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Development and Preliminary Evaluation of a Certainty-Factor-Based School Counseling Support System for Gaming-Related Behavioral Indicators

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A B S T R A C T

This study developed a web-based expert system to help school counselors document gaming-related behavioral indicators among students at SMA Negeri 1 Bukittinggi. The application was developed using a Waterfall process, Laravel, MySQL, and certainty-factor (CF) calculations based on 15 indicators and expert-assigned weights. All 25 reported black-box test scenarios passed. The product evaluation also reported a mean Aiken's V of 0.68, a Moment Kappa of 0.99, and an N-Gain of 0.74. One rule-based output was 18.00%, labeled "Low Risk" under the application's operational categories. These findings describe reported software functionality and product evaluation measures; they do not demonstrate clinical screening accuracy. The indicator set, risk thresholds, and underlying evaluation data require further verification by the authors. The application is intended to support preliminary school counseling review, not to serve as a clinical diagnostic tool.

Abstrak

Penelitian ini mengembangkan sistem pakar berbasis web untuk membantu Guru Bimbingan dan Konseling (BK) mencatat indikator perilaku bermain gim siswa di SMA Negeri 1 Bukittinggi. Pengembangan mengikuti model Waterfall, menggunakan Laravel, MySQL, dan metode Certainty Factor (CF) berbasis 15 indikator serta bobot pakar. Pengujian yang dilaporkan mencakup 25 skenario black-box, semuanya berhasil, rerata Aiken's V 0,68, Moment Kappa 0,99, dan N-Gain 0,74. Salah satu keluaran aturan sistem adalah CF 18,00% dengan kategori operasional risiko rendah. Hasil evaluasi tersebut menggambarkan kinerja fungsi dan ukuran evaluasi produk yang dilaporkan, bukan akurasi diagnosis gaming disorder. Basis indikator, ambang risiko, dan skor evaluasi masih memerlukan verifikasi dokumen dasar serta pembandingan dengan instrumen skrining yang tervalidasi. Sistem ini ditujukan sebagai alat bantu penelaahan awal, bukan pengganti asesmen profesional Guru BK.

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1. Introduction

Gaming among adolescents should be distinguished from ordinary recreational play and patterns associated with functional impairment. Under the ICD-11, gaming disorder involves impaired control over gaming, increasing priority given to gaming, and continued gaming despite adverse consequences. Diagnosis also requires consideration of clinically significant functional impairment and the duration of the behavior [1], [2]. Systematic reviews show that prevalence estimates vary across settings and measurement instruments; population estimates therefore cannot be applied directly to an individual school [3], [4], [5], [6].

In educational settings, the relationship between problematic gaming and academic performance is not necessarily unidirectional. Reviews of empirical research generally report negative associations, while longitudinal findings suggest that the relationship may operate in both directions [7], [8].

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Adolescent studies also associate problematic gaming with psychological well-being, sleep quality, resilience, and engagement in learning. These findings cannot be reduced to a single consequence of gaming [9], [10], [11], [12], [13], [14], [15]. Schools therefore need supportive procedures that avoid clinical labeling in the absence of professional assessment.

According to observations reported at SMA Negeri 1 Bukittinggi, the initial identification of gaming behaviors that interfere with students' activities still relies on observation and discussions conducted by guidance and counseling (BK) teachers. This study responds to the operational need to record students' responses to behavioral indicators and provide rule-based outputs that counselors can review. The manuscript does not report service-time measurements, comparisons with existing manual procedures, or independent clinical assessments. Consequently, any improvements in speed or accuracy remain unverified.

A rule-based expert system can express expert knowledge and user responses through certainty-factor (CF) calculations. A CF score, however, represents confidence under a specified set of rules; it is neither a clinical probability nor confirmation of a diagnosis. To reduce the risk of misinterpretation, the selected indicators need to be related to the conceptual domains of gaming disorder and compared with psychometrically evaluated instruments. Studies of the Indonesian IGDT-10, ACSID-11, the Gaming Disorder Test, and measures of impaired gaming control provide relevant conceptual comparisons [16], [17], [18], [19], [20], [21], [22], [23], [24].

Research on gaming disorder also emphasizes the complexity of biopsychosocial factors and the limitations of relying on a single measure [25]. Software development studies must therefore distinguish successful functional testing from the content validity of behavioral indicators and from a system's ability to identify at-risk cases against an external reference standard. This distinction matters in schools, where application outputs may influence the support offered to individual students.

Previous studies have already applied CF methods to identify symptoms of problematic online gaming among adolescents [26]. Related applications have been developed for primary-school children [27], university students [28], and secondary-school students [29], [30], [31]. A methodological review further demonstrates variation in inference rules and validation procedures across expert-system studies [32]. Accordingly, the use of CF, a web application, or three risk categories does not, by itself, constitute a novel contribution. The contribution of the present study must instead be assessed in relation to the school counseling workflow, user roles, and evaluation evidence actually documented.

The research gap that can reasonably be addressed here concerns the documentation of an initial screening workflow at SMA Negeri 1 Bukittinggi involving three user roles: BK administrator, homeroom teacher, and student. The system also makes its CF calculation steps available for review. Relative to earlier CF studies, the contribution is primarily contextual and implementation-oriented, rather than a new algorithm or demonstrated improvement in diagnostic accuracy [26], [27], [28], [29], [30], [31]. No comparative evaluation is available to establish superiority over those earlier systems.

The observable development outcome is a web-based prototype that connects a list of behavioral indicators, user confidence ratings, expert-assigned weights, CF calculations, and interfaces for different school roles. Its outputs should be described as preliminary rule-based classifications rather than diagnoses of gaming disorder. The study has not established whether these outputs change counseling decisions or improve service outcomes; such benefits remain potential implications rather than demonstrated effects.

This study aimed to develop a web-based school counseling support application using CF to calculate outputs from students' self-reported gaming-related behavioral indicators and to evaluate the software functions and product measures reported in the manuscript. Its scope is limited to development and preliminary evaluation. Sensitivity, specificity, and validity against clinical diagnoses were not assessed in the reported findings.

In practice, the application is intended to help BK teachers review preliminary information in a more structured manner. Any use of its outputs still requires professional judgment, attention to individual circumstances, protection of student confidentiality, and explicit recognition that the application's risk thresholds have not been validated as diagnostic categories.

2. Research Methodology

2.1. Research Design

The study adopted a research and development (R&D) approach to produce a web-based expert-system application for SMA Negeri 1 Bukittinggi. Development followed the reported Waterfall model, comprising Requirements Analysis, Design, Development, Testing, and Maintenance. The application was built using Laravel and MySQL. The reported evidence concerns functional tests and product evaluation; this was neither a clinical accuracy study nor an experiment measuring counseling outcomes.

2.2. Research Setting and Participants

The work was conducted at SMA Negeri 1 Bukittinggi. BK teachers served as sources of knowledge about service needs and behavioral indicators, while students were the intended users of the indicator-response process. The system also accommodates BK administrators and homeroom teachers. The source manuscript does not adequately report the number of participants, their selection criteria, student characteristics, or the extent of actual use. These details need to be supplied from the original study records.

2.3. Knowledge Base and Rule Development

The knowledge base was developed from observations, interviews with BK teachers, and a literature review, as reported by the authors. The system contains 15 indicators (G01-G15) with expert-assigned CF weights listed in Table 1. Their correspondence to ICD-11 domains has not been established through construct mapping or external validation. G11 (showing enthusiasm when asked about gaming) may reflect ordinary interest, while G09 and G15 both concern concentration during study. The interpretation of these indicators and the possibility of double-counting therefore require further examination of the instrument and rule base. Research on impaired gaming control and validated measures offers conceptual comparisons, but does not establish that this study's indicators have been validated [1], [16], [17], [22].

Table 1. Gaming-Related Behavioral Indicators and Expert CF Weights

Code	Behavioral Indicator	Expert CF Weight
G01	Playing games longer than intended	0,8
G02	Difficulty stopping gaming	0,9
G03	Neglecting school assignments	0,8
G04	Reducing sleep time to play games	0,8
G05	Feeling restless when not playing games	0,9
G06	Preferring gaming to spending time with family	0,7
G07	Continuing to play despite awareness of adverse effects	0,8
G08	Spending money on games	0,6
G09	Difficulty concentrating on schoolwork	0,7
G10	Concealing or lying about time spent gaming	0,7
G11	Showing enthusiasm when asked about games	0,8
G12	Disliking interruptions while gaming	0,6
G13	Preferring gaming to physical activity or sports	0,6
G14	Using gaming as an escape when facing problems	0,9
G15	Losing focus on learning because of thoughts about gaming	0,8

2.4. Certainty Factor Procedure

The CF method was used to calculate rule-based confidence values from expert judgments and user responses. The reported basic formula is CF[H,E] = MB[H,E] - MD[H,E]. Two positive CF values supporting the same hypothesis are combined as CFcombine = CF1 + CF2(1 - CF1). The process used to assign expert weights, the handling of possible negative values, the aggregation order, and controls for overlapping indicators must be documented from the original rule base. The formula alone does not establish classification validity.

$$CF[H,E] = MB[H,E] - MD[H,E]$$

When more than one indicator supports the same hypothesis, the manuscript uses the following combination formula:

$$CFcombine = CF1 + CF2(1 - CF1)$$

The calculated value is expressed as a percentage according to the existing rule base. A CF percentage must not be interpreted as a clinical probability. The risk categories displayed by the system are operational classifications defined within the application and have not been compared with thresholds from standardized screening instruments [16], [17], [18].

The operational risk categories reported by the application are presented below. The empirical basis of the thresholds and the rounding rules at the 40-41% and 70-71% boundaries have not been documented and require confirmation by the authors.

Table 2. Operational CF Output Categories (Not Clinically Validated)

Percentage Range	Operational Risk Category
0-40%	Low Risk
41-70%	Moderate Risk
71-100%	High Risk

2.5. System Development Procedure

Development followed five reported stages of the Waterfall model:

2.5.1. Requirements Analysis

Observations, interviews with BK teachers, and a literature review were conducted to identify user requirements, online gaming-related symptoms, and the functional and nonfunctional requirements of the system.

2.5.2. Design

The application architecture, database, user interface, and system models were designed using Unified Modeling Language (UML), including use-case, activity, sequence, and class diagrams.

2.5.3. Development

A web-based application was developed in PHP using the Laravel framework and a MySQL database. It was designed to manage behavioral indicators, the knowledge base, rules, user records, consultation processes, and identification outputs.

2.5.4. Testing

Application functions and product characteristics were tested using black-box scenarios and reported assessments of validity, practicality, and effectiveness.

2.5.5. Maintenance

Maintenance was described as the correction of errors, adaptation to user requirements, and upkeep of application data and functions to support continued operation.

2.6. Testing Instruments

Functional testing comprised 25 black-box scenarios covering inputs, processes, and outputs for different user roles. The product evaluation also reported Aiken's V, Moment Kappa, and N-Gain. These indices address different questions and cannot be treated as measures of clinical accuracy. Aiken's V assesses the relevance of items according to raters [33]; Cohen's kappa measures agreement after accounting for chance [34]; and normalized gain describes pre-post score changes within a particular measurement context [35]. The authors need to verify the instruments and item-level data used for these calculations.

2.7. Data Collection Procedures

Data for development were reportedly gathered through school observations, interviews with BK teachers, and a review of the literature. The dates of data collection, interview protocols, and records showing how the indicator weights were derived were not supplied. These details must be confirmed from the original research documentation.

2.8. Data Analysis

Data analysis involved combining expert and user CF values across indicators according to the defined rules. The final value was used to assign an operational output category; this is rule-based inference, not a calibrated probability of gaming disorder. Simultaneous use of G09 and G15 should be reviewed because overlapping indicators could unintentionally inflate the combined score.

The black-box results were summarized by scenario success. The manuscript reports Aiken's V for 17 items assessed by three raters, Moment Kappa for nine practicality raters, and N-Gain for a pre-post evaluation. The constructs measured, the distributions of pre-post scores, the rating scales, and the item-level scores needed to reproduce the calculations are not sufficiently documented. Interpretation of these measures is therefore limited to the values reported.

2.9. Ethical Considerations

The source manuscript states that the school authorized the use of student data and that access was restricted according to user roles. However, documentary evidence was not provided for student or parent/guardian consent, the protection of sensitive information, data retention, or the basis on which results may be shared with homeroom teachers. These matters need to be confirmed before further deployment. This statement does not substitute for actual ethical approval or permission.

Application outputs should be used only for preliminary review by authorized personnel, without diagnostic labels or unnecessary disclosure of individual student data. Research on digital mental health interventions for adolescents highlights the importance of professional oversight, privacy safeguards, and evidence of suitability before wider use [36].

3. Results and Discussion

3.1. Results

3.1.1. System Requirements

Based on the reported observations and interviews, the application was designed to document responses to behavioral indicators and preliminary review results. It has three user roles: BK administrators manage the knowledge base and reports; homeroom teachers access information within their permissions; and students respond to the indicators. Role-based access is a software feature, but the effectiveness of confidentiality protections still requires technical verification.

3.1.2. Knowledge Base and Rule Base

The knowledge base contains 15 indicators and their expert-assigned weights, as shown in Table 3. The values have been retained from the source manuscript. The adequacy of the weights, their correspondence to clinical domains, and agreement among raters could not be assessed because the original weighting records were unavailable. The existing rules should therefore be viewed as a prototype requiring further validation.

Table 3. Behavioral Indicators and Expert CF Weights in the Implemented System

Code	Behavioral Indicator	Expert CF Weight
G01	Playing games longer than intended	0,8
G02	Difficulty stopping gaming	0,9
G03	Neglecting school assignments	0,8
G04	Reducing sleep time to play games	0,8
G05	Feeling restless when not playing games	0,9
G06	Preferring gaming to spending time with family	0,7
G07	Continuing to play despite awareness of adverse effects	0,8
G08	Spending money on games	0,6
G09	Difficulty concentrating on schoolwork	0,7
G10	Concealing or lying about time spent gaming	0,7
G11	Showing enthusiasm when asked about games	0,8
G12	Disliking interruptions while gaming	0,6
G13	Preferring gaming to physical activity or sports	0,6
G14	Using gaming as an escape when facing problems	0,9
G15	Losing focus on learning because of thoughts about gaming	0,8

These CF weights form part of the rules used to combine students' responses with expert confidence ratings. No documentation is available to determine whether G09 and G15 should be combined or how G11 should be interpreted when an interest in gaming is not accompanied by functional impairment.

3.1.3. Certainty Factor Calculation

The system reportedly multiplies the user CF and expert CF values for each indicator, then combines the resulting values sequentially using the CF combination formula. The output represents confidence assigned under the system's rules. A single worked example cannot demonstrate decision validity or confirm a clinical diagnosis.

For each indicator, the system applies the following calculation:

$$CF(H, E) = CF_{Pakar} \times CF_{User}$$

The indicator-level values are then combined using:

$$\text{CFCombine}=\text{CF1}+\text{CF2}(1-\text{CF1})$$

One example in the source manuscript reports a final output of 18.00%, labeled "Low Risk." This value is retained as an illustrative software output, not as validation of the risk category, diagnostic accuracy, or the clinical probability of any particular student.

3.1.4. System Implementation

The implemented system uses Laravel and MySQL to manage behavioral indicators, the rule base, user records, consultations, CF results, and report generation. Screenshots illustrate interface functions but do not, by themselves, establish classification accuracy or the security of every feature.

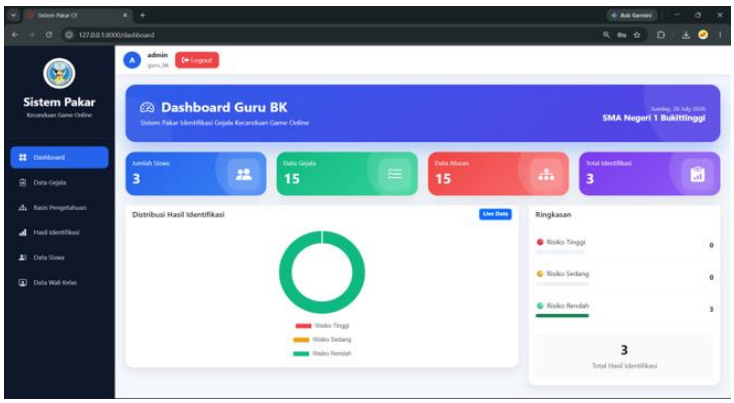


Figure 1. Dashboard Interface

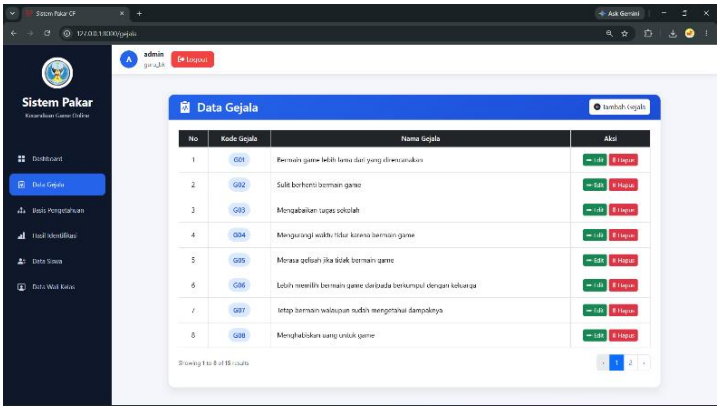


Figure 2. Behavioral Indicator Management Page

During consultation, students answer the available behavioral indicators, after which the system calculates a CF score and displays an operational output category. The detail page retains their selected responses so that BK teachers can review the information provided during the consultation. These records may support an initial discussion with the student, but they must be considered alongside the student's individual circumstances and the possibility of measurement error. They should not be treated as an independent clinical assessment.

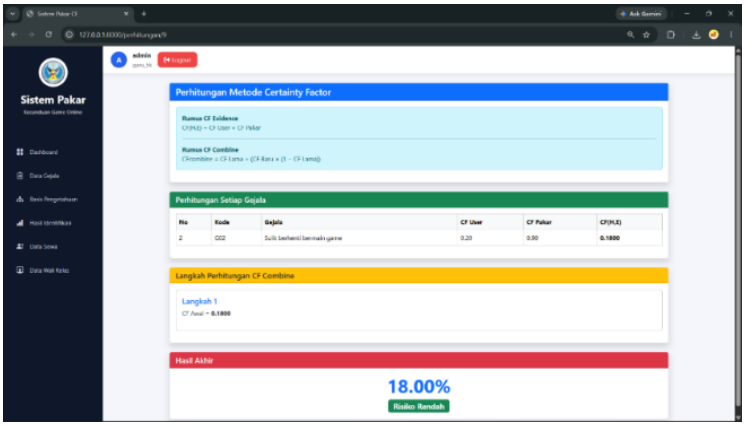


Figure 3. CF Calculation Page

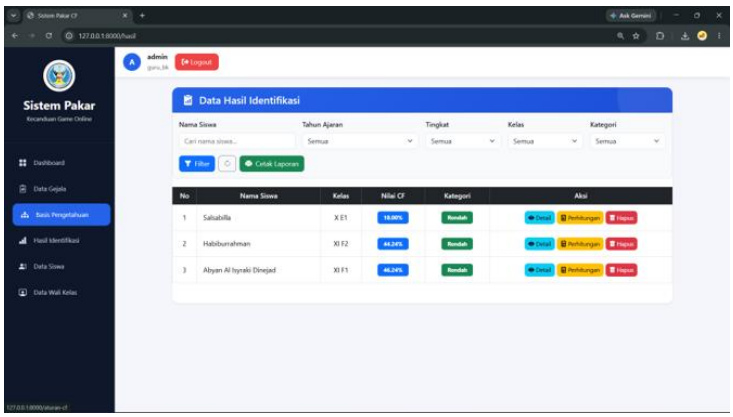


Figure 4. Identification Results Page

In addition to displaying preliminary results, the system provides history, search, filtering, and report-printing functions. These are observed implementation features; their effects on service effectiveness or counseling decisions have not been measured.

3.1.5. Functional Testing

The reported black-box testing covered 25 scenarios across three user roles. All scenarios were marked "Passed," as shown in Table 4. These results support the functioning of the tested features under the specified conditions, but do not measure the sensitivity or specificity of gaming-disorder identification or the security of student data.

Table 4. Functional Test Results (25 Scenarios)

No.	User Role	Feature Tested	Test Scenario	Result
1	BK Admin	Login	The administrator enters valid login credentials	Passed
2	BK Admin	Dashboard	The administrator opens the dashboard	Passed
3	BK Admin	Indicator Data	The administrator adds a new indicator	Passed
4	BK Admin	Knowledge Base	The administrator selects an indicator and enters its expert CF weight	Passed
5	BK Admin	Student Data	The administrator views student records	Passed
6	BK Admin	Teacher Records	The administrator adds a homeroom teacher record	Passed
7	BK Admin	Teacher Records	The administrator edits a homeroom teacher record	Passed
8	BK Admin	Results	The administrator views student identification results	Passed
9	BK Admin	Filter Results	The administrator searches by name, class, or academic year	Passed
10	BK Admin	Result Details	The administrator views identification details	Passed
11	BK Admin	CF Calculation	The administrator views the calculation process	Passed
12	BK Admin	Print Report	The administrator prints an identification report	Passed
13	BK Admin	Logout	The administrator selects Log out	Passed
14	Homeroom Teacher	Login	A BK or homeroom teacher enters valid login credentials	Passed
15	Homeroom Teacher	Dashboard	A BK or homeroom teacher opens the dashboard	Passed
16	Homeroom Teacher	Student Data	A BK or homeroom teacher accesses student records	Passed
17	Homeroom Teacher	Results	A BK or homeroom teacher accesses identification results	Passed
18	Homeroom Teacher	Filter Results	A BK or homeroom teacher searches or filters records	Passed
19	Homeroom Teacher	Result Details	A BK or homeroom teacher views student result details	Passed
20	Homeroom Teacher	Logout	A BK or homeroom teacher selects Log out	Passed

No.	User Role	Feature Tested	Test Scenario	Result
21	Student	Login	A student enters an incorrect username or password	Passed
22	Student	Responses	A student selects a response for each indicator	Passed
23	Student	Processing	A student submits the completed responses	Passed
24	Student	Results	A student views the identification result	Passed
25	Student	Logout	A student selects Log out	Passed

The test results show that the features listed in Table 4 operated as expected under the reported testing conditions. They should not be interpreted as evidence that the CF risk outputs agree with clinical assessments or that BK counseling services have become more effective.

3.1.6. Product Evaluation

The following product evaluation measures describe reported application outcomes, not the accuracy of identifying gaming disorder. The original instruments and underlying data for each index must be provided to audit the calculations and their interpretation.

The reported validity assessment used Aiken's V for 17 items rated by three evaluators, yielding a mean of 0.68. The practicality assessment used Moment Kappa with a reported group of nine evaluators and yielded 0.99. The pre-post evaluation reported an N-Gain of 0.74, but the measured variable, participants, timing, and baseline scores were not sufficiently described. These measures must be interpreted in relation to their respective constructs and do not establish screening accuracy or clinical improvement without an appropriate comparison study [33], [34], [35].

Table 5. Summary of Reported Product Evaluation Results

No.	Evaluation Type	Method	Score	Level
1	Validity	Aiken's V	0,68	Valid
2	Practicality	Moment Kappa	0,99	Very High
3	Effectiveness	N-Gain	0,74	High

3.2. Discussion

3.2.1. Interpretation of Key Findings

The application generated CF outputs from the selected indicators, and all 25 specified black-box test scenarios reportedly passed. Aiken's V (0.68), Kappa (0.99), and N-Gain (0.74) were reported as product evaluation measures, not diagnostic accuracy estimates. Successful software functions, the construct validity of the indicators, and the validity of decisions against a reference standard are distinct matters. This distinction is consistent with research on gaming-disorder measures that separately examines reliability and classification performance [16], [17], [18], [19], [21].

3.2.2. Comparison with Previous Studies

Wibisono and colleagues also used CF weights for symptoms of problematic gaming in adolescents and generated output categories [26]. Fadilah and colleagues examined CF using nine indicators among primary-school children, while Muslimin and colleagues combined backward chaining with CF for university students [27], [28]. More recent secondary-school applications and methodological comparisons show that this type of system is not entirely new [29], [30], [31], [32]. A distinguishable feature of the present implementation is its integration of BK administrator, homeroom teacher, and student access within one application. Without comparison against validated instruments, however, the study cannot claim greater accuracy than earlier systems. Validation studies across countries further show that psychometric testing is needed before an operational category can be treated as equivalent to standardized screening [16], [17], [24], [23], [20].

3.2.3. Practical Implications for School Counseling

The application may help BK teachers document preliminary indicators and plan follow-up, but its potential service benefits should not be confused with evidence of software functionality. Trials of cognitive behavioral therapy (CBT) and media literacy interventions among students indicate that preventive effects require separate outcome measurements and longitudinal follow-up [37], [38], [39]. Treatment reviews likewise distinguish measured changes in symptoms from the operational success of digital tools [40], [41]. The application should therefore be positioned as a counseling support tool, not an intervention shown to reduce gaming disorder.

3.2.4. Ethical Considerations

Student-related outputs must remain confidential and be shared only when there is a clear need and appropriate authorization. CF values and category labels should not be used to stigmatize students, impose sanctions, or make automated clinical decisions. ICD-11 guidance and research on digital mental health emphasize functional impairment and professional oversight [1], [2], [36]. The authors need to document the actual consent procedures, access permissions, and data retention arrangements.

3.2.5. Limitations

The study was limited to development and preliminary evaluation at one school. The 15 indicators have not been validated against ICD-11 domains; neither have the category thresholds been calibrated or the system compared with established screening instruments or expert diagnoses. There is also no evidence of long-term effects on counseling services. G11 may reflect ordinary enthusiasm for gaming, while G09 and G15 may overlap. In addition, the underlying data used to calculate Aiken's V, Kappa, and N-Gain were not supplied. Functional software results cannot therefore be generalized into claims of clinical effectiveness.

3.2.6. Future Research

Future work should map the indicators onto ICD-11 domains, verify the CF weights and rounding rules, and compare application outputs with instruments validated for use in Indonesia. Studies should also involve more diverse experts and students [16], [19]. Evaluating service benefits will require an appropriate design, safeguards for children's data, and follow-up over a meaningful period. Decision validation should be distinguished from software testing and evaluation of prevention programs [38], [36].

4. Conclusion

The study produced a Laravel- and MySQL-based expert-system prototype to support the documentation of preliminary gaming-related behavioral indicators in school counseling at SMA Negeri 1 Bukittinggi. The system uses 15 indicators and the CF values reported by the authors to generate rule-based outputs and operational categories. The application is not intended to establish a clinical diagnosis.

All 25 reported black-box test scenarios passed. The product evaluation also reported a mean Aiken's V of 0.68, a Moment Kappa of 0.99, and an N-Gain of 0.74. These findings concern the reported functional and product assessments; they do not, on their own, establish the construct validity of the indicators, the accuracy of risk categories, or benefits for counseling.

The principal contribution is the implementation of an indicator-recording workflow and differentiated user access to support preliminary review by BK teachers. Its outputs require cautious interpretation because the risk thresholds, indicator weights, underlying evaluation calculations, and correspondence with standardized screening have yet to be verified. Further assessment of the instruments, decision accuracy, student-data protection, and service outcomes is required before wider deployment.

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Declarations

Author Contribution Statement

Arif Malik Priyandri contributed to the study's conceptualization and design, data collection and analysis, system development, and preparation of the original manuscript. Liza Efriyanti contributed to supervision, methodological review, critical revision of the manuscript, and approval of its final version, consistent with the submitted authorship declaration.

Funding Statement

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Data Availability Statement

The study data and school records are not publicly available because they contain confidential student and institutional information. Requests for appropriately de-identified supporting materials may be directed to the corresponding author, subject to school authorization and applicable privacy requirements. Complete instrument records needed to verify every reported index were not included in the submitted manuscript.

Declaration of Interests Statement

The authors declared no relevant financial or nonfinancial conflicts of interest.

AI Use Statement

GPT-6 (OpenAI) assisted with post-review editing and restructuring of the manuscript, literature searching and synthesis, and language refinement. This assistance was not used to generate field data or statistical results. The authors remain responsible for verifying sources, numerical results, and scientific statements and for approving the version submitted to the journal.

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