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EXPERT SYSTEM TO DETECT ONLINE GAME ADDICTION FOR UNIVERSITY STUDENTS USING THE BACKWARD CHAINING AND CERTAINTY FACTOR APPROACHES

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Abstract

Online gaming addiction harms students' physical health, mental well-being and academic performance. The addiction to playing online games has three categories, namely high, moderate and low, which are rarely known by the general public. The significant of knowledge acquisition on the addiction symptom and preventive activities forces the emergence of new idea on expert system identification platform. Therefore, this research aims to develop an expert system using the Backward Chaining (BC) and Certainty Factor (CF) approaches to detect the initial addiction level of online games for university students. Herein, the BC is used to identify the levelling of online game addiction based on the symptoms experienced by the user. There are thirty-three symptoms (G01-G33) provided through the thorough literature reviews and interviews with psychiatrics. Meanwhile, the CF is applied to calculate the level of certainty in determining the possibility of addiction describing in six scale level interpretation. As a result, the application of these two methods has effectively succeeded and reached proper accuracy in identifying the level of addiction of students towards their behavior on playing online games. The comparison of CF testing values between the system calculation and expert judgement shows the sophisticated result. Thus, this research can be utilized by the medical and psychiatric authorities, parents, and students in assessing their symptoms of addiction as an early warning in facing the possible risks arising from online game addiction.

Keywords: *Backward Chaining, Certainty Factor, Online games.*

1. INTRODUCTION

According to the Indonesian Dictionary, the term "students" are defined as people who are currently studying at tertiary institutions[1]. The development stage of the student is categorized in the age range of 18 to 30 years. It is classified from late adolescence to early adulthood with life maturity period development [2]. The students bear their position in the community and grow into community role models due to the knowledge provided by the universities[3]. The students also develop into the educational agent of change as the young generation with adequate cultivation to continuously enrich their insights and bring about diversity and revolution for the nation and environment[4]. Thus, the expected students afford to transform into skilled people, broad-minded, environment and society responsiveness, active and productive knowledge acquisition, and capable of utilizing information technology for scientific development and benefit.

Information technology has emerged as a facilitator tool to enhance the quality of human work in various lines of life, including education, economics, business, government, politics, manufacturing, etc. However, the possibility of information technology negative impact is also inevitable, especially during the transition occurrence in behaviour, ethics, norms, rules or morals of human life that sometimes contradicts religious, social or community values[5], including the turning out of technology as well as online game addiction. Online games are information technology tools utilized for entertainment by computer connection and network technology online or offline[6]. Currently, the online game is growing into a new trend that provides great demand users, especially for teenagers and adults, to play individually or group simultaneously from various locations and times [7]. The excessive use of online games from duration times and inappropriate timing outspread a negative impact that leads to addiction[8]. Someone with serious addiction ignores the everyday human basic needs such as having meals and drinking, a sporadic lifestyle, and criminal tendencies, viz., stealing, killing and other acts of violence. An online game addiction stimulates the students to neglect their primary duties and obligations, including time for lecturing, conducting

assignments, group discussions, assistance, and various positive activities[9]. The levels and symptoms of online game addiction among university students vary. Due to the students, parents, and the environment's lack of knowledge and concern, this addiction is not well indicated and overlooked. Essentially, online game addiction is categorised into three kinds of a level low, moderate and high addiction[5] based on the appearance of symptoms, including the massive desire and intensity in online games, online games interfere the daily tasks and responsibilities (for example housework, cleaning up, personal treatment, college works/assignments), hard to stop the online games even received punishment, extremely enthusiastic on online games and information about, hard to concentrate on work, study, attending lecturing, sensitive and emotional, spending much money for online games, disregard personal needs, getting insomnia, peel off the social circle, easy to conflict (arguments, fraud, theft) due to online game[10]–[13].

The severity of online game addiction requires distinctive attention and prevention efforts. However, a few people realize their addiction and lack of knowledge to deal with it. The reluctance to psychologist or psychiatrist consultation due to embarrassment or substantial costs trigger online game addiction is challenging to overcome. Moreover, the lack of parents, environments or societal consideration of the student's condition develops into a silent killer for educational and mental development for the young generation nowadays. Therefore, this study tries to deploy a web-based expert system application that can be used to diagnose online game addiction early for university students. Hence, online game users, especially students, parents and their surrounding environment, are provided with the basic knowledge of online game addiction, the symptoms, the indications, and the first aid treatment as preventive and curative action in dealing with it.

An expert system application is a computational technology that adopts the experts' knowledge in detecting and producing the best judgment based on the noticeable characteristics or symptoms. Expert systems are widely applied to solve various problems, especially in medicine and health[14]. However, the utilization in other fields is recognized, for example, in engineering [15], education[16], manufacturing[17], agriculture and farming[18], and environment[19]. The expert system adopts the rule-based knowledge management and acquisition approach, including the Backward Chaining (BC) technique. BC performs a searching strategy from the conclusion, positive hypothesis, rule-based condition or supported facts[20]. Previous studies discussed BC, including Fiati and Kurniati (2022), have successfully identified the learning obstacles for disabilities students using BC [21]; Wibowo et al. (2019) evaluated the effectiveness of BC in improving the installation buttons' skill of children with disabilities and poor eyesight[22]; Hamdallah (2022) has succeeded in applying the BC method to diagnose online game addiction as a psychologist alternative consultation [20]. In a nutshell, the above research explored the advantages of BC in decision-making and optimum rule rule-based cement to be more accessible, time-saving, flexible, and efficient[23].

The Certainty Factor (CF) emerged as standard the typical approach to other f expert systems in order to support the complexity and uncertainty of rule-based management and expert's beliefs[25] and [26]. Wang (2019), in his research on modelling landslide hazard predictions in Wen Country, northwest China, has successfully compared the effectiveness of information value, weights-of-evidence and CF for predicting landslide accuracy. The result found that CF performed more accurately than the others[26]. Azareh et al. (2019) examined ditch erosion vulnerability modelling in a semi-arid Iran region by applying CF and Maximum Entropy (ME) Models. The resource of data modelling is obtained by GPS map. This study reveals that CF equips the performance area under the curve (AUC) of 81.8%, which means it is superior and more precise than ME with an AUC value of 88.6%.[27]. Denda et al. (2022) has been successfully applied the CF algorithm for online game addiction and found an accuracy testing of 83%[28]. The reviews of BC and CF trigger the emergence of research ideas for integrating the above methods in identifying university students' online game addiction levels.

Previously, the integration of these two methods has been applied in various scientific fields, including Hidayatullah et al. (2020) combined the above methods to identify HIV/AIDS infection. This study has successfully deployed BC and CF for twenty data tests with an accuracy value of 75%.[29].

This paper uses the BC approach to reconcile the facts or rule-based statements regarding online game addiction. Meanwhile, the CF method is applied to calculate the certainty values of such facts or rule-based statements in detecting online game addiction for university students. The research limitation focuses on the university students, facts or symptoms obtained based on psychologists' interviews and observations. This paper contributes as an information resource and additional knowledge platform on online game addiction for students, parents, and the surrounding community. Thus, preliminary prevention and treatment can be immediately taken before getting addicted.

2. RESEARCH METHODS

2.1. Expert system

An expert system is the branch of artificial intelligence technology that embeds human knowledge and interaction into computers and sets it

based on knowledge base management and inference systems to replace the expert function in problem-solving and decision-making [30] and [31].

2.2. Backward Chaining (BC)

Backward Chaining (BC) utilizes a goal-driven approach by querying the expected hypothesis and rooting the supported facts and evidence into a conclusion. Commonly, this stage process requires preliminary formulation and tentative hypothesis testing. Therefore, BC is potentially adopted for incapacious decision three construction and less horizontal rule extension. BC administers the more accessible data query or searching the rule-based from backward to forward. Hence, it makes decision-making process development more accessible, time-saving, and efficient[23]. The flexibility of the BC method is described by allowing the expert system to adjust solutions or recommendations based on the calculation values of supported information. If the backward step finds the supported information leads to a different solution than the expert system, adjust the calculation path to find a more relevant solution by the conditions and facts [24] and [34]. BC is also flexible in rule-based maintenance, easily adaptable for knowledge or rules-based acquisition without any comprehensive diversity of decision tree structure significantly. Thus, the maintenance of expert systems and knowledge-based management eventually be more efficient and easily adapted [24] and [35]. However, the limitation of rules based induces the BC issues in finding the conclusion [34].

2.3. Certainty Factor (CF)

CF is applied when dealing with an uncertainty or probability problem [35]. Herein, the CF accommodates the expert uncertainty in analyzing information with the emergence of phrases such as "maybe", "likely", "almost certain", and so on [36], [37]. Meanwhile, the other probability method, such as Naive Bayes, only provides definite probabilities based on the frequency or number of events[38]–[40]. In addition, the CF method has been widely applied in various expert system contexts, including diagnosing childhood diseases[39], determining the interests and talents of students[41],and diagnosing spinal cord disease[41]. Contrarily, the other probability methods commonly emphasise statistical analysis and predictions. In a nutshell, the combination of BC and CF contributes to positive future work and development; thus, it becomes the main reason for solving the case in this paper. This paper studies the application of CF to measure the trustworthiness of statements in online game addiction. Meanwhile, BC focuses on achieving the optimal final goal or conclusion based on rules. The integration of the two approaches provides low-uncertainty calculations of inference engines. Thus, decision accuracy grows more precise, fast, and efficient in complex and ambiguous situations.

2.4. Online Game Addiction

Herein, the following symptoms of online game addiction and the addiction level are transcribed based on the interviews and literature studies from psychiatrists and experts at Tampan Mental Health Hospital in Pekanbaru. Table 1 explains the thirty-three addiction symptoms as the knowledge base. It is sybolized as G1 for the symptom: feeling the laziness, G2 for accesing online games frequenty, and so forth. Table 2 points out the addiction level and general suggests treatment for each level, for example the student who identified as Low level addiction should conduct the treatment including maintaining positive activities by joining the group study, student association, sport and religous community; develop bonding communication, and physical and mental health preservation.

Table 1. Symptom Data

No	Symptom	Symptom ID	References
1	Feeling the laziness	G1	[5], [10]–[13], [20], [28], [42]–[44]
2	Accessing online games frequently	G2	
3	Playing online games for less than 1 hour per day	G3	
4	Turning up the irregular lifestyle (ignoring basic human needs such as eating, drinking, sleeping, bathing etc.)	G4	
5	Hard to focus on studying	G5	
6	High enthusiasm and interest in online games	G6	
7	Playing online games between 1 into 3 hours per day	G7	
8	Insomnia due to the online games	G8	
9	Hard to stop playing the online game despite getting the parents' warning	G9	
10	Emotional easily	G10	
11	Spending much money playing the online games	G11	
12	Withdrawing from the social life circle	G12	
13	Playing online games for more than 3 hours per day	G13	
14	Emulating the online game characters	G14	
15	Feeling proud and satisfied with the online game achievement	G15	
16	Joining the online game community	G16	
17	Always updating any news and information regards on the online games	G17	

18	Feeling disappointed when losing the online game	G18
19	Spending pocket money for playing the online games	G19
20	Feeling more comfortable around addicted online games circle and community	G20
21	Feeling so angry with network interruption while playing the online game	G21
22	Feeling so happy when discussing the online games	G22
23	Always try to increase your online games skills and ambition to be the winner	G23
24	Feeling excited about exploring and playing kinds of online games	G24
25	Unlimited computer or gadget operation for online games	G25
26	Feeling anxious and irritable when missing the online games	G26
27	Suffering a sleep disorder or insomnia	G27
28	Suffering back and neck pain due to the oe games.	G28
29	Suffering the migrants and eyes sore eyes to the online games	G29
30	Having wrist problems	G30
31	Feeling uncomfortable when missing the online game	G31
32	Preferring to play online games rather than hang out with family	G32
33	Feeling high dependency on the online games	G33

Table 2. Addiction level and treatment suggestions

Level Addicted	Suggestion	ID Addiction Level	References
Low	Maintaining positive activities, communication, and physical and mental health	**P01**	[5], [10]–[13], [20], [28], [42]–[44]
Moderate	Self-introspection by determining back the meaning and purpose of human life; developing bonding communication with e-friends, families and positive people; balancing the positive activities and environment	P02	
High	Evolving the decisive surrounding environment that constantly reminds the time management on gadget utilization, staying focused on life goals achievement, calling up on the positive and productive activities and people interaction, conducting a lot of worship and faith activities in God almighty. However, going to meet the psychologist for in-person consultation if the above suggestions provide no impact on reducing the online games addiction	P03	

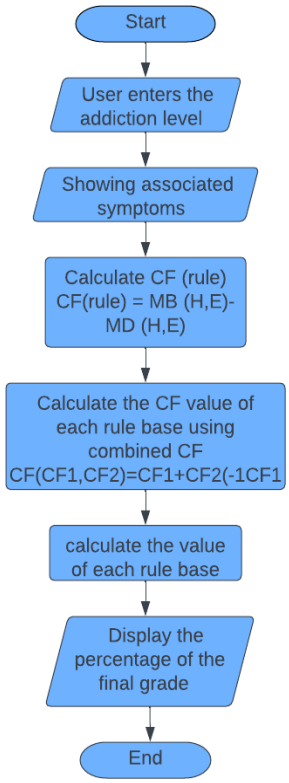

Figure 1. The Flow Process of Online Game Addiction Diagnostic System

The stage process for diagnosing and identifying online game addiction can be depicted in Figure 1. Figure 1 illustrates that the first stage of diagnosis begins by inputting the approximation of online game addiction level based on the patient's/users' perceptions. Then, the system presents the possible symptoms related to the addiction by referring to the rule-based development. Herein, the patient is asked for the condition of the fact displayed in the consultation form by answering with "no", "do not know", "a little sure", "fairly sure", "sure", and "very sure" as explained in Table 3 and 4. Table 3 weights the six catagory of user answered into scale 0 to 1

with 0.2 scale. Each answer provides its own CF value to measure the confidence level of diagnosis as explianed in Table 4. Table 4 presents the calculation of the CF value for each symptom by following the formula at Equation (1) [45].

Table 3. User and expert weighting scale

No	Type of User/Expert Answer	Weight
1	No	0
2	Do not know	0.2
3	Little sure	0.4
4	Pretty sure	0.6
5	Certain	0.8
6	Very confident	1

CF formula:

$$CF(h,e) = MB(h,e) - MD(h,e) \quad (1)$$

Where:
CF(h,e) = Certainty factor
MB(h,e) = The trustworthiness toward the hypothesis (h), and given evidence (e) (e is defined between 0 and 1)
MD(h,e) = The dis-trustworthiness toward the hypothesis (h), and given evidence e (e is defined between 0 and 1)

Resolving the question and answer consultation form, the expert CF and user CF values calculation are then integrated to perform the percentage of addiction level finally. The application of this expert system follows the Object-Oriented Analysis and Designed codes using the PHP programming language and MySQL database. In order to test the efficacy of this application, the Blackbox testing and User Acceptance Test (UAT) approaches are applied. The Blackbox utilizes to assess the functionality of the module provided by the expert system application. Meanwhile, UAT is then distributed to ten potential users among the university students to evaluate the ease and usefulness of this application.

3. RESULTS

3.1. Determining the Certainty Factor Value

Based on the interviews conducted with two psychiatrists, the CF weighting value for each symptom is explained in Table 4. Meanwhile, Tables 5 are developed to explain the correlation between the symptoms and level of addiction, for example the symptom G01 contributes the addiction level P01 (Low) and P02(Moderate) at CF value as 0.4 and 0.6, respectively. Meanwhile G02 makes a contribution of P02 and P03 with CF values at 0.4 and 0.8, respectively. Besides, Table 6 presents the rule-based performed for addiction identification. Herein, P01 defines by tracking the rule based on the conditional IF [G01 with CF 0.4] AND [G03 with CF 0.8] AND [G15 with CF 0.2] AND [G16 with CF 0.2] AND [G19 with CF 0.6] are fulfilled.

Table 4. The CF values based on Expert weighting

Symptom ID	CF value	Symptom ID	CF value
G1	0.6	G18	0.8
G2	0.8	G19	0.6
G3	0.8	G20	0.4
G4	0.4	G21	0.8
G5	0.4	G22	0.6
G6	0.45	G23	0.6
G7	0.8	G24	0.4
G8	0.6	G25	0.4
G9	0.8	G26	0.2
G10	0.65	G27	0.4
G11	0.8	G28	0.2
G12	0.6	G29	0.6
G13	0.8	G30	0.4
G14	0.4	G31	0.4
G15	0.8	G32	0.2
G16	0.4	G33	0.6
G17	0.2		

Table 5. Symptoms and Addiction Level Relationship

	Level Code		
Symptom Code	P01(Low)	P02(Moderate)	P03(High)
G01	V(0.4)	V(0.6)	
G02		V(0.4)	V(0.8)
G03	V(0,8)		
G04			V(0.4)
G05		V(0.4)	
G06		V(0.4)	V(0.45)
G07		V(0.8)	
G08		V(0.4)	V(0.6)
G09		V(0.6)	V(0.8)
G10			V(0.65)
G11			V(0.8)
G12			V(0.6)
G13			V(0.8)
G14		V(0.4)	
G15	V(0.2)	V(0.4)	V(0.8)
G16	V(0.2)	V(0.3)	V(0.4)
G17		V(0.2)	V(0.2)
G18		V(0.4)	(0.6)
G19	V(0.6)		
G20		V(0.2)	V(0.4)
G21		V(0.4)	V(0.8)
G22		V(0.4)	V(0.6)
G23		V(0.4)	V(0.7)
G24		V(0.4)	V(0.6)
G25		V(0.2)	V(0.4)
G26			V(0.2)
G27			V(0.4)
G28			V(0.2)
G29			V(0.6)
G30			V(0.4)
G31			V(0.4)
G32			V(0.2)
G33			V(0.6)

Table 6. Rule Based Development

No	Rules
1	IF[G01:0.4]AND[G03:0.8] AND[G15:0.2]AND[G16:0.2]AND[G19:0.6] THEN P01
2	IF[G01:0.6]AND[G02:0.4]AND[G05:0.4]AND[G06:0.4]AND[G07:0.8]AND[G08:0.4]AND[G09:0.6]AND[G14:0.4]AND [G15:0.4]AND[G16:0.3]AND[G17:0.2]AND[G18:0]AND[G20:0.2]AND[G21:0.4]AND[G22:0.4]AND[G23:0.4]AND[G24: 0]AND[G25:0.2] THEN P02
3	IF[G02:0.8]AND[G04:0.4]AND[G06:0.45]AND[G08:0.6]AND[G09:0.8]AND[G10:0.65]AND[G11:0.8] AND[G12:0.6]AND

	[G13:0.8]AND[G15:0.8]AND[G16:0.4]AND[G17:0]AND[G18:0.6]AND[G20:0.4]AND[G21:0.8]AND [G22:0.6]AND[G23:0.6]AND[G24:0.4]AND[G25:0]AND[G26:0.2]AND[G27:0.4]AND[G28:0.2]AND [G29:0.6]AND[G30:0.4]AND[G31:0.4] AND[G32:0.2]AND[G33:0.6] THEN P03

3.2. Online Game Software Designed and Implementation

Refering to the analysis and diagnosis stages, the system architecture is designed as shown in Figure 2.

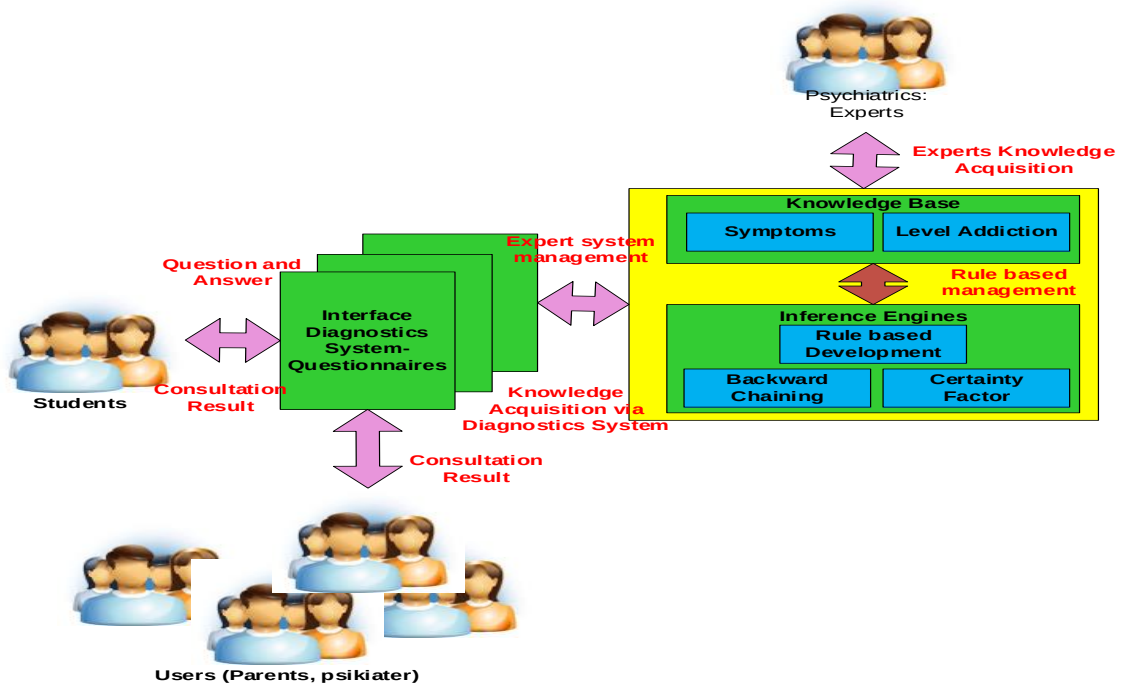

Figure 2. The System Architecture

Figure 2 explains that this application administers two main actors: users or patients and admins or experts. The admin or expert manages the knowledge base and creates the system rules. Meanwhile, the user or patient takes over a consultation part through the question and answer page around the perceived symptoms and addiction level assumption. The consultation page can be seen in Figure 3.

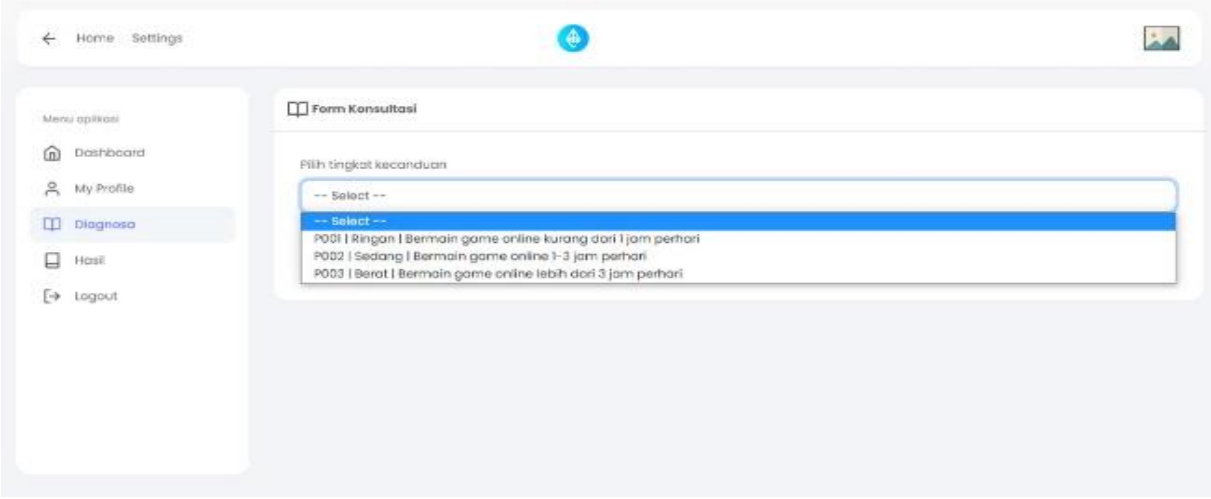

Figure 3. The Consultation Page

Herein, Figure 3 as the consultation page is interactive and designed using the question and answer formatted. In order to overcome the user/patient input mistake, each question provides detailed information and a description of the symptom and level of addiction. Figure 4 displays the conclusion page and the final diagnosis that determines the percentage of beliefs on university students' online game addiction level.

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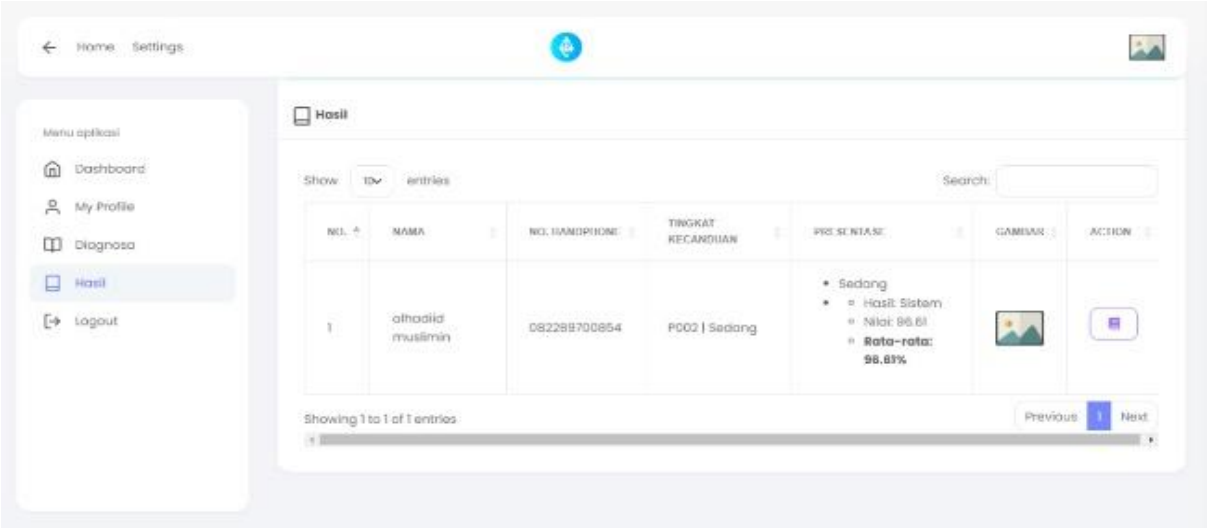

Figure 4. The conclusion page

3.3. The Software Testing

Comparing experts' judgement is conducted between the system operation and expert rating to test the validity of diagnosis calculation. The comparison analysis and rating based on the CF values and expert beliefs from ten students are depicted in Table 7. Table 7 clarifies that the system calculation and expert judgement equips the similar result on identifying the levelling category of online game addiction for student 1 into 10.

Table 7. The Comparison of expert judgment

User	CF value	System Rating	Expert Rating	Information
Student 1	98.31%	Moderate	Moderate	equal
Student 2	77.17%	Low	Low	equal
Student 3	84.19%	Low	Low	equal
Student 4	97.58%	Moderate	Moderate	equal
Student 5	99.17%	Moderate	Moderate	equal
Student 6	92.12%	Moderate	Moderate	equal
Student 7	99.79%	High	High	equal
Student 8	99.79%	High	High	equal
Student 9	99.93%	High	High	equal
Student 10	99.99%	High	High	equal

In a nutshell, the expert system development has fulfilled the software standard development and provides the benefit for users in detecting the online games level addiction. Besides, the expert judgement has been confirmed the efficacy and accuracy of this identification addiction level in ensuring and strenghtened the system calculation result.

4. DISCUSSION

This study has been successfully presents hows the integration of two approaches viz., BC and CF in expert system can enhanced the rule-based management, the expert's beliefs, the effectiveness of information value, the weights of evidence in predicting the online game addiction level accuracy. The advantages of both methods contribute into the sophisticated of CF values and accuracy. As supported by Tambunan et al. (2019) that have been developed an expert system for diagnosing the plant diseases using BC and CF. They found that CF can handling the uncertainty of probability found from user answer [46]. Meanwhile, BC aids the efficacy of uncertain rule development and inference engines. Moreover, Deslianti (2020) and Made et al. (2019) discovered the flexibility of BC in adjusting the calculation path and solution, rule-based maintenance, the efficiency of decision tree structure, and knowledge-based management [24] and [34]. Meanwhile, Ningsih et al. (2022) and Dewi et al. (2022) beared out that CF fits in with the users (experts or commonly users) uncertainty and bias information [36] and [37]. In a nutshell, the combination of BC and CF provides a better result rather than personal approach.

5. CONCLUSION

This paper has successfully analysed and designed the expert system application for online game-level addiction. Herein, the BC and CF approaches are utilized to optimal the inference engines schematics and rule-based development for the scope of university students' addiction. Based on the literature reviews and experts' judgment, the thirty-three symptoms have been flourishingly defined. The CF calculation and BC rule-based tracing have determined three addiction categories: high, moderate, and low. The calculation testing from ten university students at the Faculty of Science and Technology and Faculty of Teaching Training UIN Suska Riau has successfully validated the precision and accuracy based on the psychiatrists' beliefs from the Mental Health Hospital. Blackbox and UAT have tested the expert system's development and shown a satisfactory outcome. The respondents agree with this application's usefulness and friendly use as an early

detection tool instead of the expert's consultation. The preventive suggestion is also given according to the addiction category. Hence, the users receive basic knowledge and information in overcoming and avoiding online game addiction. Besides, this application advises university students to become wiser in time management and productivity towards successful future achievement.

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