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IMPLEMENTATION OF A WEB-BASED EXPERT SYSTEM FOR DIAGNOSIS OF RED BLOOD CELL PRODUCTION DISORDERS

R Bagus Bambang Sumantri[1*], Imam Ahmad Ashari[2], Hadi Jayusman[3]
[1,3]Information Systems Study Program, Harapan Bangsa University, Central Java
[2]Information Technology Study Program, Harapan Bangsa University, Central Java
[1,2,3]Raden Patah Street No. 100, Ledug, Kembaran, Banyumas, Central Java, Indonesia
E-mail: bagusbambang@uhb.ac.id[1], imamahmadashari@uhb.ac.idhadijayusman@uhb.ac.id[2]

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Corresponding authors
*bagusbambang@uhb.ac.id

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Abstract
The expert system is one of the branches of artificial ingenuity that studies how to adopt an expert's way of thinking in solving a problem and making a decision to draw conclusions. In this case an expert system is used to diagnose anemic diseases. Problems that arise in the community such as not knowing the characteristics of the disease, its impact is felt for a long time, and being lazy to consult a doctor. Overcoming these problems takes a lot of time and money, so an application is needed that can help doctors diagnose web-based red blood cell production disorders. The use of web technology combined with expert systems in supporting decisions, can better socialize the system. The data collection methods used are literature study methods, interviews with health experts and documentation. Fact-finding in expert systems uses the forward chaining method, to seek conclusions from existing facts. The application development phase includes interface design and system testing. The result of this study is to produce an output in the form of an application to diagnose impaired red blood cell production. The black box test shows that the program is in accordance with the knowledge of health experts regarding impaired red blood cell production.

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I. INTRODUCTION

Expert systems can be stated as computer-based systems formed based on reasoning, knowledge, or facts that can help solve a problem [1]. The use of this expert system is common to find solutions to problems in various fields, including agriculture, banking and education [2]. An expert system is a computer program that in such a way imitates the process of knowledge and thinking of experts in many fields, whether in the fields of health, industry, or education. This expert system in relation to the health sector can be used in diagnosing diseases. Anemia is a medical problem that is often experienced by the community, in addition to many of the main problems of society that have a major impact on health [3]

The Expert System has the goal of transferring the expertise of an expert to a computer, then passing it from the computer to another person (who is not an expert), while an expert or expert (human expert) is someone with superior understanding abilities over certain problems [4]

Body health is something that is crucial in human life, but many people do not pay enough attention to their health because of lazy treatment. The majority of people will seek treatment and see a doctor after the disease becomes more acute. People are still not fully aware that the difficulty of obtaining information related to anemia makes them not understand anemia itself [5]. Through this system, it will be easier for the public to find out the types and symptoms of anemia by not having to directly see a doctor, and can find out solutions to prevent the onset of the disease [6] [7].

Communication in relation to the nursing process is very important, where this can be done through a simple blood test so that you can find out the anemia that exists. The next development can be seen from the many expert system application programs applied in the medical world, one of which is to diagnose disorders of red blood cell production in humans, not in order to replace the function of a doctor, but limited to being used as a tool and complement that is still limited, because the production disorder diagnosis program These red blood cells are limited to acting as consultative or advisors and are not like a doctor who can diagnose diseases with an action or movement. Taking knowledge stored in a particular domain, an inexperienced user can solve problems and can make decisions. The use of an expert system in diagnosing disorders of red blood cell production is expected to provide solutions to problems that are often experienced by the community. In general, people do not pay much attention to the problem of impaired red blood cell production because of the following:

1. Not knowing the characteristics of the disease
2. The impact is felt for a long time
3. Society is reluctant

Seeing this problem, a certain system is needed that can be accepted by the community without disturbing their activities. Along with the development of the internet now, it can be utilized the development of the internet through making "Implementation of an Expert System for Diagnosis of Web-Based Red Blood Cell Production Disorders" which can be used through internet media so that it can be directly used by the public.

II. RESEARCH METHODS

Research methodology is used as a guide in carrying out research because it is a work step [8]. The form of framework description in this study begins with data collection consisting of literature studies and interviews with speakers. Then the system design technique consists of system design, system making, trial and implementation. System design consists of a forward chaining expert system, collecting data on equipment, analyzing the Forward Chaining method. The linking of this system uses the waterfall method categorized in the SDLC (Software Development Life Cycle) method. The Waterfall method is a method that is often used in developing software from a sequential or sequential approach starting from analyzing, designing, coding, testing, and supporting [9]. As for the description of the Waterfall method:

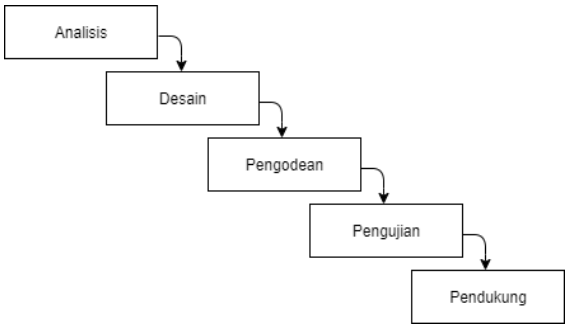

Figure 1. Model Waterfall

As stated [10] the Waterfall method is divided into several stages, namely:

1. Analysis
   The analysis stage is carried out by identifying problems and making designs as solutions to a problem.
2. Design
   The design stage is carried out by designing from the system in the form of a database design using DAD ERD.
3. Coding
   The encoding stages use the Bootstrap framework. In addition, the website also implemented PHP programming language and implemented MySQL database.
4. Testing
   The test stage is carried out by looking for errors in coding and implementing the website directly on the web hosting.
5. Supporters
   The supporting stages are maintenance and alteration or development of the website using the Bootstrap framework and the PHP programming language with versions that are still relevant for use today and in the next few years.

Forward Chaining Forward Chaining expert system is a process driven by data (data driven) [11]. The beginning of this lesson process is from the input information as well as the subsequent attempt to provide a depiction of the conclusions. Forward tracking finds the conformity of facts with the IF in section of the IF-THEN rules [12]. The interpreter rules in this method match the facts in the database under certain conditions expressed in the IF rule or the left-hand section. If the facts in the database have met the IF rules, then the rules are excited. The process of designing an expert system with the Forward Chaining method is described as below:

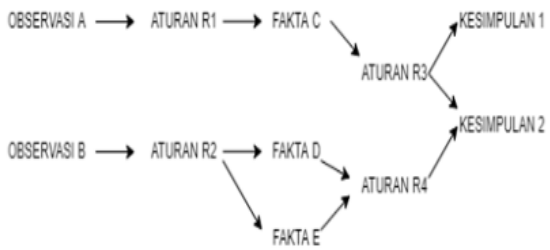

Figure 2. Forward Chaining **[12]**

The fact that users enter to obtain certain decisions is a forward chaining inference engine [13]. These various facts are early signs or symptoms of impaired red blood cell production. In the expert system, implement the expertise or knowledge of an expert to make a decision or conclusion [14].

Analysis of the Forward Chaining Method The analysis of the Forward Chaining method is carried out at this stage, namely through setting rules that will be used in solving problems in the expert system with the Forward Chaining method. The formation of rules from various disease and pest data on kale plants that have been carried out by feeders. After the formation of rules, then a decision tree can be built.

III. RESULTS

3.1. Expert-generated system applications

a) Identified Problems and Needs
Based on the results of research methods such as interviews, documentation, and literature studies, a web-based expert system has been created to diagnose disorders of red blood cell production. Before carrying out treatment or prevention, a doctor or health expert will identify the type of disease experienced by the patient. In identifying, the doctor or health expert will carry out a diagnosis on the patient by recording the symptoms observed both in terms of physique and the cause or history of the disease. These steps can be found in the system which is realized by opening a consultation between the user and the system to get the conclusion that the user wants, by answering the statement of disease symptoms proposed by the system.

b) Problem Adjustments
The problems studied in this study are very appropriate using an expert system, because red blood cell production disorders are very complex suffered by humans. With an expert system, decisions made by computers can be easily documented through tracking each activity of related systems and computer services more easily, cheaply and the time period is quite short.

c) Alternatives Considered
In the expert system, it uses a database management system in solving a problem. What is prioritized with the Database Management System (DBMS) is to store information or data and limited to accessing if needed.

d) Identification and Tools Used
The software used in this study is the Windows 11 Home operating system, while the software used is the PHP programming language while the web server used is xampp and to see the results through mozilla firefox, this software is quite optimal to use.

e) Constructed Science Engineering
In making an expert system in order to diagnose reproductive disorders in human blood cells is to conduct various literature studies to various sources related to reproductive disorders in human blood cells and directly explore knowledge from competent experts in the field. After getting data in the form of symptoms, diseases, treatment methods and causes, it is stored into a table to hold the data data, which uses a data base. There is also one of the results can be seen as follows:

Table 1. Symptom Knowledge Base Examples

No	Role
1.	IF pale face (1) AND shortness of breath (2) THEN easy to faint (3)
2.	IF weak body (4) AND easy fatigue (5) THEN pale face (6)
3.	IF easily fainted (5) AND frequent nausea (6) THEN loss of appetite (7)
4.	IF loss of appetite (7) THEN easy headaches (8)
5.	IF easy headache (8) AND no inflammation of the tongue (9) THEN attacked by Folic Acid Deficiency Anemia (1-2-3-4-5-6-7-8-9)
6.	IF weak body (1) AND easily tired (2) THEN pale face (3)
7.	IF pale face (3) THEN fever (10)
8.	IF fever (10) THEN easy to get infected (11)
9.	IF easily exposed to infection (11) THEN bleeding from the skin (12)
10.	IF has bleeding from the skin (12) THEN also has bleeding from the nose (13)
11.	IF bleeding from the nose (13) THEN bleeding from the gums (14)
12.	IF bleeding from the gums (14) THEN bleeding from the vagina (15)
13	IF bleeding from the vagina (15) THEN afflicted with Aplastic disease (1-2-3-10-11-12-13-14-15)
14.	IF weak body (1) THEN easily tired (2)
15.	IF easily tired (2) AND tongue red flesh (16) THEN swollen tongue (17)
16.	IF the tongue is swollen (17) AND the tongue feels slippery (18) THEN in the corners of the mouth is swollen (19)
17.	IF in the corners of the mouth swollen (19) AND on the nails will be shaped like a spoon (20) THEN attacked by Iron Deficiency Anemia (1-2-16-17-18-19-20)

3.2 System Modeling

1) Data Flow Chart (DAD)

a. Context Diagrams

The function of this diagram is to facilitate functions and modeling in system development, which can be reviewed in the figure below:

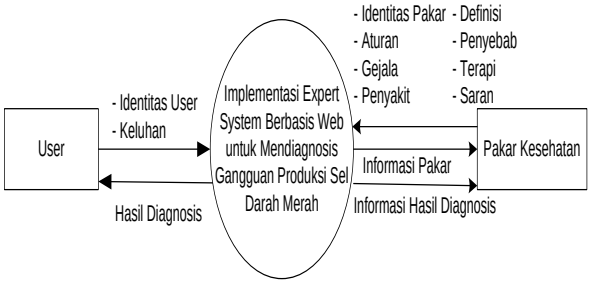

Figure 3. Web-Based Expert System Context Diagram for Diagnosing Red Blood Cell Production Disorders

b. Level 0 Data Flow Chart

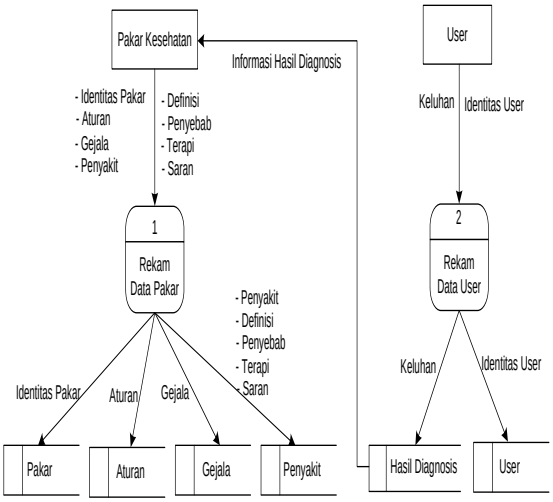

Figure 4. DAD Level 0 Web-Based Expert System for Diagnosing Red Blood Cell Production Disorders

a. Level 1 Data Flow Chart

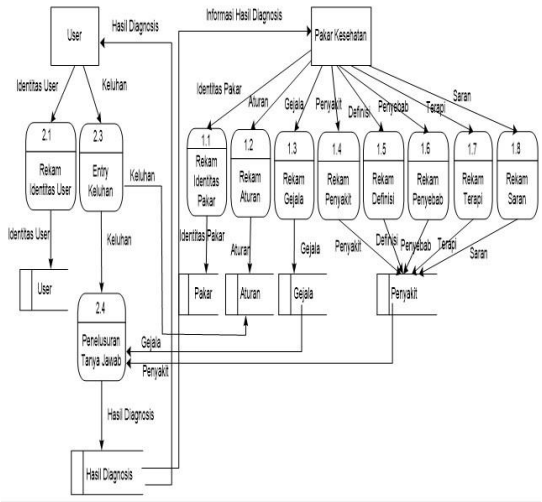

Figure 5. DAD Level 1 Web-Based Expert System for Diagnosing Red Blood Cell Production Disorders

2. Entity Relationship Diagram (ERD)

a. Initial Conceptual Design

From the data flow chart (DAD) design specification, it can be connected into an initial conceptual design in the following table:

Table 2. Early conceptual design

Entity Type	attributes
User	id_user, password, name, gender, date_birth, email, address.
Diseases	id_disease, disease name, definition, cause, therapy, advice
Symptom	symptom_code, group, symptom name

b. Entity Relationship Diagram

Entity Relationship Diagram (ERD) is intended to determine several components of the set of relationships and the set of an entity that describes the real facts used for system creation needs, so that the Data Flow Diagram (DAD) that has been previously described, it can be seen that for the creation of the system, entities and data attributes are needed in the form of disease knowledge

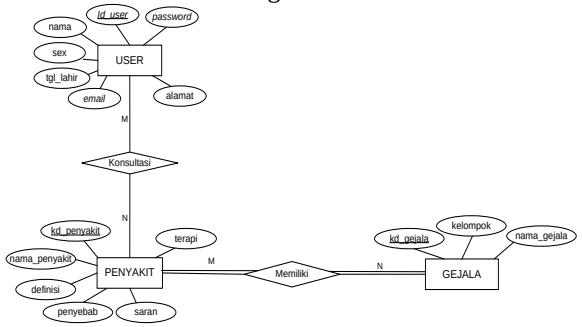

Figure 6. Web-based ERD Expert system to Diagnose red blood cell production disorders

c. Table Design

After the ERD design stage has passed, then this application is related to the implementation system, several entities or tables are needed along with the fields or attributes they have. The table used is:

1) User Table

Is a table used in accommodating user data that has consulted. The key attribute in this table is id-user.

Table 3. User Table

Field	**Type**	**Size**	**Information**
id_user	varchar	25	*id_user*
password	varchar	32	*password* user
name	varchar	25	user's full name
gender	varchar	6	gender
birthdate	date	10	birthdate
email	varchar	25	*email*
address	varchar	50	address
Date	date	10	Date
Time	time	8	Time

2) Tabel Guest

Tabel 4. Tabel Guest

Field	Type	Size	Information
name	char	20	name
email	varchar	25	*email*
address	varchar	50	address
Comment	text	255	Comment
Date	date	10	date
Time	time	8	time

3) Table of Diseases

This is a table whose use is aimed at storing expert knowledge about the types of diseases that attack the reproductive disorders of red cells. Where the key attribute is the Disease code.

Table 5. Table of Diseases

Field	Type	Size	Information
Code_disease	varchar	2	Code_disease
name_disease	varchar	255	name_disease
definition	longtext	-	disease definition
reason	longtext	-	cause of disease
therapy	longtext	-	disease therapy
suggestion	longtext	-	disease suggestions

4) Symptom Table

It is a table used in storing expert knowledge about the symptoms of diseases that attack red blood cell reproductive disorders. Where the key attribute is the Disease code.

Table 6. Symptom Table

Field	Type	Size	Information
code_symptoms	varchar	2	code_symptoms
group	varchar		group
name_symptoms	varchar	255	name_symptoms

5) New Symptom Table

It is a temporary table to accommodate the presence of new facts or symptoms of the disease.

Table 7. New Symptom Table

Field	Type	Size	Information
no	integer	4	number
name_symptoms	varchar	255	name_symptoms

6) Table of Diagnosis Results

Is a table used to display tracking or diagnostic results after a user consults.

Table 8. Table of Diagnosis Results

Field	Type	Size	Information
id_user	varchar	25	*id user*
Code_disease	varchar	2	Code_disease
Date	date	10	access data date
Time	time	8	hours of user access

3.3. Solution Tracking Structure

In determining the disease of impaired red blood cell production using the Forward Chaining method, from the structure of disease tracing, for example, folic acid deficiency anemia, and deficiency anemia, a trace graph image can be made based on the rules used for the disease, namely:

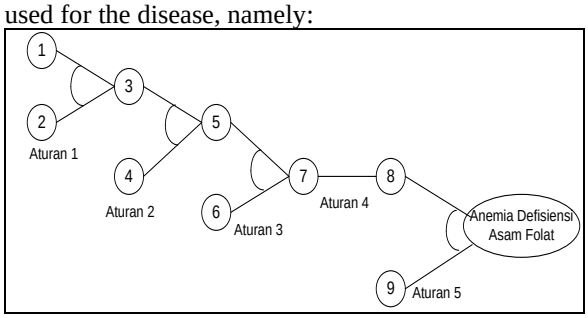

Figure 7. Folic acid deficiency anemia tracing graph

As for cobaltamine deficiency anemia, the research graph can be seen in the following figure:

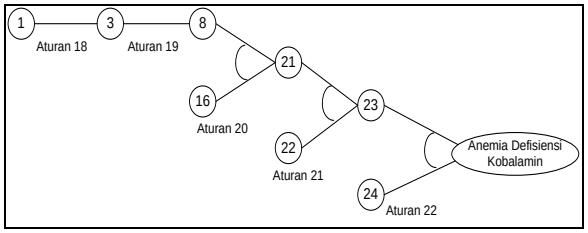

Figure 8. Cobaltamine deficiency anemia tracing graph

3.4. Program Implementation

The main page is a page that first encounters a user. It provides links to the Main Menu page which is divided into six parts, namely links to the home page, searching for diseases, consultations, articles, guest books, help, search and the Manager Menu which is divided into three parts, namely links to the health expert login menu, visitor login and admin and programmer logins. On this page there is also a link to the registration of a health expert. The link option on the main page will take the user to the page desired by the user. The main page of the web has a view as shown in figure 7 below:

Figure 9. Web main page

This page is an input menu for disease rules by inputting the name of the disease, the definition of the disease, its symptoms, causes, therapy and suggestions, as shown in figure 10 below:

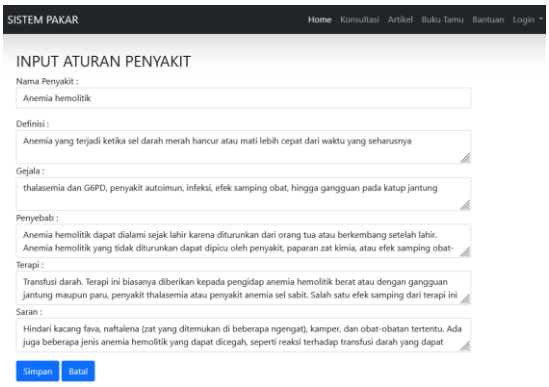

Figure 10. Rule Data Input Menu

This page is a consultation page between the user and the system based on the symptoms experienced by the user in the system

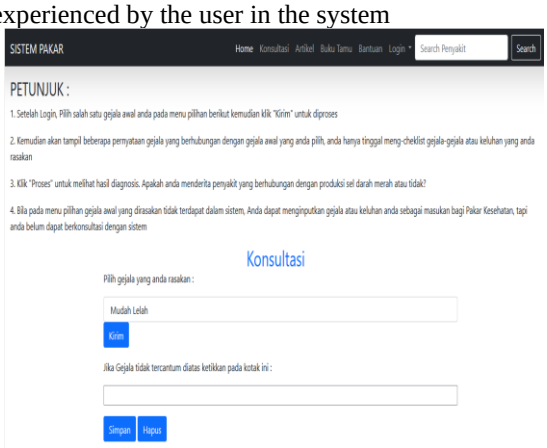

Figure 11. Consultation Page

After the user clicks the submit button in selecting the initial symptoms felt, a page appears as shown in figure 12 below:

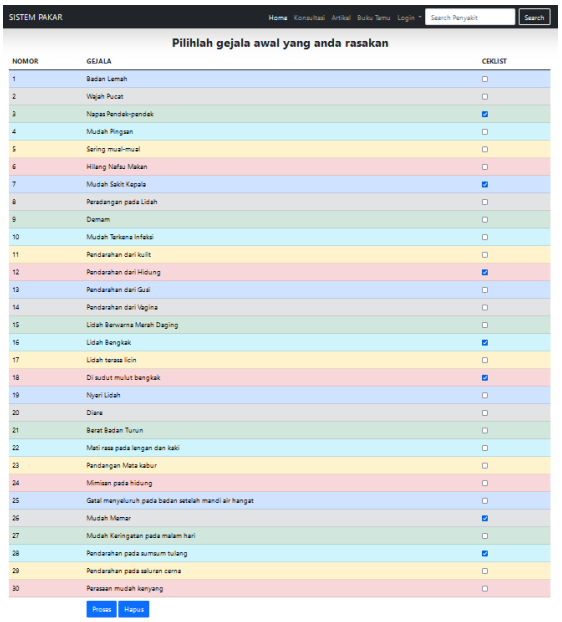

Figure 12. Consultation Page

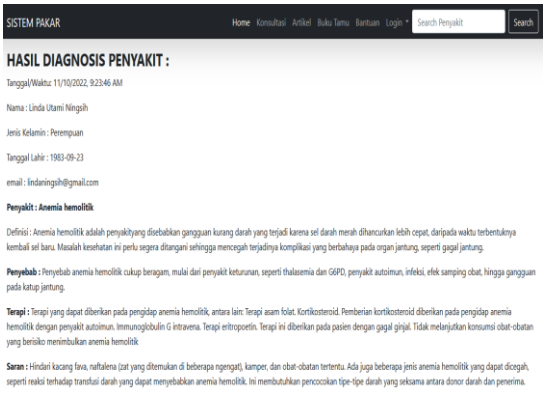

Figure 13. Diagnosis results page

On the diagnosis results page, user identity, program access date, disease name, definition of the disease, causes, therapy, and advice are displayed. The program script pieces to build the diagnosis results are once the expert system is developed, users only need to set aside time to test and find faults. In this test, it uses 2 (two) methods, namely:

a. Black Box Test
   Black box test, which is a system test that is carried out by observing the output of various inputs. If the system output is in accordance with the design for data variations, then it is declared good for the system.
b. Alfa Test
   This is a system test carried out by the user, so that a response can be obtained from the user about the program, either based on the level of friendliness, appearance, or format of the program. If the majority of users declare either the output or input to be in line with expectations then the system is considered good.

This stage of testing is sought in knowing the validity of the expert system, so that the system

actually runs according to the expected goals. The need for system testing in order to find out how successful the system is and to correct if there are still errors.

IV. CONCLUSION

From the results of making this program in building a "web-based expert system implementation to diagnose red blood cell production disorders" conclusions were produced. A web-based application program has been built to diagnose red blood cell production disorders" that can help users or patients in finding the disease suffered and providing information on the definition of the disease, causes, therapy or treatment and advice on the disease. Based on system testing conducted by health experts (black box test) that the knowledge presented in the system is correct.

The system that has been created can still be developed by paying attention to the following, to make the application program more interactive, the program should not only be limited to text but must be equipped with images to make it more attractive. Users or users of this system at least understand and know about the use of computers or application programs.

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