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Limited Implementation of a Hybrid Intelligent System for Student Resilience Support

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Abstrak

Penelitian ini mengembangkan dan melaksanakan implementasi terbatas dari sistem pendukung ketahanan hibrida cerdas yang dirancang untuk memfasilitasi identifikasi dini kebutuhan ketahanan siswa serta memandu respons konseling sekolah berjenjang. Desain penelitian dan pengembangan ini disusun dalam lima tahap—analisis, perancangan, pengembangan, implementasi, dan evaluasi—serta melibatkan 60 siswa Kelas XI dan konselor. Sistem ini mengintegrasikan penilaian yang terdiri dari 23 item yang mencakup tujuh dimensi ketahanan, klasifikasi Random Forest, sistem pakar berbasis aturan, dan validasi oleh konselor. Analisis kebutuhan menghasilkan 92,6% tanggapan positif. Semua item memenuhi kriteria validitas empiris, dengan Cronbach's alpha = 0,949 dan koefisien V Aiken berkisar antara 0,909 hingga 0,960. Selama implementasi terbatas, 28,3% siswa diklasifikasikan memiliki ketahanan rendah, 45,0% memiliki ketahanan sedang, dan 26,7% memiliki ketahanan tinggi, dengan tingkat kesetiaan implementasi sebesar 95,8%. Kesesuaian antara sistem dan konselor mencapai 91,7%, skor macro-F1 sebesar 0,919, skor rata-rata Skala Kegunaan Sistem sebesar 81,38, tanggapan siswa sebesar 87,9%, dan tingkat kepraktisan konselor sebesar 87,5%. Temuan ini mendukung kelayakan, kegunaan, dan kesiapan sistem sebagai alat bantu pengambilan keputusan; namun, temuan ini tidak membuktikan efektivitas kausal dalam meningkatkan ketahanan.

Kata kunci: kecerdasan buatan; ketahanan psikologis; Random Forest; sistem pakar; bimbingan konseling sekolah.

Abstract

This study developed and conducted a limited implementation of a hybrid intelligent resilience support system designed to facilitate early identification of students' resilience needs and guide tiered school-counseling responses. A research-and-development design was organized into five stages—analysis, design, development, implementation, and evaluation—and involved 60 Grade XI students and counselors. The system integrates a 23-item assessment covering seven resilience dimensions, Random Forest classification, a rule-based expert system, and counselor validation. The needs analysis yielded 92.6% positive responses. All items met the empirical validity criterion, with Cronbach's alpha = 0.949 and Aiken's V coefficients ranging from 0.909 to 0.960. During the limited implementation, 28.3% of students were classified as having low resilience, 45.0% moderate resilience, and 26.7% high resilience, with an implementation fidelity of 95.8%. System–counselor agreement reached 91.7%, the macro-F1 score was 0.919, the mean

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System Usability Scale score was 81.38, student response was 87.9%, and counselor practicality was 87.5%. These findings support the system's feasibility, usability, and readiness as a decision-support tool; however, they do not establish causal effectiveness in improving resilience.

Keywords: *artificial intelligence; psychological resilience; Random Forest; expert system; school counseling.*

INTRODUCTION

Adolescence is a developmental period in which academic demands, peer evaluation, identity formation, family expectations, and preparation for educational or occupational transitions occur simultaneously. The accumulation of these demands may become a significant source of stress when students lack sufficient psychological resources to regulate emotions, appraise difficulties realistically, sustain optimism, and seek support. In school contexts, resilience should therefore not be treated as a fixed personality label, but rather as an adaptive capacity that may change over time, across contexts, and according to the availability of support. Recent reviews indicate that school-based resilience interventions can benefit adolescents, although the magnitude of their effects varies with participant characteristics, intervention design, implementation quality, and follow-up duration (Llistosella et al., 2023; Llistosella et al., 2024).

The need for resilience monitoring is increasingly important because students' psychological difficulties are not always identified at an early stage. In school guidance and counseling practice, identification often occurs only after observable changes in academic performance, behavior, or emotional functioning have emerged. Preventive approaches, however, require mechanisms that enable counselors to recognize patterns of need before problems become more severe. Current priorities in school-based mental health services emphasize accessibility, scalability, contextual sensitivity, and the integration of interventions into actual school service pathways (Rooney et al., 2024; Lyon et al., 2024). Accordingly, structured screening instruments should be linked to professional follow-up rather than ending with the assignment of a score or category.

Digital technologies offer opportunities to accelerate data collection, enable repeated monitoring, and connect students with counselors more efficiently. However, adolescents' acceptance of digital support is determined by more than interface usability. Privacy, credibility, relevance, perceived safety, and access to human support are important determinants of young users' engagement (Wanniarachchi et al., 2025; Zhu et al., 2025). Reviews of digital mental health interventions also indicate that technological benefits do not automatically eliminate access gaps or the digital divide, underscoring the need for systems to account for users' social context and capacities (Piers et al., 2023).

Artificial intelligence can extend an application's role from data recording to decision support. In this study, the machine-learning layer uses Random Forest to identify patterns in resilience-assessment features, while a rule-based expert system translates resilience categories and dimensional profiles into service recommendations for counselor review. This functional separation is important because data classification and intervention decisions are distinct tasks. The literature indicates that machine learning may support detection, risk stratification, and personalization in mental health services; nevertheless, data validity, bias, interpretability, privacy, and human oversight remain essential prerequisites for responsible implementation (Andrew et al., 2023; Higgins et al., 2023; Liu et al., 2024).

A hybrid intelligent approach was adopted to ensure that system outputs are not treated as automated psychological decisions. Random Forest functions as the pattern-recognition layer, whereas explicit rules within the expert system preserve the traceability of recommendations. Counselors remain human-in-the-loop, responsible for considering contextual information, confirming priorities, modifying recommendations, and determining follow-up actions. This principle is consistent with explainable artificial intelligence in education, which positions

transparency, accountability, fairness, ethics, and human-centered design as key foundations of trust in AI systems (Khosravi et al., 2022). Ethical scholarship on digital mental health similarly emphasizes the need to maintain professional involvement, data security, transparency, and accountability throughout the technology-use lifecycle (Coghlan et al., 2023; Warrier et al., 2023).

Evidence of technology acceptance should not be equated with evidence of psychological effectiveness. An application may be easy to use without necessarily improving resilience, and a classification model may demonstrate operational agreement without having undergone independent algorithmic validation. A recent meta-analysis of digital mental health interventions for children and adolescents reported relatively small overall effects, with outcomes influenced by moderators such as age and intervention duration (Takizawa et al., 2026). System development must therefore distinguish clearly among feasibility, measurement quality, usability, acceptability, operational agreement, and causal effectiveness.

This study focuses on the development and limited implementation of a Hybrid Intelligent Resilience Support System for secondary school students. The system integrates a 23-item assessment representing seven resilience dimensions, Random Forest classification, a rule-based expert system, a protected database, a monitoring dashboard, and counselor validation. The study aimed to describe the user needs underpinning development, evaluate instrument quality and product validation, map resilience profiles during limited implementation, assess implementation fidelity, and obtain formative evidence concerning system–counselor agreement, usability, student responses, and counselor-rated practicality. No causal claim regarding increased resilience is made because outcome evaluation is still in progress.

RESEARCH METHOD

This study employed a research-and-development (R&D) design organized into five stages: analysis, design, development, implementation, and evaluation. This proceedings paper reports the completed development activities and a limited implementation; outcome-effectiveness evaluation is still ongoing and is therefore not presented as a completed result. The empirical implementation was conducted at SMA Negeri 13 Medan and SMA Negeri 3 Medan, North Sumatra, during the limited implementation phase of the broader ongoing study. Participants were 60 Grade XI students from two classes (30 students per class) and three guidance and counseling teachers who evaluated the system from the service-provider perspective. Student records were anonymized using research codes before analysis.

During the analysis stage, students' needs for technology-assisted psychological services were examined using a 14-indicator questionnaire. The design stage produced the Hybrid Intelligent System architecture, data flow, use cases, process flow, entity relationships, sequence logic, user roles, access controls, and linkages among machine-learning classification, expert-system rules, and counselor validation. Development included programming the web application, integrating the database, processing resilience assessments, implementing Random Forest classification, encoding rule-based recommendation logic, developing dashboard functions, and conducting expert validation. Limited field implementation involved students completing the assessment and counselors using system outputs for monitoring and follow-up. Evaluation in this paper was formative and operational rather than a test of causal effectiveness.

The system architecture separates three decision layers. First, the assessment and scoring engine transforms students' responses into structured features, including reverse scoring and dimension scores. Second, Random Forest generates resilience-category classifications. Third, the rule-based expert system links categories and dimensional patterns to options for recommendations, counseling priorities, monitoring, or referral, which are subsequently reviewed by a counselor. A protected database stores user, assessment, result, history, and follow-up records to support longitudinal monitoring. A module for processing students' narrative input is positioned as an additional component requiring separate testing and is not used as the basis for performance claims in this study.

The needs instrument comprised 14 indicators rated on a four-point response scale. The resilience assessment consisted of 23 items representing emotion regulation, impulse control,

optimism, causal analysis, empathy, self-efficacy, and reaching out. Item quality was examined using corrected item–total correlations, with r = 0.254 as the comparison criterion in the study dataset, while internal consistency was estimated using Cronbach's alpha. Expert validation covered guidance and counseling content, system/technology, and language/media, summarized using Aiken's V coefficients. Implementation fidelity was observed across two sessions using 12 indicators.

Implementation results were analyzed descriptively using frequencies, percentages, means, and standard deviations. Resilience was reported in low, moderate, and high categories. The system's final operational classifications were compared with counselor categories using accuracy, precision, recall, class-specific F1 scores, and the macro-F1 score. Student response was summarized using a 10-indicator response instrument, while usability was assessed with the System Usability Scale (SUS). Counselor evaluation covered overall response, practicality, and usefulness. Because a pretest–posttest effectiveness dataset with an adequate comparison structure had not yet been completed, this paper does not report a causal test of resilience improvement.

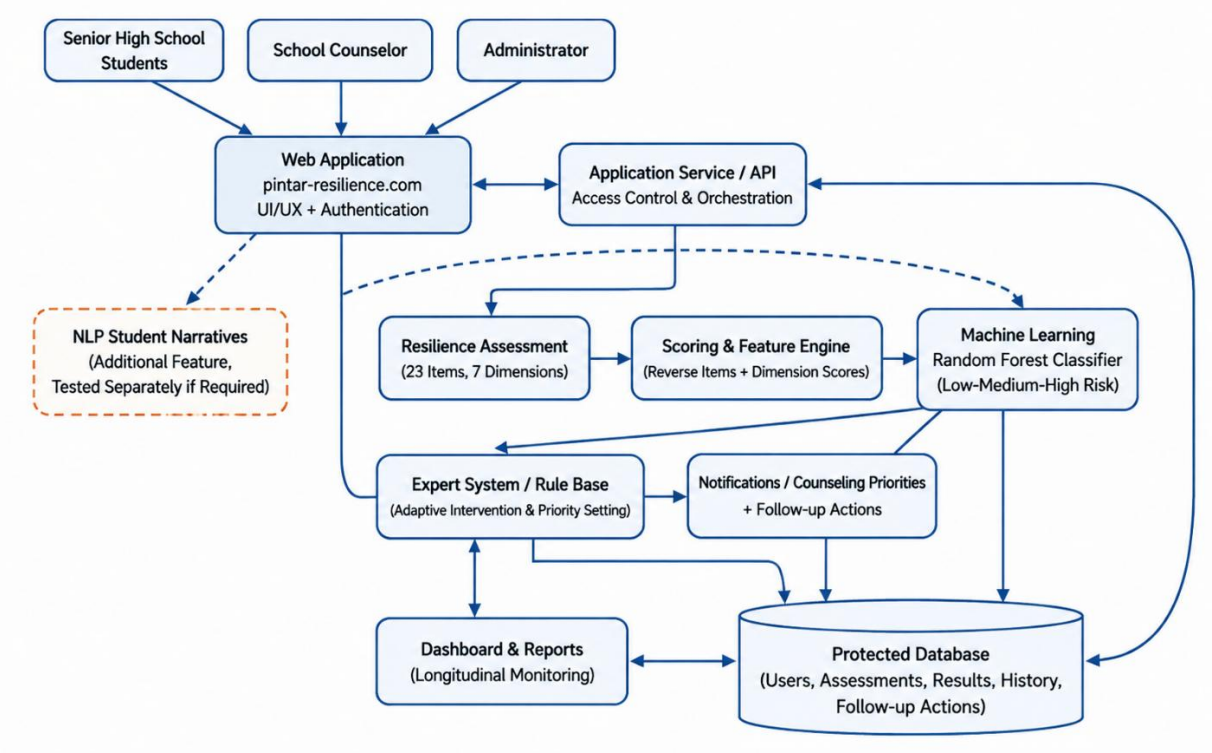

Figure 1. Logical architecture of the Hybrid Intelligent Resilience Support System.

RESULTS AND DISCUSSION

User Needs and Design Implications

Across the 14 need indicators, the mean proportion of Agree and Strongly Agree responses was 92.6%. Twelve indicators were classified as very strong and two as strong. The most prominent signals concerned students' habitual use of digital applications, the need for rapid connection with a counselor when problems become serious, and restrictions on who may access psychological data. These findings indicate that students' needs extend beyond ease of use to include rapid access, comprehensible interfaces, confidentiality, self-monitoring, and a clear pathway to professional support.

Table 1. Summary of Development Evidence by Stage

Stage	Key evidence	Development implication
Analysis	92.6% positive needs response; 12/14 indicators very strong	Rapid access, privacy, self-monitoring, counselor connection
Design	Hybrid architecture; Random Forest; expert system; data flow	Data classification separated from recommendations and human validation
Development	23/23 valid items; alpha = 0.949; Aiken's V = 0.909–0.960	Instrument and product adequate for limited implementation
Implementation	60 Grade XI students; fidelity = 95.8%	System operationally feasible in the test-school context
Formative evaluation	91.7% agreement; macro-F1 = 0.919; usability = 81.38	Supports decision-support readiness, not causal effectiveness

The high level of digital need should not be interpreted merely as a preference for technology. Research with adolescents indicates that accessibility, privacy, credibility, and human connection jointly shape engagement with digital mental health services (Wanniarachchi et al., 2025; Zhu et al., 2025). Accordingly, the application in this study was designed as blended support: technology accelerates screening, monitoring, and communication, while the counseling relationship and contextual decisions remain the responsibility of human professionals. This approach is also consistent with evidence that young people's successful engagement is influenced by perceived usefulness, connectedness, usage burden, and the capacity of interventions to adapt to users' capabilities (Ho et al., 2025; Cross & Alvarez-Jimenez, 2024)

Product Validity and Psychometric Quality

All 23 resilience-assessment items exceeded the empirical criterion in the study dataset. Corrected item–total correlations ranged from 0.483 to 0.770, and Cronbach's alpha reached 0.949, indicating high internal consistency in the tested secondary-school sample. Expert validation also showed very strong agreement, with Aiken's V values of 0.933 for guidance and counseling content, 0.909 for system/technology, and 0.960 for language/media. Mean ratings on the four-point scale were 3.80, 3.73, and 3.88, respectively.

Table 2. Validity and Reliability Evidence

Indicator	Result	Interpretation
Corrected item–total correlation	0.483–0.770	All 23 items exceeded the study criterion
Cronbach's alpha	0.949	Very high internal consistency
Aiken's V – counseling content	0.933	Very strong expert agreement
Aiken's V – system/technology	0.909	Very strong expert agreement
Aiken's V – language/media	0.960	Very strong expert agreement

Psychometric quality is critical because computational classification is meaningful only when the input data are sufficiently coherent. In a Hybrid Intelligent System, error may arise from both psychological measurement and the computational layer. The high internal consistency and expert-validation results support limited use in the tested secondary-school context, but they do

not automatically justify generalization to other age groups. Application to different populations would require separate developmental and psychometric validation. This principle aligns with reviews of AI in mental health that identify data quality and precise task definition as prerequisites for broader interpretation of algorithmic performance (Andrew et al., 2023; Higgins et al., 2023).

Resilience Profile and Service Implications

The total resilience score among the 60 students had a mean of 68.17, a standard deviation of 20.88, and a range of 32–105. Seventeen students (28.3%) were in the low category, 27 (45.0%) in the moderate category, and 16 (26.7%) in the high category. This distribution indicates heterogeneous support needs within the same grade level. The moderate category constituted the largest group, while more than one quarter of students were identified as requiring higher-priority review and potentially more intensive counseling support.

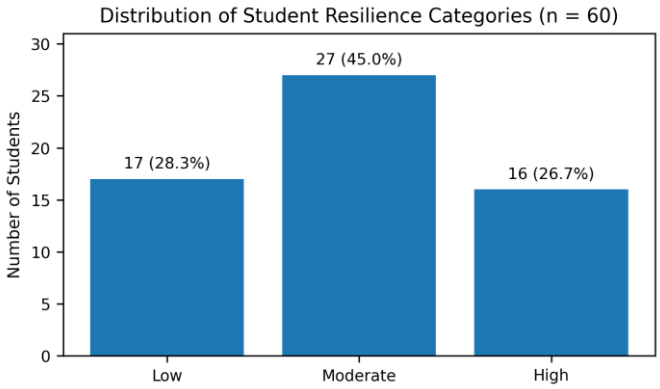

Figure 2. Distribution of resilience categories during the limited implementation.

Table 3. Profile of the Seven Resilience Dimensions

Dimension	Mean/item	% of maximum
Emotion regulation	2.99	59.7%
Impulse control	3.03	60.6%
Optimism	2.92	58.4%
Causal analysis	2.91	58.1%
Empathy	3.00	60.0%
Self-efficacy	2.94	58.8%
Reaching out	2.97	59.4%

Mean dimension scores were relatively close, ranging from 2.91 to 3.03 on the five-point item scale. Impulse control had the highest mean (3.03), followed by empathy (3.00) and emotion regulation (2.99). Causal analysis (2.91), optimism (2.92), and self-efficacy (2.94) were relatively lower. These differences are descriptive and were used to guide service emphasis rather than to indicate statistically significant between-dimension differences. The profile reinforces the need for tiered services: students in the low category may be prioritized for individual assessment and closer monitoring; those in the moderate category may be directed to group or classroom guidance and targeted skills training; and those in the high category may receive maintenance and enrichment activities. The school-resilience intervention literature indicates that program benefits depend heavily on intervention structure and implementation conditions; therefore, the system-generated categories should be used to organize services rather than as fixed labels (Llistosella et al., 2023; Llistosella et al., 2024).

Implementation Fidelity and Operational Adaptation

Implementation fidelity was observed across two sessions using 12 indicators. The first session achieved 91.7% fidelity, with 11 of 12 indicators fulfilled; the unmet indicator concerned infrastructure support. In the second session, all indicators were fulfilled, producing 100% fidelity. Mean fidelity across the two sessions was 95.8%. This improvement indicates rapid operational adaptation after the initial infrastructure constraint was addressed.

Table 4. Implementation Fidelity

Session	Fidelity	Observation
Session 1	91.7%	11/12 indicators fulfilled; infrastructure not yet optimal
Session 2	100.0%	12/12 indicators fulfilled
Mean	95.8%	Very high implementation fidelity

The high fidelity level indicates that the system can be integrated into routine school services once initial infrastructure requirements are addressed. Nevertheless, implementation sustainability involves more than ensuring that application functions operate correctly. Implementation science in school mental health suggests that fidelity, professional development, implementation mechanisms, intervention redesign, and sustainability must be addressed jointly if innovations are to become routine practice (Lyon et al., 2024). The digital cumulative complexity model likewise emphasizes balancing the demands imposed by an application with users' capacity, indicating that simplifying counselor workflows may be as important as adding new features (Cross & Alvarez-Jimenez, 2024).

Operational Evaluation, Usability, and the Counselor's Role

Comparison of the system's final categories with counselor ratings showed agreement in 55 of 60 cases, equivalent to 91.7% operational agreement. The macro-F1 score was 0.919, with class-specific F1 scores of 0.909 for low resilience, 0.909 for moderate resilience, and 0.938 for high resilience. Five disagreements occurred: one low case was classified by the system as moderate, two moderate cases as low, one moderate case as high, and one high case as moderate. These discrepancies reinforce the need for counselor validation before intervention decisions are made.

The 91.7% figure should be interpreted as end-to-end agreement between the operational system output and counselor categorization, not as independent validation of the Random Forest model. The research records underlying this paper do not contain fold-level predictions, output probabilities, train–test splits, hyperparameter settings, or evaluation logs that would enable separate reproducibility. Strong claims about algorithm-level performance therefore cannot yet be made. Maintaining this distinction prevents the implementation results from exceeding the available evidence and allows subsequent confirmatory evaluation to report the training and validation pipeline transparently.

Table 5. Summary of Formative Evaluation

Indicator	Result	Interpretation
System–counselor agreement	91.7%	High operational agreement
Macro-F1	0.919	Balanced performance across three classes
Student response	87.9%	Very positive
System Usability Scale	81.38	Acceptable; good–excellent
Counselor response	93.3%	Very positive
Counselor practicality	87.5%	Highly practical
Counselor usefulness	94.2%	Highly useful

Student response to the system reached 87.9%. The highest-rated indicators were ease of understanding the interface and language (91.7% each), followed by comfort and perceived safety (91.2%) and support for early detection (90.8%). The lowest scores, although still positive, concerned willingness to recommend the system to peers (81.2%) and perceived increases in attention to one's own psychological condition (83.3%). The mean System Usability Scale score was 81.38 (SD = 4.20; range = 70–90), placing the interface within the acceptable to good–excellent range. The three counselors rated overall response at 93.3%, practicality at 87.5%, and usefulness at 94.2%.

High usability is a supporting condition rather than a substitute for outcome evidence. A meta-analysis of digital tools for adolescent mental health promotion reported promising findings but continued to emphasize the roles of support, adherence, and implementation setting (Wright et al., 2023). Another review found that effects of digital interventions on several mental health outcomes may be small or nonsignificant and that engagement reporting is often limited (Raeside et al., 2024). More recent meta-analytic evidence likewise indicates small post-intervention effects, moderated by age and intervention duration (Takizawa et al., 2026). Accordingly, the high acceptance scores in this study are treated as a prerequisite for subsequent effectiveness testing rather than as evidence that resilience has already improved.

The hybrid intelligent architecture contributes by separating classification from intervention logic. Random Forest is used for nonlinear pattern recognition, whereas explicit expert-system rules preserve the traceability of recommendations. This arrangement allows counselors to review, modify, and contextualize automated outputs. The human-in-the-loop principle is particularly important when system outputs concern mental health support. Recent studies show that users recognize the potential of AI agents to expand access but continue to express concerns about empathy, safety, privacy, and professional replacement; most still prefer human involvement (Lee et al., 2025). Clinicians' evaluations of AI-generated psychological advice likewise show that technical quality does not eliminate issues of trust and perceptions of information sources (Foyen et al., 2025). Counselor oversight in this system therefore represents a substantive safety mechanism rather than merely a usability feature.

Limitations and Future Development

This study has several limitations. The empirical implementation involved only 60 Grade XI students from two classes and three counselors, limiting generalizability to other schools, regions, and developmental levels. The implementation evidence is primarily descriptive and does not yet include a completed causal-effectiveness analysis. Operational system–counselor agreement cannot replace independently reproducible evaluation of the Random Forest model because the model-development pipeline is incompletely documented in the available research records. Usability and acceptance are self-report measures that may be influenced by novelty and social desirability, while claims concerning cybersecurity and data governance require technical auditing beyond expert perceptions. Future research should complete pretest–posttest or

comparative evaluation, independently validate the Random Forest pipeline, assess fairness across subgroups, and formalize alert, referral, override, and data-retention procedures. Findings from a feasibility trial of a school mental health program in Indonesia further underscore the importance of evaluating local contextual feasibility before broader implementation (Yani et al., 2026).

CONCLUSION

This study successfully developed and conducted a limited implementation of a Hybrid Intelligent Resilience Support System for Grade XI students at SMA Negeri 13 Medan. The system integrates a structured seven-dimension assessment, Random Forest classification, a rule-based expert system, protected data storage, a monitoring dashboard, and counselor validation. Needs analysis indicated strong demand for technology-assisted psychological services; the 23-item instrument demonstrated high internal consistency, expert validation was very strong, and implementation fidelity reached 95.8%. Student profiles showed that 28.3% were in the low category, 45.0% in the moderate category, and 26.7% in the high category. Formative evidence showed 91.7% system–counselor agreement, a macro-F1 score of 0.919, an SUS score of 81.38, positive student responses, and high counselor ratings of overall response, practicality, and usefulness. These findings support the system's feasibility, usability, and readiness as a decision-support tool in the tested context. However, the study has not established a causal increase in resilience; broader implementation requires completion of outcome evaluation, independent machine-learning validation, and stronger governance of privacy, fairness, and counselor oversight.

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