An Expert System for Early Diagnosis of Anxiety Levels in Gen Z Using the Beck Anxiety Inventory (BAI) Method Based on Android

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Abstract — *The level of anxiety among Generation Z is increasing due to academic pressure, the influence of social media, and concerns about the future. If left unaddressed, anxiety can have a negative impact on quality of life. The Beck Anxiety Inventory (BAI) is a standard assessment method used to measure an individual's level of anxiety through 21 questions. However, the manual process is time-consuming and prone to human error. This study aims to develop an expert system application based on Android that utilizes the BAI method to assist users in performing a self-assessment of their anxiety levels. The system also integrates the Certainty Factor (CF) method to enhance the accuracy of the diagnosis results. Data collected through interviews, observations, questionnaires, and literature studies is processed within an application called IREMIA. The application is designed using the Flutter framework and the Cloud Firestore database. The results of the study indicate that the application can efficiently and effectively provide a diagnosis of the user's anxiety level. This application not only facilitates Generation Z in understanding their mental condition but also raises awareness of the importance of mental health. With its easily accessible self-assessment feature, this application is expected to be a practical solution in supporting the mental well-being of Generation Z.*
Keywords: Beck Anxiety Inventory, Certainty Factor, Generation Z, Anxiety

I. INTRODUCTION

Generation Z, growing up in the digital age, faces challenges that can trigger higher levels of anxiety than previous generations. Academic pressure, the influence of social media, and uncertainty about the future are major contributing factors. This mental health issue is receiving increasing attention and requires prompt and effective treatment.

The Beck Anxiety Inventory (BAI) is a measurement tool often used by psychologists to determine a person's anxiety level. While effective, manual methods are time-consuming and prone to human error. Therefore, this study developed an Android-based expert system to facilitate self-assessment for users. By using the Certainty Factor (CF) method, diagnostic accuracy is expected to increase.

This research aims to develop an application that can help Generation Z identify their mental health more easily and accurately. This system is expected to be an innovative solution to raise awareness of the importance of mental health.

II. LITERATURE REVIEW

A. Expert system

According to Ongko (2013:10) an expert system is a branch of artificial intelligence , which is a computerized application that attempts to imitate the reasoning process of an expert in solving specific problems and making decisions or conclusions because the knowledge is stored in a knowledge base for problem-solving processing. The basis of an expert system is how to transfer the knowledge possessed by an expert to a computer, and how to make decisions and draw conclusions based on that knowledge.

B. Certainty Factor Method

The Certainty Factor (CF) method is a method used to express confidence in an event (fact or hypothesis) based on evidence or expert judgment. *Certainty Factor* is a technique used to address uncertainty in decision-making and recommendations (Maryana & Suhartini, 2022:15) .

$$CF (H ,E) = MB (H,E) – MD (H,E) \quad\quad (1)$$

Information:

CF(H,E) = Certainty factor

MB(H,E) = Measure of confidence / level of belief in hypothesis H, if given / influenced by evidence E (between 0 and 1).

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CF(H,e) = Measure of disbelief / level of uncertainty regarding hypothesis H, given / influenced by evidence E (between 0 and 1).

There are two ways to get the confidence level of a rule, namely:

a. The Net Belief method proposed by EH Shortliffe and BG Buchanan

$$CF\ (Rule) = MB\ (H,E\ ) - MD\ (H,E) \qquad (2)$$

$$MB(H,E) = \begin{cases} 1, \text{ if } P(H) = 1 \\ \dfrac{\max[P(H|E), P(H)] - P(H)}{\max\ [1,0] - P(H)} \ (3) \end{cases}$$

$$MD(H,E) = \begin{cases} 1, \text{ if } P(H) = 0 \\ \dfrac{\min[P(H|E), P(H)] - P(H)}{} \ (4) \end{cases}$$

Information:

CF(Rule) = Certainty factor

MB(H,E) = Measure of belief in hypothesis H, given evidence E (between 0 and 1).

MD(H,E) = Measure of disbelief (measure of disbelief) towards evidence E (between 0 and 1).

P(H) = Probability of the truth of hypothesis H.

P(H|E) = Probability that H is true given fact E.

b. By interviewing an expert

Table 1. Certainty Factor Values

Uncertain term	CF
Definitely not	-1.0
Almost certainly not	-0.8
Most likely not	-0.6
Probably not	-0.4
Don't know	-0.2 to 0.2
Possible	0.4
Most likely	0.6
Almost certainly	0.8
Certain	1.0

Table 2 is derived from expert interpretations of "terms," which have been converted into specific CF values according to the table. If a CF value is not yet available for each symptom causing the disease, the basic formula used to diagnose the disease is used.

1) Certainty Factor for rules with a single premise/symptom (single premise rules):

CFsymptoms = CF [user] * CF [expert](5)

2) If there are rules with similar conclusions (similar concluded rules) or more than one phenomenon, then the CF is then calculated using the equation:

CFcombine = CFold + CFsymptom* (1- CFold)(6)

3) Meanwhile, to calculate the percentage of disease, the following equation is used:

CFpercentage = CFcombine * 100(7)

C. Anxiety

Anxiety, or in Indonesian, "worry," is a natural part of life, so at certain times a person experiences it. Anxiety is characterized by persistent feelings of fear, nervousness, and worry, which, if excessive, can disrupt daily activities (Panji Rachmat Setiawan et al. 2022).

Furthermore, according to Fitria et al. (2020), anxiety is a feeling of unsettling mental tension resulting from an inability to cope with a problem or a lack of security. This feeling of uncertainty is generally unpleasant and can lead to physiological and psychological changes.

D. Beck Anxiety Inventory (BAI)

According to Toledano-Toledano et al., (2020:2) Beck Anxiety Inventory (BAI) is an instrument to assess anxiety symptoms that are independent of depressive symptoms. Then according to (Madinah et al., (2023:1511) BAI is a survey containing 21 questions used to measure anxiety levels. This method produces better measurement results than other instruments. The BAI method consists of 21 items that cover two main factors, namely somatic symptoms and affective-cognitive symptoms. The following is a BAI table according to Kim's research (2014:260):

Table 2. *Beck Anxiety Inventory* (BAI) Table

Symptom	Not at all	Light (Sometimes)	Currently (Quite Often)	Heavy (Often)
Numbness or tingling	0	1	2	3
Feeling hot for no reason	0	1	2	3
Shaking legs	0	1	2	3
Can't relax	0	1	2	3
Afraid something bad will	0	1	2	3

happen				
Dizzy	0	1	2	3
Heart beating fast	0	1	2	3
Unstable when standing	0	1	2	3
Great fear / panic	0	1	2	3
Tense / nervous	0	1	2	3
Feeling suffocated	0	1	2	3
Shaking hands	0	1	2	3
Unstable when walking	0	1	2	3
Fear of losing control	0	1	2	3
Difficulty breathing	0	1	2	3
Fear of death	0	1	2	3
Feeling scared	0	1	2	3
Indigestion	0	1	2	3
Lightheadedness like I'm about to faint	0	1	2	3
Red face	0	1	2	3
Hot/cold sweats	0	1	2	3

III. RESEARCH METHODOLOGY

In conducting this research, the author employed a systems development method. The development method used by the author was the Agile Method, as shown in Figure 1 below.
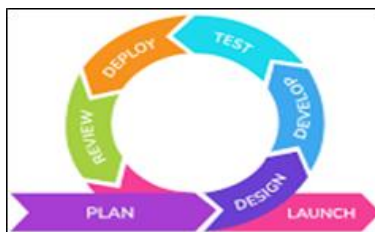

Figure 1. *Agile* Method

The following is an explanation of the application of the agile method in this research, which is depicted in the image above:

a. Plan

In the Planning stage, researchers will create a design based on a system analysis of the expert system application's requirements through observation, interviews, questionnaires, and literature review. The analysis will then produce assessment data needed to develop the application.

b. Design

In this stage, the author designs the interface of an application consisting of five menus and seven sub-menus, in order to see the results of the data

that was processed in the previous stage.

c. Develop

In this Develop stage, the author creates and develops the IREMIA application based on the design that has been created.

d. Test

Testing will be conducted to determine whether the application is ready for deployment. At this stage, the author will also check for any bugs in the application being developed to ensure it runs smoothly. Testing will be conducted using black box testing by the author and alpha testing by experts.

e. Deploy

In this stage, the process of launching the APK format file is carried out which is still in development mode or beta mode which will later be reviewed by user testers, which in this case is tested by experts or counselors.

f. Review

During the review phase, user testers will conduct experiments to determine whether the application is ready for public release. This phase is also called beta testing, meaning user testers conduct experiments.

g. Launch

In the Launch stage, the author will release the application in production mode on the Play Store, which means the application is ready to use.

IV. RESULTS AND DISCUSSION

To diagnose anxiety levels in Gen Z, the authors sampled 30 students from the Faculty of Health Sciences at Dehasen University, Bengkulu. The Faculty of Health Sciences, Dehasen University, Bengkulu, still manually collects data from students seeking consultations and diagnoses of anxiety symptoms. The lack of a dedicated application for diagnosing anxiety levels in students results in significant time-consuming data collection, diagnosis, and reporting of these results.

A. BAI Calculation

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The following is the BAI calculation based on sample data from the questionnaire:

Student name : RN (Initials)

Study program : Bachelor of Public Health

Age : 21 years

Table 3. BAI Calculation

No.	Symptom	BAI Value
1	Numbness or tingling	3
2	Feeling hot for no reason	3
3	Shaking legs	0
4	Can't relax	0
5	Afraid something bad will happen	1
6	Dizzy	2
7	Heart beating fast	0
8	Unstable when standing	0
9	Great fear / panic	1
10	Tense / nervous	1
11	Feeling suffocated	0
12	Shaking hands	0
13	Unstable when walking	0
14	Fear of losing control	2
15	Difficulty breathing	0
16	Fear of death	3
17	Feeling scared	2
18	Indigestion	0
19	Lightheadedness like I'm about to faint	1
20	Red face	1
21	Hot/cold sweats	1
Total BAI		21

BAI value range:

0 to 7 = no anxiety.

8 to 15 = mild anxiety.

16 to 25 = moderate anxiety.

26 to 63 = severe anxiety.

Based on the BAI calculation above, the student with the initials RN is in the moderate anxiety category.

B. Application of Certainty Factor in diagnosing students' anxiety levels

The following is a certainty factor calculation based on sample data similar to the BAI calculation above:

a. Determining Symptoms and Solutions

overall symptoms of *anxiety can be seen in table 4 below.*

Table 4. Symptoms of Anxiety Disorders

Code	Symptom
G01	Numbness or tingling
G02	Feeling hot for no reason
G03	Shaking legs
G04	Can't relax
G05	Afraid something bad will happen
G06	Dizzy
G07	Heart beating fast
G08	Unstable when standing
G09	Great fear / panic
G10	Tense / nervous
G11	Feeling suffocated
G12	Shaking hands
G13	Unstable when walking
G14	Fear of losing control
G15	Difficulty breathing
G16	Fear of death
G17	Feeling scared
G18	Indigestion
G19	Lightheadedness like I'm about to faint
G20	Red face
G21	Hot/cold sweat

The overall solution to anxiety can be seen in table 5.

Table 5. Solutions for *Anxiety Disorders*

Name of Disease	Solution
Low Anxiety	Providing reinforcement or calming. Provide positive and constructive suggestions. Directing users to give positive suggestions to themselves. recommend eating healthy foods, getting enough sleep and regular exercise
Moderate Anxiety	Direct the user to calm down. If the user feels there is no improvement or change, it is recommended to consult a professional.
Severe Anxiety	It is recommended to consult a professional for further treatment.

b. Data Rule

The next step in the certainty factor method process is the formation of rules used to determine the expert system's output decisions. The expert system's rules for diagnosing anxiety levels are as follows:

Table 6. Rules

Rules	IF	Solution
R1	IF CFTotal <= 7 THEN No Anxiety	There is no solution
R2	IF 8 <= CFTotal <= 15 THEN Low Anxiety Level	S01, S02, S03, S04
R3	IF 16 <= CFTotal <= 25 THEN No Moderate Anxiety	S05, S06
R4	IF CFTotal >= 26 THEN No Severe Anxiety	S07

c. Determination of CF Value of Symptoms to Disease

This study did not use MB and MD values because the rule only applies to one premise. Therefore, the CF value for each disease symptom was determined by experts. The expert values for anxiety symptoms based on the CF assessment in Table 2 can be seen in Table 7 below:

Table 7. Expert CF Values for Disease

No.	Symptom	Expert CF Value
1	Numbness or tingling	0.05
2	Feeling hot for no reason	0.05
3	Shaking legs	0.15
4	Can't relax	0.05
5	Afraid something bad will happen	0.15
6	Dizzy	0.05
7	Heart beating fast	0.15
8	Unstable when standing	0.25
9	Great fear / panic	0.25
10	Tense / nervous	0.05
11	Feeling suffocated	0.15
12	Shaking hands	0.15
13	Unstable when walking	0.25
14	Fear of losing control	0.05
15	Difficulty breathing	0.25
16	Fear of death	0.25
17	Feeling scared	0.15
18	Indigestion	0.25

19	Lightheadedness like I'm about to faint	0.25
20	Red face	0.05
21	Hot/cold sweat	0.15

d.   Determining User CF Value

The following is the determination of the CF User value based on the BAI scale:

Table 8. User CF Values

No	Symptom Intensity (BAI scale)	User CF Value
1.	Not at all (0)	0.0
2.	Sometimes (1)	0.1
3.	Quite Often (2)	0.2
4.	Often (3)	0.3

e.   Symptom Data Selection by User

One example of the certainty factor calculation is taken from the questionnaire sample that has been mentioned in the calculation using BAI in table 3. The symptoms selected by the user when filling out the questionnaire can be seen in the following table:

Table 9. Symptoms Experienced by Users

No.	Symptom	BAI Value	Symptom Intensity	User CF Value
1	Numbness or tingling	3	Often	0.3
2	Feeling hot	3	Often	0.3
3	Shaking legs	0	Not at all	0
4	Can't relax	0	Not at all	0
5	Afraid something bad will happen	1	Sometimes	0.1
6	Dizzy	2	Quite Often	0.2
7	Heart beating fast	0	Not at all	0
8	Unstable when standing	0	Not at all	0
9	Great fear or panic	1	Sometimes	0.1
10	Tense or nervous	1	Sometimes	0.1
11	Feeling suffocated	0	Not at all	0
12	Shaking hands	0	Not at all	0
13	Unstable when walking	0	Not at all	0
14	Fear of losing control	2	Quite Often	0.2
15	Difficulty breathing	0	Not at all	0
16	Fear of death	3	Often	0.3
17	Feeling scared	2	Quite Often	0.2
18	Indigestion	0	Not at all	0
19	Lightheadedness like I'm about to faint	1	Sometimes	0.1
20	Red face	1	Sometimes	0.1
21	Hot or cold sweats	1	Sometimes	0.1

f.   Calculation of CF Value from User Symptoms

Based on the symptoms and CF value of the selected user, the CF value of the disease can be calculated as follows:

1)   Calculating the CF Value $_{of symptoms}$

Below is a table of CF symptom values for each anxiety symptom based on those selected by the user and calculated using the following formula:

Table 10. CF $_{Symptom Values}$

No.	Symptom	User CF Value	Expert CF Value	CF Symptom Value
1	Numbness or tingling	0.75	0.05	0.015
2	Feeling hot	0.75	0.05	0.015
3	Shaking legs	0	0.15	0
4	Can't relax	0	0.05	0
5	Afraid something bad will happen	0.25	0.15	0.015
6	Dizzy	0.5	0.05	0.01
7	Heart beating fast	0	0.15	0
8	Unstable when standing	0	0.25	0
9	Great fear or panic	0.25	0.25	0.025
10	Tense or nervous	0.25	0.05	0.005
11	Feeling suffocated	0	0.15	0
12	Shaking hands	0	0.15	0
13	Unstable when walking	0	0.25	0
14	Fear of losing control	0.5	0.05	0.01
15	Difficulty breathing	0	0.25	0
16	Fear of death	0.75	0.25	0.075
17	Feeling scared	0.5	0.15	0.03
18	Indigestion	0	0.25	0
19	Lightheadedness like I'm about to faint	0.25	0.25	0.025
20	Red face	0.25	0.05	0.005
21	Hot or cold sweats	0.25	0.15	0.015

2)   Calculating the $_{percentage CF value}$

Once the individual CFsymptoms have been identified, the combined CF value can be calculated. The formula for calculating combined CF is as follows:

$$CF_{combine}(CF_{symptom1}, CF_{symptom2}) = CF_{symptom1} +$$
$$CF_{symptom2} * (1 -$$
$$CF_{symptom1})$$
$$= 0.015 + 0.015 * (1$$
$$- 0.015)$$
$$= 0.029775$$

Table 11. CF Value of Combination of all symptoms

CFCombine	CFcombine Value
CFcombine (CFsymptom1, CFsymptom2)	0.029775
CFcombine (CFold2, CFsymptom3)	0.029775

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CFcombine (CFold3, CFsymptom4)	0.029775
CFcombine (CFold4, CFsymptom5)	0.044328375
CFcombine (CFold5, CFsymptom6)	0.053885091
CFcombine (CFold6, CFsymptom7)	0.053885091
CFcombine (CFold7, CFsymptom8)	0.053885091
CFcombine (CFold8, CFsymptom9)	0.077537964
CFcombine (CFold9, CFsymptom10)	0.082150274
CFcombine (CFold10, CFsymptom11)	0.082150274
CFcombine (CFold11, CFsymptom12)	0.082150274
CFcombine (CFold12, CFsymptom13)	0.082150274
CFcombine (CFold13, CFsymptom14)	0.091328771
CFcombine (CFold14, CFsymptom15)	0.091328771
CFcombine (CFold15, CFsymptom16)	0.159479114
CFcombine (CFold16, CFsymptom17)	0.18469474
CFcombine (CFold17, CFsymptom18)	0.18469474
CFcombine (CFold18, CFsymptom19)	0.205077372
CFcombine (CFold19, CFsymptom20)	0.209051985
CFcombine (CFold20, CFsymptom21)	0.220916205

$$CFend = CFcombine(CFold20, CFsymptom21) * 100$$

$$CFakhir = 0.220916205 * 100$$

$$CFakhir = 22$$

Based on calculations using BAI and CF, it can be concluded that the diagnosis results of a student from the Faculty of Health Sciences, Dehasen University, Bengkulu with the initials RN are experiencing moderate anxiety.

V. CLOSING

Based on the results and discussion of independent research and tests that have been carried out, it can be concluded that the application of the Beck Anxiety Inventory (BAI) method integrated with Certainty Factor (CF) in the Expert System for Early Diagnosis of Anxiety Levels in Gen Z is made using software namely the Dart programming language, flutter framework and cloud firestore database . Diagnosis of anxiety levels is carried out independently by users by answering questionnaires in the application with a limit of once a month for using this feature, and will display the diagnostic results for users to know about their current anxiety level along with their references, so that later users can be facilitated in determining the actions that must be taken after knowing the current anxiety level.

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