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Expert System Prediction of Covid-19 Transmission Vulnerability using Forward Chaining

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ABSTRACT

Covid-19 is a pandemic that is currently sweeping the world, where the number of infected victims has reached millions. The sudden outbreak of the Covid-19 pandemic has caused unprepared communities to panic and worry, although there are also those who are indifferent or unconcerned about this contagious disease, which is a major factor in the rapid spread of the virus. This study aims to build a system to predict the vulnerability of users to contracting Covid-19 through an expert system application. The expert system method uses forward chaining to determine the user's vulnerability level based on factors used and inputted by the user. The large number of patients who still do not believe in the existence of Covid-19 and the spread of hoax news complicates the handling of Covid-19. With an expert system that predicts vulnerability to contracting the Covid-19 virus as a tool, it can increase awareness among low-awareness communities and reduce the spread of the Covid-19 virus.

1. Introduction

The world has been hit by several pandemic cases, and these pandemics have had a significant impact on both the economy and health. Pandemics can last for a long time and can claim thousands to millions of lives. However, pandemics have been successfully controlled, reducing their spread and minimizing economic losses and casualties. The author explains the background of the research, problem identification, problem limitations, problem formulation, literature review, and previous research (references from journals/scientific publications within the last 3 years). Additionally, the author also explains the purpose and benefits of the research. The background of the research, problem identification, problem limitations, problem formulation, purpose, and benefits of the research are written without sub-sections.

At the end of 2019, a new outbreak hit Wuhan, Hubei Province, which is one of the provinces in China. This *pneumonia* outbreak was caused by the coronavirus [1] [2], which continued to spread throughout China and eventually worldwide. At the end of January 2020, the World Health Organization (WHO) [3] reported the SARS-CoV-2 [4] outbreak as a global health emergency.

The coronavirus is classified as a superdomain of biota, within the virus kingdom. The coronavirus is the largest group of viruses in the *Nidovirales* order. All viruses in the *Nidovirales* order are non-segmented positive-sense RNA viruses. The coronavirus is classified in the family *Coronaviridae*, subfamily *Coronaviridae*, genus *Betacoronavirus*, and *subgenus Sarbecovirus*. The classification of viruses was initially based on serology, but now it is based on phylogenetic classification [5]. The early similarity of symptoms of coronavirus with the common flu has caused people to be unsure about the existence of a new deadly virus outbreak. This is compounded by rumors circulating on the internet related to the COVID-19 virus [6], which has impacted the awareness of the public to take early preventive measures to stop the spread of the virus.

The outbreak of COVID-19 has affected the conditions of Jatiuwung Tangerang health center, by improving the existing health protocols and adding health protocols such as the 3M protocol (wearing a mask, washing hands, and maintaining distance). The Jatiuwung health center also plays a role in helping to manage the spread of the COVID-19 virus by providing education and knowledge related to the COVID-19 outbreak, identifying residents who are suspected of having COVID-19, managing nearby residents who are suspected to have high risk or have been infected with the COVID-19 virus, and documenting Jatiuwung residents who have received the first and second doses of the vaccine. The role of the health center is limited to helping and not treating, administering treatment and/or quarantining COVID-

19 patients. If there is a COVID-19 patient with symptoms, they will be referred to a specialized facility such as a COVID-19 patient accommodation or a hospital. COVID-19 patients without symptoms will undergo self-quarantine. Although the role is only to assist, it does not mean that there are no difficulties encountered. Difficulties include rejection from residents who are suspected of having COVID-19 and family members who will undergo PCR (Polymerase Chain Reaction) testing. This happens due to a lack of understanding and the existence of punishments and incorrect social views of COVID-19 patients, resulting in rejection of those diagnosed with COVID-19, and some residents refusing vaccination due to believing fake news circulated on the internet. The existence of these problems proves that there is a low level of awareness and understanding of COVID-19 cases.

2. Method

To help raise awareness and prevent the spread of the COVID-19 pandemic, the author has developed an expert system that can predict the susceptibility to COVID-19 infection based on user's internal and external factors using the forward chaining method [7].

A. Forward Chaining

Forward chaining is data-driven because inference starts with available information and new conclusions are obtained. If an application creates a wide and shallow tree, forward chaining can be used. The forward chaining process is straightforward and has a relatively high level of accuracy. It is also supported by available information and the calculations using forward chaining are fast. With the reasons and justifications mentioned above, the author feels that the forward chaining method is suitable for use. The expert system will be implemented in the form of an Android application [8] to make it easier and more convenient to use.

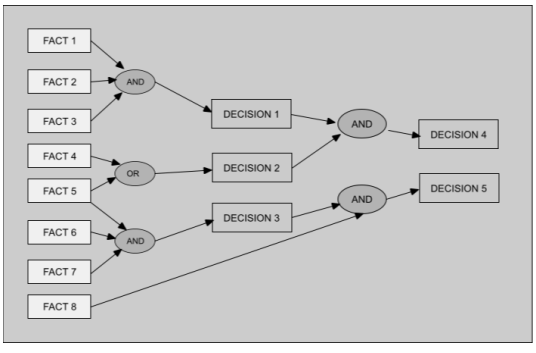

Figure 1. Forward Chaining

B. Research Object

This research is a direct study of the Jatiuwung Community Health Center, in order to obtain accurate data for mapping the location, by studying the current system to understand the details of the health center's profile. The following are the data collected from observational studies:

1. Literature Review

   At this stage, the researcher collects and studies journals and articles with the aim of increasing insight and knowledge in the topic of the research. The researcher also conducts research and monitors the latest developments related to the Covid-19 virus through news portals such as CNN Indonesia, Kompas and CNBC Indonesia and the official government website covid19.go.id to see the spread and data of Covid-19 cases in Indonesia.

2. Interviews

   Data collection method conducted through face-to-face interviews and direct question and answer between the researcher and the informant. Obtaining information by asking and conducting surveys with officers who work at the Jatiuwung community health center.

3. Observation

   At this stage, the researcher observes the Jatiuwung community health center to increase insight and knowledge in the research process by conducting direct interviews with general practitioners who have undergone special training for handling the Covid-19 virus and have a better understanding and knowledge for Covid-19 cases.

4. Testing

   The steps that have been taken in this session are tested systematically, including the functional and robustness of the system. From the validation, the suitability of the design results with the expected needs analysis can be known.

C. Expert System Design

An expert system consists of several main components that must be possessed, including Expert, Knowledge, Inference Engine, and Data Base. To fulfill all of these components, an expert system is created consisting of [9]:

1. Expert

   The expert selected for this system is a general practitioner who has knowledge about the Covid-19 virus and vaccination. General practitioners assist specialist doctors who go directly to the field in handling Covid-19 patients and vaccinating residents in the surrounding area.

2. Knowledge

   Knowledge is the special skills possessed by an expert that will be used as the basis for determining the flow of an expert system. The following knowledge is also obtained from the expert:

a. Vulnerability Factors

The following are vulnerability factors that are considered the easiest to detect and the most decisive in determining vulnerability to covid-19 infection[10]:

1) Age Age is divided into 4 age ranges used from ages 0-15, 16-30, 30-45, and 46-60 and above.

2) Gender As we know, there are only 2 genders: male and female.

3) Comorbidities The comorbidities used are common comorbidities and those with a high potential for increasing a person's vulnerability to covid-19 infection. The following are the comorbidities used: Hypertension, Chronic Obstructive Pulmonary Disease, Immunodeficiency, and Respiratory Disorders.

4) Vaccination Vaccination plays a significant role in preventing someone from contracting covid-19. The vaccination stage, as we know, is divided into 2 vaccination stages. The results of interviews conducted found that the first vaccination affects immunity up to 60%, the second vaccination affects immunity up to 80%-90%, and those who have not been vaccinated are at a very high risk of contracting covid-19.

5) Work Environment The work environment also plays a role in influencing a person's vulnerability. The work environment is divided into 3 categories: indoor, outdoor (field), and health agencies (such as community health centers and hospitals).

6) Residential Environment In the residential environment, a zoning system is used that is divided into 4 zones, which are obtained from the zoning division applied by the government, namely green zone, yellow zone, orange zone, and red zone.

b. Vulnerability Level

Vulnerability level is categorized into 3 levels: low, medium, and high, and is obtained from the factors possessed by the application users.

c. Inference Engine

The inference engine is a flow created in such a way as to solve a problem in an expert system. From the above knowledge, an inference engine can be arranged with a forward chaining flow.

d. Object Table

The Object Table is a grouping of several objects into a table that have the same characteristics. The Object Table formed is as follows:

Table 1. Object Table

No	*Object*	*Value*
1	Low	Male
		Female
		Age between 0-15
No	*Object*	*Value*
1	Middle	There are no comorbidities.
		2nd time vaccination
		In Room
		Green Zone
2	Middle	Male
		Female
		Age between 16-30
		Age between 31-45
		Hypertension
		1 time vaccination
		Outside Room
		Yellow Zone
		Orange Zone
3	High	Male
		Female
		Age between 46-60
		Chronic Obstructive Pulmonary Disease
		Autoimmune
		Breathing difficulty
		Not vaccinate yet
		Health Institution
		Red Zone

D. Database

In creating the information base of an expert system, all knowledge must be translated into rule-based form to create a consistent expert system. The following is the rule base that has been successfully constructed:

Table 2. Factor

No	*Code*	*Factor*
1	F01	Male
2	F02	Female
3	F03	Age between 0-15
4	F04	Age between 16-30
5	F05	Age between 31-45
6	F06	Age between 46-60
7	F07	Hypertension
8	F08	Chronic Obstructive Pulmonary Disease
9	F09	Autoimmune
10	F10	Breathing difficulty
11	F11	There are no comorbidities
12	F12	1 time vaccination
13	F13	2nd time vaccination
14	F14	Not vaccinate yet
15	F15	In Room
16	F16	Outside Room
17	F17	Health Institution
18	F18	Green Zone
19	F19	Yellow Zone
20	F20	Orange Zone
21	F21	Red Zone

Table 3. Risk Level

No	*Code*	*Risk Level*
1	R01	Low
2	R02	Middle
3	R03	High

Table 4. Matrix

No	*Code*	*Risk Code*		
		R1	*R2*	*R3*
1	F01	✓	✓	✓
2	F02	✓	✓	✓
3	F03	✓		
4	F04		✓	
5	F05		✓	
6	F06			✓
7	F07		✓	
8	F08			✓
9	F09			✓
10	F10			✓
11	F11	✓		
12	F12		✓	
13	F13	✓		
14	F14			✓
15	F15	✓		
16	F16		✓	
17	F17			✓
18	F18	✓		
19	F19		✓	
20	F20		✓	
21	F21			✓

E. Diagram of System Design

In this proposed information system design research, the orientation is towards using Astah to illustrate Use Case Diagrams [11], Activity Diagrams , Sequence Diagrams, and Class Diagrams [12]

1. Use Case Diagram

The use case diagram illustrates the expected functionality of a system. The emphasis is on "what" the system does, not "how" it works. A use case represents an interaction between an actor and the system.

Figure 2. The Use Case Diagram of System

Based on the use case diagram, the explanations are as follows:

a. Login Use Case The admin must log in first to access the application.

b. Manage Vulnerability Factor Data Use Case The admin can add, delete, or make changes to vulnerability factors.

c. Manage Vulnerability Level Data Use Case The admin can add, delete, or make changes to vulnerability levels.

d. Manage Rule Base Use Case The admin can add, delete, or make changes to the rule base.

e. Manage User Data Use Case The admin can add, delete, or make changes to user data.

f. Consultation Use Case Users can consult the application by utilizing the expert system.

g. Prediction Results Use Case Users can obtain prediction results by consulting the application utilizing the expert system.

h. Prediction Results Use Case The admin can view the consultation results that have been saved in the system.

3. Results and Discussion

In the implementation process of the expert system for predicting the vulnerability of contracting COVID-19 using the forward chaining method, requirements specifications are needed such as hardware, software, and brainware users. The requirements will be explained below:

A. Application Interface Display

1. Android Application Home Page.

Figure 3. First page of Android Application

The home page is the first page that will appear and be seen by application users before proceeding to the diagnosis page on the application to fill out the provided questions.

B. Page of Diagnosis

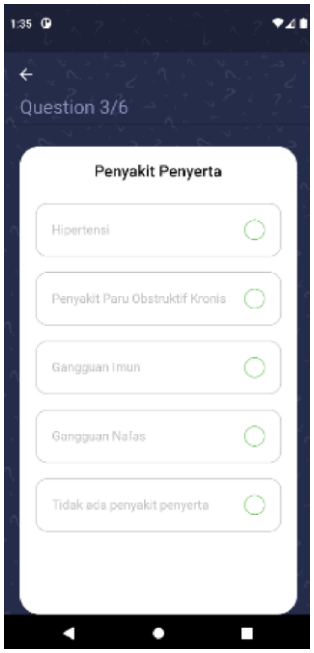

Figure 4. Page of Diagnosis

On the diagnosis page, users will be shown prepared questions, and the user is required to choose 1 (one) answer from several answer options given for each question. The user's answer results will be used to determine the prediction of the risk level of contracting COVID-19.

C. Page of Diagnosis Results

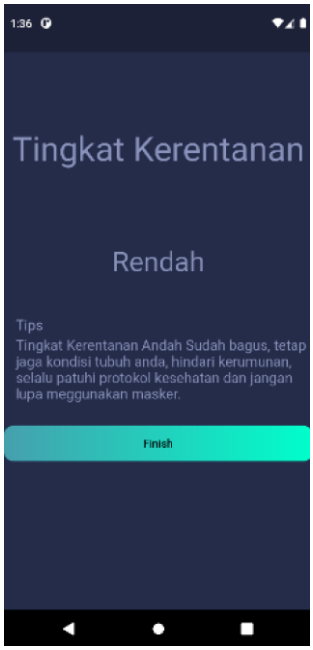

Figure 5. Page of Diagnosis Results

The diagnosis page on Android functions as the result of the user's answers to each question provided on the diagnosis page. On this page, the predicted risk level and advice or tips to prevent the user from contracting COVID-19 will be displayed.

4. Conclusion and Suggestion

A. Conclusion

After conducting analysis and research on the COVID-19 disease that is present among the general public and the Jatiuwung health center staff, the author can conclude the following:

1. The COVID-19 patient handling system using the Forward Chaining algorithm can help predict the user's vulnerability level and facilitate the handling of COVID-19 patients.
2. The challenges faced in handling many people who still do not understand the danger of COVID-19 and are influenced by the spread of hoax news, compared to skilled medical experts.
3. The implementation of the expert system design using the forward chaining method on the vulnerability prediction system for COVID-19 transmission goes through several stages, beginning with collecting vulnerability factor information, managing data combination by creating a combined data between vulnerability level information and vulnerability factor information, ensuring user needs through elicitation, designing a new procedure with UML, designing a database with MySQL [13] and the system is designed using the PHP programming language [14] using Visual Studio Code, and testing the vulnerability level by sorting the

vulnerability factors in the consultation form.

B. Suggestion

The expert system that has been developed still has some weaknesses both in terms of data and functionality. Therefore, further development is needed to provide better benefits to the community. Some things that can be developed are as follows:

1. Combining the forward chaining method with other methods to obtain more accurate results.
2. The implementation of the program can be made in the Dart and PHP programming languages.
3. References about vulnerability factors and vulnerability levels data can be increased, so that the obtained factor data becomes more accurate and of higher quality.

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