

## EXPERT SYSTEM FOR DEPRESSION DETECTION IN TEENAGERS

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**Abstract.** Depression (major depressive disorder) is a common and serious medical illness that negatively affects how you feel, think, and act. Fortunately, it is treatable. Depression causes sadness and/or a loss of interest in activities once enjoyed. It can lead to various emotional and physical problems and decrease a person's ability to function at work and home. Teenagers often experience this disorder because their emotions are still unstable. They also don't have many chances to consult with a psychologist and doctor. Through this research, an expert system was created that implements knowledge from experts related to depression so that teenagers can do a self-test when needed. The expert system was developed using the Certainty Factor method for the knowledge inference engine. The system was tested iteratively and could achieve similar results with a domain expert. We hope that the system can detect early symptoms of depression among teenagers and minimize the negative impact it may cause.

**Keywords:** certainty factor, depression, detection, expert system, teenagers.

### INTRODUCTION

The life of a human being goes through several phases change. This phase starts from when humans are babies until humans die. In human growth, there is an adolescent phase, namely the transitional phase of children to maturity in the age range of 12 years to 20 years [1].

Adolescence in a child can have various dynamic changes, one of which is emotion. Therefore, a teenager must be able to adapt to any changes that exist. When a teenager cannot adapt or control himself over his emotions and thoughts, it is not uncommon for a teenager to be depressed due to negative thoughts. Depression experienced by a teenager is not just a temporary feeling of stress and sadness, but there is a serious condition that can permanently affect behaviour, emotions, ways of thinking, and character that must be given special treatment to overcome it [2].

For teenagers who are in that phase, they may find it difficult and confused about who to go and consult to. This expert system that we designed aims to help teenagers and parents to make an early diagnosis of depression that may occur in a teenager. Our expert system is designed in the form of a website due to the ease of internet access, particularly in Indonesia.

By conducting this research, we hope to help teenagers to find out the level of depression they are experiencing. The other purpose of this system is to facilitate communication between parents and children regarding depression. With this expert system, it is hoped that parents can facilitate further treatment for their child if needed. To support this goal, the prediction results must have good accuracy. Here, we implement the Certainty Factor method in inferencing the knowledge base to the final decision shown to the user.

With this expert system, we hope that teenagers will have the courage to carry out self-diagnosis with good accuracy so that they can communicate with their parents for further treatment. For parents who are also worried about their child, they can monitor the child's actions and carry out a diagnosis with the child. This system can also help psychologists in carrying out their duties more quickly.

## **THEORETICAL BASIS**

### **A. Expert System**

An expert system is a computer-based system that can replace experts in solving problems by using knowledge, facts, and reasoning techniques [3]. The definition of an expert system is a computer program that has expert knowledge of a specific field. From these two definitions, it can be concluded that an expert system is a program designed to have the knowledge to solve problems in a specific field like an expert.

In the development of an expert system, there are two main structures, namely the development environment and the consultation environment. The development environment is useful for entering expert knowledge into the expert system and the consultation environment is used by users to get results from the knowledge of an expert via the system [4].

### **B. Scrum Method**

Software Development Life Cycle (SDLC) is a cycle in making a system with the aim of solving a problem effectively. With the proper use of SDLC, the resulting system can be of high quality and in accordance with the wishes or objectives of the formation of the system. According to Mulyani [5], SDLC is a set of logical processes applied by a systems analyst to develop an information system that involves requirements, validation, training, and discussion with system owners.

Scrum is basically one of the lightest Agile methods but can provide advantages in setting the stages and control in the development of a system or product [6]. This method relies on a collection of methods and practices that apply the values and principles of the Agile Manifesto [7]. With the use of Scrum, there is a sprint component which is a series of stages carried out in one process simultaneously. The main purpose of using Scrum is to get the Minimum Viable Product (MVP) value at the end of each sprint [8].

### **C. Depression**

Depression is a condition in which a person's daily life is filled with feelings of pain, disappointment, sadness, and emotional confusion. Depression can be caused by trauma, guilt, isolation, and deep pain [9]. Depression can be concluded as a continuous feeling of sadness that a person feels and impacts on a person's thoughts and actions that can be caused by the environment around them and themselves.

In this study, we used 29 symptoms of depression in teenagers as mentioned by Burns in Widians et al. [10]. Table 1 shows the list of those symptoms used in this study.

**Table 1.** Depression symptoms [10]

Code	Symptom	Code	Symptom
G001	Sad	G016	Feeling lonely
G002	Tiredness in doing activities	G017	Feeling guilty
G003	Difficulty to focus	G018	Often feel being punished
G004	Feeling bored	G019	Self-hatred
G005	Daydreaming	G020	Easily offended
G006	Not excited	G021	Loss of appetite
G007	Often upset	G022	Worried about one appearance
G008	Pessimistic about the future	G023	Very sensitive
G009	Often cries without explainable reasons	G024	Prefer to be alone
G010	Insomnia	G025	Having thoughts of suicide
G011	Often anxious	G026	Difficulty to make a decision
G012	Disappointed with oneself	G027	Difficulty to do activities well
G013	Often disturbed	G028	Weight gain or loss
G014	Looks gloomy	G029	Less confident
G015	Loss of interest in hobbies that used to be liked		

#### D. Certainty Factor

Certainty Factor (CF) is a method proposed by Shortliffe and Buchanan in 1975 to accommodate the exact reasoning of an expert [11]. An expert (for example: doctor) often analyses information with the expressions “probably”, “most likely”, “almost certain”. So that with the Certainty Factor method, it can describe the level of confidence of an expert on the problem at hand. The basic formula to calculate the confidence level of a rule is shown in [12]:

$$CF[h, e] = MB[h, e] - MD[h, e]$$

where  $CF[h, e]$  is the certainty factor,  $MB[h, e]$  is the measure of belief of hypothesis ( $h$ ) given evidence ( $e$ ), and  $MD[h, e]$  is the measure of disbelief of hypothesis ( $h$ ) given evidence ( $e$ ).

Moreover, Certainty Factor formula for one premise is shown in  $CF[h, e] = CF[t] * CF[rule] = CF[user] * CF[expert]$ , while for two or more premises is shown in [13]–[15]:

$$CF_c(CF_1, CF_2) = \begin{cases} CF_1 + CF_2(1 - CF_1), & \text{if } CF_1, CF_2 > 0, \\ CF_1 + CF_2(1 + CF_1), & \text{if } CF_1, CF_2 < 0, \\ \frac{CF_1 + CF_2}{(1 - \min\{|CF_1|, |CF_2|\})}, & \text{if } CF_1 < 0 \text{ xor } CF_2 < 0, \end{cases} \quad (1)$$

where  $CF[e]$  is the certainty factor of given evidence which can be represented as certainty factor given by user,  $CF[rule]$  is the certainty factor rule given by an expert,  $CF_c$  is the combined certainty factor from the other two known certainty factor following the rules (1).

## METHODOLOGY

In this research, we use Scrum method. Scrum itself uses an approach from another method, namely Agile. Scrum helps teams to solve problems, by having strong communication between team members [16]. Steps in the Scrum Method are follows:

1. Define the team.
2. Determine the processing time.
3. Define roles in the team.
4. Collect various problems.
5. Start a sprint. Sprint is a series of work carried out to solve a problem, especially the creation of a new product.

Our research is assisted by qualitative data collection methods. Qualitative research is a type of research whose findings are not obtained through statistical procedures or other forms of calculation and seeks to understand and interpret the meaning of an event of human behavior interaction in certain situations according to the researcher's own perspective [17]. We use interviews and literature study as data collection tools.

1. **Interview.** In addition to observations, direct interviews were also conducted with experts who have special knowledge about depression in adolescence.

2. **Literature Study.** In this method, searches and learning are carried out from various kinds of literature, and documents that can support the work of this project, including from books, scientific articles, scholarly journals, and also from various internet websites that provide information that is relevant with the study.

## RESULTS AND DISCUSSION

### A. Implementation Results

Based on the research and iterative development procedure, there are several further development from the initial design of the system which is finalize as follows. Firstly, there is homepage as main display when the site is accessed (Fig. 1). There is a "Get Started" button which will lead to the Identification menu to perform a diagnosis.



Fig. 1. Homepage of the system

On the Identification page as shown in Fig. 2, users can fill in the symptoms provided for the calculation process to be carried out using the Certainty Factor method. There is a total of 29 questions being used in this study. When finished inputting symptoms, the user can click the button with the magnifying glass icon at the bottom right of the screen to display the results of the diagnosis (Fig. 3).

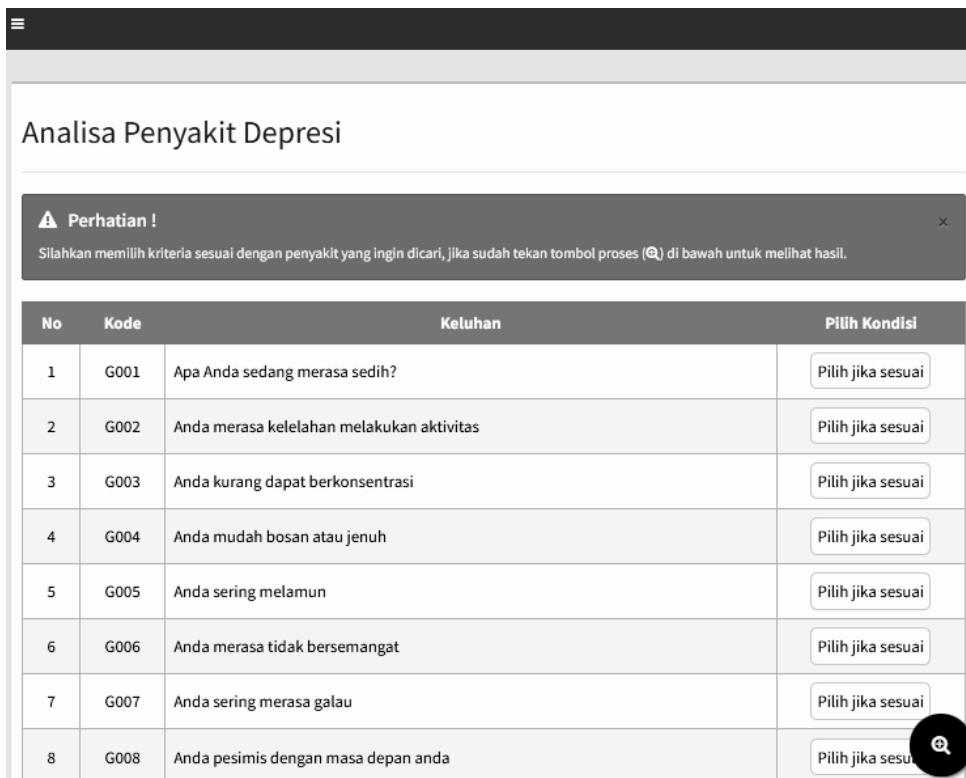


Fig. 2. Identification page

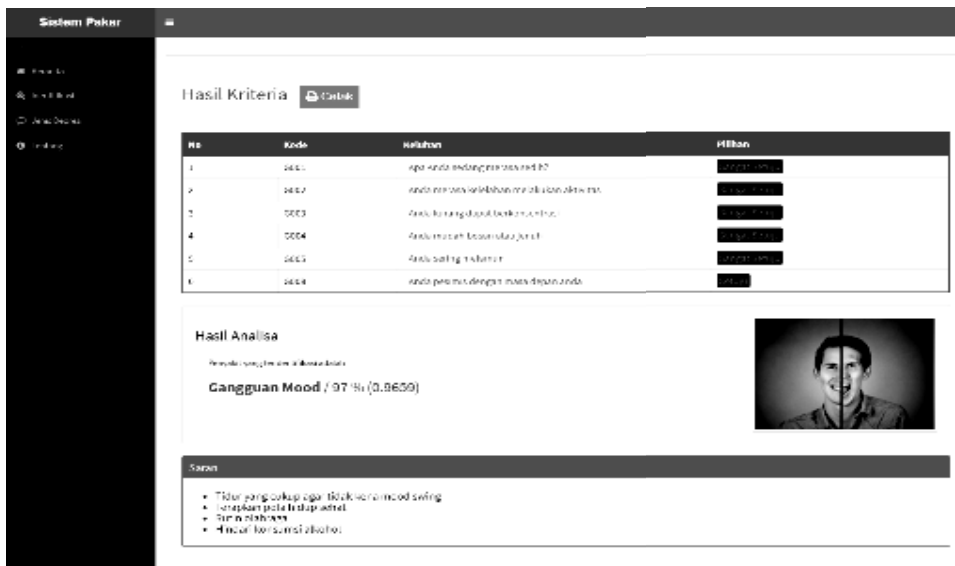


Fig. 3. Analysis result

There is also a page which show the basic information about depression as shown in Fig. 4. On this page, users can read information about the level of depression, details of the depression level, and some suggestions that have been provided. The system prototype may be found at <https://uasexpertsystem.000webhostapp.com/>.

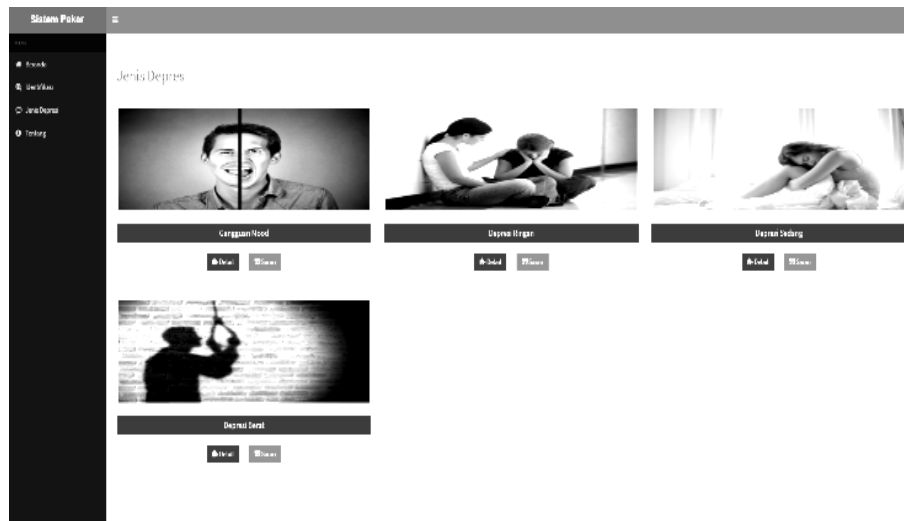


Fig. 4. Types of depression

### B. Evaluation and Discussion

We conducted several evaluation methods, including the usability test of the built system and expert evaluation from a psychologist who has a legal license to perform his practice as an expert in this domain. Table 2 shows the usability test results on three main functionalities provided in the system.

Table 2. Usability test results

System component	Results
Main menu	The main menu is simple and easy to use where when the user wants to identify depression, they can click the “Get Started” or “Identify” button on the menu bar on the left
Identification menu	Has clear instructions for identification and easy-to-read writing. After identifying the user, he gets information about the identified depression and gets suggestions that can be applied by the user
Depression Type menu	It has an easy-to-understand display where there are types of depression, a “Details” button that displays a description of depression, and a “Suggestion” button that displays suggestions for selected depression sufferers

The evaluation with experts was carried out for the first time on November 17<sup>th</sup>, 2021. During the evaluation process, a calculation test was carried out three times with the following results as shown in Table 3.

Table 3. First evaluation result

Iteration #	Result	Expectation
1	Severe Depression (1%)	Middle Depression
2	Severe Depression (12%)	Mood Disorder
3	Severe Depression (1%)	Severe Depression

From the results of the calculation test above, it was found that there was an error in the calculation formula and a mismatch of the Certainty Factor value for the knowledge based used in this study. Therefore, several changes were made so that the calculation results got the final value as shown in Table 4.

**Table 4.** Optimization result

Iteration #	Result	Expectation
1	Middle Depression (98%)	Middle Depression
2	Mood Disorder (100%)	Mood Disorder
3	Severe Depression (100%)	Severe Depression

## CONCLUSION

In this study, we have successfully built an expert system for diagnosing depression in teenagers. The system knowledge is inferenced by the Certainty Factor method and could diagnose the level of depression based on the existing knowledge base that is quite accurate. Based on the evaluation results, the system gives results that are in line with expert expectations.

In the future, this research can still be developed by increasing the level of complexity and variations in the value of trust and the value of distrust that is more specific with the latest symptoms in the depression level detection. Other inference methods, ranging from Forward and Backward Chaining [18] to Fuzzy-based [19] or even Machine Learning-based such as the Long Short-Term Memory [20], might be applied in comparison with this study result.

## ACKNOWLEDGEMENTS

We would like to extend our gratitude for the support given by Universitas Multimedia Nusantara during the study.

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Received 23.02.2022

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**ЕКСПЕРТНА СИСТЕМА ВИЯВЛЕННЯ ДЕПРЕСІЇ У ПІДЛІТКІВ** / Б. Рахарджа, Е.Б. Самудера, Ф. Лей, С. Хансун

**Анотація.** Депресія (великий депресивний розлад) є поширеним і серйозним медичним захворюванням, яке негативно впливає на самопочуття, на те, як думаєте і як дієте. На щастя, це піддається лікуванню. Депресія викликає почуття смутку та/або втрату інтересу до діяльності, яка колись приносила насолоду. Це може призвести до різноманітних емоційних і фізичних проблем і знизити здатність людини функціонувати на роботі та вдома. Цей розлад часто трапляється у підлітків, оскільки їхні емоції більш нестабільні. У них також не так багато шансів проконсультуватися з психологом і лікарем. Завдяки цьому дослідженню створено експертну систему, яка реалізує знання експертів, пов'язаних з депресією, щоб підлітки могли проводити самоперевірку, коли це необхідно. Експертну систему розроблено з використанням методу фактора визначеності для механізму виведення знань. Систему перевірено ітеративно, подібних результати отримано і за допомогою експерта в галузі. Сподіваємося, що система зможе виявити ранні симптоми депресії серед підлітків і мінімізувати негативний вплив, який вона може спричинити.

**Ключові слова:** фактор визначеності, депресія, виявлення, експертна система, підлітки.