Expert System for Diagnosis of Tifoid Disease Using Dempster Shafer Method

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Abstract:
An expert system in general is a system that seeks to adopt human knowledge into computers so that computers can solve problems as is usually done by experts, or in other words, an expert system is a system designed and implemented with the help of a particular programming language to be able to solve problems as experts do. It is hoped that with this system even ordinary people can solve certain problems, both "a little" complicated even "without" the help of experts in the field. As for the experts, this system can be used as an experienced assistant. Typhus or typhoid fever is an acute infection of the small intestine caused by the bacterium Salmonella typhi. In this final project, a system is designed to diagnose typhoid. The lack of sensitivity to the symptoms of diseases that are often experienced by the community and the lack of availability of medical personnel at the Benjamin Guluh Kolaka Hospital requires a system that can diagnose typhoid. The system is designed based on an expert system for the diagnosis of typhoid using the Dempster Shafer method. The time needed to prepare this research is approximately 3 (three) months, starting in October-December 2021. The researcher conducts research at Benjamin Guluh Kolaka Hospital, Kolaka District, Kolaka Regency, Southeast Sulawesi. In developing the system the researcher uses the Waterfall model. The inside of the expert system consists of 2 main components, namely the knowledge base which contains the knowledge base and the inference engine that describes the knowledge.

Key Word: Typhoid Disease; Dempster Shafer; Expert System

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I. Introduction

Typhoid or typhoid fever is an acute infection of the small intestine caused by the bacterium Salmonella typhi. Typhoid fever is characterized by prolonged heat followed by bacteremia and invasion of Salmonella typhi bacteria as well as multiplication into mononuclear phagocytic cells from the liver, spleen, intestinal lymph nodes and Peyer's patches (Abdoerrachman, 2008). Typhoid fever can also be transmitted from people who are exposed to typhoid fever and food infected by the bacterium Salmonella typhi.

WHO (World Health Organization) estimates that there are about 17 million deaths occur each year due to this disease. Asia ranks highest in this typhoid case, and 13 million cases are occurring each year. In Indonesia, it is estimated that between 800-100,000 people are affected by typhoid fever throughout the year. Typhoid cases are suffered by 91% of children aged 3-19 years with a mortality rate of 20,000 per year. In developing countries, Salmonella typhi is transmitted through food and water that has poor sanitation such as in roadside stalls and infects various foodstuffs such as water, ice cubes, raw vegetables and fruits. Whereas in developed countries, typhoid fever is obtained as a result of being transmitted by travelers who have traveled from endemic areas with typhoid fever (Rahayu, 2013). In Indonesia, this disease is endemic and is a public health problem, one of which is at the Benjamin Guluh Kolaka Hospital.

The availability of medical personnel or doctors is also still relatively minimal at the Benjamin Guluh Kolaka Hospital. So it makes many people find it difficult to diagnose typhoid early so medical treatment becomes too late and even fatal for the patient. So it is very necessary to create a system that can diagnose diseases such as experts or experts. So we need a system that can diagnose typhoid.

An expert system is a computer program that contains knowledge from one or more human experts regarding a specific field (Kusumadewi, 2003). The method used to support the diagnosis is the Dempster Shafer method. There are two important things in the Dempster Shafer method, namely belief function and plausible reasoning. Both of these are used to combine separate pieces of information (evidence) to calculate the probability of an event. The Dempster Shafer theory is based on two ideas, namely the idea of obtaining a degree of confidence from various subjective possibilities and the Dempster Shafer rule itself to combine the degree of confidence based on the evidence obtained. The Dempster Shafer method is used because it has advantages such as being able to combine evidence from several sources, being able to distinguish between...
uncertainty and ignorance, having characteristics according to the way an expert thinks, very suitable for use in expert systems that measure something uncertain or not. Previously, the Dempster Shafer method had been used by previous researchers, namely (Sinaga & Sembiring, 2016) which in their research applied the Dempster Shafer method to diagnose diseases caused by Salmonella bacteria. The Dempster Shafer method has been successfully applied to diagnose diseases caused by Salmonella bacteria. Therefore, the researcher will create an expert system using the Dempster Shafer method, which is expected to be able to diagnose typhoid and be able to provide information to the public about the disease, symptoms of an attack and how to prevent it.

II. Materials And Methods

Research schedule
The time needed to prepare this research is approximately 3 (three) months, starting in October-December 2021. The researcher conducts research at Benyamin Guluh Kolaka Hospital, Kolaka District, Kolaka Regency, Southeast Sulawesi.

System Development Method
In developing the system the researcher uses the Waterfall model with the following stages:

1) System requirements analysis
   The stage where the researcher determines the needs of the system to be made in this case an expert system for diagnosing typhoid disease using the Dempster-Shafer method.

2) System design
   In this stage the researcher makes a system design using several tools to describe the current system or new system. The tools and materials that will be used by the researcher in designing the system are system design using table structures, DFD (Data Flow Diagrams), and process design flowcharts in the system flow design function to describe in general what the system will be made.

3) Coding
   At this coding stage, the researcher uses the PHP programming language.

4) System testing
   At this stage, the program that has been made is tested per unit and then put together into a complete system and tested as a whole to test the level of integration between the previously created units. Where the functions of the software are tested so that the software is free from errors and the results must meet the needs. The test used in this study is Black Box testing. Where this test also includes manual calculations and system calculations that are useful for testing the system whether it is correct and can be used or not. System testing is carried out to determine the level of system accuracy using system accuracy testing to find out the final results or outputs in the form of possible types of diseases produced by the expert system and those produced by experts.

5) Implementation
   The implementation stage is the longest in the waterfall cycle phase (life cycle). The system is installed and put into simple use. Maintenance involves correcting errors that were not found in the early stages of the waterfall cycle, improving the implementation of system units and improving system serviceability as new requirements are discovered.

Data collection technique
1) Observation
   The researcher made direct observations with related parties to find data and information related to typhoid disease.

2) Study of literature
   The researcher searches for reference data related to research through literature, journals, books, articles and online references.

3) Interview
   The types of data used in this research are primary data and secondary data. Primary data is data obtained through the interview method. Secondary data is data obtained from literature studies. The data and information collection carried out included disease criteria, symptoms, belief values, and treatment.

System Design
The processing design that will be carried out in the application of the Dempster-Shafer method is: first the User will input data on symptoms of the disease, and then the system will condition the symptoms if the symptoms experienced are not by what the system displays, the User can choose no, then the User will re-enter the other symptoms. However, if the symptoms experienced are those displayed by the system, the user can
choose yes, to select the symptoms then the system will perform Dempster-Shafer reasoning from the symptoms that have been inputted then the system will automatically display a diagnosis of the disease from the symptoms of the attack experienced and how to prevent it.

The process of an expert system for diagnosing typhoid using the dempster-shafer method, the user first inputs the symptoms and selects the symptoms experienced by the patient for dempster-shafer calculations then the system will display the results of the diagnosis of typhoid.

Needs Analysis
Some of the hardware used are; Acer Aspire 3 Laptops and 2700 . IP Printer. Some of the software used are; 1) Sublime Text, 2) Xampp, and 3) Google Chrome

III. Result

System Analysis
In this research, a system analysis was carried out to apply an expert system to diagnose typhoid using the WEB-Based Dempster Shafer method. Software analysis is a step in understanding the problem before taking an action or decision to resolve the main result. The availability of medical personnel or doctors is also still relatively minimal at the Benyamin Guluh Kolaka Hospital. So with this, many people find it difficult to diagnose typhoid early so medical treatment becomes too late and even fatal for the patient. So it is very necessary to create a system that can diagnose diseases such as experts or experts. So we need a system that can diagnose typhoid.

An expert system is a computer-based information system that uses expert knowledge to achieve high-level decision performance in a narrow problem domain. The inside of the expert system consists of 2 main components, namely the knowledge base which contains the knowledge base and the inference engine that describes the knowledge. The method used to support the diagnosis is the Dempster Shafer method. There are two important things in the Dempster Shafer method, namely belief function and plausible reasoning. These two are used to combine separate pieces of information (evidence) to calculate the probability of an event.

System analysis in this study aims to formulate a problem that occurs and identify the expected system requirements so that improvements can be proposed and ensure that the system analysis has been running on the right track.

Running System
In the running system, the staff receives patient complaint data and diagnoses the patient's typhoid disease. After being diagnosed, the staff will make a diagnosis report so that it becomes a diagnosis report and is given to the patient.

Proposed System
In the proposed system, the user or admin (nurse) inputs disease data, symptoms, rules, and patients along with the symptoms they experience into an expert system to diagnose typhoid using the Dempster Shafer method and generate reports of diagnostic results that can be provided to patients.

Shafer's Dempster Method
The types of typhoid fever (typhoid) are as follows:

<table>
<thead>
<tr>
<th>Disease Code</th>
<th>Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>P01</td>
<td>Typhoid Epidemic</td>
</tr>
<tr>
<td>P02</td>
<td>Endemic Typhoid</td>
</tr>
<tr>
<td>P03</td>
<td>Typhoid Scrub</td>
</tr>
</tbody>
</table>

Table 1 is the type of typhoid fever (typhoid) that the researchers studied in the form of epidemic typhus, endemic typhus and scrub typhus.

The symptoms of typhoid are fever and chills, headache, rapid breathing, muscle and body pain, rash, cough, nausea and vomiting, confusion, back and joint pain, dry cough, stomach pain, and dark area at the bite site. mites like scabs, Mental changes occur, and enlarged lymph nodes.
IV. Discussion

System planning
a. Context Diagram
   In the context diagram, the admin can input data on symptoms, diseases, rules, and patient symptom data into the system. So that the system generates a report on the results of the diagnosis that can be given to the patient.

b. Diagram of Level 0
   In the diagram of level 0, the admin can input data on symptoms, diseases and rules, each of which will be stored in the tb_disease, tb_symptoms and tb_rule tables. Admin and patients can also carry out the diagnosis process by entering patient symptom data and the data will be stored in the tb_diagnosis table. Then the system can generate diagnostic results that can be given to the plant owner.

c. Diagram of Level 1 Process 1
   In the diagram of level 1 process 1, the admin can input data on symptoms, diseases and rules, each of which will be stored in the tb_disease, tb_symptoms and tb_rule tables.

d. Diagram of Level 1 Process 2
   In the diagram of level 1 process 2, the admin and patient can input patient symptom data so that the system will produce the results of the diagnosis which will be stored in the tb_diagnosis table.

e. Diagram of Level 1 Process 3
   In the diagram of level 1 process 3, the system will produce diagnostic results that can be seen by plant owners and admins can view information on symptoms and diseases.

Database Design
1. Table Structure
   a. Disease Data Storage Table
      Table Name: tb_disease
      Primary Key: id_disease
      Description: Filled with disease data
      Disease data storage table is a table that serves as a place to store disease data. member disease consists of id_disease and name_disease. The primary key of the disease table is id_disease.

   b. Symptom Data Storage Table
      Table Name: tb_symptoms
      Primary Key: id_symptoms
      Description: Filled with symptom data
      The symptom data storage table is a table that functions as a data storage place for symptom data. The symptom table consists of symptom_id and symptom_name. The primary key of the symptom table is id_symptom.

   c. Rules Data Storage Table
      Table Name: tb_rule
      Primary Key: id_rule
      Description: Filled with data rules
      The rule data storage table is a table that serves as a place to store rule data data. The rule table consists of id_rule, id_symptom, id_disease and probability. The primary key of the rules table is id_rule.

   d. Diagnostic Data Storage Table
      Table Name: tb_diagnosis
      Primary Key: id_diagnosis
      Description: Filled with diagnostic data
      A diagnostic data storage table is a table that serves as a place to store diagnostic data. The diagnosis table consists of diagnosis_id, owner_name, diagnosis_date, disease_id and value. The primary key of the diagnosis table is id_diagnosis.
e. **User** Data Storage Table

   - Table Name: `tb_user`
   - Primary Key: `id_user`
   - Description: Filled with admin data

   *User* data storage table is a table that serves as a place to store admin data. The *user* table consists of `id_user`, `user` and `pass`. The primary key of the *user* table is `id_user`.

### 2 Relationships Between Tables

![Figure 1 Relationships Between Tables](image)

In Figure 1 there are four interrelated tables, namely `tb_rule` which is related to `tb_symptoms` and `tb_disease` and the last is `tb_disease` which is related to the `tb_diagnosis` table.

#### Flowchart

A **flowchart** is a scheme that describes the sequence of activities of a program from start to finish. Some of the flowcharts used are as follows:

1. **Flowchart Login**
   
   In the **login flowchart**, the admin inputs the *user* name and password, if the admin presses the login button then the system will validate the *user* name and password, if correct then the system goes to the main menu page and if wrong, the system will display the message "sorry login failed".

2. **Main Menu Flowchart**

   In the admin main menu **flowchart**, there are five main menus, namely the homepage which will display the home page, the database menu which will display disease, symptom and rule submenu, and the consultation menu which when clicked will display the consultation page, the **output menu** which if clicked it will display a diagnosis report submenu and a logout menu which if clicked will return to the login page.

3. **Disease Input Form Flowchart**

   In the disease **input form flowchart**, if the admin presses add data then the system will display the form add disease data and the admin inputs data by pressing the submit data button and the system will save the data, if the admin presses edit data then the system will display the disease data **edit form** and admin input data by pressing the update data button and the data will be updated and if you press delete then the system will delete data based on the deleted id.

4. **Flowchart of Symptom Input Form**

   In the symptom input form **flowchart**, if the admin presses add data then the system will display the add symptom data form and the admin inputs data by pressing the submit data button and the system will save the data, if the admin presses edit data then the system will display the symptom data **edit form** and admin input data by pressing the update data button and the data will be updated and if you press delete then the system will delete data based on the deleted id.

5. **Flowchart Input Rule**

   In the **flowchart of the input rule form**, if the admin presses add data, the system will display the add data rule form and the admin inputs data by pressing the submit data button and the system will save the data, and if you press delete, the system will delete the data based on the id you entered, deleted.
6. Diagnostic Flowchart

In the admin diagnosis flowchart first inputs the patient’s symptom data, then the system will perform the calculation process and produce a diagnosis of the disease experienced by the patient.

System Implementation

1. Login Page

Figure 2 Login Page

In Figure 2, the admin login page needs to input the user name and password, after that press the login button and the system will check the user name and password in the database. If the user name and password are in the database, the system will display the main page and if they are not in the database, the system will display an incorrect user name and password message.

```php
$sql = mysql_query("SELECT * from $table where user = '$user' and pass = '$pass'") or die(mysql_error());
if($sql > 0){
    if($row['level'] == 'admin') {
        $SESSION['admin'] = $row['id_user'];
        $SESSION['time'] = time()+20*60;
        header("location: index.php");
    }
    else {
        $SESSION['userid'] = $row['id_user'];
        $SESSION['time'] = time()+20*60;
        header("location: $path/index.php");
    }
} else {
    echo "User Name atau Password Salah!
    window.history.go(-1);"
} return 0;
```  

2. Admin Main Menu Page

Figure 3 Admin Main Menu Page

In Figure 3 the main menu page contains six main menus, namely the homepage which when clicked will display the home page, the input menu which will display disease, the symptom and rule submenus, the diagnosis menu which will display the diagnosis page, the output menu which will display a submenu of the diagnosis report, the user, which will display the user page and the logout menu, which will return to the login page.
3. Disease Input Page

In Figure 4, the disease input page, if the admin presses add data then the system will display the form to add disease data and the admin inputs data by pressing the submit data button and the system will save the data. If the admin presses edit data then the system will display the disease data edit form and the admin inputs data by pressing the data update button and the data will be updated. And if you press delete then the system will delete data based on the deleted id.

4. Symptom Input Page

In Figure 5, the symptom input page, you can see the list of symptoms with their details.
In Figure 5 the symptom input page, if the admin presses add data then the system will display the form add symptom data and the admin inputs data by pressing the submit data button and the system will save the data, if the admin presses edit data then the system will display the symptom data form and the admin inputs data by pressing the data update button and the data will be updated and if you press delete then the system will delete data based on the deleted id.

```
<?php
$sql = "SELECT * from tb_gejala";
while($query = mysql_fetch_array($sql))
{

<?}
<td><a href="#" class="btn btn-warning btn-xs">Add more</a></td>
<td><a href="#" class="btn btn-success btn-xs">Update</a></td>
<td><a href="#" class="btn btn-danger btn-xs">Delete</a></td>
```

5. Input Rule Page

In Figure 6 the input rule page, if the admin presses add data, the system will display the add data rule form and the admin inputs data by pressing the submit data button and the system will save the data and if you press delete, the system will delete the data based on the deleted id.

```
<?php
$sql = "SELECT * from tb_rule inner join tb_penyakit on tb_rule.id_penyakit = tb_penyakit.id_penyakit inner join tb_gejala on tb_rule.id_gejala = tb_gejala.id_gejala order by tb_penyakit.id_penyakit, tb_gejala.id_gejala";
```

6. Diagnosis page

In Figure 7 on the diagnosis page, the admin first inputs patient data and symptoms experienced by the patient, then the system will perform the calculation process and produce a diagnosis of the disease experienced by the patient.
7. Sample Report

In Figure 8 the diagnosis report is an output of an expert system for diagnosing typhoid disease using the Dempster Shafer method which contains diagnostic data that has been carried out by the admin.

System Test

The following is a case for testing software built using the Black Box method. This test attempts to find errors in the categories of incorrect or missing functions, interface errors, errors in data structures or external database access, performance errors, and initialization and terminal errors.
1. System Testing on the Login Page
   In the system test on the admin login page, the researcher performs a test scenario by emptying one of the textboxes and pressing the login button, and from the researcher's observations the system has run as (valid) as expected. The researcher also conducted a test scenario by inputting the appropriate user name and password in the database, and from the researcher's observations, the system was running as (valid) as expected.

2. System Testing on the Admin Main Page
   In the system test on the admin main menu page, the researcher performs a test scenario by clicking the dashboard menu, and from the researcher's observation the system has run as (valid) as expected. The researcher also conducted a test scenario by clicking the logout menu, and from the researcher's observation, the system was running as (validly) as expected.

3. System Testing on the Disease Data Page
   In the system test on the disease data page, the researcher performs a test scenario by clicking the add button, and from the researcher's observations the system has run as (valid) as expected. The researcher also conducted a test scenario by clicking the delete button, and from the researcher's observations, the system was running as (validly) as expected.

4. System Testing on Symptom Data Pages
   In the system test on the symptom data page, the researcher performs a test scenario by clicking the add button, and from the researcher's observations the system has run as (valid) as expected. The researcher also conducted a test scenario by clicking the delete button, and from the researcher's observations, the system was running as (validly) as expected.

5. System Testing on the Rule Data Page
   In the system test on the rule data page, the researcher performs a test scenario by clicking the add button, and from the observations of the researcher, the system has run as (valid) as expected. The researcher also conducted a test scenario by clicking the delete button, and from the researcher's observations, the system was running as (validly) as expected.

System Accuracy Test
   System accuracy testing is done to determine the accuracy of a system. Testing the accuracy of this system is done using a confusion matrix. Based on 10 data from the results of the diagnosis using the Dempster Shafer method with the results of the diagnosis carried out by experts, 8 data that match the expert results with the results of the Dempster Shafer system and 2 data results using the Dempster Shafer method that is not by the expert results.

   \[ x = \frac{ji}{ji + hd} \times 100 \%
   \]

   \[ x = \frac{8}{10} \times 100 \% = 80\%
   \]

   Is known:
   \[ x : \text{variable adjustment of expert results with the results of Dempster Shafer}\n   \]

   Table 2 Results of Appropriate and Incompatible System Testing Data

<table>
<thead>
<tr>
<th>Name</th>
<th>Disease Typhoid</th>
<th>Expert result</th>
<th>note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siti Raehana</td>
<td>Epidemic Typhoid</td>
<td>Epidemic Typhoid</td>
<td>match</td>
</tr>
<tr>
<td>Suci Fitria</td>
<td>Epidemic Typhoid</td>
<td>Epidemic Typhoid</td>
<td>match</td>
</tr>
<tr>
<td>Gita</td>
<td>Scrub Typhus</td>
<td>Scrub Typhus</td>
<td>match</td>
</tr>
<tr>
<td>Ardi</td>
<td>Endemic Typhoid</td>
<td>Endemic Typhoid</td>
<td>match</td>
</tr>
<tr>
<td>Rezky</td>
<td>Scrub Typhus</td>
<td>Endemic Typhoid</td>
<td>did not match</td>
</tr>
<tr>
<td>Kiano</td>
<td>Endemic Typhoid</td>
<td>Endemic Typhoid</td>
<td>match</td>
</tr>
<tr>
<td>Kahar</td>
<td>Scrub Typhus</td>
<td>Scrub Typhus</td>
<td>match</td>
</tr>
<tr>
<td>Nurhasda</td>
<td>Scrub Typhus</td>
<td>Scrub Typhus</td>
<td>match</td>
</tr>
<tr>
<td>Siti Susanti</td>
<td>Endemic Typhoid</td>
<td>Endemic Typhoid</td>
<td>match</td>
</tr>
<tr>
<td>Nasir</td>
<td>Endemic Typhoid</td>
<td>Scrub Typhus</td>
<td>did not match</td>
</tr>
</tbody>
</table>

   In table 2, the appropriate and inappropriate system testing, the researchers conducted tests to determine the accuracy of the Dempster Shafer method expert system with the results of the diagnosis carried out by experts and from the tests carried out by the researchers that two data that did not match, namely the results of

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the Rezky and Nasir diagnose. According to the results of Dempster Shafer Rezky, he was diagnosed with Scrub Typhus, while according to the expert, Rezky was diagnosed with Endemic Typhoid and Dempster Shafer Nasir was diagnosed with Epidemic Typhoid, while according to the expert, Nasir was diagnosed with Scrub Typhus. So from 10 data there are 8 data that match the expert results with the results of Dempster Shafer with an accuracy rate of 80%.

V. Conclusion

Based on the discussion in the previous chapters, the researcher can conclude several things by using an expert system to diagnose typhoid disease using the Dempster Shafer method as follows:

1. By using an expert system to diagnose typhoid disease using the Dempster Shafer method, it can diagnose typhoid in patients with 80% accuracy testing.

2. Based on the results of black box testing, it can be concluded that the expert system for diagnosing typhoid using the Dempster Shafer method is free from program errors.

References