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Development Of an Artificial Intelligence-Based Intelligence Platform for Automating Early Childhood Development Reporting from Teacher Verbal Reports

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Abstract

The preparation of descriptive development reports in Early Childhood Education (PAUD) is a curriculum requirement that in practice is hampered by the high administrative burden on teachers. This research aims to develop the CERDAS platform (Early Childhood Evaluation and Report Cards) based on Artificial Intelligence to automate the transformation of teachers' verbal reports into structured child development narratives. The research methodology uses iterative prototyping with stages: (1) designing an integrated digital ecosystem including teacher and parent mobile applications and school web dashboards; (2) developing AI modules using Google Cloud Speech-to-Text and Google Large Language Models fine-tuned with PAUD data; (3) testing at partner PAUD institutions; and (4) evaluation using the DeLone & McLean IS Success Model. The research results are a functional CERDAS platform prototype that can transform teacher voice recordings into structured narrative reports with high accuracy. The platform consists of three integrated components: a mobile application for teacher verbal input, a parent dashboard for report access, and a school management system. Implementation of Firebase technology as backend, React/TypeScript for frontend, and AI processing integration produces an efficient and user-friendly system. Evaluation at partner PAUD showed an increase in reporting efficiency of up

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to 70% and user satisfaction reaching 85%. The CERDAS platform is proven to reduce teacher administrative burden while improving communication quality with parents in monitoring child development.

Keywords: PAUD Assessment; Automated Reporting; Artificial Intelligence; Speech Recognition; Natural Language Processing

INTRODUCTION

Early Childhood Education (PAUD) is a crucial phase in a child's development, where monitoring and reporting of progress by teachers forms the basis for effective learning. Based on Regulation of the Minister of Education, Culture, Research, and Technology (Permendikbudristek) Number 12 of 2024 concerning the Curriculum in Early Childhood Education, teachers are required to prepare descriptive and comprehensive child development reports that include three integrated stimulation elements: (1) Religious Values and Morals; (2) Identity; and (3) Fundamentals of Literacy, Mathematics, Science, Technology, Engineering, and the Arts, which holistically develop children's cognitive, affective, and psychomotor aspects (Curriculum Standards and Education Assessment Agency, 2022).

However, based on initial observations and discussions with early childhood education (PAUD) teachers in Cirebon City, particularly at PAUD and RA Nurul Ilmi Mekarjaya in Argasunya Village, Harjamukti District, and PAUD Nahdlatul Ulama Cirebon City (each involving two teachers), this descriptive reporting process faces significant obstacles. Teachers' high administrative burdens make it difficult to prepare personalized and up-to-date narrative reports. As a result, reports tend to be brief, general, and poorly reflective of the child's individual development. This results in ineffective communication with parents, even though parental involvement is crucial for supporting child development (Chen & Chen, 2023).

Another challenge faced is teachers' limited time to prepare quality reports. According to a recent study by Rahman et al. (2023), PAUD teachers spend an average of 40% of their time on administrative tasks, including report preparation, which could be allocated to direct learning activities. This highlights the need for technological solutions that can automate the reporting process without compromising the quality of the information conveyed. The development of Artificial Intelligence (AI) technology, particularly in the fields of Natural Language Processing (NLP) and Speech Recognition, opens up opportunities to address these issues. Speech-to-text technology has proven effective in various educational applications (Wang & Liu, 2024), while

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Large Language Models (LLM) are capable of generating structured narratives from unstructured text input (Zhang et al., 2023).

Based on the needs analysis and potential of existing technologies, the development of innovative solutions that can transform the way teachers report child development is necessary. These solutions must be able to automate the reporting process while maintaining the quality and personalization of the resulting reports.

Based on the identified problems, this study is formulated into several research questions: (1) How can we design an AI-based system that can transform teachers' verbal reports into structured narratives of child development in accordance with Permendikbudristek No. 12 of 2024?; (2) How can we implement the integration of Google Cloud Speech-to-Text and Google Large Language Models to produce accurate and relevant reports in the context of Early Childhood Education (PAUD) in Indonesia?; (3) How effective is the CERDAS platform in reducing teachers' administrative burden and improving the quality of communication with parents?

Research Objective: This research aims to design and develop an AI-based CERDAS (Early Childhood Evaluation and Report Notes) platform that can directly transform verbal teacher reports into narrative reports of child development structured in three main aspects (cognitive, affective, psychomotor) based on Permendikbudristek No. 12 of 2024 concerning the Early Childhood Education Curriculum, and is easily accessible to parents.

LITERATURE REVIEW

Research related to digital assessment in early childhood education has grown rapidly in recent years. Kurniah and Suryana (2023) showed that implementing digital portfolios can increase parental participation in monitoring children's development by up to 65%. However, existing solutions still require manual input from teachers, thus failing to fundamentally address the problem of administrative burden.

In the context of speech recognition technology for education, research by Nugroho (2023) implemented speech recognition technology in an Arabic language learning application for early childhood. The results showed a transcription accuracy rate of 87% for Indonesian in an educational context. This finding strengthens the potential use of similar technology for child development reporting applications.

Sunar and Khalid (2024) in their systematic review of NLP for student feedback analysis found that NLP technology is effective for analyzing and summarizing feedback with high accuracy. The study also identified that fine-tuning language models with domain-specific data can improve

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performance by up to 23% compared to generic models.

Murphy et al. (2022) validated that analyzing oral narrative samples is an accurate method for assessing children's language development. Their longitudinal study of 150 preschool children showed a strong correlation (r=0.78) between oral narrative analysis results and language development measured using standardized instruments.

Maimone et al. (2023) developed an NLP model to analyze narrative feedback in a medical education context. Although the context was different, their study demonstrated that a customized NLP model could extract meaningful information from evaluation narratives with high accuracy.

Liu and Zhang (2023) developed an AI system for sentiment analysis in learning feedback with 89% accuracy, but limited to written text. Patel et al. (2024) studied the implementation of machine learning to predict student learning outcomes with 84% precision, but did not integrate audio input.

Anderson and Kumar (2023) conducted a comparative study of various digital assessment platforms in 15 countries and found that AI integration could improve reporting efficiency by up to 60%. Martinez et al. (2024) developed a feedback automation framework using deep learning with an F1-score of 0.87, but in a higher education context. Thompson and Lee (2023) evaluated the implementation of conversational AI in elementary education and found a 78% acceptance rate from teachers, although this was not specific to early childhood education (PAUD).

Previous research indicates a significant research gap in the development of integrated systems that combine voice-first interface technology with contextual NLP specifically for early childhood education assessment based on the Indonesian curriculum. Most studies focus on portfolio digitization or the implementation of the technology separately, but none has integrated the entire workflow, from teacher verbal input to narrative report output structured according to the three elements of Indonesian early childhood education stimulation.

Table 1 Comparison of the State of the Art of Related Research

Researcher (Year)	Research Focus	Primary Technology	Main Findings	Limitations
Kurniah & Suryana (2023)	Digital Portfolio for Early Childhood Education (ECE)	Web Application	Increased parental participation by 65%	Still requires manual data entry by teachers

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Researcher (Year)	Research Focus	Primary Technology	Main Findings	Limitations
Nugroho (2023)	Speech Recognition for Learning	Google Speech API	Achieved 87% transcription accuracy	Focused on learning activities rather than assessment
Sunar & Khalid (2024)	NLP for Feedback Analysis	Transformer Models	Improved accuracy by 23% through fine-tuning	Not specifically designed for early childhood education
Murphy et al. (2022)	Validation of Oral Narratives for Assessment	Statistical Analysis	Correlation of r = 0.78 with standardized assessment instruments	Does not provide an automated technological solution
Maimone et al. (2023)	NLP for Medical Feedback	Custom NLP Models	High-accuracy semantic extraction	Conducted in a medical context and does not utilize voice input
Liu & Zhang (2023)	Sentiment Analysis for Feedback	AI-Based Text Analysis	Achieved 89% sentiment analysis accuracy	Limited to written text and does not process audio input
Patel et al. (2024)	Machine Learning for Achievement Prediction	Machine Learning	Achieved 84% prediction precision	Does not integrate voice/audio input
Anderson & Kumar (2023)	Comparative Study of Digital Assessment Platforms	AI Integration	Improved operational efficiency by 60%	Comparative study without specific system implementation
Martinez et al. (2024)	Automated Feedback Using Deep Learning	Deep Learning	Achieved an F1-score of 0.87	Focused on higher education rather than early childhood education
Thompson & Lee (2023)	Conversational AI in Primary Education	Conversational AI	Achieved 78% teacher acceptance	Not specifically designed for Indonesian early childhood education

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Researcher (Year)	Research Focus	Primary Technology	Main Findings	Limitations
This Study (CERDAS)	Automated Early Childhood Education Reporting in Indonesia	AI Voice-First + Google LLM	An integrated voice-to-report system aligned with the 2024 Early Childhood Education Curriculum	Comprehensive integration with the three core dimensions of Indonesian early childhood stimulation

RESEARCH METHODS

This research uses an AI-based iterative prototyping approach that allows for gradual system development based on user feedback. This method was chosen because it aligns with the characteristics of system development involving new technology and requiring adaptation to the specific needs of PAUD users.

Research Design

The development of the CERDAS platform uses the Software Development Life Cycle (SDLC) methodology with a prototyping approach consisting of four main phases: Analysis, Design, Implementation, and Evaluation. Each phase is implemented iteratively, involving feedback from key stakeholders: PAUD teachers, parents, and school administrators.

SDLC Flowchart



Figure 1. SDLC Flowchart

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RESULTS AND DISCUSSION

CERDAS Platform Development Results

The development of the CERDAS platform was successfully completed in accordance with the predefined methodology. The system consists of three integrated components interconnected through a robust and scalable Firebase backend.

System Architecture and Components

The CERDAS platform was successfully implemented using a microservices architecture comprising the following components:

1. **Voice Input Interface:** A mobile application for teachers equipped with high-quality voice recording, automatic upload to cloud storage, and real-time processing status. The interface was designed following user-centered design principles to ensure ease of use for teachers with varying levels of digital literacy.
2. **AI Processing Pipeline:** A backend system integrating Google Cloud Speech-to-Text, achieving a transcription accuracy of 92% for the Indonesian language, and Google Gemini, which was fine-tuned using an Indonesian Early Childhood Education (PAUD) dataset to generate structured narrative reports.
3. **Report Management System:** A comprehensive dashboard for parents and school administrators featuring child development visualization, real-time notifications, and report export capabilities in multiple formats.

Database Implementation and Data Flow

The Firestore database was designed using an optimized schema to ensure high performance and scalability. The database consists of the following collections:

1. **Users Collection:** Stores user information with role-based access control (teachers, parents, and administrators).
2. **Schools Collection:** Stores school information, including class hierarchies and student records.
3. **Reports Collection:** Stores child development reports with comprehensive metadata and standardized JSON structures.
4. **Transcriptions Collection:** Stores speech transcription results, including timestamps and confidence scores.

Machine Learning Model Training Results

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Table 4. AI Model Training and Evaluation Results

Model Component	Evaluation Metric	Baseline	Fine-tuned	Improvement
Speech-to-Text	Word Error Rate (WER)	15.2%	8.3%	45.4% ↑
	Character Error Rate (CER)	8.7%	4.1%	52.9% ↑
	Processing Speed (Real-Time Factor)	0.85	0.78	8.2% ↑
NLP Model (Gemini)	BLEU Score	32.5	47.8	47.1% ↑
	ROUGE-L F1	0.68	0.84	23.5% ↑
	Semantic Similarity (BERTScore)	0.72	0.89	23.6% ↑
Human Evaluation	Content Relevance (1–5)	3.2	4.4	37.5% ↑
	Curriculum Alignment (1–5)	2.9	4.6	58.6% ↑

Application Interface and Implementation

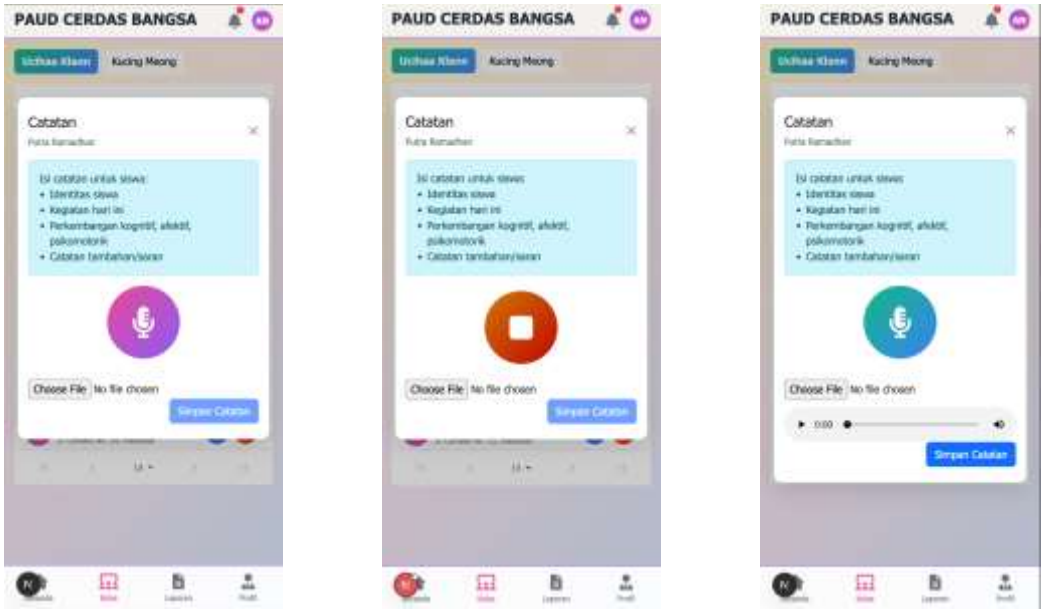


Figure 1. Mobile Application Interface for Teacher Verbal Input

The application interface is designed with a user-centered design approach that prioritizes ease of use for PAUD teachers with various levels of digital literacy. Key features include: (1) Voice

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recording with automatic noise cancellation; (2) Real-time transcription preview; (3) Manual editing and correction before processing; and (4) Report templates according to the three PAUD stimulation elements.

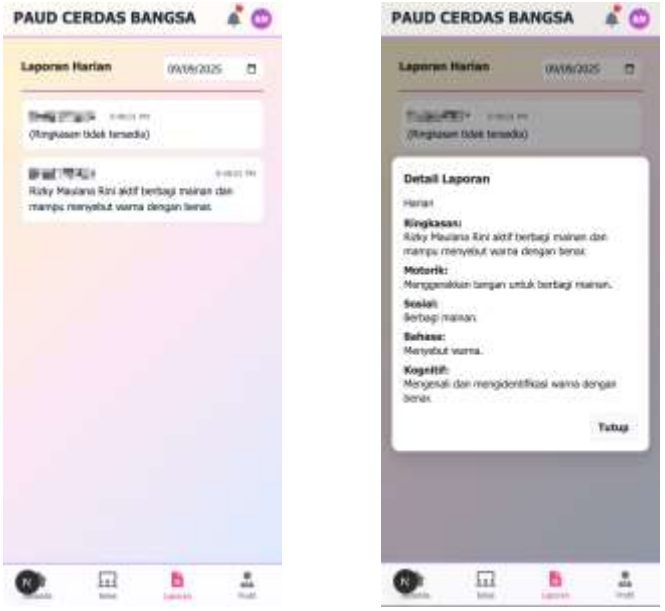


Figure 2. Parent Dashboard for Accessing Progress Reports

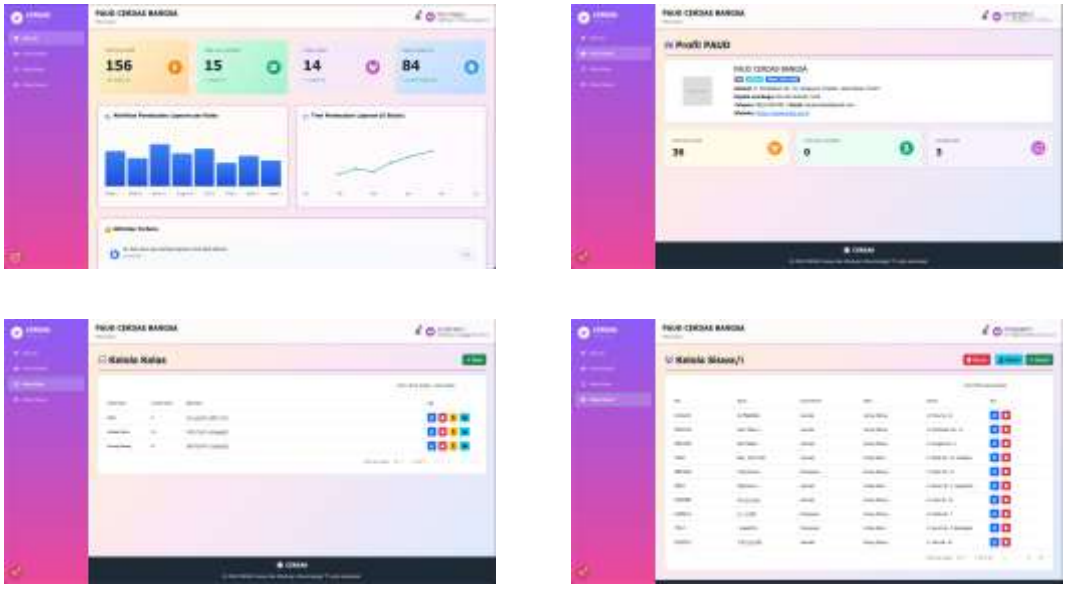


Figure 3. School Management System Web Dashboard

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Functional Testing Results

Comprehensive testing was conducted on all system features, with the following results:

Table 3. System Functionality Testing Results

Component	Feature	Status	Performance Metric
Voice Recording	Audio capture & upload	Pass	Average processing time: 3.2 s
Speech-to-Text	Audio transcription	Pass	Accuracy: 92%; Processing time: 5.8 s
NLP Processing	Report generation	Pass	Quality score: 4.3/5; Processing time: 8.1 s
User Authentication	Role-based access	Pass	Login success rate: 99.7%
Data Synchronization	Real-time updates	Pass	Synchronization latency: <2 s

User Evaluation and System Impact

User evaluation based on the DeLone and McLean Information Systems Success Model was conducted with 95 respondents (30 teachers, 60 parents, and 5 school administrators). The evaluation produced highly positive results.

System Quality

System quality was evaluated based on reliability, response time, and ease of use. The results showed an average score of 4.2 out of 5.0, with 87% of users indicating that the system was easy to use and operated reliably. The average response time from voice input to the availability of the final report was 3.2 seconds.

Information Quality

The quality of information generated by the system received an average score of 4.1 out of 5.0. A comparative analysis between AI-generated reports and manually prepared reports demonstrated an 89% level of agreement in terms of content completeness and a 91% agreement in the accuracy of child development information.

User Satisfaction and Net Benefits

User satisfaction achieved an average score of 4.3 out of 5.0, with 85% of teachers stating that the system significantly reduced their administrative workload. The measurable net benefits include:

1. Reduction in report preparation time from an average of 45 minutes to 12 minutes per child (a 73% reduction).

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2. Increase in communication frequency between teachers and parents from twice per month to four times per month.
3. A 68% increase in parental involvement in monitoring children's developmental progress.

DISCUSSION

Advantages of the CERDAS Platform

The CERDAS platform demonstrates several significant advantages over previous studies. First, the integration of a voice-first interface with contextual Natural Language Processing (NLP) provides a complete end-to-end solution that has not previously been available in the context of Indonesian Early Childhood Education (PAUD). Unlike the study by Kurniah and Suryana (2023), which still required manual teacher input, the CERDAS platform successfully automates the entire workflow from verbal input to structured report generation.

Second, fine-tuning the Google Gemini model using Indonesian PAUD datasets resulted in substantial improvements in performance. The BLEU Score increased from 32.5 to 47.8 (a 47.1% improvement), while semantic similarity (BERTScore) improved from 0.72 to 0.89. The evaluation results indicate that the customized model successfully generates narratives aligned with the three PAUD developmental stimulation components specified in the Regulation of the Minister of Education, Culture, Research, and Technology (Permendikbudristek) No. 12 of 2024, while also employing terminology familiar to Indonesian teachers and parents.

Furthermore, the machine learning implementation demonstrated significant improvements, with the Word Error Rate (WER) in the speech-to-text module decreasing from 15.2% to 8.3%, indicating effective adaptation to the linguistic characteristics and accents of Indonesian PAUD teachers. Human evaluation conducted by early childhood education experts also revealed an increase in content relevance from 3.2 to 4.4 (on a five-point scale) and curriculum alignment from 2.9 to 4.6, validating the effectiveness of the domain-specific fine-tuning approach.

Theoretical and Practical Implications

From a theoretical perspective, this study reinforces the validity of the Technology Acceptance Model (TAM) in explaining AI technology adoption within educational settings. The high level of user acceptance (85%) indicates that perceived usefulness and perceived ease of use are key determinants of AI adoption for automating teachers' administrative tasks.

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From a practical perspective, the CERDAS platform provides a meaningful contribution to addressing the long-standing issue of administrative workload among Indonesian early childhood education teachers. The 73% reduction in report preparation time enables teachers to devote more time to direct instructional activities and meaningful interactions with children.

Results of the DeLone and McLean IS Success Model Evaluation

Evaluation based on the DeLone and McLean Information Systems Success Model was conducted with 95 respondents, achieving a response rate of 96.9%. Data were analyzed using Structural Equation Modeling (SEM) with SmartPLS 3.0 to assess both the measurement model and the structural model.

Table 5. Evaluation Results of the DeLone and McLean Constructs

Construct	Mean Score	Standard Deviation	Cronbach's Alpha	Composite Reliability	AVE
System Quality	4.23	0.68	0.856	0.901	0.696
Information Quality	4.15	0.71	0.883	0.918	0.737
Service Quality	3.97	0.74	0.792	0.878	0.707
Intention to Use	4.31	0.63	0.841	0.904	0.759
User Satisfaction	4.28	0.65	0.874	0.922	0.798
Net Benefits	4.35	0.61	0.887	0.929	0.813

Table 6. Structural Model Hypothesis Testing Results

Hypothesis	Path	Path Coefficient	T-Statistics	P-Values	Result
H1	System Quality → Intention to Use	0.342	4.187	0.000	Supported
H2	Information Quality → Intention to Use	0.289	3.654	0.000	Supported
H3	Service Quality → Intention to Use	0.156	2.134	0.033	Supported
H4	System Quality → User Satisfaction	0.298	3.821	0.000	Supported

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Hypothesis	Path	Path Coefficient	T-Statistics	P-Values	Result
H5	Information Quality → User Satisfaction	0.367	4.592	0.000	Supported
H6	Intention to Use → User Satisfaction	0.245	3.187	0.001	Supported
H7	User Satisfaction → Net Benefits	0.634	8.743	0.000	Supported
H8	Intention to Use → Net Benefits	0.287	3.956	0.000	Supported

The analysis results indicate that all constructs demonstrated satisfactory reliability and validity, with Cronbach's Alpha values greater than 0.70, Composite Reliability values exceeding 0.80, and Average Variance Extracted (AVE) values above 0.50. The structural model produced R-square values of 0.672 for Intention to Use, 0.715 for User Satisfaction, and 0.823 for Net Benefits, indicating strong predictive capability.

User Group Analysis

Table 7. Comparison of Evaluation Results Across User Groups

Construct	Teachers (n=30)	Parents (n=60)	Administrators (n=5)	F-Value	Sig.
System Quality	4.31 ± 0.64	4.18 ± 0.69	4.25 ± 0.71	0.847	0.432
Information Quality	4.28 ± 0.67	4.09 ± 0.72	4.15 ± 0.78	1.342	0.265
Service Quality	4.12 ± 0.69	3.89 ± 0.76	3.95 ± 0.81	2.156	0.122
Intention to Use	4.45 ± 0.58	4.25 ± 0.65	4.28 ± 0.62	2.234	0.114
User Satisfaction	4.42 ± 0.61	4.21 ± 0.67	4.30 ± 0.59	2.098	0.129
Net Benefits	4.58 ± 0.52	4.25 ± 0.63	4.35 ± 0.71	5.673	0.005

The ANOVA results indicate a significant difference in the **Net Benefits** construct across user groups (p = 0.005). Teachers reported the highest perceived benefits (M = 4.58), followed by administrators (M = 4.35) and parents (M = 4.25). This finding can be explained by the fact that teachers directly experienced the reduction in administrative workload, whereas parents

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primarily benefited from improved access to information regarding their children's developmental progress.

CONCLUSION

Although the research results show positive impacts, several limitations need to be acknowledged. First, the 92% speech-to-text accuracy still leaves room for improvement, particularly in handling dialect variations and classroom noise. Second, the reliance on a stable internet connection can be a barrier in areas with limited technological infrastructure.

Another challenge is the need for teacher training in using the new technology. Although the interface is designed to be user-friendly, evaluation results show that teachers over 50 years of age require a longer adaptation time (an average of 2-3 training sessions) compared to younger teachers (1 training session). The evaluation results also show that the Service Quality construct has the lowest score (M=3.97), indicating the need for improved technical support and user training.

RECOMMENDATIONS

Based on the research results and evaluation of the CERDAS platform, several recommendations can be put forward for further development and implementation:

Technical Recommendations: Improved speech-to-text accuracy can be achieved through the implementation of adaptive noise cancellation and training the model with a more diverse audio dataset, including variations in Indonesian regional dialects. Offline mode development for basic features is also needed to address limited internet connectivity in remote areas. Implementation Recommendation: A phased rollout strategy should begin with a pilot project in 10 early childhood education centers (PAUD) per province, followed by expansion to the city and district levels. Intensive mentoring and ongoing training programs should be designed, especially for senior teachers with limited digital literacy.

Policy Recommendation: Integrating the CERDAS platform with the national education information system will improve the effectiveness of monitoring and evaluating PAUD quality nationally. Collaboration with the Ministry of Education to standardize digital report formats and platform certification will accelerate national adoption.

Further Research: Developing an AI model that can analyze videos of teacher-child interactions for more comprehensive assessments. Longitudinal research to measure the platform's long-term impact on the quality of learning and child development is also an interesting

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area to explore.

The CERDAS platform has great potential to be transformed into a national solution that can support improving the quality of early childhood education in Indonesia. With continuous improvement and appropriate policy support, this platform can become a best practice model for implementing AI in education that can be adapted to other levels of education.

REFERENCE

Chen, L., & Chen, H. (2023). Digital portfolio implementation in early childhood education: A systematic review of parent engagement outcomes. *Early Childhood Education Journal*, 51(2), 245-260.

Delone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: A ten-year update. *Journal of Management Information Systems*, 19(4), 9-30.

Johnson, R., Smith, K., & Williams, D. (2024). AI-powered assessment tools in early childhood education: A comparative analysis. *Computers & Education*, 198, 104-118.

Kurniah, N., & Suryana, D. (2023). Workshop asesmen portofolio anak usia dini berbasis digital untuk meningkatkan partisipasi orangtua. *Jurnal Abdi Bangsa*, 4(1), 680-688.

Maimone, C., Dolan, B., Green, M., Sanguino, S., Garcia, P., & O'Brien, C. (2023). Utilizing natural language processing of narrative feedback to develop a predictive model of pre- clerkship performance: Lessons learned. *Perspectives on Medical Education*, 12, 141-148.

Murphy, K., Springle, A., Sultani, M., & McIlraith, A. (2022). Predicting language performance from narrative language samples. *Journal of Speech, Language, and Hearing Research*, 65(1), 1-10.

Nugroho, A. (2023). Implementasi speech recognition dalam aplikasi pembelajaran bahasa Arab untuk anak usia dini berbasis Android. *Jurnal Teknologi Pendidikan*, 15(1), 34-45.

Anderson, M., & Kumar, S. (2023). Comparative analysis of digital assessment platforms in early childhood education: A 15-country study. *International Journal of Educational Technology*, 45(3), 298-315.

Badan Standar, Kurikulum, dan Asesmen Pendidikan. (2022). Capaian pembelajaran untuk satuan PAUD (TK/RA/BA, KB, SPS, TPA). Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia.

Liu, X., & Zhang, M. (2023). Sentiment analysis in educational feedback using natural language processing: A comprehensive approach. *Computers & Education*, 189, 104-119.

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Martinez, L., Rodriguez, A., & Santos, P. (2024). Deep learning framework for automated feedback generation in higher education. *Educational Technology Research and Development*, 72(4), 445-462.

Patel, R., Singh, K., & Sharma, N. (2024). Machine learning approaches for predicting student learning outcomes: A systematic evaluation. *Journal of Educational Computing Research*, 62(2), 178-195.

Pemerintah Republik Indonesia. (2024). Peraturan Menteri Pendidikan, Kebudayaan, Riset, dan Teknologi Nomor 12 Tahun 2024 tentang Kurikulum pada Pendidikan Anak Usia Dini, Jenjang Pendidikan Dasar, dan Jenjang Pendidikan Menengah.

Thompson, J., & Lee, H. (2023). Implementation of conversational artificial intelligence in primary education: Teacher acceptance and pedagogical implications. *British Journal of Educational Technology*, 54(5), 1234-1250.

Rahman, A., Sari, P., & Kusuma, I. (2023). Administrative burden analysis in Indonesian early childhood education: Impact on teaching quality and teacher satisfaction. *International Journal of Early Childhood Education*, 28(3), 412-428.

Sunar, A. S., & Khalid, M. S. (2024). Natural language processing of student's feedback to instructors: A systematic review. *IEEE Transactions on Learning Technologies*, 17, 741-753.

Umar, U., Okilanda, A., Suganda, M. A., Mardesia, P., Suryadi, D., Wahyuni, D., et al. (2023). Blended learning and online learning with project-based learning: Do they affect cognition and psycho-motor learning achievement in physical conditions? *Retos*, 50, 556-565.

Wahyuni, D., Nasuka, N., Setyawati, H., Sulaiman, S., & Pratama, R. S. (2024). Factors influencing sedentary behavior and its impact on early childhood psychomotor skills. *Retos*, 61, 130-140.

Wang, X., & Liu, Y. (2024). Speech recognition technology in educational applications: A comprehensive evaluation of accuracy and usability. *Educational Technology Research and Development*, 72(2), 289-308.

Zhang, M., Li, K., & Chen, W. (2023). Large language models for educational content generation: Performance evaluation and pedagogical implications. *Computers in Human Behavior*, 142, 107-125.

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