Telegram Bot-Based Expert System as A Detection Tool for Early Symptoms of Borderline Personality Disorder

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Abstract— The prolonged COVID-19 pandemic may cause stress that leads to both physical and mental health issues, especially for those who categorized as mentally fragile people, such as the people with Borderline Personality Disorder (BPD) where their fragility is caused by overreaction to stress compared to normal people. This journal explains how AI is applied in form of a Telegram-bot based expert system that aims to be a tool to detect early symptoms of BPD and provide treatment advice to people with BPD (PWBPD) as well as people who can potentially be PWBPD, according to recommendation of the psychologist. This research was conducted with qualitative method. The data collection is done by interview and literature study. Application development is carried out using waterfall method, forward chaining reasoning method, PHP, and MySQL. Application testing is done by interview to psychologist. The study shows an overall result that this tool is useful in providing education, detection, and the right ways to treat early symptoms of BPD. This application is also considered interesting and easy to use. The application testing results have been confirmed to pass the qualitative test using interview method with the psychologist and BPD expert, Dr. Christin Wibhowo, S.Psi, M.Si.

Keywords— borderline personality disorder, expert system, telegram bot.

I. INTRODUCTION

On January 30, 2020, World Health Organization (WHO) has declared the current COVID-19 outbreak as Public Health Emergency of International Concern (PHEIC). Corresponding to this statement, Indonesian government has also declared various restrictions on public activities, such as Pembatasan Sosial Berskala Besar (PSBB) and Pemberlakuan Pembatasan Kegiatan Masyarakat (PPKM) in order to minimize human physical contact and reduce the transmission of COVID-19.

All these restriction enforcements gradually resulted in various negative impacts in many sectors, such as the health, economic, tourism, socio-cultural, and other sectors [1]. Especially for mentally fragile people, the ongoing COVID-19 pandemic situation may cause stress that leads to both physical and mental health issues [2]. According to [2], this fragile group includes people with BPD whose fragility is caused by an act of overreaction to stress compared to normal people.

Theoretically, BPD is a mental disorder characterized by pervasive pattern of interpersonal relationship instability, unstable self-image, extreme mood swings, and extreme reactivity to interpersonal stresses that usually include impulsive reactions such as self-mutilating and suicidal behavior [3]. Unfortunately, along with the number of BPD sufferers that keeps increasing, lack of research regarding to BPD in Indonesia causes the actual numbers of PWBPD to be unclearly known [4].

Although the number of PWBPD in Indonesia is not yet known, according to [5], the total number of mental disorder sufferers in Indonesia has reached 236 million people

and only less than 15% of them get the necessary mental health treatments. This is aligned with the previous statement of WHO which revealed that in low-middle income countries including Indonesia, there is still gap in mental health treatment.

Apart from income issues, there is also wrong stigmas about mental illness in society, such as people with mental disorders are often considered strange, deserves to be ostracized from society, and can embarass the family [6]. There is also lack of awareness and public knowledge about the symptoms of mental disorders, that cause people with mental disorders to underestimate their condition, avoid to seek help from the experts, and late to receive mental health treatments from the psychiatrists or psychologists [7].

In the other hand, the rapid advance of technology nowadays can be used to solve this problem. The Telegram bot-based expert system in this research can be seen as a system that obtained its knowledge from psychologists that consists of sets of early BPD symptoms, solutions, and follow-ups that can be carried out to overcome the early symptoms non-medically. In addition, the use of Telegram bot in this expert system is intended to be flexibly accessed online under the supervision of psychologist at a low cost with only an activated computer or smartphone in the user's hand.

Using this expert system, people with BPD that is unable to directly meet a psychologist can still gain a better understanding of their psychological condition and can effectively obtain initial treatment based on psychologist's recommendation itself.

II. LITERATURE REVIEW
A. RISKS OF BPD

According to [3], the characteristic of BPD consists of hypersensitivity to rejection resulting in impulsive behavioral tendencies and difficulty to establish interpersonal relationship with others. Besides, some BPD patients also have shown actual signs of self-damaging behavioral tendencies. About 17-80% of people with BPD have shown a tendency to physically self-harming behaviors [8], while 46-92% of people with BPD had suicidal ideation and a total of 5.9% of them has died by suicide [9].

B. BPD SYMPTOMS DETECTION

There are 9 symptoms of BPD according to [3]:
1. Frantic efforts to real or imagined abandonment.
2. A pattern of unstable and intense interpersonal relationships characterized by extreme alternating between idealization and devaluation.
3. Persistently unstable self-image.
4. Potentially self-damaging impulsivity in at least two areas (e.g., spending, sex, substance abuse, reckless driving, binge eating).
5. Iterative suicidal or self-mutilating behavior.
6. Affective instability due to reactivity of mood.
7. Chronic feelings of emptiness.
8. Inappropriate anger or difficulty to control anger.
9. Temporary stress-related paranoid ideation.

The diagnosis of BPD can be carried out through interview. If an individual experienced at least 5 of 9 symptoms mentioned above, they can be diagnosed to suffer from BPD.

C. EXPERT SYSTEM DEFINITION

An expert system is a system that strived to input expert's knowledge into computer using a certain programming language so that the computer can solve problems by doing the reasoning effort like an expert herself/himself [10]. According to [10], expert systems indeed cannot completely replace the role of an actual expert, but it can draw conclusions based on the expert's knowledge that has been stored into the system.

D. BASIC STEPS OF EXPERT SYSTEM DEVELOPMENT

According to [11], there are several basic stages that must be passed to develop an expert system:
1. Determining problems and the source of knowledge
2. Obtaining knowledge from the expert
3. Deciding a matching approach
4. Writing expert system program
5. Testing the performance of expert system

E. EXPERT SYSTEM COMPONENTS

There are 3 main componens that must exist in an expert system [11]:
1. Dialog structure

   An expert system requires information input from the users to be analyzed to finally produce a solution. Therefore, an expert system must implement an understandable Graphical User Interface/GUI that is also interesting and easy to use, so that the users can feel comfortable when interacting with the system.
2. Inference engine

   An expert system works by analyzing the information entered by users to produce a solution. Therefore, an expert system must be equipped with a control structure which is capable of performing analysis of various assumptions based on expert knowledge until a conclusion is possible to be decided.

   An inference engine can be built easily by implementing a reasoning method, such as forward chaining method that tries to do forward search iteratively based on the rules that match the premises until there are no more rules that match the premise (resulted to a new fact).
3. Knowledge base

An expert system adopts the expert knowledge to create solutions to solve the problems of the users. Therefore, the expert knowledge indeed needs to be stored completely, consistently, and accurately into the safe database.

F. TELEGRAM BOT API

Telegram provides a Bot Application Programming Interface/Bot API used to develop bots that contains system program designed with a simple query response interface that can be integrated by its users [12]. Using the Bot API, a user can make bots to do various tasks in a conversation concept where users can send messages to get responses from the bots.

The first step to make a Telegram bot is to finish bot setup by texting BotFather to ask for an authentication token. This token will be used later to access the Bot API. After granting the token, a bot developer can send requests to Bot API using the simple webhook method. According to [12], webhook is a method for an application to call another application to send real-time information by adding a URL link. The message sent by users will be forwarded to the software of the developer server immediately, then the Telegram server will handle the communication and encryption with the Bot API [13].

Responses sent by the Bot API will be in the form of Javascript Object Notation/JSON that received by the developer server using a JSON Post method, which is a method that contains 3 main functions, such as php:input function (to get the JSON strings), file_get_contents() function (to receive JSON datas and read it as string files), and json_decode() function (to get the JSON string and convert it into a PHP variable).

III. RESEARCH METHOD

Research method means a way to search again [14]. In this paper, the authors want to see the implementation of a Telegram bot-based expert system development as a detection tool for early symptoms of BPD and also to provide proper solutions for each of the symptoms. Since this topic still lacking of concept or theory from the previous researches and there is a need to explore, describe, and develop theory in a greater depth, therefore according to [14], the approach that matched this kind of research is the qualitative approach.

A. RESEARCH FLOW

Qualitative research is a research that seeks to understand social or human problems which are then described holistically using words and detailed views to informants naturally [14]. More clearly, the methodology of this research can be seen in the chart below:
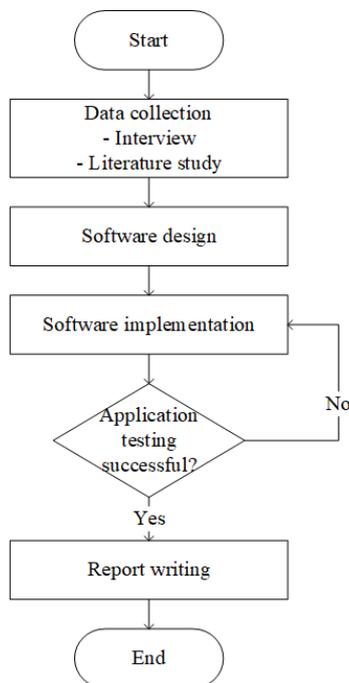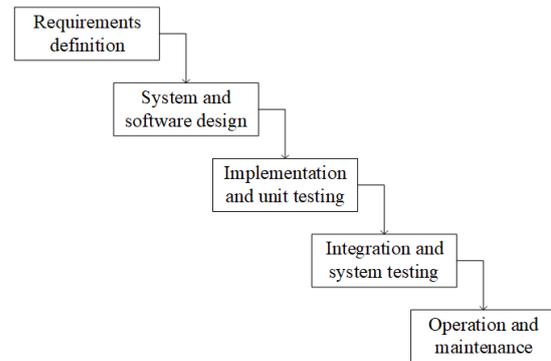

Figure 1.

Research Flow

B. APPLICATION DEVELOPMENT METHOD

Telegram Bot-Based Expert System as A Detection Tool for Early Symptoms of Borderline Personality

Disorder in this research was carried out using the waterfall application development method. The waterfall method is a system development method which is systematic and sequential [15]. The steps of waterfall method can be seen in Figure 2.

Figure 2. Waterfall Method

C. APPLICATION TESTING METHOD

The application testing in this research is being carried out using the interview method with psychologist, Dr. Christin Wibhowo, S.Psi, M.Si as the expert of BPD. The result acquired from this interview is used as the testing basis for the Telegram Bot-Based Expert System as A Detection Tool for Early Symptoms of Borderline Personality Disorder.

D. DATA SOURCES

According to [16], there are two types of data sources, such as primary data and secondary data. Data sources used in this research such as:

1. Primary Data

Primary data is a source of data that is directly provided to data collectors without intermediaries [16]. The primary datas in this research are obtained through an interview with the psychologist, Dr. Christin Wibhowo, S.Psi, M.Si.

2. Secondary Data

Secondary data is a source of data that is provided to data

collectors through intermediaries [16]. The secondary datas in this research are obtained through the previous international journals about BPD from other authors.

E. DATA COLLECTION

According to [16], the data collection in qualitative research can be carried out using observation, interview, questionnaire, documentation, and triangulation/combination method. Meanwhile, this research uses two data collection methods, such as:

1. Interview

   The authors collected data from a virtual interview with psychologist, Dr. Christin Wibhowo, S.Psi, M.Si as the expert of BPD to acquire further information about BPD, early symptoms of BPD, and proper solutions and daily follow-ups to handle BPD symptoms.

2. Literature Study

   In this research, the authors conducted a literature study by searching for theories and collecting informations about BPD through e-books, journals, thesis reports, and internet.

IV. DESIGN AND TESTING

The system and software design are summarized in 3 components, such as the the pseudocode that consists of each programming function in the expert system chatbot to perform its tasks, screenshots of Telegram bot-based expert system for users, and screenshots of admin website for psychologist. These design components are then followed by the application test results.

A. PSEUDOCODE

```
Establish database connection
Setting $botToken = ""
```

URL to acess Telegram bot API
```
$website="https://api.telegram.org/bot".$botToken;
```
Get information from webhook by JSON Post
Get user unique $chatId = $message["chat"]["id"];
Get user unique username $chatUsername=$message["chat"]["username"];
Get text messages sent by user $key= $message["text"];

If ($key = "Hi" || "Hello")
    Validate if user data record exists and has finished the question-and-answer process → initialize $query3 = get 'chat_id' and 'username' from table chat_history that the bot reply or 'balasan' has asked the last question or 'finish'. If 'finish' then display it as '1' and if not 'finish' then display it as NULL.
    Loop
    If Not Finish
        Bot replies $balasan = "You have not been checked. Please click Start"
    Else
        Bot replies $balasan = "You have been checked. Please click Follow Up, or if you have got the follow ups from PsikoBot and those solutions can't seem to solve your symptoms, go to psychologist. To re-check, please click Restart"
INSERT chat_id, chat_username, keyword, balasan, dinilai 0 INTO table chat_history
End

Else If ($key = "View Result")
    Validate if user data record exists and has finished the question-and-answer process → initialize $query3 = get 'chat_id' and 'username' from table chat_history that the bot reply or 'balasan' has asked the last question or 'finish'. If 'finish' then display it as

'1' and if not 'finish' then display it as NULL.
Loop
If Not Finish
 Bot replies $balasan = "You have not been checked. Please click Start"
Else
 Initialize $query3 → Count the user message or every different 'keyword' that valued 1 (everytime the user answered Yes to the symptoms asked by the bot) from table chat_history and display them as field 'dinilai' or score for each username
 Loop
 If 'dinilai' or $total score of Yes answers are greater or equals to 5
  Bot replies $balasan = "You seem to have some symptoms of Borderline Personality Disorder, such as :"
  Initialize $query4 → Get every different user message or 'keyword' from table chat_history that valued 1 (everytime the user answered Yes to the symptoms asked by the bot)
  Loop
  Initialize $queryhasil → Get user message 'keyword', symptom analysis 'nilai', and its solution 'solusi_1' for each symptom that user answered by Yes or valued 1
  Loop
  Bot sends messages that combine each symptom analysis 'nilai' and its solution 'solusi_1'.
 Else If 'dinilai' or $total score of Yes answers are lower than 5
  Bot sends message contains of symptom analysis $nilai that has been set to = "You do not seem to have any symptoms of Borderline Personality Disorder"

INSERT chat_id, chat_username, keyword, balasan, dinilai 0 INTO table chat_history
End

Else If ($key = "Follow Up")
Validate if user data record exists and has finished the question-and-answer process → initialize $query3 = get 'chat_id' and 'username' from table chat_history that the bot reply or 'balasan' has asked the last question or 'finish'. If 'finish' then display it as '1' and if not 'finish' then display it as NULL.
Loop
If Not Finish
 Bot replies $balasan = "You have not been checked. Please click Start"
Else
 Count the user message or every different 'keyword' that valued 1 (everytime the user answered Yes to the symptoms asked by the bot) from table chat_history and display them as field 'dinilai' or score for each username → initialize $query3
 Loop
 If 'dinilai' or $total score of Yes answers are greater or equals to 5
  Bot replies $balasan = "Welcome back, (.$chatUsername.). Previously, you have done the Borderline Personality Disorder symptom screening with PsikoBot and the results shown that you may have symptoms of Borderline Personality Disorder. Are the solutions given by PsikoBot can make you feel better?"
  Display instruction "Click one..." followed by inline keyboard buttons "Can" and "Cannot" for instant user input.
 Else
  Bot sends message contains of symptom analysis $nilai that has been set to = "You have not

shown any symptoms of Borderline Personality Disorder"
INSERT chat_id, chat_username, keyword, balasan, dinilai 0 INTO table chat_history
End

Else If ($key = "Cannot")
Initialize $query3 → Count the user message or every different 'keyword' that valued 1 (everytime the user answered Yes to the symptoms asked by the bot) from table chat_history and display them as field 'dinilai' or score for each username
    Loop
    If 'dinilai' or $total score of Yes answers are greater or equals to 5
        Bot replies $balasan = "Understood. Don't worry, you can continue to do some further tips below :"
        Initialize $query4 → Get every different user message or 'keyword' from table chat_history that valued 1 (everytime the user answered Yes to the symptoms asked by the bot)
        Loop
        Initialize $queryhasil → Get user message 'keyword', symptom analysis 'nilai', and its follow up 'solusi_2' for each symptom that user answered by Yes or valued 1
        Loop
        Bot sends messages that combine each symptom analysis 'nilai' and its follow up 'solusi_2'.
    Else If 'dinilai' or $total score of Yes answers are lower than 5
        Bot sends message contains of symptom analysis $nilai that has been set to = "You do not seem to have any symptoms of Borderline Personality Disorder"

INSERT chat_id, chat_username, keyword, balasan, dinilai 0 INTO table chat_history
End

Else
Initialize $query → get bot reply 'reply' and user score 'dinilai' from table tele_bot to every user message that has similar combination to particular 'keyword'
Loop
To fill bot reply $balasan, look for field 'reply' in table tele_bot
To fill user score $dinilai, look for field 'dinilai' in table tele_bot
If ($key = "Agree")
    Bot sends message that combines "Successfully reset conversation history of " and $chatUsername
    Initialize $query2 → Update 'deleted' status to true for each username from table chat_history
If ($key = "Restart")
    Bot sends message that combines "Successfully reset conversation history of ", $chatUsername, and "Please type Start to begin again..."
    Initialize $query2 → Update 'deleted' status to true for each username from table chat_history
If ($key = "Start")
    Display instruction "Click one..." followed by inline keyboard buttons "Agree" and "Disagree" for instant user input to gain user agreement to give honest answers only while entering the question-and-answer process later.
Else
    Begin the BPD symptoms detection process formed in 9 items of question-and-answer dialogues based on the knowledge base mapped in table tele_bot in the database
    If (bot reply $balasan = "Have you ever felt very upset, sad, or disappointed when someone else

ignored you and ended up moving away from that person so you don't get ignored next time?")

    Display inline keyboard buttons for instant user input : "Yes, I really don't like being ignored" and "No, I feel just normal to be ignored"

Else If (bot reply $balasan = "Have you ever engaged in impulsive (reckless, thoughtless) behavior that was harmful to yourself and others?")

    Display inline keyboard buttons for instant user input : "Yes, I often act impulsively" and "No, I never act impulsively"

Else If (bot reply $balasan = "Have you ever hurt yourself or thought to commit suicide?")

    Display inline keyboard buttons for instant user input : "Yes, I have" and "No, I never even think about it"

Else If (bot reply $balasan = "Is your mood or feeling quickly change from one to another drastically?")

    Display inline keyboard buttons for instant user input : "Yes, I often have mood swing" and "No, my mood tends to be stable"

Else If (bot reply $balasan = "Do you often feel lonely or empty?")

    Display inline keyboard buttons for instant user input : "Yes, I often feel lonely" and "No, I rarely feel lonely"

Else If (bot reply $balasan = "When you were angry, did you experience struggle to control emotion and ended up to act inappropriately/embarassing?")

    Display inline keyboard buttons for instant user input : "Yes, I'm explosive when angry" and "No, I stay in control when angry"

Else If (bot reply $balasan = "When you stressed, did you tend to be paranoid and end up to act different than how you used to?")

    Display inline keyboard buttons for instant user input : "Yes, I tend to do so when stressed" and "No, I'm good at managing stress"

Else If (bot reply $balasan = "Last question, have you ever felt that your interpersonal relationship situation with family, friends, partners, or others tend to be unstable, short-lived, or too idealist?")

    Display inline keyboard buttons for instant user input : "Yes, my relationships are unstable" and "No, my relationships are stable"

Else If (bot reply $balasan = "Thankyou for spending your time to honestly answer all PsikoBot's questions")

    Display inline keyboard buttons for instant user input : "View Result" and "Restart"

Else

    Bot send replies $balasan

End

Else (general bot response for all unpredicted user messages or 'keyword' in variable $key that has never been stored in database)

    Bot replies $balasan = "Thankyou, (.$chatUsername.), for spending time to greet PsikoBot. Please note, PsikoBot is a bot that can detect early symptoms of Borderline Personality Disorder that you may have. Therefore, when you are ready to be checked, type Start. If you want to get follow up for your daily life, type Follow Up (Start/Follow Up)"

INSERT chat_id, chat_username, keyword, balasan, dinilai INTO table chat_history

End

B. TELEGRAM BOT

Implementation of the Telegram bot-based expert system are shown in the screenshots below:

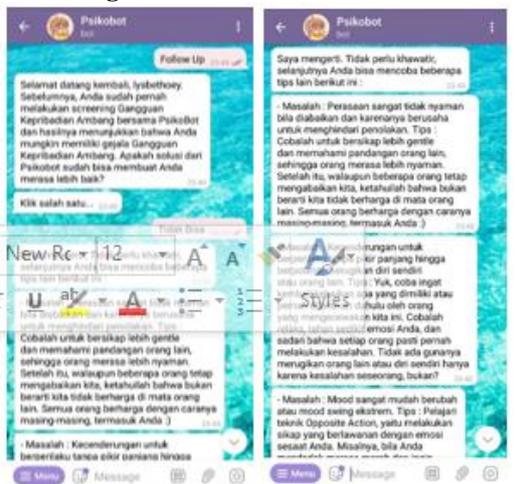**Figure 3. Welcome Message and "Start" Menu**

Figure 4. "View Result" Menu

Figure 5. "Follow Up" Menu

Figure 6. "Restart" Menu

Figure 7. Sample Result of Non-BPD Patient

C. ADMIN WEBSITE

Admin website is a website which developed for psychologist to supervise, manage, and download PDF reports of all Telegram bot-based expert system user. This website is integrated with the Telegram bot-based expert system database and contains conversation history between users and the bot. Implementation of the admin website for psychologist are shown in the screenshots below:

Figure 8. Admin Registration Page

Figure 9. Admin Login Page

Figure 10. Respondent Data Page

Figure 11. Print Respondent Data

Figure 12. PDF Download

Figure 13. PDF Report of A Respondent

D. TESTING RESULTS

After the software has finished the implementation stage, this expert system was then tested by the psychologist, Dr. Christin Wibhowo, S.Psi, M.Si during a virtual interview session to examine its feasibility.

The testing results, according to the statement of the psychologist herself, showed that the implementation of Telegram Bot-Based Expert System as A Detection Tool for Early Symptoms of Borderline Personality Disorder is good enough to use by the psychologist, because it can detect early symptoms of BPD using a simple scoring method and give proper solutions to handle each of the occurred symptoms in individuals accurately. When an individual shows at least 5 of 9 symptoms of BPD or get the "total score" of greater or equal to 5 during the question-and-answer detection process, then he can be concluded as person with BPD and then given the solutions to overcome the symptoms.

The Telegram Bot-Based Expert System as A Detection Tool for Early Symptoms of Borderline Personality Disorder is also effective to overcome early symptoms of BPD by giving solutions and necessary follow ups for daily life of the users based on the psychologist knowledge that has been completely mapped into the database of the expert system.

During the interview, the psychologist also stated that this Telegram Bot-Based Expert System as A Detection Tool for Early Symptoms of Borderline Personality Disorder is also able to educate people about the detection, symptoms, and proper solution/treatments as well as to give follow ups to overcome BPD symptoms in daily life of individuals, so that people can have deeper understanding and awareness about BPD.

According to the psychologist herself, this Telegram Bot-Based Expert System as A Detection Tool for Early Symptoms of Borderline Personality Disorder is also considered interesting because of its inline keyboard buttons for instant user input, reminder when question-and-answer session of a user is not finished, and follow up feature. Furthermore, this expert system is also considered easy to use, because it can be easily accessed through a famous social media application, Telegram, just by using a laptop or smartphone in user's hands.

V. CONCLUSION

This expert system can accurately detect symptoms through a scoring process, such as summing the scores obtained by the user, after conducting a short question-and-answer process with Telegram bot, based on the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition: DSM-5 book, published by the American Psychiatric Association in 2013; when an individual shows at least 5 of 9 symptoms of BPD or get the "total score" of greater or equal to 5 during the question-and-answer detection process, then he can be concluded as person with BPD and then given the solutions to overcome the symptoms. Meanwhile, solutions to solve or ways to handle each early BPD symptom is obtained through symptom analysis based on user answers to the previous question-and-answer process with the Telegram bot that mapped out in the solution table, compiled by the psychologist.

This expert system can help overcome BPD in individuals through its symptom detection process which then followed by solutions and follow-ups that may help them overcome their symptoms daily under the supervision of the psychologist. Basically, this expert system provides alternative answers for up to two levels before the user is being delivered to the psychologist for direct treatment.

This expert system is easy for public access through the well-known social media application, Telegram, that has been widely used by the community, just by having a laptop or smartphone in their hands. This expert system is also considered interesting to use because of its features, such as the answer buttons that make user easier to input answers, a reminder when the detection process is still unfinished, and also make it possible for users to greet the bot to get a follow-up on their results from the previous detection, to help them overcome their BPD symptoms in daily activities.

Nevertheless, the authors suggest to conduct further research on the impact of treatment suggestions and follow-ups generated by the Telegram bot-based expert system, so the evaluation to the feedback generated by the expert system can be obtained. It is also suggested that further research on user preferences about the length of the bot responses is necessary, so the answers generated by the expert system can be more accurate. Further research of the depth of the detection process of the Telegram bot-based expert system is also important, so the expert system can give more detailed results in the future.

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