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Comparative Analysis of Expert System Methods for Early Diagnosis of Online Game Addiction: A Systematic Review

Noka Prakasa Rhomadona[1] Luqman[2]

[1-2] Department of Master of Computer Science, Institut Teknologi PLN, Jakarta, Indonesia 11750.

noka2430003@itpln.ac.id

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Abstract

The phenomenon of online game addiction has become a serious issue that requires effective early detection and prevention mechanisms. This study aims to analyze and compare various expert system methods applied to diagnosing online game addiction to identify the most effective and efficient approaches. The methods reviewed include Backward Chaining, Forward Chaining, Certainty Factor, Euclidean Distance, Fuzzy Tsukamoto, Fuzzy Sugeno, Fuzzy Mamdani, Case-Based Reasoning, and K-Nearest Neighbor. Certainty Factor achieves an accuracy ranging from 79% to 81.2%, while the combination of Certainty Factor and Forward Chaining reaches 99.64%. Backward Chaining, combined with Certainty Factor, achieves an accuracy of 80%. Meanwhile, hybrid approaches such as Fuzzy Tsukamoto combined with Fuzzy Sugeno and Case-Based Reasoning demonstrate the highest performance, achieving 100% accuracy. These results suggest that hybrid expert system methods integrating fuzzy inference and reasoning techniques have strong potential to effectively support early diagnosis of online game addiction, closely resembling the diagnostic process of psychologists.

Keywords: *Expert System, Diagnosis, Online Game Addiction, Certainty Factor, Fuzzy Logic, Case-Based Reasoning.*

Abstrak

Fenomena kecanduan permainan daring telah menjadi masalah serius yang memerlukanmekanisme deteksi dini dan pencegahan yang efektif. Studi ini bertujuan untuk menganalisis dan membandingkan berbagai metode sistem pakar yang diterapkan dalam mendiagnosis kecanduan permainan daring guna mengidentifikasi pendekatan yang paling efektif dan efisien. Metode yang ditinjau meliputi Backward Chaining, Forward Chaining, Certainty Factor, Euclidean Distance, Fuzzy Tsukamoto, Fuzzy Sugeno, Fuzzy Mamdani, Case-Based Reasoning, dan K-Nearest Neighbor. Certainty Factor mencapai akurasi antara 79% hingga 81,2%, sementara kombinasi Certainty Factor dan Forward Chaining mencapai 99,64%. Backward Chaining, dikombinasikan dengan Certainty Faktor, mencapai akurasi 80%. Sementara itu, pendekatan hibrida seperti Fuzzy Tsukamoto dikombinasikan dengan Fuzzy Sugeno dan Penalaran Berbasis Kasus menunjukkan kinerja tertinggi, mencapai akurasi 100%. Hasil ini menunjukkan bahwa metode sistem pakar hibrida yang mengintegrasikan teknik inferensi dan penalaran fuzzy memiliki potensi kuat untuk mendukung diagnosis dini kecanduan game online secara efektif, mirip dengan proses diagnostik psikolog.

Katakunci : Sistem Pakar, Diagnosis, Kecanduan Permainan Online, Faktor Kepastian, Logika Fuzzy, Penalaran Berbasis Kasus.

1. Introduction

Technological developments have changed everyday human behavior, one of which is entertainment through gaming. Today's games use sophisticated visuals and audio, making them highly engaging and accessible via the internet [1]. The internet allows games to be played with family and friends without the constraints of distance or location, a phenomenon commonly referred to as online gaming. Essentially, online gaming has both positive and negative effects [2]. Negative effects can lead to a person's reduced social interaction with neighbors, family, and close friends. They also tend to use rude and offensive language, lack sympathy and empathy for others, and lead to health problems due to frequent late-night stays [3]. These negative effects are very dangerous, and early detection and prevention are essential before online gaming addiction develops. For prevention, a psychologist needs to investigate and diagnose whether an individual is addicted to online gaming or simply finds it a way to unwind.

Based on this, a system is needed that can provide results and recommendations to diagnose whether someone is addicted to online games, similar to a psychologist. With such a system, people can conduct independent checks at an affordable cost, anytime, and without the need for a visit to a hospital or psychologist [4]. Applying an expert system to diagnose online game addiction requires a method. Based on a Google search, many methods have been applied, including: Backward Chaining, Certainty Factor, Certainty Factor and Euclidean Distance, Certainty Factor and Forward Chaining, Backward Chaining and Certainty Factor, Fuzzy Tsukamoto and Fuzzy Sugeno, Case-Based Reasoning, Fuzzy Tsukamoto, Certainty Factor and K-Nearest Neighbor, Fuzzy Mamdani, Fuzzy Sugeno, and Fuzzy Mamdani [5]. Since many methods have been used in developing expert systems for diagnosing online game addiction, it is necessary to analyze which methods are effective and efficient based on the data obtained [6].

2. Method

Several methods have been implemented to diagnose online game addiction, including Backward Chaining, Certainty Factor, Certainty Factor and Euclidean Distance, Certainty Factor

and Forward Chaining, Backward Chaining and Certainty Factor, Fuzzy Tsukamoto and Fuzzy Sugeno, Case-Based Reasoning, Fuzzy Tsukamoto, Certainty Factor and K-Nearest Neighbor, Fuzzy Mamdani, Fuzzy Sugeno and Fuzzy Mamdani.

Backward Chaining is a tracking technique that begins with a set of conclusions and then develops a desired hypothesis. Backward Chaining is used in expert systems to determine answers or solutions to addiction problems by identifying the desired end goal and then evaluating evidence against the level of addiction. Backward Chaining can also be defined as reasoning that begins at the highest level, building a hypothesis, and works its way down to the lowest level of facts that can support the hypothesis—this is called top-down reasoning **[7].**

The Certainty Factor was introduced by Shortliffle Buchanan. The Certainty Factor is a single number that combines two elements: belief and disbelief. This data is called qualitative data and is represented as a degree of belief. To express the degree of belief, a value called the certainty factor (cf) is used to estimate an expert's level of confidence in the data **[3].**

Euclid's distance is a calculation that measures the distance between two points in Euclidean space, studying the relationship between angle and distance. The Euclid's distance method provides data from the certainty factor method stages, including the training data and the data [5]. Forward Chaining is a method of reasoning from data or facts to conclusions. Forward chaining can be interpreted as button-up reasoning, or bottom-up reasoning, because it considers evidence at lower levels, facts, leading to conclusions at higher levels **[10].**

Fuzzy Tsukamoto is a fuzzy logic system whose rules are expressed as if-then statements and are interpreted within a fuzzy set, along with the observer's membership, to yield the output of each rule. From each rule generated from each explicit or crisp predicate or fire straight, the final result is obtained using a weighted average. For example, if there are two input variables, var-1 (x) and var-2 (y), and so on, using the Tsukamoto fuzzy logic algorithm method **[9].**

Fuzzy Sugeno is a method that has fuzzy inference values for rules that can be represented in the form of an if-then language, where the output or consequence of the system is not only a fuzzy set but also a constant or linear equation. If x is a and is B, then z = f(x,y), where the numbers A and B have fuzzy sets in the antecedent, and z = f(x,y) functions explicitly in the consequent of a first-order polynomial or FIS, which is also called the fuzzy Sugeno model **[9].**

Case-Base Reasoning (CBR) is a method for solving new problems or cases by adapting methods used to solve old problems or cases **[11].** Case-Base Reasoning (CBR) uses previous

experience with similar cases to understand and solve new problems **[11]**. The Case-Base Reasoning method has four stages: retrieve, reuse, revise, and retain. Retrieve is the previous case that is most similar to the new problem. Reuse refers to reusing previous cases as a reference for existing diagnoses. Revised solutions are calculated, evaluated, and refined to minimize errors in new problems. In this process, solutions are retained, indexed, integrated, and new solutions extracted, which are then stored in the knowledge base for future problem solving.

The K-Nearest Neighbor algorithm is a frequently used algorithm for classification, although it can also be used for estimation and prediction. K-Nearest Neighbor is an example of a learning base where training data is stored so that classifications for unclassified data can be found by comparing them to the training data records [13]. The Mamdani fuzzy algorithm is similar to the fuzzy algorithm, in that Mamdani has ascending and descending lists, also known as MIN and MAX, where these calculations are searched for in the case study.

3. Results and Discussion

In the expert system analysis for diagnosing online game addiction, 15 sources of information data were used to compare the methods used, namely:

No	Information Data Title	Result
1	Sistem Pakar Diagnosa Gejala Kecanduan Game Online Berbasis Web Menggunakan Metode Backward Chaining.	Backward chaining works with small computational overhead.
2	Sistem Pakar Diagnosa Gejala Kecanduan Game Online dengan Metode Backward Chaining	With 8 levels of game addiction categories, it is more specific to detect symptoms of online game addiction.
3	Rancangan Bangun Sistem Pakar Diagnosa Gejala Kecanduan Game Online Pada Remaja Menggunakan Metode Certainty Factor	The accuracy rate of detecting online game addiction is 79% from 14 data samples.
4	Sistem Pakar Deteksi Digital Kecenderungan Kecanduan Game Pada Remaja Menggunakan Metode Forward Chaining Berbasis Web	Implementation is simpler because there is no need to determine the initial goal, by processing all rules according to the available facts.
5	Sistem Pakar Diagnosa Kecanduan Game Online dengan Metode	Combining Certainty Factor and Euclidean Distance produces a diagnostic level close to certainty.

No	Information Data Title	Result
	Certainty Factor dan Euclidean Distance Berbasis Web	
6	Sistem Pakar Diagnosis Tingkat Kecanduan Game Online Menggunakan Certainty Factor dan Forward Chaining Berbasis Website	The diagnosis of users with severe addiction to online games with the highest score of 99.64%
7	Sistem Pakar Diagnosa Gejala Kecanduan Game Online Menggunakan Metode Backward Chaining dan Certainty Factor Berbasis Web	The calculation results from 20 sample data with a success rate of 80% from comparing system and manual calculations.
8	Sistem Pakar Penentuan Tingkat KecanduanGame OnlinePada Anak BerbasisWebMenggunakan MetodeCertainty Factor(Studi Kasus : SDN Pagojengan 03)	The test results of 90 sample data have an accuracy level of 81.2%
9	Diagnosa Gejala Kecanduan Bermain Game Online dengan Metode Fuzzy Tsukamoto dan Fuzzy Sugeno	In a system with a percentage of 100% the data has 100% accuracy.
10	Application of Forward Chaining to Identify the Negative Impact of Online Game Addiction on Mental Health and Adolescent Behavior	The percentage of rule compliance from the total score that matches compared to the maximum score of the overall data is 94%
11	Penerapan Metode Case Base Reasoning Mendeteksi Kecanduan Game Online pada Remaja (Studi Kasus: SMP YPK Paulus)	The results of the comparison of the system and expert opinion obtained results in accordance with the expert system's opinion, it can be said that the level of confidence in the system results is 100%.
12	Sistem Pakar Deteksi Dini Tingkat Kecanduan Gadget pada Anak Menggunakan Fuzzy Tsukamoto	74 correspondent data using 64 rules yielded 87.83%.
13	Analisis Tingkat Kecanduan Game Online terhadap Manajemen Waktu dengan Menggunakan Metode Certainty Factor dan Algoritma K-Nearest Neighbor Lombok Tengah	Accuracy obtained based on rapidminer 80%
14	Implementasi Logika Fuzzy Mamdani untuk Mengidentifikasi Tingkat Kecanduan Pelajar terhadap Game Online	The application of the Mamdani fuzzy method can be used to identify online game addiction.

No	Information Data Title	Result
15	Diagnosa Kecanduan Gadget Pada Anak Usia Dini dengan Metode Fuzzy Sugeno dan Fuzzy Mamdani	Children under 9 years old can still be controlled in their use of gadgets, while those aged 9 years and above are difficult to control.

4. Conclusion

Expert system methods that have been used to diagnose online game addiction based on various sources include: Backward Chaining, Certainty Factor, Certainty Factor and Euclidean Distance, Certainty Factor and Forward Chaining, Backward Chaining and Certainty Factor, Fuzzy Tsukamoto and Fuzzy Sugeno, Case-Based Reasoning, Fuzzy Tsukamoto, Certainty Factor and K-Nearest Neighbor, Fuzzy Mamdani, Fuzzy Sugeno and Fuzzy Mamdani.

The results of applying expert system methods to diagnose game addiction vary due to the amount of data and rules used. Without involving the amount of data and rules for the accuracy of the certainty factor method, the certainty factor is 79%, the certainty factor and forward chaining are 99.64%, backward chaining and certainty factor are 80%, the certainty factor method is 81.2%, fuzzy Tsukamoto and fuzzy sugeno are 100%, forward chaining is 94%, case base reasoning is 100%, fuzzy Tsukamoto is 87.83%, certainty factor and K-Nearest Neighbor are 80%. So it can be seen that high accuracy is obtained using the fuzzy Tsukamoto-fuzzy Sugeno method and the reasoning method.

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