so that this research is more focused on being carried out. Proceed to the literature study stage, with the aim of finding scientific references related to the topic of expert systems with Naive Bayes algorithm methods and case studies of menstrual disorders. The next stage was data collection, in which interviews with experts and other sources were conducted. The purpose of this stage is to collect various symptoms of menstrual disorders. The next stage was system design. The system is designed like a database according to the data obtained and the needs of the system that uses the Naive Bayes inference engine and the Web interface of the system. After the design was in accordance with the requirements, then proceeded with the system development stage until the system was ready for use. The location of the researchers carrying out system development was at the Multimedia Laboratory, Universitas Pendidikan Nasional which is located at Jalan Waturenggong No.164, Panjer, West Denpasar District, Denpasar City, Bali. After the system was ready, the system was tested. Testing was done in 3 ways: Black Box testing, validation of results with experts, and User Acceptance Test (UAT). At the testing stage, data collection was also carried out, the results were then analyzed, and a data validation process was carried out to ensure the system's performance. After getting the results, the results of each stage of the research were documented in a report. The last step was to draw conclusions related to formulating the problem that had been made before. The time used by researchers to conduct this research was in the period of approximately 4 months.

System Flowchart

The system consists of 2 actors: admin and user. The 2 actors play a role in the flow of this system. Admin determines training data based on primary and secondary data sources that have been collected. And the user is the one who uses the application to conduct consultations regarding menstrual disorders. Naïve Bayes calculation starts when the user selects a symptom that has been or is being experienced on the consultation page. The detailed system workflow can be explained as a system flowchart, as shown in Picture 2 below.



Picture 2. System Flowchart
Source: Research Processed Results

After the admin gathers the necessary data, then the admin determines data training and the value of the weight on each data, especially on disease data and rules. The weighting is obtained from an expert. After fulfilling all data requirements for calculations, the system can be used for diagnostics.

Starting from users who want to make a diagnosis by going to the Consultation menu. On the Consultation page, the user is asked to choose the symptoms experienced. If there is no symptom selected, then the system will tell the user to select symptoms. After that Naïve Bayes calculation will start after there is an input of symptoms. Here is formula 2.1, namely the Naïve Bayes probability formula.

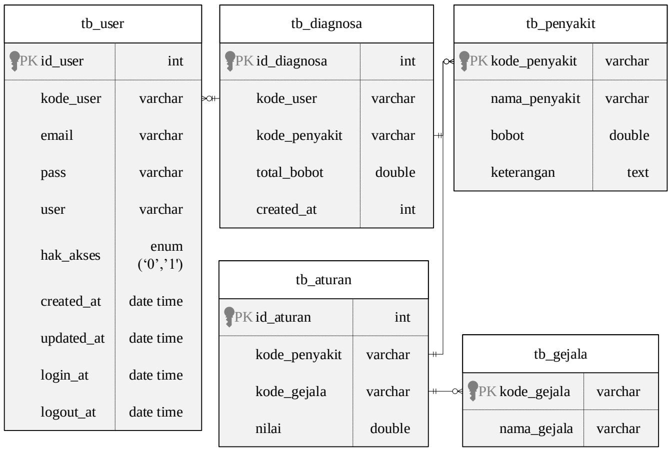
$$p(G) = \frac{p(K)*p(K)}{p(G)} \quad 1$$

Formula 1. Naïve Bayes Formula

Each disease is calculated its probability with each symptom based on predetermined rule values. Then after calculating everything, the total percentage of each probability will be searched for the largest, and the disease with the largest percentage level is the final result or diagnosis according to the Naïve Bayes calculation. In the results of the diagnosis, there is a description of the explanation and treatment of the disease. Diagnostic results and symptoms selected by the user will be stored in a database so that the user and the admin can see the diagnosis history on the History page. Afterward, the user will be given a choice again whether to consult again or not. If yes is selected, then the user is taken back to the initial view of the Consultation page to select another symptom.

Database Planning

The expert system in this study uses MySQL as its database. It also uses PHPMyAdmin, an open-source software written in the PHP programming language. Picture 3 shows the Entity Relationship Diagram required to build the database in the system.



Picture 3. ERD Database
Source: Research Processed Results

The database consists of 5 tables: user table, symptom table, disease table, rule table, and diagnosis table. The database stores the data needed for Naïve Bayes algorithm calculations and saves the results of the consultation.

Results and Discussions

Data Training

The first stage that needs to be prepared is collecting knowledge base such as data on menstrual disorders, symptoms, and rules that will later be applied to Naïve Bayes. Data training is learning data to predict opportunities so as to produce decisions. Data were collected from Primary data sources (direct interviews with experts) and Secondary data sources (books, the internet, journals). Training data is stored on a database set using PHPMyAdmin with a MySQL-based database. Collection and analysis of training data produce 3 types of training data, namely training data on diseases, symptoms, and rules. Table 1 below is the processed data training for the rules.

Table 1. Data Training for Rules

Symptoms	Illness									
	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10
G01	P	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*
G02	P	*TA*	KB	*TA*	*TA*	*TA*	P	*TA*	*TA*	*TA*
G03	KB	TA	KB	*TA*	M	M	*TA*	P	*TA*	*TA*
G04	*TA*	P	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*
G05	KB	KB	KB	M	HP	M	KB	KB	HP	HP
G06	*TA*	*TA*	P	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*
G07	M	M	KB	M	KB	M	KB	*TA*	KB	KB
G08	*TA*	*TA*	*TA*	P	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*
G09	*TA*	*TA*	*TA*	*TA*	P	*TA*	*TA*	*TA*	*TA*	KB
G10	M	M	M	KB	KB	*TA*	*TA*	*TA*	M	*TA*
G11	M	*TA*	*TA*	M	KB	*TA*	*TA*	*TA*	*TA*	*TA*
G12	TA	P	*TA*	HP	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*
G13	HP	HP	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*
G14	P	*TA*	KB	*TA*	*TA*	*TA*	HP	*TA*	*TA*	*TA*
G15	M	M	*TA*	*TA*	KB	*TA*	*TA*	*TA*	*TA*	*TA*
G16	*TA*	KB	*TA*	*TA*	M	*TA*	*TA*	M	*TA*	M
G17	M	M	M	M	M	KB	M	*TA*	*TA*	*TA*
G18	M	M	*TA*	*TA*	*TA*	*TA*	M	M	KB	M
G19	*TA*	*TA*	*TA*	*TA*	*TA*	P	P	*TA*	*TA*	*TA*
G20	M	KB	M	KB	KB	*TA*	*TA*	*TA*	*TA*	*TA*
G21	M	M	M	M	KB	*TA*	M	*TA*	*TA*	HP
G22	P	*TA*	KB	*TA*	*TA*	*TA*	HP	*TA*	*TA*	*TA*
G23	M	M	M	M	KB	M	M	*TA*	*TA*	*TA*
G24	*TA*	KB	*TA*	HP	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*
G25	M	*TA*	*TA*	HP	*TA*	*TA*	*TA*	*TA*	*TA*	M
G26	M	M	M	M	M	HP	M	*TA*	*TA*	*TA*
G27	*TA*	*TA*	*TA*	*TA*	*TA*	M	*TA*	*TA*	*TA*	*TA*
G28	*TA*	*TA*	*TA*	*TA*	*TA*	M	*TA*	*TA*	*TA*	*TA*
G29	M	M	M	*TA*	*TA*	*TA*	M	*TA*	*TA*	*TA*
G30	KB	M	M	*TA*	*TA*	*TA*	KB	*TA*	HP	*TA*
G31	*TA*	*TA*	*TA*	*TA*	KB	*TA*	*TA*	*TA*	*TA*	*TA*
G32	M	*TA*	*TA*	*TA*	*TA*	*TA*	M	*TA*	*TA*	*TA*
G33	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	M	M	*TA*
G34	KB	*TA*	M	*TA*	KB	*TA*	*TA*	HP	*TA*	*TA*
G35	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	KB	*TA*	*TA*
G36	KB	M	M	*TA*	M	*TA*	KM	HP	HP	*TA*
G37	M	*TA*	*TA*	*TA*	M	*TA*	*TA*	KB	*TA*	*TA*
G38	KB	M	M	*TA*	*TA*	*TA*	M	KB	HP	*TA*
G39	KB	M	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	HP	M
G40	KB	*TA*	M	*TA*	M	*TA*	*TA*	HP	HP	*TA*
G41	M	*TA*	M	*TA*	M	M	M	KB	HP	*TA*
G42	KB	M	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	HP	KB
G43	M	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	KB	*TA*
G44	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	HP
G45	KB	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*
G46	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	HP
G47	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	*TA*	HP

Source: Research Processed Results

Rules data amounted to 470 rules data stored in the database. The data obtained from each disease has all existing symptom data and is then given a weight value for each. Information in red is for a symptom that can occur in the disease. Meanwhile, rule data with TA information is 0 because the disease has no symptoms.

System Implementation

According to the set rules, the symptoms that the user chooses will be weighted using Naive Bayes calculations. Naïve Bayes algorithm based on Bayes probability calculations is then implemented in a Bayes class and stored in bayes.php. Bayes class will be called on hasil.php to determine the diagnosis of menstrual disorders. In the Bayes class, there are three constructors initialized with array parameters which are called when a new object is created. The three constructors are used to declare data needed for calculations, namely $selected, $disease, and $data. Here is the program code.

```
Program Journal
* @param array $selected Selected symptom
* @param array $disease All disease data (code, name, weight, description)
* @param array $data Disease weight data for each symptom
```

Picture 4. Constructors Code

The class constructor is then used as a parameter in the __construct function with the names $selected, $disease, $data. In that function, there is a calculate function that will run when the __construct parameter is met. The following is the program code for the __construct function.

```
Program Journal
function __construct($selected, $desease, $data)
{
$this->selected = $selected;
$this->disease = $disease;
$this->data = $data;
$this->count();}
```

Picture 5. Construct Function Code

When the __construct function runs, the required data is declared, and function count is executed. Count function is function calculation according to the Naïve Bayes probability formula. That is, Posterior Probability (probability of disease/symptoms) is equal to Likelihood (probability of symptoms/disease) multiplied by Class Prior Probability (disease probability) divided by Predictor Prior Probability (probability of symptoms). The calculation of the Likelihood value with Class Prior Probability is performed first, namely the weight value of the selected symptom rule multiplied by the disease weight value. The results are named probability symptoms of the disease. Calculations are made as many as the number of diseases in the database (ten times). An array variable is needed to accommodate the results of calculating the search for disease symptoms, namely pro_symptoms_disease. The following is the program code for searching for the probability of disease symptoms as well as an explanation of each syntax, which is explained with comments.

```
Program Journal
/** probability of symptom|disease */
$this->pro_symptoms_of disease = array();
/** disease recurrence */
foreach ($this->data as $key => $val) {
/** symptom recurrence and weight for each disease */
foreach ($val as $k => $v) {
 /** the weight multiplied by the symptom weight */
 $this->pro_symptoms_of disease[$k][$key] = $v * $this->disease[$key]->weight;
}
}
```

Picture 6. Searching for the Probability of Disease Symptoms Code

The calculation is carried out continuously until all the selected symptoms have received their respective results. The next calculation is to find the Predictor Prior Probability value. This value is obtained by multiplying the result of Likelihood in a disease with the weight value of the disease, then the results are added up with the following diseases. The total calculation is stored in the pro_symptoms variable. Here are the Predictor Prior Probability calculations with explanatory comments.

```
/** probability Predictor Prior Probability (symptoms) */
$this->pro_symptoms = array();
```

```
foreach ($this->pro_symptom_disease as $key => $val) {
/** total (sum) the probability of disease symptoms for each symptom */
$this->pro_gejala[$key] = array_sum($val);
}
```

Picture 7. Predictor Prior Probability Calculations Code

After obtaining the probability of disease symptoms (Likelihood multiplied by Class Prior Probability) and Predictor Prior Probability, the next step is to search for Posterior Probability. The pro_disease variable is needed to perform calculations. The pro_symptoms_disease variable is broken down first to get the disease and its symptoms. pro_disease has 3 elements, namely x for the probability of disease symptoms, y for Predictor Prior Probability, and z for the quotient of x and y. Here is the Posterior Probability calculation program code.

```
/** probability Posterior Probability (disease|symptoms) */
$this->pro_disease = array();
/** disease recurrence */
foreach ($this->pro_symptom_disease as $key => $val) {
/** symptom recurrence */
foreach ($val as $k => $v) {
 /** x is (pro disease symptoms) */
 $this->pro_disease[$k][$key]['x'] = $v;
 /** y is (pro symptom) */
 $this->pro_disease[$k][$key]['y'] = $this->pro_symptom[$key];
 /** the probability of disease is x / y */
 $this->pro_disease[$k][$key]['z'] = $this->pro_disease[$k][$key]['x'] / $this-
>pro_disease[$k][$key ]['y'];
 }}
```

Picture 8. Posterior Probability Calculation Code

The results of the Posterior Probability calculation are stored in the result array variable which has a disease element with the result value. The entire program code above is executed until all the selected symptoms have a Posterior Probability value. Then all the probabilities per disease (z) are added up. So that the final result is a Posterior Probability value per disease. This process is called learning for an expert system, which means machine learning based on existing rules and weights. The following is the resulting program code for Posterior Probability.

```
/** Posterior Probability result */
$this->results = array();
foreach ($this->disease as $key => $val) {
$this->result[$key] = 0;
/** add up all the probabilities per disease (z) */
foreach ((array) $this->pro_disease[$key] as $k => $v) {
 $this->result[$key] += $v['z'];
} }
```

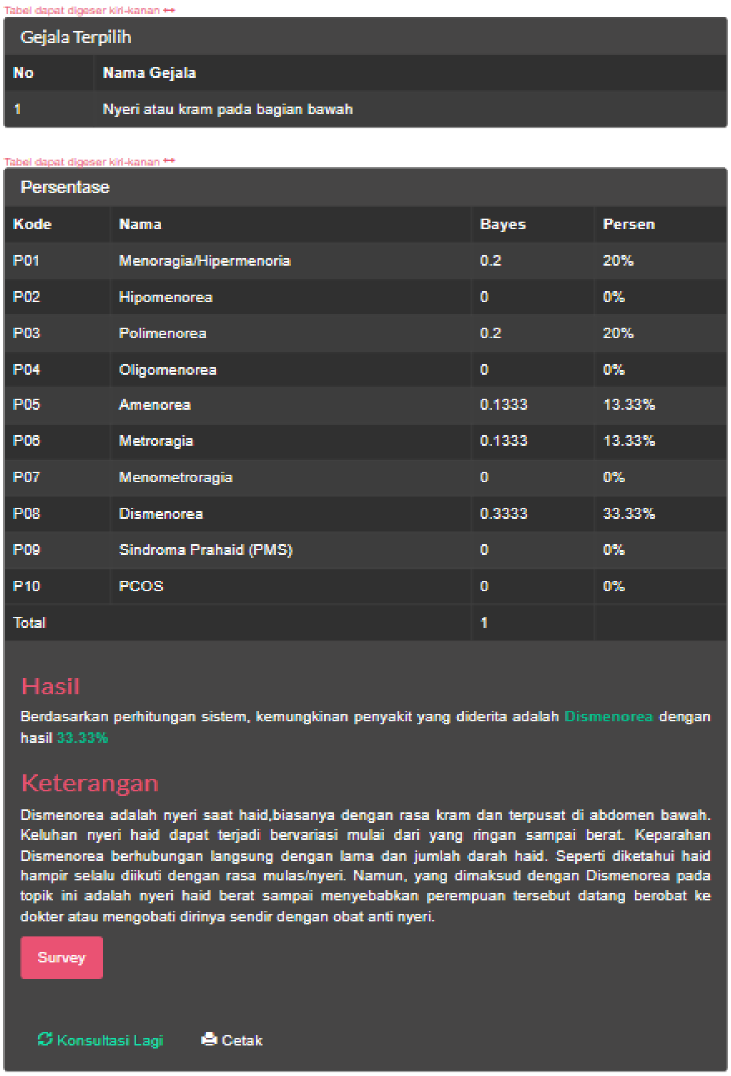
Picture 9. Posterior Probability Result Code

Learning that has been completed produces output in the form of Bayesian probability numbers. The Bayes results for each disease are then summed up so that the results are in accordance with the number of symptoms selected by the user. The total value is stored in the total variable. The Bayes result is then converted into a percentage to make it easy to understand. The percent array variable is used to store the total quotient with each disease Bayes outcome. The following is the program code to find the percentage of the Bayes result for each disease.

```
/** percentage */
$this->percent = array();
/** totals all disease probabilities */
$total = array_sum($this->result);
foreach ($this->result as $key => $val) {
/** divide each disease probability result by the total */
$this->persen[$key] = $val / $total;
}
```

Picture 10. Bayes Result Code

Learning on the system stops when it reaches this point. Up to this point, the system has produced a diagnosis of probable disease based on the Bayes value with the highest percentage. The results of program code execution with selected examples of symptoms are shown in Picture 11 below:



Picture 11. Consultation Results
Source: Research Processed Results

System Testing

The system that has been implemented proceeds to the system testing stage. There are 3 tests in this study, namely Black Box Testing, Validation testing, and User Acceptance Test (UAT). Each data obtained from the test results is then analyzed to obtain a conclusion. Before the system is used by the community, the system is tested first using Black Box testing. After passing the test, the system application is continued with trials by the community and data collected from respondents. After collecting data from respondents, the diagnostic data for each respondent is tested by validation testing. Validation is carried out with experts to measure the level of accuracy of the system in providing an initial diagnosis. Respondents who have used the system will fill out a questionnaire for User Acceptance Test (UAT). This testing is done to see how worthy and accepted the system is by the community.

a. Black Box Testing

This test ensures that the system is running according to its functional requirements before the system is used directly by the public (Kusrini et al., 2020). Table 2 presents the results of the tests contained in the consultation scenario to provide diagnostic output.

Table 2. Black Box Testing Results

No	Trials	Information	Time
1	Experiment 1	Corresponding	0.03414
2	Experiment 2	Corresponding	0.00091
3	Experiment 3	Corresponding	0.00264
4	Experiment 4	Corresponding	0.00103
5	Experiment 5	Corresponding	0.00111
6	Experiment 6	Corresponding	0.00148
7	Experiment 7	Corresponding	0.00197
8	Experiment 8	Corresponding	0.00083
9	Experiment 9	Corresponding	0.000125
10	Experiment 10	Corresponding	0.00379

Source: Research Processed Results

b. Validation

The history of the results of diagnoses from respondents who have used the system to carry out consultations were recorded and then tested for the accuracy of the system's diagnosis. This test was carried out by comparing the results of system diagnostics with diagnoses from experts (Sulardi & Witanti, 2020). Validation testing was carried out using 50 valid and clear diagnostic data from the respondents. Then the average value was calculated to obtain a conclusion. Table 3 presents the results of the validation test with experts.

Table 3. Validation Test Results

No	Symptoms	System Results	Expert Results	Note
1	G02, G03, G11, G13, G14, G22, G34, G35, G36, G37, G38, G40, G41, G42, G47	*Menorrhagia*	*Menorrhagia*	Corresponding
2	G19	*Menometrorrhagia*	*Metrorrhagia*	Dissimilar
3	G13, G18, G39, G40, G41, G42	*Menorrhagia*	*Premenstrual Syndrome*(PMS)	Dissimilar
4	G01, G08, G34	*Menorrhagia*	*Menorrhagia*	Corresponding
5	G18, G21, G29	*Menometrorrhagia*	*Polycystic Ovary Syndrome* (PCOS)	Dissimilar
6	G04, G13, G14, G40, G42	*Menorrhagia*	*Menorrhagia*	Corresponding
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
49	G13, G18, G21, G47	*Polycystic Ovary Syndrome* (PCOS)	*Polycystic Ovary Syndrome* (PCOS)	Corresponding
50	G03, G21, G25, G26, G38	*Menorrhagia*	*Polycystic Ovary Syndrome* (PCOS)	Dissimilar

Source: Research Processed Results

c. User Acceptance Test

This test was carried out after the respondent has used the system to determine the feasibility level of the system for the community (Afdal & Humani, 2020). The respondent was given a link to a Google form in which some questions were set. Respondents then answered by selecting multilevel scale items. Starting from Strongly Disagree to Strongly Agree, each item has its own weight value. 65 respondents filled out the questionnaire, respondents filled out the questionnaire at the Sudirman Agung Pharmacy. Table 4 below is the result of UAT.

Table 4. Results of User Acceptance Test

No	Question	Acceptance Rate
1	This system is easy to learn	80.75%
2	You feel comfortable using this system	81.5%
3	You are satisfied with the diagnostic results provided by this system	80.25%
4	Description of the diagnosis is easy to understand	81.5%
5	The language used in the system is easy to understand	83.25%
6	The system display is easy to understand	80.75%
7	The menu in the system is easy to understand	81.75%
8	The layout of this system is neat	81.5%
9	You do not experience error when using the system	82.25%
10	You are satisfied with this system	81.5%

Source: Research Processed Results

Conclusions

Expert System for Early Diagnosis of Menstrual Disorders can help the community as first aid and education on women's reproductive health. Based on the Black Box Testing, it was concluded that the system has run according to expectations and is suitable for use by the community. In validation testing, the Early Diagnostic Expert System for Menstrual Disorders was able to diagnose menstrual disorders with 84% accuracy. However, this diagnosis is still not strong enough to state that the patient has menstrual disorders, because the system can only make an initial diagnosis. The system can provide a differential diagnosis to make it easier for medical personnel or experts to carry out further evaluations. From the User Acceptance Test (UAT) for the Early Diagnostic Expert System for Menstrual Disorders, it can be seen that the system has received a positive response from respondents. System applications are considered appropriate, accepted, and well-regarded by the community. Suggestion for the next research combining Naïve Bayes with another algorithm like Fuzzy, Certainy Factors to increase the accuracy of the result.

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