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Expert System for Diagnosing Early Symptoms of COVID-19 Using the Certainty Factor Method

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ABSTRACT

Coronavirus Disease 2019 (COVID-19) is a viral pathogen that is the main cause of outbreaks of respiratory diseases that can cause respiratory problems such as lung infections and can cause death. The spread of COVID-19 moves quickly, where people can be infected without showing symptoms, and have the ability to be able to spread it to other people. This of course makes it very difficult for the community to detect early symptoms that arise in the community. In this study, the classification of symptoms that arise using the expert system model with certainty factor method is carried out to find out the symptoms that arise based on clinical symptoms that have been determined by the government. The results of this study show that the expert system model with the certainty factor method can provide 92% accurate results which show the initial clinical symptoms of being infected with COVID-19 in accordance with government regulations. The certainty factor method in the expert system model to detect early clinical symptoms is very suitable to be used, because it can provide accurate results and can be used as a reference in the diagnosis of COVID-19.

1. Introduction

An application which is used to provide problem solving solutions that usually require human intelligence and use human knowledge[1]. Coronavirus 2019 (COVID-19) better known as severe acute respiratory syndrome which can pose a significant danger to human life in all countries[2]. COVID-19 was initially divided into four types: mild, moderate, severe, and critical cases.³ However, with the global outbreak of coronavirus, there is increasing evidence that many COVID-19 infections are asymptomatic, but that they can transmit the virus to other people[3]. The implementation of an expert system in the medical world has been carried out with the aim of supporting the doctor's diagnosis process and also giving consideration to the diagnosis results in accordance with the clinical symptoms that appear based on what has been determined[4]. Knowledge of a problem in the medical field by an expert in diagnosing a disease is always associated with uncertainty, so to overcome this, a classification process is carried out with the aim of knowing the group of symptoms that are in accordance with the disease that arises, one of them by using an expert system model[5]. The current spread of COVID-19 has certainly entered a very high level of risk so that people are expected to have attention and concern in dealing

with the transmission of COVID-19. In order to help the public understand in detail the symptoms and impacts caused by the coronavirus, an expert system is needed to be able to recognize the early clinical symptoms that appear in Covid-29. This research is more focused on determining the initial clinical symptoms of COVID-19 infection by using an expert system model and the certainty factor method. Currently, the public lacks understanding or education about transmission models, the impacts that arise on health, and how to prevent the spread of COVID-19. Based on the description above, the author is interested in developing an expert system in detecting early clinical symptoms of Covid-19 infection

2. Related Work

Expert system is one of the fields of artificial intelligence, which is known as a knowledge-based system that utilizes computers as a medium to implement various rules and contains knowledge and analysis performed by humans in solving certain problems[6]. An expert system is an application designed to be able to adapt and imitate human knowledge to be implemented in computers through programming languages so that applications in computers can be used to solve problems as experts do[7]. An expert system is a computer-based application that utilizes knowledge, facts, and rules of

reasoning techniques as a basic reference in solving problems that are usually solved by experts in a particular field, and also tries to represent and duplicate certain functions and procedures so as to be able to solve problems like an expert in a particular field[8]. Certainty theory is a framework for representing and measuring the level of certainty or trust in a solution modeled in the form of a percentage of truth in a knowledge-based system, also representing the level of confidence in a fact or hypothesis based on the data or evidence provided[9]. Still according to [9] that, the CF value is between -1 (definitely wrong) and +1 (definitely true) to measure the level of confidence (positive number) and uncertainty (negative number) of the conclusions generated by the system. To measure the certainty factor according to [9], that the equation as below is carried out:

$$CF[h,e] = MB[h,e] - MD[h,e] \tag{1}$$

Noted:

CF[h,e] = Certainty Factor

MB[h,e] = Size of trust/confidence level of hypothesis h, if given/influenced evidence e (between 0 and 1)

MD[h,e] = Size of distrust/uncertainty level of hypothesis h, if given/influenced evidence e (between 0 and 1)

4. Methodology

This chapter provides information about the research method which consists of several stages, namely: the research framework, the research method to be used, the development of the model, and the research plan to be carried out.

a. Research Method

This study uses the Design Science Research method as depicted in Figure 1, where the stages have several processes, namely

1. Goal-Based Solution Detection (Literature Study), The process of collecting various references such as supporting theories taken through various sources such as books, journals, and previous research, which are included in the bibliography.
2. Problem Identification and Motivation, the stages used to collect and identify the main problems in the research, and collect various facts behind the problem, so that research is important to do.
3. Determination of Research Objectives, The research objective is one of the processes to describe the impact of the results of the research conducted, it is also a description of the problem solving process that underlies the implementation of research in achieving the stated goals.
4. Solution Design and Development, This stage is a process to design and implement the research results that have determined the direction. is

described in the form of a UML diagram. This stage is also used to define the minimum requirements for software and hardware as a reference for implementing research results.

5. Demo, This process is carried out to find out the performance of each feature in the application that has been designed and also to find out what features are still having obstacles to support the research results.
6. Testing, is a stage carried out to test the performance of the system that has been designed and evaluate the performance of the system against bugs and errors found in the implementation process. The testing process is also carried out at this stage.
7. Discussion, This stage is used to determine the performance of the system to the response generated by user interaction with the application and also to perform maintenance on features that experience process failure when the application is implemented.
8. Conclusion, The conclusion stage is used to conclude a result from the research obtained from the discussion stage.

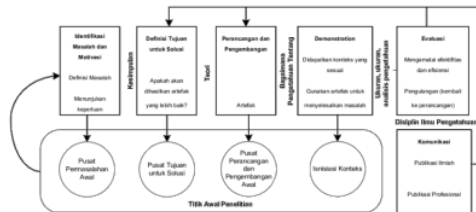


Figure 1 Metode Design Science Research

c. Research Plan

The research process to be carried out is an experimental research model using the Design Science Research Methodology (DSRM) method which is divided into 6 stages, as shown in Figure 2. The stages include.

1. Problem Identification & Motivation, this process is carried out to identify the main problems in research, identify data sources and research locations, and determine rules and knowledge bases as a reference in providing diagnostic results to users. The data collection process was carried out by interviewing experts and observing data at the location of the health service center.
2. Definition of Goals for Solutions, this process is carried out to describe the objectives to be achieved in the research, using the certainty factor method which is implemented in the expert system application.
3. Design & Development, This stage is carried out to design the model to be proposed along with the

features that have been previously determined and the testing process scheme to support the implementation of the expert system that will be proposed as a solution in solving problems.

4. Demo or Implementation, at this stage, the design that has been made will be implemented which is then carried out with a validation test process and a testing process for all the features that have been developed, including the mechanism for the application performance test process.
5. Evaluation, The evaluation process is a mechanism to see whether the system is running well or not, it is also carried out to see the failure of every process carried out by the user. The results of the evaluation are used as a reference to carry out the maintenance process on the system.
6. Communication, at this stage, the results of the research are published in the process of publication as a form of contribution in the field of research.



Figure 2 Research Plan

5. Result and Discussion

At this stage, information will be conveyed about the initial process in determining the goals and solutions to the main problems and research so that an application design is obtained that is in accordance with the needs of the community as part of the process of breaking the chain of spread of COVID-19. These stages include:

a. Problem Identification

Infection with the Covid-19 virus has caused great concern for people's lives, where they cannot know when they are infected or not. The lack of understanding about infection and symptoms of the covid-19 virus makes people not care and feel no need to check on available health services. . The problems faced are 1) The spread of COVID-19 infection is not followed by an increase in health workers, health facility service systems and the ability to trace users who are detected to have the opportunity to carry the Covid-19 virus. 2) Lack of public attention to the negative impact of covid-19 so that they don't feel the need to carry out an initial detection of symptoms that arise due to covid-19 infection. 3) Lack of availability of applications that can be reached by the public when visiting health facility services to know for sure the

initial clinical symptoms that appear when infected with COVID-19. So we need an expert system that can detect early clinical symptoms that appear in patients infected with COVID-19.

b. User Requirement

In designing information systems, user requirements are needed which are then implemented as part of the features contained in the system design. These features will be used to assist users in implementing the system as a whole. The user requirements include:

Tabel I. User Requirement

Functional	
Analisa Kebutuhan	
1	Menampilkan halaman utama
2	Menampilkan form <i>login user</i>
3	Menyediakan form pendaftaran <i>user</i>
4	Menampilkan menu konsultasi
5	Menampilkan menu data kasus
6	Menampilkan menu riwayat dapat mencetak dan hapus riwayat konsultasi
7	Menampilkan menu profil <i>user</i>
8	Menampilkan form <i>login administrator</i>
9	Menampilkan menu <i>dashboard admin</i>
10	Menyediakan form tambah gejala, hapus, dan ubah data gejala
11	Menyediakan form tambah kasus, hapus, dan ubah data kasus
12	Menyediakan form tambah pengetahuan, hapus, dan ubah data pengetahuan
13	Menyediakan form pencarian data, cetak dan hapus data diagnosa
14	Menyediakan form tambah admin, ubah, dan hapus data admin
15	Menyediakan form hapus data <i>user</i>

Non Functional

Saya ingin sistem dapat:

- 1 *Administrator* berhak mengakses seluruh data yang terdapat dalam aplikasi
- 2 *User* harus melakukan pendaftaran agar dapat berkonsultasi serta mengelola data yang dimiliki berupa *profil user* dan riwayat diagnosa
- 3 Mudah digunakan dan dipahami oleh *user*
- 4 Menyimpan dan mencetak hasil diagnosa penyakit

c. Alternative Solution

Based on the results of problem identification, it was found that the need for a system that makes it easier for the public to access the system to find out the early symptoms of being infected with COVID-19, including 1) Designing an expert system application to find out the types of early clinical symptoms of COVID-19 infection. 2) Create an expert system application that is able to assist the community in identifying COVID-19.

d. Provide Solution

Based on the results of the analysis on the point alternative solution, it can be formulated goals and solutions that are offered. The intended solution is an expert system application design that can facilitate the user in conducting the consultation process for the initial symptoms that arise. The solution design is described in the form of a UML model consisting of use cases, activity diagrams and relational databases. The proposed design can be seen below:

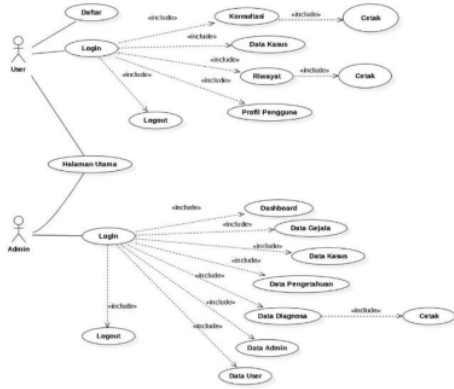


Figure 3 Use Case Diagram

In Figure 3 it is explained that the features that will be used in the proposed expert system application have several features. Where these features are represented in the form of a use case that will be implemented into the system as a whole

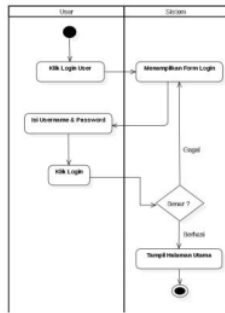


Figure 4 Activity Diagram

Activity diagram is the process of interaction between the system and the user, which describes the flow of information as a form of response between the user and the system

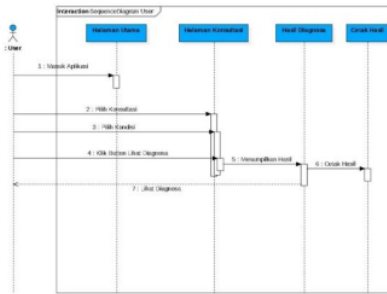


Figure 5 Sequence Diagram

Sequence diagram is a schematic that describes the flow of processes that occur in the system. Sequence diagrams also show the communication of the system to the sub-systems that are in it.

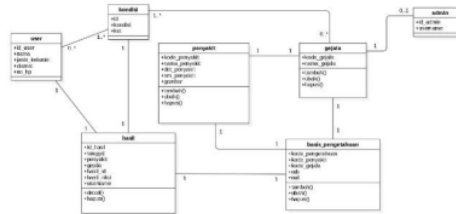


Figure 6 Database Relational

A relational database is a form of representation of a causal relationship between tables in the database. This relationship describes the relationship between data and information that can be processed in an expert system

e. Desain Model Expert System

The design of the expert system model is a representation of the user requirements for the application to be designed. The model designed is an interpretation of the community's need for the presence of a system capable of detecting early clinical symptoms of COVID-19 infection.

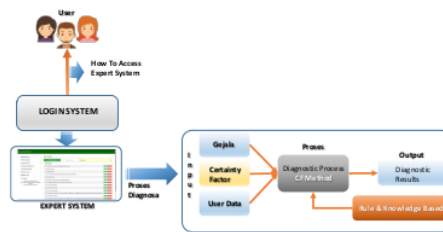


Figure 7 Expert System Model

Figure 7 above explains that the expert system application model designed is a representation of the decision-making process or determination of diagnosis

results based on symptom input data performed by the user. The model above explains that the determination of the results is based on the established rule base and knowledge base. The knowledge-based tables include:

Tabel II. Rule Based

No	Rule
1	IF G1 (0.4) AND G2 (0.4) AND G3(0.4) AND G5 (0.4) AND G10 (0.4) AND G12 (0.4) AND G13 (0.6) THEN P1
2	IF G1 (0.4) AND G4 (0.4) AND G6 (0.6) AND G7 (0.6) AND G8 (0.2) THEN P2
3	IF G15 (0.8) AND G11 (0.8) AND G9 (0.2) AND G14 (0.2) THEN P3

Tabel III. Knowledge Base

No	Knowledge
G1	Demam suhu tubuh 38 Derajat Celcius / lebih
G2	Sesak nafas
G3	Batuk kering
G4	Kongesti Hidung (hidung tersumbat, penumpukan berlendir)
G5	Bersin-bersin
G6	Hilangnya kemampuan indra perasa (ageusia)
G7	Hilangnya kemampuan indra penciuman (anosmia)
G8	Nyeri tenggorokan
G9	Kelelahan (fatigue)
G10	Sakit kepala/pusing
G11	Pernah bersentuhan fisik langsung (seperti bersalaman, berpegangan tangan) dengan seorang yang terkonfirmasi atau probable.
G12	Mual dan muntah
G13	Pada 14 hari terakhir sebelum timbul gejala memiliki riwayat tinggal atau bekerja di tempat berisiko tinggi penularan
G14	Mengalami penurunan kesadaran
G15	Pernah memberikan perawatan langsung terhadap kasus probable atau konfirmasi tanpa menggunakan APD

6. Testing & Implementation Phase

The implementation of the design results that have been carried out and the coding process using the PHP and MySQL programming languages are executed at this stage, where all the features that have been defined are tested through the testing process. The implementation stage is the stage where the application begins to be used according to the function that has been defined. The results of implementation and testing can be seen below:

Figure 8 Register Page

In Figure 8, space is given for the user to register first in accessing the system. The purpose of this registration process is to maintain the confidentiality of patient test results information on the level of infection in covid-19.

Figure 9 Login Page

In figure 9, the login process is carried out by each user and admin who will access the system, the purpose of this form is to maintain the security of information and data in the database that has been provided.

Figure 10 Consultation Process

In figure 10, the consultation process carried out by the user can be accessed in real time, where the user can determine the symptoms that may arise as well as other symptoms felt by the patient. This stage also provides accurate results based on the symptom data that has been inputted. The results of the diagnosis displayed refer to the rule base and knowledge base that have been programmed in this application, so that the results are given in the form of a confidence percentage.

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